Papers on anthropology

VII

PAPERS ON ANTHROPOLOGY
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Prof. Juhan Aul
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PREFACE

This collection is dedicated to the centenary of Prof. Juhan Aul (1897–1994), the founder of the Estonian school of anthropology. His well-known statements about the role of anthropology among other sciences and his long-lasting anthropological investigations earned Estonian anthropology its remarkable reputation. Estonian anthropologists, experts with fundamental education in a number of specialities, have united to the Centre for Physical Anthropology at the University of Tartu. This is an interdisciplinary institution with the aim to develop and teach physical, medical, sports and historical anthropology. It also organises graduate studies and refresher courses for students and specialists of different specialities.

Anthropometric measurements of schoolchildren and adults are continually carried out in the Republic of Estonia. Their results are related to health, nutrition and other issues; the availability of modern statistical methods has made it possible to introduce anthropological methods in present-day research and practice.

Permanent co-operation between the anthropologists of different countries is needed to perfect the compilation of the human body model. We thank all the authors for their contributions to this collection.

We expect our co-operation to continue in the following collection.

Organising Board of the Conference

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Anthropologische Forschungen in Eesti.

JUHAN AUL.

Ungeachtet dessen, dass schon im XVIII Jahrhundert ein paar, den physischen Habitus des Esten berührende Abhandlungen erschienen, könnten wir den Anfang unserer anthropologischen Forschung doch zurückführen zum Jahr 1814, in welchem die Inaugusal-Dissertation C. E. v. Baers[1], in welcher der Autor es für angebracht findet unter Anderem auch eine anthropologische Beschreibung des Esten zu geben, erschien.

Während des folgenden Halbjahrhunderts erscheinen noch mehrere derartige Beschreibungen (A. Hueck[2], G. Schultz[3], J. v. Holst[4], A. Schrenck[5] u. a.). Das wesentlichste historische Interesse von diesen verdienen vielleicht diejenigen von A. Hueck und J. v. Holst, von welchen in der ersteren zum ersten Mal die Estenschädel, in der zweiten die Estenfrau behandelt werden.

Unter dem Einfluss der in Westeuropa zu gleicher Zeit zur Blüte gelangten kraniologischen Schule, aber teils auch vom Bedürfnis die Lücken auszufüllen, welche die vergleichende Kraniologie bezüglich der Esten aufdeckte, erscheint nun eine Reihe spezieller Arbeiten über den Schädel des Esten oder dessen Teile (H. Welcker[6], P. Broca[7], P. Topinard[8], H. Meyer[9], H. Witt[10] u. a.). Es sei bemerkt, dass es P. Broca war, welcher uns auf Grund der an vier (!) Estenschädeln gefundenen Nasenindexgrösse in die Gruppe der mongolischen Völker stellt und dass P. Topinard es sich

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1) Carolus Ernestus Baer, De morbis inter Esthonos endemicis. Diss. inaug. Dorpati MDCCCXIV.

2) A. Hueck, De craniis Esthonum commentatio anthropologica. Dorpati 1838.

3) G. Schultz, Bericht über Messungen an Individuen von verschiedenen Nationen zur Ermittelung der menschlichen Körperverhältnisse. — Bulletin de la classe physico-mathématique de l'Academie Imp. des sc. de St.-Petersbourg. T. IV.

4) J. v. Holst, Die Estin in gynäkologischer Beziehung. — Beiträge zur Gynäkologie u. Geburtskunde. II Heft. Tübingen 1867.

5) A. Schrenck, Studien über Schwangerschaft, Wochenbett und Geburt bei der Estin. Dorpat 1880.

6) H. Welcker, Craniologische Mittheilungen. Arch. für Anthropologie I Bd. Braunschweig 1866.

7) P. Broca, Recherches sur l'indice nasal. Revue d'Anthropologie. T. I. Paris 1872. pag. 35.

Ders., Classification et nomenclature craniologique d'après les indices cephaliques. Revue d'Anthropologie. Paris 1872. p. 423.

8) P. Topinard, Du Prognathisme alvéolo-sous-nasal. Revue d'Anthropologie. T. I. Paris 1872. pag. 661.

9) H. Meyer, Beiträge zur Kenntnis der Estenschädel. Archiv f. Anthropologie. Bd. 8, Braunschweig 1875.

10) H. Witt, Die Schädelform des Esten. Dorpat 1879.

erlaubt uns auf Grund der an denselben Schädeln gemessenen Grösse des Prognathismus zwischen die indo-europäischen und mongolischen Völker zu stellen. Auf die Irrtümlichkeit dieser Ergebnisse werden wir später zurückkommen.

Einen Schritt vorwärts in der Geschichte unserer anthropologischen Forschung bezeichnet das Jahr 1878, in welchem O. Grubes[1] anthropologische Untersuchung über die Esten erschien. Dieses ist die erste Arbeit, in welcher der Versuch gemacht wird, auf Grund entsprechender Messungen — wenn man die Versuche von G. Schultz an vier Esten nicht berücksichtigt — ein objektives Bild vom physischen Habitus des Esten zu geben. Obgleich Grubes Messungstechnik in Manchem der gegenwärtigen nicht entspricht, auch die Anzahl der Gemessenen — welche ausserdem einem engbegrenzten Gebiet (Mittel-Tartumaa) entstammen — nur 100 beträgt und die Bearbeitung der Daten den Anthropologen nicht befriedigt, ist Grubes Arbeit dennoch für seine Zeit modern und bietet auch gegenwärtig interessante Daten über den rassischen Bestand des Kreises Tartumaa. Was aber gleichfalls Beachtung verdient, ist die These Grubes: an jeder Hochschule sei ein besonderer Lehrstuhl für Anthropologie.

Von den Fortschritten der folgenden Jahre wäre hervorzuheben der Versuch die Frage des Wuchses (Körperlänge) der Esten mit dem der anderen Völker des russischen Reiches vergleichend zu behandeln. Im Jahre 1889 bringt D. Anutschin[2] Längenmasse, welche in der Zeit von 1874 bis 1883 von den in der russischen Armee dienenden Esten genommen wurden und im Jahre 1894 und 1895 erscheinen von A. Charuzin[3] Angaben gleichen Inhalts über aus Nord-Eesti stammende Esten.

Zur Neige des Jahrhunderts und zu Beginn des gegenwärtigen Jahrhunderts entwickelt der Privatdozent R. Weinberg[4] in Tartu eine lebhafte anthropologische Tätigkeit, indem er eine Reihe eingehender Spezialforschungen, besonders osteologischer Art, sowie eine übersichtliche Zusammenfassung über die anthropologische Stellung der Esten veröffentlicht. Unter anderem beschrieb R. Weinberg (1903 und 1905) einen in Wõisiku gefundenen Schädel, welcher in die jüngere Steinzeit gehört und der erste derartige aus dem Ostbaltikum ist.

Im Jahr 1914 gibt C. M. Fürst[5] eine Beschreibung und anthropologische Analyse der bei Kõljala in Saaremaa gefundenen neolithischen Menschenknochen.

Aus der Zeit der staatlichen Selbständigkeit verdient zunächst die im Jahre 1926 veröffentlichte anthropologische Forschung über Esten von R. Villems[6] erwähnt zu werden. Obwohl dieses Werk keine speziellen anthropologischen Fragen berührt, gibt es dem Anthropologen eine Reihe objektiver Daten in Form von Messungsergebnissen, welche auf moderner Messungstechnik beruhen und verdient daher volle Anerkennung als ein grosser Fortschritt in der Klärung unserer allgemeinen rassischen Fragen.

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1) O. Grube, Anthropologische Untersuchungen an Esten. Dorpat 1878.

2) D. Anutschin, Über die geographische Verbreitung d. Körpergrösse der männl. Bevölkerung Russlands (russ.). Sapiski der k. russ. geograph. Gesellschaft. Abt. Statistik. VII. 1889.

3) A. Charuzin, Zur Anthropologie der Bevölkerung des Gouvernement Estland (russ.). Jahrbuch d. Gouv. Estland. Buch I. 1894. S. 287. II. 1895. S. 225

4) R. Weinberg, Ueber einige Schädel aus älteren Liven, Letten u. Esten Gräber. — Sitz. Ber. d. Gel. Estn. Ges. 1896.

Ders., Der Bau des Grosshirns bei Esten, Letten u. Polen (russ.). — Anthr. sec. d. Kaiserl. Ges. Freunde d. Naturw., Anthropol. u. Ethnol. 1898.

Ders., Vaterländische anthropol. Studien. I. Körpergrösse estnischer Rekruten. — Sitzungsber. Gel. Estn. Ges. 1902.

Ders., Die anthropologische Stellung d. Esten. — Zeitsch. f. Ethnol. 35. Jahrg. 1903.

Ders., Der Schädel von Woisek. — Sitz. Ber. d. Naturf.-Ges. b. d. Universität Dorpat 1905.

5) C. M. Fürst, Neolithische Schädel von der Insel Oesel. — Baltische Studien zur Arch. u. Gesch. Riga. 1914.

6) R. Villems, Zur Anthropologie der Esten. Manuskript, Tartu 1926.

Im selben Jahr erscheint von Prof. G. S o m m e r[1] eine kurze Übersicht über die Anthropologie der Esten; im Jahr 1933 erscheint eine Arbeit gleichen Inhalts von J. A u l[2]. In letzterer befinden sich zum ersten Mal zeitgemässe metrische Daten auch über die estnische Frau. J. Aul hat auch einige vorläufige Mitteilungen über seine anthropologischen Forschungen in Saaremaa und Viljandimaa veröffentlicht. Im vorigen Jahr erschien von ihm unter anderem eine Beschreibung, der bei uns in letzter Zeit gefundenen neolithischen Menschenknochen. 1931 besorgte H. R e i m a n[3] den Druck der Forschungsresultate von R. Villems in die estnische Sprache. G. M i c h e l s s o n[4] versucht die Resultate der an unserem Militär ausgeführten Längenmessungen anthropologisch zu verwerten. A. F r i e d e n t h a l[5] (1931) beschreibt die in die ältere Bronzezeit gehörenden Skelette aus Nord-Eesti. Im Jahre 1932 untersucht S. E h r h a r d t[6] in Viljandimaa die Bewohner des Kirchspiels Kõpu und veröffentlicht später eine diesbezügliche Beschreibung. Einige Beiträge zur Anthropologie liefern auch die Arbeiten von H. M a d i s s o o n[7] (über das Gehirngewicht der Esten und über das Alter der Menarche bei Esten), die Forschungen von G. R o o k s[8] und Anderen über die Blutgruppen der Esten und die Zusammenfassung von A. L ü ü s[9] über die Körpermasse neugeborener Esten. Zu vermerken ist, dass auch unsere Geographen, Ethnographen, Archäologen und Historiker der Anthropologie wertvolles Material geliefert haben.

Aber trotz alledem und auch ungeachtet dessen, dass sich so zahlreiche Forscher, darunter mehrere bekannte Namen, mit unserer Anthropologie beschäftigt haben, besteht bis in die letzte Zeit d e r Z u s t a n d, d a s s m a n u n s a n t h r o p o l o g i s c h f a l s c h o d e r s e h r m a n g e l h a f t k e n n t, u n d d i e s e s n i c h t n u r i n d e r F a c h l i t e r a t u r, s o n d e r n a u c h k a r t o g r a f i s c h u n d i n d e n L e h r b ü c h e r n.

Diese Erscheinung ist dadurch bedingt, dass die älteren Angaben, auf welche sich die diesbezüglichen Übersichten gründen, zu mangelhaft, um nicht zu sagen

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[1]) G. S o m m e r, Die Esten (estn.). — Sammelwerk „Eesti". Tartu 1926. a.

[2]) J. A u l, Die Esten (estn.). — Eesti Entsüklopeedia, II Bd. Tartu 1933.

D e r s., Quelques données sur l'Anthropologie des Sõrviens. Tartu Ülikooli j. o. Loodusuurij. Seltsi Aruanded XXXV, 3—4, Tartu 1929.

D e r s., Über den anthropol. Einfluss des Weltkrieges auf die Saaremaaner (estn. mit franz. résumé). — Tartu Ülikooli j. o. Loodusuurij. Seltsi Aruanded XL (3—4), Tartu 1933.

D e r s., Zur Frage der Rassenkreuzung im Bereiche des europiden Rassenkreises. — Zeitschr. f. Rassenkunde. Bd. II, Stuttgart 1935.

D e r s., Übersicht über die Anthropologie des Kreises Viljandimaa (estn.). — Sammelwerk Eesti V, Viljandimaa, Tartu 1935.

D e r s., Etude anthropologique des ossements humains néolithique de Sope et d'Ardu. — Õpetatud Eesti Seltsi aastaraamat 1933. Tartu 1935.

D e r s., Über die Körpergrösse des estnischen Mannes (estn. mit engl. résumé). — Eesti Loodus, nr. 2. Tartu 1936.

[3]) H. R e i m a n, Über die rassische Zusammensetzung des estnischen Volkes (estn.). Tartu 1931.

[4]) G. M i c h e l s s o n, Die Körpergrösse der Esten. — Zeitschr. f. Morphologie u. Anthropologie, Bd. XXVII. H. 3.

[5]) A. F r i e d e n t h a l, Ein Beitrag zur vorgeschichtlichen Anthropologie Estlands. — Zeitschr. f. Ethnologie, 63. Jahrg. 1931.

[6]) S. E h r h a r d t, Die Rassenzusammensetzung des estnischen Volkes. — Volk u. Rasse, 8. Jahrg. München 1933.

[7]) H. M a d i s s o o n, Über d. Alter d. Menarche bei Esten (estn. mit franz. résumé). — Eesti Arst, Tartu 1926.

D e r s., Einige Daten über die Schwere des Gehirnes bei den Esten (estn.). — Vaba Sõna nr. 9, Tartu 1925.

[8]) G. R o o k s, Zur Verteilung der Blutgruppen und die Aussichten zur Bestimmung der Paternität mittels der Blutgruppen in Eesti (estn.). Manuskript, Tartu 1932.

[9]) A. L ü ü s, Données anthropologiques sur les nouveaux-nés estoniens. — Acta et Commentationes Univ. Tartuensis A. XXIX. 7, Tartu 1936.

Fig. 1. Verzeichnis der anthropologischen Einheiten (Kirchspielen) Eestis nach Kreisen (zu den Karten Fig. 2—6).

Saaremaa

1. Jamaja
2. Anseküla
3. Lümanda
4. Kihelkonna
5. Mustjala
6. Kärla
7. Nord-Kaarma (Loona)
8. Süd-Kaarma
9. Püha
10. Valjala
11. Süd-Karja (Pärsama)
12. Nord-Karja (Leisi)
13. Jaani
14. Pöide
15. Muhu

Läänemaa

16. Emmaste
17. Käina
18. Pühalepa
19. Reigi
20. Varbla
21. Hanila & Karuse
22. Mihkli
23. Vigala
24. Lihula & Kirbla
25. Martna
26. Ridala
27. Noarootsi
28. Lääne-Nigula
29. Kullamaa
30. Märjamaa

Pärnumaa

31. Tõstamaa
32. Audru
33. Pärnu-Jaagupi
34. Tori
35. Vändra
36. Käru (Nord-Vändra)
37. Uulu & Reiu
38. Häädemeeste
39. Laiksaare & Talli (SW-Saarde)
40. Saarde
41. Halliste
42. Karksi

Harjumaa

43. Risti & Madise
44. Keila
45. Nissi
46. Hageri
47. Nord-Rapla
48. Süd-Rapla
49. Juuru
50. Kose
51. Jüri
52. Harju-Jaani
53. Jõelehtme
54. Kuusalu

Järvamaa

55. Ambla
56. Järva-Madise
57. Anna & Nord-Türi
58. Süd-Türi
59. Paide & Peetri
60. Koeru
61. Järva-Jaani

Virumaa

62. Haljala
63. Kadrina
64. Rakvere
65. Väike-Maarja
66. Simuna
67. Viru-Jaagupi
68. Viru-Nigula
69. Lüganuse
70. Jõhvi
71. Nord-Iisaku
72. Süd-Iisaku
73. Vaivara

falsch, oder so speziellen Inhalts, so fragmentarisch, oder lokalkoloristisch sind, oder weiter sich auf so geringe Daten stützen, dass sie von uns keinerlei einheitliche und richtige Darstellung zu geben vermögen. Das Letztere gilt auch bezüglich der neueren Arbeiten. Zum Teil geht aber diese Erscheinung auch aus der Entwicklung der Anthropologie selbst hervor. Denn die moderne Anthropologie ist bei Weitem nicht mehr dasselbe, wie diejenige des vergangenen Jahrhunderts, sogar nicht die der vergangenen Jahrzehnte. Für die moderne Anthropologie hat die „weisse Rasse" aufgehört zu existieren. Sie ist zur Rassengruppe geworden, und die Anthropologie muss aufklären, welcherlei weisse Rassen und in welchem Masse diese für gewisse Volkskörper — wir reden von europäischen Verhältnissen — von Wichtigkeit sind. Die moderne Anthropologie muss auch die im Volkskörper vorkommenden Rassenverwandtschaften und deren Genese aufklären. Dieses sind s y s t e m a t i s c h e Fragen im naturwissenschaftlichen Sinne des Wortes, deren Behandlung aber zahlreiche und vielseitige Daten und die in der Systematik gebräuchlichen Methoden erfordert.

Demnach war es einleuchtend, dass wir planmässig zu einer weitgreifenden Datensammlung schreiten mussten, um die Lücken in der Wissenschaft auszufüllen, deren Ausfüllung zu unseren patriotischen Aufgaben und internationalen Verpflichtungen gehört.

Was haben wir denn getan oder schaffen können?

W i r h a b e n e i n g e h e n d r u n d 12000 e r w a c h s e n e M ä n n e r, ü b e r 2000 S c h u l k i n d e r u n d n a h e a n 600 e r w a c h s e n e F r a u e n g e m e s s e n; w i r h a b e n d i e G r u n d l a g e f ü r u n s e r e a n t h r o p o l o g i s c h e B i l d e r s a m m l u n g g e l e g t, w i r h a b e n e i n e S a m m l u n g a u s g e g r a b e n e r m e n s c h l i c h e r S k e l e t t e g e s c h a f f e n. Eine grosse Arbeit ist eingeleitet.

Dieses Material halte ich noch für ungenügend, um zu endgültigen Zusammenfassungen zu schreiten, aber es ist dennoch ein solches, welches ein diesbezügliches Allgemeinbild zu erhalten ermöglicht. Veränderungen, welche die Ergänzungsdaten, deren Sammlung gegenwärtig im Gang ist, in dieses Allgemeinbild bringen, sind bestimmt nicht gross und auch nicht von wesentlicher Bedeutung.

Welches ist nun das Allgemeinbild unseres anthropologischen Bestandes?

Vor allen Dingen müssen wir uns dessen bewusst sein, dass u n s e r V o l k e i n ä h n l i c h e s M i s c h v o l k i s t, w i e a l l e V ö l k e r E u r o p a s. Dieses ist, ohne spezielle Forschung, *a priori* klar. Denn wie das übrige Europa, so ist auch unser Land kein „verschlossener Kontinent", der durch grosse Wasserflächen, riesige Gebirgsketten oder unwegsame Wälder und Moore so abgeschlossen ist, dass das Volk sich hier reinrassig erhalten oder entwickeln könnte.

Und in der Tat, wir kennen in unserem Gebiet Völkerwanderungen schon 2000 Jahre v. Chr., um welche Zeit aus Mitteleuropa hierher wahrscheinlich indoeuropäische Völker eindringen. Diese vertreiben die Aborigenen teils nach Osten, teils siedeln sie sich unter diesen an, um sich zum Schluss endgültig mit ihnen zu

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V i l j a n d i m a a

74. Nord-Põltsamaa
75. Süd-Põltsamaa
76. Kolga-Jaani
77. Pilistvere
78. O-Suure-Jaani
79. W-Suure-Jaani
80. Viljandi
81. Kõpu
82. Paistu
83. Tarvastu

T a r t u m a a

84. Avinurme
85. Torma
86. Laiuse
87. Kursi
88. Palamuse
89. Äksi
90. Maarja-Magdaleena
91. Kodavere
92. Tartu
93. Rannu
94. Rõngu
95. Puhja
96. Nõo
97. Otepää
98. Kambja
99. Võnnu

V a l g a m a a

100. Helme
101. Sangaste
102. Karula & Hargla

V õ r u m a a

103. Urvaste
104. Kanepi
105. Nord-Põlva
106. Süd-Põlva
107. Räpina
108. Mõniste & Roosa
109. Rõuge
110. Nord-Vastseliina
111. Süd-Vastseliina

P e t s e r i m a a

112. Lobotka
113. Petseri
114. Irboska

verschmelzen. Zu Ende der Bronzezeit (ca. 500 Jahre v. Chr.) sind an unsere Küsten, wahrscheinlich aus Skandinavien, in beschränkter Anzahl germanische Ansiedler gekommen, die sich aber gleichfalls mit den Eingeborenen vermischt haben. Im ersten Jahrhundert n. Chr. entsteht in Nord-Eesti, besonders in Virumaa, eine Reihe ostgermanischer — gotischer — Ansiedlungen, welche im fünften Jahrhundert, teils durch den Abzug der Germanen, teils durch Verschmelzung mit der einheimischen Bevölkerung, wieder verschwinden. In dem Zeitraum vor dem Verlust der Selbständigkeit finden wir unsere Vorfahren im öfteren kriegerischen aber auch kaufmännischen Kontakt mit ihren Nachbarn — den Letten, Litauern, Russen und Skandinaviern — was die Entstehung einer besonderen aus Gefangenen gebildeten Sklavenschicht nach sich zog, welche durchaus nicht geringen Umfanges war, später aber, im XIV und XV Jahrhundert, soviel sie sich noch erhalten hatte, sich endgültig in die einheimische Bevölkerung auflöste. Im XIII Jahrhundert beginnt die, rund 1½ Jahrhundert andauernde Besiedelung unserer Nordküste durch die Schweden. Nachkommen dieser Schweden befinden sich noch gegenwärtig auf den Inseln Pakri und Wormsi, in Noarootsi u. s. w. Ein Teil der Schweden verschmolz aber mit den Esten. Ungefähr um dieselbe Zeit beginnt die Besiedelung der Ufer des Peipsi Sees durch Russen. Gegen Ende der Ordenszeit, während der Periode der grossen Kriege (im XVI und XVII Jahrhundert), wird das Land verheert; grosse Gebiete, besonders in Mittel-Eesti, werden menschenarm, stellenweise sogar menschenleer, was eine Kolonisierung der leeren Gebiete zur Folge hat. So kommen zum Beispiel nach Alutaguse Russen, die hier grosse Gebiete besiedeln. Im Festlandgebiet von Süd-Eesti waren in den Jahren 1638/41 nach den Revisionsbüchern 15,8% oder $^1/_6$ der Bevölkerung fremdstämmige Einwanderer, hauptsächlich Finnen, Russen, Polen, Schweden und Letten. Nach Nord-Eesti kamen Finnen. Der nordische Krieg mit seiner langen Dauer (1700—1721) und mit seinen Verheerungen, verursachte gleichfalls eine starke Bevölkerungsabnahme, was später aber durch Kolonisierung ausgeglichen wird. Eine Bereicherung unseres Volkes mit einem rassischen Fremdkörper bedeutet in gewissem Masse auch der Weltkrieg durch das Hierbleiben vieler aus Russland stammender Völkerelemente und durch die aus den Mischehen der Optanten hervorgegangenen Kinder. Letztere Erscheinung tritt besonders in den Städten zu Tage.

Andererseits müssen wir bekennen, dass die Völker Nordeuropas, ersterhand in dem Gebiet, welches wir unter dem Namen Baltoskandia kennen, rassisch kein allzukompliziertes Gewebe haben.

Wie es diesbezügliche Untersuchungen bei unseren Nachbarvölkern erweisen, haben wir es hier mit zwei Rassen zu tun: mit der ostbaltischen und mit der nordischen Rasse. Die nordische Rasse charakterisiert bekanntlich ein hoher und schlanker Wuchs, längliche (dolichocephale) Kopfform, langes und schmales Gesicht, schmale, im Profil gerade oder gekrümmte Nase, zurückweichende Stirn und weisse, oftmals rosaschattierte Haut. Das Hauptverbreitungsgebiet dieser Rasse ist Skandinavien. Der Typus der ostbaltischen Rasse ist von mittlerem Wuchs, kräftigem, etwas untersetztem Körperbau, breitschultrig, mittelköpfig (mesocephal) oder mit einer Neigung zur Kurzköpfigkeit, mit niedrigem und breitem Gesicht, breiter, im Profil gerader oder eingebuchteter Nase, steilerer Stirn und mit weisser, zuweilen gräulichgelblich schattierter Haut. Kommt hauptsächlich östlich vom Baltischen Meer vor, wovon auch der Name. Was sowohl der nordischen als auch der ostbaltischen Rasse gemeinsam ist und was dadurch anthropologisch auch das ganze Baltoskandien charakterisiert, sind die hellen Färbungstöne: die blauen bis grauen Augen und das helle (blonde bis braune) Haar.

Zur Betrachtung unserer Daten übergehend, können wir zunächst feststellen, dass u n s e r V o l k h e l l f a r b i g ist und deshalb vollkommen in den Rahmen des Nordeuropa charakterisierenden anthropologischen Bildes hineinpasst.

Behandeln wir zunächst die Haarfarbe. Diese ist bei der vorwiegenden Mehrzahl der Esten hell: Hellfarbige, d. h. Blonde bis Hellbraune (diese mitgerechnet) waren unter den Gemessenen 71,8%, Dunkelhaarige (Braune bis Schwarzbraune) aber nur 28,2%. Bei eingehenderer Unterscheidung erhalten wir folgende Verhältniszahlen: hellblondes und rotblondes Haar (Fischers Farbenskala Nr. 2—3 und 13—20) finden wir 3.3%, blondes (Nr. 21—24) 28,2%, dunkelblondes (Nr. 9—12) 17,9%, hellbraunes (Nr. 7—8) 22,4%, braunes (Nr. 6) 19,8%, dunkel-

Fig. 2. Die Verteilung der hellen Haarfarbe in Eesti.

braunes (Nr. 5) 7,3% und schwarzbraunes (Nr. 4) 1,1%. — In Schweden gibt es bekanntlich 72,7% helles Haar, unter den Norwegern 67,3% und in Südwest-Finnland 46,1%, in Lettland sind Blonde 56% und „Brünette" 36%.

Ebenso wie die Esten hellhaarig sind, sind sie auch helläugig. Rein hellfarbige Augen (blaue und graue in verschiedener Schattierung) haben 78,0%. Zählt man zu diesen auch die Personen mit hellmelierten (gelblichgrünen und mit Blau und Grau gemischten) Augen, deren Prozent 11,2% beträgt, so steigt die Anzahl der Helläugigen auf 89,2%. Braunäugige (hell- bis dunkelbraun) sind nur 6,6%. Zählen wir zu diesen auch die Personen mit dunkelmelierten (einer Mischung von Braun mit Hell) Augen, deren Prozent 4,2 ausmacht, so erhalten wir Dunkeläugige 10,8%. — In Schweden findet man braune Augen 5,0%, in Norwegen 7,0%, in Finnland 7,4%, in Lettland (Braun mit Mischfärbung) 9,1% (im Wendenschen Kreise).

Ein grosses Interesse bietet uns das Bild von der Verteilung der Färbungen nach den Ortsgebieten. Die Verbreitung der Haarfärbung zeigt eine merkliche Gesetzmässigkeit (Fig. 2). Dunkles Haar ist verbreitet im westlichen Küstengebiet und auf den Inseln (ausgenommen Muhumaa), teilweise im östlichen Teil Mittel-Eestis (in Nõo, Palamuse und Maarja-Magdaleena) und in besonders grossem Masse in Südwest-Eesti (im südlichen Teil der Kreise Pärnumaa und Viljandimaa sowie im nördlichen Teil des Kreises Valgamaa). Nord-Eesti (besonders Harjumaa) und das Zentrum von Nordwest-Eesti (Nord-Pärnumaa und Ost-Läänemaa) sind verhältnismässig rein-hellhaarig, ebenso auch Järvamaa (ausgenommen das Kirchspiel Koeru). Ein weiteres Kerngebiet von Hellhaarigen ist Südost-Eesti: Süd-Tartumaa, Võrumaa (ausgenommen das Kirchspiel Rõuge und der nördliche Teil des Kirchspiels Vastseliina) aber insbesondere der Kreis Petserimaa.

Die Verbreitung der Augenfärbung fällt im grossen und ganzen mit der Verbreitung der Haarfärbung zusammen (Fig. 3): Nord-, Nordwest- und Südost-Eesti sind helläugig, die Inseln (wiederum Muhumaa ausgenommen), teilweise das westliche Küstengebiet, das östliche und stellenweise das südliche Mittel-Eesti sind dunkeläugig. Doch gibt es auch Abweichungen. Wir könn-

Fig. 3. Die Verteilung der hellen Augenfarbe in Eesti.

ten nach der Haarfärbung urteilend, auf den Inseln mehr Dunkeläugige erwarten, auf der Insel Hiiumaa entspricht das hellhaarige Gebiet dem dunkeläugigen Gebiet und vice versa, im westlichen Küstengebiet ist nur der nördliche Teil von Läänemaa und der südliche von Pärnumaa dunkeläugig. In Südwest-Eesti ist sowohl der westliche als auch der östliche Festlandsteil hell- und nur das Zentrum dunkeläugig. Abweichungen in Einzelheiten kommen vor in Tartumaa; in Virumaa ist der Prozentsatz und das Verbreitungsgebiet der Braunäugigen viel grösser als man dieses nach der Haarfärbung erwarten könnte.

Wenn man nun zur Betrachtung der Körperhöhe oder des Körperwuchses übergeht, so muss man die Esten als ein hochwüchsiges Volk bezeichnen. Die mittlere Höhe der Gemessenen beträgt 172,08 cm. In Berücksichtigung dessen, dass die mittlere Höhe des Mannes für Europa auf 165 cm geschätzt wird und dabei Männer über 170 cm für „lange“ und über 180 cm für „sehr lange“ gehalten werden, ist die Bezeichnung „hochwüchsig“ für die Esten vollkommen berechtigt. Am besten können wir uns davon überzeugen, indem wir die Länge der Esten mit der seiner nächsten Nachbarn vergleichen: die Länge der Liven beträgt 174,18 cm, der Schweden 172,23 cm, der Finnen 170,91 cm, der Russen 167,19 cm, der Letten 171,3 cm, der Litauer 166,2 cm, der Deutschen (aus Preussen) 168,2 cm, der Polen 167,7 cm, der Dänen 169,32 cm u. s. w.

Schon früher ist bemerkt worden, dass der Wuchs bei uns in den östlichen Reichsteilen niedriger ist als in den westlichen. Unsere gegenwärtigen Daten bestätigen dieses vollkommen. Als mittlere Länge erweist sich:

für Saaremaa	173,3 cm	für Tartumaa	171,7 cm
Läänemaa	173,2 „	Viljandimaa	171,3 „
Pärnumaa	172,9 „	Valgamaa	171,3 „
Tallinn	172,6 „	Virumaa	171,3 „
Harjumaa	172,3 „	Võrumaa	171,0 „
Järvamaa	172,1 „	Petserimaa	170,1 „

Dementsprechend wären die längsten Esten die Bewohner von Saaremaa. In Wirklichkeit müssten wir für die längsten wohl die Bewohner des festländischen

Fig. 4. Die Verteilung der Körperhöhe in Eesti.

Läänemaa (Mittel 173,4 cm) halten, dass aber die Bewohner von Saaremaa in der Länge diejenigen von Läänemaa übertreffen, ist dem Umstande zuzuschreiben, dass die Bewohner Muhumaas im Vergleich mit den eigentlichen Bewohnern Saaremaas lang, und die Bewohner Hiiumaas im Vergleich mit denen des festländischen Läänemaas kurz sind (Fig. 4). In jedem Fall bleibt für uns Saaremaa das Gebiet der Langwüchsigen, was besonders betont werden muss, weil die ausländische Literatur (Lundborg und Linders, 1926) noch immer Saaremaa als den Ursprungsort der Kurzwüchsigen bezeichnet. Im übrigen ist aber der Wuchs in Saaremaa recht variabel: im Zentrum kurz, im Westen lang. Die Kreise Läänemaa und Pärnumaa kann man gleichfalls als „unruhig" bezeichnen. In Läänemaa ist, wie schon bemerkt, die Insel Hiiumaa und hier besonders das Kirchspiel Emmaste, kurzwüchsiger als das festländische Läänemaa. Die nördlichen Küstengebiete und das Zentrum (die Kirchspiele Kirbla und Martna) des zuletzt genannten Gebietes weisen einen recht hohen Wuchs (über 175 cm) auf; Kurzwüchsigen begegnen wir hier nur im Kirchspiel Mihkli. In Pärnumaa ist der nordwestliche Teil (besonders Tõstamaa) und das ganze Küstengebiet langwüchsig. Kurzwüchsige trifft man im nordöstlichen und südlichen Teil (Laiksaare und Talli). In den anderen Kreisen ist der Wuchs weniger schwankend. In Harjumaa begegnen wir relativ Langwüchsigen nur noch im Kirchspiel Nissi. In der Mehrzahl der Fälle schwankt hier in den Kirchspielen der Wuchs zwischen 172 und 173 cm. In Järvamaa finden wir Langwüchsige im Zentrum des Gebietes (besonders in den Kirchspielen Paide und Peetri). In Viljandimaa ist der nördliche Teil im Allgemeinen etwas langwüchsiger als der südliche. In Letzterem finden wir aber im Kirchspiel Paistu ein Gebiet der Langwüchsigsten (172 cm), „Nester" von Kurzwüchsigen in Nord-Viljandimaa finden sich in Kolga-Jaani und stellenweise in Nord-Põltsamaa. Von den östlichen Kreisen ist Tartumaa am langwüchsigsten. Das Gebiet der Allerlängsten sind hier die Kirchspiele Kursi, Rannu, Nõo und Tartu, relativ kurzen Wuchs finden wir in Avinurme, Torma, Rõngu und Otepää. In Virumaa ist das Zentrum (die Kirchspiele Rakvere und Viru-Jaagupi) langwüchsig. Herde für Kurzwüchsige sind hier teilweise Kadrina und grosse Gebiete in Alutaguse (Lüganuse, Jõhvi, Illuka u. a.). Einen einheitlichen Wuchs hat Valgamaa. Võrumaa ist schon recht

Fig. 5. Die Verteilung des Kopfindex in Eesti.

abwechslungsreich. In Nord-Võrumaa finden wir noch verhältnismässig hohen Wuchs (Kanepi und Nord-Põlva), im Süden (Rõuge) aber kommen die Allerkurzwüchsigsten vor. In Petserimaa, das unser kurzwüchsigster Kreis ist, finden wir den relativ kürzesten Wuchs in dessen südöstlichem Teil.

Von anderen rassischen Merkmalen möchte ich hier nur noch den Längen-Breiten-Index des Kopfes und den morphologischen Gesichtsindex behandeln.

Der Längen-Breiten-Index des Kopfes ist durchschnittlich 80,76. Indem wir als Grundlage für die Zergliederung dieses Index die Einteilung annehmen, nach der man Männer mit einem Längen-Breiten-Index des Kopfes bis 78 als langköpfige (dolichocephale), mit einem Index von 78—84 als mittelköpfige (mesocephale) und mit einem Index von 84 und darüber als kurzköpfige (brachycephale) bezeichnet, finden wir, dass 19,0% von den Gemessenen langköpfig, 63,4% mittel- und 17,6% kurzköpfig sind. Die Esten sind demnach mittelköpfig, mit schwacher Neigung zur Langköpfigkeit.

Wenn wir bezüglich des Längen-Breiten-Index des Kopfes uns mit unseren Nachbarn vergleichen, finden wir, dass unsere Nachbarn aus dem Norden, Osten und Süden einen grösseren Längen-Breiten-Index des Kopfes haben als wir, d. h. sie sind kurzköpfiger (bei den finnischen Kareliern ist dieser Index 81,67, bei den Russen 81,4, bei den Letten 81,3, bei den Litauern 81,5); unsere westlichen Nachbarn aber, die Skandinavier, haben einen niedrigeren Index als wir, sie sind langköpfiger (bei den Schweden ist dieser Index 77,69, bei den Norwegern 78,97).

Unser langköpfigstes Gebiet ist der nördliche Teil von West-Eesti (das festländische Läänemaa, Nord-Pärnumaa, sowie teilweise West-Harjumaa) und bis zu einem gewissen Grade auch Mittel-Eesti sowie Saaremaa. Eine diesbezügliche besondere Hervorhebung verdienen Muhumaa, Tõstamaa, Pärnu-Jaagupi und Vändra. Die Kurzköpfigen konzentrieren sich in folgende drei Zentren: in den Ostteil Nord-Eestis (Ost-Harjumaa, Nord-Järvamaa, Virumaa), das südöstliche Eesti (Valgamaa, Südost-Tartumaa, Võrumaa, und insbesondere Petserimaa), sowie in den südwestlichen Teil von Pärnumaa. Gleichfalls relativ kurzköpfige Gebiete sind Hiiumaa und das mittlere Saaremaa (Fig. 5).

Der morphologische Gesichtsindex, dessen arithmetisches Mittel 86,07 beträgt, zeigt, dass die Mehrzahl der Esten mittelgesichtig (mesoprosop) mit schwacher Neigung zur Schmalgesichtigkeit (Leptoprosopie) ist, denn 49,7% von allen sind mittelgesichtig (mit einem Index von 83—89); Langgesichtige (mit einem Index von 89 und darüber) finden sich 27,3%, breitgesichtige (mit einem Index bis 83) — 23%.

Die Verbreitung des morphologischen Gesichtsindex zeigt, dass die Bewohnerschaft von West-Eesti (besonders in Saaremaa und Läänemaa) schmalgesichtiger als die von Mittel- und Ost-Eesti ist.

Was kann man aus diesen Daten folgern?

Der Wuchs erlaubt die Annahme, dass bei uns das Element der nordischen Rasse recht stark vertreten sein könnte. Die Verbreitung des Wuchses zeigt, dass auf den Inseln, in Läänemaa, in West-Pärnumaa und Harjumaa der Anteil der nordischen Rasse den Anteil der ostbaltischen Rasse stark übertreffen müsste. Der Kopfform nach stehen wir im allgemeinen näher zur ostbaltischen als zur nordischen Rasse. Die Verbreitung des Längen-Breiten-Index des Kopfes erlaubt die Annahme einer starken Vertretung des nordrassischen Elements nur in Läänemaa (ausgenommen Hiiumaa), in West-Harjumaa und in ganz Zentral-Eesti.

Die Verbreitungsdaten der Gesichtsform weisen auf einen grösseren Anteilwert der nordischen Rasse in West-Eesti hin. Die Verbreitung der Haar- und Augenfärbung erlaubt die Annahme, dass in Nord-Eesti und teilweise auch in Nordwest-Eesti wir es mit einem Verbreitungszentrum der nordischen, in Südost-Eesti aber mit dem der ostbaltischen Rasse zu tun haben, aber gleichfalls auch, dass die dunkelfarbigen Rassenelemente bei uns in Mittel-Eesti und teilweise in Saaremaa vorherrschend vorkommen könnten.

Viel übersichtlicher gestaltet sich die Anteilbewertung der einzelnen Rassen wenn wir alle diese Merkmale im Zusammenhang an einem Individuum in Betracht ziehen und auf diese Weise die rassische Zugehörigkeit eines jeden festzustellen versuchen.

Zur Grundlage einer solchen Anteilbewertung wählte ich, da die schwedischen Daten am meisten den unsrigen entsprechen, die vom schwedischen Anthropologen H. Lundborg[1] eingeführte Rassentypen-Bestimmungsmethode. In drei Punkten weiche ich jedoch von seiner Methode ab: erstens berücksichtige ich die Grösse des morphologischen Gesichtsindex, zweitens schreibe ich den Vertretern der nordischen und ostbaltischen Rassentypen auch braune Haarfärbung zu und drittens unterscheide ich nur zwei dunkle Typen, nicht drei.

Ich unterscheide demnach folgende Rassentypen und in folgender Weise:

1. Alle Individuen mit hellem bis braunem Haar, mit hellen Augen, mit einem Wuchs von wenigstens 168 cm, mit einem Längen-Breiten-Index des Kopfes bis 78, wobei der morphologische Gesichtsindex wenigstens 84 sein muss, oder aber mit einem Längen-Breiten-Index des Kopfes bis 81 und einem morphologischen Gesichtsindex über 89, — alle diese Individuen zähle ich zum nordischen Rassentypus.

2. Individuen mit hellem bis braunem Haar, mit hellen Augen, mit einem Wuchs bis 173 cm, mit einem Längen-Breiten-Index des Kopfes über 80 und mit einem morphologischen Gesichtsindex bis 89 gehören zur ostbaltischen Rasse.

3. Individuen mit hellem bis braunem Haar, mit hellen Augen, aber deren andere Merkmale in, weder der nordischen noch der ostbaltischen Rasse eigener Kombination vertreten sind, nenne ich als Vertreter der hellen Mischtypen.

4. Individuen mit hellem Haar und braunen Augen, oder mit braunem Haar und dunklen Augen, oder aber mit dunkel- bis schwarzbraunem Haar und hellen Augen nenne ich dunkelfarbige oder dunkle Mischtypen.

5. Individuen mit dunkelbraunem bis schwarzbraunem Haar und mit dunklen Augen nenne ich dunkelfarbige oder dunkle Typen.

Eine Zusammenfassung der Resultate zeigt, dass summarisch an erster Stelle (32,7%), wie es auch zu erwarten war und was auch ganz natürlich ist, der helle Mischtypus steht. Da dieser Typus sich jedoch hauptsächlich aus den Elementen

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[1]) H. Lundborg a. F. I. Linders, The Racial characters of the Swedish Nation. Uppsala 1926.

der ostbaltischen und nordischen Rasse zusammensetzt und offenbar in derselben Proportion wie diese als reine Typen vertreten sind, so bleibt als Bewertungskriterium des Anteils der nordischen und ostbaltischen Rasse in unserem Volkskörper zunächst noch immer die Beziehung der genannten Typen zu einander. Eine diesbezügliche Zusammenfassung ergibt, dass von unserem Volk 29,2% ostbaltische Typen sind, aber Typen der nordischen Rasse 24,8%.

Demnach wäre das rassische Grundelement unseres Volkes die ostbaltische Rasse; gleichfalls zahlreich, wenn auch in etwas geringerer Anzahl, ist bei uns die nordische Rasse vertreten, wobei aber beide Rassen sich gründlich vermischt haben. Dunkelfarbige Rassen sind in grosser Minderzahl (13,3%).

Ebenso prägnant, wie von dem Verhältnis der genannten Rassentypen zu einander, können wir uns nun auch eine Vorstellung von deren ortsgebietlicher Verbreitung machen. Letzteres ist bekanntlich ausserordentlich wichtig, denn ohne eine Topographie (Anteilbewertung) der Rassentypen ist das Finden ihres genetischen Zusammenhangs, eine Verbindung der Gegenwart mit der Vergangenheit, unmöglich.

Wenn wir zunächst etwas bei der Betrachtung der Verbreitung unserer grundlegendsten Rassenelemente, der ostbaltischen und nordischen, verweilen, bemerken wir, dass diese nicht unregelmässig durcheinander geworfen sind, sondern Gebiete für sich bilden (Fig. 6).

Nord-Pärnumaa (beginnend mit Tori), das festländische Läänemaa und Ost-Harjumaa, Muhumaa sowie in grossem Masse Saaremaa sind recht stark überwiegend nordrassisch. In besonderem Masse gilt solches für Muhumaa, Tõstamaa, Pärnu-Jaagupi und Kirbla. Im genannten nordrassischen Gebiet finden sich ostbaltische Typen relativ häufig nur in Varbla, Vigala und Hageri, aber gleichfalls in Mittel-Saaremaa (besonders in Loona und Leisi) und in Sõrve.

Das Kernland der ostbaltischen Rasse bei uns sind Süd-Pärnumaa, Südost-Eesti (ausgenommen Põlva) sowie Nord-Eesti (ausgenommen Väike-Maarja) und Hiiumaa (Pühalepa ausgenommen, wo auch zahlreich das nordrassische Element vertreten ist). Besonders ostbaltisch ist das ganze Petserimaa, Otepää, Talli-Laiksaare sowie Ost-Alutaguse.

Mittel-Eesti, beginnend mit Halliste und Karksi im Süden und beschliessend mit den Kirchspielen Äksi, Nõo und Tartu im Osten sowie den Kirchspielen Peetri, Paide und Põltsamaa im Norden, ist ein mischrassiges Gebiet, in welchem abwechselnd mal das ostbaltische, mal das nordrassische Element vorwiegend ist.

In Betracht ziehend, dass während der jüngeren Steinzeit in den Gebieten, die gegenwärtig ostbaltisch oder überwiegend ostbaltisch sind (Lüganuse, Kolga-Jaani), die nordische Rasse vertreten war (Aul, 1935) und dass später, während der älteren Bronzezeit, an unserer Nordküste die nordische Rasse noch in grosser Überzahl war (Friedenthal, 1931), lässt sich annehmen, dass im Verlaufe der Zeiten die Rassenverhältnisse sich bei uns — entweder durch das Eindringen ostbaltischer Elemente in die nordische Rasse, dadurch den

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Fig. 6. Übersichtskarte der relativen Häufigkeit der Rassentypen in Eesti. Rot bezeichnet den nordischen, Blau den ostbaltischen Typus. In den Gebieten, wo Blau und Rot sich gemeinsam finden, sind die nordischen und ostbaltischen Typen mehr oder weniger gleichmässig (Unterschied bis 5%) vertreten; ist das Rot an erster Stelle, so prävaliert die nordische etwas, ist aber das Blau an dieser, so die ostbaltische Rasse. Ein roter resp. blauer Kreis bedeutet, dass nordische resp. ostbaltische Typen mit 5—10% die ostbaltischen resp. nordischen Typen übertreffen; zwei rote resp. blaue Kreise bedeuten, dass die entsprechende Rasse ein Übergewicht von 10—20%, drei Kreise, dass diese ein solches von 20—35% hat vier Kreise bedeuten ein Übergewicht der betreffenden Rasse von über 35%. Mit Schwarz sind bezeichnet die Gebiete, in denen dunkle Typen mit mehr als 15% vertreten sind, mit Lila — Gebiete, wo der helle Mischtypus mit über 40% vertreten ist.

Rückgang der Letzteren verursachend, oder durch eine Steigerung des Anteils der ostbaltischen Elemente aus anderen Gründen — geändert haben. Dass die nordische Rasse bei uns in früheren Zeiten stärker vertreten gewesen ist, ersieht man auch daraus, dass ihre gegenwärtige Verbreitung sich gerade auf die Gebiete erstreckt, die am besten durch natürliche Grenzen vor verheerenden Kriegszügen geschützt waren. Interessant ist, dass die später besiedelten Gebiete (Hiiumaa, Süd-Pärnumaa u. a.) ostbaltisch sind.

In welchem Masse die nordische Rasse im mischrassigen Gebiet von Mittel-Eesti als Relikt zu betrachten ist, oder in welchem Masse sie das Produkt einer Wiederbesiedelung ist, müssen zukünftige Forschungen klären. Die osteologischen Sammlungen, die wir aus diesem Gebiet besitzen, müssten diese Frage selbstverständlich beleuchten. Ebenso müssten die in Petserimaa ausgegrabenen osteologischen Funde die Frage zu lösen helfen, ob Südost-Eesti schon ursprünglich, seit alters her, ostbaltisch war, oder ob dieses eine sekundäre Erscheinung ist. Wahrscheinlich ist die erste Annahme richtiger.

Gehen wir jetzt an die Behandlung der Probleme der dunklen Typen. Den dunklen Typus findet man bei uns zerstreut in Saaremaa, besonders in dessen Strandgebieten, ferner in Läänemaa im Gebiet der schwedischen Besiedelung und in den Kirchspielen Mittel-Eestis (Karksi, Halliste, Helme, Kõpu, Viljandi, Rannu, Nõo, Tartu, Maarja-Magdaleena, Palamuse, Simuna, u. a.).

Da dieses Gebiete sind, die mehrfach sowohl von zufälligen Einwanderern aus Süd- und Westeuropa als auch (nach dem Russisch-Livischen Kriege) am ausgedehntesten von Fremdvölkern aus dem Süden besiedelt wurden, da bei uns besondere Zentren einer Ansammlung von dunklen Typen fehlen und solche auch bei unseren nächsten Nachbarn nicht vorhanden sind, da zugleich die dunklen Typen bei uns in den Gebieten, die verhältnismässig zahlreich ihre ursprüngliche Bewohnerschaft (Nordwest- und Südost-Eesti) erhalten haben, eine unbedeutende Rolle spielen — so ist es ersichtlich, dass die in Rede stehenden Rassenelemente ein Fremdkörper in unserem Volkskörper sind. Die beschränkte Anzahl und die Zersprengtheit der dunklen Typen hat ihre Assimilierung in dem Masse bedingt, dass sie beinahe nirgends bei uns als Vertreter erkannter Rassen auftreten. Aus diesem Grunde haben wir die erwähnten Typen vorläufig keiner anthropologischen Analyse unterzogen, sondern uns mit der Einteilung derselben in nur zwei Gruppen im Umfange der vorher genannten Bezeichnungen begnügt.

Früher teilten wir die Ansicht, dass unter den dunklen Typen die alpine Rasse an erster Stelle sein könnte. Gewiss könnte dieses örtlich der Fall sein, aber eine nähere Analyse, die ich stellenweise versuchte, scheint es nicht zu bestätigen. Sehr oft findet man dunkle Färbungen selbst bei lang- und schlankwüchsigen, bei langköpfigen und schmalgesichtigen Individuen, mit anderen Worten bei offensichtlich sonst nordrassischen Typen. Eine Analyse unserer dunklen Typen ist noch Zukunftsarbeit, bei welcher unsere Besiedelungshistoriker und Genealogen grosse Mitarbeit leisten können.

In Verbindung mit der Frage der dunklen Typen möchte ich hier die sogenannte Mongolen-Frage berühren. Noch gegenwärtig behaupten manche ausländische Lehrbücher, dass die Esten der mongolischen Rasse angehören. Da aber die mongoliden Menschenrassen dunkelfarbig sind und ausserdem noch eine Reihe spezifischer Merkmale (Hautfärbung, Haarwuchs, Mongolenfleck, Bau der Augenspalten, straffes Haar u. s. w.), die den Esten fehlen, besitzen, so ist es offensichtlich, dass diese Behauptung vollkommen unbegründet ist.

Es ist wahr, dass sich unter uns Individuen mit mongoliden Gesichtszugen, mongolide Typen, finden; dieses ist jedoch die Folge sekundärer Beeinflussung, da in unser Volk so manches mal tropfenweise — zuletzt noch während des grossen Weltkrieges — mongolide Rassenelemente gedrungen sind. Vermuten kann man, dass dieser Kontakt mit den mongoliden Elementen um so enger war, in je fernerer Vergangenheit dieser stattfand. Dieses ist selbstverständlich etwas ganz anderes, als eine systematische Zugehörigkeit des Volkes zur mongolischen Völkergemeinschaft und hat nichts Gemeinsames mit einem genetischen Zusammenhang unserer völkischen Grundrassen mit den mongoliden Rassen.

Weiter hat man die Aufmerksamkeit darauf gelenkt, dass viele Esten, ähnlich den Vertretern mongolider Rassen starke Backenknochen besitzen. Obwohl dieses der Tatsache entspricht, ist es dennoch bewiesen (R. Weinberg, 1903), dass

Fig. 7. Ostbaltische Rassentypen aus Eesti.

1. Lehrer, stammend aus Holstre. 2. Lehrerin, aus Nõo. 3. Redakteur und Lehrer, aus Wändra. 4. Lehrerin, aus Jamaja. 5. Lehrer, aus Tartu. 6. Landwirtin, aus Jamaja. 7. Landwirt, aus Kose. 8. Landwirt, aus Laiuse. 9. Schülerin, aus Holstre.

Fig. 8. Nordische Rassentypen aus Eesti.

1. Staatsmann und Professor, stammend aus Wiljandi. 2. Gymnasialdirektor und Staatsmann, aus Muhumaa. 3. Lehrer, aus Tarvastu. 4. Kapitän der Luftschiffahrt, aus Kose. 5. Bürgermeister und Arzt, aus Karula. 6. Landwirtin, aus Muhumaa. 7. Lehrer, aus Kanepi. 8. Landwirt, aus Pöide. 9. Seemann, aus Kihelkonna.

Fig. 6. ◌ — Lila, ◌ — Blau, ◌ — Rot, ● — Schwarz

der Bau unserer Backenbögen ein ganz anderer ist, als bei den Mongolen. Und wenn er auch derselbe wäre, würde es doch nichts ändern, denn jedem Systematiker ist es genügend bekannt, dass sehr unterschiedliche Arten, Rassen u. s. w. gemeinsame Merkmale haben können: eine gewöhnliche Konvergenzerscheinung. Auf Grund nur eines Merkmals kann man keine Folgerungen einer systematischen Zusammengehörigkeit ziehen.

Zum Abschluss der Übersicht unserer Arbeiten und deren Resultate möchte ich jetzt noch mit einigen Worten die anthropologischen Züge, welche den hier versammelten stammesverwandten Völkern gemeinsam sind, erwähnen. Was unsere Stammesbrüder aus dem Norden, die Finnen, anbelangt, so kann an unserer rassischen Ähnlichkeit, resp. Zusammengehörigkeit mehr kein Zweifel herrschen. Wie die finnischen Anthropologen (K. Hildén, F. W. Westerlund, J. Wilskman, N. Pesonen u. a.) bewiesen haben, ist auch in Finnland der häufigste Typus der ostbaltische, zu welchem sich der nordische gesellt; ebenso wie bei uns, sind auch dort die dunklen Typen in grosser Minderzahl.

Was nun unsere südlichen Stammesbrüder, die Ungarn, anbelangt, so ist unsere anthropologische Zusammengehörigkeit mit diesen entschieden geringer, aber das ostbaltische Element, welches dort nach den Forschungen von Prof. L. Bartucz ungefähr 35% ausmacht, ist dennoch ein Band, welches an unserer Blutsverwandtschaft keine Zweifel aufkommen lässt. In der Vergangenheit war dieses verbindende Band selbstverständlich viel grösser.

Als Folgerung des Genannten möchte ich betonen, dass unseren Anthropologen ein Arbeitsfeld mit vielen gemeinsamen Aufgaben offen steht!

Nicht zufällig hat man den Namen der ostbaltischen Rasse mit dem Namen der finnisch-ugrischen Völker verbunden. Das Verbreitungsgebiet unserer Völker ist ohne Zweifel das Kerngebiet, zum wenigsten ein Kerngebiet der Verbreitung der ostbaltischen Rasse. Zur Klärung dieser Rasse und zur Charakterisierung ihrer Typen ist aber doch nicht alles getan. Noch findet man in den diesbezüglichen Arbeiten und Diagnosen eine Reihe von Widersprüchen und Missverständnissen, noch gehen die Vorstellungen vieler Forscher über diese Rasse auseinander, bedingt durch den Umstand, dass die ostbaltische Rasse in der Tat in den verschiedenen Gebieten verschiedene Züge aufweist, aber auch dadurch, dass wir diese Rasse mit ihrer Vielseitigkeit noch wenig kennen.

Eine gemeinsame Aufgabe unserer Anthropologen ist es, die Formenvielheit der ostbaltischen Rasse zu klären!

Es ist mir eine besondere Freude hier betonen zu können, dass bisher auf diesem Gebiete sowohl die finnischen als auch die ungarischen Anthropologen Hervorragendes und allgemein Anerkanntes geleistet haben, was auch für unsere Arbeit von grossem Nutzen gewesen ist.

Jetzt hoffen auch wir an dieser grossen gemeinsamen Aufgabe und wertvollen Arbeit nach Kräften teilnehmen zu können.

Tartu Ülikooli Zooloogia-Instituudi ja -Muuseumi tööd. Nr. 19, Tartu, 1936.

Über den Sexualdimorphismus der anthropometrischen Merkmale von Schulkindern, Jugendlichen und Erwachsenen

Sexual dimorphism of anthropological characteristics of school children, adolescents and adults.

Von J. Aul, Tartu

I. Einleitung

Wissenschaftliches Interesse an den Geschlechtsunterschieden (Sexualdimorphismus) der Menschen reicht in ferne Zeiten zurück. An diesen Unterschieden begannen zuerst Anatomen, Ärzte und Künstler ein großes Interesse zu nehmen.

Genauere Kenntnisse über den Sexualdimorphismus der Menschen wurden uns aber erst dann zugänglich, als man die Geschlechtsunterschiede mittels Messungen zu ermitteln begann. Mit der Entwicklung der Anthropometrie wuchs auch das Interesse an dergleichen Untersuchungen, besonders als die wissenschaftliche Anthropologie diese Untersuchungen unter ihre Fittiche nahm und anthropologische Messungen auch an Schulkindern vorgenommen wurden.

Eine Kenntnis der geschlechtlichen metrischen Unterschiede von Frauen und Männern erwies sich für die Anthropologen als besonders notwendig. Ermöglicht doch die Kenntnis des genauen geschlechtlichen Unterschieds einzelner Körpermaße anthropologische Angaben von Frauen und Männern zusammen zu bearbeiten und somit das anthropologische Gepräge der Population wirklichkeitsgetreuer kennenzulernen. Es ermöglicht auch eine kritische Beurteilung der erhaltenen Daten und Literaturangaben. Wenn die geschlechtlichen Unterschiede eines anthropologischen Männer- und Frauenmaterials irgendeiner Population den *Standardwerten* nicht entsprechen, so ist das gegebene Männer- und Frauenmaterial untereinander nicht vergleichbar: die einen von ihnen oder sogar beide entsprechen nicht der Wirklichkeit. Eine exakte Kenntnis der Geschlechtsunterschiede ermöglicht auch einen genaueren Vergleich der Körperproportionen von Männern und Frauen.

Ärzte und Pädagogen erhalten ferner auf diesem Wege die Möglichkeit, Geschlechtsunterschiede in der physischen Entwicklung der Schuljugend genauer zu erfassen. Auch Sportler haben angefangen, Interesse für die anthropometrischen Unterschiede der Knaben und Mädchen zu zeigen. Ist es doch offensichtlich, daß mit diesen Unterschieden bei der Körpererziehung und sportlichen Auswahl gerechnet werden muß. Eine vielseitige Erforschung der Geschlechtsunterschiede ermöglicht es auch, einige allgemeinanthropologische Gesetzmäßigkeiten genauer kennenzulernen.

Mit all dem Gesagten ist es auch erklärlich, daß in letzter Zeit auf dem Gebiet der Altersanthropologie ununterbrochen Arbeiten erscheinen, um die Lücken auf diesem Wissensgebiet auszufüllen und die regionalen Erfordernisse des praktischen Lebens zu befriedigen.

Dabei kann aber nicht ungesagt bleiben, daß einiges in allen Ergebnissen dieser Untersuchungen noch unsicher ist. In erster Linie deshalb, weil gewöhnlich mit einem *ungenügenden (zu kleinen) Material gearbeitet wurde.* Was die Materialien der Erwachsenen betrifft, so leiden dieselben gewöhnlich auch unter *Fehlen der Einheitlichkeit* — die Angaben über die Männer- und Frauengesamtheiten sind meistens nicht vergleichbar.

Der Autor dieses Aufsatzes ist im Besitz von Materialien, deren Bearbeitung Ergebnisse brachte, welche die Fragen des Sexualdimorphismus bei Schulkindern, sowie auch bei Jugendlichen und Erwachsenen *präzisieren* dürften.

Es ist zweckmäßig, diese Fragen bei Schulkindern und Jugendlichen getrennt von denen der Erwachsenen zu behandeln. Im ersten Fall haben wir es mit einem großen dynamischen Prozeß — mit Wachstum und Entwicklung zu tun, bei den Erwachsenen reduziert sich dieser Prozeß auf ein Minimum. Bei ersteren — Schulkindern — haben wir es gewöhnlich mit einem mehr- oder weniger einheitlichem Material zu tun, das Material von Erwachsenen ist jedoch gewöhnlich ungleichartig und schwer vergleichbar.

II. Sexualdimorphismus bei den Schulkindern

Meine Arbeitsergebnisse basieren auf einem Material, das im Laufe der letzten 10 Jahre gesammelt wurde. Es wurden über 30 000 estnische Schüler und Schülerinnen im Alter von 7—18 Jahren gemessen. Ihre Einteilung nach Alter und Geschlecht ist in nachstehender Tabelle wiedergegeben:

Alter in Jahren	Anzahl der Gemessenen ♂	♀	Alter in Jahren	Anzahl der Gemessenen ♂	♀
7	623	626	13	1517	1517
8	1215	1205	14	1500	1476
9	1355	1300	15	1387	1465
10	1402	1373	16	1213	1276
11	1466	1419	17	970	1091
12	1538	1544	18	666	903

Für einige Merkmale ist die Anzahl der Gemessenen um ein weniges geringer. Es sei bemerkt, daß bezüglich der Siebenjährigen das Material verhältnismäßig gering ist, und die Angaben ihrer Maße kaum völlig real sind. Das Material der Siebzehn- und Achtzehnjährigen unterliegt gewissermasen einer *Auswahl* (denn ein Teil der Schüler — besonders der Jungen — war in diesen Jahren abgegangen), und daher entsprechen ihre Messungsangaben auch nicht in vollem Maße den Gleichaltrigen des ganzen Volkes.

Das Material wurde in den westlichen, wie auch den östlichen Regionen des Landes, einschließlich der Städte Tartu und Tallinn, gesammelt. Somit dürfte es vom Entwicklungsniveau der Schülerschaft ganz Estlands ein mehr oder weniger der Wirklichkeit entsprechendes Bild ergeben. Als Plus des Materials kann die Anzahl der Gemessenen gelten, die eine genügende Zuverlässigkeit garantiert, als Minus die geringe Anzahl der untersuchten Merkmale; der Arbeitsbedingungen wegen war es jedoch nicht möglich, mehr Messungen durchzuführen.

Welche Fragestellungen kommen nun bei der Bearbeitung des Materials der Schulkinder und Jugendlichen im Hinblick auf die Geschlechtsunterschiede in Betracht? Diese Fragen lauten wie folgt:

1. Geschlechtsunterschiede des Wachstumsniveaus einzelner Merkmale und ihre Veränderung mit dem Alter.
2. Wachstumsdynamik der Merkmale.
3. Veränderung der relativen Werte der Merkmale, resp. Geschlechtsunterschiede der Körperproportionen.
4. Veränderung der Variabilität der Merkmale bei Knaben und Mädchen.

1. Wachstumsniveau der Merkmale

Der mittlere absolute Wert eines jeden anthropometrischen Merkmals in jedem Lebensjahr ist die Grundlage, auf welcher die Analyse aller Aspekte des Sexualdimorphismus beruht. Deshalb bringen wir vor allem die *arithmetischen Mittelwerte* der behandelten Merkmale (Tab. 1 und 2). Aus diesen Angaben sehen wir, daß die Werte aller Merkmale entsprechend dem Alter und Geschlecht der Untersuchten *unterschiedlich* ansteigen. Es stellt sich nun die Frage, wie man die Geschlechtsunterschiede in ihrem Wachstumsniveau hervorheben kann. Man hat dazu gewöhnlich die Differenzen zwischen den betreffenden Merkmalswerten benutzt. Da aber für jedes Merkmal verschiedene Maßeinheiten angewandt werden, so ermöglicht diese Methode keine *vergleichbare*

Vorstellung über die Größe der Differenzen. Vorteilhafter ist es daher, dazu den *Index des Sexualdimorphismus* (ISD) der Merkmale zu gebrauchen, d. h. die Mädchenmerkmalswerte in Prozent von denjenigen der Knaben. Die Indexwerte lassen sich vergleichen, und in ihrer Größe spiegelt sich die Größe des Geschlechtsunterschiedes eines entsprechenden Merkmals wider: je größer der Index, desto kleiner der Geschlechtsunterschied.

In Tab. 3 sind diese Indices (ISD) für eine Reihe von Merkmalen angeführt. Beim Vergleich derselben stellt es sich heraus, daß im frühen Schulalter (7.–9. Lebensjahr), gleichfalls auch im späteren Schulalter, die Maße der Knaben größer sind als diejenigen der Mädchen. Eine Ausnahme bildet aber der Oberschenkelumfang, welcher vom Anfang bis zum Schluß der Schulzeit (18. Lebensjahr) bei den Mädchen sowohl absolut, als auch relativ größer ist als bei den Knaben.

Tab. 1: Veränderung der arithmetischen Mittelwerte der anthropometrischen Merkmale der Knaben mit dem Alter.

Alter in Jahren	Körperhöhe	Körpergewicht	Sitzhöhe	Schulterbreite	Beckenbreite	Brustumfang	Ganze Armlänge	Ganze Beinlänge	Kopflänge	Kopfbreite	Gesichtsbreite	M. Gesichtshöhe	Unterkieferwinkelbr.
7	121,85	23,36	67,00	26,33	19,64	59,55	53,00	66,58	179,35	149,10	121,00	96,34	92,18
8	126,74	26,22	69,10	27,33	20,24	61,52	55,17	69,93	180,18	149,71	122,96	98,10	93,70
9	131,05	28,80	71,08	28,34	20,27	63,50	57,50	73,35	181,09	150,41	124,51	99,80	95,28
10	136,55	31,54	72,95	29,32	21,58	65,51	59,79	76,54	182,09	151,00	126,00	101,51	96,77
11	141,36	34,48	74,72	30,26	22,33	67,57	62,06	79,93	183,02	151,63	127,55	103,19	98,45
12	146,22	37,70	76,61	31,27	23,13	69,94	64,47	83,10	184,05	152,30	129,00	105,15	99,90
13	151,41	41,84	78,81	32,32	24,00	72,69	67,29	86,55	185,19	152,97	130,74	107,31	101,40
14	157,30	47,05	81,45	33,74	24,95	76,22	70,25	89,96	186,60	153,72	132,54	110,15	103,16
15	163,90	53,59	84,78	35,39	26,08	80,35	73,00	93,97	188,20	154,63	134,58	113,70	105,21
16	168,87	60,11	87,89	36,89	26,93	84,28	75,41	96,56	189,61	155,44	136,84	116,28	107,00
17	172,20	64,01	90,07	38,04	27,81	87,77	78,86	98,35	191,22	156,28	138,89	118,24	108,14
18	174,10	66,78	91,36	38,78	28,10	89,97	77,60	98,71	192,80	157,11	140,25	119,43	108,88

Tab. 2: Veränderung der arithmetischen Mittelwerte der anthropometrischen Merkmale der Mädchen mit dem Alter.

Alter in Jahren	Körperhöhe	Körpergewicht	Sitzhöhe	Schulterbreite	Beckenbreite	Brustumfang	Ganze Armlänge	Ganze Beinlänge	Kopflänge	Kopfbreite	Gesichtsbreite	M. Gesichtshöhe	Unterkieferwinkelbr.
7	120,80	23,28	66,27	26,11	19,51	57,56	52,02	66,10	175,29	145,18	119,60	94,12	90,18
8	125,74	25,45	68,36	27,05	20,15	59,40	53,98	69,48	176,10	145,65	121,00	95,55	91,70
9	130,64	28,00	70,44	28,03	20,86	61,47	56,20	72,54	176,97	146,30	122,48	96,94	93,11
10	135,70	30,98	72,50	29,07	21,70	63,88	58,65	76,26	177,89	146,79	124,02	98,60	94,60
11	141,37	34,50	75,08	30,27	22,66	66,73	61,26	79,89	179,20	147,50	125,67	100,65	96,42
12	147,46	39,29	77,86	31,58	23,77	70,27	64,13	83,40	180,60	148,48	127,39	103,13	98,21
13	152,72	44,51	80,72	32,85	25,00	73,75	67,00	86,55	181,94	149,42	129,20	105,37	99,63
14	157,30	49,33	83,22	33,98	25,98	77,01	68,78	89,16	182,90	150,08	130,92	107,38	100,91
15	159,90	53,92	85,02	34,84	26,80	80,21	69,90	90,06	183,64	151,03	132,27	109,10	102,10
16	161,17	57,62	85,88	35,29	27,34	82,22	70,42	90,67	184,18	151,56	133,55	109,96	103,06
17	162,20	59,51	86,62	35,54	27,72	83,31	70,69	91,05	184,64	151,82	134,32	110,58	103,78
18	162,53	60,03	86,85	35,81	28,04	83,55	70,92	91,08	184,80	151,77	134,43	111,12	104,05

Weiter sehen wir in Tab. 3, daß die *Körpermaße* — ausgenommen die Vitalkapazität der Lungen und Länge der oberen Extremitäten — im Pubertätsalter — *besonders im 13. Lebensjahr* — bei den Mädchen diejenigen der Knaben übertreffen. Besonders groß ist dieser Unterschied im Körpergewicht, der Beckenbreite und dem Oberschenkelumfang. Die *Kopfmaße* verhalten sich anders: diese sind während der ganzen Schulzeit — wie bei den Erwachsenen — bei den Knaben größer als bei den Mädchen. Im Pubertätsalter ist aber der Geschlechtsunterschied dieser Maße zugunsten der Mädchen am größten.

In den *frühesten Schuljahren* ist der Geschlechtsunterschied am größten in der Druckkraft der Hände, im Körpergewicht, im Brustumfang, in den *spätesten Schuljahren* in

Tab. 3: Indices des Sexualdimorphismus der anthropometrischen Merkmale bei estnischen Schulkindern.

Alter	Körperhöhe	Körpergewicht	Sitzhöhe	Schulterbreite	Beckenbreite	Brustumfang	Oberschenkelumfang	Ganze Armlänge	Ganze Beinlänge	Vitalkap. d. Lungen	Kopflänge	Kopfbreite	Gesichtsbreite	Unterkieferwinkelbreite	Morph. Gesichtshöhe
7	99,12	96,84	98,91	99,08	99,28	96,65	101,37	98,15	99,28		97,73	97,37	98,35	97,83	97,70
8	99,21	97,10	98,93	98,98	99,60	96,56	102,33	97,84	99,32		97,74	97,30	98,40	97,86	97,50
9	99,23	97,22	99,10	98,99	99,95	96,80	101,73	97,74	98,90		97,71	97,27	98,37	97,72	97,13
10	99,38	98,22	99,38	99,08	100,55	97,51	101,97	98,09	99,63	91,56	97,70	98,18	98,43	97,76	97,13
11	100,01	100,05	100,48	100,01	101,47	98,76	102,74	98,71	99,95	91,13	97,92	97,28	98,52	97,93	97,54
12	100,84	104,21	101,63	100,99	102,77	100,47	103,81	99,47	100,36	91,80	98,13	97,49	98,75	98,30	98,70
13	100,87	106,38	102,42	101,64	104,17	101,46	106,00	99,57	100,00	92,62	98,25	97,68	98,82	98,25	98,19
14	100,00	104,84	102,17	100,71	104,12	101,04	106,92	97,91	99,11	88,69	98,01	97,64	98,78	97,81	97,49
15	97,56	100,61	100,28	98,44	102,76	99,82	106,26	95,75	95,84	83,87	97,58	97,65	98,28	97,04	95,95
16	95,44	95,76	97,71	95,66	101,52	97,56	105,68	93,38	93,90	76,94	97,15	97,50	97,60	96,31	94,56
17	94,19	92,96	96,17	93,43	99,68	94,92	104,90	91,97	92,58	72,30	96,56	97,15	96,71	95,96	93,52
18	93,35	89,90	95,06	92,34	99,78	92,86	102,75	91,39	92,27	68,72	95,85	96,60	95,85	95,56	93,04

der Vitalkapazität der Lungen, im Körpergewicht, in der Länge der oberen Extremitäten, in der Schulterbreite, Brustumfang und Länge der unteren Extremitäten. Der Geschlechtsunterschied zugunsten der Mädchen ist am größten im Oberschenkelumfang, im Körpergewicht und in der Beckenbreite.

In den Kopfmaßen ist der Geschlechtsunterschied zwischen Knaben und Mädchen im frühen Schulalter am kleinsten in der Gesichtsbreite, im späteren Schulalter in der morphologischen Gesichtshöhe.

2. *Wachstumsdynamik der Merkmale*

Das Wachstum eines Menschen ist ein *dynamischer Prozeß*. Es ist allgemein bekannt, daß das Wachstumstempo bis zum „Erwachsenenalter" sich progressiv versangsamt, außer der Zeit unmittelbar vor der Pubertät, wo eine Beschleunigung des Körperwachstums stattfindet — *puberaler Wachstumsschub* — bei den Mädchen ein paar Jahre früher als bei den Knaben. Es ist auch allgemein bekannt, daß das Wachstum der Mädchen früher aufhört als dasjenige der Knaben. Die Angaben über Einzelheiten der Wachstumsdynamik sind jedoch noch ziemlich unterschiedlich und widersprechend.

In den Tab. 4 und 5 ist der *jährliche relative Zuwachs* der Körpermaße (zum Teil auch der funktionalen Merkmale) angeführt. Vielleicht helfen diese Angaben, angesichts des Umfangs des Materials, das Wachstumstempo der Merkmale und ihre Geschlechtsunterschiede etwas zu präzisieren.

Aus diesen Angaben sehen wir zu allererst, daß während der Schulzeit im Wachstum der Körperteile *nur eine einmalige Beschleunigung stattfindet — bei den Knaben im Alter von 14—15 und bei Mädchen von 11—12 Lebensjahren*: in dieses Alter fällt das *Maximum* des relativen Zuwachses der Mehrzahl der behandelten metrischen Merkmale. Nur Sitzhöhe, Beckenbreite, Brustumfang, Oberschenkelumfang und Kopfbreite bei den Mädchen und Länge der oberen Extremität und Lungenkapazität bei den Knaben scheinen eine Ausnahme von dieser „Regel" zu bilden: diese Maße erreichen ihr Maximum des Zuwachses etwas später oder sogar früher (Tab. 4 und 5). Besonders abweichend verhält sich das Wachstumstempo der unteren Extremität: die Beschleunigung des Wachstums tritt bei diesem Maß zu früh (zwischen dem 9.—12. Lebensjahr) ein (Tab. 5). Es sei aber bemerkt, daß wir es im gegebenen Fall nicht mit einer tatsächlichen Länge der unteren Extremität zu tun haben, sondern mit der Iliospinalhöhe („physiologischer Länge der unteren Extremität"). Eigenartig abweichend verhält sich auch die Gesichtsbreite (Tab. 5). Wieweit alle solche Abweichungen real sind, bleibe den zukünftigen Forschungen zu entscheiden.

Der Sexualdimorphismus im Wachstumstempo der anthropometrischen Merkmale äußert sich also in sehr charakteristischer Weise in einmaliger und geschlechtsverschiedener Wachstumsbeschleunigung (Kulmination des Jahreszuwachses) der Merkmale. *Das Maximum der jährlichen relativen Zuwachsrate* der Merkmale fällt mit der Ge-

Tab. 4: Jährliche relative Zuwachsrate der antropometrischen Merkmale.
♂ — Knaben ♀ — Mädchen

Alter im Jahren	Körperhöhe		Körpergewicht		Sitzhöhe		Schulterbreite		Beckenbeite		Brustumfang		Frontale Brustweite		Sagittale Brustweite	
	♂	♀	♀	♂	♂	♀	♂	♀	♀	♂	♂	♀	♂	♀	♀	♂
7— 8	4,08	4,08	9,43	9,32	3,13	3,15	3,80	3,60	3,05	3,28	3,41	3,20	2,25	2,50	2,42	2,35
8— 9	3,87	3,90	9,87	10,02	2,86	3,04	3,70	3,62	3,11	3,55	3,22	3,48	2,86	2,64	2,48	2,44
9—10	3,72	3,75	9,51	10,64	2,63	2,84	3,46	3,71	3,75	4,03	3,17	3,92	3,17	3,49	2,36	2,58
10—11	3,52	4,17	9,32	11,68	2,43	3,55	3,20	4,12	3,47	4,42	3,14	4,46	3,31	4,00	2,64	2,81
11—12	3,44	4,28	9,34	13,88	2,45	3,70	3,34	4,33	3,58	4,90	3,50	5,30	3,30	4,46	2,89	4,14
12—13	3,55	3,56	10,98	13,29	2,87	3,67	3,36	4,02	3,76	5,17	3,97	4,96	3,70	4,41	3,69	4,49
13—14	3,89	3,00	12,45	10,83	3,45	3,10	4,38	3,44	3,96	3,92	4,85	4,42	4,86	3,70	4,28	3,37
14—15	4,20	1,65	13,90	9,32	4,09	2,16	4,89	2,85	4,53	3,16	5,42	4,15	4,80	2,59	4,97	2,07
15—16	3,03	0,79	12,17	8,86	3,67	1,01	4,24	1,29	3,26	2,01	4,89	2,50	4,66	1,61	3,67	1,91
16—17	1,95	0,64	6,50	3,29	2,48	0,86	3,12	0,85	2,90	1,39	4,14	1,32	4,36	1,34	3,19	1,77
17—18	1,11	0,20	4,33	0,87	1,43	0,27	1,94	0,84	1,04	1,15	2,51	0,29	2,67	0,90	1,75	0,62

Tab. 5: Jährliche relative Zuwachsrate der anthropometrischen Merkmale.
(Fortsetzung)
♂ — Knaben ♀ — Mädchen

Alter im Jahren	Oberschenkelumfang		Lange d. oberen Extrem.		Länge d. unteren Extrem.		Vitalkapazität d. Lungen		Kopflänge		Kopfbreite		Gesichtsbreite		Unterkieferbreite		M. Gesichtshöhe	
	♂	♀	♂	♀	♀	♂	♂	♀	♂	♀	♀	♂	♂	♀	♂	♀	♀	♂
7— 8	4,50	4,86	4,10	3,77	4,37	4,63			0,46	0,52	0,41	0,32	1,12	1,17	1,65	1,69	1,72	1,52
8— 9	4,36	3,75	4,22	4,11	4,31	4,45			0,50	0,47	0,46	0,45	1,26	1,22	1,69	1,54	1,84	1,47
9—10	3,89	4,13	4,00	4,36	4,35	5,12			0,55	0,55	0,40	0,34	1,20	1,26	1,57	1,60	1,70	1,71
10—11	3,64	4,42	3,80	4,45	4,42	4,77	9,33	8,78	0,51	0,74	0,42	0,48	1,23	1,33	1,73	1,92	1,66	2,08
11—12	3,83	4,91	3,88	4,68	4,02	4,39	9,60	10,40	0,56	0,77	0,45	0,67	1,24	1,70	1,48	1,86	1,90	2,46
12—13	3,79	5,96	4,37	4,49	4,03	3,78	10,74	11,78	0,62	0,74	0,44	0,64	1,35	1,42	1,50	1,45	2,05	2,17
13—14	4,00	4,93	4,40	2,66	4,20	3,01	14,00	9,16	0,76	0,53	0,49	0,42	1,38	1,33	1,74	1,28	2,65	1,91
14—15	4,90	4,33	3,89	1,63	4,17	1,02	14,09	7,89	0,86	0,40	0,58	0,64	1,54	1,03	1,98	1,18	3,22	1,60
15—16	3,59	3,04	3,32	0,74	2,81	0,67	13,30	3,95	0,75	0,30	0,52	0,37	1,67	0,97	1,70	0,94	2,27	0,80
16—17	3,12	2,36	1,67	0,38	1,85	0,42	8,86	2,29	0,85	0,23	0,54	0,17	1,51	0,57	1,06	0,70	1,69	0,56
17—18	2,97	0,84	0,83	0,32	0,36	0,04	6,57	1,31	0,81	0,09	0,53		1,98	0,08	0,68	0,26	1,01	0,49

schlechtsreifezeit zusammen, ist also ein „Vorzeichen" der Pubertät (Eintritt der ersten Menstruation). Dieser Zusammenhang ist so offensichtlich, daß wir die Zeit des maximalen Wachstums der anthropometrischen Merkmale als ein Mittel zur Bestimmung der (statistischen) Pubertät benutzen können. Und wenn wir die Schulzeit der (7—18jährigen) Kinder in irgendwelche „Perioden" einteilen wollen, so müssen wir nur mit der obengenannten Wachstumsbeschleunigung rechnen: mehrfache „Streckung" und „Fülle" (nach Stratz) existiert nicht.

In den meisten, die Altersanthropologie behandelnden Arbeiten — besonders in letzter Zeit — wird verzeichnet, daß bei den Knaben das Wachstum des Körpers und seiner Einzelteile im 18. Lebensjahr aufhört, bei den Mädchen früher. *Die hier angeführten Angaben bezeugen das in keiner Weise:* in den genannten Jahren ist der jährliche relative Zuwachs noch ziemlich groß. Wahr ist jedoch, daß bei den Mädchen der Zuwachs — im Vergleich mit den Knaben — merklich geringer ist, aber dennoch groß genug, um von einer Fortsetzung des Wachstums zu sprechen. Wenn 17- und 18jährige Jungen nach ihren absoluten Körpermaßen im Vergleich mit den Erwachsenen einer entsprechenden Population wirklich größer sind, so bedeutet das noch nicht einen Abschluß des Wachstums. Hier handelt es sich um eine *Auslese,* die in den Schlußklassen der Mittelschulen stattgefunden hat. Im Abschluß des Wachstums hat keine „Akzeleration" stattgefunden.

3. Sexualdimorphismus der Körperproportionen

Zur Bestimmung der Körperproportionen werden *Indices* und *relative Werte der Körpermaße* angewandt.

Der *Rohrer-Index* oder Index der Körperfülle verringert sich ununterbrochen mit dem Alter, erlangt ein bestimmtes Minimum und beginnt dann zu steigen, wobei er bei den Erwachsenen auf einem mehr oder weniger stabilen Niveau stehen bleibt. Dieses Minimum — *Mikrobarie* — fällt bei Knaben in das 13.–14., bei Mädchen in das 11.–12. Lebensjahr. Zugleich sehen wir, daß im jüngeren Alter (7.–10. Lebensjahr) Knaben und Mädchen sich in der Körperfülle wenig unterscheiden, nach dem 14. Lebensjahr beginnt aber die Körperfülle der Mädchen rasch zuzunehmen. Auch die Körperfülle der Knaben nimmt zu, jedoch verhältnismäßig wenig. Die Mikrobariezeit ist die einzige Streckungsperiode (bei den Knaben im 12.–15., bei den Mädchen im 10.–13. Lebensjahr) in der Entwicklung der Jugendlichen.

Tab. 6: Geschlechtsunterschiede einiger Indices und ihre Veränderung mit dem Alter.
♂ — Knaben ♀ — Mädchen

Alter in Jahren	Rohrer-Index		Kormus-index		Thorakal-index		Quadrat. Brustumf.-Index		Becken-Schulter-Index		Quadrat. Vitalkap.-index		Kopf-index		M. Gesichts-index	
	♂	♀	♀	♂	♂	♀	♂	♀	♀	♂	♂	♀	♂	♀	♀	♂
7	1,306	1,291	55,00	54,89	73,55	73,51	29,10	27,43	74,60	74,72			83,12	82,80	74,25	78,73
8	1,277	1,267	54,53	54,36	73,67	73,42	29,97	28,05	74,03	74,50			83,07	82,73	79,64	79,02
9	1,247	1,243	53,96	53,90	73,42	73,28	30,63	28,92	73,64	74,42			83,06	82,70	80,18	79,18
10	1,233	1,228	53,42	53,41	72,84	72,75	31,42	30,05	73,60	74,65	12,00	11,13	82,88	84,55	80,52	79,50
11	1,220	1,200	52,89	53,06	72,36	71,88	32,30	31,50	73,80	74,85	12,24	11,16	82,90	82,40	80,92	80,11
12	1,212	1,212	52,41	53,78	72,07	71,67	33,44	33,48	73,97	75,26	12,54	11,32	82,73	82,18	81,47	81,02
13	1,209	1,238	52,05	52,80	72,06	71,70	34,90	35,62	74,15	76,10	12,96	11,80	82,58	82,12	82,08	81,60
14	1,203	1,255	51,80	52,88	71,67	71,49	36,94	37,70	73,95	76,46	13,68	12,14	82,40	82,20	83,16	82,08
15	1,213	1,301	51,74	53,15	71,77	71,14	39,38	40,23	72,70	76,92	14,38	12,67	82,16	82,22	84,46	82,46
16	1,221	1,346	52,06	53,27	71,67	71,34	42,06	41,94	73,13	77,47	15,35	12,96	82,00	82,26	85,00	82,30
17	1,250	1,384	52,28	53,36	71,02	71,64	44,72	42,80	73,11	78,00	16,07	13,09	81,76	82,25	85,12	82,34
18	1,267	1,393	52,42	53,42	70,40	71,46	46,47	42,95	72,46	78,30	16,75	13,20	81,54	82,16	85,18	82,65

Der *Kormusindex* oder die relative Sitzhöhe ist, wie bekannt, bei den Jünglingen größer als bei den Erwachsenen. Auch wissen wir, daß dieser Wert mit dem Alter abnimmt, dann aber wieder zu steigen beginnt. Die angeführten Angaben zeigen, daß der Kormusindex der estnischen Knaben bis zum 14.–15. Lebensjahr, derjenige der estnischen Mädchen aber bis zum 13.–14. Lebensjahr abnimmt und dann wieder zu steigen beginnt. Während dieser Lebensjahre sind somit die Schulkinder *am stärksten brachykorm*. Es sei auch bemerkt, daß im 7.–9. Lebensjahr die Knaben etwas mehr makrokorm zu sein scheinen als die Mädchen.

Der Thorakalindex. Bekanntlich besitzen die Männer einen flacheren Brustkorb als die Frauen. Bei den Schulkindern vermindert sich der Thorakalindex mit dem Alter — wie Knaben, so werden auch die Mädchen flachbrüstiger. Dabei weisen die Knaben bis zum 16. Lebensjahr einen höheren Index auf als die Mädchen, und erst dann werden sie flachbrüstiger als die Mädchen.

Quadratischer Brustumfangsindex. Da dieser Index in dem Falle, wenn der Brustumfang der Körperhöhe *korrelativ* entspricht, konstant ist, so zeigen seine Altersveränderungen bei Schulgängern die Geschlechtsunterschiede des Brustumfanges besser als dessen relativen Werte. Bei den Knaben wie bei den Mädchen vergrößert er sich fortgesetzt und ist bis zum 12. Lebensjahr bei den Knaben größer als bei den Mädchen, im 12.–15. Lebensjahr übertrifft er bei den Mädchen den der Knaben und vom 16. Lebensjahr an ist er wieder bei den Mädchen kleiner als bei den Knaben.

Becken-Schulterindex. Dieser Index zeigt (Tab. 6), daß sich die Beckenbreite der Knaben in bezug auf die Schulterbreite zuerst (im 7.–10. Lebensjahr) verringert, sich dann im 11.–13. Lebensjahr vergrößert, aber dann allmählich wieder abnimmt. Anders ist die Situation bei den Mädchen: Auch hier verringert sich im 7.–9. Lebensjahr der Becken-Schulterindex, nimmt jedoch nachher ununterbrochen und stark zu. Die Beckenbreite der Mädchen ist in bezug auf die Schulterbreite in allen Schuljahren größer als bei den Knaben, daher ist also ihre Zunahme in den mittleren und besonders in den älteren Schuljahren ein sehr charakteristischer Geschlechtsunterschied.

Der *Quadratindex der Vitalkapazität der Lungen*, analog dem quadratischen Brustumfangsindex, gibt eine gute Vorstellung von den funktionalen Geschlechtsunterschieden bei Knaben und Mädchen. Bei den Knaben ist dieser Index während des ganzen Schulalters größer als bei den Mädchen. Vom 15. Lebensjahr an vergrößert er sich bei den Mädchen nicht mehr, bei den Knaben aber nimmt er progressiv zu (entsprechend dem Geschlechtsunterschied in der Körperhöhe).

Der *Längen-Breiten-Index des Kopfes* (Kopfindex). Vom Standpunkt des Sexualdimorphismus ist über diesen Index bei Kindern und Jugendlichen schon wiederholt geschrieben worden, doch widersprechen sich zum Teil die Ergebnisse. Auf Grund unseres großen Materials kann festgestellt werden, daß *die Knaben bis zum 15. Lebensjahr brachykephaler sind als die Mädchen*, aber von diesem Zeitpunkt an werden die letztgenannten brachykephaler als die erstgenannten und bleiben es ihr Leben lang.

Der *morphologische Gesichtsindex* zeigt, daß die Knaben während ihrer ganzen Entwicklung leptoprosoper sind als die Mädchen. Beide, die Knaben wie die Mädchen, werden in dieser Zeit leptoprosoper, doch ist die Zunahme des Gesichtsindex dabei charakteristischen Veränderungen unterworfen. Im früheren Alter (bis zum 11. Lebensjahr) vergrößert sich der Index mehr oder weniger parallel, vom 12. Lebensjahr an beschleunigt sich bei den Mädchen die Zunahme der Indexwerte. Bei Knaben beginnt eine derartige Beschleunigung im 14. Lebensjahr. Im 12. und 13. Lebensjahr nähern sich daher die Knaben und Mädchen einander in ihrer Gesichtsform, vom 14. (besonders aber vom 15.) Lebensjahr an verändert sich die Gesichtsform der Mädchen nicht mehr viel, bei den Knaben aber setzt sich die Zunahme des Gesichtsindex in schnellem Tempo fort. Die Pubertas setzt somit dem Sexualdimorphismus der Gesichtsform seinen markanten Stempel auf.

Die *relativen Körper-, Kopf- und Gesichtsmaße* sind hinsichtlich ihres Sexualdimorphismus sehr verschieden (Tab. 7).

Die *relative Länge der oberen und unteren Extremitäten* ist bei den Knaben während des ganzen Schulalters *größer* als bei den Mädchen. Gleichartig ist auch der Geschlechtsunterschied bei den Knaben und Mädchen in den absoluten Werten der genannten Maße.

Der *relative Oberschenkelumfang* ist dagegen bei den Knaben während der ganzen Schulzeit *kleiner* als bei den Mädchen. Besonders vergrößert sich der relative Oberschenkelumfang der Mädchen vom 16. Lebensjahr an.

Die *relative Schulter- und Beckenbreite* ist in früheren und späteren Schullebensjahren bei den Knaben *größer* als bei den Mädchen. Im 12.–16. Lebensjahr ist aber die relative Schulterbreite und im 10.–17. Lebensjahr die relative Beckenbreite bei den Mädchen größer als bei den Knaben.

Tab. 7: Geschlechtsunterschiede einiger relativer Körper-, Kopf- und Gesichtsmaße und ihre Veränderung mit dem Alter.
♂ – Knaben ♀ – Mädchen

Alter in Jahren	Schulterbreite		Beckenbreite		Länge der oberen Extremität		Umfang des Oberschenkels		Kopflänge		Kopfbreite		Gesichtsbreite		Unterkieferbreite	
	♂	♀	♀	♂	♂	♀	♂	♀	♀	♂	♂	♀	♂	♀	♀	♂
7	21,62	21,61	19,64	19,51	43,49	43,06	28,28	29,08	14,71	14,51	12,23	12,02	9,97	9,90	7,90	7,47
8	21,56	21,51	20,24	20,15	43,53	42,94	28,40	29,30	14,21	14,05	11,81	11,58	9,70	9,62	7,39	7,29
9	21,52	21,45	20,87	20,86	43,68	43,02	28,47	29,26	13,76	13,55	11,42	11,20	9,46	9,37	7,20	7,13
10	21,48	21,42	21,58	21,70	43,80	43,22	28,58	29,32	13,33	13,11	11,06	10,82	9,23	9,14	7,13	6,87
11	21,41	21,41	22,33	22,66	43,90	43,33	28,62	29,40	12,94	12,67	10,73	10,43	9,02	8,89	6,96	6,82
12	21,35	21,41	23,13	23,77	44,10	43,49	28,75	29,56	12,58	12,24	10,42	10,07	8,82	8,64	6,83	6,66
13	21,30	21,51	24,00	25,00	44,43	43,87	28,79	30,19	12,23	11,81	10,10	9,79	8,63	8,46	6,70	6,51
14	21,44	21,60	24,95	25,98	44,66	43,73	28,83	30,84	11,86	11,63	9,70	9,54	8,42	8,32	6,66	6,42
15	21,59	21,79	26,08	26,80	44,54	43,71	29,04	31,63	11,48	11,48	9,43	9,44	8,21	8,27	6,42	6,39
16	21,84	21,89	26,93	27,34	44,64	43,68	29,20	32,30	11,23	11,42	9,20	9,40	8,10	8,28	6,34	6,39
17	22,10	21,91	27,81	27,72	44,63	43,58	29,53	32,90	11,10	11,38	9,07	9,36	8,06	8,28	6,28	6,40
18	22,27	22,03	28,10	28,04	44,57	43,63	30,08	33,11	11,07	11,37	9,02	9,34	8,05	8,27	6,26	6,40

Die *relativen Kopf- und Gesichtsmaße* sind während des ganzen Schulalters bei den Knaben bis zum 15. Lebensjahr größer als bei den Mädchen, aber von diesem Lebensjahr an übertreffen die relativen Kopf- und Gesichtsmaße der Mädchen diejenigen der Knaben. Wahrscheinlich ist das dadurch bedingt, daß sich nach dem 15. Lebensjahr bei den Mädchen die Körperhöhenzunahme merklich verlangsamt und zwar in stärkerem Maße als die Kopf- und Gesichtsmaße.

4. *Die individuelle Variabilität der anthropologischen Merkmale der Knaben und Mädchen*

Als Maß der Variabilität der Merkmale wurde hier der Variationskoeffizient benutzt, da er für die verschiedenen Merkmale vergleichbare Werte liefert.

Vor allem: *wie verändert sich mit dem Alter die Variabilität der Merkmale* bei Knaben und Mädchen? Aus Tab. 8 ist ersichtlich, daß während der jüngeren Lebensjahre die Variabilität der Merkmale bis zu einem gewissen Maximum steigt und dann schnell abnimmt. Eine Ausnahme scheint die Kopfhöhe zu bilden, die eine solche Gesetzmäßigkeit nicht aufweist.

Tab. 8: Variationskoeffizienten einiger anthropometrischer Merkmale und ihre Veränderung mit dem Alter.

Alter i. Jahren	Körperhöhe		Körpergewicht		Sitzhöhe		Länge d. oberen Extremität		Schulterbreite		Beckenbreite	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
7	4,23	4,30	13,27	15,05	3,86	3,97	5,00	5,11	4,88	5,05	5,86	5,95
8	4,34	4,35	13,35	15,15	3,94	4,05	4,97	5,06	4,91	5,04	5,93	6,05
9	4,31	4,38	13,47	15,37	4,00	4,18	5,07	5,20	4,94	5,13	6,01	6,28
10	4,36	4,46	13,95	16,24	4,07	4,35	5,18	5,22	5,01	5,26	6,11	6,60
11	4,46	4,70	14,02	16,75	4,10	4,71	5,11	5,31	5,12	5,55	6,31	6,67
12	4,58	4,82	14,80	17,98	4,21	4,91	5,13	5,45	5,39	5,75	6,48	6,77
13	4,92	4,64	16,01	17,89	4,69	4,84	5,32	5,29	5,94	5,84	6,87	6,81
14	5,15	4,01	17,00	15,81	5,37	4,30	5,65	4,78	6,43	5,30	7,09	6,31
15	5,27	3,64	17,18	14,17	5,40	3,73	5,44	4,24	6,58	4,76	6,94	5,60
16	4,70	3,44	14,62	13,17	5,02	3,49	4,87	4,22	6,07	4,62	6,31	5,38
17	3,96	3,39	12,36	12,26	4,27	3,36	4,38	4,02	5,33	4,59	5,87	5,41
18	3,39	3,32	10,74	11,71	3,68	3,28	4,17	4,13	4,48	4,47	5,55	5,17

	Brustbreite		Brustumfang		Oberschenkelumfang		Kopflänge		Gesichtsbreite		M. Gesichtshöhe	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
7	4,95	5,08	4,70	5,18	8,77	8,82	3,62	3,38	3,73	3,66	4,58	4,46
8	5,15	5,17	5,01	5,52	9,10	8,96	3,60	3,46	3,80	3,65	4,54	4,44
9	5,26	5,45	5,35	5,89	8,97	9,05	3,50	3,46	3,76	3,78	4,65	4,59
10	5,34	5,79	5,45	6,52	8,80	9,32	3,48	3,41	3,82	3,70	4,75	4,65
11	5,44	6,00	5,56	7,04	8,60	9,68	3,52	3,36	3,72	3,72	4,91	4,90
12	5,58	6,42	5,83	7,30	8,47	9,82	3,56	3,33	3,70	3,78	4,93	5,00
13	5,82	6,43	6,40	7,36	8,57	9,90	3,57	3,34	3,72	3,83	5,10	5,01
14	6,54	6,28	6,73	6,75	8,60	8,97	3,54	3,36	3,78	3,75	5,47	4,90
15	6,72	5,70	7,21	6,00	8,87	7,90	3,57	3,30	3,93	3,54	5,48	4,78
16	6,46	5,61	6,32	5,59	7,71	7,14	3,56	3,20	3,83	3,50	5,31	4,80
17	6,00	5,50	5,63	5,48	6,70	6,80	3,40	3,27	3,71	3,53	5,00	4,70
18	5,55	5,49	5,07	5,29	5,91	6,47	3,41	3,24	3,49	3,34	4,97	4,70

In welchen Lebensjahren erreicht das Variieren der Merkmale sein Maximum? *Bei den Knaben tritt es für die meisten Merkmale im 15. Lebensjahr auf.* Eine Ausnahme bilden die Länge der Extremitäten, die Beckenbreite und die morphologische Gesichtshöhe: bei diesen Maßen fällt das Variationsmaximum in eine frühere Zeit. *Bei den*

Mädchen tritt für die Mehrzahl der Maße ihr Variationsmaximum im 12. und 13. Lebensjahr auf. Es sei bemerkt, daß bei ihnen das Varitionsmaximum der *Standardabweichung* der meisten Merkmale in das 13. Lebensjahr fällt (Aul 1970).

Wessen Merkmale variieren mehr, diejenige der Knaben oder der Mädchen? Eine Betrachtung einzelner Merkmale nach einzelnen Lebensjahren gibt uns keine Klarheit. Um diese Frage im allgemeinen zu beantworten, berechnet man hinsichtlich eines jeden Merkmals den *mittleren Variationskoeffizient* der Knaben, sowie auch der Mädchen für alle Lebensjahre. Diese mittleren Werte sind in zunehmender Reihenfolge untenstehend gegeben. Pluszeichen nach einem jeden Maß bedeutet, daß dieses Maß bei den Knaben, und Minuszeichen — daß das entsprechende Maß bei den Mädchen mehr variiert.

	♂	♀	
Kopflänge	3,53	3,39	+
Kopfbreite	3,55	3,41	+
Gesichtsbreite	3,75	3,64	+
Sitzhöhe	4,38	4,10	+
Körperhöhe	4,47	4,12	+
Unterkieferwinkelbreite	4,67	4,45	+
M. Gesichtshöhe	4,97	4,74	+
Länge d. ober. Extremität	5,02	4,84	+
Schulterbreite	5,42	5,11	+
Länge d. unt. Extremität	5,51	5,25	+
Brustbreite	5,73	5,74	
Brustumfang	5,77	6,16	—
Beckenbreite	6,23	6,08	+
Brusttiefe	6,67	7,04	—
Oberschenkelumfang	8,25	8,57	—
Körpergewicht	14,23	15,13	—
Vitalkapazität d. Lungen	16,47	16,32	+

Aus dieser Übersicht ergibt sich, daß *die Knaben in einer erheblich größeren Zahl von Merkmalen stärker variieren als die Mädchen.* Die Mädchen zeigen eine größere Variabilität als die Knaben nur in Brusttiefe (sagittaler Brustweite), Brustumfang, Oberschenkelumfang und Körpergewicht, also in den Maßen, die die Körperfülle charakterisieren.

Betrachtet man den Geschlechtsunterschied der Variabilität der Maße mit zunehmendem Alter, so sehen wir, daß *die Variabilität der Maße während der jüngeren Lebensjahre (bis zum 13.—14. Lebensjahre) bei den Mädchen größer ist als bei den Knaben; vom 14. Lebensjahr an variieren aber die Knaben mehr als die Mädchen* (Tab. 8). Anders verhalten sich die Kopfmaße: diese variieren fast in allen Lebensjahren bei den Knaben mehr als bei den Mädchen.

Wenn wir nun zurückblicken auf die Altersveränderungen der Geschlechtsunterschiede der Schulkinder und Jugendlichen, so sehen wir, daß in allen Gebieten diese Veränderungen im Zusammenhang mit der Pubertät stehen. Alle der charakteristischsten Wendepunkte in diesen Veränderungen — *Maximum der individuellen Variabilität* der Merkmale, *Mikrobarie, Brachykormie, Maximum der Indices der Geschlechtsunterschiede* — fallen ungefähr in ein und dasselbe Alter: bei den Knaben in das 15., bei den Mädchen in das 13. Lebensjahr. Die genannten *Erscheinungen bilden somit einen Komplex,* der mit der Pubertät zusammenfällt. Diesen Komplex könnten wir *morphologischen Pubertätskomplex* nennen, mit Hilfe dessen wir die physiologische Pubertät bestimmen können (Aul 1964). Wie genau die morphologische Pubertät mit der physiologischen zusammenfällt, wird die Zukunft zeigen.

III. Sexualdimorphismus bei den Erwachsenen

Das Material, das ich bei der Behandlung der anthropometrischen Geschlechtsunterschiede der Erwachsenen benutze, stammt aus West-Estland (Audru- und Tostamaa-Gebiet), wo ich im Jahre 1940 730 21—45jährige ortsansässige Männer und 850 20—45-jährige Frauen messen konnte. Bei den Korrelationsrechnungen habe ich auch die „Eingewanderten" (ca. 90 Personen) einbezogen.

Wie bezüglich der Herkunft, so ist das gesamte Material auch berufsmäßig *einheitlich,* denn alle Gemessenen waren Landbewohner und in der Landwirtschaft (zum Teil auch in der Fischerei) tätig. Folglich sind die *Männer- und Frauenangaben des Materials vergleichbar.* Auch ist das Material verhältnismäßig groß und repräsentativ, denn es war möglich, ungefähr 85 % der Lokalbevölkerung im genannten Lebensalter zu messen.

Es ist bekannt, daß die Körperhöhe, sowie auch die einzelnen Körperteile des Menschen im Erwachsenenalter nicht unverändert bleiben. Die Körperhöhe und einige andere Längenmaße beginnen sich bald nach dem 30. Lebensjahr zu verringern, andere Maße aber setzen ihr „Wachstum" fort, einige sogar bis zum 50. Lebensjahr (Aul 1940). Analoges finden wir auch im gegebenen Material, was am Beispiel der Körperhöhe gezeigt werden soll (Tab. 9). Zwar sind solche Veränderungen nicht sehr groß, aber immerhin groß genug, um bei altersmäßig merklich verschiedenen Populationen — besonders beim Vergleich des Männer- und Frauenmaterials — in Betracht gezogen zu werden. Aus der Tabelle ist auch ersichtlich, mit welchen Individuenzahlen wir es zu tun haben.

Tab. 9: Körperhöhe in verschiedenen Altersgruppen (cm).

Alter in Jahren	Männer n	Männer M ± m	Männer σ	Alter in Jahren	Frauen n	Frauen M ± m	Frauen σ
21—30	257	175,83 ± 0,35	5,73	20—30	312	162,57 ± 0,30	5,14
31—35	165	175,25 ± 0,44	5,70	31—35	190	162,24 ± 0,37	5,20
36—40	172	174,60 ± 0,42	5,66	36—40	198	161,92 ± 0,35	5,27
41—45	112	173,37 ± 0,54	5,76	41—45	152	160,84 ± 0,38	4,75

Bei der Behandlung des Sexualdimorphismus der einselnen Merkmale habe ich das Material in vier Altersgruppen eingeteilt. Natürlich ist in diesem Falle die Individuenzahl in jeder Gruppe zu klein, um die entsprechenden Unterschiede als Signifikant zu bezeichnen. Doch kann man damit die allgemeine Richtung und Größe der Altersveränderungen der Merkmale feststellen.

1. *Geschlechtsunterschiede bei den absoluten Maßen*

Wie bei den Jugendlichen, so benutzte ich auch hier zum Vergleich der *Größe* der Geschlechtsunterschiede den Index des sexuellen Dimorphismus (ISD).

Einer der ersten Wissenschaftler, der dieses Verfahren benutzte, um den Geschlechtsunterschied der Körperhöhe der Männer und Frauen zu untersuchen, war Fr. Galton (1899). Nach seinen Untersuchungen beträgt der entsprechende ISD 92,6.

Spätere Forscher bringen z. B. folgende Indizes: R. Martin 92,0, K. Saller 93,5, W. Scheidt 93,0, V. Bunak 93,5, V. Pesonen 93,3, Bojew 92,9, L. Nikolajev 93,8 usw.

Somit gibt es bezüglich der Geschlechtsdifferenz in der Körperhöhe zwischen Männern und Frauen ziemlich unterschiedliche Angaben. Analog ist die Lage bei anderen Körper- und Kopfmaßen.

Kehren wir nun zu unserem Material zurück. In der Tab. 10 sind Indices der Geschlechtsunterschiede (ISD) von 20 Merkmalen in Altersgruppen wiedergegeben. Plus- und Minuszeichen am Ende eines jeden Merkmals zeigen, ob dieser Index sich mit dem Alter vergrößert (+) oder verringert (−).

Daraus sehen wir, daß *in bezug auf die meisten Maße* (besonders der Körpermaße) *der ISD mit dem Alter zunimmt,* d. h. *der betreffende Geschlechtsunterschied wird kleiner.* Es gibt einige Maße (Brustdurchmesser, Kopflänge und Kopfbreite, morphologische Gesichtshöhe), deren Geschlechtsunterschied mit dem Alter *unverändert* zu bleiben scheint. Zugleich zeigen diese Angaben, daß die ISD-Unterschiede, die in der Literatur zu finden sind, nur zum Teil der Realität entsprechen.

Wenn wir nun die anthropologischen Merkmale der Männer und Frauen bezüglich der Geschlechtsunterschiede *vergleichen* wollen, so können wir das nur dann tun, wenn das zu vergleichende Material in bezug auf das Alter (natürlich auch in anderen Beziehungen) *einheitlich* ist. Als solch ein „anthropologisches Alter", welches die konstantesten (vergleichbarsten) ISD aufweist, dürfte das *Alter von 21—35 Jahren* gelten.

Tab. 10: Index der Geschlechtsunterschiede (ISD) der anthropometrischen Merkmale nach Altersgruppen.

	21—30 J.	31—35 J.	36—40 J.	41—45 J.	21—35 J.	21—45 J.	
Druckkraft der rechten Hand	64,45	64,40	63,86	62,13	64,4	64,1	—
Vitalkapazität der Lungen	67,60	69,86	73,92	75,84	68,9	69,3	+
Körpergewichte	86,82	86,85	88,68	89,14	86,8	87,7	+
Transversaler Brustdurchmesser	91,19	91,22	90,37	91,35	91,2	91,2	
Taillenumfang	89,96	90,07	90,67	90,24	89,9	90,3	+
Sagittaler Brustdurchmesser	91,19	91,22	90,37	91,35	91,2	91,2	
Spannweite der Arme	91,17	91,14	91,48	92,05	91,2	91,3	+
Schulterbreite	90,70	90,24	91,48	92,05	91,2	91,2	+
Länge der oberen Extremität	91,35	91,21	91,58	91,70	91,3	91,4	+
Brustumfang	91,55	91,15	92,06	92,57	91,4	91,7	+
Körperhöhe	92,45	92,59	92,74	92,77	92,5	92,6	+
Sitzhöhe	93,92	93,84	93,90	93,43	93,9	93,8	—
Morphologische Gesichtshöhe	91,09	91,22	90,73	91,35	91,1	91,1	
Unterkieferwinkelbreite	93,78	92,30	91,75	91,88	93,2	92,7	—
Gesichtsbreite	94,08	94,19	93,41	92,88	94,1	93,8	—
Physiognomische Gesichtshöhe	94,34	94,40	94,62	95,27	94,4	94,6	+
Kopflänge	94,78	94,85	94,83	94,80	94,8	94,8	
Ohrhöhe des Kopfes	94,97	95,21	95,39	95,54	95,0	95,3	+
Kopfbreite	95,71	95,77	95,60	95,63	95,7	95,7	
Stirnbreite	97,33	97,37	96,72	96,11	97,3	96,8	—

Wenn wir beim Vergleich der Geschlechtsunterschiede anthropometrischer Merkmale den ISD der Körperhöhe (92,6) als Ausgangsmaß annehmen, so sehen wir, daß der *Geschlechtsunterschied der meisten anderen Körpermaße der Männer und Frauen kleiner ist als derjenige der Körperhöhe und daß sich der ISD der meisten Körpermaße mit dem Alter vergrößert.* Was aber die Kopf- und Gesichtsmaße betrifft, so sind die ISD fast aller dieser Maße *größer* als der der Körperhöhe, und nur die entsprechenden ISD der Höhenmaße scheinen mit dem Alter zuzunehmen.

Der größte Geschlechtsunterschied in den Körpermaßen der Männer und Frauen besteht in der Druckkraft der rechten Hand und in der Vitalkapazität der Lungen (d. h. in funktionalen Merkmalen), der kleinste in der Sitzhöhe. In den Kopf- und Gesichtsmaßen finden wir den größten Geschlechtsunterschied in der morphologischen Gesichtshöhe und Unterkieferwinkelbreite, den kleinsten in der Stirn- und Kopfbreite.

2. *Indizes und relative Maße*

Um eine Vorstellung über die Geschlechtsunterschiede der *Körperproportionen und deren Altersveränderungen* bei Männer und Frauen zu erhalten, benutzen wir wieder die *Indizes* und *relative Maße* der Merkmale (Tab. 11).

Wir sehen, daß die *relativen Maße der Männer und Frauen* (außer der relativen Druckkraft der rechten Hand) *sich mit dem Alter vergrößern.* Mit dem Alter vergrößern sich auch Rohrer-Index und Thorakalindex. Der Längen-Breiten-Index des Kopfes und der Quadratindex der Vitalkapazität der Lungen dagegen nehmen mit dem Alter ab.

Das Wichtigste, was wir aus dieser Tabelle ersehen, ist aber Folgendes: *Die relativen Körpermaße der Männer sind größer als diejenige der Frauen. Das Gegenteil sehen wir bei den relativen Kopf- und Gesichtsmaßen:* Diese sind bei den Frauen größer als bei den Männern. *Die Mehrzahl der Indices* (außer dem Quadratindex der Vitalkapazität der Lungen und dem morphologischen Gesichtsindex) *sind bei den Männern kleiner als bei den Frauen.*

Die *größten* Geschlechtsunterschiede finden wir im Rohrer-Index, dem Quadratindex der Vitalkapazität der Lungen und (besonders) in der relativen Druckkraft der rechten Hand. Die *kleinsten* Geschlechtsunterschiede treten in der relativen Unterkieferwinkelbreite und in den relativen Gesichtsmaßen auf.

Es sei noch bemerkt, daß die angeführten Angaben über die Geschlechtsunterschiede in den relativen Maßen und Indices nur zum Teil zuverlässig und exakt sind, zum Teil

Tab. 11: Indices und relative Maße der anthropometrischen Merkmale nach Altersgruppen. (Obere Reihe — Männer, untere Reihe — Frauen)

	21—30 J.	31—35 J.	36—40 J.	41—45 J.	21—45 J.
Indizes					
Quadratindex der Vital-	17,50	17,08	15,78	14,63	16,84
kapazität der Lungen	13,83	15,97	13,57	12,89	13,55
Rohrer-Index	1,346	1,360	1,365	1,402	1,364
	1,481	1,473	1,528	1,527	1,502
Kormus-Index	52,82	52,86	53,00	53,14	52,92
	53,62	53,58	53,65	53,52	53,61
Thorakalindex	71,87	72,64	73,18	73,73	72,56
	73,57	74,66	74,98	75,53	74,36
Längen-Breiten-Index des Kopfes	79,98	79,74	79,77	79,26	79,70
	80,77	80,52	84,30	85,04	84,30
Morphologischer Gesichtsindex	86,72	86,98	86,75	86,52	86,75
	84,25	84,52	84,30	85,04	84,30
Relative Maße					
Druckkraft der rechten Hand	27,74	27,41	26,40	26,49	27,18
	19,34	19,07	18,18	18,05	18,83
Spannweite der Arme	105,21	105,34	105,42	105,44	105,31
	103,56	103,82	103,98	104,61	104,00
Taillenumfang	46,27	47,00	47,59	48,56	47,21
	44,97	45,74	46,52	47,22	45,80
Brustumfang	53,71	54,44	54,43	55,00	54,30
	53,13	53,60	54,00	54,89	53,80
Ganze Armlänge	44,92	44,91	45,00	45,24	45,05
	44,33	44,23	44,43	44,72	44,45
Schulterbreite	22,50	22,60	22,57	22,61	22,57
	22,04	22,18	22,32	22,40	22,22
Kopflänge	11,15	11,22	11,29	11,40	11,24
	11,41	11,49	11,55	11,64	11,51
Kopfbreite	8,92	8,94	9,01	9,03	8,96
	9,22	9,25	9,28	9,31	9,26
Gesichtsbreite	8,12	8,15	8,24	8,34	8,19
	8,26	8,30	8,31	8,34	8,30
Morphologische Gesichtshöhe	6,94	6,99	7,00	7,20	7,11
	6,97	7,01	7,03	7,08	7,00
Unterkieferwinkelbreite	6,30	6,36	6,41	6,50	6,37
	6,36	6,34	6,37	6,44	6,38
Stirnbreite	6,21	6,25	6,30	6,36	6,28
	6,53	6,57	6,57	6,59	6,56

aber nur eine allgemeine Orientierung in dieser Frage geben. Für genauere Angaben müßte ein wesentlich größeres (natürlich vergleichbares) Material zur Verfügung stehen, als es bei dieser Arbeit möglich war.

3. *Individuelle Variabilität der anthropometrischen Merkmale*

Sind Männer oder die Frauen in ihren Merkmalen variabler? Diese Frage ist nicht neu und bezüglich der Tiere wurde sie schon von Ch. Darwin in seiner Arbeit „Animals and Plants under Domestication" (1868) gestellt. Er kam zu der Schlußfolgerung, daß die Männchen variabler sind als die Weibchen. Später fand K. Pearson, daß im allgemeinen die Frauen variabler sind als die Männer.

Um der Lösung dieser Frage näher zu kommen, benutzen wir hier die *Variationskoeffizienten* (V) der in meinem Material zur Verfügung stehenden Merkmale.

In Tab. 12 finden wir alle diese Koeffizienten, angefangen mit den größten und schließend mit den kleinsten. Auch sind in dieser Tabelle die Differenzen (D) zwischen den Variationskoeffizienten der Männer und Frauen angegeben. Das Pluszeichen hinter den Variationskoeffizienten eines jeden Merkmals bedeutet, daß das entsprechende

Merkmal bei den Männern größer als bei den Frauen ist, ein Minuszeichen bedeutet die umgekehrte Situation.

Aus dieser Übersicht sehen wir, daß in der Tabelle etwas mehr Variationskoeffizienten mit einem Pluszeichen vorhanden sind. Es wäre aber unrichtig, daraus zu folgern, daß die Männer variabler sind als die Frauen. Wenn man die Zahl der Merkmale vergrößert — und das ist immer möglich — dann, vielleicht, fällt die Waagschale in entgegengesetzter Richtung. Die Frage darf man folglich nicht in der Weise stellen: sind Männer oder Frauen variabler? Man kann fragen: *welche Merkmale variieren bei den Männern mehr als bei den Frauen*, oder — umgekehrt?

Tab. 12: Variationskoeffizienten (V) der anthropometrischen Merkmale und deren Differenzen (D).

Merkmal	Männer	Frauen	D	
Vitalkapazität der Lungen	19,62 ± 0,55	20,63 ± 0,69	1,01	—
Druckkraft der rechten Hand	14,04 ± 0,39	20,47 ± 0,52	6,45	—
Körpergewicht	10,50 ± 0,29	11,39 ± 0,30	0,89	—
Nasenwurzelbreite	7,80 ± 0,21	7,27 ± 0,20	0,53	+
Taillenumfang	6,68 ± 0,18	7,88 ± 0,18	1,10	—
Nasenbreite	6,66 ± 0,18	7,27 ± 0,20	0,61	—
Sagittal-Brustweite	6,18 ± 0,17	6,82 ± 0,18	0,64	—
Nasenhöhe	5,49 ± 0,15	5,59 ± 0,14	0,10	—
Frontal-Brustweite	5,30 ± 0,15	6,18 ± 0,16	0,83	—
Morphologische Gesichtshöhe	5,18 ± 0,14	4,97 ± 0,13	0,21	+
Brustumfang	4,87 ± 0,18	5,54 ± 0,14	0,67	—
Physiogn. Gesichtshöhe	4,83 ± 0,13	4,56 ± 0,12	0,27	+
Fingerspitzenhöhe	4,75 ± 0,13	4,72 ± 0,15	0,05	+
Unterkieferwinkelbreite	4,90 ± 0,13	4,45 ± 0,11	0,45	+
Schulterbreite	4,45 ± 0,12	4,35 ± 0,11	0,10	+
Ganze Armlänge	4,08 ± 0,11	4,10 ± 0,10	0,02	—
Ohrhöhe des Kopfes	3,79 ± 0,10	3,82 ± 0,10	0,03	—
Spannweite der Arme	3,78 ± 0,10	3,71 ± 0,09	0,07	+
Stirnbreite	3,75 ± 0,10	3,67 ± 0,09	0,08	+
Gesichtsbreite	3,60 ± 0,10	3,36 ± 0,08	0,08	+
Schulterhöhe	3,55 ± 0,12	3,36 ± 0,11	0,19	+
Körperhöhe	3,29 ± 0,09	3,16 ± 0,08	0,13	+
Sitzhöhe	3,25 ± 0,09	3,14 ± 0,08	0,11	+
Kopfbreite	3,25 ± 0,09	3,23 ± 0,08	0,02	+
Kopflänge	3,07 ± 0,08	3,02 ± 0,08	0,05	+

Diese Frage kann folgendermaßen beantwortet werden: *in der Körperhöhe und den meisten Vertikalmaßen, desgleichen den meisten Kopf- und Gesichtsmaßen variieren die Männer mehr als die Frauen; in Körpergewicht, Brust- und Taillenumfang, den Brustdiametern und funktionellen Merkmalen* (Druckkraft der Hand, Vitalkapazität der Lungen) *sind die Frauen variabler als die Männer.*

So wie die Variabilität der Körper- und Kopfmaße Geschlechtsunterschiede aufweist, so verhalten sich auch ihre Indizes und relativen Maße. Einige der Variationskoeffizienten dieser Indizes sind unterstehend angeführt:

	Männer	Frauen	D	
Rohrer-Index	9,56 ± 0,26	10,06 ± 0,26	0,50	—
Nasenindex	8,98 ± 0,25	8,84 ± 0,22	0,14	+
Morphol. Gesichtsindex	5,53 ± 0,15	5,38 ± 0,14	0,15	+
Länge-Breiten-Index des Kopfes	4,21 ± 0,11	3,79 ± 0,10	0,42	+
Kormus-Index	2,30 ± 0,06	2,22 ± 0,06	0,08	+

Verändert sich die Variabilität der einzelnen Merkmale mit dem Alter? Und wenn ja — in welchem Maße und in welcher Richtung? Verändert sich dabei der Sexualdimorphismus der Variabilität?

Aus Tab. 13 ist ersichtlich, daß die Variabilität (Variationskoeffizienten) der Merkmale bei den Männern und Frauen sich mit dem Alter ziemlich verschieden verändern. Die Variabilität der meisten Merkmale nimmt in beiden Geschlechtern mit dem Alter zu (Taillenumfang, Körpergewicht, Stirnbreite), oder vermindert sich (Schulterbreite, Gesichtsbreite, Kopflänge). Daraus folgt, daß sich der Sexualdimorphismus der Variabilität *solcher* Merkmale mit dem Alter fast nicht verändert. Der Variationskoeffizient anderer Merkmale nimmt bei einem Geschlecht mit dem Alter zu, aber beim anderen Geschlecht — vermindert er sich (Brustumfing, Länge der oberen Extremitäten u. a.). In diesen Fällen vergrößert sich folglich der Sexualdimorphismus der Variabilität der Merkmale mit dem Alter. Wenn sich das verallgemeinern ließe, d. h. es bei allen Populationen so ist, so entsteht die Frage: *warum* die Variabilität der Merkmale und der Sexualdimorphismus der Variabilität der Merkmale sich mit dem Alter verändern und so verschieden verändern? Die Altersveränderungen des Sexualdimorphismus sind jedoch zu klein und größtenteils auf Grund des vorliegenden Materials statistisch nicht gesichert. Weitergehende Überlegungen müssen daher zurückgestellt werden.

Tab. 13: Die Veränderung der Variationskoeffizienten der Merkmale mit dem Alter.

	Männer		Frauen	
Merkmale	21—35 J.	36—45 J.	20—35 J.	36—45 J.
Vitalkapazität der Lungen	18,90 ± 0,65	21,86 ± 0,92	20,56 ± 0,66	20,33 ± 0,80
Druckkraft der rechten Hand	13,86 ± 0,48	14,94 ± 0,63	18,81 ± 0,60	20,48 ± 0,76
Körpergewicht	10,28 ± 0,35	10,67 ± 0,36	11,17 ± 0,36	11,77 ± 0,47
Taillenumfang	6,09 ± 0,23	6,50 ± 0,27	7,49 ± 0,24	8,07 ± 0,32
Morph. Gesichtshöhe	4,97 ± 0,17	5,14 ± 0,21	4,83 ± 0,15	4,83 ± 0,18
Brustumfang	4,83 ± 0,17	4,72 ± 0,20	5,60 ± 0,18	5,84 ± 0,22
Schulterbreite	4,22 ± 0,14	3,93 ± 0,16	4,72 ± 0,15	4,46 ± 0,19
Ganze Armlänge	4,12 ± 0,14	4,25 ± 0,18	4,02 ± 0,13	3,93 ± 0,14
Stirnbreite	4,33 ± 0,15	3,88 ± 0,16	3,63 ± 0,12	3,74 ± 0,14
Jochbogenbreite	3,56 ± 0,12	3,25 ± 0,13	3,39 ± 0,11	3,30 ± 0,12
Kopfbreite	3,39 ± 0,12	3,19 ± 0,13	3,18 ± 0,10	3,18 ± 0,11
Körperhöhe	3,26 + 0,11	3,27 ± 0,14	3,18 ± 0,10	3,12 ± 0,11
Sitzhöhe	3,18 ± 0,11	3,36 ± 0,14	3,08 ± 0,10	3,00 ± 0,11
Kopflänge	3,13 ± 0,11	3,01 ± 0,13	3,12 ± 0,10	2,93 ± 0,11

4. *Sexualdimorphismus in den korrelativen Beziehungen zwischen der Körperhöhe und einigen anderen Merkmalen*

Der Bestimmung korrelativer Beziehungen zwischen den anthropologischen Merkmalen wird in der Anthropologie ziemlich große Bedeutung beigemessen, besonders beim Vergleich der Körperproportionen der Populationen. Bezüglich der Korrelationskoeffizienten müssen wir uns aber bewußt sein, daß diese *sehr variabel* (nicht beständig) und *nur bei ziemlich großem Material verwendbar sind.*

Da das gegebene Material bezüglich der Männer und Frauen wenigstens recht *einheitlich* ist, bringe ich hier eine Übersicht einiger Korrelationskoeffizienten (r) zwischen der Körperhöhe und einigen Körpermaßen (Tab. 15).

Dabei interessieren uns folgende Fragen: 1. welche Merkmale sind mit der Körperhöhe bei Männern und welche bei Frauen enger korreliert? und 2. bei welchen Merkmalen ist deren Korrelation mit der Körperhöhe größer und bei welchen kleiner?

Es erweist sich, daß die *Korrelation zwischen der Körperhöhe und den meisten Körpermaßen bei den Männern größer zu sein scheint als bei den Frauen.* Bezüglich der Kopf- und Gesichtsmaße ist ein solcher Geschlechtsunterschied zwischen Männern und Frauen dagegen nicht zu bemerken, eher umgekehrt.

Aufmerksamkeit verdient, daß bezüglich einiger Merkmale (Brustumfang, Kopfbreite, Jochbogenbreite) der Geschlechtsunterschied zwischen den Korrelationskoeffizienten der Männer und Frauen recht groß ist

Tab. 14: Geschlechtsunterschiede in den Korrelationskoeffizienten zwischen Körperhöhe und einigen anderen Maßen.

Maße	Männer (n = 750)	Frauen (n = 850)	Früher gemessene Männer (n = 15000)
Länge der oberen Extremitäten	0,854 ± 0,010	0,847 ± 0,008	0,810 ± 0,002
Sitzhöhe	0,770 ± 0,016	0,723 ± 0,017	0,779 ± 0,003
Körpergewicht	0,635 ± 0,022	0,567 ± 0,024	0,660 ± 0,005
Schulterbreite	0,521 ± 0,028	0,464 ± 0,027	0,516 ± 0,006
Brustumfang	0,416 ± 0,031	0,310 ± 0,030	0,405 ± 0,005
Kopflänge	0,306 ± 0,034	0,308 ± 0,031	0,273 ± 0,008
Unterkieferwinkelbreite	0,235 ± 0,038	0,271 ± 0,032	0,260 ± 0,007
Jochbogenbreite	0,228 ± 0,021	0,272 ± 0,015	0,257 ± 0,008
Stirnbreite	0,210 ± 0,038	0,217 ± 0,026	0,199 ± 0,008
Kopfbreite	0,124 ± 0,031	0,232 ± 0,032	0,123 ± 0,007

Den stärksten korrelativen Zusammenhang mit der Körperhöhe weist die Länge der oberen Extremitäten auf. Danach folgen: andere *Körpermaße:* Sitzhöhe, Körpergewicht, Schulterbreite, Brustumfang. Die Korrelation zwischen Körperhöhe und den *Kopfmaßen* ist dagegen recht gering. Zum Vergleich bringe ich noch die entsprechenden Koeffizienten der 21—22jährigen Männer, die ich schon früher gemessen habe (Tab. 15, letzte Kolonne).

Man darf zwar nicht vergessen, daß wir es hier mit estnischem Material zu tun haben, *wieweit* die Korrelationen einen *allgemeinen Charakter* haben, muß die Zukunft zeigen. Soviel ist aber klar: *Sexualdimorphismus existiert auch in den Korrelationsverhältnissen der anthropometrischen Merkmale.*

Zusammenfassung

Bei rund 30 000 estnischen Schülern und Schülerinnen von 7 bis 18 Jahren wurden 13 absolute Körper- und Kopfmaße genommen (Tab. 1, 2) und Indices des Sexualdimorphismus berechnet (Tab. 3). Die Zuwachsraten (Tab. 4, 5) lassen die Geschlechtsunterschiede des puberalen Wachstumsschubes erkennen. Aus den Maßen wurden 8 Indices berechnet (Tab. 6, 7) und in gleicher Weise auf Sexualdimorphismus und dessen Altersunterschiede geprüft. Es fällt auf, daß die Knaben bis zum 15. Lebensjahr stärker brachykephal sind als die Mädchen, während sich dann das Verhältnis umkehrt. Die Variationskoeffizienten (Tab. 8) der Körpermaße sind bei den Mädchen bis zum 13.—14. Lebensjahr größer als bei Knaben; in den höheren Altersklassen und bei den Kopfmaßen variieren dagegen die Knaben stärker. Es läßt sich ein morphologischer Pubertätskomplex beschreiben, mit dessen Hilfe das physiologische Pubertätsalter bestimmt werden könnte. Der Sexualdimorphismus bei Erwachsenen wurde bei 730 Männern und 850 Frauen aus Westestland untersucht (Tab. 9, 10, 11), dabei wurden 4 Altersklassen unterschieden. Bei einer Reihe von Körpermaßen und Funktionsmerkmalen variieren die Frauen stärker als die Männer (Tab. 12), sonst überwiegen die höheren Variationskoeffizienten der Männner. Es besteht eine gewisse Tendenz zur Abnahme der Geschlechtsunterschiede mit zunehmendem Alter, doch ist ein durchgehender Trend nicht zu erkennen (Tab. 13). Auch die Korrelationen der Körpermaße mit der Körperhöhe zeigen einen Sexualdimorphismus: sie tendieren bei Männern zu höheren Werten.

Summary

Thirteen absolute body and head measurements were taken for around 30,000 Estnic boy and girl pupils between 7 and 18 years of age (Tables 1, 2) and the indices of sexual dimorphism had been computed (Table 3). The rate of growth (Tables 4, 5) reveals sexual differences in acceleration of growth during puberty. From the measurements, 8 indices were calculated (Tables 6, 7) and tested in the same manner for sexual dimorphism and its respective age differences. It is obvious that boys up

to 15 are stronger brachykephal than girls, whereas the trend reversed after that. The coefficient of variation (Table 8) of head measurements is larger in girls than in boys up until the 13th—14th year of life; as opposed to this, in the older age groups and in head measurements, boys vary more greatly. A morphological puberty complex may be described, with whose aid the physiological age of puberty could be determined. The sexual dimorphism of adults was tested in 730 men and 850 women from Western Estland (Tables 9, 10, 11); thereby four age categories could be differentiated. In a series of head measurements and function characteristics, the women vary more than the men (Table 12); otherwise the men predominate the higher variation coefficients. There is a certain tendency for the sexual differences to decline with increasing age; a prevailing trend is, however, not identifiable (Table 13). Also the correlation of the head measurements to the head heights demonstrates sexual dimorphism: in men the correlation tends to be higher.

Résumé

Chez environ 50 000 écoliers et écolières esthoniens, âgés de 7 à 18 ans, on a pris 13 mesures absolues du corps et de la tête (tabl. 1, 2) et puis on a calculé les indices du dimorphisme sexuel (tabl. 3). L'accroissement (tabl. 4, 5) laisse reconnaitre les différences sexuelles du bond pubertaire de la croissance. Le dimorphisme sexuel et ses différences de l'âge était estimé à partir de 8 indices, calculés des mesures (tabl. 6, 7). Il se fait remarquer que les garçons sont plus brachycéphales que les filles jusqu'à l'âge de 15 ans, pendant que plus tard, c'est l'inverse. Les coéfficients de variation (tabl. 8) des mesures du corps sont plus élevés chez les filles à l'âge de 13—14 ans que chez les garçons; après cet âge et en ce qui concerne les mesures de la tête, au contraire, la variation est plus grande chez les garçons. On peut décrire un complexe pubertaire morphologique avec l'aide duquel se laisse déterminer l'âge pubertaire physiologique. Le dimorphisme sexuel des adultes a été étudié chez 730 hommes et 850 femmes de l'Esthonie occidentale (tabl. 9, 10, 11), et on a distingué 4 groupes d'âge. Pour une série de mesures corporelles et de caractères fonctionels, la variation chez les femmes est plus grande (tabl. 12), du reste, les coéfficients de variation élevés prédominent chez les hommes. En avancant à l'âge, il existe une certaine tendance à une diminution des différences sexuelles, mais un trend contiunant n'est pas à reconnaitre (tabl. 13). Aussi les corrélations des mesures corporelles avec la stature montrent un dimorphisme sexuel: elles tendent chez les hommes aux valeurs élevées.

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THE STATURE RECONSTRUCTION OF CHILDREN ON THE BASIS OF PALEOOSTEOLOGIGAL MATERIALS

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ABSTRACT

The purpose of present paper is to analyse the paleoosteological materials of children: to observe changes in the growth of long limb bones, to reconstruct the stature and to compare stature of rural and town' children of 14th–18th cc. Also to analyse the difference in stature between present and medieval children.
Key words: paleoosteology, children, stature reconstruction, growth studies

MATERIAL AND METHOD

The skeletal series of children one found from Central Estonia at Tääksi cemetery and another from North Estonia in Tallinn (St. Barbara cemetery) are analysed. The Tääksi cemetery was used in 14th–18th cc. and St. Barbara cemetery in 14th–17th cc. The Tääksi sample contains 49 skeletons of children at the age of 0 to 12 years and St. Barbara sample 119 skeletons at the age of 0 to 15 years. The age at death of the children was estimated on the basis of dental development (Merchant, Ubelaker, 1977; Ubelaker, 1978).

The diaphyses of five long limb bones of both body side were measured and the growing velocity of bones was analysed (Tab. 1). Next the stature was calculated. For the determination of the body height of children the method of A. Telkkä (Telkkä, 1962) was used.

It must be noted, that the formulas for calculating the body height from femur at the age of 1 to 9 years did not work on our material (the stature, calculated by this formula where the length of the diaphyses of femur is transformed logarithmically, was obviously smaller than we expected). Maybe, that the modern children have much bigger length of the femur, it needs further investigation. So on our material we used this formula without logarithmical transformation.

Table 1

The lengths of the diaphyses of long limb bones and growth changes according to age (in mm)

	St. Barbara 14th–17th cc.					Tääksi 14th–18th cc.					Lithuania 14th–17th cc.				
bone	hum	rad	uln	fem	tib	hum	rad	uln	fem	tib	hum	rad	ulna	fem	tib
age	v 0...1					v 0...1					v 0...1				
avg	70.09	56.13	61.11	89.00	68.38	72.30	54.00	63.14	86.17	74.45	74.72	59.49	66.77	91.00	77.43
n	11	8	9	12	8	10	7	7	12	11	63	44	38	54	48
age	y 1...2					y 1...2					y 1...2				
avg	106.75	80.13	87.43	127.67	100.80	98	81.48	87.47	132.40	103.54	108.55	82.01	90.35	137.08	110.91
n	16	15	14	12	10	15	14	15	15	13	50	34	31	39	37
change	36.66	24.01	26.32	38.67	32.43	25.70	27.48	24.32	46.23	29.08	33.83	22.52	23.58	46.08	33.48
age	y 3...4					y 3...4					y 3...4				
avg	125.15	90.67	103.58	161.78	129.55	125.67	94.57	107.29	160.04	127.95	125.47	95.27	106.02	162.28	130.80
n	27	15	19	18	11	24	14	14	23	20	70	41	33	53	46
change	25.27	18.58	19.11	39.42	31.45	27.67	13.10	19.82	27.64	24.41	16.92	13.26	15.67	25.19	19.89
age	y 5...6					y 5...6					y 5...6				
avg	150.42	109.25	122.69	201.20	161.00	159.27	115.45	129.09	209.08	162.42	155.86	117.21	129.67	207.44	167.13
n	26	16	16	20	12	11	11	11	12	12	22	19	18	24	23
change	25.27	18.58	19.11	39.42	31.45	33.61	20.88	21.81	49.04	34.47	30.40	21.94	23.65	45.16	36.33
age	y 7...8					y 7...8					y 7...8				
avg	168.83	123.29	135.62	228.00	176.59	184.31	132.70	147.33	244.45	192.50	189.53	140.39	155.71	257.70	203.32
n	30	21	21	24	17	13	10	9	11	10	18	14	12	22	20
change	18.41	14.04	12.93	26.80	15.59	25.03	17.25	18.24	35.37	30.08	33.67	23.18	26.04	50.26	36.19
age	y 9...10					y 9...10					y 9...10				
avg	193.17	145.00	159.26	263.93	203.39	215.25	156.25	170.00	297.67	227.50	205.90	152.65	170.36	287.50	222.90
n	41	28	27	28	23	4	4	4	3	4	15	13	14	13	10
change	24.34	21.71	23.64	35.93	26.80	30.94	23.55	22.67	53.21	35.00	16.37	12.26	14.65	29.80	19.58
age	y 11...12					y 11...12					y 11...12				
avg	215.48	156.25	178.50	297.96	240.07	213.20	159.20	175.80	302.00	228.67	218.55	166.00	183.90	312.90	247.72
n	21	12	16	23	15	5	5	5	6	6	10	10	10	10	9
change	22.31	11.25	19.24	34.03	36.68	(2.05)	2.95	5.80	4.33	1.17	12.65	13.35	13.54	25.40	24.82
max. growth	145.39	100.12	117.39	208.07	171.69	140.9	105.2	112.66	215.83	154.22	143.83	106.54	117.13	221.9	170.29
rel. growth	3.07	2.78	2.92	3.35	3.51	2.95	2.95	2.78	3.54	3.07	2.92	2.79	2.75	3.44	3.20

The determination of sex of the children on the basis of paleoosteological finds is almost impossible, so the body height was calculated by the formulas for boys as well for the girls and the mean was taken to be the most realistic for body height.

Table 2

Stature calculated from each long limb bone separately (in cm)

sample		St. Barbara					Tääksi				
bone		hum	rad	uln	fem	tib	hum	rad	uln	fem	tib
age group											
y 0...1	n	9	6	6	6	4	7	4	5	7	7
	avg	77.38	61.53	62.43	60.28	57.08	64.08	60.51	61.45	58.78	60.05
	STD	2.12	8.52	9.77	7.16	4.71	7.80	7.77	6.97	6.51	6.87
	min	73.60	49.81	50.82	47.75	49.30	53.60	53.89	53.83	49.25	50.21
	max	79.87	73.24	75.89	69.31	61.39	78.06	73.75	74.38	69.06	70.46
y 1...2	n	12	9	10	9	6	9	10	10	9	8
	avg	83.87	74.23	74.21	74.72	72.98	75.35	73.61	73.86	75.11	74.08
	STD	2.26	6.46	6.39	2.95	2.46	2.83	2.41	2.38	3.45	2.87
	min	80.43	63.60	64.97	70.93	70.21	70.00	69.32	70.24	69.63	70.04
	max	87.48	88.07	89.54	79.05	77.15	79.54	77.58	77.84	80.68	79.86
y 3...4	n	17	12	13	12	6	14	8	10	14	11
	avg	92.39	82.24	83.06	84.93	82.37	84.06	84.06	85.68	85.03	82.18
	STD	2.83	3.01	5.47	5.16	5.31	4.85	2.16	3.93	6.48	5.23
	min	87.99	78.22	76.09	80.03	76.81	74.98	79.49	79.60	73.53	72.58
	max	96.89	86.48	96.27	99.85	92.89	95.14	87.43	95.98	99.53	91.37
y 5...6	n	15	11	10	13	8	6	6	6	6	6
	avg	100.56	93.64	92.22	98.66	92.28	98.03	97.23	98.12	100.85	93.88
	STD	2.25	5.10	8.16	5.13	4.14	3.94	2.60	2.94	4.19	2.87
	min	97.05	81.40	73.35	87.83	83.92	94.06	93.47	95.39	95.46	90.01
	max	104.29	100.46	101.53	108.30	97.80	105.98	101.41	103.00	108.30	98.81
y 7...8	n	20	16	14	15	11	7	5	5	6	5
	avg	109.28	102.31	101.99	106.79	98.78	108.52	108.53	108.55	111.77	104.06
	STD	2.83	4.38	5.35	5.40	4.00	4.16	3.09	3.54	4.02	3.72
	min	105.16	94.74	93.64	98.23	91.71	100.34	106.18	104.17	105.38	99.15
	max	113.98	109.99	110.02	115.13	104.9	112.70	114.12	114.40	117.73	108.80
y 9...10	n	23	17	17	17	13	2	2	2	2	2
	avg	120.37	117.61	117.95	116.58	108.4	122.56	123.50	122.30	127.39	115.91
	STD	3.64	6.74	6.87	4.73	6.68	6.61	9.06	7.31	6.74	5.59
	min	114.79	100.46	103.29	107.33	96.93	115.95	114.44	114.99	120.65	110.32
	max	126.15	127.38	128.79	122.27	121.6	129.17	132.55	129.61	134.14	121.49
y 11...12	n	12	8	10	12	9	3	3	3	3	3
	avg	129.62	124.83	130.32	124.00	126.0	123.14	126.40	128.42	125.19	122.81
	STD	1.67	6.10	8.10	8.99	6.90	6.98	8.39	7.22	5.58	5.49
	min	127.47	113.80	116.72	110.97	115.26	113.97	117.64	120.28	120.90	115.88
	max	132.84	132.69	144.69	143.34	139.6	130.88	137.71	137.84	133.06	129.32
y 12...15	n	10	10	9	10	9					
	avg	133.41	136.18	139.06	134.19	132.6					
	STD	2.88	5.87	5.45	5.73	4.24					
	min	131.20	125.02	128.24	123.99	124.4					
	max	141.71	144.50	147.44	144.02	138.0					

The stature was calculated in two different ways. At first the stature was estimated from each long limb bone separately for age groups of both series (Tab. 2), and secondly the mean stature for stages of dental development and for age groups from all five long limb bones was calculated (Tab. 3).

Then the body height of medieval and present children was compared (Tab. 4, Fig. 1). As the sex of medieval children was not estimated the mean of boys' and girls' stature of present children was calculated. The data of different authors was used for comparison (Aul, 1982; Heapost 1984; Silla, Teoste 1985; Jankauskas, 1992).

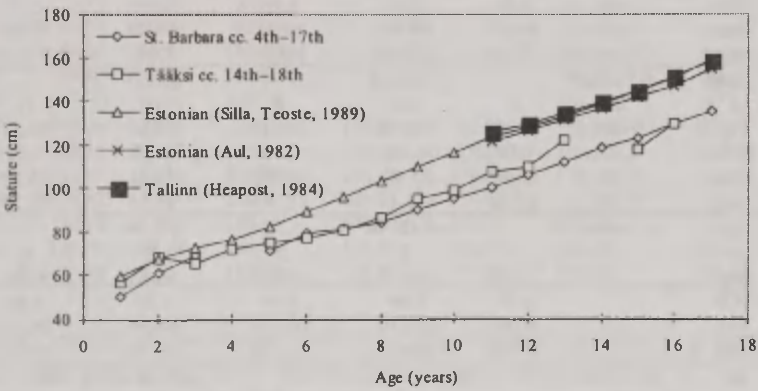

Figure 1. The growth curves of stature of medieval and present Estonian children.

RESULTS AND DISCUSSION

The length of the long limb bones.

The maximum lengths of the diaphyses of five long limb bones (humerus, radius, ulna, femur and tibia) of both samples were measured. To observe the growing velocity of different bones according to the age we divided the children into age groups and calculated the changes in bone size for every age group (Tab. 1). The length of femur shows the biggest and the length of radius and ulna the smallest growth according to the age. Exeptional is the age group of 11....12 y in Tääksi sample where the length of humerus is growing less than the length of ulna and radius and in St. Barbara sample where the length of the tibia is increasing more than the lenght of femur.

Table 3

Mean stature calculated from five long limb bones for the stages of dental development and for age groups (in cm)

sample	St. Barbara	Tääksi	St. Barbara	Tääksi	St. Barbara	Tääksi
age	m 0...6 m		y 5±16 m		y 0...1	
n	1	5	4	2	9	9
avg	49.85	56.81	89.85	95.05	61.49	61.52
STD	0.00	4.09	4.04	0.93	6.96	6.68
min	49.85	51.72	84.54	94.12	49.85	51.72
max	49.85	64.27	94.78	95.98	71.44	73.14
age	m 6±3 m		y 6±24 m		y 1...2	
n	6	3	11	4	8	10
avg	60.93	68.07	95.30	98.91	71.25	74.46
STD	5.43	4.56	4.20	3.16	3.71	2.67
min	54.22	62.07	89.10	94.62	64.29	69.84
max	71.44	73.14	103.45	103.50	77.17	79.10
age	m 9±3 m		y 7±24 m		y 3...4	
n	2	1	14	4	21	15
avg	69.00	65.41	100.29	107.25	82.24	83.34
STD	1.99	0.00	6.44	3.59	4.83	5.25
min	67.01	65.41	83.80	102.86	73.44	73.05
max	71.00	65.41	111.13	112.48	95.55	95.50
age	y 1.±4 m		y 8±24 m		y 5...6	
n		4	6	3	15	6
avg		72.02	106.17	109.97	93.85	97.62
STD		1.77	3.08	2.86	4.81	3.20
min		70.04	101.70	105.93	84.54	94.12
max		74.09	109.40	112.29	103.45	103.50
age	y 1.5±6 m		y 9±24 m		y 7...8 m	
n	8	2	13	2	20	7
avg	71.25	74.74	111.58	122.33	102.05	108.41
STD	3.71	0.45	4.94	7.06	6.26	3.56
min	64.29	74.29	102.09	115.27	83.80	102.86
max	77.17	75.19	118.03	129.39	111.13	112.48
age	y 2±6 m		y 10±30 m		y 9...10	
n	4	4	11		24	2
avg	79.23	76.76	118.62		114.81	122.33
STD	5.61	1.81	5.02		6.09	7.06
min	73.44	74.01	111.43		102.09	115.27
max	88.50	79.10	125.04		125.04	129.39
age	y 3±12 m		y 11±30 m		y 11...12	
n	8	8	6	1	13	3
avg	81.21	80.54	122.72	117.73	126.31	125.19
STD	3.31	4.36	5.27	0.00	7.77	6.59
min	77.57	73.05	113.06	117.73	113.06	117.73
max	87.49	85.59	129.70	117.73	141.98	133.76
age	y 4±12 m		y 12±30 m		y 12...15	
n	9	7	7	2	9	
avg	84.50	86.55	129.38	128.92	134.99	
STD	4.55	4.25	8.23	4.85	5.74	
min	79.76	81.41	115.76	124.07	124.69	
max	95.55	95.50	141.98	133.76	142.23	

Table 4

Stature of medieval and modern children (in cm)

sample	St.Barbara	Tääksi	Estonian	Estonian	Tallinn	Lithuanian	Estonian
authors			Silla, Teoste, 1989	Aul, 1982	Heapost, 1984	Jankauskas, 1992	summarized
centuries	cc. 14th–17th	cc. 14th–18th	modern	modern	modern	cc. 14th–17th	cc. 14th–18th
age							
m 0..6	49.85	56.81	59.50			60.63	53.33
m 6	60.93	68.07	67.60			66.29	64.50
m 9	69.00	65.41	72.70			73.89	67.21
y 1		72.02	76.30			73.53	72.02
y 1.5	71.25	74.74	81.85			76.26	73.00
y 2	79.23	76.76	89.00			81.12	77.99
y 3	81.21	80.54	95.65			85.62	80.87
y 4	84.50	86.55	102.80			90.89	85.53
y 5	89.85	95.05	109.30			96.60	92.45
y 6	95.30	98.91	116.50			102.28	97.10
y 7	100.29	107.25	123.70	121.33	125.31	109.69	103.77
y 8	106.17	109.97	127.90	126.24	129.23	116.69	108.07
y 9	111.58	122.33	132.90	131.15	134.56	120.85	116.53
y 10	118.62		138.90	136.13	139.67	126.65	118.62
y 11	122.72	117.73	144.55	141.22	144.27	130.13	120.22
y 12	129.38	128.92	150.35	146.84	150.77	131.08	129.15
y 12...15	134.99		158.98	154.55	157.98	137.06	135.43

The length of the femur indicates the biggest maximum growth while ulna and radius show the smallest in both samples (Tab. 1).

The relative growth (the length of the bone in age 11...12 y/ the length of the bone in age group 0...1 y) of long limb bones of Tääksi and St. Barbara children is different.

In Tääksi sample the relative growth of femur is fastest (it increases from the age of 0 to 12 years 3.50 times) and that of ulna is slowest (2.78 times).

In St. Barbara sample the relative growth of tibia is fastest (3.42 times) and that of radius is slowest (2.78 times).

The Lithuanian children show bigger values of the lengths of long limb bones than Estonian children (exeptions are the length of the humerus in Tääksi sample at the age of 3 to 6 years, and that of ulna at the age of 3 to 4 years).

In both Estonian samples the lengths of the long bones of lower limb show faster growth than the lengths of long bones of upper limb. The same tendency is observable in Lithuanian material from 14th–17th cc.

The stature reconstruction of children.

At first the stature of children was calculated from each long limb bone separately (Tab. 2).

We can observe that in Tääksi population the stature calculated from tibia is smallest in most age groups, exeptional case is the age group of 0...1 y, where stature calculated from radius is smallest. The tallest body height is estimated from the length of humerus at the age of 0 to 2 years, from ulna in age groups 3...4 y and 11...12 y and from femur at the age of 5 to10 years.

In most age groups of St. Barbara population the stature calculated from humerus is biggest, the age groups of 11...12 y and 12...15 y. are exeptional with the tallest body height is determined from ulna. The smallest body height is calculated from tibia at the age of 0…2 y, from radius at the age of 3…4 y, from ulna at the age of 5...6 y and from femur at the age of 11…12 y.

In Lithuanian population the stature calculated from femur indicates the biggest values at the age of 1 to 10 years, from humerus at the age of 0…1 years, from ulna at the age of 11 and up. The smallest stature is calculated from tibia at the age of 0…1 y and 3…10 y, from ulna 1…2 y and from humerus at the age of 11 and up (App. 1).

As we see in St. Barbara sample the stature calculated from humerus indicates the biggest values in most cases. So we can suppose that the medieval children in Tallinn had relatively long proximal segment of upper limb. (Of course there is possibility that this sample contains more skeletons of the boys. Boys have longer arms than girls (Aul, 1982; Heapost, 1984, Silla, Teoste 1985)).

In the case of Tääksi' children we can not say it for sure, because in some age groups the stature from femur demonstrates the biggest values (there is a similarity to the Lithuanian material). We can only conclude that the children in Tääksi village had different body proportions than children in Tallinn.

We must note that at the age of 11 and up in both Estonian series (Tab. 2) and in Lithuanian paleopopulation (App. 1) the stature calculated from ulna is biggest. We can guess that it is connected with the changes in growing process that take place in prepuberial age.

The mean stature calculated for the stages of dental development and for age groups from all five long limb bones

The mean values of the body height calculated from all long limb bones are shown in tabel 3. As we see in most cases the stature of the

Tääksi' children is bigger. We can suppose that in Middle Ages the body height of children in Tääksi village was taller than in Tallinn. It became obvious in comparing the stature of different stages of dental development and age groups of the two samples. The difference is plausible, because the present children of West and South-West Estonia are also taller than of North Estonia, it may be due to the ethnic differences (Silla, Teoste, 1985). Certainly the taller body height of rural children in the Middle Ages could as well result from more favourable enviromental conditions in the countryside.

Exeptions are the stages of dental development of 9 months (±3 m) and 12 years (±12 m) in St. Barbara sample where the stature is bigger than in Tääksi sample, also in age groups 0...1 years and 11...12 years where the children of St. Barbara sample show taller body height than the children in Tääksi. It can be due to the scantiness of material.

Different researchers have opined that it is not possible to get real growth curves of childrens stature on the basis of paleoosteological materials, because it is deflected part, not the healthy and normal part of population (Johnston, 1962).

We share the same position with the authors who assert that in paleopopulations children died mostly in consequense of acute not chronic diseases (Lovejoy *et al*, 1990, Iregren 1992).

Proceeding from this point of view the growth curve of stature of children for both series was composed (Fig. 1). The body height of children of two medieval populations was compared with present children's (Fig. 1, Tab. 4). The difference in body height of medieval and present children is about 4 to 10 mm at the age of 0 to 2 years. (The stature at the age of 1 year ± 4 months is obviously too high in Tääksi material, caused probably by the scantiness of material.) From the age of 6 years on the difference in stature between medieval and present children is about 20 mm and even more. The Lithuanian children of 14.–17. cc. are taller than their contemporary children in Estonia in most cases (Fig. 2, Tab. 4).

The difference in stature of present and medieval children has certainly many enviromental as well genetic causes.

E. Iregren (1992) has studied the enamel hypoplasia of children in Early Medieval period. She found that between two and four and half years every second individual had dental hypoplasia. She guessed that this period coincides to the period of weaning, when child was forced to eat adult food and didn't digest it properly. The calcium/ strontium ratio in bones shows that children at the age of two to two and half still receive their mothers milk. The Ca/Sr ratio shows decreasing values at the age of 6–7 years (Iregren, 1992).

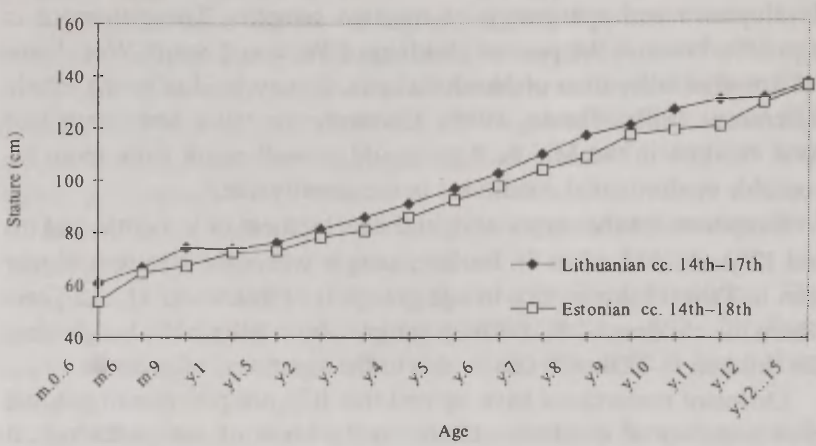

Figure 2. The growth curves of children's stature of Estonian and Lithuanian paleopopulations.

In our material the growth curves of medieval populations show some changes at the age about 1 to 3 years. There is a slight diminishing of growing velocity at this age. At the age of four or five the growing velocity will be restored, but the stature difference between medieval and present children about 20 mm and more remains (Tab. 3, Fig. 1). This is natural, because on the one hand, the difference in stature exists between medieval and present adult populations too. The modern men in Estonia are about 5 to 15 cm higher than medieval (Mark, 1962: Heapost, 1993; Aarma, 1987). On the other hand the enviromental as cultural conditions and dietery regimen are rather different nowadays than centuries ago.

In comparison with Estonian children (summarized data of both series) the Lithuanian children seem to have the slight diminishing of growth a little earlier (Fig. 2).

Of course the connection between weaning period and the changes in growth velocity needs further investigation.

CONCLUSIONS

1. The stature of Estonian children at the 14th–18th cc. was about 20 mm smaller than nowadays. The difference in stature is relatively small for children under two years.

2. The body height of rural children at 14.–18. cc. was longer than their contemporary children in town.
3. The stature calculated from ulna is biggest from the age of 11 years and up.
4. At the age of one to free years (coincides with the weaning period) there seem to be some changes in growing velocity — that needs further investigation.
5. The Lithuanian children of 14th–17th cc. are taller than their contemporary children in Estonia.

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Appendix 1

Stature calculated from long limb bones separately and summarily Lithuanian children of 14th–17th cc. (in cm)

bone		hum	uln	rad	fem	tib	from all bones
age	age group	avg	avg	avg	avg	avg	avg
new		55.77	59.92	59.53	55.02	52.63	56.57
m 0...2		60.62	62.10	59.44	56.37	54.95	58.69
m 2...6		70.64	68.12	68.15	65.00	61.18	66.62
m 6...12		76.97	76.39	75.28	74.99	65.83	73.89
	y 0...1	66.00	66.63	65.60	62.84	58.65	63.94
y 1...1.5		74.10	72.50	72.86	74.47	73.73	73.53
y 1.5...2		74.07	74.43	74.77	82.89	75.16	76.26
y 2...2.5		80.75	80.20	81.33	82.89	80.44	81.12
	y 1...2	76.30	75.71	76.32	80.08	76.44	76.97
y 2.5...3		81.74	82.84	82.39	88.39	81.58	83.39
y 3...4		85.54	86.91	87.10	94.98	84.77	87.86
	y 3...4	83.64	84.87	84.74	91.68	83.18	85.62
y 4...5		92.58	93.31	92.83	100.32	90.57	93.92
y 5...6		96.82	98.71	98.69	106.68	95.47	99.27
	y 5...6	94.70	96.01	95.76	103.50	93.02	96.60
y 6...7		101.07	103.85	105.07	116.65	99.76	105.28
y 7...8		111.41	113.94	113.42	124.02	107.72	114.10
	y 7...8	106.24	108.90	109.24	120.34	103.74	109.69
y 8...9		118.49	119.04	120.69	126.18	112.00	119.28
y 9...10		118.51	122.51	121.21	135.54	114.35	122.42
	y 9...10	118.50	120.77	120.95	130.86	113.17	120.85
y 10...11		128.40	134.12	132.90	129.92	128.99	130.87
y 11...12		125.27	133.12	130.92	128.92	128.76	129.40
	y 11...12	126.83	133.62	131.91	129.42	128.88	130.13
y 12...14		130.99	136.53	131.14	133.92	131.25	132.77
y 14...16		135.60	147.44	145.98	139.99	137.73	141.35
	y 12...16	133.30	141.98	138.56	136.96	134.49	137.06

Appendix 2

Lengths of long limb bone diaphyses of Estonian children of 14th–18th cc (in mm)

	hum	rad	uln	fem	tib		hum	rad	uln	fem	tib
m 0...4(6)						y 5±16m					
n	6	6	6	8	8	n	11	10	10	10	8
avg	63.83	47.83	55.83	72.50	64.38	avg	147.00	108.50	119.80	192.20	153.25
STD	6.23	4.06	3.29	9.01	9.08	STD	10.55	6.58	6.71	14.08	8.77
min	56	41	52	64	55	min	126	90	103	168	133
max	76	52	60	93	79	max	156	113	128	210	161
m 6±3m						y 6±24m					
n	12	7	9	12	10	n	26	17	17	22	16
avg	72.42	58.57	64.56	93.67	76.70	avg	155.62	113.71	128.53	209.59	165.94
STD	7.74	7.93	7.76	10.08	7.28	STD	9.99	6.00	6.65	12.40	7.89
min	61	49	51	79	69	min	141	103	115	185	152
max	90	68	75	107	91	max	177	122	138	232	178

Continue

	hum	rad	uln	fem	tib		hum	rad	uln	fem	tib
m 9±3m						y 7±24m					
n	3	2	1	4	1	n	26	19	17	22	17
avg	80.67	65.00	76.00	99.50	84.00	avg	169.85	123.53	135.41	226.68	177.71
STD	3.40	3.00	0.00	2.50	0.00	STD	15.28	6.60	8.63	16.76	12.40
min	76	62	76	97	84	min	145	111	121	201	156
max	84	68	76	102	84	max	193	133	147	253	195
y 1±4m						y 8±24m					
n	4	5	5	5	6	n	17	12	13	13	10
avg	100.25	75.00	84.20	124.60	97.33	avg	179.12	130.75	144.00	244.15	190.60
STD	3.90	2.45	2.48	10.09	6.60	STD	6.45	6.82	8.09	9.73	12.82
min	94	71	81	113	92	min	170	120	132	231	171
max	104	78	88	136	110	max	193	142	157	261	208
y 1.5±6m						y 9±24m					
n	14	12	14	12	9	n	27	17	18	20	20
avg	101.93	75.17	84.14	127.00	99.00	avg	193.07	144.12	158.11	264.65	206.50
STD	7.22	5.57	5.04	8.07	5.52	STD	15.32	12.92	11.81	19.94	17.37
min	90	62	72	117	92	min	168	120	137	229	178
max	114	82	91	142	106	max	233	172	184	313	245
y 2±8m						y 10±30m					
n	13	12	10	10	8	n	18	15	13	11	7
avg	114.15	85.42	93.70	137.10	109.88	avg	198.22	149.00	164.15	271.82	208.29
STD	10.22	7.06	7.62	6.77	7.67	STD	9.71	8.95	8.99	17.68	11.28
min	101	77	85	125	102	min	179	131	149	249	193
max	137	101	114	147	121	max	211	160	177	294	225
y 3±12m						y 11±30m					
n	25	12	13	19	14	n	13	10	12	14	8
avg	120.68	91.92	101.15	151.11	117.43	avg	208.85	154.20	172.00	286.57	224.88
STD	9.11	4.23	5.50	15.06	11.82	STD	10.65	9.81	10.47	14.34	14.23
min	105	86	91	125	99	min	191	137	154	260	204
max	134	98	108	172	134	max	226	166	188	306	245
y 4±12m						y 12±30m					
n	26	17	20	22	17	n	13	7	9	15	13
avg	129.92	93.00	107.75	169.18	137.65	avg	221.23	161.29	185.67	310.20	244.15
STD	9.16	4.49	9.00	17.40	12.85	STD	20.79	13.00	13.86	28.06	23.82
min	118	85	94	150	120	min	185	144	163	262	202
max	152	100	126	206	160	max	254	180	205	356	283
						y 12...15					
						n	15	15	12	19	17
						avg	234.60	173.80	194.58	328.95	260.47
						STD	13.39	10.33	9.27	16.98	13.93
						min	212	156	175	297	233
						max	255	189	210	359	279

PATTERNS OF LINEAR ENAMEL HYPOPLASIA IN LATE MEDIEVAL ALYTUS ADULT POPULATION

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ABSTRACT

Developmental enamel defects — linear enamel hypoplasia (LEH) — represent stress-induced growth disruptions. Deficiencies of enamel thickness resulting from systemic growth disturbances were used as indicators of previous growth disruptions and stress and the relationship between different kinds of enamel defects and age at death were examined in a sample of 193 adults from the Late Medieval age of adult population from Alytus. The defects were observed and classified according to criteria of Schultz (1988) [18]. No significant differences in LEH incidence by sex were detected (males — 40.59% and females — 42.39%). The age at death distribution for individuals with LEH showed the highest peak in the 20–30 year age class. Certain differences of LEH occurrence in chronological groups were found, group with highest life expectancy showing highest incidence of LEH. The early mortality of individuals with enamel defects may be related to increased exposure to environmental stressors and biological response. The Alytus burial ground requires further investigation.
Key words: enamel hypoplasias, biological — environmental stress, mortality.

INTRODUCTION

Tooth size and external morphology has provided a wealth of information on dietary adaptations, evolutionary relationship within and among species [3]. Indicators of general metabolic stress represent an important source of data for the reconstruction of health status of skeletal populations. Stress has been defined as a stereotypic physiological reaction to environmental insult [9, 11]. One result of severe stress is growth disruption. Skeletal and dental indicators of stress are nonspecific in nature and include radiographic lines of increased density (Harris lines), fluctuating dental asymmetry, microscopic developmental enamel defects (Wilson bands), and macroscopic developmental enamel defects (hypoplasias and hypocalcification) [6]. Defects in enamel may also be caused by disturbances during growth. One well recognised group of defects in man is due to fluorosis. Fluorine ions are present in most of drinking water and become incorporated into the enamel. The very low concentrations in drinking water do not usually cause any defect and indeed confer some protection against dental caries. At concentration above 0.5ppm, however, some individuals begin to show changes in their enamel. The defects vary from a mottling of opaque white patches, which may become stained yellow or brown, to a hypoplastic pitting and grooving [13]. Opacity and hypoplasia occur together and affect most of the crown surface in most of the dentition. It is possible to assign scores to these defects and calculate a "community index of dental fluorosis" [6] combining severity with the proportion of the community affected. This is correlated with fluoride concentration in drinking water. Potentially, the index could be used in archaeology to reconstruct the fluoride content of water, but defects of this kind have not yet been observed in excavated material [13]. Thus enamel hypoplasias and other enamel developmental defects are most regularly used in a variety of analyses of skeletal and archaeological samples [2, 6, 10]. Linear enamel hypoplasia (LEH) is a deficiency resulting from intermition of deposition of enamel rods during the secretory phase of enamel development [20]. On the mature tooth LEH manifests as circumferential grooves, lines, or series of pits of decreased enamel thickness [10]. LEH has no specific etiology but results from a wide variety of systemic disturbances severe enough to disrupt amelogenesis [15]. Pindborg listed conditions which have been linked with increased incidence of hypoplasia in man (excluding fluorosis discussed above): systemic causes (chromosomal anomalies, congenital defects, inborn errors of metabolism, neonatal disturbances, infectious disease, neurological disturbances, endocrinopathies, nutritional deficiencies, nephropathies, enteropathies, intoxications) and local causes (producing effects on only a few neighbouring teeth) — local acute mechanical trauma, electric burn, irradiation, local infection, regional odontodysplasia [16].

The purpose of this research was to look after relationship between linear enamel hypoplasia and the age at death, testing the hypothesis that individuals who were stressed in early life suffer a different pattern of mortality than those who were not.

ARCHAEOLOGICAL AND DEMOGRAPHIC CONTEXT OF THE SAMPLE

Alytus burial ground, the largest cementery of late medieval age (14–17 c.c. AD) in Lithuania, investigated in 1984–1986 by archaeologist E.Svetikas (1152 registered graves) and representing the population of typical small town of that period [4]. Thus the estimation of the health status of this population is of great importance to biological anthropologists and archaeologists. Sample is large and skeletal materials are well preserved. Archaeological evidence indicates a year-round occupation of the site for a time span of 300 years.

Paleodemographic data revealed minor fluctuations of life expectancy (e_o) in Alytus chronological-archaeological groups (14–16 c.c., 15–17 c.c., 16–17 c.c., graves without inventory = ND). Average life expectancy was lowest for the "graves without inventory" group for both sexes and highest for people buried at the 2nd half of 16th — 17th c.c. The mortality rate of Alytus population comparing with rural ones, was 35,93 versus 35,19 per thousand and reproduction indexes R_{pot} corespondingly 0,81 and 0,85, R_o ,when U_c = 8, 2,12 and 2,17) [14]. This demonstrates worse life conditions in medieval town comparing with village.

MATERIALS AND METHODS

This study reports observations on the occurrence of dental enamel hypoplasia in the late medieval adult population of Alytus. Selection of the sample used in this study was random, as an attempt was made to fill 10 year age-at-death intervals. Selection of individuals within these 10 year intervals was, however, random. Sex was determined using routine morphological criteria [17]. The age of death was estimated according to Olivier, Simpson and Gerasimov [1]. In a study of the distribution of enamel hypoplasias within teeth was found that the middle third of tooth was invariably the most hypoplastic, followed by the incisal/cuspal and cervical thirds and it also became clear that labial sides of anterior teeth are more hypoplastic than lingual sides as in Goodman and Armelagos (1985). Thus, loss of enamel near the occlusal surface due to attrition is likely to be of minimal significance. Anyway, teeth with dental attrition estimates of 5 or 6 degree were deleted from the sample.

At least six undamaged permanent teeth needed to be present for an individual to be included in to the sample. At least three of these needed to come from the anterior dentition (incisors, canines). The latter was required due to the greater sensitivity of the anterior teeth to hypoplasia [8]. So the sample consisted of 193 adults (101 males and 92 females). Specimen from these groups were over 20 years of age. Each dentition was examined using a stereomicroscope and magnifying lens. All enamel defects were classified based on the criteria of Schultz [18]. Linear enamel hypoplasias were graded for severity based on width, depth, and definition.

RESULTS

The linear enamel hypoplasias distribution in chronological groups is shown in Figure 1. The number of individuals with enamel defects had tendency to grow slightly from earliest to later periods and reach peak in 16–17 c.c., where incidence was 50.00±11.78%. Individuals from the group of graves without inventory (ND) had lowest incidence of LEH.

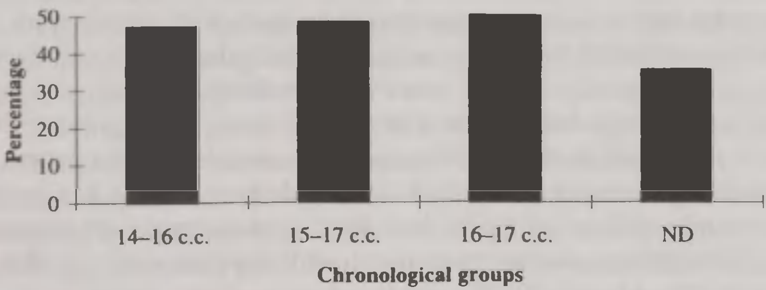

Figure 1. LEH distribution depending.

Were detected no significant differences between sexes were found: for males, percentage was 40.59%, females — 42.39%.

Figure 2 shows the percentage of individuals with LEH in age at death groups. This distribution shows decrease of proportion of individuals with LEH in older age classes. No significant difference was detected for pitting hypoplasias.

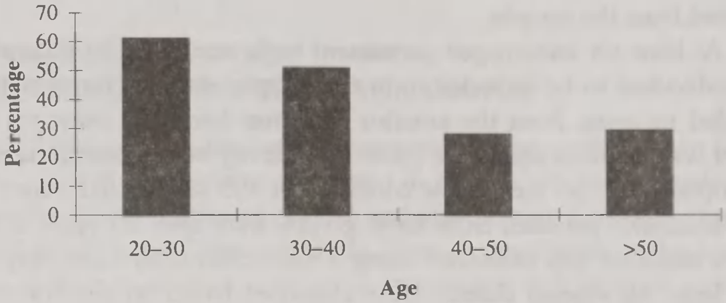

Figure 2. Age at death distribution for individuals with LEH.

DISCUSSION

Goodman and Armelagos (1988) examined the relationship between linear hypoplasias and age at death in three different cultural horizons of the Dickson Mounds population. They found the relationship to be nonsignificant in the earliest, late Woodland sample. In the Mississippian Acculturated LateWoodland sample, individuals with one hypoplasia/stress episode died 5.5 years younger than individuals with normal teeth, while individuals with two or more hypoplasia/stress episodes died 8 years younger than individuals with normal teeth. In the latest, Middle Mississippian sample, individuals with one hypolpasia/stress episode died 7.3 years younger than individuals with normal teeth, while individuals with two or more such episodes died 15.7 years younger than individuals with normal teeth. This pattern of increasing mortality of stressed individuals over time is concordant with other skeletal and dental indicators, wich suggest a deterioration in the health status of the Dickson Mounds population during Middle Mississippian times [7]. The results of our analysis also reveal a significantly lower mean age at death for individuals with enamel defects. No significant differences were found between distributions of sex with enamel defects.

Studies of skeletal stress indicators other than enamel defects lend further support to the hypothesis that early childhood stress results in reduced age at death. In a study of tooth crown size and age at death in prehistoric Native Americans from Averbuch site in Tennessee, Guagliardo found that the permanent teeth of juveniles were significantly smaller than those of adults. Archeological and biological evidence suggests that the Averbuch population suffered considerably from environmental stressors. The findings of this study suggest that teeth may fail to develop to their maximum genetic size potential in the presence of cronic environmental stressors [12].

The findings for Alytus are in fundamental agreement with these earlier study. The hypothesis that individuals who are stressed early in life suffer an earlier mean age at death appears to be strongly supported. The mechanism responsible for this early mortality of stressed individuals remains to be elucidated.

In Alytus burial ground which spans about a 300 years, individuals with enamel defects may represent persons who lived during periods of resource deficiency; both the enamel defects and the early mortality would result from the resource deficiency.

During a 300 year time span, several periods of severe resource deprivation are almost certain to occur. There are abundand historical evidences on the years of famine and epidemies in Late Medieval Lithuania [5]. Individuals in early childhood, living during these periods of deficiency would be likely to experience nutritionally related morbidity. These episodes of morbidity would be recorded on the teeth as enamel defects. Malnutrition is known to interact synergistically with infectious disease, resulting in both severe morbidity and increased risk of mortality. In this pattern, early mortality is not the result of biological damage during development. It is instead the result of an individual having the misfortune to survive during an extended period of resource deficiency.

The first major problem with this potential mechanism of mortality is the time interval between enamel defect formation and age at death. Enamel defects form during early childhood, with enamel formation complete by age 7 years, except in the third molar [19], the second problems antemortal tooth loss, that could decrease number of individuals with hypoplastic teeth in older age groups; this difficulty is avoided to some extent when only frontal teeth are taken for analysis, as first and second molars have highest antemortal loss rate in our materials. Finally, question of interpretation of morbidity as recorded in LEH and mortality seems to be worth of more detailed discussion. We think that striking on first sight discordance between high mortality in the "graves without inventory" group but lowest LEH score is not accidental. Archaeological data suggest that these could be either poorest members of community, either living in the latest period of cementery use (late 17th c.). In both cases, they had to suffer most stress, as the second half of 17th c. was the times of Russian invasion and heavy losses. Thus it seems that higher children mortality in the age when LEH are formed contributed to lower incidence of stress markers in adult age — simply lower number of stressed individuals survived to enter older age class. This way estimation of population general health status from sress markers alone not taking into account general demographic profile can lead to erroneous conclusions.

CONCLUSIONS

The early mortality of individuals with enamel defects at Alytus appears to be most likely due to environmental stress and biological response during development. The biological damage through activation of the physiological stress response during early childhood, social differences in access to resources and different survivorship rate, genetic variation in disease susceptibility were probably primary causes of early mortality at Alytus. The burial ground of Alytus requires further investigation.

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CZECH OBESE CHILDREN — LOSS OF BODY WEIGHT DURING REDUCING TREATMENT

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ABSTRACT

Childhood obesity is considered at present one of the most difficult problems in paediatrics, and it is one of the major health problems of industrialized society. Growth and development of obese children is different in several aspects. The authors submit the results of an anthropometric survey implemented in 1989 to 1996 in a group of 6 880 Czech obese children aged 6 to 18 years.

The patients were measured by the standard anthropometric technique according to Martin and Saller at the beginning and end of a six-week therapeutic weight reduction programme. The skinfold thickness at 14 sites was assessed by means of a Best caliper. The body composition was evaluated using Matiegka's equations. For evaluation of the weight reduction programme the paired t-test was used as a criterion of the quality of the evaluated parameters.

For the needs of the medical profession curves of the empirical percentiles of BMI for both sexes were plotted to evaluate the grade of obesity. From the analysis of anthropometric data using the paired t-test in 1949 probands it ensues that the most valuable information as regards circumferential measurements in boys is provided by the circumference of the abdomen, the gluteal area followed by the chest circumference. In girls the results are partly different — the gluteal circumference of thigh highly dominates, gluteal circumference follows, mesosternal chest circumference is the third. As to skinfolds, the authors recommend to monitor in boys the supraileac, subscapular and abdominal skinfold. In girls the following order was suggested: supraileac, thoracic (at the level of the 10th rib) and subscapular skinfold. From the accurate assessment of the body composition of obese children subjected to weight reduction ensues our recommendation that the loss of adipose tissue should be at least seven times greater than the loss of muscles. A lower ratio should be an indication for changing the reducing treatment. Methods of direct anthropometry, incl. calipering, can be unequivocally recommended as the method of first choice because of their non-invasive character.

Key words: Czech obese children, body composition, BMI, weight reduction.

INTRODUCTION

Childhood obesity is considered one of the most difficult problems in paediatrics [12] and the main nutritional problem in industrialized society [8]. Obesity is a complex pathological entity with a multiform and frequently undefinable etiology. We know that obesity develops from a very small imbalance of energy intake and output and that its etiological factors include in addition to genetic predisposition socio-economic status, size, education and lifestyle of the obese child's family [12]. Childhood obesity is defined as more than 120% of the ideal weight in relation to height-derived age [9].

The risks associated with obesity can be classified as mechanical and metabolic. The former include arthritis, osteoporosis, degenerative joint and bone diseases, muscular hypotrophy and respiratory deficiency. The main metabolic risks are hypercholesterolaemia, altered glucose regulation and hyperuricaemia [8]. Childhood obesity can be characterized from the metabolic aspect as basal and reactive hyperinsulinaemia concurrent with a reduced growth hormone response to provoking stimulation and elevated IGFl plasma concentration [11].

The effect of obesity on echocardiographic parameters is recorded by means of modern cardiological methods from the age of six years [14]. The incidence of hypertension is much higher in obese children and the correlation between hypertension and obesity is highly significant [19]. Evidence has been provided that the effect of obesity treatment (e.g. a low-calorie diet) should be evaluated with regard to the ratio of adipose tissue and lean body mass [13].

The simplest way how to define obesity is anthropometry. Even combined clinical and anthropological studies using the most recent imaging, laboratory and anthropometric methods are an asset.

The simplest ways how to define and detect obesity include the use of selected anthropometric methods which, combined with clinical and biochemical ones, make it possible to assess more accurately the body composition and biochemical status of the obese subject. A combination of the mentioned methods makes it also possible to propose and follow up objectively the process of weight reduction.

A typical feature of obese subjects is body composition with a dominating above average development of the adipose component. Quantification and classification, also as regards distribution of subcutaneous body fat, is despite various methods a problem not only in the obese population.

Objectives

1. To elaborate criteria for the evaluation of obesity of the contemporary Czech child population, as the criteria used in this country and worldwide are very problematical.

2. To elaborate and offer paediatricians, family physicians and obesitologists respective generally available non-invasive methods for the evaluation of the habitus and body composition during childhood.

3. To define a battery of anthropometric parameters according to which obesity will be evaluated as well as its changes in conjunction with the aimed reducing treatment and the prognosis of risks associated with obesity and its therapy.

MATERIAL

In 1986 and 1996 a large amount of anthropological, biochemical, anamnestic and clinical data on obese children aged 6 to 18 was gathered. The data were collected in children's sanatoria in Sadska and Podìbrady.

Sample 1: n = 1,949 (720 boys, 1,229 girls) — the data of a complex anthropological examination at the beginning and at the end of the stay in the sanatorium, essential anamnestic and biochemical data were studied. Sample 2: n = 6 880 (2 585 boys, 4 295 girls) — examined data height, body weight at onset and at the end essential biochemical data, blood pressure, length at birth, body weight at birth, period of breast-feeding, start of obesity, parents body composition were studied. Samples of obese children examined in sanatoria include different degrees of obesity.

METHODS

A comprehensive anthropological examination was made at the beginning and at the end of the six-week period of the children's stay in the sanatorium. The anthropometric examination was made by standardised anthropometric technique according to Martin-Saller [2, 4, 10, 14]. The skinfold thickness was assessed with the Best type caliper [1, 18] — the Harpenden caliper has a range of only 40 mm which is notsufficient for obese children. Body composition was assessed by Matiegka's equations.

Besides height and body mass, 11 length and height parameters, 11 width and 13 circumference parameters and the thickness of 14 skinfolds were assessed. In most cases the skinfolds thickness was measured at the beginning and at the end of therapy for many years by the same anthropologist. Since 1995 measurement of bioeletric impedance has been added to test the possibility of using this method for assessing the amount of fat. Age categories were defined according to WHO (e.g. children aged six include probands aged 6.00 to 6.99). Data were processed by the computer program "ANTROPO" [4].

RESULTS

For medical practice it is certainly important how the individual is classified with regard to the diagnosis, in our case "ad obesitas". Therefore, based on data assembled from 6,880 obese Czech children and adolescents aged 6–18 years, percentile BMI values were calculated and percentile figures were plotted (Fig. 1, 2). Classifying the child according to BMI in the graph of obese children is necessary for the assessment of the grade of obesity and the therapeutic plan.

Another important objective of our project was to select a battery of anthropometric characteristics suitable as markers of successful treatment and to assess the order of importance of selected characteristics. As a criterium for evaluation of the importance of a characteristic with regard to the success of treatment, its main objective being to reduce the body weight by reduction of the body fat, the paired t-test was used [5]. More than 202 body parameters were tested in patients at the beginning and end of six-week's treatment. Of these 70 proved useful for obesitology.

The calculations were made separately for each sex and separately for different age groups. So far 971 pairs of girls and 569 pairs of boys have been studied. (The final number will be higher as the groups examined in autumn 1996 were not yet included into the final groups). Also the total number of examined probands at the onset of treatment was higher than at the end as some patients did not complete their stay for various reasons. Here we are presenting data for combined age groups. The value of the paired t-test depends always in a certain way on the size of the group. In different age groups the number of obese children is different, being usually smaller in the younger age groups. At the beginning of school age, according to our experience, the percentage of obese subjects in the child population is lower and increases with age. Since 1980 we have been engaged in research where we subjected more than 40,000 children to detailed anthropological examinations [1, 2, 3, 4, 15]. A higher percentage of children comes to the sanatorium at the age around puberty and afterwards and there are also marked differences in the number of boys and girls. We calculated also the values of the paired t-test for a uniform value of n = 100. We are aware of the fact that the calculation is not quite accurate, but it makes it possible to eliminate different frequencies in different age groups. A higher value of the paired t-test implies that the given parameter changed more markedly during treatment. In different groups characteristics from the highest to the lowest value of the paired t-test were investigated.

We assume thus that parameters with a higher "t" value are also more accurate markers of successful treatment. The selected signs and characteristics were divided into groups where the measurements a) need not be done by an anthropologist (group of circumferential measurements and set of selected skinfolds) and b) where the participation of an anthropologist is essential (in addition to the above mentioned parameters others are involved which make it possible to assess the body composition constituents according to Matiegka's equations, ponderal and other indexes.).

First we analyzed the circumferential measurements (Table 1). Of 12 selected circumferences in boys the most important ones are the abdominal and gluteal circumference followed by the circumference of the chest along the mesosternale (in boys measured across the thelion), after a major interval followed by a set of four circumferences — the chest circumference measured acrosss the xiphosternale and three circumferences on the upper extremity. The last ones are the circumference of the wrist and minimum circumference of the leg. In the girls the results are different — the gluteal circumference of the thigh dominates in a marked way, followed by the gluteal circumference, the third is the chest circumference measured across the mesosternale, followed by a group of five circumferences of the upper and lower extremities. The least important are, similarly as in boys, the circumferences of the wrist and the minimum circumference of the leg.

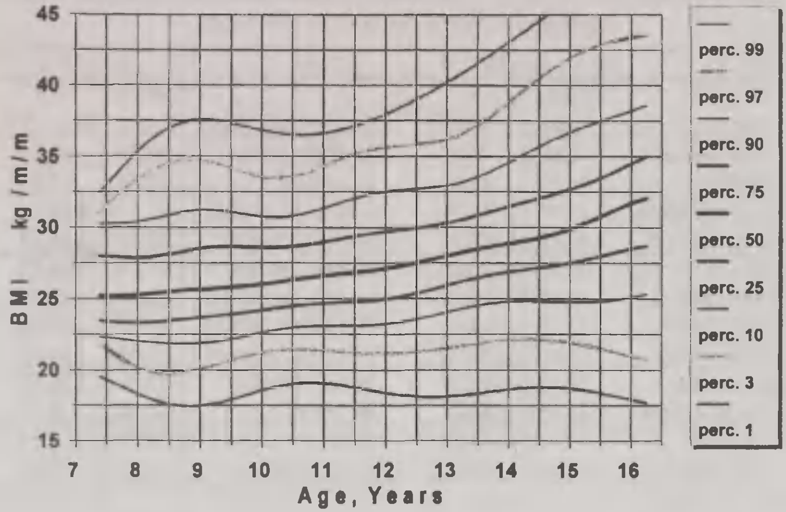

Figure 1. BMI of Czech obese boys.

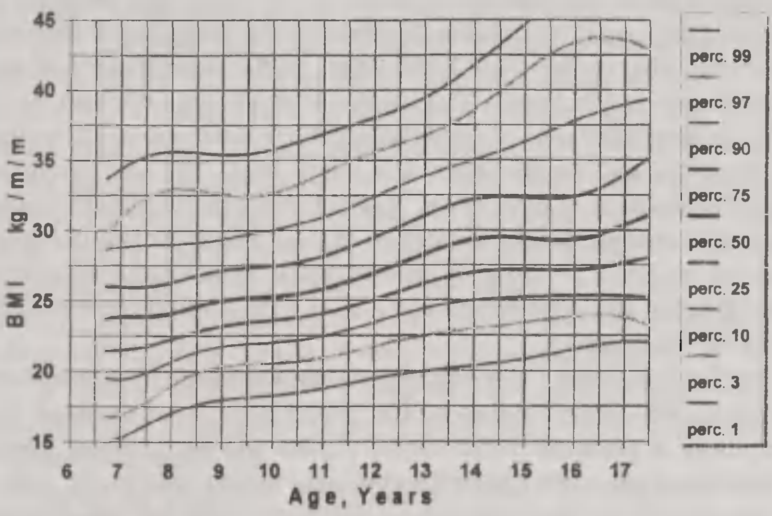

Figure 2. BMI of Czech obese girls.

Table 1

Seleted parameters (circumferential measurements) listed according to paired t-test obese Szech children (6–18 years)

Boys	(n = 569)		Girls	(n = 971)	
Circumference	Paired T-test	for (n = 100)	Circumference	paired T-test	for (n = 100)
1. abdominal	**45,86**	**19,23**	**1. thigh gluteal**	**66,05**	**21,24**
2. gluteal	**45,52**	**19,09**	*2. gluteal*	*55,24*	*17,86*
3. chest (OTHM)	***42,85***	***17,96***	3. chest (OTHM)	49,52	15,93
4. thigh gluteal	***42,60***	***17,85***	4. abdominal	47,54	15,29
5. chest (OTHX)	33,87	14,20	**5. arm relaxed**	**43,22**	**13,90**
6. arm relaxed	33,65	14,19	**6. arm flexed**	**42,34**	**13,82**
7. arm flexed	31,77	13,41	**7. chest (OTHX)**	**41,98**	**13,50**
8. forearm max.	31,63	13,40	**8. forearm max.**	**39,44**	**12,68**
9. calf max.	**29,33**	**12,29**	9. thigh medial	33,81	10,88
10. thigh medial	**29,22**	**12,25**	10. calf max	29,08	9,35
11. wrist	19,73	8,34	*11. wrist*	*24,76*	*8,08*
12. calf min.	16,59	7,01	*12. calf min.*	*16,31*	*5,33*

When checking the therapeutic results we assessed also 14 skinfold thicknesses (Table 2). In obese boys the dominating position is held by the suprailiacal skinfold, followed by the subscapular and abdominal one, the third group is formed by the skinfold under the chin above the hyoid bone and on the chest 2. Significantly less information is obtained from the skinfold above the biceps. In obese girls the highest values of the paired t-test were obtained in the suprailiacal skinfold and the skinfold on the chest 2, the value for the subscapular and abdominal skinfold is lower. The above skinfolds are followed by a group of three skinfolds — on the thigh above the quadriceps, on the leg 2) medial and on the chest 1 (axillary line). The last group is formed similarly as in boys by the skinfold above the biceps. From the results it is obvious that for evaluation of loss of body weight the skinfolds on the trunk particularly are important, in boys also skinfolds under the chin above the hyoid bone and in girls skinfolds on the thigh above the quadriceps.

Furthermore some other calculated characteristics were analyzed (Table 3): the highest values of the paired t-test were assessed for body mass, in particular BMI, Rohrer's index and the ponderal index. The assessed values are higher than for body weight, also the "t" value for the sum of ten skinfolds is high. High values of the paired t-test were not found for the percentage of adipose tissue in boys — assessed according to the method of Pařízková [18]. Low values of the paired t-test were recorded for the waist-hip ratio, WHR.

Table 2

Selected parameters (skinfolds thicknesses) listed according to paired t-test obese Czech children (6–18 years)

Boys	(n = 569)		Girls	(n = 971)	
skinfold	paired T-test	for (n = 100)	skinfold	paired T-test	for (n = 100)
1. suprailiacal	**49,96**	**20,94**	**1. suprailiacal**	**54,26**	**17,45**
2. subscapular	***45,86***	***19,24***	**2. chest 2**	**53,45**	**17,35**
3. abdomen	***43,76***	***18,36***	***3. subscapular***	***50,98***	***16,39***
4. chin	41,01	17,19	***4. abdomen***	***50,92***	***16,37***
5. chest 2	40,00	17,02	5. thigh frontal	43,53	14,00
6. chest 1	**38,89**	**16,31**	6. calf medial	41,58	13,92
7. thigh frontal	**37,34**	**15,18**	7. chest 1	42,32	13,61
8. triceps	35,52	14,89	**8. triceps**	**40,10**	**12,89**
9. calf medial	34,07	14,46	**9. chin**	**38,59**	**12,41**
10. cheek	*28,39*	*11,90*	**10. patella**	**37,58**	**12,09**
11. patella	*27,92*	*11,72*	11. calf 1	34,56	11,11
12. calf 1	*26,71*	*11,21*	12. biceps	31,06	9,99
13. forearm	*24,45*	*10,26*	13. cheek	30,	9,92
14. biceps	*15,53*	*6,51*	14. forearm	26,66	8,57

As already mentioned, one of the suitable methods for assessment of body composition also in the obese are Matiegka's equations [7, 17]. As apparent from table 3, during the stay in the sanatorium on average also a reduction of the muscle mass in kg occurred in both sexes. The assessed value of the paired t-test is significant and provides thus evidence of our previous findings that rapid reduction of body weight leads also to a loss of muscle mass. This was confirmed not only in obese children but also in sportsmen, even in elite sportsmen. The finding is associated with objective difficulties linked with reducing therapy. The finding is in our opinion more serious in children as compared with adults as the loss of muscles in the growing organism signalizes the risk of relative protein deficiency.

A marked decrease of the adipose tissue constituent is certainly desirable and the assessed values of the paired t-test are not among the highest assessed values.

From our long-term investigations ensues the important finding which must be considered in connection with loss of body weight, and not only in obese children, that a procedure for weight reduction can be recommended only if the loss of adipose tissue is at least seven times higher than the loss of lean body mass. In subjects with greater losses of muscles a modification of the reducing treatment should be considered. Our initial results obtained formerly indicated an adverse muscle/fat ratio during treatment.The management of the sanatorium accepted our findings, they modified treatment and recently the above ratio is much more favourable in the majority of patients.

Table 3

Selected parameters listed according to paired t-test
obese Czech children (6–18 years)

	Boys	(n = 569)		Girls	(n = 971	
Parameter	paired T-test	for (n=100)	difference	paired T-test	for (n=100)	difference
Body weight	56,54	23,70	8,67 kg	70,80	22,72	7,60 kg
Weight comput.	40,04	19,44	7,79 kg	48,87	18,63	6,95 kg
Muscles – Mat.	9,24	3,89	–0,82 kg	6,87	2,21	–0,45 kg
	28,62	12,02	+3,66%	37,94	12,21	+3,54%
Fat – Matiegka	55,35	23,27	–7,79 kg	68,11	21,90	–6,56 kg
	50,47	21,21	–6,94%	58,66	18,87	–6,32%
Sum of 10 skinfolds	64,32	29,92	–56,8mm	68,60	24,72	–49,2 mm
% of fat (Pařizková)	45,34	19,69	–3,43%	68,60	22,22	–4,76%
indexes						
BMI	71,58	30,00	–3,56	86,31	27,70	–3,21
Rohrer	66,64	27,94	–0,23	76,68	24,	–0,21
Ponderal	71,64	30,03	+1,80	78,88	25,31	+1,61
WHR	15,81	6,23	–2,37	14,63	4,71	–2,30

DISCUSSION

At present in medical practice evaluation of obesity is usually based on the relation of height and body weight of the individual. Several criteria are used. Thus, e.g., we consider children obese when their body weight exceeds that corresponding to age and height by two standard deviations. Children who are in the range between 1 and 2 standard deviations are described as overweight [2, 3] children. Some authors express the degree of obesity in per cent above the reference value (15–30% excess weight is classsified as mild obesity. 30–50% as medium severe obesity and more than 50% as severe obesity). The first criterion is considered suitable for children, the second for adults.

One of the most widely used body weight indexes worldwide is the BMI, the body mass index. It is calculated as body weight in kg divided by the square of height in metres. We know, however, that the BMI, similarly to other body mass indexes, can provide only an orientation on the actual body composition of the individual — in a high BMI value the development of muscles and skeleton may play a fundamental part. For evaluation in adults the classification suggested by Knight [15] is usually used (a BMI value under 20 in men and under 19 in women is evaluated as low, 20 to 24.9 in men and 19 to 23.9 in women as medium, 25 to 29.9 in men and 24 to 28.9 in women as high and values above 30 and 29 respectively as very high). This classification and similar other classifications cannot be used for the child population due to the postnatal highly dynamic ontogenesis of the BMI.

As mentioned above, body indexes cannot provide more detailed information on body composition. Therefore, according to our experience, and that does not apply only to obese subjects, if we want to continue to use the BMI, we must break down its value to the body fat and "lean body mass", using anthropological methods for the calculation of body fat (e.g. assessment of skinfold thickness by a caliper, bioimpedance, etc.). The calculated body fat of the BMI proved for the interpretation of our data the most valid criterium of all methods used for the evaluation of the degree of obesity (appendix 1, 5, 12).

For obesitology the method of assessment of skinfold thicknesses by using a Best caliper with a sufficient range of the limbs is very important. Assessment of skinfolds thickness by means of a caliper is one of the non-invasive methods which makes it possible to assess the distribution of subcutaneous body fat and also to differentiate proportional obesity caused by overeating from unproportional obesity (usually with an endocrine etiology).

Attention is drawn to the greater pretentiousness and errors when making measurements in obese subjects.

The second approach makes it possible to assess the components of body composition, i.e. to assess the ratio of the skeleton, muscles, adipose tissue and the so-called residue. For our population it is clearly most suitable to assess the body composition according to Matiegka's equations [1, 5, 10, 17]. This method was elaborated on the central European population and we provided evidence that it is suitable also for the obese population. We elaborated for our population reference values of the mentioned basic components for both sexes from 3 to 70 years of age (see quoted publications).

Reference values for body composition by Matiegka have been published (Anthropometry of the Czechoslovak population aged 6 to 55 years, Èeskoslovenská spartakiáda 1985, volume I, part 1, volume 1 part 2, ÚNZ VS Praha 1986, Bláha P. *et al.* Anthropometry of Czech preschool children aged 3 to 7 years, volume 1, part 2, ÚSM Praha 1990, Bláha P. *et al.*, Application of physical anthropology in physical training and sports (Handbook of functional anthropology, Olomouc 1993, J. Riegerová M. Ulbrichová).

Matiegka's method based on skinfold thickness measurements, evaluation of basic dimensions of the postcranial skeleton and basic circumferences using computer programmes available in the Czech Republic ("ANTROPO") makes it possible to assess by non-invasive methods, which are neither time consuming nor expensive but very exact, the child's body composition and possible changes during reduction therapy.

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A SHORT COMMUNICATION ON THE FACIAL PROFILE OF NEOLITHIC SKULLS FROM SCANDINAVIA

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ABSTRACT

This investigation examines the facial profile of Scandinavian Neolithic skulls.
Key words: Neolithic skull, facial profile, ethnic anthropology

INTRODUCTION

Vertical and horizontal profiles of the skull are the most significant diagnostic features of the two main human racial stems: the profile is sharp in Caucasoids and flat in Mongoloids.

The vertical profile, first of all, is characterised by the nasal angle or trait 75(1) after R. Martin. It demonstrates a protrusion of the nasal bones from the sagittal middle line of the face. The angle is large in Caucasoids and small in Mongoloids. The development degree of the nasal bridge is usually defined by the simotic and dacryal indices. The first of them (SS:SC) expresses the percentual ratio between the simotic width, or chord (SC, measurement 57 after R. Martin), i.e. the shortest distance between nasomaxillar sutures, and the simotic height (SS) or the shortest projection of the nasal bridge to the simotic chord. The dacryal index (DS:DC) is also the ratio between the chord and the height, but in this case the chord is being estimated between the dacryons (DC or measurement 49(a) after R. Martin). The simotic index characterises the development degree of the nasal bones, and the dacryal index expresses that of the entire nasal bridge, including the frontal process of the maxilla. The values of the indices are high in Caucasoids and low in Mongoloids [1].

The horizontal profile of the upper part of the face is reflected in the value of the nasomalar angle (trait 77 after R. Martin). Its apex lies on the nasion and its sides go through the fronto-malar-orbital points. The angle fluctuates between 135° and 139° in Caucasoids and is about 148° or 149° in Mongoloids. The profile of the middle part of the face is being characterised by the zygomaxillar angle (<zm'), which has its apex on the subspinal point and its sides touching the anterior zygomaxillar points [2]. The mean values of the angle are low (124°–127°) in Caucasoids and high (141°–142°) in Mongoloids. The sharp horizontal facial profile of the upper part is called clinopy, that of the middle part—clinognathy, that of the entire face—clinoprosopy, and the flat profile is called correspondingly platiopy, platignathy and platiprosopy. If both parts of the face are flattened to the same extent, the phenomenon is treated as homoplatiprosopy, the opposite case is named heteroplatiprosopy [3].

Investigations of facial profiles are not very common in the West, however, they form an obligatory part of craniometric programs of Russian anthropologists, who very often examine the population from the borderline of two racial stems—Caucasoids and Mongoloids.

In addition to these essential diagnostic features, there are more Mongoloid characteristics, as obligatory brachycrany, hipsiconchy, very broad forehead, a rather peculiar ratio between segments of sagittal vault arch, i.e. shortening of the parietal segment on account of the occipital one [4], differences in the depth of the canine fossa and bend of the zygomatic bone, etc. Anthropologists, especially Russian, use the above-mentioned traits, particularly the horizontal facial angles, not only for delimitation of the main racial stems but also in order to estimate the Mongoloid, or oriental, racial admixture in Caucasoid populations, especially in the contact areas.

As early as in 1940, E. V. Zhirov expressed the opinion that a very ancient Mongoloid admixture is characteristic of East and even of Central Europe (as far as the Berlin line). The discussion that flared up immediately has been elucidated comprehensively by Gochman [5], Alekseyev [6] and Gerasimova [7], therefore it is not necessary to present here the historiography and references of the question. It is sufficient to say that anthropologists are divided into two groups. Some of them have treated and treat the flattening of the face (and particularly of its upper part) that has really taken place in the skulls of the region since the Mesolithic times as oriental admixture (Vitov, Mark, Cheboksarov, Debets, Alekseyev, Denisova, and others); the other group has explained the phenomenon as the process of morphological convergence, for they did not perceive the traces of the entire Mongoloid complex for substantiation of the mixing hypothesis (Yakimov, Bunak, Schwidetzky, Gochman, and others). According to Yakimov [3], a slight flattening of the face and particularly of its upper part is a pseudo-Mongoloid peculiarity, and it is necessary to look for its source in the initial homeland of *Homo Sapiens*, in the group of the *Paleoanthropus*.

Leaving aside the theoretical side of the question, we were concerned with examining the facial profile of Scandinavian Neolithic skulls. Such data from the western part of Europe are lacking. They might help to solve the above-mentioned problems of ethnic anthropology in Central and East Europe.

MATERIALS AND METHODS

The Middle Neolithic crania from Bidstrup, Frejlev, Skov and Kyndelöse as well as the Late Neolithic ones from Borreby, Denmark, were investigated in Panuminstitute, Copenhagen. The crania were dated and their sex determined according to the publications by Jørgensen [8] and Bennike [9]. In the Osteological Laboratory of Stockholm University and in the Stockholm Museum of History, we had an opportunity to examine the facial profile of the Middle Neolithic population from Gotland (Visby, Ihre, Västerbjers) and continental Sweden from the triangle between the lakes of Vänern and Vättern as well as from Gothenburg (Karleby, Slutarp, Knaggården). The dating and sex diagnosis was performed according to the publications by Stenberger *et al.* [10], Janzon [11] and Retzius [12]. The nasomalar and zygomaxillar angles as well as the simotic and dacryal indices were measured in 77 skulls (Tables 1, 2 and 3). Measurements were made using a co-ordinate calliper. Simple statistics for evaluation of the facial profile were performed, hoping to use more complex methods for comparing different craniological samples from West Europe, when the data on their facial profile become available. This paper might be the first contribution to such studies in the West.

Table 1

Facial profile of Neolithic Danish skulls

Sample	Dacryal index	Simotic index	Nasomalar angle	Zygomaxillar angle
		Males		
Bidstrup	51.4 (3)	48.1 (3)	137.5 (4)	125.2 (3)
Frejlev Skov	49.5 (2)	45.3 (3)	141.3 (3)	123.8 (3)
Kyndelose	55.2 (3)	46.2 (4)	141.6 (5)	125.2 (6)
Middle Neolithic totally	52.3 (8)	46.5 (10)	140.1 (12)	124.8 (12)
Borreby	58.0 (13)	53.4 (14)	140.5 (16)	126.0 (13)
Middle and Late Neolithic totally	55.9 (21)	52.6 (24)	140.4 (28)	125.5 (25)
		Females		
Bidstrup	–	–	–	–
Frejlev Skov	–	41.5 (1)	131.9 (1)	–
Kyndelose	55.2 (3)	39.1 (4)	141.7 (4)	126.6 (3)
Middle Neolithic totally	55.2 (3)	39.6 (5)	139.7 (5)	126.6 (3)
Borreby	51.1 (8)	42.5 (8)	138.9 (9)	126.5 (8)
Middle and Late Neolithic totally	52.2 (11)	41.4 (13)	139.2 (14)	126.5 (11)

Table 2

Facial profile of the Middle Neolithic skulls from Sweden

Sample	Dacryal index	Simotic index	Nasomalar angle	Zygomaxillar angle
		Males		
Visby	52.4 (2)'	45.5 (3)	141.3 (4)	124.2 (2)
Ihre	–	58.2 (1)	142.0 (4)	124.6 (2)
Västerbjers	54.2 (6)	38.4 (6)	142.7 (7)	127.3 (5)
Pooled Gotland sample	53.8 (8)	42.5 (10)	142.2 (15)	126.0 (9)
Karleby	–	53.5 (1)	145.1 (3)	–
Slutarp	–	51.2 (1)	133.5 (1)	–
Knaggården	72.7 (1)	45.4 (1)	134.0 (1)	116.4 (1)
Pooled continental sample	72.7 (1)	50.0 (3)	140.5 (5)	116.4 (1)
Total sample	55.9 (9)	44.2 (13)	141.8 (20)	125.1 (10)
		Females		
Visby	52.4 (1)	28.9 (1)	141.8 (2)	121.7 (1)
Ihre	59.5 (1)	51.1 (1)	139.2 (1)	124.2 (1)
Västerbjers	52.4 (1)	22.8 (1)	141.5 (6)	126.5 (2)
Pooled Gotland sample	54.8 (3)	34.4 (3)	141.4 (9	124.8 (4)
Karleby	46.6 (3)	36.0 (5)	142.6 (5)	128.0 (1)
Slutrap	60.1 (1)	39.4 (1)	135.6 (1)	123.8 (1)
Knaggården	–	–	–	–
Pooled continental sample	50.0 (4)	36.6 (6)	141.6 (6)	125.9 (2)
Total sample	52.1 (7)	35.8 (9)	141.4 (15)	125.1 (6)

Table 3

The main statistical parameters of the Neolithic Scandinavian skulls

The trait	Male skulls					Female skulls				
	N	M±m	S	As	E	N	M±m	S	As	E
Denmark										
Dacryal index	21	55.9±3.4	7.9	0.3	−0.9	11	52.2±3.1	5.2	−0.2	−1.5
Simotic index	24	52.6±3.2	8.1	−0.2	−0.6	13	41.4±3.5	6.4	1.4	1.7
Nasomalar angle	28	140.4±1.3	3.5	0.6	0.5	14	139.2±2.3	4.3	0.4	−0.5
Zygomaxillar angle	25	125.5±3.1	7.9	0.0	−2.9	11	126.5±3.4	5.8	−0.1	−1.0
Sweden										
Dacryal index	9	55.9±5.3	8.0	0.6	−0.3	7	52.1±5.4	7.3	−0.5	−1.3
Simotic index	13	44.2±5.1	9.4	−0.2	−0.8	9	35.8±7.7	11.8	0.1	−1.4
Nasomalar angle	20	141.8±2.3	5.1	0.7	0.5	15	141.4±2.9	5.7	0.3	−0.1
Zygomaxillar angle	10	125.1±2.2	3.6	−0.9	0.9	6	125.1±2.0	2.6	0.4	−1.2
Scandinavia totally										
Dacryal index	30	55.9±2.8	8.0	0.4	−0.7	18	52.2±2.8	6.1	−0.4	−1.1
Simotic index	37	49.7±4.0	9.4	−0.4	−0.3	22	39.1±3.9	9.4	−0.2	0.0
Nasomalar angle	48	141.0±1.2	4.3	0.8	1.3	29	140.3±1.9	5.2	0.5	0.1
Zygomaxillar angle	35	125.3±2.7	3.4	−0.1	0.9	17	126.0±2.3	4.9	0.2	−0.6

RESULTS AND DISCUSSION

In comparison with the Stone Age samples from the eastern coast of the Baltic Sea and some series from East Europe (Fig. 1), the zygomaxillar angle of the Scandinavian groups does not reach the maximum limit for Caucasoids, and this fact indicates a sharp facial profile in its middle part. However, the values of the nasomalar angle cross the limit and point to some flattening of the upper part of the face. In some Swedish samples (Table 2), the values exceed significantly the upper limit for Caucasoids: the value of the angle is 142.0° in the males of Ihre, 142.7° in those of Västerbjers, 141.8° in the females of Visby, 142.6° in those of Karleby. Thus we can ascertain some degree of platiopy with preserved clinognathy at the same time. It is necessary to point out that this characteristic makes the Scandinavian Stone Age skulls very similar to the samples of Boat Axe and Pamariu (Baltic Coastal) cultures from the South-East Baltic region (Lithuania and Prussia).

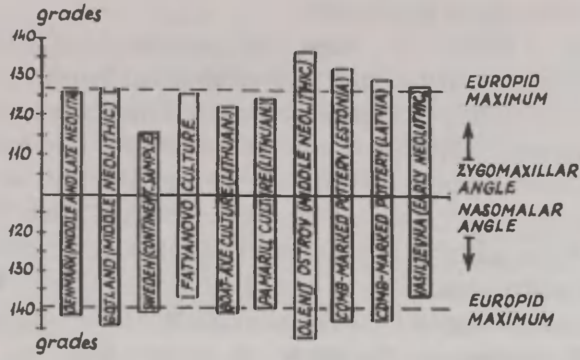

Figure 1. Comparison of horizontal profile angles

Individual variability of the simotic and dacryal indices is usually very high, and their mean values depend to a great extent on the number of cases investigated. Nevertheless, it is possible to say that the mean values of the indices are rather high in the Scandinavian groups and this indicates a good development of the nasal bridge, which is characteristic of Caucasoids (Fig. 2). It would be very useful to examine the whole complex of the above-mentioned oriental traits in Scandinavian skulls; unfortunately, it was technically impossible at that time. Still, according to the publications [8, 13, 9], the Scandinavian Neolithic populations were rather homogeneous Caucasoids.

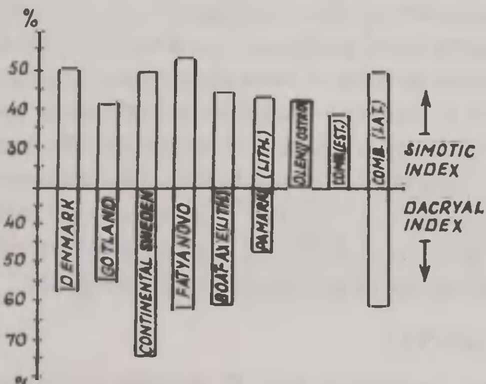

Figure 2. Comparison of dacryal and simotic indexes

What might be the reason for platiopy (heteroplatiprosopy) of the Scandinavian Neolithic population?

Concerning Gotland, the Stone Age populations of which were mixed from the viewpoint of cultural attribution but homogeneous from the viewpoint of anthropological structure [14, 13], it is quite believable that there was some infiltration of newcomers from the East Baltic coast. Only 80 sea miles separate Gotland from the Latvian coast, where platiprosopic people of the Comb- and Pit-marked Pottery Culture have been detected [15]. In addition, rare examples of that kind of pottery have been found on the island [11]. Besides, Fürst [16] and Dahr [14a] drew attention to some "atypical" skulls from Visby and Västerbjers. Certainly, while looking at the photo of female skull No. 6 from Västerbjers, a rather flat face and high orbits arrest one's attention. Nevertheless, according to 7 craniometric traits, the "atypical" crania do not differ from the others mathematically [13].

Quite a different answer might be given concerning a slight platiopy in South-Western Sweden and especially in Denmark. There is no data that the tribes of oriental origin might reach so far North-West and to such an extent that it would be possible to change the anthropological type of the autochtonous population, or actually, not the entire type but only one trait of the facial profile. Though mesobrachycrany was not rare and rather old in Scandinavia, at least synchronous with the Stone Age dolichocrany [17], it need not have emerged obligatorily from the East. The Caucasoid character of other profile traits in the Danish and continental Swedish skulls investigated make an admixture of oriental elements quite dubious.

Generalising the results of this investigation, it is possible to say that the new data on the facial profile of Scandinavian Neolithic tribes permit us to support the opinion of the authors, who maintain that it is too risky to suppose an oriental admixture in Caucasoid populations only on the basis of platiopy when other cranial traits of oriental origin and, particularly, historical facts about human migration are lacking. Thus, in many cases, platiopy (even if combined with mesobrachycrany) in Central Europe and the Baltic region must be treated rather as not a result of mixing but of morphological convergence.

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PUBERTAL STAGES OF ESTONIAN CHILDREN

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ABSTRACT

A random sample of 941 southern Estonian children (444 boys and 497 girls) from age groups 9 to 15 years were randomly selected from 17 primary schools for the assessment cardiovascular risk factors. During the physical examination the sexual maturation rate was evaluated according to the internationally accepted Tanner's five stages ranking. The 10th, 25th, 50th, 75th and 90th centiles were calculated for the development of the breast and pubic hair in girls and genitalia and pubic hair in boys. Mean age for menarche was 13.2±0.97. The median ages of onset of puberty were 11.6 years in girls and 12.2 in boys. The advancement of puberty coincides with the increase in weight and height in both boys and girls. Previous studies on pubertal development in Estonian children were performed in 1980s. Contemporary cross-sectional data provide information to newly started family doctors and pediatricians on the age- and sex — specific course of maturation. Sexual maturation data are indispensable in order to diagnose and treat abnormal sexual maturation.
Key words: Estonian children, sexual maturation, physical growth

INTRODUCTION

There is a wide variation in the normal onset and rate of puberty and there are many conditions which may affect this normal process [1]. Genetic and environmental factors both affect the onset of puberty. Since the 1990s marked socioeconomic changes have affected lifestyle in Estonia among them nutrition habits. Nutrition habits are among determinants for physiologic growth. Physical development parallels development of secondary sexual characteristics [2] and the changes of physical growth may influence sexual maturation course.

The cross-sectional study from 1908s in Estonian children done by R. Silla and M. Teoste [3] showed that the onset of puberty in girls was about 10 years and about 12 years in boys. The findings of cross-sectional studies have to be re-evaluated from time to time due to the problem of secular acceleration.

This study is aimed to obtain baselin information of age- specific course of maturation in girls and boys and physical characteristics according to sexual maturity rate.

MATERIALS AND METHODS

The school-based cross-sectional study was carried out from 1993 to 1995 in Southern-Estonia as a part of study on cardiovascular risk factors of Estonian children. The schools were selected from 5 counties resulting in a total of 17 secondary schools- 7 from towns and 10 from the countryside. Within a chosen school, children were randomly selected from the school roll and every third child within the appropriate age and sex group was proposed to participate. An overall response rate of 76% resulted in 941 children in the age range 9–15 years. The sample includes children of all socio-economic classes from urban as well as rural regions.

The assessment of puberty was based on the system devised by Tanner [4] which rates breast (B 2–5) and pubic hair development for girls (PH 2–5) and genital development (G 2–5) and pubic hair for boys on a five-point scale. To evaluate sexual maturity during these examinations, physicians referred to photographic atlas of the Tanner classification and assigned a grade of pubic hair development. Testicular size was estimated by palpating left testis and matching the size of wood ovoids of Prader orchidometer. The testis volume of boys aged 9 was measured by physician. In older age groups the measurement was performed by boys themselves.

The subjects' heights and weights were measured with the subjects in their underwear, and without shoes. Beam platform scales were used and weight was recorded to the nearest 0.1 kg. The scales were adjusted regularly in every school each year. Height was measured twice to the nearest 0.5 cm using wooden length boards. The child's head was placed in the Frankfort horizontal plane. An average of two measurements was used in the data analyses. Measurements were obtained by pediatricians, although other staff assisted in some schools.

The study was approved by the Ethics Committee of the Medical Faculty of Tartu University.

STATISTICAL ANALYSIS

The statistical package SAS was used for data processing. PROC UNIVARIATE was used for calculations of percentiles. Cumulative frequency curves for each pubertal stage (except for stage 1) were constructed. From these frequency curves, the median and various percentile values for each pubertal stage were obtained.

The range of normal for progress through the stages of sexual maturity is wide. Therefore the 10th, 25th, 50th, 75th and 90th percentiles were calculated.

RESULTS

There were 444 boys and 497 girls in the study sample. The progression of sexual maturation and the median ages and the respective percentile values for different stages of sexual maturation of girls and boys are summarized in Table 1. Puberty was reached at about

Table 1

Median ages and the respective percentile values for 10th, 25th, 50th, 75th and 90th centiles for sexual development in girls and boys

	Age (years)				
	Centiles 10th	25th	50th	75th	90th
Girls					
Breast					
B2	9.6	11.2	11.6	12.2	12.7
B3	11.2	11.6	12.2	13	14.6
B4	12.6	14.3	14.6	15.1	15.3
B5	14.4	14.7	15.0	15.4	15.6
Pubic hair					
PH2	11.3	11.8	12.1	12.4	13.1
PH3	11.8	12.3	14.1	15.0	15.4
PH4	14.2	14.6	14.9	15.2	15.5
PH5	14.3	14.8	15.4	15.6	15.6
Boys					
Genitals					
G2	10.0	11.6	12.2	12.6	13.7
G3	11.4	12.1	13.6	14.5	14.9
G4	13.1	13.6	14.1	15.1	15.3
G5	14.5	14.8	15.1	15.6	15.8
Pubic hair					
PH2	11.5	12.0	12.9	13.5	13.9
PH3	12.5	13.1	13.6	14.1	15.3
PH4	13.1	13.6	14.9	15.2	15.5
PH5	14.5	14.8	15.2	15.6	15.9

11.6 years in girls and 12.2 years in boys. Mean height and weight by pubertal stages is given in Table 2. Percentage of children reached different pubertal stages according to age groups 9, 12 and 15 years is shown in Table 3. Figure 1 shows age distribution according to different mammalian developmental stages in girls.

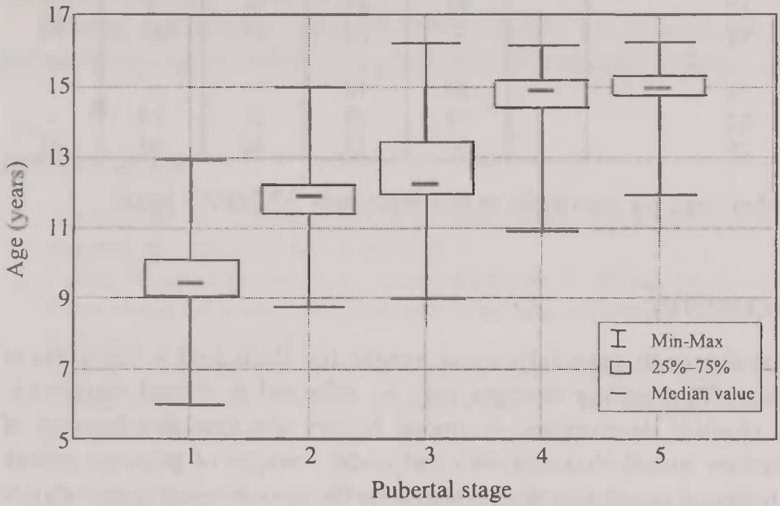

Figure 1. Age distribution in different pubertal stages of girls

Table 2

Mean height and weight by pubertal stages

	Mean height, cm	Mean weight, kg
Girls		
Pubertal stage		
2	148.9±7.6	37.8±6.7
3	157.5±7.4	45.1±7.3
4	164.4±5.7	54.5±8.0
5	165.4±5.6	56.4±6.4
Boys		
2	151.2±9.6	40.6±9.3
3	162.7±10.7	51.1±11.4
4	172.2±6.8	59.9±11
5	173.8±8.3	60.7±9.7

Table 3

Percentage of children reached different pubertal stages according to age

Age group (years)	N	Pubertal stages 1–5				
		1	2	3	4	5
Girls						
9		88	11	1.5	–	–
12		15	42	38	5	–
15		–	1.7	17	45	36
Boys						
9		84	16	–	–	–
12		19	59	21	0.9	–
15		–	13	32	34	20

Mean age for menarche in this study was 13.2±0.97 years.

DISCUSSION

Physical growth, especially mean weight, has decreased in teenagers of Estonia. This secular changes may be reflected in sexual maturation. The physical development is among factors affecting development of secondary sexual characteristics and under changes of physical growth in childhood population the standards for the sexual development should be revised.

Growth curves are in use since 1993 in Estonia and growth monitoring is more accurately performed compared to staging of sexual maturation. The measurements of sexual maturity rate of girls is more widely used. Determining testicular volume has been and remains an approximation. Testicular volume have been determined by several methods. Direct measurements have been obtained by use of calipers, ruler and wooden orchidometer. The use of orchidometers, the more convenient way for testicular measurements compared to other methods, is not in everyday use as well as other measurement methods among practicing physicians in Estonia.

When comparing the up to date onset of puberty of girls to data from study done in 1980s, it seems that the girls of the present study were somewhat later in their breast and pubic hair development than girls investigated in 1980s. There were no comparable data for boys. A comparison of average ages at the attainment of pubertal stages in various European studies according to Eveleth and Tanner [5], B 2 in most was reached at about 10.8 years, B3 was reached about a year later. In the present study the girls reached the puberty at about 11.6 years. Regarding the boys, G2 was reached at about 12 years. B2 preceeds G2 by 0.4 years. The entry of boys in this study to G2 is later compared to recently performed study by Roede in Netherlands [6] and by Willers in East Germany [7].

We also demonstrate that changes in physical growth parallel changes in sexual development.

Though age-specific cross-sectional studies are indispensable, a prospective longitudinal studies are needed for pubertal staging.

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CRANIOLOGY OF NEOLITHIC IN HUNGARY

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ABSTRACT

The authors investigated Neolithic (5100-3200 B. C.) cranial finds belonging to five different civilisations in the territory of today's Hungary. The typical variants of these cultures covering different periods and areas were grouped by a non-hierarchical cluster and a discriminant analysis. The variants constituted by a considerable number of crania were characterised by descriptive statistics.

According to the results, there are two circumstances being relevant for the population history of Neolithic in the Middle Danube Basin. The one of greater importance is the survival of autochthonous populations. The other is the assumed integration of southern (Balkan) elements into the local processes. In the authors' opinion, an elimination tendency of cranial differences can be outlined behind the variety of anatomical profile in time and space.

Key words: craniology, Neolithic, Carpathian Basin

INTRODUCTION

The present study aims at providing attainments concerning Neolithic populations in the territory of today's Hungary and going beyond the achievements of the previous research as regards both database and methodology [cf. 12, 13, 23, 29, 30, 31, 32, 33, 45, 47].

We could judge the population system of the cultures differing in time and space by diversity of fairly complete cranial samples. On the basis of osteological remains (Tables 1 and 2, Fig. 1), however, only fragments of the population history of Neolithic could be reconstructed.

Parallel with the representative sample of Neolithic Körös (K) population in the Hungarian Great Plain [25, 19] — a culture of southern origin, the first to settle down and live on for nine hundred years on this territory, we could reckon with only one Starèevo (S) cranium in the Transdanubian region [8]. East of the Danube we are in possession of chronologically continuous information available on the populations of Alföld Linear Pottery (ALP) culture [9] and Tisza culture which followed Körös culture. The emergence of ALP culture may have been attached to the development of a peripheral Mesolithic autochthonous population. After the climate optimum in the Atlantic, this expansion, setting out from the northeastern periphery and spreading to the south, progressively occupied the former Körös culture areas and differentiated into several groups (Tiszadob, Bükk, Szakálhát) [18, 36]. The skeletal remains from Tisza culture primarily represent populations of the tell settlements which developed under southern influences [10, 14]. West of the Danube altogether 5 male crania represent the so-called Bicske phase of Transdanubian Linear Pottery (TLP) culture [17]. The cranial finds that are at our disposal from Lengyel culture, the formation of which is still much debated, date back to approximately the same period as the finds from Tisza culture [7, 40].

Our comparative approach, therefore, is asserted in a chronological aspect (including Körös, ALP and Tisza cultures) and in a synchronic aspect (including Late Lengyel and Tisza cultures).

Table 1

List of finds

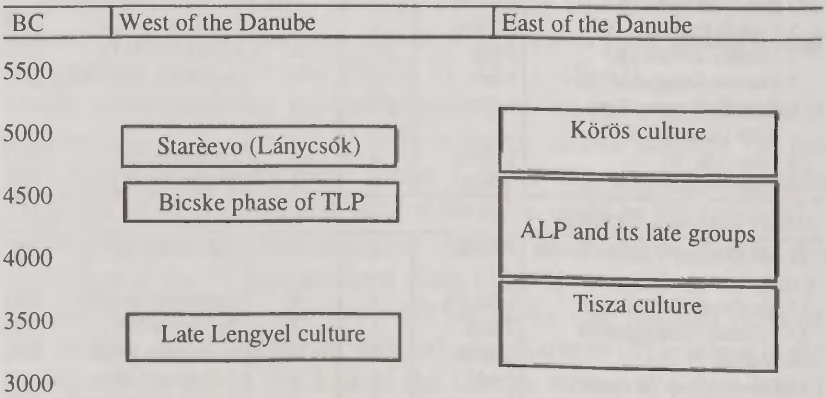
Locality	Code	Males	Females	References	
Körös-Starčevo Culture					
1. Csorvás-Orosházi útfél (K)	CsorO	1	0	Zoffmann 1984–85	(48)
2. Endrõd "1936" (K)	Endrod	1	0	Farkas 1975	(4)
3. Hódmezõvásárhely-Bodzáspart (K)	HmvBod	1	0	Farkas 1975	(4)
4. Hódmezõvásárhely-Kotacpart-Vata tanya (K)	HKV	7	4	Farkas 1975	(4)
5. Vaskút-Hieslkert (K)	Vaskut	1	0	Nemeskéri 1944	(22)
6. Deszk I. olajkút (K)	Desz	0	2	Lipták 1974–75	(15)
7. Szarvas-Szappanos (K)	Szarv	0	2	Zoffmann 1984–85	(48)
8. Szolnok-Szanda-Tenyõsziget-Dersi gát (K)	Szoln	0	2	Zoffmann 1993	(49)
9. Lánycsók (S)	Lanycs	0	1	Zoffmann 1977	(43)
10. Szajol-Felsõföld (K)	Szajol	0	1	Szathmáry in print	(37)
Alföld Linear Pottery Culture					
11. Mezõberény-Laposi kertek alja	MezoL	3	1	Zoffmann 1993	(49)
12. Mezõcsát-Csemetekert	Mez-Cs	1	0	Szathmáry in print	(38)
13. Tiszaluc-Sarkadpuszta	TiszS	1	1	Zoffmann 1993	(49)
14. Vadna	Vadna	1	0	Szathmáry 1986	(34)
15. Felsõvadász-Várdomb	Fv-V	2	0	Zoffmann 1993	(49)
16. Zaránk	Zarank	1	0	Szathmáry 1978–79	(27)

Continue

Locality	Code	Males	Females		
17. Csanytelek-Újhalastó	CsU	2	1	Zoffmann 1993	(49)
18. Csongrád-Bokrospuszta	CsB	1	0	Zoffmann 1993	(49)
19. Körösladány-Kengyelköz	KorKe	1	0	Zoffmann in print	(50)
20. Békés-Déló	BekDe	0	1	Zoffmann 1983–84	(46)
21. Tiszalök-Hajnalos	TlokH	0	1	Szathmáry 1989	(35)
22. Miskolc-Büdöspest	MiskBu	0	1	Bartucz 1916	(1)
23. Miskolc-Hillebrand barlang	MiskHi	0	1	Szathmáry 1976	(26)
Transdanubian Linear Pottery Culture					
24. Bicske-Galagonyás	BiG	5	0	Zoffmann 1978	(44)
Tisza Culture					
25. Békés-Povádzug	BekP	1	2	Lipták-Farkas 1967	(16)
26. Hódmezõvásárhely-Gorzsa-Czukor major	HmGC	3	5	Farkas 1975; Farkas-Marcsik 1987	(4) (5)
27. Megyes-Bodzás	Megy	1	0	Farkas 1975	(4)
28. Őszentiván VIII	Osze	1	0	Farkas 1975	(4)
29. Szegvár-Tûzköves	SzeT	2	0	Zoffmann 1984–85	(48)
30. Vésztõ-Mágori halom	Vesz	3	3	Farkas 1974	(3)
31. Hódmezõvásárhely-Kökénydomb-Kapocsi tanya	HKK	0	1	Farkas 1975	(4)
32. Mezõtúr-Szentmiklószug-Berettyópart	MeSzBe	0	1	Zoffmann 1984–85	(48)
33. Őszentiván	Osze	0	1	Farkas 1975	(4)
Lengyel Culture					
34. Lengyel	Le	3	0	Malán 1929, Virchow 1890	(20) (39)
35. Pári	Pari	2	2	Kiszely 1973	(11)
36. Villánykõvesd	Vill	5	2	Zoffmann 1971	(41)
37. Zengõvárkony	Zen	10	13	Zoffmann 1974	(42)

Table 2

Chronology of the craniological samples on the basis of conventional dating



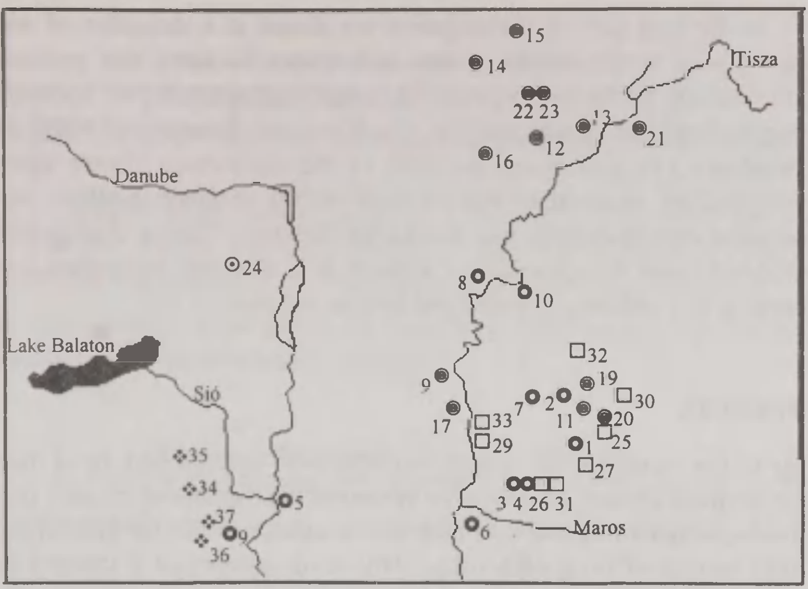


Figure 1. Neolithic localities examined.
Numbers refer to localities (see Table 1).
Cultures: ○ K-S, ◎ ALP, ⊙ TLP, □ Tisza, ❖ Lengyel.

MATERIAL AND METHODS

The database of Neolithic finds in Hungary includes 10 dimensions of 60 adult male and 49 adult female cranial finds from 37 localities (Tables 1, 10 and 11, Fig. 1). 11 male and 12 female finds belong to K-S culture, 13 male and 7 female finds to ALP culture, 5 male finds to TLP culture, 11 male and 13 female finds to Tisza culture and 20 male and 17 female finds to Lengyel culture.

Unfortunately, some dimensions had to be neglected because of the lower number of valid cases. Thus, for males 9 dimensions on the restored skulls were analysed the Martin's numbers. of which [21] are the following: 1, 8, 9, 20, 48, 51,52, 54, 66; for females, having dropped the dimension no. 66, we analysed 8 dimensions on the restored skulls.

In the sexes the missing values (for males maximum 6 ones, for females maximum 5 ones by individuals; for the total sample about 30%) were reconstructed by Dear's [2] method on the early sample of Neolithic (K-S, ALP, TLP) and on the late sample of Neolithic (Tisza and Lengyel cultures) separately.

In the first part of investigation we aimed at a detection of well definable cranial variants in time and space. To solve this problem, after having performed a principal component analysis, we applied a non-hierarchical cluster analysis, the K-means clustering of SPSS for Windows 7.0 version, on the basis of the individuals' factor scores weighted by eigenvalue. For this method the distance measure used between cluster centres was Euclidean distance. Then a discriminant analysis made this procedure complete as a diversity estimation concerning five cultures in males and four in females.

RESULTS

First, the structure of cranial variants was approached by a non-hierarchical cluster analysis. We increased the number of clusters until the individuals or groups of individuals characteristic for special cultures separated from each other. This level comprised 8 clusters for males (Table 10) and 6 clusters for females (Table 11). There is not any female finds belonging to TLP culture suitable for our analysis.

Table 3

Number of individuals belonging to a given cluster
in different Neolithic cultures

Males

Cluster	A	B	C	D	E	F	G	H	Total
K-S	–	1	4	–	3	1	1	1	11
ALP	3	1	5	–	2	2	–	–	13
TLP	1	–	3	–	–	–	–	1	5
Tisza	2	2	3	–	–	1	–	3	11
Lengyel	4	3	–	2	5	–	1	5	20
Total	10	7	15	2	10	4	2	10	60

Females

Cluster	A	B	C	D	E	F	Total
K-S	–	–	1	1	1	9	12
ALP	1	–	–	–	–	6	7
Tisza	–	–	2	1	4	6	13
Lengyel	2	3	5	–	4	3	17
Total	3	3	8	2	9	24	49

Table 3 clearly represents that new variants as compared to the initial phase are manifested in the clusters A and D and appears in ALP and Lengyel culture. The state of the cluster B is a permanent survivor. The cluster H is quite similar to that except for the initial autochthonous phase (ALP). The alternation of clusters C and D is also noteworthy. For males, since the first canonical discriminant function is significant, the cultures can be discriminated in 47 per cent of the total variance (Table 4).

Table 4

Canonical discriminant functions — Males

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr		After Fcn	Wilks' Lambda	Chi-square	df	Sig
					:	0	0.33899	56.25	36	0.0170
1	0.6258	47.25	47.25	0.6204	:	1	0.55113	30.98	24	0.1543
2	0.4728	35.70	82.95	0.5666	:	2	0.81170	10.84	14	0.6979
3	0.1945	14.68	97.63	0.4035	:	3	0.96957	1.60	6	0.9521
4	0.0314	2.37	100.00	0.1744	:					

As distinguished from males, no significant dsc function can be observed in the case of females (Table 5).

Table 5

Canonical discriminant functions — Females

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr		After Fcn	Wilks' Lambda	Chi-square	df	Sig
					:	0	0.47111	31.61	24	0.1369
1	0.6593	70.91	70.91	0.6303	:	1	0.78172	10.34	14	0.7367
2	0.2332	25.08	95.99	0.4349	:	2	0.96402	1.53	6	0.9569
3	0.0373	4.01	100.00	0.1897	:					

The separate parts of the samples are, therefore, similar to each other to such an extent that their characteristic features cannot be estimated in time and space reliably. Consequently, it is a survival that can be emphasised. In females, among the groups which are constituted by a considerable number of individuals, the cluster F may match the criteria of survival best. This cluster, however, contains more than half of all crania. The criteria of survival which does not comprehend early autochthony are manifested in the clusters C and E. New variants of ALP and Lengyel populations appear in the clusters A and B in females as well (similarly to A and D clusters in males). This phenomenon cannot be left out of consideration despite the low number of individuals (Table 3).

We deem expedient to describe the standard cranial variants only on the basis of clusters comprised by a considerable number of finds. Thus, we analyse four groups (A, C, E, H) in males and three groups (C, E, F) in females. If these groups are assessed by applying dsc analysis, their definite separation reveals. The percentage of correctly classified cases is 100.0 for males and 97.6 for females. On the basis of standardised canonical dsc function coefficients, these extracted variants can be differentiated according to 5 cranial dimensions in males and 6 cranial dimensions in females. Descriptive statistics are shown in Tables 6 and 7.

Table 6

Descriptive statistics of the main variants of males in discriminative cranial measurements

Measurements	Cluster A			Cluster C			Cluster E			Cluster H		
(Martin no)	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
1	8	194.5	7.1	13	185.3	4.8	10	184.0	4.2	9	190.9	6.2
8	8	136.3	9.7	14	139.9	3.6	10	140.6	5.4	9	128.8	5.6
9	7	97.0	3.2	15	97.7	2.3	8	93.9	3.8	10	95.2	3.2
20	8	125.5	3.1	12	116.1	2.8	9	116.2	3.2	5	120.6	3.0
66	4	98.5	4.2	8	102.1	3.7	7	93.8	3.4	1	95.0	–

Table 7

Descriptive statistics of the main variants of females in discriminative cranial measurements

Measurements	Cluster C			Cluster E			Cluster F		
(Martin no)	N	Mean	SD	N	Mean	SD	N	Mean	SD
1	8	174.9	3.9	9	177.3	5.4	22	182.2	4.6
8	8	129.5	6.0	8	129.4	4.3	21	136.8	5.6
48	7	60.9	3.6	5	67.0	1.6	12	66.8	3.1
51	8	35.9	1.2	8	39.6	1.4	10	37.5	1.8
52	8	30.6	1.3	7	34.0	1.5	11	30.6	1.5
54	6	23.5	2.4	4	24.8	1.7	10	25.0	1.3

They demonstrate long brain case in two clusters (A, H) of males. This phenomenon combines with high vertical dimension in one cluster (A) and medium vertical dimension in the other cluster (H). The two other variants (clusters C and E) manifest shorter and wider brain cases than those. The main difference between the two latter variants lies in bigonial breadth.

In the sample of females, the three extracted variants show expressed separation in cranial length. The shortest-headed type (cluster C) demonstrates low upper face and narrow orbital and nasal regions. The longest-headed type (cluster F), on the other hand, can be characterised as having wide brain case and large nasal and upper facial dimensions, while in the medium-length-headed type (cluster E) almost all dimensions of the face are considerably expanded.

The results outlined above indicate that at present we still are not in the possession of sufficient knowledge to reconstruct the history of

Neolithic populations in details. This is well represented by the fact that we could hardly point out parallel anatomical variants in the two sexes. The dimensional structure of female sample, by way of illustration, is so indefinite that it does not have significant dsc function (Table 5). As a consequence, it is the survival of Atlantic populations rather, which has already been assumed, that is worth emphasising [cf. 24].

Nevertheless, in the final part of our paper we make an attempt to introduce a possible reconstruction of the population system of each culture according to the classification results gained by the dsc analysis of the total sample (Tables 8 and 9).

Table 8

Average classification results — Males

Actual Group	No. of Cases	Predicted Group Membership (%)				
		1	2	3	4	5
1 K-S	11	54.5				
2 ALP	13	21.4	46.2			
3 TLP	5	24.6	3.9	60.0		
4 Tisza	11	4.6	3.9	4.6	63.6	
5 Lengyel	20	7.1	16.6	5.0	19.1	55.0

Percent of "grouped" cases correctly classified: 55.00%

Table 9

Average classification results — Females

Actual Group	No. of Cases	Predicted Group Membership (%)			
		1	2	4	5
1 K-S	12	50.0			
2 ALP	7	8.4	85.7		
4 Tisza	13	24.1	11.0	61.5	
5 Lengyel	17	7.1	17.7	12.7	41.2

At first sight (i), it is striking that an unambiguous connection between ALP and Lengyel cultures presents itself in both sexes. (As it has already been set forth, new cranial variants can be pointed out in these two cultures.) We are inclined to consider this interrelation as a representation of the autochthony of population in the Middle Danube Basin.

Secondly (ii), we have reasonable ground to presume that a considerable part of Körös population which developed under southern civilisation influences, infiltrated into ALP population which was more autochthonous than the former one was.

Thirdly (iii), we must call the attention for the grounded conjecture that the population of the two cultures (Körös and Tisza) which developed under southern impulses may have imported gene pools of similar character into the Carpathian Basin.

Fourthly (iv), we assume that in the course of the development of populations which are supposed to have been autochthonous, exterior influences may have been of minor importance. This assumption is also reinforced by the consequences of our first observation (i). In our opinion, in the course Neolithic, the former genetic and anatomical differences between the populations of the eastern and western regions of Middle Danube Basin may have become integrated by the age of Late Lengyel and Tisza cultures. This elimination process was broken by the so called Aeneolithic transformation [cf. 6, 28].

DISCUSSION

To sum up, we may establish that there is two circumstances determining the development of populations in the Middle Danube Basin during Neolithic. One is the autochtony, the other is the infiltration of southern (Balkan) influences. We are inclined to assume the survival of the basic population to have been the determinative factor with which the southern genetic impulses may have become integrated. The interconnection system of regional, cultural and chronological differences of cranial samples refers to an elimination of former differences which took place in the course of Neolithic.

Table 10

Basic data and cluster membership of finds — Males

Case Number	Culture	Code	Measurements' Martin nos.										Cluster
			1	8	9	20	45	48	51	52	54	66	
1	K-S	CsorO1	187	138	98								C
2	K-S	Endrod	173	135	94	113		74	40	33			G
3	K-S	HmvBod	178	145	99								C
4	K-S	HKV3/3	190	142	96	115		81	41	39	26		E
5	K-S	HKV3/5	195	146	104	126							B
6	K-S	HKV3/8	174	134	98			69	39	32	34	102	F
7	K-S	HKV78		143	98							99	C
8	K-S	HKVV/1	181	143	97	117							C
9	K-S	HKVA/1	184	139	90				38	30		93	E
10	K-S	HKV5/1	187	129	96	116		53	39	34	25		H
11	K-S	Vaskut	180	142	95	119	128	62		37	25	89	E
12	ALP	MezoL1	185		97	111		65				105	C
13	ALP	MezoL3	187	141	100	113	132	68					C
14	ALP	MezoL5	180	144	100	119	144	72				115	F

Continue

Case Number	Culture	Code	Measurements' Martin nos.										Cluster
			1	8	9	20	45	48	51	52	54	66	
15	ALP	Mez-Cs	186	139		110						96	E
16	ALP	TiszS9	185	142	102	118						95	C
17	ALP	Vadna1	202			130					27	100	A
18	ALP	Fv-V1A	185	144	98	117	135	74					C
19	ALP	Fv-V1B	177	147	107	114	141	77				107	F
20	ALP	Zarank	181	138		115		70	44	32	26		E
21	ALP	CsU6	188	147	93	126							A
22	ALP	CsU188	194	140	99	118	132	70				105	C
23	ALP	CsB6	188	148	97	129	129	71					A
24	ALP	KorKe1	190	143	104	126							B
25	TLP	BiG1.1	182	142	97	121		63	37	35	25	104	C
26	TLP	BiG2		140	92	115					29		C
27	TLP	BiG4	188	123	95	124							H
28	TLP	BiG5	181	137	96	116							C
29	TLP	BiG7	205	117		122							A
30	Tisza	BekP42	194	146	107			66			28	108	B
31	Tisza	HmGC8	201	131	98								A
32	Tisza	HmGC18	205	125	93				41		25		H
33	Tisza	HmGC20			102			67	42	31	26		A
34	Tisza	Megy13		149	103		132	75	38	31	27	111	F
35	Tisza	Osze	192	127	93								H
36	Tisza	SzeT67	188	132		122		65	40	31	29	107	B
37	Tisza	SzeT69	186	136	100	120					27	95	H
38	Tisza	Vesz2	182	135	100	114		62	38	33		100	C
39	Tisza	Vesz7	188	134	97	114	128	71	38	36	30	104	C
40	Tisza	Vesz13	194	135	96	119	129	72	37	31	24	105	C
41	Lengyel	Le1	187	139	95								H
42	Lengyel	Le3	186	128	99								H
43	Lengyel	Le2000	174	131	97	114	125	67	36	28	23		G
44	Lengyel	Pari5	192	122	95	122							H
45	Lengyel	Pari6a	195	130	97	121	128	68	37	27	24		H
46	Lengyel	Vill5	203		90						28	86	D
47	Lengyel	Vill9	193	145	82	121		70	40	28		91	D
48	Lengyel	Vill13	192	141	96	120	131	71	42	31	26	94	E
49	Lengyel	Vill17			89				35	30	25		H
50	Lengyel	Vill24	193	158	107	123		70	42	33	30	101	B
51	Lengyel	Zen57	180	134	95	114	133	73	44	33	26	97	E
52	Lengyel	Zen99	181	151	90	116		68	39	33	24	98	E
53	Lengyel	Zen102	194	137	99	125	145	62	42	35		98	A
54	Lengyel	Zen120	183	133	89	120	92		41	34	24		E
55	Lengyel	Zen125		138	97	121	94			34	29	93	A
56	Lengyel	Zen238	195	146	103	118	143	70	45	33	28	109	B
57	Lengyel	Zen272	190	135	93	125	96	68	40	34		103	A
58	Lengyel	Zen314	188	146		131		68	39	34		108	B
59	Lengyel	Zen338	188	137		126		61	41	30	27		A
60	Lengyel	Zen355	183	147	100	117					27	90	E

Table 11

Basic data and cluster membership of finds — Females

Case Number	Culture	Code	Measurements' Martin nos.										Cluster
			1	8	9	20	45	48	51	52	54	66	
1	K-S	Desz5	177	132	88	108	120	66	37	34	24	97	E
2	K-S	Desz6	177	138	96	109	128	70	39	29	25	100	F
3	K-S	HKV3/8	174	134	98			69				102	F
4	K-S	HKV113	179	142	94	110		70	39	29	25	101	F
5	K-S	HKV3/3	178	136	91	113							F
6	K-S	HKV5/2		141	98				39	32	26	92	F
7	K-S	Szarv1	183	122	98						27		F
8	K-S	Szarv5	185	145	92	113							F
9	K-S	Szoln3	182		93		118	64				92	F
10	K-S	Szoln6	185	142	95	120	130	64	34	31		97	F
11	K-S	Lanycs	169	135		106	122	62	34	31		94	C
12	K-S	Szajol	197	144	90	113							D
13	ALP	BekDe1	176	134	86	117						86	F
14	ALP	MezoL4	191	141	95	120		66				91	F
15	ALP	TiszS5	183	142	98	120	141						F
16	ALP	TlokHa	184	135	90	110			38	32	22		F
17	ALP	MiskBu	171	131	97	111	124	61	42	31	22	96	A
18	ALP	MiskHi	177	136	103	92						99	F
19	ALP	CsU252	190	139	92	119	124	67					F
20	Tisza	BekP43	184	134	94	116							F
21	Tisza	BekP68	174	134	86	116	112		41	32		99	E
22	Tisza	HmGC4	182	134	92	117	113		35	30	25		F
23	Tisza	HmGC5	173	134	92	107		68	39	34	23	96	E
24	Tisza	HmGC9	187	134		119							F
25	Tisza	HmGC10	172	133	92	114	118	62	35	31	26	90	C
26	Tisza	HmGC24	180	132	90	108		59	36	30	26	91	C
27	Tisza	HKK2	194	148	87	129	114	71		32		93	D
28	Tisza	MeSzBe			97	120		61	37	28			F
29	Tisza	Osze1	178	126	92								E
30	Tisza	Vesz1	181	134	96	118	119	71		31	26	96	F
31	Tisza	Vesz4	183	128	90	108		65	41	34	27		E
32	Tisza	Vesz6	180	136	96	117					25		F
33	Lengyel	Pari1	177	132	95	116	125	65	37	31	22		C
34	Lengyel	Pari8	173	128	90	108	115	65	36	28	21		C
35	Lengyel	Vill10	190		91	109		66	39	31	24	87	F
36	Lengyel	Vill21	176	110	94	112			39	33			A
37	Lengyel	Zen7	180	117	88	118			35	32	21		C
38	Lengyel	Zen021	177	127	99				39	33	25		E
39	Lengyel	Zen34	176		95	110		69	41	34			E
40	Lengyel	Zen43	188	122	97	129			39				E
41	Lengyel	Zen57	174	134		112		57	36	32			C
42	Lengyel	Zen88a	179	146	95	114		64	37	33			F

Continue

Case Number	Culture	Code	Measurements' Martin nos.										Cluster
			1	8	9	20	45	48	51	52	54	66	
43	Lengyel	Zen88b	189	139	93	120			42	34	26		B
44	Lengyel	Zen90	175	135	93	196							B
45	Lengyel	Zen281	170	132	90	106		67	40	37			E
46	Lengyel	Zen286	168	131	95	113	124	60	39	30	22		A
47	Lengyel	Zen337	186	135	91	125		70	39	32	29		B
48	Lengyel	Zen452	174	125	84	110		56	38	30	25		C
49	Lengyel	Zen741	182	128	98	114		69	38	31	25		F

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GENETIC AND CRANIOLOGICAL CHARACTERISATION OF ESTONIANS (IN RETROSPECT TO J. AUL'S STUDIES)

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ABSTRACT

The present work gives a population-genetic and craniological characterisation of the Estonian populations. The genetic data is based on 8 polymorphic systems on 39 Estonian territorial locations, the craniometric data on Estonian Medieval and Neolithic skulls. For comparison cranial samples from neighbouring territories from the Mesolithic to Medieval times were used. Genetic distances and cluster analysis methods were used. The study shows genetic heterogeneity of Estonians, with the greatest genetic differences in the West-East direction. The islands, West and North-West Estonia differ from the other regions, particularly from the eastern regions (East, South-East, also South-West and Central Estonia) which form a compact cluster. Estonians reveal closest similarities to the nearest neighbouring peoples, regardless of their language group. The mean gene frequencies of the Estonians are comparable to those typical of the populations of North-Eastern Europe, but the gene frequencies are characterised by the tendencies in two opposite (western and eastern) directions as in the other Finno-Ugric populations and the other anthropological traits. The dual branching of genetic data corresponds well with cranial data and the distribution of West and East-Baltic anthropological types in Estonia. Cranial types of Medieval Estonia were common to a wide territory and similar cranial forms can be traced back to the local Bronze Age and Neolithic.

Key words: population genetic features, structure, cranial types, Estonians.

INTRODUCTION

. Aul in his profound monograph "Антропология эстонцев" [1], on the basis of measuring data of over 15,000 Estonian young men in the 1930s, presents numerous somatological traits and their variation of Estonians —

body build, constitution, regional distribution etc., but also the racial composition of Estonians. As early as in 1936 J. Aul [2] proved, that in Estonia one can consider two main anthropological types — the West-Baltic and the East-Baltic. Both types are purely Europoid, characterised by light eyes and fair hair. The West Baltic type has very high stature; it is comparatively dolichocephalic, with a narrower and higher face. The East Baltic type is somewhat shorter in stature, more brachycephalic, with a comparatively wider and lower face. Both types are spread all over Estonia, but the West Baltic type is spread mostly in West Estonia, the East Baltic type — on the one hand East Estonia and on the other hand in South-West Estonia. Their distribution territories are not isolated from one another, but are connected with large overlapping areas.

J. Aul points out the originality of the Estonians, comparing the West Baltic type with the Scandinavian type of the Atlanto-Baltic race and the Estonian East Baltic type with the more eastern variant. According to J. Aul [1] the greatest differences between the Scandinavian and Estonian anthropological types can be found in head shape. The cephalic index of the Scandinavian type is smaller, breadth measurements of the head and the face are also smaller than those of West Estonians, whose face is also a little lower. The Estonian East Baltic type is characterised by higher stature than its more eastern form. The East Baltic type in south-east Estonia differs somewhat from the northern variant in Estonia [1]. In his work J. Aul indicates the enormous distribution area of the East Baltic type in the northern, the southern and, particularly, in the eastern direction.

In his paleoanthropological studies on the basis of Stone Age Sope and Ardu skeletons J. Aul asserted that the Stone Age fore-runners of the Estonians were not anthropologically homogeneous [3]. According to his standpoint, at earlier times the East and West Baltic types did not occur in their pure forms either, and already at that time the territorial transition between these two types was rather smooth as it is nowadays. He also opined that at that time these types were not yet genetically differentiated to such a degree as at modern times.

The other, more recent anthropological studies are in good accordance with J. Aul's studies about anthropological heterogeneity of Estonians [4, 5, etc.].

In the present survey I have made an attempt to give a short survey of Estonian population genetics and the general anthropological position of Estonians in Europe using genetic as well as craniological data.

MATERIAL AND METHODS

The genetic data is based on seven blood group systems (A_1A_2BO, Duffy, Kell, Lewis, MN, P, Rhesus) and the trait of phenylthiocarbamide (PTC) tasting (altogether 24 alleles) on 39 Estonian territorial locations. The individuals examined were indigeneous Estonians; i.e., their great-grandparents on both sides had been born in the same locality [6]. The local samples were joined into seven regional groups more or less according to the main dialectal territories [7]. The comparison of the Estonians with other Finno-Ugric and neighbouring populations is based on six blood group systems (A_1A_2BO, Rhesus, MN, P, Duffy, Kell, a total of 19 alleles). To compare the Estonians with some Finno-Ugric, some neighbouring and some more western populations (Finns, Finnish Swedes, Swedes, Russians, Hungarians, Germans and Poles) five polymorphic systems were used (A_1A_2BO, Rhesus, MNSs, Haptoglobin, Transferrin, 23 alleles in total). Data for interpopulational comparisons were taken from literature: for Finns and Finnish Swedes (8); for Karelians (9); for Komis (10); for Latvians [11, 12, 6]; for Lithuanians [13]; for Maris [14]; for Russians [15]; for Vologda Russians [16]; for Germans, Hungarians, Poles and Swedes [17].

The craniometric data is based on Estonian Medieval and Neolithic skulls. Data for comparison were taken from literature (see Table 4). The following craniometrical traits were used (according to Martin's enumeration): cranial length (1), cranial breadth (8), minimal frontal breadth (9), cranial height (17), bizygomatical breadth (45), upper facial height (48), orbital breadth (51), orbital height (52), nasal breadth (54), nasal height (55). For comparison, cluster analysis has been used (average Euclidean distances using 10 craniometric traits).

The degree of genetic diversity of the groups is determined by the method of genetic distances [30]. The grouping of populations on the basis of these distances has been made using the cluster analysis method of means.

RESULTS

The genetic systems studied and the gene frequencies for the Estonian mean (with min. and max.) and for the four most different regions are given in Table 1. Relatively great differences can be observed in the frequency of alleles (in their variation range) and also between their regional groupings. In spite of heterogeneity in the distribution of different gene frequencies, the east-west direction of population genetic features can be easily noticed [6]. In earlier studies it was shown that the biggest differences in Estonia can be found between the populations of the Western and the Eastern regions: the genetic distance between these populations is about 3.5 times bigger than that between the Northern and the Southern ones [6, 31].

Table 1

Gene frequencies of the polymorphic systems used in all investigated Estonians and in the four most different regions

System and alleles	Estonia, Mean (min-max)	West Islands	West Estonia	North-East Estonia	South-East Estonia
ABO:					
A_1	0.2009 (0.1289–0.2489)	0.2126	0.1851	0.2008	0.2072
A_2	0.0391 (0.0194–0.0824)	0.0433	0.0317	0.0489	0.0382
B	0.1606 (0.0950–0.2038)	0.1443	0.1737	0.1267	0.1829
0	0.5993 (0.5164–0.6983)	0.5998	0.6096	0.6235	0.5716
n	2722	650	456	330	573
Duffy:					
Fy^a	0.3562 (0.2291–0.4426)	0.3591	0.2811	0.2924	0.3730
n	1544	224	183	153	486
Kell:					
K	0.0483 (0.0208–0.0885)	0.0330	0.0447	0.0510	0.0548
n	1614	324	183	151	462
Lewis:					
le	0.4445 (0.3368–0.6268)	0.4431	0.5184	0.3368	0.4610
n	1711	327	186	97	454
MN:					
M	0.6174 (0.5303–0.7357)	0.6166	0.5791	0.6445	0.6231
n	5249	639	613	550	1214
P:					
P_1	0.3907 (0.2893–0.5286)	0.3970	0.4532	0.3369	0.3896
n	1969	327	258	206	590
Rhesus:					
cDe (R_0)	0.0389 (0.0000–0.0975)	0.0416	0.0198	0.0356	0.0248
Cde (R_1)	0.3902 (0.2953–0.4897)	0.3960	0.4243	0.3479	0.4047
$C^wDe(R_1{}^w)$	0.0280 (0.0100–0.0545)	0.0227	0.0253	0.0335	0.0332
cDE (R_2)	0.1529 (0.0751–0.2176)	0.0869	0.1292	0.1803	0.1740
CDE (R_z)	0.0208 (0.0000–0.0925)	0.0206	0.0046	0.0470	0.0253
cde (r)	0.3287 (0.2423–0.4072)	0.3805	0.3350	0.3249	0.3177
Cde (r')	0.0271 (0.0000–0.0790)	0.0243	0.0497	0.0309	0.0127
cdE (r")	0.0134 (0.0000–0.0540)	0.0274	0.0121	0.0000	0.0077
n	2039	330	257	209	558
PTC-tasting:					
t	0.5007 (0.3475–0.6358)	0.6003	0.4976	0.4900	0.4780
n	2796	332	571	366	685

The results of grouping of regional populations on the basis of genetic distances are shown in Fig. 1. The Central, South-Western, Eastern, and South-Eastern regions are very close. The North-East, the Western Islands, and West Estonia are standing separately. The genetic differences between these regions are statistically significant.

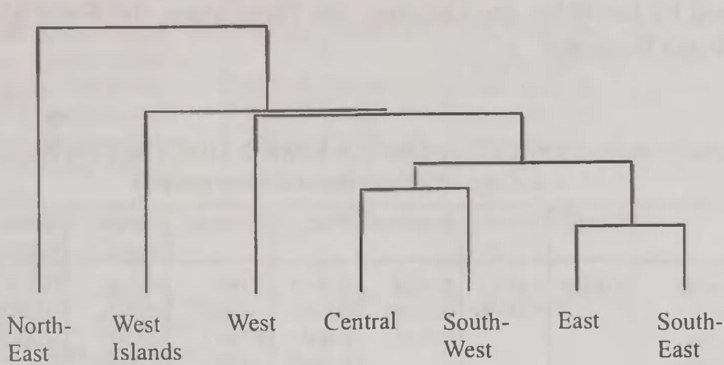

Figure 1. Clustrogram of grouping of Estonian main regional populations.

The genetic distances of the whole Estonian population from some neighbouring and Finno-Ugric populations (Table 2) suggest that the Estonians (on the basis of the used genetic markers) are most closely related to the Russians and the Latvians, also to the Vepsians and the Karelians, followed by the Finns.

Table 2

Genetic distances by Cavalli-Sforza & Edwards (1967)
between Estonians and some neighbouring and other Finno-Ugric peoples

	Vepsians	Karelians	Komis	Maris	Finns	Finnish Swedes	Latvians	Lithuanians	Russians
Estonians	0.0069	0.0074	0.0167	0.0189	0.0108	0.0115	0.0064	0.0114	0.0065
Vepsians		0.0029	0.0168	0.0128	0.0089	0.0075	0.0085	0.0072	0.0066
Karelians			0.0120	0.0104	0.0096	0.0095	0.0073	0.0094	0.0059
Komis				0.0082	0.0106	0.0103	0.0120	0.0133	0.0081
Maris					0.0080	0.0100	0.0079	0.0085	0.0058
Finns						0.0017	0.0041	0.0055	0.0043
Finnish Swedes							0.0063	0.0042	0. 0051
Latvians								0.0045	0.0032
Lithuanians									0.0033

To compare the Estonians with some other Finno-Ugric, neighbouring and some more western populations, five polymorphic systems were used (A_1A_2BO, Rhesus, MNSs, Haptoglobin, Transferrin; 23 alleles in total). Unfortunately in this case the Baltic language group was left out. According to this comparison (Table 3) the smallest genetic distance is between the Estonians and the Russians, followed by the Poles, the Germans, the Hungarians, the Finns and the Vologda Russians.

Table 3

Genetic distances by Cavally-Sforza & Edwards (1967) between Estonians and some neighbouring and other peoples

	Finns	Swedes	Russians	Poles	Germans	Hungarians	Vologda Russians
Estonians	0.0095	0.0082	0.0038	0.0057	0.0057	0.0064	0.0097
Finns		0.0056	0.0078	0.0055	0.0082	0.0072	0.0045
Swedes			0.0051	0.0042	0.0012	0.0025	0.0068
Russians				0.0045	0.0043	0.0030	0.0079
Poles					0.0038	0.0027	0.0040
Germans						0.0035	0.0078
Hungarians							0.0066

To understand the population-genetic characterisation and structure of Estonians comparative studies of Estonian Medieval and Neolithic cranial samples were carried through on the basis of cluster analysis. It was shown that the Estonian cranial samples could be assembled into two main clusters [19]. One cluster includes the mesomorphic, mesocran samples. That cluster embraces a large part of East-Estonian cranial samples. The other cluster combines the cranial samples of a different type, with a massive, very long and high dolichocran with high face skulls. The cranial samples of 12th–13th centuries (the complex group of the pit graves skulls, Pada from North Estonia, Karja from Saaremaa Island) and also the cranial sample of the Neolithic inhabitants of the Boat Axe Culture in Estonia belong to this cluster.

Close anthropological similarity of Estonian cranial samples with Latvian cranial samples and East-Estonian cranial samples with those from the north-western districts of Russia, also from Volga-Kama districts, as well as with the cranial samples from Finland and Karelia have been pointed out earlier on the basis of Penrose's distance method and factor and cluster analysis [20, 19, 32]. Most of these samples belong to the mesocran anthropological type with some local variations, and all

Table 4

The list of cranial samples used

No	Territory, cemetery, ethnicity	n max/min	Dating	References
1.	West-Estonia (Karja, Kaberla, complex group of pit graves, Pada)	46/42	1100–1500	Mark, 1965; (18) Heapost, 1995 (19)
2.	East-Estonia (Siksali, Otepää, Makita, Jõuga)	70/50	1100–1500	Mark, 1956; (4) Heapost, 1993 (20)
3.	Chudes (Novgorod)	127/88	1100–1400	Ctljd, 1952 (21)
4.	Slovenes (Novgorod)	126/60	1100–1400	Ctljd, 1952 (21)
5.	Finno-Ugrians (Polom, Demenkovo, Mydlan-Shai)	40/31	300–900	Fktrcttdf, 1973 (22)
6	Zemgallians (Cukani-Drengeri, Annas-Bundzene)	15/7	900–1400	Ltybcjdf 1977> (23) 1990 (24)
7.	Latgallians (Nuksi, Kristapeni Cibla, Zilupe, Oglenieki, Dignajas-Strutmali)	14/5	900–1200	Ltybcjdf, 1975 (25)
8.	Livonians (Daugava, Gauja)	13/8	900–1200	Ltybcjdf, 1975 (25)
9.	Selonians (Lejasdopeles)	7/5	1200–1300	Ltybcjdf, 1975 (25)
10.	Rumxsiskes (Lithuania)	28/20	1300–1600	Cesnys & Balciuniene, 1988 (26)
11.	SW Sweden (Gudhem, Västergötland, Varnhem, Kongahälla, Bohuslän)	14/12	1200–1300	Rösing & Schwidetzky, 1981 (27)
12.	SE Sweden (Lund, Visby)	14/13	900–1200	Rösing & Schwidetzky, 1981 (27)
13.	Jena	35/11	1200–1300	Rösing & Schwidetzky, 1981 (27)
14.	Kiel	38/21	1350–1571	Rösing & Schwidetzky, 1981 (27)
15.	Schleswig	40/11	1239–1575	Rösing & Schwidetzky, 1981 (27)
16.	Hungary	719/465	900–1400	Rösing & Schwidetzky, 1981 (27)
17.	Poland	562/303	800–1700	Rösing & Schwidetzky, 1981 (27)
18.	Jaunpiebalga (Latvia)	11/10	1200–1500	Ltybcjdf, 1977 (23)
19.	Boat Axe Culture (Estonia)	5/3	2700–2000 B.C	Mark, 1956 (4)
20.	Kivutkalns (Latvia)	46/41	1300–1100 B.C	Ltybcjdf, 1975 (25)
21.	Zvejnieki (Latvia)	12/10	5000–4000 B.C	Ltybcjdf>1975 (25)
22.	Zvejnieki (Latvia)	15/11	4000–3000 B.C.	Ltvbcjdf> 1975 (25)
23.	Zvejnieki (Latvia)	38/27	3000–2000 B.C.	Ltybcjdf, 1975 (25)
24.	Norway (Asum)	35	1100–1200	Kalling, 1995 (28)
25.	Denmark	15/13	500–700	Rösing & Schwidetzky, 1977 (29)

the cranial samples, used in comparison, form completely mixed clusters with Estonian and other Finno-Ugric samples. The anthropological type represented by East-Estonian Medieval cranial samples was spread in one or another variant on a large area of East-European forest belt. Evidently these population groups have been closely related. It is interesting to note that the Finno-Ugrians of the Volga district had pure Europoid characters before any possible Slavic influence could have occurred.

In this report the Estonian morphologically close cranial samples were summed up into two bigger ones (according to the main clusters in cluster analysis). These two types of bigger samples were compared to some samples from the neighbouring territories (Latvia, Lithuania, North-West Russia and Volga-Kama district, Hungary, Poland, Germany, Denmark, Norway, Sweden) mainly from the second half of the I and the first half of the II Millennium, to Kivutkalns Bronze Age sample, Boat Axe culture sample of Stone Age of Estonia and to the Mesolithic to late Neolithic cranial samples from Zvejnieki (Tables 5 and 6).

Table 5

Mean cranial measurements of the samples used in comparison

Martin's No Samples	1	8	9	17	45	48	51	52	54	55
3	184.1	142.9	99.4	136.7	136.0	68.7	43.2	31.2	25.2	49.8
2	185.9	142.0	99.0	136.4	134.8	70.0	42.4	31.7	25.1	50.4
4	183.9	141.9	97.6	136.5	132.5	68.7	43.3	31.5	24.9	49.5
10	184.1	144.1	96.3	134.8	133.3	68.4	41.2	31.4	24.6	50.0
16	183.2	141.7	97.5	134.6	132.3	70.2	40.3	32.6	25.0	51.2
5	186.3	141.4	96.9	135.3	133.7	70.7	42.5	32.4	26.4	51.5
17	185.6	140.5	97.0	136.4	131.7	69.2	41.3	32.4	24.9	50.7
9	187.6	140.3	97.6	137.2	132.2	67.8	42.2	32.4	25.8	50.6
8	184.7	137.5	95.7	133.3	129.8	71.0	42.8	33.9	24.5	51.3
14	188.6	142.0	96.8	130.9	132.6	69.9	41.8	33.3	24.7	50.0
13	186.5	143.0	97.7	131.8	131.0	71.8	41.8	33.9	23.8	51.9
12	188.7	141.4	96.6	132.4	130.4	69.6	40.7	34.0	23.9	53.0
15	189.1	141.9	97.1	129.6	128.8	72.8	42.1	33.5	24.2	52.7
24	190.4	140.5	92.2	135.7	133.2	69.3	43.2	33.7	24.3	50.7
20	192.0	136.9	96.4	141.0	129.3	72.5	43.3	34.6	23.8	53.1
1	191.4	137.2	97.3	139.9	133.6	73.1	42.9	32.1	24.1	51.9
6	195.7	138.3	99.1	136.6	130.9	72.1	43.1	33.6	25.3	51.5
7	193.2	141.2	99.3	139.4	135.6	72.7	44.6	33.4	25.9	52.0
19	195.4	137.2	97.5	140.7	136.5	74.6	44.5	32.6	27.0	53.8
11	192.3	143.8	101.4	138.3	135.5	71.9	40.9	33.3	25.0	55.9
25	185.7	142.0	100.1	141.4	135.5	70.5	41.8	31.1	25.0	53.3
23	188.1	142.0	99.3	139.3	139.9	69.5	44.2	32.4	25.4	51.8
18	185.1	138.9	99.3	136.0	136.9	69.3	44.0	32.9	25.2	52.2
21	187.6	136.5	96.8	140.2	136.9	70.4	43.6	32.3	24.8	51.8
22	190.4	138.1	99.3	144.7	139.1	71.3	44.7	33.9	25.0	53.6

These samples were compared with the help of cluster analysis on the basis of 10 cranial traits.

Table 6

Mean cranial measurements of the samples on the dendrogram by clusters (or cluster parts)

Martin's No Samples	1	8	9	17	45	48	51	52	54	55
3, 2, 4, 10, 16, 5, 17, 9	185.1	141.8	97.7	136.0	133.3	69.2	42.0	31.9	25.2	50.5
8	184.7	137.5	95.7	133.3	129.8	71.0	42.8	33.9	24.5	51.3
14, 13 12, 15	188.2	142.1	97.0	131.2	130.7	71.0	41.6	33.7	24.1	51.9
24	190.4	140.5	92.2	135.7	133.2	69.3	43.2	33.7	24.3	50.7
20, 1, 6 7, 19	193.5	138.2	97.9	139.5	133.2	73.0	43.7	33.3	25.2	52.5
11	192.3	143.8	101.4	138.3	135.5	71.9	40.9	33.3	25.0	55.9
25, 23, 18, 21, 22	187.4	139.5	99.0	140.3	137.7	70.2	43.7	32.5	25.1	52.5

On Fig. 2 one can see that the samples compared have been assembled mainly into two clusters — the mesocran, mesomorphic cranial samples from East-Estonia, North-West Russia (Novgorod district), Volga-Kama district (Finno-Ugrians), Hungary, Poland, also the Selonians from Latvia and the Lithuanian sample belong to one comparatively compact cluster (No. of samples 3–9 on Fig. 2). The mesocran samples subcluster characterised mainly by lower cranial height consists of the German samples and the South-East Swedish sample (No. 14–15). The Livonian sample (No. 8) characterised by a narrow head and face and low cranial height is linked to the German subcluster. The Norwegian sample stands apart, being linked to the cluster of mesocran cranial samples (No. 24). The other main cluster (No. of samples 20–22 on Fig. 2) is composed of dolichocran samples (No. 20–19) — the West-Estonian sample, closely by Bronze Age Kivutkalns sample, Latvian samples (Zemgallians and Latgallians) and the Neolithic Boat Axe Culture sample from Estonia from one side. The South-West Swedish sample joins that cluster. The dolichocran Zvejnieki samples, and also the Zvejnieki Late Neolithic sample, the Danish and Jaunpiebalga sample from Latvia (No 25–22), join the dolichocran samples cluster from the other side.

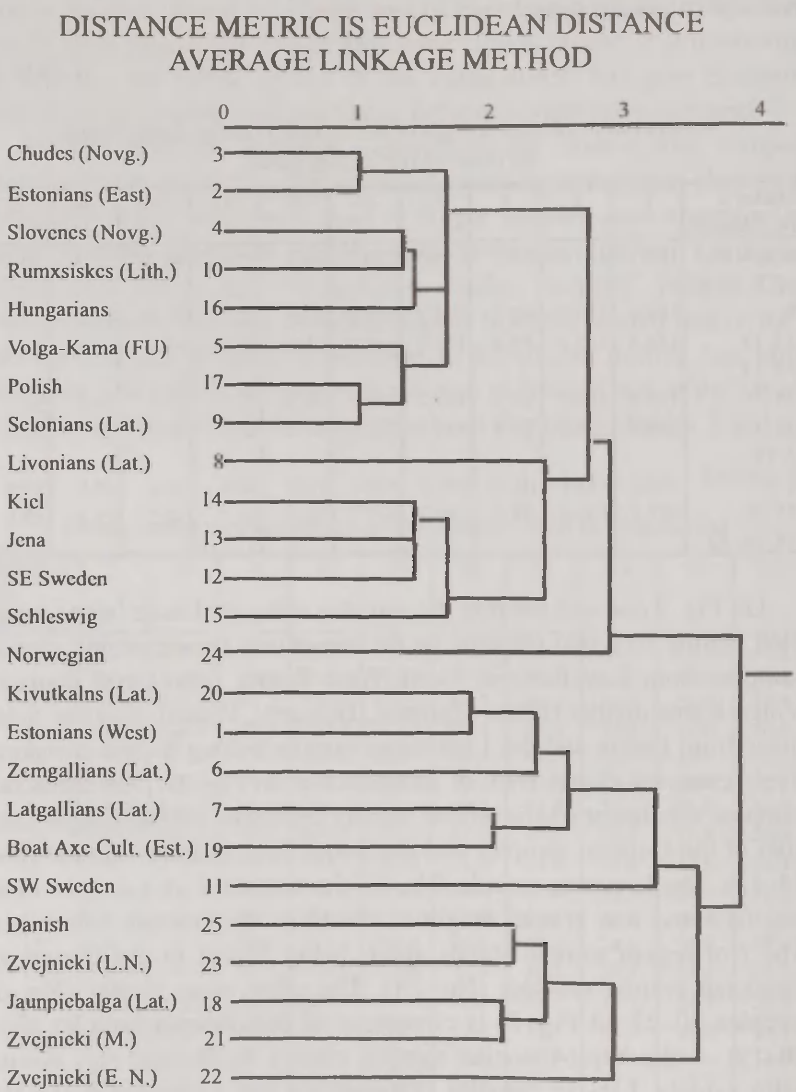

Figure 2. Clustrogram of grouping of the cranial samples.

DISCUSSION

According to genetic data, relatively great differences exist between the local population samples in Estonia. In spite of heterogeneity, the differences in gene frequencies between the regions are observable. The differences between West and East Estonia are more impressive than those between the South and the North. The West Islands and West Estonian groups differ considerably from the others, particularly from the eastern regions. The samples of Islands and West Estonia show heterogeneity, as was the case with other anthropological characteristics [1, 5]. The Eastern and South-Eastern regions are genetically close to each other, South-West and Central Estonia are similar to them, while the North-Eastern region differs from these.

The mean gene frequencies of the Estonians are comparable to those typical of the populations in North-East Europe, but the gene frequencies are characterised by tendencies in two opposite directions (like in other Finno-Ugric populations): western (a higher frequency of K, Lu^a, MS, S, Hp^1, lower Fy^a, Cde) and eastern (with higher B, CDE, Hypolactasia, with lower A_2, P_1, cde, t, Le (a+) phenotype) [6, 31]. The combination of some "western" or even "ultra-western" and "eastern" traits of dental system in Estonians and in other Finno-Ugric populations, in the Baltic region as well as in the Volga and Ural regions has also been ascertained [33, 34, 35].

Genetic data show great similarities of Estonians with their neighbouring peoples regardless of their language group. Differences between the separate regions of Estonia are often greater than that of the Estonians' mean compared to neighbouring peoples. More precise results can be obtained comparing Estonians' data from different parts of the country with other peoples. So the South-Eastern and Eastern Estonians stand genetically closest to Latvians; Moscow Russians stand genetically closer to West Estonians; the Swedes from Uppland — to West Estonians, their differences are greater in comparison with North and South-East Estonia; western Finns stand genetically somewhat closer to Estonians than eastern Finns. The first are particularly close to West and North-East Estonians, etc. [6].

The dual branching of genetic data corresponds well with cranial, odontological and other anthropological data and the distribution of the two main anthropological types (West- and East-Baltic types) in Estonia. Cranial types in Medieval Estonia were common to a wide territory and similar cranial forms can be traced back to the local Bronze Age and Neolithic.

Some conclusions.

1. Both genetic and craniological material show genetic heterogeneity of Estonians.
2. The closest genetic similarities of Estonians with the neighbouring populations are not related to their language groups.
3. The mean gene frequencies of Estonians are comparable to those typical of the populations in North- and East-Europe, but the gene frequencies are characterised by the tendencies in two opposite (western and eastern) directions as in other Finno-Ugric populations.
4. The craniological types spread in Estonia were common over a wide territory both in eastern and western districts.
5. Forms similar to the cranial samples of Medieval Times can be traced back to the local Bronze Age and the Neolithic.
6. The heterogeneity and the antagonistic traits in Estonians seem to be a trace of the original genetic structure of a Finno-Ugric ancestor population, which was neither Mongoloid nor Caucasoid.

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DERMATOGLYPHIC DIVERSITY OF THE FINNO-UGRIANS

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ABSTRACT

We studied finger and palm key features in 165 Finno-Ugrian local groups (111 male and 54 female) totalling 17297 persons. Two independent methods of multivariate analysis were used — intergroup scale and PC's. The diversity was investigated at two taxonomic levels, i.e. populations and ethnic groups. The results confirmed the racial heterogeneity of the Finno-Ugrians who contain Europoid and Mongoloid components and besides reveal a lot of intermediate forms. The Europoid component prevails in a major part of samples which are differentiated in accordance with the share of Northern or Southern Europoid components. The Mongoloid component is of West-Siberian origin. In general dermatoglyphic divergence of the Finno-Ugrians is highly connected with the race-somatological divergence. There is no correspondance between the dermatoglyphic and linguistic divergence.
Key words: dermatoglyphics, Finno-Ugrians, populations, peoples, multivariate analysis.

INTRODUCTION

Finno-Ugrians are one of the well-studied language groups in respect for dermatoglyphics. The generalized papers were published by H. L. Heet [1] and R. L. Jantz, H. Brehme & Eriksson [2]. At present we have a lot of new materials. It enables us to reexamine relationships among the Finno-Ugrians using all the available data.

MATERIAL AND METHODS

Data on 165 local groups were used (111 male and 54 female ones), which belong to 12 ethnic groups (Tab. 1). The total sample size is over 17000 persons (11907 males and 5390 females). Finger and palm prints were processed by the authors (with the exception of 37 groups) according to the standard methods of Cummins/Midlo, the axial palmar triradii were determined on the basis of A. Sharma's scheme [3]. Multivariate analysis was done twice, using two independent ways: 1) intergroup scale method, i.e.the method of G. Debetz and J. Hiernaux, which was introduced into dermatoglyphics by Heet [4]; 2) principal components. The first method includes three stages: 1) typological assesment of traits combination with the use of polygons; 2) estimation of racial complex (Europoid-Mongoloid, or EMC, former MC); 3) computation of dermatoglyphic distance, DD, as a total measure of the between-groups divergence. Male and female groups were analysed separately. Five key traits were examined: finger pattern intensity index (PII), main line index (MLI), proximal axial palmar triradius (t), percentage of the true hypothenar patterns (Hy) and the total frequency of accessory interdigital triradii (AIT). This variables have some specific properties and first of all they are independent at the intragroup level and have racial gradients [5]. The results were considered at two taxonomic levels — local groups and ethnical.

Table 1

Finno-Ugrian groups investigated

Group	Males		Females		M+F	
	n	sample size	n	sample size	n	sample size
1. Finns	16	1685*	4	261	20	1946*
2. Karelians	3	234	3	203	6	446
3. Vepses	4	633	4	678	8	1311
4. Estonians	7	880*	2	143	9	1023*
5. Mordvinians	15	1516*	11	1114*	26	2630*
6. Komi	11	1058	6	583	17	1641
7. Mari	6	749*	2	286*	8	1035
8. Udmurts	8	657	7	689	15	1346
9. Lapps	3	208	3	231	6	439
10. Hungarians	30	3722	4	492	34	4214
11. Mansi	4	255	4	269	8	524
12. Khanti	4	310*	4	441	8	751*
Totally	111	11907*	54	5390*	165	17297*

n — number of local groups; * — pooled with random samples

RESULTS AND DISCUSSION

Differentiation of local groups of Finno-Ugrians. The Finno-Ugrians are extremely heterogenous. All traits show a wide range of variations. Individual profiles range from "supereuropoid" to "supermongoloid" ones (Fig. 1). The male average intergroup DD equals to 15,1 with the standard deviation of 5,64 and exceeds the corresponding value for Eurasia in total [6]. The Europoid-Mongoloid complex also varies widely (from 31 to 73 in males and from 33 to 72 in females). Extragroup correlations between separate features show the significant tendency to formation historical complexes which should be estimated as the result of interaction Mongoloids with Europoids, i.e. the higher are MLI, AIT, Hy, the lower are PII, t, etc. The result of cluster analysis of the matrix including 6105 paired DD we describe without illustration, for the space reason. There are three distinct clusters, embracing almost all male groups besides some of Khanti and Finnish groups. Last ones were tested by t-Student criterium on the resemblance with three above clusters (by the use of averaged unweighted means of groups of a cluster) and then distributed between them. In this way, three large but unequal clusters of Finno-Ugrians were revealed, which represent three different variants or types (see Fig. 1). Both FU-1 and FU-2 belongs to Europoids. FU-2 is the most numerous and the most characteristic of the Finno-Ugrians. As compared to FU-1, FU-2 shows stronger Mongoloid (EMC=47,7) and Northern Europoid components. FU-3 is distinctly connected with Mongoloid populations of Western and Southern Siberia, being characterized by the weakening traits typical of the Mongoloids. This may be due to the mixed (europoid — mongoloid) origin of this type. The total measure of divergence, DD, testifies to resemblance of FU-1 — and FU-2 and to clear isolation of FU-3. The latter is more similar with FU-2 than FU-1 for it includes the Northern Europoid component, too. These variants of Finno-Ugrians in trait values, EMC and measure of heterogeneity (the average DD) as a rule, differ significantly. In this way the types of Finno-Ugrians are really existing. Concerning the types composition it should be noted that FU-1 includes 40% of Finnish and Hungarian groups, above half of Mordovian and Komi samples, the part of Udmurt and Estonian samples. FU-2 embraces all the Karelian and Vepsian groups, about 90% of Estonian and 40% of Hungarian samples, above 60% of Finnish, single samples of Kola Lapps, Mansi, Mari and Udmurts. FU-3 includes all groups of Khanti, major part of Mansi,

Figure 1. Polygonic graphs showing combinations of dermatoglyphic traits in male groups. Circle radius corresponds to the Eurasian extra-group range taken for 100%, circle center representing minimal value. Three first polygons represent generalized data on aborigines of different regions: Europoids of East Europe (EE), Europoids of the Caucasus (C), Mongoloids of Siberia (S). Number of samples is given in brackets. Finno-Ugrian extreme variants: KZ-Komi-Zyrians from Ust-Uhta, Kh — Khanti from Beriozovo. FU — 1, 2, 3-types of Finno-Ugrians revealed by cluster analysis of 111 male groups.

Lapps and Udmurts, half of Mari and one group of Komi. The same types are revealed in female samples. By PC analysis, two first significant components account for 58% of the total variation in male samples and 64% — in female ones. Factor loading on the I PC reflects intergroup differences which could be connected with the share of Europoid and Mongoloid components. The II PC reveals intergroup differences which could be interpreted in two ways, due to the presence of Northern and Southern Europoid components, or Europoid and Mongoloid ones. This fact is due to coincidence of both vectors for almost all traits. The majority of groups allocates equally in the space of two first components and forms not any clusters (Fig. 2). But the combination of two multivariate methods (intergroup scale and PC) allows us to systematize the results. All the three types overlap with each other. But all groups of FU-3-variant show positive (or "Mongoloid") values of the I PC. The groups of FU-2 are placed mainly in the "Europoid" area of the I PC and reveal the clear Northern Europoid component in comparison with FU-1, according PC-II. Fu-1 is the most dispersed in the taxonomic area: the part of groups overlaps with the area of FU-3, only single groups are in the area of FU-2 and, at least, some groups definitely show the presense of Southern Europoid component.

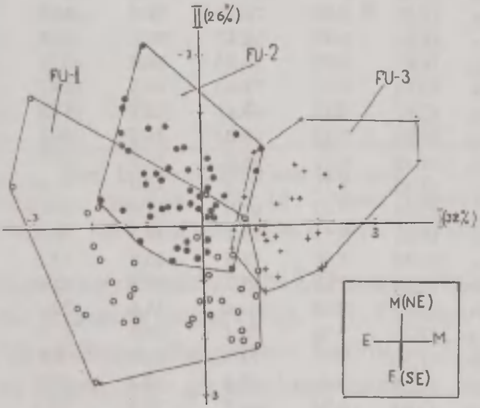

Figure 2. Combination of the results of PC and cluster analyses of 111 local Finno-Ugrian male groups. The scheme of racial vectors of both PC is given separately: E, M, NE, SE — Europoids, Mongoloids, North. Europoids, South. Europoids, correspondingly.

Ethnical differentiation of the Finno-Ugrians

The principal regularities, especially the heterogeeity, are most clear at this level (Table 2). According to traits combinations we can distinguish the group of Europoid peoples (Finns, Karelians, Estonians, Mordvinians, Komi, Hungarians and Vepses). In the same time the Vepses, Karelians and Finns have the specific Northern Europoid combination while Khanti have a well — developped Mongoloid one. Mari, Udmurts, Lapps and Mansi have intermediate type of combinations being closer to Khanti (see Fig.1).

Table 2

Key dermatoglyphic traits in the Finno-Ugrians

Group	PII	MLI	t	Hy	AIT	Th/I	EMC
			MALES				
1. Finns: x	11.90	8.64	66.0	26.7	14.0	7.9	43.8
min	10.87	7.97	56.8	17.4	6.6	4.6	35.9
max	12.50	9.22	75.7	36.9	21.4	12.8	54.3
2. Karelians: x	11.84	8.63	67.0	24.8	8.8	9.4	47.4
min	11.73	8.48	64.3	21.4	7.1	7.6	46.1
max	11.96	8.82	72.3	26.5	10.4	12.3	48.9
3. Vepses: x	11.40	7.99	70.0	27.8	15.6	10.3	46.2
min	11.32	7.79	68.3	25.8	14.2	8.1	44.4
max	11.48	8.07	74.4	30.5	17.3	14.6	48.1
4. Estonians: x	12.60	8.78	72.3	30.4	13.7	11.4	46.3
min	11.53	8.60	65.6	25.7	8.7	8.7	30.6
max	13.37	9.09	76.3	34.7	24.8	16.7	51.2
5. Mordvinians: x	12.34	8.37	66.4	30.2	18.4	10.4	43.6
min	11.67	7.77	56.3	24.5	8.4	2.0	36.1
max	13.56	9.11	72.4	38.1	31.7	14.8	50.1
6. Komi: x	12.12	8.23	67.4	32.7	17.6	7.6	43.0
min	11.39	7.72	55.6	24.5	8.0	4.6	31.0
max	13.19	8.72	76.5	39.5	29.7	11.3	53.0
7. Mari: x	13.10	7.71	72.2	32.0	11.9	7.5	54.9
min	12.73	7.47	62.5	28.6	10.0	4.6	46.8
max	13.88	8.13	78.4	39.5	14.7	10.5	61.0
8. Udmurts: x	13.30	7.90	72.6	26.9	17.2	7.2	54.9
min	12.22	7.62	63.2	19.5	13.6	3.3	44.7
max	14.17	8.23	80. 0	34.8	22.4	9.3	63.4
9. Lapps: x	12.79	7.98	76.4	26.2	13.4	6.0	56.0
min	11.30	7.77	73.3	21.1	9.8	2.8	48.5
max	14.15	8.14	80.9	30.2	16.7	10.1	64.6
10. Hungarians: x	13.02	8.24	69.3	32.4	18.3	8.6	47.1
min	12.26	7.71	53.3	24.5	9.9	4.8	36.3
max	14.49	8.63	77.2	40.0	28.0	13.1	56.9
11. Mansi: x	13.84	7.98	67.4	30.5	13.2	9.0	54.5
min	13.06	7.75	61.0	24.6	9.2	5.4	45.0
max	14.47	8.34	76.3	35.2	17.8	12.1	62.2
12. Khanti: x	14.19	8.08	77.7	24.1	18.1	13.4	60.3
min	13.65	7.40	70.5	20.7	9.9	2.7	55.3
max	14.84	8.62	95.2	32.8	26.7	18.0	73.0

Continue

1. Finns: x	11.67	8.31	52.6	32.0	9.2	6.5	46.4
min	11.36	8.19	41.9	26.3	6.3	5.5	42.2
max	12.29	8.41	60.2	36.5	15.1	7.4	53.9
2. Karelians: x	10.99	8.50	54.0	32.0	11.6	6.9	42.4
min	10.26	8.30	50.6	24.2	9.6	5.0	35.9
max	11.38	8.68	60.0	42.0	13.3	9.4	47.7
3. Vepses: x	10.70	7.98	64.2	28.2	13.6	8.4	49.6
min	10.00	7.70	60.9	25.4	9.4	5.7	44.6
max	11.24	8.40	68.5	31.1	15.9	14.9	56.6
4. Estonians: x	11.69	8.31	65.8	32.9	16.1	8.7	47.4
min	11.47	8.24	64.5	32.6	13.4	6.3	44.7
max	11.91	8.38	67.0	33.1	18.8	11.1	50.2
5. Mordvinians: x	12.00	8.26	58.8	34.9	15.4	9.5	45.7
min	11.09	7.46	49.0	28.5	8.7	5.5	35.3
max	12.92	8.85	69.4	46.0	28.8	14.5	54.6
6. Komi: x	11.50	7.95	60.8	37.2	17.3	6.4	45.3
min	10.94	7.62	54.2	30.8	13.9	5.0	32.7
max	11.94	8.92	63.4	48.5	22.0	8.2	50.0
7. Mari: x	12.68	7.35	68.7	31.1	13.5	8.7	60.4
min	12.72	7.07	65.8	30.3	13.8	8.5	52.8
max	12.73	7.73	69.7	33.7	19.6	9.8	63.2
8. Udmurts: x	12.45	7.53	69.3	33.9	16.1	5.5	56.2
min	11.76	7.31	61.5	30.5	13.1	1.9	46.5
max	13.40	7.69	74.7	36.7	23.2	8.0	63.1
9. Lapps: x	12.71	7.75	68.4	24.5	9.5	10.6	62.2
min	11.80	7.68	68.1	23.7	8.4	1.1	60.3
max	14.06	7.85	68.9	25.0	11.5	17.7	65.0
10. Hungarians: x	12.09	8.17	56.7	36.9	17.4	5.7	44.1
min	11.56	7.99	48.0	31.0	13.4	5.3	39.4
max	12.54	8.29	65.2	42.8	22.8	6.4	48.4
11. Mansi: x	13.10	7.90	62.9	29.1	11.3	5.7	57.5
min	12.66	7.77	52.5	24.2	6.6	3.3	50.2
max	13.36	8.07	69.4	46.4	14.7	8.2	58.9
12. Khanti: x	13.62	7.56	65.8	23.5	18.0	10.0	62.0
min	12.96	7.44	61.6	19.0	7.5	2.5	57.6
max	15.32	7.75	80.0	35.0	22.0	12.0	72.1

Source: 1, 3, 5, 12 — Heet, Dolinova, 1990 and new data; 2, 4, 6, 7, 9, 11 — Heet, Dolinova, 1990; 8 — Dolinova, 1989; 10 — Heet, Dolinova, 1990; Gladkova, Toth: 1981, 1982–83, 1985; Gladkova, Toth, Kondyk, 1984 (see reference 6).

By the clusterisation of male groups DD-matrix (Table 3) there were distinguished the following clusters (Fig. 3-b): 1) Finns, Karelians, Vepses; 2) Komi, Mordvinians, Hungarians, Estonians; 3) Lapps, Udmurts, Mari, Mansi; 4) Khanti, who are absolutely isolated. In general, Finno-Ugrians are divided on the value of Europoid—Mongoloid Complex in the same way, with maximum in Khanti (Fig. 3-a). The differentiation of female groups is simpler. The peoples with Europoid combinations of traits (Karelians, Finns, Hungarians, Mordvinians, Komi, Estonians and Vepses) constitute the first cluster; the second one embraces all other peoples. Khanti being the most isolated.

PC-method gives in general the same results (Fig. 3-c). Two first PC are significant and account for 68 and 79% of the total variance in male and female samples, resp. There are clearly distinguished the Northern Europoid peoples: Karelians, Finns, Estonians, Vepses. Mordvinians and Komi are close to them on I PC, being unlike on II PC due to some southern europoid affinities. The Hungarians are similar with two last peoples on II PC and show an unique position among Finno-Ugrians: it is the single people who is placed in the "neutral" area of the I PC (i.e. on the break of "Mongoloid" and "Europoid" values). Mansi, Mari, Lapps, Udmurts and Khanti are in the "Mongoloid" area of I PC. A similar result was obtained in female samples, instead of their less representativeness.

Table 3

Paired dermatoglyphic distances (DD) between FU peoples

Group	Fi	Ka	V	E	Mo	Ko	Ma	U	L	H	Man
					Males						
Finns	–										
Karelians	4.0	–									
Vepses	8.9	11.5	–								
Estonians	8.1	11.1	12.7	–							
Mordvinians	7.4	11.0	10.0	8.1	–						
Komi	8.7	11.8	8.8	10.2	3.8	–					
Mari	16.6	17.9	13.1	10.3	13.2	11.9	–				
Udmurts	14.2	17.4	10.2	11.8	11.4	11.9	7.2	–			
Lapps	12.2	14.2	9.8	9.7	12.4	13.0	8.2	6.1	–		
Hungarians	13.1	16.2	11.8	9.3	5.8	4.8	7.9	7.9	10.7	–	
Mansi	14.6	17.0	13.1	12.0	11.2	11.4	7.8	8.3	9.9	8.9	–
Khanti	20.2	21.4	17.5	18.0	16.8	17.8	15.6	8.5	9.8	13.3	11.6
					Females						
Finns	–										
Karelians	5.0	–									
Vepses	13.0	10.8	–								
Estonians	8.2	10.0	9.1	–							
Mordvinians	7.6	9.4	11.6	4.9	–						
Komi	12.0	12.8	9.5	7.4	6.3	–					
Mari	17.9	19.8	13.4	13.0	14.7	15.1	–				
Udmurts	17.8	19.6	13.9	9.6	11.1	10.8	4.6	–			
Lapps	16.1	19.9	12.6	14.8	16.5	16.9	7.9	9.9	–		
Hungarians	9.6	11.4	13.7	7.7	3.5	5.0	16.3	12.0	18.1	–	
Mansi	13.0	15.1	9.6	12.1	11.8	12.2	9.2	11.2	7.0	13.4	–
Khanti	23.6	25.4	16.4	16.3	18.6	17.3	10.8	10.4	9.3	18.4	10.6

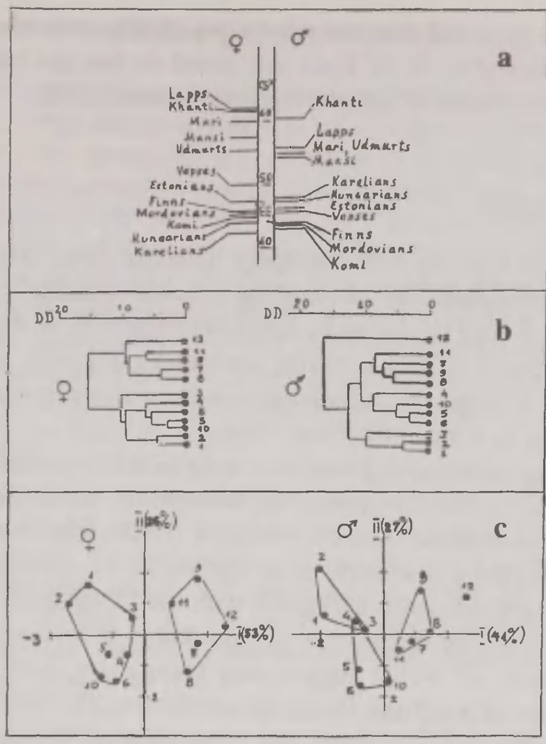

Figure 3. Comparison of Finno-Ugrians ethnic groups: a — Europoid-Mongoloid Complex (comparable only inside of each sex); b — clustering of DD matrix; c — PC-space clusters of the dendrogram (b) being outlined. Groups: 1 — Finns, 2 — Karelians, 3 — Vepses, 4 — Estonians, 5 — Mordvinians, 6 — Komi, 7 — Mari, 8 — Udmurts, 9 — Lapps, 10 — Hungarians, 11 — Mansi, 12 — Khanti.

Thus on the ethnical level the dermatoglyphic differentiation of the Finno-Ugrians is linked to the race-somatological differentiation. There are distinguished two extrems — the groups of Western Finns (i.e. the Northern Europoids) and Khanti (the Mongoloids of Ural type). The rest Finno-Ugrian ethnic groups are possesed of the position between these two sharply different complexes, being heterogeneous on their racial composition and in no accordance with the linguistical classification.

It should be noted that our results practically coincide with those formerly obtained by H. L. Heet and based on her less representative materials with the use of simpler statistical methods [1].

CONCLUSIONS

1. The Finno-Ugrians are extremely heterogeneous concerning the dermatoglyphics traits, and exceed the average euroasiatic level of differentiation. It may be due to as initial heterogeneity of their ancestors as Finno-Ugrians mixing between themselves and with neighbouring populations. The process of mixing was the most important in all anthropological hystory of the Finno-Ugrians.

2. Among the Finno-Ugrians two main racial components stand out quite distinctly; the Europoid and Mongoloid ones. The Europoid component is subdivided on two variants. To the first one belongs the majority of Finnic speakers, it is the result of cross-breeding the Northern Europoids (who prevailed) with the Mongoloids of Western-Siberian origin. The second one is represented in less cases, linked to the population of Volga region and Hungarians who include the marked share of Southern Europoid admixture. The mongoloid component is connected with aboriginal population of Western and Southern Siberia. This picture is observed on both the territorial and ethnical levels.

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EMO-SOCIOLOGY OF PAGAN AND CHRISTIAN HUNGARIANS IN THE 10TH–11TH CENTURIES

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ABSTRACT

In the present paper the authors raise the methodological question whether the existence or the lack of grave-furniture may be regarded a variable of socio-economical status.

For the methodological presentation of the problem we chose the 10th–11th century cemetery in Püspökladány-Eperjesvölgy in eastern Hungary, which, as a prominently representative locality, can serve as a ground for investigations of model value. The cemetery consists of 230 individuals from the pagan era (10th century) and 371 individuals from the Christian era (11th century).

As the results show the main difference appeared not in the mortality of the two centuries but in the mortality of those who were buried with and without grave-goods. This may refer to either a similar respect for the similar age-groups in both centuries or to the fact that, if we do not refuse that the existence or lack of grave furniture indicates the individual's socio-economical status, social rank influenced mortality of the individuals likewise in both centuries.
Key words: paleodemography, paleosociology, 10th century, 11th century, Hungarians

INTRODUCTION

Paleodemography is an auxiliary science shared by archaeology and anthropology, the main object of which is to study demographic characteristics of ancient populations. In addition, it may also contribute to the outline of social structure, especially, if it extends the scope of investigations to grave contents, the material culture of ancient populations, beside biological characteristics.

Paleodemographic studies have three main methodological phases. In the first phase, the age of death and the sex of individuals whose skeletons were excavated are assessed by means of anthropological methods. In the second phase, the data are subjected to mathematical-statistical analysis. On the basis of the age at death and sex, mortality charts of the population examined are prepared, separately for the overall population and for both males and females considered to be adult from an osteological aspect. The third phase involves the study of material culture relics, according to the demographic characteristics of the population, and is also called paleosociology.

Paleosociology may be regarded as a discipline independent of paleodemography, but it should not be forgotten that the only possibility for a realistic evaluation of material culture relics is their analysis on the basis of demographic statistics. Only this method can guarantee that the analysis shall provide a reliable picture not only of the 'rich' or 'poor' character of the cemetery in question, but also of the ancient society.

MATERIAL AND METHODS

In the present paper the 10^{th}–11^{th} century cemetery of a Hungarian population at Püspökladány-Eperjesvölgy is performed. The cemetery is extremely populous, being 5–10 times larger than other cemeteries excavated from the same period.

In addition, due to the favourable soil conditions, the skeletons are well preserved, the majority of them being suitable for anthropological analysis. From the 601 anthropologically assessable skeletons unearthed in the rescue excavations by M. Nepper, Ibolya between 1977 and 1982, 230 individuals may date from the 10^{th} century and 371 from the 11^{th} century [3].

Anthropological studies on the population of Püspökladány-Eperjesvölgy cemetery were done by the following methods: for subadult individuals, the age of death was determined according to the concepts of Schour and Massler [4] and Johnston [2], for the adults the method of Acsádi and Nemeskéri [1] was used; the same method [1] was applied for sex determination. Mortality charts contain the following data: age=X; distribution of deaths, number at age $X=D_x$; distribution of deaths, percentage at age $X=d_x$; distribution of surviving individuals, percentage at the beginning of age $X=l_x$; probability of death at age $X=q_x$; life expectancy at age e_x^o.

Table 1

Mortality chart of the overall population of Püspökladány-Eperjesvölgy (10th century)

Age	D_x	d_x	l_x	q_x	e_x^0
0	4,00	1,74	100,00	0,02	27,07
1–4	25,67	11,16	94,86	0,04	26,82
5–9	35,92	15,62	83,70	0,04	27,22
10–14	13,17	5,72	68,08	0,02	26,54
15–19	8,23	3,58	62,36	0,01	23,41
20–29	22,86	9,94	58,78	0,02	17,66
30–39	53,80	23,39	48,84	0,06	13,74
40–49	24,81	10,79	25,45	0,05	11,57
50–x	33,60	14,61	14,66	0,16	5,51
Total	230,00	100,00	–	–	–

Table 2

Mortality chart of the overall population of Püspökladány-Eperjesvölgy (11th century)

Age	D_x	d_x	l_x	q_x	e_x^0
0	9,67	2,61	100,00	0,03	28,26
1–4	50,50	13,61	97,39	0,04	28.03
5–9	48,25	13,01	83,78	0,03	28,50
10–14	25,42	6,85	70,78	0,02	27,21
15–19	13,71	3,69	63,93	0,01	24,40
20–29	36,67	9,88	60,23	0,02	18,90
30–39	74,34	20,04	50,35	0,05	14,21
40–49	55,31	14,91	30,31	0,06	11.01
50–x	56,97	15,35	15,40	0,17	5,24
Total	371	100	–	–	–

It appears to us that, when a classification of grave contents is performed, consideration must be given to the length of the period studied and the nature of the changes which took place in beliefs and ideology during the period in question. In the present sample, social customs of the pagan period and of early Christian era appear to intermingle within the same cemetery.

RESULTS

Data for a demographic profile of the population analyzed are supplied in two overall mortality charts (Tables 1 and 2). On examining the burial customs of the two periods, significant changes can be noticed, especially in the group of weapons and artifacts. This category of grave furniture could be found in great strength in male graves of the pagan period but they are almost entirely missing from burials of the Christian era. Similar alterations can generally be observed in burials of the same age, owing to the changed beliefs about after-life.

Table 3

Percentage distribution of graves provided with grave furniture in cohorts (Püspökladány-Eperjesvölgy)

	10^{th} century		11^{th} century	
Age	Male	Female	Male	Female
0-22	43% (43)		44% (67)	
23-39	61% (24)	71% (23)	15% (6)	71% (46)
40-59	73% (25)	63% (12)	14% (9)	62% (22)
60-x	75% (3)	25% (1)	21% (3)	83% (5)
Adults total:	67%	65%	15%	69%

Surveying the existence or lack of grave goods alone, we can conclude that pagan burial rite provided the dead more abundantly (131 individuals supplied with grave goods out of 230) than Christian rite did (158 individuals supplied with grave goods out of 371). In Table 3, the figures in brackets in each cohort show the number of graves provided with grave furniture, and the percentage of the same graves within the cohorts is also given. As it appears from these facts, the number of males with grave furniture fell to one-fourth by the 11^{th} century (which was the dawn of Christianity). (Mainly male graves lacked weapons and artifacts almost entirely by the 11^{th} century.)

Significant tendencies manifest if we chart the age distribution of individuals buried with and without grave furniture diagrammatically (Figure 1). Data of infant mortality may be used for very reserved valuations only since this age-group is low-represented in this cemetery. Being buried closer to the surface and having weaker skeletons, infants are a lot more exposed to getting destroyed than individuals of older age-groups. In addition, infants in the pagan period are not often buried in cemeteries. In Püspökladány-Eperjesvölgy cemetery, the uneven mortality rate (d_x) in the group of infants may reflect these effects. In the first mortality wave in both centuries, individuals supplied with grave furniture seem to outnumber, slightly, the ones buried without grave goods. This result may be explained by two models, the conjugate effects of which may also have been assumed. (i) The existence of grave contents refers to the socio-economical status of the deceased infant's family: children of well-to-do families were buried with grave furniture while children of the poorer families were not given anything. In addition we have good reason to take it for granted that lower social position may have gone with higher infant mortality. Studies on present-day mortality seem to confirm this model. (ii) Social respect for children, and for deceased infants thereupon, was not high in the ages in question, which is expressed in the small number of graves provided with grave furniture.

This model does not involve references to socio-economical status which influences both mortality and the custom of grave furnishing.

The aspect of the second mortality wave does not decide in favour of either model discussed above. A great number of individuals belonging to the age group 25–37 were buried with grave goods. We may presume a high social respect for this age group and, because of the eventual raids and incursions, a higher mortality of the well possessed strata within this age group.

The third mortality wave reveals an unexpected correlation. In both centuries, individuals buried without grave goods 'produce' an earlier and higher peak in curve while those provided with grave furniture 'draw' a lower and more receding curve with peaks later in time. This picture may not show the true nature of social respect for the age groups in question as it does not seem probable that individuals who died in their forties were less respected than those who died in their fifties with individuals dying in their thirties and receiving such an outstanding and spectacular recognition. It seems more probable that socio-economical status made its impact again and individuals living in more favourable economical circumstances may have had fairer life expectancy.

The three mortality waves may be connected with three different biological crises. These mortality peaks can be observed in any population examined, although the values, and distributions according to age groups may vary. It may be assumed that socio-economical status of the individuals becomes effective at times of biological crises with values dependent on type of the crisis. Thus, higher status decreases infant and late-adult mortality but increases adult mortality. Nevertheless, we are not in possession of enough data to settle the question.

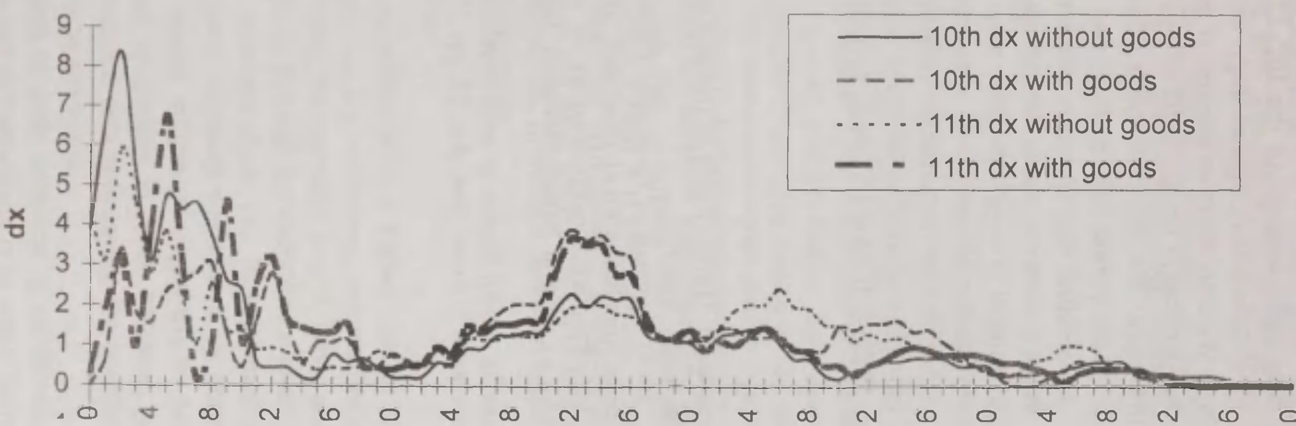

Figure 1. Age distribution of individuals buried with and without grave furniture (dx).

CONCLUSIONS

During the paleodemographic analysis of the 10^{th}–11^{th} century Hungarian population of Püspökladány-Eperjesvölgy cemetery we prepared mortality charts. We also made an attempt at analyzing the social conditions of the population on the basis of examination of the custom of grave furnishing. We observed major differences between the burial rites of the pagan period (10^{th} century) and of Christian era (11^{th} century). We can conclude that the main difference appeared not in the mortality of the two centuries but in the mortality of those who were buried with and without grave-goods. This may refer to either a similar respect for the similar age-groups in both centuries or to the fact that, if we do not refuse that the existence or lack of grave furniture indicates the individual's socio-economical status, social rank influenced mortality of the individuals likewise in both centuries.

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THE INFLUENCE OF PARENTS' HIGH BODY WEIGHT TO NEWBORNS' HEALTH

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ABSTRACT

Parent's overweight (body mass index BMI≥27) to newborns anthropometry, adaptation in early neonatal period and lipid content was investigated in 193 families. There were two times more fathers with high body mass index compared with mothers (p<0,001). The birthweight and Ponderol index of newborns of mothers having high BMI were higher (p=0,02, p=0,04). Pathers' BMI didn't influence to these data. Newborns had higher Apgar score at 5-th life min. if father had high BMI. The mean level of serum glucose was lowest, if mother had high BMI (p=0,009). Lipid fractions showed little differencies: mother with high BMI had newborns with lower LDL-C/Apo B (p=0,03), fathers with high BMI — children with higher atherogenic and antiatherogenic (HDL-C/Apo A-I) lipid fractions. Parents owerweight influence to newborns' anthropometry, adaptation and lipid content, but from mother's and father's side the effect is different.
Key words: parents, overweight, newborn, anthropometria, maturity, lipids, apolipoproteins

INTRODUCTION

Overweight is associated with a higher risk of cardiovascular and metabolic diseases [1]. It's wellknown, that mother's obesity increases complications during the antenatal period, labor and delivery as well as puerperium [2, 3, 4]. High prevalence of mother's owerweight was detected in our previous study [5]. In epidemiological studies was shown, that perinatal mortality was caused by preterm deliveries [3]. Overweight of mother influenced negatively to newborn's antenatal development and adaptation in early neonatal period [5, 6]. We couldn't find literature data concerning the possible influence of fathers' overweight to newborns.

As the problem of early detection of cardiovascular diseases risk factors, one of which is overweight, is as actual before.

The aim of our investigation was to detect the influence of parents' overweight to newborns' health.

MATERIAL AND METHODS

In the framework of epidemiological study "The prevalence of noncommunicable diseases risk factors and their primary prophylactis in young families" 424 couples, married in 1994–95 in Tallinn were investigated and generally accepted noncommunicable diseases' risk factors were detected. Anthropometrical data were measured, body mass index (BMI) was calculated BMI=(weight/height) [kg/m^2]. BMI≥27 was accepted as overweight HBMI. 193 newborns from those families were investigated. Objective status on 1.–2. days of life was determined, data from medical documents were fixed: gestational age, anthropometria, Apgar score at 1. and 5.-th life minutes. Ponderol index (birht weight / birth length) [g/cm] was calculated.

Newborns' objective status was evaluated by usually accepted criteria used in neonatology: reaction to examination, skin color and signs, muscule tonus, changes in unconditioned, existance of pathological congenital reflexes were detected and types of feeding.

Newborns maturity was assessed by Dubowitz' score [7]. Disturbancies in adaptation in early neonatal period were assessed. Maximal weight loss percent was calculated (birthweight — minimal weight)×100. Positive weight gaine day was fixed. Cord blood for lipidological investigation was taken immediately after birth from the placenta's side cord. Total — cholesterol (T-C, mmol/l) high density lipoproteins (HDL-C, mmol/l), triglycerids (TG, mmol/l) were measured enzymatically.

Low density lipoproteins cholesterol (LDL-C, mmol/l) was calculated by Friedewald's formula [8]. Atherogenic coefficient was calculated:

$$AK=((T\text{-}C)-(HDL\text{-}C))/HDL\text{-}C.$$

Apo A-I and Apo B were measured from serum rackett-immunoelectrophoretically [9] by Curry [10] modification.

Control group consisted of newborns, whose parents had normal (BMI<27) body mass index. Mathematical analysis was performed by personal computer using different programmes (Statgraphics, Statistica, Systat).

RESULTS AND DISCUSSION

A hundred ninety three newborns were investigated. Overweight was detected in 7,25% of mothers and 15,5% of fathers (p<0,001). Anthropometrical data of newborns according to parents body mass index are presented in Table 1.

Table 1

Newborns anthropometric data according to parents' body mass index

	HBMI (M±SD)		NBMI (M±SD)	
	Mother (n=13)	Father (n=16)	Mother (n=179)	Father (n=87)
Birthweight (g)	3780,8±550,3*	3513,4±388,3	3505,0±423,0	557,9±465,1
Birthheight (cm)	51,1±1,7	49,9±2,4	50,0±2,0	50,3±2,2
Head circumference (cm)	35,6±1,1	35,6±1,1	35,01±1,4	35,0±1,4
Ponderol index	73,9±9,2**	70,3±5,8	69,9±6,6	70,6±7,1

* p=0,02; ** p=0,04; HBMI — high body mass index; NBMI — normal body mass index

The birthweight and Ponderol index of newborns' of mothers having HBMI were higher (p=0,02, p=0,04 correspondingly) compared with control group. The same results were detected in our previous investigation [5].

Fathers' body mass index didn't influence to newborns' anthropometry. Data of newborns maturity and objective status according to parents' body mass index are presented in Table 2.

Maturity of newborns of parents with high body mass index was a little higher compared with control, Apgar score at 5-th minutes was higher (p=0,02) if father had HBMI. Maximum weight loss percent didn't differ in groups. The mean serum glucose level was lowest if mother had high body mass index (p=0,009). Hypoglycemia in neonatal period is a frequent disturbancy in adaptation of children born to diabetic and/or adiposed mothers caused by hyperinsulinaemia [11].

Lipid data of newborns according to parents body mass index (Table 3) showed only some differencies: when the mother had higher body mass index, the newborns' ratio atherogenic lipids (LDL-C/ApoB) was lower (p=0,03), but when fathers' overweight was detected, this atherogenic lipid and antiatherogenic lipid (HDL-C/Apo A-I) ratio had tendency to be higher.

These findings might undirectly show the different influence of parents to newborns lipid content.

Table 2

Maturity and objective status of newborns according to parents' body mass index

	HBMI (M±SD)		NBMI (M±SD)	
	Mother (n=9)	Father (n=16)	Mother (n=176)	Father (n=87)
Maturity	56,0±7,5	56,3±3,7	53,5±7,5	52,4±8,3
Apgar 1'	7,6±0,8	8,1±0,4	7,8±0,7	7,9±0,7
Apgar 5'	8,2±0,6	8,8±0,4*	8,5±0,6	8,4±0,6
Max. weight loss (%)	4,9±1,9	5,0±1,8	5,0±2,8	5,0±2,4
Positive weight (days)	4,4±0,7	4,7±1,2	4,2±1,0	4,2±0,9
Mean glucose	2,4±1,1**	6,1±0,6	4,3±1,4	3,7±1,4

* p=0,02; ** p=0,009; HBMI — high body mass index; NBMI — normal body mass index.

Table 3

Lipid content of newborns' cord blood according to parents' body mass index

	HBMI (M±SD)		NBMI (M±SD)	
	Mother (n=9)	Father (n=16)	Mother (n=93)	Father (n=87)
T-C (mmol/l)	1,8±0,5	2,3±0,7	2,0±0,8	2,1±0,8
HDL-C (mmol/l)	0,59±0,2	0,8±0,2	0,72±0,3	0.7±0,4
TG (mmol/l)	0,6±0,3	0,5±0,2	0,5±0,2	0,5±0,2
LDL-C (mmol/l)	0,8±0,5	1,3±0,5	1,1±0,6	1,2±0,6
Apo A-I (mgl/dl)	97,4±21,3	102,0±12,4	95,3±17,4	92,7±19,6
Apo B (mgl/dl)	22,7±4,2	24,4±6,8	24,3±9,0	24,5±10,2
Apo B/ Apo A-I	0,2±0,03	0,2±0,05	0,3±0,08	0,3±0,09
HDL-C (%)	37,7±8,6	35,8±6,5	34,9±7,9	31,8±7,4
LDL-C/Apo B	1,2±0,8*	2,1±0,3**	1,7±0,5	1,7±0,5
HDL-C/Apo A-I	0,3±0,03	0,3±0,07***	0,3±0,07	0,2±0,08***
AK	1,8±0,6	1,9±0,5	2,0±0,7	2,3±0,7

* p=0,03; ** p=0,06; *** p=0,05; HBMI — high body mass index; NBMI — normal body mass index

CONCLUSION parents overweight influence to newborns' anthropometry, adaptation and lipid content. but mother's and father's effect differs.

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THE SEXUAL MATURATION AND ANTHROPOMETRIC CHARACTERISTICS OF 15- TO 18-YEARS-OLD SCHOOLGIRLS

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ABSTRACT

The aim of the investigation was to study the correlation of main anthropometric characteristics of height and weight with sexual maturation of 15- to 18-years-old Estonians girls in Tartu town, using typification of anthropometric measurements by 5 height and weight SD-classes.

A school-based cross-sectional study using anthropometric measurement and a questionnaire about health status involved 1187 girls from Tartu town secondary schools. Results: The mean sexual age of subjects was in correlation with weight, but not with height. The subjects with late menarche were significantly lighter than others. All the premenarcheal subjects belonged to SD-classes I (*smalls*) and V (*leptosomes*), the same prevalence was among the subjects with menarche after the age of 14 years. The subjects with menarche before the age of 12 years had more mean weight and less mean height. The correlation of sexual maturation with the main anthropometric characteristics as height and weight was analysed using the typification of subjects by height and weight classes. Our investigation showed that the main characteristic for menarcheal age is weight.

Key words: menarche, sexual maturation, weight, height, schoolgirls

INTRODUCTION

The physical and sexual maturation is a dynamic process. It has therefore been proposed that there is a threshold weight and height before the menarche can occur. A positive correlation is found between menarcheal age and final body height. Early menarche is associated with excess weight, late menarche with underweight [1]. Although menarche is a middle pubertal event, it is used as an indication of the general trend of pubertal development. Over the past century, the trend has been towards earlier menarche, with a decrease of about three or four months per decade in industrialised countries [2, 3]. Reports of a halt in this trend have come from such countries as UK, Iceland, Italy, Poland and Sweden. But in other countries, such as Germany, the fall in age is still continuing [3, 4]. In Estonia, on the sample of Tartu town, the mean age at menarche before the year of 1896 was 15.10 years and in 1974 it was 13.2 years [5].

So the weight, height and chronological age are characteristics of the onset of puberty. Correlation analysis of data have showed that the girls' bodily stature is based on a system of characteristics where height and weight have the strongest correlation with the other anthropometric characteristics [6, 7].

The aim of this research was to investigate 15- to 18-years-old Estonian schoolgirls' main anthropometric characteristics — height and weight correlation with sexual maturation, using the typification of anthropometric measurements by 3 corresponding and 2 non-corresponding height and weight SD-classes.

SUBJECTS AND METHODS

The study group consisted of 1187 schoolgirls of 10^{th}, 11^{th} and 12^{th} form of Tartu secondary schools, thus the age of subjects was from 15 to 18 years. The studied group made up to 87.9% of whole corresponding contingent. The investigation was carried out from October 1995 to April 1996. The examination and anthropological measurement was made during the forenoon in specially equipped room at school. Measurements were taken according to the classical methods of Martin (8). Sexual maturation was evaluated according to the Tanner's five stages ranking modified by V. Kask (stages 0 to 4) [9]. To avoid technical mistakes the examination and the measuring was made by the same person. The age at menarche was determined by the retrospective method. The age was calculated as a full year ±0.5.

The statistical package SAS, version 6.12 was used for data processing. Comparisons between means was used PROC GLM, the Turkey's Studentized Range Test for variables was used, the $p<0.05$ level was selected as the criterion of statistical significance.

RESULTS

Involved 1187 girls were 15- to 18- years-old, respectively 64, 444, 406 and 273. The main statistics of anthropometric characteristics — body weight, height and BMI by age are presented in Table 1. Statistically significant difference occured only in weight values: The weight of 15-years-old girls differed from the weight of all other age-groups. The height of 15-years-old girls was less than height of girls of older age-groups, but the difference was not significant. The values of BMI did not differ significantly between age-groups.

For the systematisation of anthropometric material was used the typification by standard deviation (*SD*) classes of height and weight into five *SD*-classes of both characteristics. All the subjects were divided into three equal classes (*SD*-classes: small or light: $<-0.5\ SD$; medium: from $\bar{x}\ -0.5\ SD$ to $\bar{x}\ +0.5\ SD$; tall or heavy: $\bar{x}\ >\ +0.5\ SD$). Thus, in total, five classes were formed (Figure 1).

3 classes with correspondence between height and weight:

I class (*smalls*) — subjects with small height and weight (height $\bar{x} < -0.5\ SD$; weight $\bar{x} < -0.5\ SD$);

II class (*mediums*) — subjects with medium height and weight (height from $\bar{x} > -0.5$ SD to $\bar{x} < +0.5$ SD; weight from $\bar{x} > -0.5$ SD to $\bar{x} < +0.5$SD);

III class (*bigs*) — subjects with big height and weight (height $\bar{x} > +0.5$ SD; weight $\bar{x} > +0.5$ SD);

and 2 classes with non-corresponding height and weight:

IV class (*pycnics*):

- subjects with small height and medium or large weight (height $\bar{x} < -0.5\ SD$; weight $\bar{x} > -0.5\ SD$)
  and
- subjects with medium height and big weight (height from $\bar{x} > 0.5\ SD$ to $\bar{x} < +0.5\ SD$; weight $\bar{x} > +0.5\ SD$);

V class (*leptosomes*):

- subjects with big height and small or medium weight (height $\bar{x} > +0.5\ SD$; weight $\bar{x} < +0.5\ SD$)
  and
- subjects with medium height and small weight (height from $\bar{x} > -0.5\ SD$ to $\bar{x} < +0.5\ SD$; weight $< -0.5\ SD$).

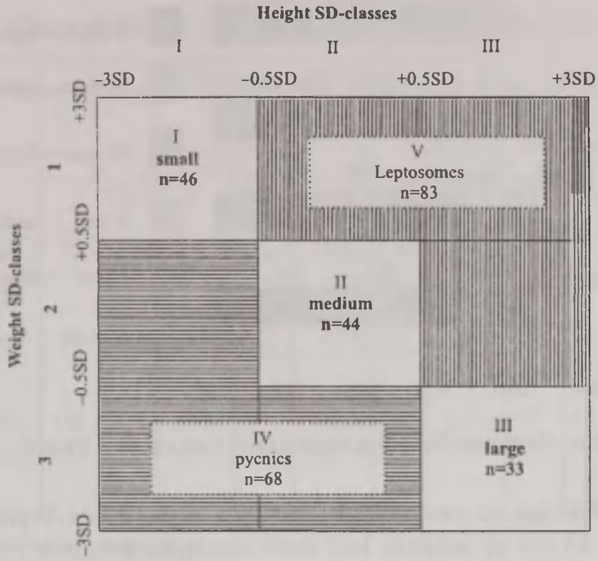

Figure 1. Classification of girls by height-weight SD-classes.

Table 1

Mean values of girls weight, height and BMI by age

Age (years)	N	Anthropometric caracteristic	$\bar{x}$	SD	Min	Max	Median	Significance
15	64	weight	56.2	8.0	40.7	75.7	55.2	
		height	164.8	5.8	151.9	178.6	164.9	–
		BMI	20.8	2.7	15.9	29.4	19.9	–
16	444	weight	57.9	7.8	35.0	91.3	57.1	15&16, p<0.05
		height	166.2	5.6	152.0	183.3	166.4	–
		BMI	20.9	2.5	15.0	32.0	20.6	–
17	406	weight	59.0	8.5	34.5	91.1	57.9	15&17, p<0.01
		height	166.1	5.9	149.4	186.6	166.2	–
		BMI	21.4	2.8	15.4	32.4	20.8	–
18	273	weight	59.1	8.0	40.9	87.6	58.2	15&18, p<0.005
		height	166.9	6.0	147.7	182.4	166.9	–
		BMI	21.2	2.5	15.0	30.0	21.0	–

The 15-, 16-, 17- and 18- years-old subjects were analysed as separate age groups (Figure 2). As it is seen on the figure 2 the height and weight SD-classes proportion distribution in all age groups was the same.

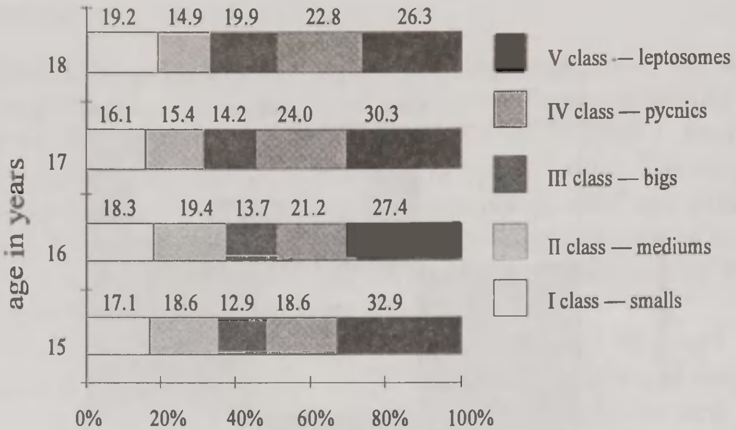

Figure 2. Distribution of height-weight SD-classes of girls by age.

The mean age at menarche of subjects was 13.1±1.1 years. The main part, 83.0% of subjects had their menarche between 12 and 14 years (Table 2). Before the age of 12 years had menarche 6% and premenarcheal (Me_0) were 0.85% (n=10) subjects. There was 10% of girls who had their menarche at the age of 15 or later. The mean sexual age (sexual age = chronological age — age at menarche) of subjects was 3.61±1.39 years, whereas the maximum was 9.02 years. The sexual age was correlating with weight (r=0.20; $p<0.0001$) and with BMI (r=0.24; $p<0.0001$), but not with height (p=0.78). The subjects with menarche before the age of 12 years were significantly heavier than others. The subjects not had their menarche were the lightest and shortest. The subjects with early menarche have significantly higher BMI to compare with others ($p<0.05$). The premenarcheal subjects had the smallest weight ($p<0.05$). The sexual age was correlating with weight, but not with height of subjects.

The characteristics of the height and weight SD-classes and sexual maturation showed that the subjects belonging to the *leptosomes* (SD-class V) had menarche significantly later than the subjects of *smalls* and *pycnics* (SD-classes I, IV) (see Table 3). All subjects belonging to the *mediums, bigs, pycnics,* and *leptosomes* (SD-classes II, III, IV and V) had reached the 4 stage of mammalian (Ma), axillar hair (Ax) and pubic hair (Pu) development. Only the subjects belonging to the *smalls* (SD-class I) had mean Ma, Ax and Pu stage 3.9±0.4.

Table 2

Characteristics of physical maturation by menarcheal age

	Menarcheal age (years)								
	≤11 *1*		12–14 2		≥15 *3*		Me_0* *4*		
n	71		979		118		10		
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	Significance $p<0.05$
age (years)	16.8	0.8	16.8	0.9	16.9	0.8	16.2	0.9	–
sexual age (years)	5.9	0.9	3.7	1.2	1.8	0.8	0	0	*1& 2, 3*
weight (kg)	60.8	0.2	58.7	0.2	55.6	6.8	44.3	6.5	*1& 2, 3, 4* *2& 3, 4* *3& 4*
height (cm)	165.7	5.1	166.2	5.9	167.3	5.5	157.3	6.7	*4& 1, 2, 3*
BMI (kg/m^2)	22.1	3.1	21.3	2.6	19.9	2.1	18.2	0.8	*1& 2, 3, 4* *2&3, 4* *3&4*

*Me_0 premenarcheal subjects

The analyse of results of height and weight SD-classes by age at menarche of the subjects (see Figure 3) showed that the subjects with menarche between the age of 12 and 14 belonged to the corresponding SD-classes *smalls, mediums* and *bigs* (resp. 16.5, 17.3 and 15.3%) and to non-corresponding SD-classes *pycnics* and *leptosomes* (resp. 23.4 and 27.6%). Premenarcheal subjects (Me0) belonged to *smalls* (70%) and *leptosomes* (30%). The most subjects with menarche at the age of 15 years and more belonged to *leptosomes* (43.2%) and *smalls* (23.7%). The subjects with menarche at the age of 11 years and less belonged mostly to *pycnics* (36.6%), the remainded subjects divided equally between *smalls, mediums* and *leptosomes*.

Table 3

Height-weight SD-classes and sexual maturation Tanner's stages by V. Kask modification (1986)

Height-weight SD-class	n	menarche (years)		Ma (stage)		Ax (stage)		Pu (stage)	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
I	210	12.8	2.7	3.9	0.4	3.9	0.4	3.9	0.4
II	202	13.0	1.1	4.0	0.1	4.0	0.0	4.0	0.0
III	172	12.9	1.0	4.0	0.2	4.0	0.0	4.0	0.0
IV	265	12.8	1.0	4.0	0.2	4.0	0.0	4.0	0.0
V	338	13.2	1.7	4.0	0.2	4.0	0.0	4.0	0.0
Significance p<0.05		5&1;4				1&2;3;4;5		1&2;3;4;5	

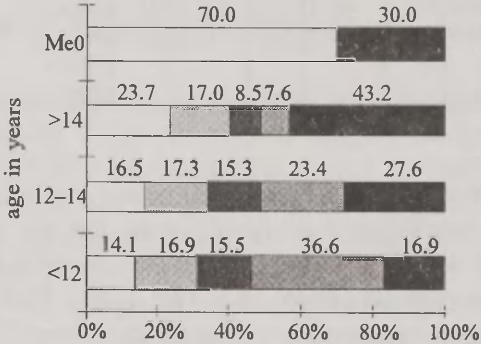

Figure 3. Distribution of height-weight SD-classes of girls by menarcheal age.

DISCUSSION

The investigations on Estonian schoolchildren reports of a halt in acceleration of bodily stature during last two decades [5]. When between 1921 and 1971 the average height of Estonian girls grew 11.8 cm and weight 8.5 kg, then the results of our investigation showed that the Estonian girls' height has not changed during the last decade (15-years-old girls' height was 164.7±5.2 cm in 1984/85 [5] versus 164.5±6.7 cm in 1996 (our result) and 18-years-old girls' height 166.5±5.1 cm versus 166.9±6.0 cm). In our investigation the height of subjects did not grow after the age of 16 years. The weight gain of Estonian schoolchildren has not been continual, the investigations show the decrease in weight. This decline is more pronounced in the girls and the tendency is particularly strong in girls after the age of 14 years who's mean weight is 3 kg lower than ten years ago [10]. In 1984/85 the average weight of Estonian 15-years-old girls was 57.8±8.3 kg and 18-years-old girls 64.4±10.2 kg [5] versus 56.2±8.0 kg and 59.0±8.0 kg in our investigation, so the decrease in weight is 1.6 kg and 5.4 kg during last decade. The decrease in BMI of Estonian schoolgirls is due to less weight.

The menarcheal age of the subjects of our investigation was 13.1 years. Over the past century the trend has been towards earlier age at menarche, with a decrease of 4 months per decade in Estonia from 1896 to 1974 [5]. According the fact that the Estonian girls are significantly lighter than ten years ago and that the mean menarcheal age in 1974 was 13.2 years, we propose that the trend of a decrease in menarcheal age of Estonian girls, similarly with many other countries, has ended.

Early menarche was associated with excess weight, late menarche with underweight. A positive correlation was found between menarcheal age and final body height [1]. In our investigation the Estonian girls having menarche before the age of 12 had the mean weight 5.2 kg more but the mean height 1.6 cm less than the girls having menarche after the age of 14 years. The premenarcheal girls had the mean height 8.4 cm less and the mean weight 16.5 kg less than girls with menarche before the age of 12 years, and 8.9 cm and 14.4 kg less than the girls with menarche between the age of 12 to 14 years. Using typification of antropometric measures of subjects by height and weight SD-classes, the results showed that the premenarcheal subjects belong to corresponding SD-class I and non-corresponding SD-class V, so they all have relatively small weight and small, medium or big height.

The biggest part of subjects with menarche after the age of 14 years belong to SD-class V and I, so they are the subjects with relatively small weight and with small, medium or big height too. The subjects with menarche before the age of 12 years belong to non-corresponding SD-class IV 37%, including pycnics, the subjects with relatively large or medium weight and small or medium height. So in our investigation results show that the main characteristic for menarcheal age is weight.

CONCLUSION

1. Typification of anthropometric measurements by standard deviation (SD) classes of height and weight is a good method to characterize the 15- to 18-years-old girls' bodily stature.

2. The main anthropometric characteristic for menarcheal age is weight as the sexual age is correlating with weight and BMI, but not with height of subjects.

3. The subjects with early menarche after the age of 15 years belonged mostly to class of *pycnics*, as the subjects with menarche after the age of 15 years belonged mostly to classes of *leptosomes* and *smalls*, whereas all the premenarcheal subjects belonged to *smalls* and *leptosomes*.

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THE RELATIONSHIP BETWEEN ANTHROPOMETRIC AND HEALTH-RELATED FITNESS PARAMETERS IN OBESE WOMEN

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ABSTRACT

The purpose of this investigation was to determine the possible relationships between anthropometrical and health-related fitness parameters in obese women. Twenty one obese (BMI>27 kg/m^2) and 12 control (BMI<27 kg/m^2) females (35–45 yrs) participated in this investigation. Three series of anthropometrical measurements were taken according to the O-scale physique assessment system. The Heath-Carter anthropometric somatotyping method was used and the ratio of waist to hip circumferences was calculated. The body composition was measured using bioelectrical impedance method (Bodystat-500, UK). The following health-related fitness tests used were: dynamic sit-up, hand-grip, sit-and-reach, single leg balance and plate tapping. Physical working capacity (PWC) was measured using single ergometer test. Obese women possessed significantly higher ($p<0.05$) values for skinfold, girth and breadth measurements. While the differences in somatotype indices were not statistically significant ($p>0.05$) between obese and control groups, the transformation of somatotype characteristics to the effect sizes (ESs) revealed that these differences were large (ectomorphy: ES=1.73; endomorphy: ES=1.64; mesomorphy: ES=1.71). Relative aerobic fitness ($Vo_{2max/kg}$, calculated from PWC) and dynamic sit-up were higher ($p<0.05$) in control subjects, while obese women presented significantly higher values for handgrip strength. The thicker skinfold thicknesses increased the absolute value of PWC in obese group ($r=0.39$–0.57; $p<0.05$). In contrast, the thinner skinfold thicknesses in suprailiac and mid-thigh significantly increased the absolute value of PWC in control women. There were only a few significant correlations between girth and breadth measures, and health-related fitness parameters. In addition, somatotype characteristics seldom influenced the results of health-related fitness tests.

INTRODUCTION

Numerous studies have linked sedentary lifestyle to low aerobic power (i.e., physical fitness) and increased risk of coronary heart disease (CHD) morbidity and mortality [1, 2]. Health-related fitness has only been assessed in a few epidemiological studies [3] and has been divided into four (i.e., aerobic, musculoskeletal, motor fitness and body composition) [4] or five (i.e., morphological, muscular, motor fitness, cardiorespiratory and metabolic) [5] components. Both health-realted fitness structures use the same classification and EUROFIT test battery [4] adds only the body composition component to the complex of health-related fitness assessment. Unfortunately, there appears to be little evidence about the relationships among body size, shape and composition with the indices of physical fitness.

Many studies have analysed possible relationships between anthropometry and physical fitness during childhood and adolescents [6]. However, there are relatively few studies, which have related health-related fitness tests to anthropometrical parameters in obese subjects. For example, only one study have suggested that 2 km walking test is a reasonably valid test to estimate the cardiorespiratory fitness in overweight persons [7]. Unfortunately, this investigation did not study the influence of anthropometric parameters to the test results. Thus, the purpose of this investigation was to determine the possible relationships between anthropometrical and health-realted fitness parameters in obese women.

MATERIALS AND METHODS

Twenty one obese (body mass index [BMI]>27.0 kg/m^2) and 12 control (BMI<27.0 kg/m^2) females (35–45 yrs) participated in this investigation (Table 1). All subjects were premenopausaled women. They provided informed written consent for the investigation.

The heights (Martin's metal anthropometer) and weights of the subjects were measured to the nearest 0.1 cm and 0.05 kg, respectively. Three series of anthropometrical measurements were taken by a trained anthropometrist according to the O-Scale physique assessment system [8]. The anthropometrist had previously shown test-retest reliability of r>0.90. The CENTURION KIT instrumentation was used (Rosscraft, Surrey, BC, Canada). In total, eight skinfolds, 10 girths and two breadths were measured. The Heath-Carter anthropometric somatotyping method was used [9]. In addition, the ratio of waist to hip circumferences (WHR) was calculated [10]. the body composition was measured using bioelectrical impedance method (Bodystat-500, UK).

Table 1

Mean (±SD) physical characteristics of obese and control groups

	Obese (n=21)	Control (n=12)
Age (yrs)	40.14±8.86	35.92±11.90
Height	167.58±5.98	164.05±5.84
Weight (kg)	92.74±14.13	68.02±4.59*
BMI (kg/m^2)	34.37±4.15	24.24±1.63*
WHR	0.79±0.04	0.76±0.05*
Body fat%	40.09±5.04	26.28±6.16*
Fat (kg)	37.70±9.72	17.92±4.76*
LBM (kg)	55.01±5.43	50.07±5.01*

BMI — body mass index; WHR — waist to hip circumferences ratio; LBM — lean body mass; * — Significantly different from obese group; $p<0.05$

EUROFIT test battery was used to evaluate health-related fitness of subjects [4]. The following parameters measured were: dynamic sit-up, hand grip, sit-and-reach, single leg balance and plate tapping. Physical working capacity (PWC) was measured using single ergometer test [11]. Three progressive workloads for four minutes duration were used. Prior to testing, the subjects completed lighter warm-up workload for three minutes. PWC was calculated graphically at individual's age-predicted maximum heart rate. Maximal O_2 consumption was calculated indirectly using the value of PWC [11].

Standard statistical methods were used to calculate mean, standard deviation (±SD) and zero-order correlations. Statistical comparisons between the groups were made using independent t-tests. In addition, the effect size (ES) transformations were used to indicate differences between obese and control groups. ESs approximately 0.2, 0.5 and 0.8 were categorized as small, moderate and large differences, respectively [12]. the pooled population SD was used in ES computations [13]. Statistical significance was set at $p<0.05$.

RESULTS

Physical profiles of obese and control subjects are presented in Table 1. The groups were not significantly different in terms of age and height. However, obese women were significantly heavier and had significantly higher values for BMI, WHR and body fat % than control subjects (Table 1).

There were significant differences in anthropometric characteristics among obese and control groups (Table 2). Obese subjects demonstrated significantly higher values for skinfold, girth and breadth

Table 2

Mean (±SD) anthropometric and somatotype characteristics of obese and control groups

	Obese (n=21)	Control (n=12)
Skinfolds (mm)		
Triceps	43.22±9.35	26.75±2.85*
Subscapular	42.69±9.91	23.03±5.72*
Biceps	26.02±8.83	12.47±2.34*
Suprailiac	54.65±13.78	23.64±6.92*
Supraspinale	35.78±8.71	19.36±7.38*
Abdominal	61.17±12.70	35.08±9.00*
Mid-thigh	56.56±10.43	40.08±6.85*
Medial calf	39.44±7.77	26.58±4.00*
Girths (cm)		
Relaxed arm	35.49±2.89	27.64±1.51*
Flexed arm	37.32±2.97	29.37±1.71*
Forearm	28.03±1.74	23.54±1.08*
Wrist	16.49±0.86	15.49±1.12*
Chest	110.97±7.41	94.43±4.64*
Waist	94.50±8.80	75.49±4.22*
Gluteal	119.02±9.66	99.92±4.38*
Thigh	65.76±4.00	57.47±3.67*
Calf	43.02±3.08	37.69±2.35*
Ankle	24.81±1.45	22.25±1.38*
Breadths (cm)		
Humerus	6.70±0.36	6.26±0.34*
Femur	10.71±0.59	9.61±0.47*
Somatotype		
Ectomorphy	0.12±0.07	1.58±0.76
Endomorphy	9.25±1.15	6.47±0.81
Mesomorphy	7.39±1.18	4.11±0.88

* Significantly different from obese group; $p<0.05$

measurements. While differences in somatotype values were not statistically significant ($p>0.05$) between the groups (Table 2). However, the transformation of somatotype characteristics to the ESs revealed that differences between obese and control groups were large (ectomorphy: ES=1.73; endomorphy: ES=1.64; mesomorphy: ES=1.71). This suggested that the absence of statistically significant differences between the groups was due to low statistical power rather than the absence of a real difference.

Table 3

Mean (±SD) health-related fitness parameters of obese and control groups

	Obese (n=21)	Control (n=12)
PWC (W)	201.14±42.74	200.92±37.48
Vo_{2max} ($l \cdot min^{-1}$)	2.72±0.53	2.72±0.47
Vo_{2max}/kg ($ml \cdot min^{-1} \cdot kg^{-1}$)	29.65±5.43	40.05±6.20*
Vo_{2max}/LBM ($ml \cdot min^{-1} \cdot kg^{-1}$)	49.45±7.64	54.43±8.07
Dynamic sit-up (n)	10.62±4.52	14.17±2.59*
Hand grip (kg)	38.79±5.58	34.88±3.91*
Sit-and-reach (cm)	22.72±4.20	22.60±2.66
Single leg balance (n)	5.14±3.05	4.83±4.20
Plate tapping (sec)	12.37±1.30	11.93±1.91

PWC — physical working capacity; * — Significantly different from obese group; $p<0.05$

Zero order correlations between anthropometric parameters and health-related fitness items are presented in Table 4. It appeared that thicker skinfold thicknesses increased the absolute value of PWC in obese group. In contrast, the thinner skinfold thicknesses (i.e., suprailiac and mid-thigh) increased the absolute value of PWC in control subjects (Table 4). While the flexibility (sit-and-reach) in obese and control subjects was better for persons with thicker and thinner skinfolds, respectively (Table 4). It appeared that skinfold thickness values were not influenced by the results of single leg balance and plate tapping tests. In addition, skinfold thickness measures were seldom related to dynamic sit-up and hand grip test results (Table 4). There were only few significant correlations between girth and breadth measures, and health-related fitness test results. Similarly, somatotype seldom influenced the results of fitness tests (Table 4).

Table 4

Relationships between anthropometric parameters and health-related fitness tests results in obese and control (in brackets) groups

	PWC	Dynamic sit-up	Hand grip	Sit- and-reach	Single leg balance	Plate tap-ping
Age	–.30	.25	.02	–.51*	–.10	.15
	(.10)	(.22)	(–.14)	(–.59*)	(.54*)	(–.32)
Height	.60*	–.04	.66*	.44*	–.36	.04
	(.73*)	(–.01)	(.59*)	(.18)	(–.14)	(.24)
Weight	.52*	–.20	–.49*	.34	–.08	.00
	(.40)	(.18)	(.62*)	(.02)	(.32)	(.38)
BMI	.27	.20	.21	.15	.15	–.03
	(–.37)	(.19)	(–.01)	(–.18)	(.49)	(.14)
WHR	–.09	–.10	–.03	–.16	.12	–.03
	(.45)	(.21)	(.23)	(–.01)	(.10)	(–.33)
Body fat%	.15	–.54*	.00	.15	.06	.16
	(–.29)	(–.37)	(.16)	(–.32)	(–.56*)	(.82*)
Body fat, kg	.40*	–.43*	–.15	.36	.22	.04
	(–.19)	(.18)	(–.15)	(–.51*)	(.82*)	(.24)
Skinfolds						
Triceps	.28	–.20	.34	.32	–.06	.16
	(.40)	(.18)	(.62*)	(.02)	(.32)	(.38)
Subscapular	.49*	–.27	.37	.23	–.08	.24
	(–.39)	(.19)	(–.01)	(–.18)	(.49)	(.14)
Biceps	.40*	–.29	.33	.38*	–.05	.09
	(–.27)	(–.18)	(–.21)	(–.14)	(.24)	(–.14)
Suprailiac	.48*	–.48*	.27	.40*	–.26	.03
	(–.52*)	(–.37)	(–.91*)	(.28)	(.03)	(–.10)
Supraspinale	.57*	–.36	.42*	.38*	–.19	.25
	(–.17)	(0.7)	(.00)	(–.76*)	(–.18)	(.28)
Abdominal	.50*	–.36	.18	.11	–.10	.22
	(–.27)	(–.08)	(–.11)	(–.73*)	(–.14)	(.13)
Mid-thigh	.35	–.21	.36	.37*	–.09	.03
	(–.62*)	(–.36)	(–.24)	(–.06)	(.46)	(0.19)
Medial calf	.39*	–.13	.08	.18	.00	.17
	(–.31)	(.08)	(.13)	(–.52*)	(.46)	(.19)
Girths						
Relaxed arm	.19	–.18	.20	.19	.07	.11
	(–.14)	(.06)	(.23)	(–.18)	(.20)	(.11)
Flexed arm	.22	–.24	.28	.20	.04	.17
	(.00)	(.12)	(.43)	(–.19)	(.28)	(.13)
Forearm	.29	–.41*	.37	.35	.07	–.08
	(.42)	(–.07)	(.69*)	(.14)	(–.17)	(–.26)
Wrist	.23	–.29	.27	.45*	–.04	–.12
	(.15)	(–.21)	(.50*)	(.06)	(.24)	(–.37)
Chest	.47*	–.08	.32	–.03	.02	.21
	(.41)	(.02)	(–.15)	(.10)	(.30)	(.40)
Waist	.34	–.24	.26	–.01	.13	.07
	(.35)	(.09)	(–.09)	(–.24)	(.57*)	(–.15)

Continued

Gluteal	.45*	–.20	.32	.10	.07	.09
	(–.29)	(.39)	(.17)	(–.30)	(.60*)	(.31)
Thigh	.29	–.17	.36	.54 *	.02	–.27
	(–.24)	(.27)	(.34)	(–.02)	(.15)	(.42)
Calf	.22	–.13	.15	.18	.07	–.08
	(.14)	(.21)	(.75*)	(–.06)	(.06)	(–.01)
Ankle	.27	–.21	.13	–.02	–.14	–.20
	(.32)	(–.20)	(.76*)	(.16)	(–.13)	(–.19)
Breadths						
Humerus	.02	–.11	–.05	.06	–.01	–.45*
	(.55*)	(–.12)	(.57*)	(–0.6)	(.21)	(–.07)
Femur	.33	–.35	.19	.26	.00	.01
	(.21)	(–.01)	(.82*)	(.03)	(.11)	(.13)
Somatotype						
Ectomorphy	–.15	.12	–.19	–.10	–.09	–.16
	(.55*)	(–.14)	(.25)	(.20)	(–.37)	(.04)
Endomorphy	.45*	–.28	.41*	.31	–.11	.23
	(–.39)	(–.08)	(–.80)	(–.08)	(.55*)	(.12)
Mesomorphy	–.23	–.19	–.27	–.12	.27	–.15
	(–.24)	(.15)	(.45)	(–.19)	(.31)	(–.05)

PWC — physical working capacity; BMI — body mass index; WHR — waist to hip circumferences ratio * $p<0.05$

DISCUSSION

The results of the present study indicated that relationships between skinfold thicknesses and PWC were mostly significant in obese subjects ($r=0.39$–0.57; $p<0.05$). Therefore, it appears that the higher values for skinfold thicknesses, body fat % and body mass increased only the absolute value of PWC in obese women. While the high suprailiac and mid-thigh skinfold thickness parameters decreased the PWC value in control subjects (Table 4). In accordance with our results, previous studies have demonstrated that higher BMI values are negatively related to maximal O_2 consumption [14].

The abdominal obesity and aerobic physical fitness have been reported to be independently associated with the risk factors of CHD in obese women [14]. Similarly, our study demonstrated that WHR was not significantly related ($p>0.05$) to the PWC value (Table 4). Several investigations have demonstrated that certain anthropometric measurements, specifically these indicating central adiposity are related to the development of total CHD and quadratically related to all-caused death rates in males [15]. However, WHR appears to be higher risk factor than BMI in females [15]. The risk of increased WHR has been reported to be independent of BMI, and of other established CHD risk factors [15].

High body fat % in obese subjects significantly reduced muscular endurance as measured by sit-ups in our investigation (Table 4). It has been reported that obese women perform about 25% fewer sit-ups than women with normal body weight [16]. Our results demonstrated that the most important skinfold thicknesses related to the muscular endurance in obese subjects was the thickness of suprailiac skinfold ($r=-0.48$; $p<0.05$). Sit-up test results were not dependent on the somatotype characteristics in our study. Thus, it appears that obese women have substantially reduced muscular endurance than age-matched controls.

According to our results, body height and weight influenced particularly the hand grip strength (Table 4). The relationship between body weight and strength has previously been demonstrated [17, 18]. Heavier persons have been reported to possess more muscle mass and, therefore, are generally stronger than leaner persons [18].

In conlusion, the results of our investigation demonstrated that all health-related fitness tests, except single leg balance and plate tapping, were significantly related to most skinfold thickness values. This relationship was more pronounced in obese women than age-matched controls. While the girth and breadth parameters did not influence health-related fitness.

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APPLICATION OF A 5-CLASS CLASSIFICATION OF HEIGHT AND WEIGHT TO SYSTEMATISE ANTHROPOMETRIC DATA OF 16-YEAR-OLD TARTU SCHOOLGIRLS

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ABSTRACT

An anthropometric study of 274 16-year-old schoolgirls from the city of Tartu was carried out. 42 single body measurements and 11 skinfolds were measured, and 45 indices and body composition characteristics were derived from them. The data were systematised into 5-class SD classification according to the correspondence between height and weight (1. small height–small weight; 2. medium height–medium weight; 3. big height–big weight) and into classes with the largest relative non-correspondence between height and weight (4. pycnics and 5. leptosomes). In addition to the well-known differences between pycnics and leptosomes it was shown that in the classes 1, 2, and 3 also gradual statistically significant changes take place. Thus, Rohrer index, body mass index, total percentage of fat (by Siri), absolute and relative mass of adipose tissue increase; body density decreases. At that the skeleton retains its characteristic proportions. Although an essential increase in height occurs in classes 1, 2, and 3, the relations of trunk height, length of the limbs, biacromial breadth, chest breadth and depth, pelvis breadth and depth, thickness of bones to height remain stable. The proportions of fat, muscles and bones are mutually connected, and while establishing norms for these proportions, it is necessary to consider body size.
Key words: schoolgirls' body build, body composition, height-weight classification, anthropometric measurements.

INTRODUCTION

Anthropometric measuring of schoolchildren is practiced regularly in most European countries [1, 2, 3, 4], including Estonia [5, 6, 7, 8, 9, 10]. Schoolchildren are complicated research material as individual, age-related and constitutional changes intertwine in them [11, 12, 13]. Therefore the problems of classification and typification of their anthropometric characteristics deserve further investigation.

Women's Hospital and Centre for Physical Anthropology, both at the University of Tartu, have been investigating young women's body structure since 1974 [14]. We have reached the conclusion that the body build structure of young women (aged 18–22) is a well-correlated system where the leading characteristics are height and weight. Integrity of the body is guaranteed by the fact that 50% of the variability of all the other characteristics are determined by height and weight. A change in the height-weight relations leads to systematic changes in height, breadth and depth measurements, circumferences and body proportions. Comparative changes of body proportions in the general contingent and in the groups of purely pycnic and leptosomic women are based on the corresponding values of their body height and weight. As a basis of the body build model we use a classification of height and weight in 3×3 or 5×5 SD classes [15, 16], which presents the dynamics of the mean values of all the characteristics investigated, and where the significance of differences may be analysed by Scheffe test.

The aim of the present research was to find how the single measurements, proportions and body build characteristics of 16-year-old girls could be studied by a SD classification of weight and height where the number of classes has been reduced to five.

MATERIAL AND METHODS

The subjects of the study were 274 practically healthy schoolgirls at the age of 16–17 from all secondary schools of Tartu. 42 body measurements and 11 skinfolds were measured according to the classical methods of Martin [17].

On the basis of these measurements, we calculated 55 characteristics which characterise body composition and proportions. In order to assess body composition, we used such generally-known characteristics as body density [18], relative mass of fat by Siri, absolute and relative mass of subcutaneous adipose tissue. In addition, we calculated the relation of the local subcutaneous adipose tissue to the remaining bone-muscle compound on the cross-sectional areas of the arm and the thigh. The measurements are preserved at the Estonian National Register of Anthropometric Data. The data were processed at the Institute of Mathematical Statistics by Säde Koskel, consultant was Prof. E. Tiit.

RESULTS

Preliminary analysis of the data is presented in Table 1. There we can see that the average height of 16-year-old girls in Tartu is 166.58 (SD=5.97), which corresponds exactly to the results of a wide-range survey of Estonian schoolchildren's absolute growth curves from age 7 to 18 [19]. The weight of our subjects as urban children was 59.689 kg (SD=9.259), which is about two kilograms heavier than the Estonian average (57.24) for this age group.

A relatively big variability of anthropometric characteristics seems to be typical for this contingent. The most stable of the principal measurements was height (v=3.58), and the most variable was weight (v=15.51). The variability of other principal measurements and indices based on them had an intermediate value. Skinfolds and the relative mass of subcutaneous adipose tissue form a separate group with a great degree of variability.

Correlation analysis of data showed that the girls' body build is based on a system of characteristics, most of which are in statistically significant correlation with one another. Height and weight have the strongest correlations with the other characteristics. The mutual r between weight and height is 0.449.

The existence of the above-mentioned correlations serves as a basis for the application of a height-weight classification. From among its possible variants, we used a 5-class system of SD classes (1. small height–small weight; 2. medium height–medium weight; 3. big height–big weight; and the classes with the largest noncorrespondence — 4. pycnics and 5. leptosomes) (see Fig. 1).

The mean values of all the individual characteristics studied (n=42), indices and body composition characteristics formed from anthropometric data (n=55) were calculated for all the five height-weight classes and the statistical significance of their differences was assessed by Scheffe-test (Tables 2 and 3).

Table 1

Basic statistics of 16-year-old girls anthropometric measurements and indices (n=274)

N°	Variable	Mean	Minimum	Maximum	SD	V
1.	weight (kg)	59.689	40.700	99.800	9.259	15.51
2.	height (cm)	166.58	152.600	186.600	5.97	3.58
3.	sternum length (cm)	14.07	10.50	20.10	1.66	11.80
4.	abdomen length	36.51	26.90	44.10	2.76	7.55
5.	trunk length	50.61	39.00	66.80	2.78	5.49
6.	upper limb length	71.71	39.70	88.40	4.26	5.95
7.	lower limb length	90.02	78.80	102.50	4.30	4.77
8.	biacromial breadth	34.87	30.0	45.50	1.81	5.18
9.	chest breadth	24.00	20.00	29.50	1.45	6.03
10.	waist breadth	22.66	18.50	29.50	1.99	8.80
11.	pelvis breadth	27.10	17.00	32.50	1.59	5.88
12.	chest depth	16.74	13.00	24.50	1.38	8.24
13.	abdomen depth	15.66	12.50	24.00	1.58	10.09
14.	femur breadth (cm)	8.76	7.00	10.70	0.61.	6.91
15.	ankle breadth	6.85	6.00	12.00	0.51	7.44
16.	humerus breadth	6.15	4.30	8.50	0.40	6.46
17.	wrist breadth	5.04	4.20	5.80	0.30	5.89
18.	head circumf.	55.24	50.3	59.7	1.41	255
19.	neck circumf.	31.84	28.4	45.80	1.78	5.59
20.	upper chest circumf.	83.19	67.8	103.30	5.39	6.48
21.	lower chest circumf.	75.45	61.70	97.20	5.50	7.29
22.	waist circumf.	68.52	55.40	95.60	6.11	8.92
23.	pelvis circumf.	85.33	69.50	109.20	6.79	7.96
24.	hip circumf.	90.67	74.00	112.90	6.44	7.10
25.	upper thigh circumf.	57.99	46.10	77.90	4.91	8.47
26.	middle thigh circumf.	48.15	32.5	65.3	4.58	9.51
27.	upper leg circumf.	34.98	21.30	49.00	3.08	8.80
28.	lower leg circumf.	22.19	18.90	33.10	1.61	7.26
29.	arm circumf.	25.80	2.57	19.70	33.70	9.98
30.	forearm circumf.	22.67	1.58	18.80	28.50	6.96
31.	wrist circumf.	15.57	0.76	13.40	18.30	4.91
32.	chin skinfold (mm)	6.69	1.99	3.00	14.00	29.87
33.	side skinfold	7.41	2.79	3.00	17.00	37.66
34.	chest skinfold	9.75	4.42	4.00	26.00	45.33
35.	waist skinfold	13.55	5.89	4.00	35.00	43.45
36.	suprailiacal skinfold	9.71	4.68	3.00	30.00	48.17
37.	umbilical skinfold	12.05	5.45	4.00	33.00	45.22
38.	subscapular skinfold	11.57	5.49	5.00	43.00	47.48
39.	biceps skinfold	7.50	3.47	2.00	29.00	46.31
40.	triceps skinfold	14.76	4.71	6.00	32.00	31.92
41.	thigh skinfold	22.11	6.06	8.00	43.00	27.40
42.	calf skinfold	14.58	6.04	3.00	33.00	41.43
43.	Rohrer index	1.291	0.977	2.49	0.189	14.61
44.	body mass index	21.49	15.72	39.58	2.29	13.95
45.	body surface area (m^2)	1.66	1.38	2.11	0.13	7.96
46.	mean skinfold (mm)	1.18	0.55	2.53	0.39	33.09
47.	mass of subcutaneous fat (kg)	8.99	3.45	22.14	3.52	39.12
48.	relat. mass of subcut. fat (%)	14.72	7.54	26.99	3.98	27.06
49.	body dersity (g/cm^3)	1.051	1.020	1.071	0.009	0.81
50.	relat. mass of fat by Siri (%)	16.67	16.28	17.82	2.60	1.56

Continue

N°	Variable	Mean	Minimum	Maximum	SD	V
51.	relat. trunk length %	30.38	23.23	35.80	1.27	4.19
52.	relat. abdomen length	21.91	16.02	25.90	1.48	6.76
53.	relat. upper limb length	43.04	24.22	47.37	1.94	4.50
54.	relat. lower limb length	54.03	48.96	57.93	1.59	2.94
55.	relat. biacromial breadth	20.93	17.74	24.38	0.93	4.45
56.	relat. chest breadth	14.42	12.18	16.89	0.84	5.81
57.	relat. waist breadth	13.61	11.13	17.99	1.16	8.50
58.	relat. pelvis breadth	16.28	10.14	18.51	0.91	5.61
59.	relat. chest depth	10.05	7.91	14.99	0.83	8.29
60.	relat. abdomen depth	9.41	7.42	14.64	0.97	10.28
61.	relat. femur breadth	5.26	4.13	6.21	0.37	7.02
62.	relat. ankle breadth	4.11	3.48	7.13	0.29	7.00
63.	relat. humerus breadth	3.70	2.46	5.27	0.22	6.03
64.	relat. wrist breadth	3.02	2.58	3.47	0.15	4.96
65.	relat. upper chest circumf.	49.97	42.64	63.03	3.12	6.25
66.	relat. lower chest circumf.	45.31	38.14	59.30	3.31	7.31
67.	relat. waist circumf.	41.15	34.78	58.33	3.64	8.84
68.	relat. pelvis circumf.	51.25	42.24	66.63	4.05	7.91
69.	relat. hip circumf	54.45	44.50	67.11	3.74	6.87
70.	relat. upper thigh circumf.	34.82	28.65	45.08	2.88	8.28
71.	relat. upper leg circumf.	21.00	13.29	30.88	1.81	8.63
72.	relat. arm circumf.	15.50	12.24	20.08	1.56	10.06
73.	relat. forearm circumf.	13.61	11.68	18.36	0.93	6.85
74.	relat. wrist circumf.	9.35	8.09	10.75	0.42	4.48
75.	arm circumf./ upper limb length %	36.14	27.36	82.87	4.84	13.38
76.	forearm circumf./ upper limb length	31.73	26.11	64.48	3.18	10.02
77.	wrist circumf./ upper limb length	21.78	18.18	42.57	1.78	8.16
78.	humerus breadth / upper limb length	8.61	5.48	15.87	0.72	8.40
79.	wrist breadth / upper limb length	7.04	5.91	82.85	0.56	8.00
80.	upper thigh circumf./ lower limb length	64.51	52.96	84.86	5.79	8.98
81.	upper leg circumf./ lower limb length	38.91	25.03	58.26	3.57	9.17
82.	lower leg circumf./ lower limb length	24.67	21.11	38.42	1.96	7.96
83.	femur breadth / lower limb length	9.74	7.76	11.88	0.68	7.03
84.	ankle breadth / lower limb length	7.62	6.34	13.44	0.57	7.54
85.	chest depth / chest breadth	69.89	54.72	100.00	6.01	8.60
86.	biacromial breadth / pelvis breadth	129.01	110.17	200.00	8.98	6.96
87.	biacromial breadth / upper chest circumf.	42.01	35.31	52.48	2.41	5.74
88.	cross-sectional area of arm (cm^2)	538.95	338.24	965.82	93.05	17.26
89.	bone-muscle rate of the cross-sectional area of arm (cm^2)	39.84	22.62	58.95	6.58	16.52
90.	fat rate of the cross-sectional area of arm (cm^2)	67.12	36.06	123.66	16.12	24.01
91.	cross-sectional area of thigh (cm^2)	538.95	338.24	965.82	93.04	17.26
92.	bone-muscle rate of the cross-sectional area of thigh (cm^2)	208.77	136.98	342.95	33.41	16.00
93.	fat rate of the cross-sectional area of thigh. (cm^2)	330.60	199.85	622.87	63.34	19.16
94.	bone-muscle rate of the cross-sectional area of arm (cm^2) / cross-sectional area of arm (cm^2)	0.38	0.24	0.44	0.03	8.37
95.	fat rate of the cross-sectional area of arm (cm^2) / cross-sectional area of arm (cm^2)	0.62	0.56	0.76	0.03	5.05

Continue

N°	Variable	Mean	Minimum	Maximum	SD	V
96.	bone-muscle rate of the cross-sectional area of thigh (cm^2) / cross-sectional area of thigh (cm^2)	0.39	0.31	0.45	0.02	6.19
97.	fat rate of the cross-sectional area of thigh (cm^2) / cross-sectional area of thigh (cm^2)	0.61	0.55	0.69	0.02	3.93

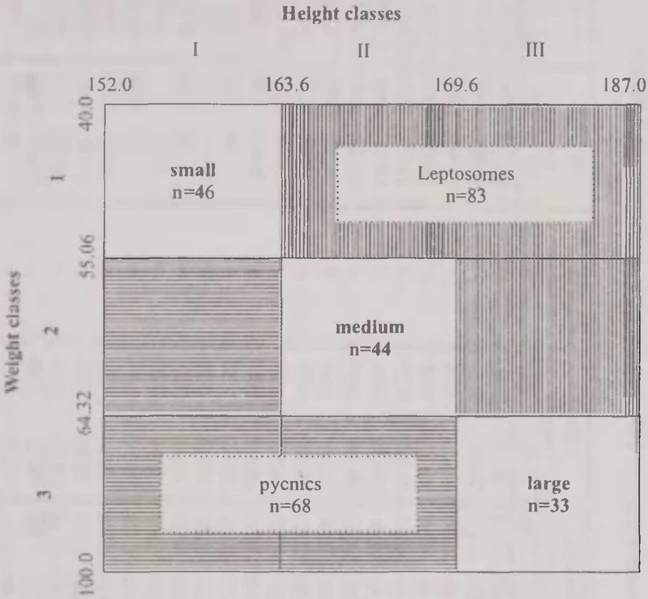

Figure 1. Classification of 16-year-old girls by 5 height-weight classes.

As seen in Table 2, in small–medium–large classes a statistically significant increase occurs in all characteristics — height, breadth and depth measurements, bone thickness and skinfolds. According to our data, sternum length (see Table 2) is an exception. Characteristic differences could also be noticed between the individual body measurements of pycnics and leptosomes (classes 4 and 5).

Gradual increase in height and weight (classes 1, 2 and 3) causes essential changes in body composition (Table 3). This is certified by a statistically significant increase in Rohrer's index, relative mass of fat by Siri, mass of subcutaneous adipose tissue and relative mass of subcutaneous adipose tissue, and a gradual decrease in body density (characteristic 49).

Table 2

Basic statistics of anthropometric measurements of 16-year-old girls grouped into 5 height-weight classes.

N°	Variable	Small (n=46)		Medium (n=44)		Large (n=33)		Significance	Pycnics (n=68)		Leptosomes (n=83)		Significance
		X	SD	X	SD	X	SD		X	SD	X	SD	
1.	weight (kg)	49.897	3.501	58.955	2.729	74.170	7.622	+	67.718	8.041	55.63	4.81	+
2.	height (cm)	159.78	2.80	166.98	1.57	175.69	3.75	+	162.64	3.90	169.77	3.54	+
3.	sternum length (cm)	13.83	1.76	14.30	1.45	14.13	1.85	-	13.43	1.60	14.58	1.51	+
4.	abdomen length	34.88	2.07	36.10	2.86	38.77	3.07	+	36.15	2.61	36.70	2.34	+
5.	trunk lenght	48.60	1.51	50.44	3.21	53.28	3.27	+	49.53	2.26	51.58	1.91	+
6.	upper limb length	69.20	2.47	71.92	2.10	76.19	3.03	+	69.55	4.94	72.97	3.80	+
7.	lower limb length	86.28	2.67	90.78	3.35	95.68	2.85	+	87.55	3.43	91.37	3.33	+
8.	biacromial breadth	33.58	1.20	35.02	1.36	37.00	1.96	+	34.79	1.59	34.70	1.65	-
9.	chest breadth	22.95	1.17	23.78	1.31	25.65	1.40	+	24.46	1.27	23.67	1.10	+
10.	waist breadth	21.04	1.24	22.66	1.30	24.97	1.83	+	23.74	1.97	21.75	1.25	+
11.	pelvis breadth	26.31	1.13	27.24	1.24	28.80	1.39	+	26.87	1.93	26.98	1.24	-
12.	chest depth	15.87	0.94	16.52	0.98	17.71	1.22	+	17.36	1.49	16.43	1.31	+
13.	abdomen depth	14.66	0.92	15.35	1.01	17.15	1.61	+	16.63	1.75	14.97	0.99	+
14.	femur breadth	8.44	0.46	8.70	0.50	9.33	0.62	+	8.96	0.58	8.57	0.54	+
15.	ankle breadth	6.57	0.29	6.90	0.85	7.24	0.37	+	6.79	0.47	6.86	0.31	-
16.	humerus breadth	5.86	0.30	6.18	0.26	6.39	0.48	+	6.12	0.47	6.23	0.31	-
17.	wrist breadth	4.81	0.25	5.06	0.30	5.31	0.24	+	4.96	0.27	5.10	0.25	+
18.	head circumf.	54.13	1.44	55.27	1.52	56.41	1.07	+	55.20	1.32	55.38	1.06	-
19.	neck circumf.	30.56	0.94	31.85	0.74	33.14	1.41	+	32.72	2.19	31.32	1.60	+
20.	upper chest circumf.	77.81	3.68	83.70	2.74	89.72	4.78	+	86.25	4.82	80.72	3.12	+
21.	lower chest circumf.	70.56	3.19	76.01	3.24	81.54	4.85	+	79.08	5.16	72.46	3.18	+
22.	waist circumf.	63.17	3.36	68.23	3.59	75.40	5.59	+	72.58	5.80	65.52	3.72	+

Continue

Nº	Variable	Small (n=46)		Medium (n=44)		Large (n=33)		Significance	Pycnics (n=68)		Leptosomes (n=83)		Significance
		X	SD	X	SD	X	SD		X	SD	X	SD	
23.	pelvis circumf.	79.40	3.99	84.84	4.24	93.23	6.04	+	89.78	5.74	82.07	4.73	+
24.	hip circumf.	84.28	3.33	90.22	4.49	99.17	6.17	+	94.53	5.05	87.86	3.66	+
25.	upper thigh circumf.	53.33	2.78	57.27	2.38	64.71	4.38	+	61.38	3.35	55.37	3.09	+
26.	middle thigh circumf.	44.61	3.10	47.21	3.35	53.08	4.69	+	51.44	3.60	45.86	2.81	+
27.	upper leg circumf.	32.35	2.19	34.60	1.73	38.55	2.46	+	36.88	2.62	33.62	2.33	+
28.	lower leg circumf.	21.22	1.95	21.99	0.92	23.80	1.17	+	22.77	1.66	21.73	1.12	+
29.	arm circumf.	23.74	1.51	25.80	1.38	30.42	2.60	+	27.72	2.30	24.32	1.73	+
30.	forearm circumf.	21.39	1.56	22.52	1.15	24.35	1.43	+	23.45	1.38	22.14	1.04	+
31.	wrist circumf.	14.83	0.45	15.54	0.56	16.54	0.63	+	23.45	1.38	15.48	0.65	+
32.	chin skinfold (mm)	6.11	1.94	6.60	2.15	7.52	1.73	+	7.87	2.03	5.77	1.34	+
33.	side skinfold	6.19	1.94	7.82	2.79	9.09	2.55	+	8.85	3.05	5.98	1.94	+
34.	chest skinfold	7.39	2.59	9.75	3.44	12.91	4.38	+	12.70	0.50	7.37	2.71	+
35.	waist skinfold	9.89	3.51	13.98	4.82	18.82	5.58	+	16.93	6.02	10.44	4.07	+
36.	suprailiacal skinfold	7.71	3.78	9.64	4.14	13.32	4.64	+	12.81	4.49	6.86	2.73	+
37.	umbilical skinfold	9.30	3.58	12.34	4.72	15.92	5.44	+	15.21	5.87	9.27	3.74	+
38.	subscapular skinfold	8.73	2.87	11.47	3.74	15.44	6.10	+	15.28	6.45	8.58	2.95	+
39.	biceps skinfold	5.92	2.25	7.34	2.77	10.27	3.64	+	9.46	3.88	5.75	2.26	+
40.	triceps skinfold	12.23	3.35	14.45	3.81	18.59	4.51	+	18.09	4.05	12.07	3.57	+
41.	thigh skinfold	18.86	3.54	21.39	4.98	26.18	5.78	+	26.13	5.59	19.92	5.41	+
42.	calf skinfold	13.42	5.59	14.06	5.56	16.85	5.88	+	17.45	6.07	12.20	5.39	+

Table 3

Basic statistics of indices and body composition data of 16-year-old girls grouped into 5 height-weight classes

N°	Variable	Small (n = 46)		Medium (n = 44)		Large (n = 33)		Significance	Pycries (n = 68)		Leptosomes (n = 83)		Significance
43.	Rohrer index	1.225	0.10	1.267	0.07	1.371	0.162	+	1.505	0.182	1.136	0.07	+
44.	body mass index	19.56	1.45	21.16	1.16	24.06	2.64	+	24.45	2.86	19.28	1.26	+
45.	body surface area (m^2)	1.50	0.05	1.66	0.03	1.90	0.09	+	1.69	0.10	1.64	0.079	+
46.	mean skinfold (mm)	9.61	2.45	11.7	3.1	15.0	3.7	+	14.66	3.71	9.5	2.6	+
47.	mass of subcutaneous adipose tissue (kg)	6.473	1.691	8.752	2.43	12.90	3.62	+	11.26	3.31	7.01	2.05	+
48.	relat. mass of subcutaneous adipose tissue (%)	13.03	3.22	14.81	3.62	17.16	3.34	+	17.20	3.68	12.52	3.28	+
49.	body density	1.055	0.006	1.051	0.067	1.045	0.009	+	1.044	0.007	1.056	0.006	+
50.	relat. mass of fat by Siri (%)	16.52	0.13	16.65	0.180	16.88	0.27	+	16.86	0.28	16.52	0.16	+
51.	relat. trunk length (%)	30.20	1.01	30.20	1.92	30.31	1.43	-	30.48	1.18	30.37	0.94	-
52.	relat. abdomen length	21.85	1.39	21.62	1.71	22.06	1.59	-	22.25	1.53	21.79	1.28	-
53.	relat. upper limb length	43.32	1.30	43.07	1.13	43.39	1.44	-	42.75	2.82	49.98	1.85	-
54.	relat. lower limb length	54.04	1.37	54.37	1.88	54.45	1.26	-	53.85	1.68	53.83	1.54	-
55.	relat. biacromial breadth	21.02	0.62	20.98	0.82	21.06	0.99	-	21.39	0.93	20.44	0.89	+
56.	relat. chest breadth	14.37	0.69	14.24	0.78	14.61	0.83	-	15.04	0.80	13.94	0.61	+
57.	relat waist breadth	13.17	0.78	13.57	0.81	14.22	1.10	+	14.60	1.17	12.81	0.68	+
58.	relat. pelvis breadth	16.48	0.65	16.32	0.79	16.40	0.85	-	16.52	1.17	15.90	0.77	+
59.	relat. chest depth.	9.94	0.65	9.90	0.60	10.09	0.74	-	10.67	0.89	9.68	0.74	+
60.	relat. abdomen depth.	9.18	0.64	9.20	0.62	9.77	0.94	-	10.23	1.07	8.82	0.62	+
61.	relat. femur breadth	5.28	0.31	5.21	0.30	5.31	0.36	-	5.51	0.35	5.05	0.32	+
62.	relat. ankle breadth	4.11	0.19	4.13	0.50	4.12	0.23	-	4.18	0.28	4.04	0.17	+
63.	relat humerus breadth	3.67	0.19	3.70	0.14	3.64	0.27	-	3.76	0.29	3.67	0.18	+
64.	relat. wrist breadth	3.01	0.15	3.03	0.18	3.02	0.11	-	3.05	0.15	3.00	0.14	+

Continue

Nº	Variable	Small (n = 46)		Medium (n = 44)		Large (n = 33)		Signi-ficance	Pycries (n = 68)		Leptosomes (n = 83)		Signi-ficance
65.	relat. upper chest circumf.	48.72	2.35	50.11	1.80	51.09	2.90	+	53.04	2.89	47.56	1.56	+
66.	relat. lower chest circumf	44.19	2.19	45.53	2.07	46.44	2.94	+	48.63	3.16	42.68	1.62	+
67.	relat. waist circumf.	39.56	2.25	40.87	2.28	42.95	3.43	+	44.64	3.53	38.60	2.07	+
68.	relat. pelvis circumf.	49.73	2.65	50.82	2.74	53.10	3.79	+	55.23	3.38	48.35	2.75	+
69.	relat. hip circumf.	52.79	2.37	54.04	2.78	56.48	3.82	+	58.16	3.02	51.76	2.03	+
70.	relat. upper thigh circumf.	33.40	1.92	34.30	1.52	36.86	2.75	+	37.75	2.01	32.62	1.77	+
71.	relat. upper leg circumf.	20.26	1.45	20.73	1.12	21.95	1.48	+	22.68	1.60	19.80	1.29	+
72.	relat. arm circumf.	14.87	1.05	15.46	0.87	16.13	1.44	+	17.04	1.36	14.33	1.00	+
73.	relat. forearm circumf.	13.39	1.03	13.49	0.75	13.87	0.85	+	14.42	0.77	13.04	0.57	+
74.	relat. wrist circumf.	9.29	0.29	9.31	0.37	9.42	0.41	-	9.66	0.40	9.12	0.36	+
75.	arm circumf./ upper limb length (%)	34.38	2.88	35.91	2.28	37.40	3.57	+	40.20	6.24	33.44	3.24	+
76.	forearm circumf./ upper limb length.	30.97	2.71	31.34	1.94	32.05	2.31	-	33.96	4.31	30.41	2.03	+
77.	wrist circumf./ upper limb length	21.46	0.96	21.62	1.07	21.77	1.11	-	22.74	2.72	21.26	1.33	+
78.	humerus breadth./ upper limb length	8.48	0.50	8.60	0.33	8.39	0.74	-	8.86	1.08	8.56	0.55	+
79.	wrist breadth / upper limb length	6.96	0.40	7.04	0.44	6.96	0.38	-	7.17	0.82	7.01	0.49	+
80.	upper thigh circumf./ lower limb length	61.97	3.79	63.26	4.19	67.52	5.39	+	70.18	4.55	60.63	3.94	+
81.	upper leg circumf./ lower limb length	37.44	2.80	38.20	2.31	40.25	2.88	+	42.15	3.34	36.85	2.74	+
82.	lower leg circumf./ lower limb length	24.47	2.30	24.24	1.27	24.86	1.49	-	26.03	2.17	23.80	1.40	+
83.	femur breadth / lower limb length	9.77	0.54	9.60	0.50	9.75	0.69	-	10.23	0.69	9.38	0.59	+

Continue

N°	Variable	Small (n = 46)		Medium (n = 44)		Large (n = 33)		Significance	Pycries (n = 68)		Leptosomes (n = 83)		Significance
84.	ankle breadth / lower limb length	7.62	0.37	7.61	0.99	7.59	0.46	-	7.77	0.57	7.51	0.35	+
85.	chest depth./ chest breadth	69.31	5.29	69.70	5.90	69.23	5.81	-	71.11	6.42	69.56	6.16	-
86.	biacromial breadth / pelvis breadth	127.83	6.28	128.81	7.21	128.78	9.89	-	130.15	11.62	128.88	8.27	-
87.	biacromial breadth / upper chest circumf.	43.24	2.36	41.93	1.81	41.36	3.20	+	40.40	2.01	42.96	1.78	+
88.	cross-sectional area of arm (cm^2)	90.09	11.38	106.27	11.41	128.61	22.39	+	123.13	20.39	94.63	13.53	+
89.	bone-muscle rate of the cross-sectional area of arm (cm^2)	34.86	4.14	39.98	4.38	45.26	6.41	+	43.91	6.89	37.02	4.74	+
90.	fat rate of the cross-sectio-nal area of arm (cm^2)	55.23	8.15	66.30	8.73	83.35	16.86	+	79.43	14.95	57.61	9.64	+
91.	cross-sectional area of thigh (cm^2)	453.92	46.93	522.86	43.61	669.32	92.87	+	601.45	65.50	489.53	54.95	+
92.	bone-muscle rate of the cross-sectional area of thigh (cm^2)	179.43	20.51	203.81	19.76	254.85	32.92	+	226.13	24.82	194.45	23.33	+
93.	fat rate of the cross-sectional area of thigh (cm^2)	274.49	29.27	319.04	30.66	414.46	64.07	+	376.39	46.23	295.74	37.35	+
94.	bone-muscle rate of the cross-sectional area of arm (cm^2) / cross-sectional area of arm	0.39	0.03	0.38	0.03	0.35	0.03	+	0.36	0.03	0.39	0.03	+
95.	fat rate of the cross-sectional area of arm (cm^2) / cross-sectional area of arm	0.610.03		0.62	0.03	0.65	0.03	+	0 64	0.03	0.61	0.03	+
96.	bone-muscle rate of the cross-sectional area of thigh (cm^2) / cross-sectional area of thigh	0.400.02		0.39	0.02	0.38	0.02	+	0.38	0.02	0.40	0.03	+
97.	fat rate of the cross-sectional area of thigh (cm^2) / cross-sectional area of thigh	0.600.02		0.61	0.02	0.62	0.02	+	0.62	0.02	0.66	0.03	+

A similar tendency can also be demonstrated locally — on the cross-sectional area of arm and thigh (characteristics 88 and 91), where the essential increase of the cross-sectional area brings about an increase in the proportion of the adipose tissue in relation to the bone-and-muscle area on both the arm (characteristics 94 and 95) and the thigh (characteristics 96 and 97). The amount of soft tissues increases on the trunk and the limbs as well, which can be demonstrated by the relative increase of the trunk and the limbs in relation to height or to the length of the corresponding limb itself (characteristics 75, 76, 80, 81).

At the same time it is interesting to note a tendency to the preservation of former proportions in the case of the skeleton. Simultaneously with an essential increase in height in classes 1, 2, and 3, the stability of proportions of trunk height, abdomen length, lengths of limbs, biacromial breadth, chest breadth and depth, pelvis breadth and bone thickness (charcacteristics 61–64) in relation to height can be noticed. There is no significant difference between the relative measures in different classes.

There are significant mutual differences between the groups of pycnics and leptosomes as well. Pycnics' essentially greater Rohrer index, body mass index, relative mass of fat by Siri, absolute and relative mass of subcutaneous adipose tissue and the greater proportion of fat on cross-sectional areas of the arm and the thigh are also due to pycnics' relatively bigger circumferences of trunk and limbs as compared to leptosomic girls. The latter are characterised by greater density of the body and relatively small breadth-depth measures and circumferences. A very characteristic index differentiating pycnics and leptosomes — *biacromial breadth/upper chest circumference* — is also smaller in pycnics (characteristic 87) and bigger in leptosomes. At the same time here, too, the proportionality of trunk and limbs to height is preserved (characteristics 51, 54), and there is no essential difference between the groups of pycnics and leptosomes in the indices *chest depth/chest breadth* (characteristic 85) and *biacromial breadth/pelvis breadth* (characteristic 86).

DISCUSSION

Classification of anthropometric data is necessary in order to find the possible systematic changes in single characteristics, indices and characteristics of body composition of the persons studied. The classification should enable us to differentiate between the body size and somatotype of the subjects. As we have shown in the present paper, a 5-class SD classification of weight and height is suitable for these purposes. On the sample of 16-year-old schoolgirls it proved possible to demonstrate that, in addition to the well-known differences between pycnic and leptosomic women [20], interesting systematic changes appear in heigh-weight correspondence classes [1, 2, 3] as well.

An increase in soft tissues leads to a relative increase in the subcutaneous adipose tissue and in the total amount of fat in the body, and to a decrease in body density. An increase in height according to classes, however, is connected with the preservation of proportionality of the following characteristics in relation to height — trunk length, limb lenght, biacromial breadth, chest breadth and depth, pelvis breadth, thickenss of limb bones (relative femur, ankle, humerus and wrist breadth).

The systematic differences found show that in the case of establishing norms for body build and body composition it is necessary to consider body size.

As the mutual correspondence between fat, muscles and bones is determined as early as at the embryonal stage [21] because all of them have developed from one and the same mesoderm, such dependence needs further study.

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PROF. JUHAN AUL AND EUGENICS

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The topic under discussion is sensitive. According to our modern attitudes, eugenics as a scientific doctrine does not suit the criteria of modern understandings about human rights, the place of minorities in the society as well as the role of biological factors shaping human fates in a society. Yet, it is evident that scientists in most cases have been influenced by their contemporary understandings and approaches. The attitudes stressing biological determination in social and individual human development have been an important part in the history of sciences. The present study will not try to condemn Juhan Aul for his role in the history of Estonian eugenics, but tries to discuss some aspects in the history of biological sciences, including anthropology, in Estonia through professor Auls's involvement in it.

By the time Juhan Aul (Johann Klein until 1931) came to biology, the eugenical attitudes typical to Western thinking, had already reached Estonia. It all had happened already before Estonia gained independence [1]. The concerns of eugenically thinking people of Estonia were similar to eugenical ideas popular in other parts of the world — worries about the supposed negative selection (low birth rates in higher/educated social strata, the devastating results of wars and revolutions, the losses society bears when supporting its weak, insane and criminal, etc.) were a problem here too. It depends on the historical and cultural background of society which groups become less valued. In Estonian context it is important to mention that their racial traits in the biological meaning did not become stressed as critical markers. Perhaps it is even normal, just to be reminded here, that Juhan Aul, becoming the Grand Old Man of Estonian physical anthropology, was also interested in racial biology of Estonian population.

The racial background of Estonians has always been a temptation for our researchers. The reason is the untypical to Europe language the Estonians speak, and, derived from this, the historical theories connecting us biologically with the Mongols, etc. It is evident that even in our century being a "Mongol" could be a sort of condemnation, and thus it is clear why Estonian anthropologists tried to "fight" such theories. In this light it could also have been normal if our people had been more enthusiastic about the racial aspects of ethnicity, and while attempting to improve their nationality (by eugenics—racial hygiene) also to fight the racial disadvantages whatever there could have been, searching for the "ideal" or "real" characteristics of Estonians. Such attempts were made in Finland [2].

Juhan Aul studied biology at Tartu University from 1921 to 1928. During his long scientific career J. Aul remained very versatile [3]. He is mainly remembered as a devoted physical anthropologist, dedicating himself to the racial constitution of the Estonian population and its neighbours as well as to the age- and sex related trends in the physical appearance of the Estonian people. His goal, pronounced in the late 1930s, was the Estonian Anthropological Institute. The latter should have run a project *Anthropologia estonica* — a broad database of anthropological information about the Estonian population, useful both for biological studies and social applications [4].

Aul stressed the practical applications he believed physical anthropology possessed. In many ways these were related to genetics — the establishment of paternity, for example. In fact, Aul stated directly that physical anthropology was a discipline of genetics [5]. When Aul applied for a longer research trip to Europe (in 1938), he stressed in his application that the outcome of his studies would be practical — for pedagogical (Aul remained an active writer on pedagogy through his entire life) and criminal anthropology [6]. One of Aul's aspirations was to chart the mental abilities together with physical ones, to research connections between the two and thus make anthropology a more applied science. It would have been especially important for children — the knowledge of anthropological development would have given wide opportunities for organising studies and choice of vocation. Here we can see perhaps a strong belief in the biological determination in intelligence, criminality, etc.

Aul possessed an understanding about anthropological capability. By that he meant the harmonious physical development of an individual. Said in a popular way, the criteria could have been the person's strength/capability for physical work. From his results, obtained through studies comparing urban and rural populations in Estonia, he concluded that in towns the children tend to become physically less and mentally more capable. Especially it could be noticed in higher social layers, among the more educated people. And when Aul treats this aspect (secondary trend in growth) as an harmful aspect of urbanisation, the whole approach could be seen as eugenically biased. The results of the studies in capability could, according to Aul, be applied, for example, in running the (inner) colonisation of the country — the settlers should be chosen from among the fittest. Another thing one can notice is Aul's quest for ideal/normal anthropological types, the latter perhaps being the same harmonious, both bodily and mentally developed individuals. Aul aquired knowledge about this aspect during the above-mentioned research trip to Europe.

J. Aul was also dedicated to zoology and in his early years particularly to genetics, which was just making its way into the newly created Estonian scientific thinking (In fact it was genetics — the studies of twins — that brought J. Aul to physical anthropology [7].) Juhan Aul was the author of first Estonian language textbook on genetics issued in 1926 [8]. Genetics, in the period under discussion, was still notoriously intermingled with the ideas now referred to as eugenical, but forming in these times an essential part of the discipline. The possibilities given by provisional knowledge about heredity tempted the thinkers to dream about something like stock-breeding among humans. Genetics/eugenics was for Aul an important part of pedagogy. In his first publication from 1919 Aul states that school should not suppress strong individuals [9]. The question of hereditary mental capabilities exited J. Aul for decades — in modern times he could have become a strong believer into the inherited factors of IQ. It is evident that for Aul the educational/popular work on genetics and eugenics was to constitute an important aspect in a scientist's work. Positive eugenics — "stock breeding" should have been run by the human participants themselves, through their awareness.

Pedagogy was also the area where Aul was quick to return to the universal laws of genetics after the Stalinist period had passed. In his studies comparing urban and rural children [10] as well as in his popular writings about hereditary factors behind the intelligence, he stresses again the biological factors as important factors in human individuality, stresses again the need for separate schools for children with different talents [11]. He gives a bitter comment: "Our "modern" genetics is too little engaged in heredity!" [12]

Aul believed (when it was politically possible) into biological factors shaping a nation's fate and into the biological body of a nation.

Aul wrote that besides the cultural and economic reasons coining a nations history, the physical people themselves, their bodily and mental characteristics give the natural basis for a nation's history. Thus studies in physical anthropology are important in historical studies and in making plans for the future [8, 13]. It is important to stress that Aul appreciated (besides wishful thinking that genetics should solve all the problems facing humankind) several ideas, now viewed as reactionary. In this article it is perhaps not necessary to refer to Aul's eugenical texts, especially because these have mainly been published in popular issues. (For modern readers they are quite unusual, anyway.) In these articles the theories of negative selection — basis for the eugenical ideology — are discussed.

In his eugenical thinking Aul was not pessimistic. Quite on the contrary, he believes that the negative evolutionary trends in society could be exterminated. This is the place where negative eugenics gets involved — the so called negative selection should be introduced by not letting the less fittest to breed. Unlike many of his contemporaries, Aul does not emphasize the violent methods of negative eugenics (abortions, sterilisation, concentration camps). This way, although being a member of the Estonian Eugenical Society "*Tõutervis*" (Racial Hygiene) — the latter kept the demand for sterilisation among its watch-words [14] — Juhan Aul remained somewhat apart from the main ideologists of negative eugenics in Estonia. On the other hand, if we want to remain neutral — he does not deny the methods. We could perhaps just state that Aul preferred the more positive methods of eugenics, like educational work, medical check-up of would-be couples and settlers, etc. It is perhaps highly characteristic that in his *curriculae* (written in numerous cases while applying for academic positions) he never mentions that he has been a board member (in 1930–1936) of the Estonian Eugenical Society [15] or even a member of that society. In these same *curriculae* he classifies his textbooks on genetics as popular writings [6].

As a conclusion, it is important to stress that Prof. Aul's scientific thinking belonged to its time. He developed his ideas according to the development of scientific knowledge (later also by the needs of the changing political environment). His engagement in eugenics tried to remain scientific, abstract, and not depending on the political and demographic hysteria reaching the Republic of Estonia in the 1930s. Aul also quite clearly distanced himself from racial attitudes which began to shade physical anthropology, especially in the light of Nazi-German anthropologically biased racism. He could be even viewed as anti-German in his writings from 1930s [16, 17]. Aul's last writing on eugenics-related topics could be that from March 1944, when he discusses again the phenomenon of a nation's anthropological capability [18]. His statement is that it is not the racial aspects of a human group but its aptitude that is important while facing the future. If we place this text into historical context — occupied by Germany, Estonia was sending its youth to fight on the loser's side — it can be viewed quite propagandistic and suitable for a newspaper article. On the other hand, this statement confirms Aul's already mentioned attitude towards anthropological racism — he, being the head of the Chair of Anthropology and Racial Studies founded at Tartu University in 1943 [6] denied in a Nazi-occupied country that the racial aspects of individuals were important (or indirectly — denied that race was a critical marker in eugenics) — contradicting himself thus with the official Nazi ideology.

In his official letter of regret (being a part of the show organised by the Soviets to reinforce their ideology) published in a newspaper [19] Aul apologises for his acceptance of the mentioned chair in Nazi-occupied Estonia. Although we can be sure that Aul did not get involved in anthropological studies and attitudes Nazi racism was based on, he must have known enough about the situation and its possible results and thus, when becoming a victim of the Soviet witch-hunt, considered this episode in his biography to be his main sin. (There were enough "skeletons" in Aul's "cupboard" from the occupation period — he had, for example, also lectured on raciology at the local school of security police [6].)

Professor Aul's fate during the Stalinist era was not favourable. The point was not racial studies — the latter did survive and develop in the U.S.S.R. The Soviet official science did not accept the idea of genetical heredity as a basis for determining the fates of individuals. The approaches run by Soviet official science favoured different methods for shaping humankind. The cause for dismissing Docent J. Aul from the University was his engagement in the so called "Mendelian-Morganistic" genetics. (He had officially apologised for that too, as it had seemed to him his second important "sin".) Perhaps his popular works on genetics and pedagogy (which also included eugenical ideas) can be behind these developments harmful to Aul.

This could be the tragical note in our story — the formal repressions against Aul took place because of ideas he himself had not seen as sensitive enough. In a strictly scientific sense, he had perhaps considered them always correct. In this context we must give Prof. Aul our credits for remaining a devoted scientist, and if we link him to eugenics, it must be remembered that it was mainly the positive message of this doctrine that was characteristic of Juhan Aul.

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ABOUT TEACHING ANTHROPOLOGY AT THE UNIVERSITY OF DERPT (TARTU) IN THE FIRST DECADES OF THE 19TH CENTURY

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Anthropology became popular in the 18th century as a result of the new attitude towards the natural sciences and their tremendously rapid development. The introduction of anthropology into the curricula of European universities laid the foundation for the establishment of independent professorships in this subject. One of the first such professorships was established at the University of Paris in 1855 [1].

For some reason, so far researchers have paid no attention to the history of teaching anthropology at the Medical Faculty of the University of Derpt (Tartu) in the first decades of the 19th century. One can find references in the literature to the effect that one or another professor had taught anthropology to medical students and students of other faculties. It is clearly impossible to find complete records in the archives or literature about the above-mentioned period because time has taken its toll.

The following study serves as an introduction to shed some light on this problem. Below we will give a short overview of those outstanding professors who were the first to teach anthropology at the Medical Faculty of the University of Derpt (Tartu) and other universities of czarist Russia almost two centuries ago.

When the University of Derpt (Tartu) was reopened in 1802, there was a plan to set up four professorships at the Medical Faculty. In fact, the university succeeded in establishing only three of them [2, 3, 4].

Daniel George Balk (1764–1826) started his work as the professor of pathology, semiotics, therapy and clinics in February 1802. He came from Köningsberg and had received a higher education at the local university there. Before coming to Tartu he had worked as a doctor in Courland [5]. For the first time Prof. Balk's list of lectures included medical-philosophical anthropology for medical students as early as in the second semester of the same year. The lecture lasted one hour at a time, and it was based on the textbook of J. D. Metzger that had been published in "Medizinisch-Philosophische Anthropologie für Aerzte und Nicht-arzte" in 1790.

These lecturers were followed by lecture on general pathology and, as the professor of anatomy had not arrived yet, also by lectures on osteology together with demonstrations of bone preparations.

In addition, Prof. D. G. Balk lectured on the influence of galvanic flow on plants and conducted experiments on living and dead animals by using the experimental method [6].

During the autumn semesters of the two following years Prof. D. G. Balk lectured on physical-philosophical anthropology as an introduction to purely philosophical anthropology. He then taught, for a semester, natural-historical-philosophical anthropology as a premise for purely philosophical anthropology. During the spring semesters of 1807 and 1808 Prof. D. G. Balk lectured on physiological-philosophical anthropology as an introduction to philosophical anthroplogy. All the above-mentioned lectured were of the same duration and were based on the named textbook [7]. Here Prof. D. G. Balk's lectures on anthropology come to an end, but he continued to work at the Medical Facultyuntil 1817, being for several times elected Dean of the Medical Faculty and Rector of the University.

In addition to D. G. Balk, during the period after reopening, the University of Derpt (Tartu) also hired Martin Ernst Styx (1759–1829), who worked as the professor of dietetics, pharmacology, history of medicine and medical literature. Born in Riga and having later worked as a doctor in several places, including Tallinn, Prof. M. E. Styx worked at the university until 1826. He was also repeatedly elected Dean of the Medical Facultyand Rector of the University [5].

Prof. Styx' list of lectures for the spring semesters of 1805 and 1806 included lectures on physical-philosophical anthropology from the viewpoint of its latest developments. The lectures took place four times a week, one hour at a time. So far we have not been able to find the textbook which served as a basis for his lectures [7].

Since 1803 the professorship of anatomy, physiology and forensic medicine was held by Heinrich Friedrich Isenflamm (1771–1825), who had come from Erlangen [5].

Beginning with the second semester of the same year, Prof. H. F. Isenflamm started to lecture on various chapters in anatomy (osteology, myology, syndesmology, etc.), proceeding from the viewpoint of age, sex, ethnic and individual characteristics. His lectures continued until 1809. In the spring semester of 1807, in addition to lectures on the comparative study of autopsy, Prof. H. F. Isenflamm gave also lectures on the pathology of human body bild, which may have included elements of anthropology. In the spring semester of 1810 Prof. H. F. Isenflamm delivered lectures on the biology of human body, which were based on the textbook of J. Döllinger published in 1805 [7].

From 1805 the standard of teaching at the Medical Faculty improved considerably, as all the six professorships that had been foreseen for the faculty were filled and the professors used to teach full lecture courses on a regular basis [7, 8].

Ludwig Emil Cichorius (1770–1829), associate professor and prosector of *Theater Anatomicum*, started his pedagogical work as a member of the Medical Faculty in the first semester of 1805. He was born in Leipzig and also got his higher education there. In 1814 he was appointed full professor of anatomy, physiology and forensic medicine [5]. Prof. Cichorius' lectures on folk medicine, six hours a week, were placed first in the curriculum. They were followed by his lectures on the individual differences of people, based on their physical, age-related and sex peculiarities, four times a week, one hour at a time, and, finally, by lectures on the history of anatomy.

In addition to folk medicine, during the second semester of 1805 he began to lecture on anthropology six hours a week. These lectures took place in the spring and autumn semesters of every succeeding year until the spring semester of 1810. In the autumn semester of 1806, Prof. L. E. Cichorius began to give lectures on essentials of anatomy with a review of anthropology, pathology, dietetics and therapy, which ended in the autumn semester of 1811. In the first semester of 1807, Prof. Cichorius started his weekly lectures on the build of human body for the would-be clergymen who were attending his lectures on anthropology and folk medicine. The lectures continued in the same amount in the spring and autumn semesters of the following years until they ended in the spring semester of 1810. In the autumn semester of 1813, Prof. L. E. Cichorius delivered lectures on the natural history of man four times a week, one hour at a time [7].

Karl Friedrich Burdach, who was born in Leipzig and who in addition to other subjects had attended lectures on anthropology at the local university there, started to work as a professor of anatomy, physiology and forensic medicine at the University of Derpt (Tartu) on July 4, 1811 [5]. Since the autumn semester of the following year he gave lectures on the natural science of man, eight hours a week, on the basis of the second volume of a manual that he had compiled himself and which had been published in 1810.

In the two semesters of 1813 Prof. K. F. Burdach lectured three hours a week on the history of the life of man, impregnation, development and death, which enjoyed tremendous popularity among the audience [7]. Unfortunately, the 38-year-old professor was forced to leave Tartu already in 1814 because of conflicts with the University Council.

Herewith, the lectures on anthropology and those with elements of this subject at the Medical Faculty of the University of Derpt (Tartu) came to an end, to start again after a short interval in the spring semester of 1822 under the leadership of Prof. Johann Jacob Friedrich Wilhelm Parrot (1791–1841) [7].

In addition to Prof. Balk's lectures on anthropology that started in 1802, Prof. H. Fr. Isenflamm started to lecture on anthropology in the autumn semester of 1803. The year 1805 could be regarded as the culmination in the teaching of anthropology — four professors were dealing with this subject at the same time. They taught five different courses on anthropology or lectures that included elements of anthropology.

After that the number of faculty members who taught anthropology declined constantly, and eventually the lectures were discontinued.

How can one explain the abrupt end of lectures on anthropology at the University of Derpt (Tartu)?

It is known from history that in the 1820s and 1830s science in czarist Russia had to develop in difficult conditions. Soon after the end of the 1812 war a period of political reaction come. One could witness an offensive on the research done by the universities; as result, the development slowed down. At that time even those brief notes about anthropology the professors of zoology used to begin their lectures with were removed from the syllabi. It was impossible to open new chairs of anthropology at universities then. In 1817 Prince A. N. Golitsyn became Minister of Education. He was narrow-minded and proposed that science should be replaced by Bible reading and that universities should become religious schools [9].

Although lectures on anthropology at the University of Derpt (Tartu) had ended, their impact had been so great that Karl Ernst von

Baer, the prospective world-famous natural scientist, defended his doctoral disseration *About the Endemic Diseases of Estonians* in 1814, i.e. a few months after his graduation [10]. At first, Baer's deep interest in botany made him choose *Livonian and Estonian carexes* for the topic of his dissertation. However, Prof. K. F. Burdach disapproved of this plan in the very beninning, as compiling a monograph on carexes would have been too much even for a man like Baer. In the *Curriculum Vitae* that Baer submitted in connection with the defence of his doctoral dissertation he appreciated highly Prof. Balk who as Dean of the Medical Faculty had influenced the final choice of the topic of his dissertation.

Baer's dissertation consists of five chapters. Chapter 2 gives an overview of Estonian dwellings, clothing and food, and paragraph 14 deals with taking care of one's body and lifestyles in different seasons [11]. Until now Baer's work has been regarded as a medical-geographical investigation [12]. On the other hand, in our view, one should not neglect the elements of anthropology that are included in the dissertation. Rather, because of the description of the bodily structure and appearance of Estonians, it would be more justified to regard this work as an anthropological-medical-geographical investigation. After years of intense work and study, Baer published his *Lectures on Anthropology for Self-study. Part I* in Köningsberg in 1824 (525 pages).

The opening lecture begins with the words 'know yourself' and it closes with thoughts about anthropology as a science that deals with the human being as a whole in every sense of the word. In his published lectures Baer treats the human being and the human races, the was unable to write the second volume that was planned to deal with human mentality, evolution theory, and comparative anthropology [13]. These lectures served as a basis for the courses of Associate Professor Hermann Johann Köhler (1792–1860), who started to teach anthropology at the University of Derpt (Tartu) in the 1830s (5, 7). The 1820 Statutes of the University of Derpt (Tartu) foresaw a redistribution of the six existing professorships for the teaching of medical subjects. In order to improve the teaching of physiology, the Chair of Physiology, Pathology and Semiotics was set up [14].

The position of the full professor of physiology, pathology and semiotics was filled in 1821 by Johann Jacob Friedrich Wilhelm Parrot. He was born is Karlsruhe, had studied at the Medical Faculty of the

University of Derpt (Tartu) and had got a doctoral degree in medicine here. In 1826, however, he continued as a professor of physics. Parrot made a number of research trips to the Pyrenees, the Caucasus, etc. In 1829 he was the first person to climb the peak of Mt. Ararat, being accompanied by Khatchatur Abovyan (1809–1848). In 1837 he studied earth magnetism in the vicinity of Nordkap (5). In the spring term of 1822 Prof. J. J. F. W. Parrot started lecturing on biology of the human body at the University of Derpt (Tartu). The lectures took place six hours a week and they were based on the textbook written by J. Prochaskas that had been published in 1812.

During the next autumn semester Prof. Parrot taught medical anthropology for non-medical students and an introduction to physiology for medical students. The lectures were based on the textbook by Chr. Bernoul that had been published in 1804 [7]. Thus, in the first quarter of the 19th century it was the anatomical-physiological direction that served as the foundation for teaching anthropology at the University of Derpt (Tartu).

The question whether the University of Derpt (Tartu) was the first university in czarist Russia to teach anthropology could be answered in the following way. At Moscow University (the oldest university in Russia, founded in 1755), Prof. I. F. Vensovitch (1769–1811), professor of anatomy, physiology, and forensic medicine of the medical faculty, gave reasons for the need to teach anthropology in his speech at the festive ceremony to celebrate the 50th anniversary of Moscow University in 1805 [15] The other universities of czarist Russia were founded as follows: Vilnius (1803), Kazan (1804), and Kharkov (1805).

This concludes our treatment of the problem under discussion.

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ON THE ACTIVITIES OF PROFESSOR EMERITUS ALEXANDER BRANDT AT THE FACULTY OF MATHEMATICS AND NATURAL SCIENCES OF THE UNIVERSITY OF TARTU IN 1922–1926

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Alexander Brandt (1844–1932), Doctor of Medicine and Zoology, Merited Professor of the University of Kharkov retired in 1911 and settled in Tartu intending to live there in his old age and be engaged in private research [1].

Since 18 October 1912 he took part in the work of the Naturalists' Society at the University of Tartu. On the recommendation of Yevgeni Shepilevski, Professor Ordinary of State Medicine and Hermann Ernst Adolphi, Professor Extraordinary of Anatomy, Professor Emeritus A. Brandt was elected an acting member of the Society at its 490th general meeting on 15 November the same year. He took an active part in the work of the society till 1916 [2], when he left for the Crimea to visit his children. In the tumult of World War I and the revolutions of 1917 he lost his pension and property. It was only in 1921, after suffering great hardships, that A. Brandt and his wife returned to Tartu from the prolonged journey. The only shelter he could find here was an almshouse. After a while he got the job of a teacher of natural sciences in a private school [3].

Proceeding from the fact that the teaching of anthropology at the University had been discontinued since 1913 [4, 5] and wishing to contribute to his new home town, the 78-year-old Professor emeritus A. Brandt wrote an application to the Faculty of Mathematics and Natural Sciences on 22nd April 1922 [6].

In the application he expressed a wish to deliver, as a *Privatdozent*, a course of lectures on anthropology which, he thought, every educated person should be acquainted with. He wished to lecture, either in German or Russian, 2–3 hours a week in both terms. The Faculty, the University Council and the Ministry of Education supported his application and he was given permission to deliver a course of lectures on anthropology as a recommended subject, however, unpaid at first. In the autumn of the next academic year Professor emeritus A. Brandt delivered, as a *Privatdozent*, lectures on anthropogeography. During the next two terms he gave lectures on anthropology together with prehistory, then on anthropology and a special part of anthropology and finally on anthropology again. All the above-mentioned lectures took place on the premises of the Institute of Anatomy at 5–7 p.m. on Tuesdays. During that period A. Brandt published 3 articles in Estonia [7]. Having received a private invitation, he and his wife participated in the 200th anniversary celebrations of the Russian Academy of Sciences in Leningrad in 1925 [8].

When the elderly Professor Emeritus A. Brandt had delivered lectures during 8 terms as a *Privatdozent* at the University of Tartu, he wrote an application to the Faculty of Mathematics and Natural Sciences on 26 November 1926. In the application he notified that with research taking up all his strength and energy, he could not continue lecturing the next term [9].

In 1927 and 1928 he published two lengthy articles in the journal "Russkii antropologicheskii zhurnal", namely on the phenomenon of right-handedness and left-handedness and the normal asymmetry of the brain [10, 11]. In addition, Alexandder Brandt published his German-language book "Feminismus" in Tartu in 1928 [12].

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ANATOMY OF THE TRANSVERSE HUMERAL LIGAMENT

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ABSTRACT

Ligamentum transversum humeri seu intertuberculare is an anatomically constant structure, which forms the anterior wall for the bony Sulcus intertubercularis, turning it into osteofibrous canal. The ligament is composed from three different units: the joint capsule, tendon of the M. subscapularis and fibres of the dense connective tissue. In case of anatomical variations tendons of the M. supraspinatus and M. teres major take part in turning the bony groove into osteofibrous canal.
Key words: transverse humeral ligament, subscapularis tendon, biceps tendon.

INTRODUCTION

In the anatomical literature the term — Ligamentum transversum humeri is not so very common. A lot of textbooks and atlases of anatomy ignore the existance of such a structure [1, 2, 3, 4, 5]; the others, contrary, describe it as a constant structure in form of an broad band of transverse fibres passing from the greater to lesser tubercules of the humerus [6, 7, 8]. Some investigators describe it as part of the M. subscapularis tendon, which attaches on the Crista tuberculi majoris [9]. The aim of the present study was to investigate the possible existance or absence, and variations of the ligament.

MATERIALS AND METHODS

36 formalin-alcohol fixed shoulder joints (26 male and 10 female; 20 right and 16 left; in age 54–83) from the dissection course cadavers were investigated. Muscles of the shoulder girdle and the shoulder joint

with the exeption of the “rotator cuff” (Mm. supraspinatus, infraspinatus, subscapularis, teres minor) and Caput longum m. bicipitis brachii were cut off. Art. acromioclavicularis was exarticulated, Ligg. conoideum et trapezoideum were removed. Lig. acromioclaviculare was cut off to examine the tendon of the M. supraspinatus.

The insertion tendons of the “rotator cuff” muscles were cleaned from the rests of Bursa subdeltoidea and connective tissue. The joint capsule between the M. subscapularis and M. supraspinatus (“rotator interval”) together with the Sulcus intertubercularis overlaying tissues were finely preparated.

RESULTS

In all the investigated preparations the tissues overlaying the Sulcus intertubercularis form a “ligament” of various shape and composition. It builds the anterior wall of the osteofibrous canal between the Crista tuberculi majoris and minoris, closing the Tendo capitis longi m. bicipitis brachii within the canal.

The investigated ligament consists of 3 main components:

1. tissue of the joint capsule
2. insertion tendon of the M. subscapularis
3. fibres of the dense connective tissue between the walls of the bony Sulcus intertubercularis.

As exeptions, tendons of M. supraspinatus and M. pectoralis major are engaged in the construction of the ligament.

Unequal partitipation of these components in the “bridge” over the Sulcus intertubercularis makes it possible to point out some typical variations of the investigated ligament. For this reason the structure was divided into cranial, middle and caudal parts.

Cranial part of the ligament.

In 29 cases it was constructed from the joint capsule. The fibres of the capsule coursed antero-laterally, combined with the tendon of the M. subscapularis and closed the bony Sulcus intertubercularis anteriorly. In 3 cases tendon of the M. supraspinatus with additional attachment on Tuberculum minus formed the cranial part of the ligament.

Middle part of the ligament

In 27 cases tendon of the M. subscapularis crossed the Sulcus intertubercularis. In 6 cases it inserted on Tuberculum minus and also on the

Crista tuberculi majoris; 21 preparations showed direct insertion on the Crista tuberculi majoris. In 9 preparations fibres of the dense connective tissue (in 6 cases their origin was combined with the M. subscapularis tendon) crossed the Sulcus intertubercularis to form the anterior wall of the osteofibrous canal. The joint capsule made the connection between the bony walls of the intertubercular groove in 2 cases.

Caudal part of the ligament

In 23 investigated preparations the caudal part of the ligament was formed by the fibres of the dense connective tissue. In 6 of them one could notice the previous connection of the superior fibres with the M. subscapularis tendon; more inferiorly they existed like independent collagen fibres. In 7 cases strong tendon of the M. subscapularis with insertion on the Crista tuberculi majoris composed the lower part of the ligament; in 2 cases the joint capsule built the lower part of the investigated structure.

In four preparations we examined a variation of the M. pectoralis major tendon. One part of it coursed upwards, got connected with the M. supraspinatus tendon and closed the Sulcus intertubercularis anteriorly with a tape-like fibrous membrane. In this case the bony walls of the sulcus were not connected with each other by an ligament-like structure. Under the tendon of the M. pectoralis only a fascia-like sheet of connective tissue overlayed the vagina synovialis of the long biceps tendon.

DISCUSSION

The term — Ligamentum transversum humeri seu intertuberculare was at first given by G. C. Brodie in 1890 [10] to point out the tissue, which builds the “bridge” over the Sulcus intertubercularis and closes the groove anteriorly, forming an osteofibrous canal. As the shoulder joint is guided predominantly by the muscles [11, 12], the Ligamentum transversum humeri between the Crista tuberculi majoris et minoris ensures the fixation of the Caput longum m. bicipitis brachii during the movements of the upper limb.

In the anatomical literature one can find different opinions concerning the composition of the ligament. It is described as: strong fibres of connective tissue [13, 14]; part of the Ligamentum coracohumerale or glenohumerale [15, 16]; thickening of the joint capsule [17, 18] or composition of the Ligg. coracohumerale and glenohumerale in the cranial part, and fibres of the dense connective tissue in the middle and caudal parts of the ligament [19].

According to the results of the present investigation, the Lig. transversum humeri is not a "true" ligament, composed from the fibres of the dense connective tissue. Mainly three structures in different form and appearance are engaged in the construction of the typical "ligament" (Fig. 1):

1) the joint capsule of the Art. humeri in the cranial part
2) the tendon of the M. subscapularis in the middle part
3) fibres of the dense connective tissue in the caudal part.

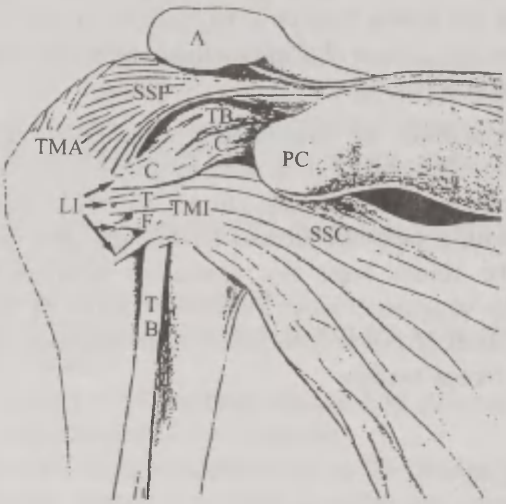

Figure 1. Schematic drawing of the anterior view of the right Art. humeri.
To show the typical composition of the Ligamentum transversum humeri, the tendons of the "rotator cuff" muscles and the structures overlaying the Sulcus intertubercularis are finely preparated.
In the cranial part of the Sulcus intertubercularis the joint capsule (C) crosses the bony groove. The middle part of the ligament is formed by the M. subscapularis tendon (T). In the caudal part one can find strong fibres (F) of the dense connective tissue. A — Acromion; PC — Processus coracoideus; SSP — M. supraspinatus; SSC — M. subscapularis; TMA — Tuberculum majus; TMI — Tuberculum minus; TB — Tendo m. bicipitis brachii; LI — Ligamentum intertuberculare.

The joint capsule was the most constant constructional element and was found in the cranial part of the ligament in 29 investigated preparations. In 2 cases the whole ligament was composed only by the capsule. When the capsule was weak, it was strenghthened by the additional tendon of the M. supraspinatus with the insertion on the Tuberculum minus [20].

The anatomical fact, that the tendon of the M. subscapularis is inserted not only on Tuberculum minus, was at first described by Tillmann and Töndury in 1987. Although this is not accepted by the majority of anatomists, some scientists support the opinion in their publications [21, 22].

In the present study we found the M. subscapularis tendon in the middle part of the ligament in 27 cases of 36. In 21 cases the whole tendon crossed the Sulcus intertubercularis and inserted on the Crista tuberculi majoris. In 6 preparations anterior fibres of the tendon ran over the Sulcus intertubercularis and attached on the Crista tuberculi majoris; dorsal fibres inserted on the Tuberculum minus and didn't cross the bony groove. According to the results, the insertion of the M. subscapularis on the Crista tuberculi majoris is not a variation but a fact of the normal human anatomy.

The finding of strong fibres of the dense connective tissue in the caudal part of the ligament correlates with the findings of previuos investigators. Their origin is either independent or achieved by separation from the M. subscapularis tendon [23, 24]. The position of these fibres within the lower part of the Ligamentum transversum humeri is influenced by the biomechanical forces, which are during the movement of the upper limb stronger anteriorly in the lower part of the osteofibrous canal than in the upper parts.

The variation of the M. pectoralis major tendon, which was partly combined with the M. supraspinatus tendon, formed the absent "ligament" to prevent medial luxation of the Caput longum m. bicipitis brachii [25, 26].

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ECOTYPOLOGICAL APPROACH TO THE INVESTIGATION OF URALIC PEOPLES

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ABSTRACT

The ecotypological approach may give possibility to bring out the traits of similarity are due to influence of the ecological factors at the period of Uralic unity origin.

The representatives of Uralic populations (Khanty, Mansi, Komi-Izhems, Komi-Permiaks) were compared with the West Siberia Russians and the Buryats by somatometrical, somatotypological and physiological traits. The total sample size is 908, males 383, females 525.

Ecotypological groups of severe-continental climate (the Buryats) of Sub-Arctic climate (the Komi-Izhems, the Mansi, the Khanty) and of moderate continental climate (the Tjumen Russians and partly the Komi-Permiaks) are opposed to each other. The main significant traits are mass-height Rohrer index, the relative (to body weight) muscular and fat components, subcutaneous fat tissue topography, torso dynamometry and plate tapping test.

We suppose that the adaptive complex formed in ancient times may even now define the anthropological unity of the peoples which belong to the Uralic family.
Key words: Uralic peoples; ecology; morphology; physiology

INTRODUCTION

The ecological and climatic peculiarities of the area where anthropological group was formed influence human physiological and morphological characteristics. The prolonged influence of strong climatic factors may lead to genetic adaptation — evolutionary changes in gene pool between generations, which enhance the biological success of the population [1]. The result of this process is forming of high adapt groups — ecotypes. Ecotypes express themselves in the tendency of morphophysiological changes in the direction favorable for existing in a particular environment [2]. So far as morphofunctional adaptation to particular climatic-geographical conditions would be traced in a population long after it changed the ecological environment, the ecotypological approach may be perspective for the study of anthropological unity among of Uralic peoples. It gives possibility to bring out the traits of similarity are due to influence of the ecological factors millenniums ago — at the period of Uralic unity origin.

Proto-Uralic groups were formed under the conditions of cold, humid and, possibly, near-glacial climate [3]. According to formal geographical characteristics the area of their origin cannot be considered as Arctic proper. Therefore we would call this hypothetical ancient Ural ecotype "Sub-Arctic" which in its main traits is close to ecotypes of Arctic and continental zones [2] but is not so strongly marked.

The further settling of Uralians took place mostly in the South-taiga zone of the moderate continental climate [4]. As the new environmental conditions of Eastern Finns and Siberian Ugrians are close to the primary ones it may be expected that the main traits of the initial ecotype in these groups will remain relatively stable.

We suppose that the adaptive complex formed in ancient times may even now define the anthropological unity of the peoples which belong to the Uralic family.

MATERIAL AND METODS

Object of research are representatives of indigenous and old-resident populations of the Urals and East Siberia, 18–35 years old: Komi-Permiaks (males=33, females=93), Komi-Izhems (m=34, f=46), Mansi (m=40, f=72), and Khanty (m=33, f=69). Uralic populations were investigated in comparison with the West Siberia (Tjumen) Russians (m=158, f=193) and the Buryats (m=85, f=52). In accordance with historical periods of living under different climatic-geographical conditions these populations are subdivided into ecotypological groups of Sub-Arctic (Komi-Izhems, Mansi, Khanty), severe continental (Buryats) and moderate-continental (Komi-Permiaks, Russians) climates.

Anthropometric examination was carried out using traditional methods. The body built components calculated by J. Matiegka [5]. Somatotype diagnosis was made by J. Carter, B. Heath [6].

Topography of subcutaneous fat was researched with caliponethric data taken in four points: subscapular, on triceps, suprailiac and on calf. The skinfold thicknesses were summarized: subscapularis + triceps (upper the waist = UW); suprailiac + calf (lower the waist = LW); subscapularis + suprailiac (trunk = TR); triceps + calf (extremities = EXT). In each sample was counted the per cent of cases of subcutaneous fat thickness prevalence upper vs lower of the waist, on the trunk vs extremities (respectively TR-UW, TR-LW, EXT-UW, EXT-LW).

Functional characteristics were researched according to standard methods [7, 8].

The received data was elaborated by traditional methods (descriptive statistics; t-criterion, Chi-square criterion, analysis of variance). The confidence level of differences was $P<0.05$.

RESULTS

Values of weight-height correlations, of relative (to body weight) body surface square and components of body built among representatives of researched groups are given in Table 1. Preliminary analysis showed that the Komi-Permiaks tend to come closer to the West Siberian Russians in these anthropometric characteristics. This fact was taken into consideration in analysis of variance of differences between different ecotypes.

The Komi-Permiak samples stand half-way between representatives of continental and moderate climate ecotypes. In male Komi-Permiak groups Rohrer index (RI) coincides with the corresponding indexes among the Khanty but mean values of relative body surface are closer to the characteristics of Russian males. As for the female samples Rohrer index among the Komi-Permiak females is closer to the female representatives of the moderate climate ecotype and relative body surface is the same as in Komi-Izhem females.

Body built components of various ethnoterritorial group representatives was compared in relative values — per cent of body weight. The muscular tissue varies little within the researched samples (Table 1). We can only note the relative weakness of muscular component development among the Komi-Permiaks and the Mansi — both males and females.

The greatest fat component in male samples was found among the Russians and the Buryats (Table 1). The Khanty and the Mansi are characterized by lower values of fat component. The Mansi differ significantly ($P<0.001$) from other researched groups. The greatest total and subcutaneous fat tissue was found among young Komi-Permiak females (differ from all other samples $P<0.05$). The Komi-Izhem females have less fat tissue than the Russians (differs by total body fat, $P<0.01$). The Mansi and the Khanty females are characterized by the least values of body fat component (differences from Komi-Permiak, Russian and Buryat females $P<0.05$).

Table 1

Rohrer Index, Relative Body Surface and Relative (to Body Weight) Content of Muscle and Fat Tissue among Representatives of Researched Groups

Ethnic group,	Rohrer Index*#		Body surface		Muscular Tissue#		Fat Tissue#	
Sex	M	SD	M	SD	M	SD	M	SD
MALES								
Komi-Permiaks	1.36	0.18	2.66	0.18	46.52	2.58	11.13	2.52
Komi-Izhems	1.44	0.12	2.59	0.14	48.73	2.88	11.06	2.38
Mansi	1.40	0.14	2.74	0.15	45.75	3.76	9.17	2.56
Khanty	1.35	0.16	2.78	0.21	48.49	5.87	11.02	3.02
Russians	1.28	0.13	2.70	0.16	48.15	2.78	11.67	2.27
Buryats	1.29	0.14	2.72	0.14	47.51	3.43	11.62	2.76
FEMALES								
Komi-Permiaks	1.43	0.16	2.75	0.17	40.17	2.27	24.89	4.63
Komi-Izhems	1.48	0.19	2.75	0.19	42.24	3.53	20.72	5.65
Mansi	1.52	0.19	2.79	0.18	38.92	3.16	20.42	5.01
Khanty	1.48	0.20	2.86	0.22	40.48	2.59	20.83	4.35
Russians	1.36	0.15	2.79	0.18	43.10	2.73	22.97	3.75
Buryats	1.45	0.20	2.74	0.11	41.71	3.17	23.43	4.64

* — belonging to the ecotype is significant ($p<0.05$) in male samples
# — belonging to the ecotype is significant ($p<0.05$) in female samples

An important characteristics is the topography of subcutaneous fat among representatives of various populations. Among the Mansi, the Khanty and the Komi-Izhem males subcutaneous fat tissue is concentrated on the body (Fig.1). It is distributed relatively evenly both above and below waist and the limb fat layer is small. Among the Russian, Komi-Permiak and Buryat males subcutaneous fat is located mostly below waist both on the body and on the limbs.

The Mansi, Komi-Permiak and Komi-Izhem females are characterized by even distribution of fat tissue without conspicuous prevalence of subcutaneous tissue either above or below waist, either on body or on limbs (Fig. 2). The Khanty and the Buryat females are characterized by greater amount of fat tissue on body above waist. Among the Russian females subcutaneous tissue is mostly concentrated below waist and on limbs. Prevalence of subcutaneous fat on limbs as compared with body occurs twice as often among the Russian females as among representatives of other researching groups.

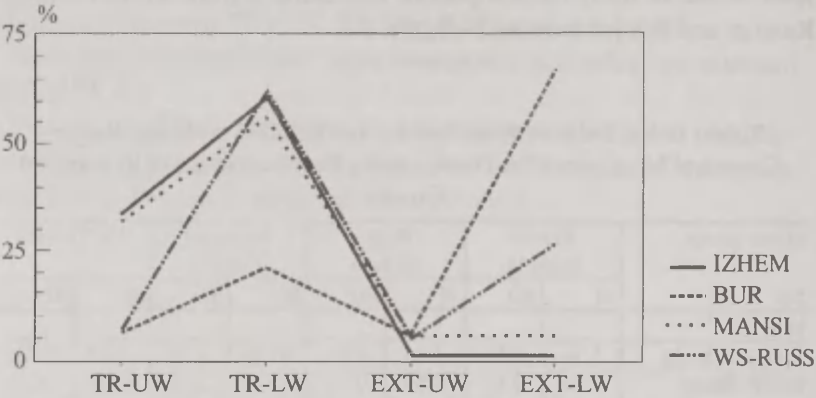

Figure 1. Subcutaneous Fat Distribution in Different Ethnic Groups (males) LEGEND: buryat — Buryats; mansi — Mansi; izhem — Komi-Izhems; ws-russ — West Siberia Russians; TR-UW — Fat tissue located mostly on the trunk upper the waist; TR-LW — Fat tissue located mostly on the trunk lower the waist; EXT-UW — Fat tissue located mostly on the upper extremities; EXT-LW — Fat tissue located mostly on the lower extremities.

While defining somatotype according to Heath-Carter scheme we found out that the Mansi, the Khanty and the Komi-Izhems are characterized by manifested mesomorphic component which dominates over endo- and ectomorphic components. All researched Mansi (males) are mesomorphic; in the Khanty and Komi-Izhem samples mesomorphic somatotypes constitute 96 and 94%. For Komi-Permiak males the quota of mesomorphic somatotypes is reduced to 89%; in Russian and Buryat samples — accordingly 81 and 85%.

In female samples the quota of endomorphic type of somatotype is higher. But in the Sub-Arctic groups frequency of mesomorphic somatotypes remains high among females as well: 80% of Komi-Izhem females are mesomorphic, among the Mansi — 75%, among the Khanty — 67%. For comparison: 40% of Russian females have mesomorphic prevalence and 51% — endomorphic; 36% of Komi-Permiak females are mesomorphic and 63% are endomorphic; among the Buryat females the values are accordingly — 23 and 76%.

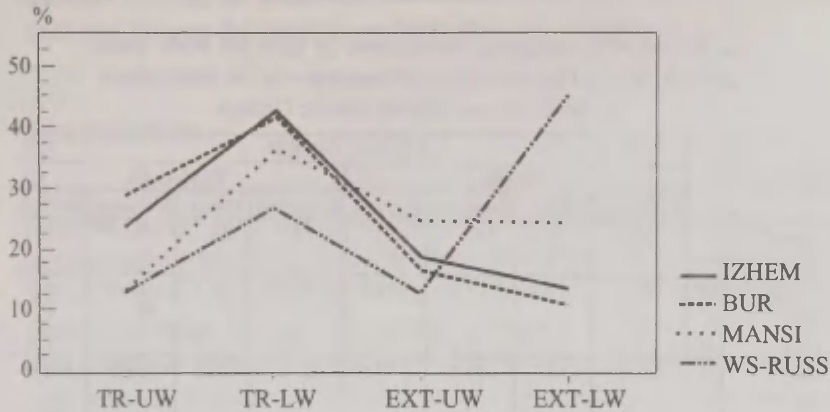

Figure 2. Subcutaneous Fat Distribution in Different Ethnic Groups (females). LEGEND: see Fig.1

While evaluating the functional characteristics we took into account that values of dynamometry and lung vital capacity depend upon total body sizes. That is why we have estimated the relative indexes (in units per body mass — Table 2).

All interethnic differences of handgrip dynamometry are non-significant. The highest relative indexes of torso dynamometry belong to the Komi-Izhems — both males and females. The differences between the Komi and the Russians as well as between the Komi and the Buryats are significant. The Mansi of both sex groups have the intermediate position between the Izhems and the Russians. Analysis of variance has shown the importance of the ecotype factor ($P<0.05$).

The lowest relative spirometry indexes were found in Komi-Izhem samples (in male samples difference from the Russians and the Mansi are significant, in female samples — from the Russians and the Buryats, $P<0.05$).

Systolic arterial blood pressure practically does not differ in Komi-Izhem, Mansi and Russian samples (Table 2). But in all these groups (for both males and females) the systolic blood pressure is significantly higher as compared with the Buryat samples. As for the diastolic blood pressure the differences are non-significant in all researched groups.

Table 2

The Relative Physiological Indications (in units per body mass), Arterial Blood Pressure and Psychophysiological Indications in the Urals and Siberia Ethnic Groups

SIGN		ETHNIC GROUP							
		MALES				FEMALES			
		K-Izhems	Mansi	Russians	Buryats	K-Izhems	Mansi	Russians	Buryats
Sample size	N	30	39	165	75	24	24	191	95
Handgrip dyn (kg)	M	75.1	77.3	75.9	72.0	50.7	51.1	48.6	46.9
	SD	9.3	11.5	11.1	8.1	8.0	7.7	9.1	7.4
Torso dyn.*# (kg)	M	270.9	237.7	222.5	177.9	162.6	138.3	107.8	101.9
	SD	34.6	42.3	32.6	36.9	54.5	54.1	26.3	23.0
Spirometry (ml)	M	5646.3	6283.5	6244.1	6076.2	4454.3	4730.8	5089.1	5049.8
	SD	691.3	923.2	902.7	898.6	1046.7	876.0	774.5	910.8
Systolic ABP (mm Hg)	M	120.79	121.84	119.14	111.48	117.08	114.60	112.77	108.64
	SD	12.93	13.44	9.89	11.29	16.15	10.10	9.73	9.68
Diastolic ABP (mm Hg)	M	70.50	73.30	73.27	69.84	71.88	70.20	70.31	68.18
	SD	10.05	9.13	7.84	08.86	7.91	7.43	8.43	7.30
Static endurance (sec)	M	38.37	38.22	42.78	41.20	41.55	34.74	27.07	32.66
	SD	14.01	13.28	15.65	15.30	26.41	19.41	9.97	14.48
Plate tapp.* (blow/15sec)	M	65.90	62.05	66.82	73.24	71.80	65.54	70.31	70.80
	SD	9.21	8.77	10.44	10.26	8.84	9.71	9.79	9.64

* — belonging to the ecotype is significant (p<0.05) in male samples
# — belonging to the ecotype is significant (p<0.05) in female samples

Values of static endurance of hand and forearm muscles in male samples are almost equal. We can point out the tendency towards the lower values among the Komi-Izhems and the Mansi. As for the females the Komi-Izhems here demonstrate the highest values of static endurance (differences from the Russians P<0.05). The Mansi and the Buryats excel Russian females non-significantly.

The results of the psychodynamic plate-tapping test are very close within the male and female samples. The exclusion is Mansi sample: it shows the lowest plate-tapping test values in both male and female groups. Among the males the differences from the Buryats are significant and among the females — from all other samples ($P<0.05$).

DISCUSSION

By our data, the representatives of Sub-Arctic ecotype stands apart from moderate- and severe-continental climate ecotypes in all the most ecologically important characteristics. According to analysis of variance (Table 1), distribution of Rohrer index values both in male and female samples showed significant influence of the ecotype factor. According to relative (in proportion to body mass) content of muscle and adipose tissues in different ethnic groups the ecotype factor is significant ($P<0.05$) for representatives of female samples. Ecotypological groups of severe-continental climate (the Buryats) of Sub-Arctic climate (the Komi-Izhems, the Mansi, the Khanty) and of moderate continental climate (the Komi-Permiaks, the Tjumen Russians) are opposed to each other.

Peculiar topography of subcutaneous fat tissue can be traced within researching ecotypological groups (Figs 1, 2). Both Komi groups as well as the Mansi demonstrate "Sub-Arctic" variant of subcutaneous fat distribution. The fact that the Khanty females tend to show the pattern of subcutaneous fat topography which is close to the Buryat females (i.e. the "Continental" type) does not disagree with the whole picture because it is known that the arctic and the continental ecotypes are very similar [2]. According to analysis of variance, the ecotype factor is important for such indication as "the total thickness of skinfolds on limbs" and also — in male samples — for "the total thickness of skinfolds below waist" ($P<0.05$).

We should note the clearly seen mesomorphness of representatives Uralic populations by Heath-Carter scheme. The growth of mesomorphic component is characteristic of the Sub-Arctic ecotype. It is confirmed by our data on the growth of active body mass among Sub-Arctic Uralians and by some other researchers' observations [2].

Representatives of Sub-Arctic ecotype are also characterized by certain functional peculiarities. Komi-Izhem and Mansi males demonstrate the highest mean values of torso dynamometry, small values of static endurance and relative "slowness" while performing psychodynamic plate-tapping test as compared with representatives of other ecotypological groups. According to analysis of variance (Table 2), ecotype factor is significant for torso dynamometry values in both sexes and among males — for results of plate-tapping test.

These data are corresponding with results of our investigations of the newborns, children and teenagers in Uralic populations [9, 10, 11].

The total body sizes and weight-height correlations among the children of researching ethnoterritorial groups coincide with "Bergman's ecological rule". Increase of body sizes among group representatives who live under more severe climatic conditions is found among newborns as well as among older children within corresponding age and sex groups.

Menarche age in different groups differs according to the ecotype too [12]. Ob Ugrian, Izhem and Komi-Permiak females are characterized by later menarche age as compared with rural residents of Buryatia and West Siberia Russian females.

We should pay attention to the peculiar — in ecotypological respect — complex of traits characteristic of the Komi-Permiaks. This group has certain traits which draw them close to both Sub-Arctic and moderate continental climate ecotypes.

Among the traits characteristic of the moderate continental climate ecotype we can name high values of Rohrer index, high development of fat tissue and — accordingly — large percent of endomorphic somatotypes among Komi-Permiak females.

Still a wide spectrum of ecologically significant morphofunctional traits unites the Komi-Permiaks with Sub-Arctic populations. Among them we can note the relatively high values of Rohrer index combined with small body surface square; moderate development of fat tissue and significant (89%) prevalence of mesomorphic somatotypes among males; very late menarche age in Komi-Permiak girls [12].

In general during the analysis of morphological and physiological characteristics among representatives of researching populations we were able to trace the likeness of many ecologically significant traits of the Ob Ugrians (the Mansi and the Khanty) and the Permians (the Komi-Izhems and partly the Komi-Permiaks). In our opinion this likeness can be partly explained by the fact that the Eastern Uralians originated from one and the same Sub-Arctic ecotype group.

In ancient times the Ural group was formed in Sub-Arctic regions. Then they dispersed either to similar climate regions or to more moderate but also relatively severe climatic zones [4, 13]. In these cases main elements of the original ecotypological morphofunctional complex were most probably kept intact which is confirmed by our research.

The results of ecotype analysis cannot solve the problem of the anthropological interrelation of the Uralic peoples. By our judgement the utility of this approach is in the exposure of the possible way of the origin of Uralians' morphological and partly physiological similarity.

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CARDIOVASCULARDISEASES RISK FACTORS IN YOUNG FAMILIES

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ABSTRACT

Young couples living in Tallinn were investigated, common and specific risk factors of cardiovascular diseases (RF CVD) were detected.

Our results showed a high prevalence of RF detected in young families already. Only 6% of couples haven't anyone. Men had more frequently higher blood pressure.

An adequate information of existance of RF in young couple allow for performing more effective prophylactic measures.
Key words: cardiovasculardiseases, risk factors, lipids, apolipoproteins.

INTRODUCTION

In Estonia there is a high prevalence in morbidity and mortality of cardiovascular diseases (CVD), 80% of them forms ishaemic heart disease [1]. Basing on those facts, the importance of more profound scientific investigations and prophylactic measures of atherosclerosis are evident. As CVD are multifactorial in origin [2], its important to detect factors as early, as possible and using intervention measures reduce them.

There are a lot of investigations of prevalence of noncommunicable diseases, CVD, and their RF among these [3, 4]. In Estonia, there have been performed profound population based epidemiological investigations of CVD RFs among Tallinn's schoolshildren and 35–59 year men populations [5, 6], but information about epidemiological situation of CVD RF among young adults 20–30 years is absent. This age is quite important, as family is created, most of children are born.

In the framework of CINDI (Countrywide Integrated Noncommunicable Diseases Intervention Program, 1988–1992 we detected a quite high prevalence of RF among pregnant women population —

43% of them had one or more CVD RF [7, 8]. Named RF influenced negatively to embryonal development and adaptation of newborns in early neonatal period [9].

Dyslipoproteinaemia as a CVD RF quite informative and connected with other wellknown RF [10].

Apolipoproteins — particles of lipoproteins (LP) which are established as genetic markers for early atherosclerosis [11, 12]. Levels of apolipoprotein B (Apo B) an atherogenic, apolipoprotein A (Apo A) — an antiatherogenic fraction and ratio Apo B/Apo A are informative indicators showing blood atherogenity [13, 4, 14]. The family study gives a good opportunity to make primary prevention of CVD RF.

Aim. Detection CVD RF in young families.

MATERIAL AND METHODS

In the framework of epidemiological study "The prevalence of non-communicable diseases risk factors and their primary prophylactic in young families" 424 couples married in 1994–95 in Tallinn were investigated. Special questionnaires with data of genealogy, reproductive function, previous diseases were filled. An objective status of investigated individuals was fixed: anthropometria (height, weigh), body mass index (BMI) was calculated by formula: weight [kg] / height [m^2]. Blood pressure and pulse rate during 30 sec. were detected. Lipids and apolipoproteins were measured. Total cholesterol (TC), triglycerids (TG), high density lipoproteins (HDLC) levels were detected in Tallinn Diagnostic Centre using enzymatic methods in general practice by KONE-Dynamic analyser. The level of low density cholesterol (LDLC) was calculated according to Friedewald formula [15]. The coefficient of atherogenity (AC) was calculated: AC=(TC–HDLC)/ HDLC. Levels of Apo A-I and Apo B_{100} in serum were measured using rackett-immunoelectrophoresis [16] by Curry modification (17). Criteria for RF were: smoking (S) — 1 sig. / die, high BMI≥27, high blood pressure (HBP)≥140/90 Hg mm at both measures once or one of them twice, positive family history of CVD — if there was at least one first degree relative having myocardial infarction (MI) or stroke before age 55 years, hypercholesterolaemia — if TC≥5,2 mmol/l [18]. Mathematical analysis of data was performed on personal computer using different statistical programmes (Statgraphics, Statistica, Systat).

RESULTS AND DISCUSSION

The men age of men was 26,77±0,39 years and women 24,4±0,26 years. Clinical data investigation in relation to sex and nationality are presented in Table 1, 2, 3. Anthropometrical data showed that estonian men and women are taller compared to russians. The lower pulse rate of estonian women might allude to their better physical training [19]. As the investigation unit was family, on Fig. 1, 2 are given the prevalence of RF-s. RF-s were detected in 94.0% of families. The most of women had one, a half of men 2 or more RF. The prevalence of 5 wellknown RF are usually detected in epidemiological studies — S, high BMI, HBP, positive family history and hypercholesterolaemia. The prevalence of common RF in our investigated population is given on Tabel 4. Men had more frequently HBP and hypercholesterolaemia compared to women. The prevalence of smoking during pregnancy was the same detected by us earlier: I trimester of pregnancy — 15,3% , II–III trimester — 7,7% [7].

Table 1

Data of clinical investigations in relation to sex

Sign	Male		Female		P
	n	M±m (s)	n	M±m (s)	
Weight (kg)	229	75,9±0,7 (11,0)	391	60,5±0,5 (10,4)	
Height (cm)	230	179,1±0,5 (6,8)	392	166,1±0,3 (5,4)	
Body mass index	229	23,62±0,19 (2,9)	391	21,89±0,17 (3,4)	<0,001
Systolic blood pressure	216	120,2±0,8 (11,2)	390	110,2±0,5 (10,1)	
Diastolic blood pressure	216	74,5±0,7 (10,1)	390	66,1±0,4 (7,9)	
Pulse rate (30 sec)	205	35,7±0,4 (5,9)	376	39,5±0,3 (6,7)	

It's wellknown that the level of atherogenic lipid fractions rises with age [1]. Data of lipids and apolipoproteins in our groups according to sex are presented in Table 5. The mean values of lipids in Tallinn's men' population are published by O. Volož [1]; data of women are absent. TC level in our population was the same as previous published data, HDLC and TG levels were lower in our couples.

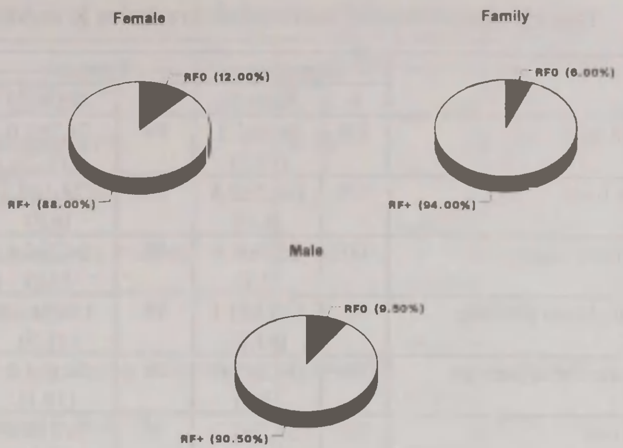

Figure 1. Common and specific risk faktors of cardiovascular diseases in young families. Legend (Fig. 1): RF0 — no risk factors; RF+ — some of risk factors were detected.

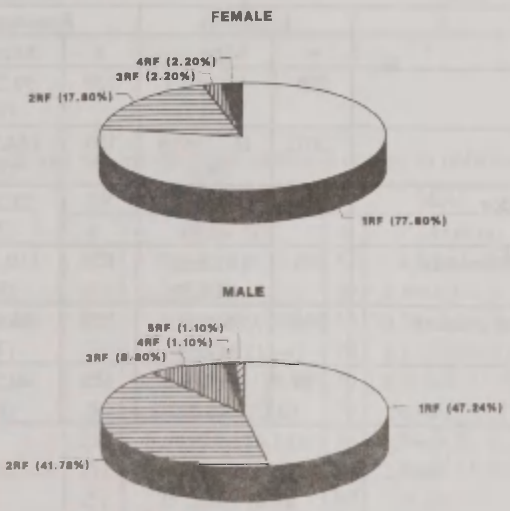

Figure 2. Combination of risk factors. Legend (Fig. 2): 1RF — one of risk factors was detected; 2RF — two of risk factors were detected; 3RF — three of risk factors were detected; 4RF — four of risk factors was detected.

Table 2

Data of clinical investigation of male in relation to nationality

Sign	Estonians		Russians		P
	n	M±m (s)	n	M±m (s)	
Weight (kg)	109	76,4±1,1 (11,2)	99	74,7±1,0 (10,2)	
Height (cm)	109	180,5±0,6 (6,4)	100	178,1±0,7 (6,8)	<0,05
Body mass index	60	23,7±0,4 (3,1)	58	24,2±0,4 (3,0)	
Systolic blood pressure	98	120,8±1,1 (11,0)	98	120,2±1,2 (11,5)	
Diastolic blood pressure	98	74,3±1,0 (9,9)	98	74,6±1,0 (10,1)	
Pulse rate (30 sec)	95	35,7±0,7 (6,4)	91	36,1±0,6 (5,4)	

Table 3

Data of clinical investigations of female in relation to nationality

Sign	Estonians		Russians		P
	n	M±m (s)	n	M±m (s)	
Weight (kg)	206	61,3±0,7 (10,7)	159	59,2±0,7 (9,2)	<0,01
Height (cm)	207	167,1±0,4 (5,4)	159	164,8±0,4 (5,2)	<0,001
Body mass index	126	22,6±0,3 (3,9)	92	22,2±0,4 (3,6)	
Systolic blood pressure	206	110,8±0,7 (10,3)	158	110,1±0,7 (9,3)	
Diastolic blood pressure	206	66,4±0,5 (7,3)	158	66,0±0,6 (7,7)	
Pulse rate (30 sec)	196	38,9±0,5 (6,8)	155	40,5±0,5 (6,5)	<0,05

Table 4

Prevalence of common risk factors of CVD in young families

	Male	Female
Positive family history (%)	8.67 n=323	12.03 n=374
Hypercholesterolaemia (%) (TC^{3}5.2 mmol/l)	38.22** n=157	32.93 n=82
High body mass index (%)	12.2 n=229	7.93 n=391
High blood pressure (%) (^{3}140/90)	12.04** n=391	1.02 n=216
Smoking in the past	72.7 n=176	47.19 n=185
Sig/per week (M±m)	76.04±49.1 n=146	34.4±29.35 n=151
In preconceptional period (%)	57.92 n=117	31.27 n=111
Sig/per week (M±m)	77.23±47.9 n=108	35.58±30.87 n=101
During first trimester of pregnancy (%)		18.42 n=63
Sig per week (M±m)		29.31±29.14 n=101
During II– III trimester of pregnancy (%)		6.18 n=11

** p<0.01

Table 5

Data of lipids and apolipoproteins in blood serum in relation to sex

Sign	Female		Male		p
	n	M±m (s)	n	M±m (s)	
TC (mmol/l)	157	5,0±0,1 (1,1)	82	4,9±0,1 (0,9)	<0,05
HDLC (mmol/l)	151	1,20±0,03 (0,33)	80	1,39±0,04 (0,34)	<0,0001
Triglycerids (mmol/l)	156	1,04±0,05 (0,58)	82	0,79±0,04 (0,32)	<0,0001
LDLC (mmol/l)	150	3,31±0,08 (1,04)	80	3,11±0,09 (0,82)	>0,05
Apo A-I (mg/dl)	152	150,5±1,62 (19,9)	76	139,2±2,2 (18,9)	<0,0001
Apo B (mg/dl)	150	84,6±1,8 (22,0)	76	76,4±2,0 (17,4)	<0,05
Apo B /Apo A-I	150	0,56±0,01 (0,14)	76	0,56±0,02 (0,14)	>0,05
Atherogenic coefficient	151	3,43±0,13 (1,55)	80	2,66±0,11 (0,97)	<0,001
HDLC/TC, %	151	25,2±0,7 (8,7)	80	29,2±0,9 (7,7)	<0,001
LDLC/Apo B	141	1,53±0,03 (0,37)	71	1,61±0,04 (0,38)	>0,05
HDLC/Apo A-I	144	0,32±0,02 (0,19)	71	0,38±0,01 (0,07)	<0,05

Our lipid data coincide with generally accepted point of view of higher atherogenic lipid levels in men. The levels of LDLC didn't differ according to sex, women had higher level of HDLC and HDLC/TC [%], but lower TG, Apo B and AK.

The mean level of Apo A-I was lower in women, the same results were detected earlier already in puberty [20]; the higher level of women's HDLC and lower Apo A-I might be reference, that there exists a more effective back transport of cholesterol. Women had lower Apo B level, higher LDLC/Apo B ratio compared with men (Table 5). As every LDLC molecule contains only one Apo B, this higher ratio indicates the existance of LDL molecules with large diameter. It's wellknown, that LDL particles with little diameter pass through the endothelial barrier better, oxidize quicklier and so are more atherogenic [21, 22].

In conclusion we can say that the family study gives a good opportunity to study CVD RF and perform more effective prophylactic measures.

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HORMONE LEVELS AND BODY DIMENSIONS IN PUBERTAL GIRLS: PREMENRACHEAL VS. POSTMENARCHEAL GIRLS

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ABSTRACT

The study was aimed to compare the blood levels of hormones as well as body dimensions in pre- and postmenarcheal girls in three year longitudinal study. Subjects were 33 healthy girls, age 11 or 12 years at the beginning of the study. Venous blood samples for RIA determination of cortisol, insulin, growth hormone, ß-estradiol, progesterone and testosterone were obtained at 9 a.m. Postmenarcheal girls were superior in height, body mass, biacromial and bicristal breaths and had more developed breast glands, pubic and axillary hair. Basal levels of growth hormone and testosterone were higher in postmenarcheal girls then in premenarcheal ones. Significant difference in ß-estradiol concentration appeared when the breast development stage was additionally considered. In the year of menarche significant increases was found in height (5.5±0.6 cm, mean ±SD), body mass (5.6±0.6 kg), biacromial (1.5±0.3 cm) and bicristal (1.1±0.2 cm) breaths, skinfold measure (2.7±0.7 cm) and testosterone concentration (1.1±0.2 mmol·ml^{-1}), but not in levels of other hormones.
Key words: cortisol, ß-estradiol, growth, growth hormone, menarche, progesterone, sexual maturation, testosterone

INTRODUCTION

The principal manifestations of puberty are: 1) the adolescent growth spurt, 2) the development of gonads, 3) the development of the secondary reproductive organs and the secondary sex characteristics, 4) changes in body composition, 5) development of the circulatory, respiratory and muscular systems [1]. Gonadal maturation is by far the most important of these components, since it orchestrates the appearance of the secondary sexual characteristics via steroidogenesis and ensures the ability to reproduce via gametogenesis [2]. At the same time sex hormones stimulate the secretion of growth hormone [3, 4], which determine the growth rate [4].

In girls the gonadal maturation is expressed by the menarche, which appears in breast stage III or IV. In most girls the peak height velocity has been found in the same stages [5].

The aim of this study is to compare the blood levels of hormones and body dimensions in pre- and post-menarcheal girls of age 11 to 14 years.

MATERIAL AND METHODS

33 healthy girls were 11 or 12 years old at the beginning of the three-year study. An informed consent was obtained from all children, their parents and principal of the school. The study was approved by the Ethical Commission of the Medical Faculty, University of Tartu.

During three subsequent years the observations were made in October or November at 9 a.m. Height, body mass, biacromal and bicristal breaths, and skinfolds on biceps, triceps and subscapular were measured. Sexual maturation was evaluated by breast, pubic and axillary hair development according to 5-stage scale of Tanner [6]. In venous blood cortisol, insulin, growth hormone, ß-estradiol, progesterone and testosterone concentrations were determined by RIA procedure.

For cross-sectional analysis the material obtained in all three years was divided into groups of pre- and postmenarcheal girls. The mean values of groups were compared used one-way ANOVA with t-test for independent unequal samples. ANOVA Simple Factoral was used to establish differences in distribution of individual data between groups. In addition Pearson product-moment correlation analysis were performed. Girls with menarche during the study period were analyzed by paired t-test in order to compare development during a year before menarche, during the year of menarche and during a year after menarche.

RESULTS

The postmenarcheal girls were superior ($P<0.05$) in height, body mass, biacromial and bicristal breaths and had more developed breast glands, pubic and axillary hair (Table 1). Significant differences were also in stages of sexual maturation and skinfold measures. The ratio between biacromial and bicristal breaths did not change. The difference in body mass index was insignificant (means 17.3 in pre- and 19,8 in postpubertal girls). Differences in distribution of individual data between pre- and postmenarcheal girls in all these indices, except skinfold measure, were found also when either age, height, body mass or breast development stage was used as cofactor (Table 2).

Table 1

Body dimensions and hormone levels in pre- amd postmenarcheal girls of age 11 to 14 years (mean±SD)

	Premenarcheal girls (n=42)	Postmenarcheal girls (n=50)
Age (years)	12.1±0.9**	13.3±1.0
Height (cm)	156.6±7.5**	162.5±5.8
Body mass (kg)	42.2±6.2*	48.5±10.8
Breast stage	2.8±0.7**	4.3±0.6
Pubic hair stage	2.6±1.2**	4.4±0.9
Axillary hair stage	1.8±1.0**	3.6±1.2
Sum of three skinfold measures (mm)	25.3±4.8*	28.5±6.6
Biacromial breath (cm)	32.4±2.4*	34.6±2.2
Bicristal breath (cm)	23.7±1.7*	25.6±1.4
Growth hormone ($ng \cdot ml^{-1}$)	7.3±7.8*	14.1±9.8
ß-estradiol ($pmol \cdot l^{-1}$)	291±187	300±220
Progesterone ($nmol \cdot l^{-1}$)	2.1±3.3	3.0±4.9
Testosterone ($nmol \cdot l^{-1}$)	0.6±1.4*	1.5±1.3
Cortisol ($nmol \cdot l^{-1}$)	297±122	280±130
Insulin ($mU \cdot l^{-1}$)	19.9±8.5	21.1±7.6

Significant differences between pre- and postmenarcheal girls
* p<0.05, ** p<0.001

Basal growth hormone and testosterone levels were higher (P>0.05) in postmenarcheal than premenarcheal girls (Table 1). Differences in distribution of individual levels of growth hormone and testosterone persisted when age was covariate, but not when covariate was either height, body mass or breast development stage (Table 2). Significant difference in distribution of individual data appeared between groups when ß-estradiol concentrations were analysed together with breast development stage.

During the 3-year period menarche appeared in 16 girls (9 girls had menarche before the study period, 8 girls did not begin to menstruate). In the year of menarche significant (P<0.01) increases was found in height (5.5±0.6 cm, mean±SD), body mass (5.6±0.6 kg), biacromial breath (1.5±0.3cm), bicristal breath (1.1±0.2 cm), skinfold measure (2.7±0.7 cm), and testosterone concentration (1.1±0.2 $mmol \cdot ml^{-1}$), but not in levels on growth hormone, ß-estradiol, progesterone, cortisol and insulin.

Table 2

Differences in distribution of individual data between pre- and postmenarcheal girls (significant F values)

	No co-variate	Covariate			
		Age	Height	Body mass	Breast stage
Age	30.6**	–	22.9**	10.4*	20.6**
Height	18.3**	22.8**	–	29.1**	9.8*
Body mass	10.9*	10.5*	29.1*	–	9.0*
Breast stage	104.3**	20.6**	9.8**	9.0*	–
Pubic hair stage	61.4**	14.2**	22.2**	10.2*	56.**
Axillary hair stage	56.7**	14.2**	19.1**	4.8*	40.6**
Skinfold	6.6*	N.S.	N.S.	N.S.	N.S.
Biacromial breath	19.6**	16.8**	88.6**	37.5**	4.5*
Bicristal breath	33.2*	27.7**	28.6**	8.6*	5.3*
Growth hormone	9.8*	N.S.	N.S.	N.S.	N.S.
ß-estradiol	N.S.	N.S.	N.S.	N.S.	6.3*
Progesterone	N.S.	4.5*	N.S.	N.S.	N.S.
Testosterone	7.6*	N.S.	N.S.	N.S.	N.S.
Cortisol	N.S.	N.S.	N.S.	N.S.	N.S.
Insulin	N.S.	N.S.	N.S.	N.S.	N.S.

* $p<0.05$, ** $p<0.001$, N.S. — non significant ($P>0.05$)

In 6 girls menarche appeared on the 2rd year of the study. During the first year, when they were premenarcheal girls, the increase in height and gain in body mass were significant, but less pronounced ($P<0.05$) than during the second year when they had menarche. During the both years the biacromial and bicristal breaths increased significantly, but differences in annual changes were insignificant. Sex hormones failed to show any significant change.

In 10 girls menarche appeared on the first year of the study. During this year significant developmental changes were found in height, body mass, biacromial and bicristal healths and sum of three skinfold measures but these changes did not differ from changes found during the next year when they were postmenarcheal girls.

Strong correlations were found between development of breast glands, axillary and pubic hairs ($r=0.755...0.785$ $P<0.001$). All three secondary characteristics of sexual maturation were in correlation with age, height and body mass ($r=0.378...0.635$, $P<0.001$). Significant correlations were not found between secondary indices of sexual maturation and blood levels of ß-estradiol, progesterone and testosterone.

DISCUSSION

The obtained results demonstrated that despite modest difference in age, postmenarcheal girls were taller and heavier. They had more wide shoulders and hips, and increased skinfold thickness compared to premenarcheal ones. Differences in distribution of individual data were related to age, height, body mass and sexual maturation stages, since using them as covariates did not change the significances of differences. The close relationships between all these indices were confirmed with the aid of correlation analysis. The longitudinal approach showed that the growth intensifies during the year of menarche: the annual changes were smaller a year before. The association of peak height velocity with the time of menarche is indicated also in other studies [5].

Unexpectedly we failed to demonstrate significant differences in female sex hormone levels between pre- and postmenarcheal girls. This negative result may be explained by the dependence of blood ß-estradiol and progesterone levels on phases of ovarian-menstrual cycle (OMC). Therefore, postmenarcheal girls might show either high or low levels of these hormones depending on phases of the OMC. These variations, obviously, excluded possibility to establish developmental changes in sex hormone concentrations. The explanation is confirmed by the difference in testosterone level, which does not depend on OMC phases. The increase in testosterone level express the adrenarche in advanced stages of sexual maturation [2].

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CHARACTERISTIC TRAITS OF ANTHROPOMETRY IN 17–18 YEAR OLD SCHOOLBOYS OF TARTU

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ABSTRACT

The aim of this paper was to study anthropometrically last year high school male students in Tartu.

The anthropometrical investigation was carried out by the rules of R. Martin. Altogether 258 students were measured. From every subject 50 dimensions were taken. The weight, 10 dimensions of the length and the height, 10 dimensions of the breadth and depth, 16 dimensions of circumferences and 13 skinfolds. In addition 7 length parameters were calculated. For analyses' data of 253 students aged 17 to 18 years were used. Multiple linear regression equations were calculated with age, height and body weight as prognostic variables for other anthropometrical measurements. As compared to H. Kaarma's results of young Estonian women's statistical models, these models are less valuable for prognosing the other anthropometrical variables. This investigation confirms that the body structure of male students can be prognose by principal dimensions of human body such as height and weight.
Key words: schoolboys, models, statistical

INTRODUCTION

Estonian schoolchildren in the age of 17–18 years have been previously anthropometrically studied by J. Aul [1, 2], L. Heapost [3], R.Silla and M. Teoste [4] and M. Thetloff [5]. Investigations by J. Aul [1, 2] and L. Heapost [3] concerned children's development and sexual dimorphism. Investigation by R. Silla and M. Teoste [4] concerned physical development, body composition and problems of health of the children. Investigation by M. Thetloff [5] concerned the methodology of statistical analyses of physical development of children. We found only two publications concerning the use of multiple linear regression equations for the prognosis of anthropometrical measures in Estonian population. H. Kaarma [6] studied the leading role of height and weight for prognosis of other anthropological variables of the body in young women. M. Thetloff [7] analyzed the prognostic value of age, height and weight for other anthropometrical variables in different groups of Estonian speaking school-girls. We did not find studies about the usage of multiple linear regression equations for estimating anthropometric measurements in Estonian male subjects.

The aim of our study was to compare the results of anthropometrical measurements of two age groups — 17 and 18 year old students for evaluation of the state of physical development. The other aim was to study the structure of the anthropometrical signs in the last year male students in the age from 17 to 18 year in Tartu high schools.

METHODS

Data of this investigation were collected in November-December of 1996 and in January 1997. All Estonian speaking high school last year male students of Tartu, who were present on the day of the investigation were measured anthropometrically in the doctor's office at school or in a separate schoolroom in the morning. Altogether 268 subjects were studied. The measurements were carried out by an experienced anthropologist (L. Saluste). The measurements were taken according to the R. Martin's [8] well-known rules. The measuring instruments were manufactured in the Technological Center of the University of Tartu. From every person were taken 50 measurements: the weight, 10 measurements of the length, 10 measurements of the breadth and depth, 16 measurements of circumferences and 13 measurements of skin fold thickness. According to the age of the subjects these data were divided into two groups: students in the age from 16 years and 6 months to 17 years, 5 months and 29 days formed a group of 17 year old students (n = 95) and the students in the age from 17 years and 6 months to 18 years, 5 months and 29 days formed a group of 18 year old students (n = 158). The data were statistically analyzed by S. Koskel from Institute of Mathematical Statistics of the University of Tartu. The means and standard deviations and the differences between groups using one tailed probability of t-criterion were used. Also the statistical models of the multiple regression equations were calculated to prognose the anthropological measurements by age, height and weight.

RESULTS

In Table 1 are given the mean values of the anthropometrical measurements of the age-groups. Additionally we calculated the length of head-neck, sternal length, abdominal length, trunk length, the upper part of body, the upper limb and the lower limb length from the measured values. From these 57 measured and calculated variables were in 54 variables the results were higher in the group of 18 year-old students. Statistically significant differences were found in weight ($p<0.01$), in five heights — the suprasternal ($p<0.05$), the 3rd finger ($p<0.01$), the sitting height ($p<0.05$), the foot length ($p<0.05$) and the trunk length ($p<0.05$). Also in 7 diameters differences were statistically significant — the biacromial diameter ($p<0.05$), the chest breadth ($p<0.05$), the waist breadth ($p<0.01$), the chest depth ($p<0.05$), the femoral, ($p<0.05$), the bimalleolar ($p<0.05$) and the humeral width ($p<0.05$). From measured 16 circumferences 10 were significantly bigger ($p<0.05$–0.01) in 18 year old group. From measured 13 skinfolds the difference was significant in the subscapular skinfold ($p<0.05$).

Table 1

Main anthropometric characteristics of subjects

Age (years)		17 n=95		18 n=158			
Nr.	Variable	Mean	SD	Mean	SD	t-value	p-value
1.	Weight (kg)	67.446	8.412	70.359	9.289	2.564	0.006**
Heights (cm)							
2.	Height	178.759	5.752	179.634	6.329	1.128	0.130
3.	Suprasternal	145.389	5.069	146.584	6.156	1.671	0.048*
4.	Xiphoid process	129.059	4.835	130.046	5.538	1.488	0.076
5.	Umbilical	107.958	4.425	108.414	5.367	0.732	0.233
6.	Symphysis pubis	92.817	3.871	92.976	4.579	0.295	0.384
7.	Ileospinal process	96.337	3.996	96.377	4.190	0.075	0.470
8.	Acromial	145.307	5.271	146.101	6.318	1.074	0.142
9.	3rd finger	66.123	3.500	67.460	3.787	2.849	0.003**
10.	Sitting height	90.564	4.166	91.708	3.838	2.171	0.014*
11.	Foot length	27.021	1.277	27.321	1.383	1.635	0.043*
12.	Head-neck length	33.350	1.797	33.051	1.977	1.231	0.114
13.	Sternal length	16.331	1.296	16.537	1.962	1.009	0.182

Continue

14.	Abdominal length	36.516	2.416	37.070	2.990	1.614	0.064
15.	Trunk	52.783	3.262	53.651	3.731	1.941	0.031*
16.	Upper part of the body	70.801	3.150	71.330	2.965	1.321	0.091
17.	Upper limb length	79.184	3.945	78.641	4.460	1.010	0.164
18.	Lower limb length	94.045	6.027	94.676	4.267	0.894	0.166
Diameters							
19.	Biacromial	39.347	2.029	39.804	1.850	1.783	0.034*
20.	Chest breadth	26.705	1.983	27.311	2.038	2.327	0.011*
21.	Waist breadth	24.563	2.303	25.472	2.355	3.012	0.002**
22.	Bicristal breadth	27.506	1.583	27.820	1.556	1.528	0.062
23.	Chest depth	18.492	1.766	18.870	1.582	1.716	0.040*
24.	Abdominal depth	17.218	1.268	17.519	1.558	1.676	0.056
25.	Femoral width	9.495	0.552	9.652	0.455	2.336	0.010*
26.	Bimalleolar width	7.692	0.438	7.811	0.524	1.944	0.032*
27.	Humeral width	7.229	0.345	7.311	0.379	1.747	0.043*
28.	Wrist width	5.912	0.383	5.947	0.334	0.756	0.223
Circumferences							
29.	Head	56.952	1.546	57.639	1.345	3.591	0.000**
30.	Neck	35.967	1.678	36.704	1.815	3.277	0.001**
31.	Chest	90.294	5.844	92.652	6.196	3.038	0.002**
32.	Chest breathing in	95.267	5.572	97.593	5.871	3.150	0.001**
33.	Chest breathing out	85.792	5.888	87.553	5.559	2.352	0.009*
34.	Waist	74.768	6.070	76.118	6.657	1.651	0.054
35.	Hip	81.446	4.555	82.614	5.849	1.770	0.049*
36.	Buttocks	88.266	3.998	88.934	5.105	1.157	0.138
37.	Thigh (upper)	55.755	3.886	56.765	4.684	1.852	0.039*
38.	Thigh (medium)	47.744	3.967	48.242	3.665	0.994	0.156
39.	Calf	36.005	2.396	36.544	2.571	1.686	0.049*
40.	Ankle	23.308	1.280	23.395	1.362	0.508	0.306
41.	Upper arm	28.049	2.620	28.558	2.751	1.466	0.074
42.	Upper arm (flexed and tensed)	30.774	2.846	31.532	2.922	2.031	0.022*
43.	Forearm	25.817	1.726	26.306	1.747	2.172	0.016*

Continue

44.	Wrist	17.267	0.740	17.384	0.705	1.231	0.105
Skinfolds							
45.	Buccal	0.617	0.138	0.628	0.138	0.619	0.268
46.	Neck	0.423	0.122	0.447	0.165	1.330	0.093
47.	Axillar	0.562	0.199	0.565	0.219	0.103	0.459
48.	Thoracic	0.660	0.257	0.708	0.352	1.245	0.107
49.	Iliac crest	0.883	0.335	0.935	0.471	1.023	0.153
50.	Supraspinale	0.558	0.247	0.604	0.338	1.236	0.125
51.	Umbilical	0.877	0.388	0.928	0.611	0.812	0.209
52.	Scapular	0.832	0.244	0.913	0.425	1.943	0.026*
53.	Biceps	0.422	0.159	0.447	0.255	0.938	0.174
54.	Triceps	0.829	0.276	0.842	0.386	0.340	0.367
55.	Front thigh	1.285	0.351	1.374	0.478	1.701	0.058
56.	Calf	1.045	0.264	1.020	0.322	0.676	0.250
57.	Flat dorsal	0.234	0.049	0.235	0.049	0.176	0.430

*p<0.05, **p<0.01

In our investigation age, height and weight were used in the multiple linear regression equation model to prognose by the other variables (1st-variant). Another model of the linear regression equation was generated using only height and weight to prognose the other variables (2nd-variant). The results of the investigation are given in Table 2. All multiple linear regression equations were statistically significant (p<0.001). As a rule diminishing the multiple linear regression equation model by one member — the age — diminishes also the prognostic power (in 38 cases from 55 models).

Table 2

Multiple linear regression equations for estimating various anthropometric measurements of 17–18 year-old boys by age(a), body height (b) and weight (c)

Heights

Nr.	Variable	Multiple regression equation	Multiple R^2(%)
3.	Suprasternal	1) –23.117**+0.447a+0.906b**–0.016c	90.4
		2) –15.515**+0.906b**–0.012c	90.3
4.	Xiphoid process	1) –18.951**+0.277a+0.800b**+0.003c	86.4
		2) –14.234**+0.800b**+0.006c	86.3
5.	Umbilical	1) –21.727**–0.111a+0.747b**–0.030c	78.7
		2) –23.616**+0.747b**–0.031c	78.7
6.	Symphysis pubis	1) –10.856–0.295a+0.619b**–0.030c	72.4
		2) –15.875**+0.619b**–0.033c	72.3

Continue

7.	Iliospinal process	1) 2.732–0341a+0.572b**–0.041c*	66.5
		2) –3.064+ 0.571b**–0.044c*	66.3
8.	Acromial	1) –12.496–0.008a+0.879b**+0.011c	83.2
		2) –12.629**+0.879b**+0.011c	83.2
9.	3rd finger	1) –27.368**+0.985a**+0.433b**–0.009c	51.7
		2) 10.613*+0.433b**–0.001c	50.1
10.	Sitting height	1) 10.214+0.757a+0.367b**+0.028c	36.9
		2) 23.145**+0.367b**+0.034	36.0
11.	Foot length	1) 3.117+0.062a+0.116b**+0.031c**	42.8
		2) 4.155*+0.116b**+0.031c**	42.8
12.	Head-neck length	1) 23.121**–0.437a+0.093b**+0.016c	11.7
		2) 15.741**+0.092b**+0.013c	10.6
13.	Sternal length	1) –4.166+0.170a+0106b**–0.019c	11.9
		2) –1.281+0106b**–0.018c	11.7
14.	Abdominal length	1) 3.086+0.299a+0.180b**+0.033c	21.2
		2) 2.004+0.181b**+0.036	20.9
15.	Trunk	1) –16.443+0.553a+0.331b**+0.009c	34.4
		2) 7.039+0.332b**+0.013c	33.9
16.	Upper part of the body	1) 20.157**+0.218a+0.251b**+0.031c	30.9
		2) 23.860**+0.251b**+0.031c	30.8
17.	Upper limb	1) 14.872–0.993a*+0.447b**+0.020c	43.6
		2) –2.017+ 0.446b**+0.012c	42.3
18.	Lower limb	1) –9.987+0.145a+0.570b**–0.004c	48.4
		2) 7.522+0.570b**–0.003c	48.4
Diameters			
19.	Biacromial	1) 17.126**+0.080a+0.077b**+0.107c**	41.9
		2) 18.480**+0.077b**+0.107c**	41.9
20.	Chest breadth	1) 15.879**+0.304a–0.008b+0.106c**	22.9
		2) 21.046**–0.008b+0.109c**	22.4
21..	Waist breadth	1) 9.294+0.474a–0.018b+0.155c**	35.4
		2) 17.353**–0.018b+0.159c**	34.5
22.	Bicristal breadth	1) 3.522+0.118a+0.110b**+0.034c**	30.0
		2) 5.523*+0.110b**+0.035c**	29.9
23.	Chest depth	1) 6.984+0.066a+0.020b+0.101c**	35.0
		2) 8.110**+0.020b+0.102c**	34.9
24.	Abdominal depth	1) 14.466**–0.008a–0.027b*+0.114c**	44.4
		2) 14.338**–0.027b*+0.114c**	44.4
25.	Femoral width	1) 4.070**+0.077a+0.014b**+0.023c**	29.1
		2) 5.377**+0.014b**+0.024c**	28.5
26.	Bimalleolar width	1) 1.251+0.063a+0.026b**+0.012c**	21.4
		2) 2.318**+0.026b**+0.012c**	21.1
27.	Humeral width	1) 2.816**+0.034a+0.017b**+0.011c**	23.0
		2) 3.399**+0.017b**+0.011c**	22.8

Continue

28.	Wrist width	1) 2.132+0.000a+0.019b**+0.007c**	18.1
		2) 2.135**+0.019b**+0.007c**	18.1
Circumferences			
29.	Head	1) 42.169**+0.461a**+0.011b+0.074c**	28.0
		2) 50.004**+0.011b+0.078c**	25.8
30.	Neck	1) 29.668**+0.325a*–0.055b**+0.158c**	56.8
		2) 35.191–0.055b+0.161c**	56.1
31.	Chest	1) 64.199**+0.761a–0.150b**+0.594c**	69.1
		2) 77.138**–0.150b**+0.600c**	68.8
32.	Chest breathing in	1) 63.653**+0.757a–0.111b**+0.572c**	72.9
		2) 76.521**–0.111b**+0.578c**	72.5
33.	Chest breathing out	1) 72.264**+0.278a–0.161b**+0.558c**	68.2
		2) 76.987**–0.161b**+0.560c**	68.1
34.	Waist	1) 81.084**–0.255a–0.247b**+0.625c**	64.3
		2) 76.751**–0.247b**+0.623c**	64.2
35.	Hip	1) 61.129**–0.282a–0.053b+0.514c**	69.2
		2) 56.326**–0.053b+0.512c**	69.1
36.	Buttocks	1) 66.956**–0.570a+0.015b+0.022c**	65.3
		2) 57.265**+0.015b+0.416c**	65.0
37.	Thigh (upper)	1) 66.170**–0.192a–0.221b**+0.479c**	79.5
		2) 62.908**–0.221b**+0.477c**	79.5
38.	Thigh (medium)	1) 59.065**–0.453a–0.162b**+0.375c**	66.3
		2) 51.364**–0.162b**+0.371c**	66.0
39.	Calf	1) 35.272**–0.081a–0.077b**+0.236c**	61.8
		2) 33.889**–0.077b**+0.236c**	61.8
40.	Ankle (minimum)	1) 22.827**–0.182a–0.017b+0.097c**	39.2
		2) 19.734**–0.017b+0.096c**	38.8
41.	Upper arm	1) 42.887**–0.177a–0.175b**+0.288c**	75.0
		2) 39.871**–0.175b**+0.286c**	74.9
42.	Upper arm (flexed and tensed)	1) 39.305**+0.045a–0.163b**+0.294c**	68.5
		2) 40.077**–0.163b**+0.294c**	68.5
43.	Forearm	1) 26.025**+0.036a–0.071b**+0.177c**	70.5
		2) 26.644**–0.071b**+0.177c**	70.5
44.	Wrist	1) 13.079**–0.048a+0.008b+0.054c**	50.2
		2) 12.260**+0.008b+0.054c**	50.1
Skinfolds			
45.	Buccal	1) 1.286**–0.002a–0.006b**+0.006c**	14.0
		2) 1.258**–0.006b**+0.006c**	14.0
46.	Neck	1) 0.465+0.003a–0.004b*+0.008c**	21.4
		2) 0.514–0.004b*+0.008c**	21.4
47.	Axillar	1) 1.720**–0.029a–0.009b**+0.014c**	27.4
		2) 1.224**–0.009b**+0.013c**	26.9

Continue

48.	Thoracic	1) 2.053**–0.019a–0.017b**+0.028c**	50.7
		2) 1.728**–0.017b**+0.028c**	50.7
49.	Iliac crest	1) 3.266**–0.035a–0.024b**+0.037c**	50.5
		2) 2.667**–0.024b**+0.037c**	50.4
50.	Supraspinale	1) 2.026**–0.005a–0.016b**+0.022c**	35.5
		2) 1.935**–0.016b**+0.022c**	35.5
51.	Umbilical	1) 3.751**–0.063a–0.028b**+0.048c**	51.6
		2) 2.679**–0.028b**+0.047c**	51.2
52.	Subscapular	1) 6.692**+0.007a–0.023b**+0.033c**	53.0
		2) 2.809**–0.023b**+0.033c**	53.0
53.	Biceps	1) 1.034–0.013a–0.008b**+0.015c**	30.2
		2) 0.822*–0.008b**+0.015c**	30.2
54.	Triceps	1) 2.370**–0.049a–0.014b**+0.026c**	38.0
		2) 1.530**–0.014b**+0.025c**	37.5
55.	Femoral	1) 2.866**+0.018a–0.022b**+0.031c**	34.5
		2) 3.172**–0.022b**+0.031c**	34.5
56.	Calf	1) 3.536**–0.067a–0.015b**+0.019c**	25.7
		2) 2.401**–0.015b**+0.018c**	24.6
57.	Flat dorsal	1) 0.349*–0.004a–0.001b*+0.002c**	12.2
		2) 0.279**–0.001b*+0.002c**	12.0

*p<0.05, **p<0.01

The height was the significant prognostic factor for all other 16 measurements of height and length, in 2 models were also weight and age statistically significant members of equation.

For 10 measurements of diameter prognosis weight was statistically significant prognosticative factor in all cases, height in 8 cases and age did not contribute significantly in any model.

For circumferences measurements weight was a significant predictor in all 16 models, height in 12 cases and age in 2 cases.

For prognosis of the skinfolds thicknesses height and weight were in all 13 models significant predictors and age had no significance in any model.

DISCUSSION

These results partly confirm previous Estonian anthropometrical investigations by J. Aul [1, 2] and M. Thetloff [5], that height increase of the male subjects in the age from 17 to 18 years is continuing. Our data did not show significant increase in height 18 year old students compared to

17 year old students, which are in good accordance with L. Heapost [3] results. We analyzed also height increase from 17 to 18 year previous studies of boys. J. Aul [2] found in 1956–1967 the increase of height in 1.9 cm. By J. Aul [2] from 1978 the increase of height was 1.8 cm, by L. Heapost [3] only 0.78 cm, by R. Silla and M. Teoste [4] 1.1 cm and by M. Thetloff [5] even 2.17 cm. In our study the respective height increase from 17 to 18 year was only 0.88 cm. It was one of the smallest increases of the height from all studies of the boys thin that age. This may be the reason why we did not found statistically significant differences in the height from 17 to 18 year.

In our material of the multiple linear regression equation models the age plays significant role as a prognostic factor only in four equations: the 3rd finger height, the upper limb length, the head and the neck circumferences. As we guessed in all height and length prognosing models was a significant prognostic factor the height. In prognosing models for diameters, circumferences and skinfolds were significant predictors weight and height. However for prognosis of two diameters — the chest and the waist breadth and for five circumferences (the head, the hip, the buttocks, the ankle and the wrist) height was not significant member of the model.

Prognostic models of 3 length measurements, 5 diameters and 6 circumference measurements are comparable to the data by H. Kaarma [6] and M. Thetloff [5]. There are differences in prognostic power of the models between our study and the data by H. Kaarma [6]. The prognostic value of the height and weight for young women's anthropometrical measurements were greater in all 14 models. The following differences between our study of male students and the study of female students by M. Thetloff [7] were found:

1) All three height-length parameters were better prognosed in statistical models for girls than for boys,
2) two diameters — the biacromial and the bicristal diameters were better prognosed in boys and three diameters — the chest breadth, the chest and abdominal depth were better prognosed in girls,
3) from three circumferences of the trunk — chest, waist and hip circumferences were better prognosed in girls and from 3 limb circumferences all three were better prognosed in boys.

By our meaning there may be the explanation to this difference in prognosis of anthropometrical variables by height and weight: the young females have better proportionality of the body build as compare the male and female students. Female students were more frequently better prognosed by statistical models as compared to male students. May be the main reason of these differences of prognostability of anthropometrical variables between our study, H. Kaarma's [6] and M. Thetloff's [7] studies were the different stage of physical maturity boys, girls and females.

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APPLICATION OF THE MULTIVARIATE CLASSIFICATION OF BODY BUILD IN ASSESSMENT OF MORPHOMETRIC CHARACTERISTICS OF NORMAL HEART IN 15-YEAR-OLD GIRLS

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ABSTRACT

246 practically healthy 15-year-old Estonian girls were studied echocardiographically and somatometrically. The dimensions of the heart and blood vessels were studied echocardiographically with a two-dimensions dopplerechocardiograph Sonos 100 and the Aloca system. Measurements (n=12) were made following the recommendations of the American Society of Echocardiography using the Penn conventions.

Somatometric investigation included 25 body measurements and 11 skinfolds.

The measurements of the heart were correlated between themselves and with body measurements (by Spearman). The significant correlations found justified the classification the heart measurements into a five-class system of height and weight (small, medium, large, pycnics, leptosomes). It was found that the measurements of the heart increase tematically in classes small, medium, large, but in the groups of pycnics and leptosomes the situation is different. In leptosomes the dimensions of the left ventricle are relatively smaller and the left ventricular wall relatively thinner as compared to pycnics.

A five-class system of weight and height is suitable for classifying heart measurements, but body surface area also has to be assessed in weight-height classes according to the abovementioned classification.
Key words: schoolgirls anthropometry, height-weight classification, heart size.

INTRODUCTION

Abnormalities in the structural characteristics of the heart are among the first markers indicating changes in its functional capacities. Because of the great variability of normal physiological values the determination of individual normal values is very important [1, 2, 3]. Clinical observations and some scientific investigations indicate a correlation between the dimensions of internal organs and body structure. In order to unify constitutional differences, various indices are used [4, 5, 6]. These indices are quotients of morphometric characteristics of the organ to body surface area. This conception is based on the fact that body surface area depends on body height and weight, and therefore it is believed to characterise the relationship between these two important measurements of body structure. However, a number of authors [7, 8] have demonstrated the limitations of standardisation of relationships between body surface and the measurements of the heart.

As can be seen from the above-mentioned, the relations between the dimensions of the heart and body build require further study. Relying on the results of the research on young women and pregnants carried out by the Centre for Physical Anthropology, University of Tartu [9, 10], the aim was set for the present research to find correlations between the dimensions of the heart and single bodily characteristics, and to systematise the dimensions of the heart according to the height-weight classification.

MATERIAL AND METHODS

The sample under observation included 246 practically healthy Estonian girls from different regions of Southern Estonia. The girls' age was 15 years (from 14 years 5 months 29 days to 15 years 5 months and 29 days). None of them had valvular diseases of the heart and arterial hypertension, neither were they trained for top-level sports. Sexual maturity of the girls was III–IV according to Tanner's scale. We chose the heart of 15-year-old girls as a model of assessment of normal cardiac values because the constitutional type should be formed by the end of puberty. At the same time there are no long-time exogenic and endogenic factors which may have had a great effect on heart size.

The dimensions of the heart and blood vessels were studied echocardiographically with a two-dimensions dopplerechocardiograph Sonos 100 and the Aloca system. The measurements were made following the recommendations of the American Society of Echocardiography using the Penn conventions [11]. Left ventricle volume was calculated comparatively according to the Techoltz formula [12] and the area-length formula [13]. Left ventricle mass was calculated comparatively according to the Devereux formula and the area-length formula [14].

The following parameters that are routinely used in clinical practice were measured: aortic cross diameter (AO), cross diameter of truncus a. pulmonalis (AP), anterior-posterior diameter of the left atrium (LA), right ventricular outflow tract (RVOT), left ventricular maximal cross diameter (LVED) and left ventricular inner diameter in diastole, left ventricular intracavity long axis in diastole (LAXin), intraventricular septum (Std) and left ventricular posterior wall (LVPW) thickness in diastole.

The same schoolgirls were also examined somatometrically according to the classical methods of Martin [14] — 25 body measurements and 11 skinfolds. Body surface area was calculated by Issakson's formula.

The variability of heart dimensions was studied in a 5-class SD classification of height and weight (see Fig. 1) compiled by us at the Centre for Physical Anthropology, University of Tartu. We distinguished between three classes of height-weight correspondence (1. small height and small weight; 2. medium height and medium weight; 3. big height and big weight) and two classes of non-correspondence between height and weight (4. pycnics and 5. leptosomes).

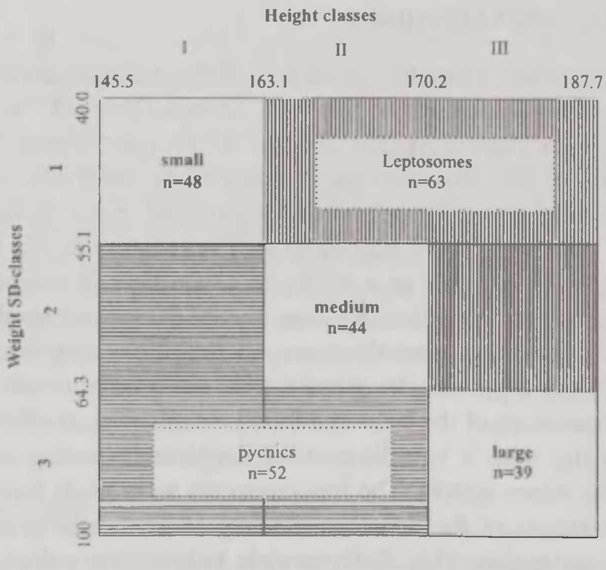

Figure 1. Classification of 15-year-old girls by 5 height-weight classes.

The data were processed with the statistical packet STATISTICA. The correlation coefficients were calculated by Spearman's method.

RESULTS

The basic characteristics of the heart measurements used in the investigation are presented in Table 1. As the Table shows, the variability of heart measurements is quite significant, particularly of the left ventricular intracavity long axis (No. 7) and left ventricular mass (No 8 and 9).

Table 1

Values of heart dimensions of girls at age 15

Variable	Mean	SD	V	Range percentiles 25–75
1. Aortic cross (AO) diameter (mm)	26.11	2.6	7.1	24.3–28.8
2. Cross diameter of truncus a. pulmonalis (AP) (mm)	17.8	1.8	3.2	16.4–18.9
3. Anterior-posterior diameter of left atrium (LA) (mm)	24.9	3.3	11.1	22.3–27.0
4. Right ventricular outflow tract (RVOT) (mm)	24.8	10.3	10.2	22.3–27.0
5. Left ventricular maximal cross diameter in diastole (LVEDd) (mm)	42.5	3.7	13.7	40.0–45.0
6. Left ventricular innere diameter in diastole (LVIDd) (mm)	42.6	3.2	10.5	43.3–44.5
7. Left ventricular intracavity long axis (LAXin) (mm)	63.9	8.5	39.1	58.8–68.8
8. Left ventricular mass calculated by Devereux formula (LVMASS1) (g)	130.1	27.0	73.0	110.4–146.8
9. Left ventricular mass calculated by area-length formula (LVMASS2) (g)	85.9	15.7	249.0	71.3–96.0
10. Left ventricular volume in diastole (LVVd) (ml)	82.5	15.3	235.8	71.3–91.0
11. Ventricular septum thickness in diastole (STd) (mm)	8.06	1.64	2.7	7.0–9.0
12. Left ventricular posterior wall thickness in diastole (PWd) (mm)	8.8	1.42	2.0	8.0-9.8

Next, correlation analysis between the heart measurements was carried out by Spearman's method. Table 2 presents the statistically significant correlation coefficients. Here we can see that the majority of characteristics are in statistically significant correlation between

Table 2

Correlation coefficients (by Spearman) between variabels of heart parameters of girl in age 15

Parameters	AO	AP	LA	RVOT	LVEDd	LVIDd	LAXin	LV-MASS1	LVMASS2	LVVd	STd	PWd
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. AO	–	–	–									
2. AP	–	–	–	–								
3. LA	–	0.18	–	–	–	–						
4. RVOT	0.27	0.19	0.38	–	–							
5. LVEDd	0.24	0.29	0.3	0.21	–							
6. LVIDd	0.24	0.33	0.3	0.25	0.73							
7. LAXin	–	–	0.26	0.29	0.29	0.28	–					
8. LVMASS1	0.27	0.34	0.22	0.24	0.22	0.21	–	–				
9. LVMASS2	–	0.25	0.4	0.26	0.36	0.45	0.57	0.5	–	–	–	–
10. LVVd	0.24	0.33	0.3	0.25	0.73	0.8	0.21	0.45	0.45	–	–	–
11. STs	0.19	0.28	–	0.19	–	–	–	0.27	0.27	–	–	–
12. PWd	0.24	–	0.18	0.15	–	–	–	0.38	0.38	–	0.3	–

Table 3

Correlaton coefficients (by Spearman) between variables of heart and anthropometrical parameters of girls at age 15

Anthropometrical parameters	Heart parameters											
	AO	AP	LA	RVOT	LVEDd	LVIDd	LAXiN	LVMASS1	LVMASS2	LVVd	STd	PWd
	1	2	3	4	5	6	7	8	9	10	11	12
1. weight	0.28	–	0.38	0.26	0.52	0.52	0.5	0.35	0.5	0.5	–	0.35
2. height	0.21	–	0.24	0.16	0.35	0.35	–	0.14	–	0.29	–	–
3. trunk length	0.13	–	0.27	–	0.3	0.3	0.33	–	–	–	0.23	–
4. sitting height	0.2	–	0.16	–	0.34	0.34	–	–	–	0.3	–	–
5. head-neck length	0.2	–	–	–	0.16	0.16	–	–	–	0.15	–	–
6. abdomen length	0.14	–	0.16	0.12	–	–	0.29	–	–	–	–	–
7. upper limb length	0.13	–	0.16	–	0.28	0.28	–	–	–	0.23	–	–
8. lower limb length	0.15	–	0.2	–	0.23	0.23	–	–	–	0.35	–	–
9. leg length	–	–	0.44	–	0.23	0.23	–	–	–	0.2	–	–
10. finger length	0.14	–	0.27	–	0.41	0.41	–	–	–	0.24	–	–
11. biacromial breadth	0.2	–	0.27	0.18	0.37	0.37	–	0.26	0.29	–	0.29	0.15
12. chest breadth	0.2	–	0.32	0.16	0.3	0.3	0.23	0.33	0.23	0.27	0.24	0.29
13. abdpmen breadth	0.21	–	0.37	0.21	0.39	0.42	0.29	0.24	0.33	0.4	–	0.19
14. chest depth	0.19	–	0.31	0.34	0.49	0.49	0.45	0.33	0.41	0.46	0.26	0.23
15. abdomen depth	0.18	–	0.26	0.19	0.36	0.36	0.32	0.23	0.43	0.42	0.29	0.21
16. head circumf.	0.21	–	0.13	0.16	0.28	0.28	0.25	0.26	–	0.2	0.24	0.27
17. neck circumf.	0.22	–	0.23	0.32	0.37	0.36	0.4	0.36	0.38	0.47	0.37	0.37
18. chest circumf.	0.24	–	0.31	0.31	0.44	0.35	0.48	0.33	0.39	0.42	0.21	0.33
19. waist circumf.	0.23	–	0.3	0.26	0.4	0.33	0.45	0.3	0.49	0.43	–	0.31
20. pelvis circumf.	0.16	–	0.14	0.2	0.26	0.25	0.46	0.4	0.41	0.16	–	0.27
21. arm circumf.	0.2	–	0.27	0.21	0.43	0.31	0.51	0.32	0.44	0.39	–	0.36
22. forearm circumf.	–	–	–	0.13	–	–	0.27	–	–	–	–	0.26
23. wrist circumf.	0.25	–	0.24	0.2	0.31	0.31	0.36	0.21	0.32	0.34	–	0.26
24. prox. thigh circumf.	0.18	–	0.2	0.2	0.32	0.32	0.4	0.23	0.44	0.41	–	0.32
25. dist. thigh. circumf.	0.17	–	0.2	0.18	0.31	0.21	0.46	0.24	0.52	0.46	–	0.29
26. calf circumf.	0.22	–	0.27	0.26	0.36	0.35	0.54	0.34	0.51	0.41	0.21	0.37
27. lower leg circumf.	0.21	–	0.31	0.25	0.28	0.36	0.26	0.28	0.37	0.36	0.32	0.22
28. mass of muscular tissue (by Matieka)	0.22	–	–	0.21	0.37	0.37	0.5	0.25	0.52	0.5	–	0.32
29. relat. mass of muscular tissue	–	–	–	–	–	–	–	–	–	–	–	–
30. mass of subcutaneous adipose tissue (by Matieka)	0.14	–	–	–	–	0.23	0.33	0.17	0.25	–	–	0.27

one another. Stronger correlations exist between the left ventricular diameters (characteristics 5 and 6) and left ventricular volume (characteristic 10) — r=0.73 and 0.8, also between the left ventricular intracavity long axis (characteristic 7) and left ventricular mass (characteristic 9). The correlation coefficient r between all the other characteristics varies from 0.2 to 0.4.

We continued our study by investigating the correlations between the heart measurements and somatometric parameters, also by Spearman's method (Table 3). We found that the majority of individual body measurements are in statistically significant correlation with the heart measurements (r=0.2–0.5). The strongest correlations exist between weight, height, chest depth, chest circumference and calf circumference. Among the characteristics of body composition, the mass of muscular tissue is most strongly correlated with the measurements of the left ventricle.

This gives reason to believe that a height-weight classification which characterises the body as a whole, could also be suitable for classifying the heart measurements.

Until now, the only recommended way to correlate heart measurements with body build has been to correlate them with body surface area [4, 5, 6]. Let us observe how body surface area changes in the 5-class height-weight system used by us (Table 4). We see that in the case of classes of correspondence between height and weight [1–3]

Table 4

Values of weigth, heigth and boby surface area in 5 height-weight classes

parameters	height-weight classes						
	1	2	3	significance	5	4	significance
	small	medium	large	difference	leptosomes	pycnics	difference
	n=48	n=44	n=39	p<0.05	n=63	n=52	p<0.05
weight M	44.07	54.1	64.9	1:2, 3	59.3	50.8	4:1, 2, 3, 5
(kg) SD	4.5	2.6	3.2	2:3	5.3	7.2	5:1, 2, 3, 4
height M	156.3	165.5	172.5	1:2, 3	162.5	168.6	4:1, 2, 3, 5
(cm) SD	4.6	2.5	2.9	2:3	4.2	4.8	5:1, 2, 3, 4
body M	1.4	1.59	1.77	1:2, 3	1.61	1.59	4:1, 3
surface area SD	0.08	0.03	0.07	2:3	0.09	0.08	5:1, 3

where body measurements increase systematically from small to medium to large, the body surface area also increases essentially together with height and weight measurements. However, if we have to do with somatotypic classes — pycnics [4] and leptosomes [5], the situation is entirely different. While the average height and weight in these classes differ considerably, the average value of the body surface area does not differ statistically significantly between those classes, being similar to the body surface area of the medium class [2].

From this we can conclude that body surface area as a single characteristic is not suitable for characterising the body as a whole because it does not distinguish between different types of body build.

Now, let us see how the heart measurements behave in a 5-class classification of height and weight (Table 5). Here we can also notice essential differences between the small, medium and large classes and between pycnics and leptosomes.

In the system small-medium-large the heart measurements studied increase gradually together with an increase of height and weight in these classes. As for the groups of pycnics and leptosomes, it should first be mentioned that in the group of pycnics the heart measurements are relatively bigger than in leptosomes. There is a statistically essential difference in left ventricular mass (No. 8), left ventricular volume (No. 10) and left ventricular posterior wall thickness (No. 12). In pycnics these measurements are considerably bigger than in leptosomes.

We also checked if there were any statistically significant differences between the five height-weight classes in the mean values of all the heart measurements studied. It was noticeable that a great number of heart measurements (characteristics 1, 2, 3, 4, 5, 7, 9, 11) do not differ considerably from the corresponding values of the medium class.

DISCUSSION

Until now correlation of heart measurements with body build has been limited to applying the body surface area [16]. We have not found any studies which would give a detailed analysis of correlations between single measurements of the heart and body measurements. The numerous correlations found by us make it possible to classify heart measurements into a 5-class height-weight classification which, as far as we know, give the best description of the peculiarities of whole body build.

This classification enables us to distinguish between changes in body build in classes of height and weight (small-medium-large) and in classical somatotypes (pycnics and leptosomes). The need for sepa-

Table 5

Values of echocardiographic heart parameters of girls at age 15 in height-weight classes

Parameters	Height-weight classes									Sig-nifi-cance diffe-rence p<0.05	Height-weight classes						Signi-ficance diffe-rence p<0.05
	1. small n=48			2. medium n=44			3. large n=39				4. pycnics n=52			5. leptosomes n=63			
	M	SD	Range per-centiles 25–75	M	SD	Range per-centiles 25–75	M	SD	Range per-centiles 25–75		M	SD	Rance per-centiles (25–75)	M	SD	Rance percen-tiles (25–75)	
1. AO (mm)	24.9	2.7	23.2–26.3	26.0	2.2	24.7–27.5	27.2	3.0	25.0–29.6	1:2, 3 2:3	24.3	2.8	24.3–28.1	26.3	2.1	24.7–27.9	1:5
2. AP (mm)	17.7	2.1	16.1–18.8	18.0	1.3	16.6–18.8	18.1	1.3	16.7–19.2	–	17.5	2.0	16.1–19.0	17.8	1.8	16.4–18.8	–
3. LA (mm)	23.6	3.2	21.3–25.9	24.9	3.4	22.5–27.0	26.5	2.6	24.7–28.1	3:1, 2	24.9	3.5	22.0–28.7	24.7	3.1	22.7–26.9	4:3 5:3
4. RVOT (mm)	24.3	2.7	22.0–26.4	24.3	2.7	22.7–26.0	26.0	2.9	23.5–28.1	3:1, 2	25.0	3.3	22.5–27.5	24.7	3.7	22.0–28.3	–
5. LVEDd (mm)	40.6	3.1	37.6–42.6	42.9	3.4	40.0–43.9	46.5	3.3	43.0–48.9	1:2, 3 3:2	42.9	3.5	40.7–45.7	42.3	3.1	40.3–44.0	4:1, 3 5:1, 3
6. LVIDd (mm)	40.2	2.9	38.6–42.7	42.6	2.7	40.8–44.3	44.5	3.1	42.0–47.0	1:2, 3 3:2	42.7	3.3	40.8–45.3	42.7	2.9	40.3–44.5	4:1, 2, 3, 5 5:1, 3, 4
7. LAXin (mm)	60.9	4.0	56.4–65.2	67.6	3.4	65.0–70.3	68.4	3.7	66.4–71.5	1:2, 3	66.1	9.5	57.9–77.1	62.8	4.1	58.6–65.4	4:1 5:3
8. LVMASS1 (g)	121.8	27.0	101–144	135.9	27.8	115–155	143.0	24.2	126–155	1:2, 3	133.8	25.7	117.2–149.0	120.4	24.3	99–134.4	4:1, 5 5:2, 3
9. LVMASS2 (mm)	83.1	16.1	63.1–93.4	97.3	11.8	83–103	105.9	11.7	93–110	1:3	97.4	19.0	72.7–118.6	91.2	14.0	81–92.1	5:1, 3
10. LVVd (ml)	84.9	16.1	73.8–94.8	73.3	10.8	64.3–81.7	82.3	11.6	74.2–89.0	2:1, 3 3:2	89.5	16.0	78.6–102.4	80.4	12.8	71.3–89.1	4:2, 3, 5 5:2, 4
11. STd (mm)	8.3	1.5	7.0–9.0	7.8	1.9	6.1–8.7	8.7	1.8	7.5–10.0	2:3	8.3	1.6	7.4–9.0	7.6	1.4	7.0–8.7	5:1, 3
12. PWd (mm)	9.0	1.5	8.0–10.0	8.7	1.3	8.0–9.3	9.1	1.4	8.0–10.0	5:1, 3	9.7	1.5	8.0–10.0	8.7	1.3	8.0–9.3	4:1, 2, 5

rating the last-mentioned classes has been discussed in our earlier studies [9], where we proved on the sample of young women that the peculiarities in the body build of pycnic and leptosomic women result namely from a non-correspondence between height and weight.

Correlation of body surface area with the five height-weight classes yielded interesting results. It appeared that a detailed description of body build types cannot be based on this characteristic as it does not differ considerably in the classes of pycnics and leptosomes and in the medium class.

Our experience in studying body structure [17] has shown that it is impossible to systematise the peculiarities of body build on the basis of one index only (Rohrer, body mass index). These indices characterise only obesity. It is always necessary to use a bivariate classification: one of the factors always has to be height and the other — either weight, Rohrer index or body mass index.

While classifying heart measurements, interesting differences between the classes appeared. When all the heart measurements studied gradually increase in classes small-medium-large, then the mass, volume and posterior wall thickness of the left ventricle (characteristics 8, 10 and 12) are considerably bigger in the class of pycnics than in the class of leptosomes. Therefore it can be concluded that from the therapeutic aspect leptosome girls need special attention as they, regardless of their size, have a relatively small heart and a thin left ventricular wall.

In conclusion it can be stated that a 5-class height-weight classification is suitable for classifying heart measurements. The relation of heart measurements to the body surface area should be classified according to height-weight classes as well.

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HEIGHT, WEIGHT, BODY MASS INDEX, SKINFOLDS AND THEIR CORRELATION TO SERUM LIPIDS AND BLOOD PRESSURE IN THE EPIDEMIOLOGICAL STUDY OF SCHOOLCHILDREN IN TALLINN

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ABSTRACT

In a cooperative cross-sectional study height, weight, skinfold thicknesses, serum lipids and blood pressure were measured in 1,328 randomly chosen schoolchildren aged 10 to 14. Anthropometric measures were compared with analogical data in Moscow, Novosibirsk and Ohrenburg. Schoolchildren in Tallinn had the highest blood cholesterol levels.

Some ethnic differences were found: Estonian pupils were taller than Russian ones. The weight (W) and height (H) indices (W/H^2 and W/H^3) were higher in Russians than in Estonians. The body mass index (BMI) was greater in girls than in boys. Weight and BMI had stronger correlations to skinfolds (stronger for subscapular than triceps one). Skinfold thicknesses, W and BMI had positive correlations to serum triglycerides (TG); while negative associations to HDL-cholesterol occured only in boys. At the pubertal age we noticed the appearance of some sex-related differences like atherogenic blood lipid profile in boys, reflected by lowering HDL-C levels. Blood cholesterol level was lower in menstruating girls than in girls without menstruation.

Overweightness was determined by the proposed criteria as follows: at the age of 10–11 (BMI≥20 kg/m^2) 16.3% of boys and 18.5% of girls were overweight; at the age of 13–14 (BMI≥22 kg/m^2) — 17.9% and 27.7%, correspondingly. In the group with higher BMI (above the 75th percentile) hypertriglyceridemia (TG≥1.1 mmol/l) and hypo-HDL-cholesterolemia (HDL-C≤1.1 mmol/l) occurred more often than in the group with lower BMI (below the 25th percentile).

There was age-dependant increase of systolic and diastolic blood pressure in both sexes, boys and girls. The indices of body mass (BMI and skinfolds) were the most common correlates for blood pressure and lipid values.

Evidence is convincing that atherosclerosis, coronary artery disease and arterial hypertension begin in childhood [1]. Many countries have studied the occurrence and development of risk factors of coronary heart disease (CHD) and their determinants already in childhood and adolescence [2, 3].

The motivation for collecting anthropometric data originated from an epidemiologic investigation to determine main cardiovascular risk factors of children in Tallinn in a cooperative study with Moscow, Novosibirsk and Ohrenburg in 1984–86. In this paper attention is concerned on the anthropometric data, as height, weight, body mass index, skinfolds and their relations to some CHD risk factor variables, as serum lipids and blood pressure.

Key words: antropometry, serum lipids, blood pressure, schoolchildren, epidemiology

MATERIAL AND METHODS

The cross-sectional study was performed in the Northern district of Tallinn in the schoolchildren subgroups aged 10–11 and 13–14 years. Althogether 1,476 randomly chosen schoolchildren (24% of the pupils of grades 4 and 7 in this population) were invited but 1,328 (=90%) of these subjects participated in the study. The total number of boys examined was 622 (46.8%): 288 of them at the age 10–11 years and 297 at the age 13–14 years. The total number of girls was 706 (56.1%): 374 from younger and 300 from older age group. By the ethnic origin groups devided to Estonians — 47.6%, Russians — 44.6% and pupils of other nationalities — 7.8%.

The study was carried out during 1984–85 and 1985–86 school-years. All personnel received special training for standardized methods at the Research Centre for Preventive Medicine, Moscow. Examination included questionnaires, interview, and anthropometric measurements. Height (H) and weight (W) were measured in subjects wearing indoor clothing without shoes. H was recorded to the nearest 0.5 cm. W was recorded to the nearest 0.1 kg. Skinfold thicknesses were measured to the nearest 0.2 mm readings: triceps skinfold (T) — a vertical fold made at the midpoint of the back of the right upper arm over the triceps; subscapular (S) — an oblique fold made below the scapula. Upper arm circumference (UAC) was measured to the nearest 0.1 cm at the midpoint between the acromion and olecranon.

Relations derived from the anthropometric measurements used in the analysis were: body mass index (BMI)=W (kg)/H $(m)^2$; Ponderal index (PI)=W (kg)/H $(m)^3$ and arm muscle circumference AMC (cm)= UAC (cm) – 0.314 × T (mm). Sexual maturation was determined by visual assessment of secondary sex characteristics (pubic hair plus breasts or genitals) and given in pubertal stages by Tanner's scale [4]. The girls were asked if they had menstruations, if so, the date of the last one was recorded. Blood pressure was measured after a 5-min rest twice on the right arm with a mercury sphygmomanometer and recorded to the nearest 2 mm Hg. Systolic pressure (SPB) was recorded for Korotkoff's first phase and diastolic pressure for both Korotkoff's fourth (DBP_{IV}) and fifth (DBP_V) phases. The mean of the two readings was used in the study. After a fast of 12 hours venous blood samples were taken from the right antecubital vein. Total cholesterol (TC) and triglycerides (TG) were determined using a Centrifihem-600 auto-analyzer and high density lipoprotein cholesterol (HDL-C) was measured after manganese-heparin precipitation [5] by means of a Technicon AA-II autoanalyzer. All the biochemical analyses were performed in the laboratorium of the Research Centre for Preventive Medicine, Moscow. The results of the internal and external quality control met the accepted criteria. Low density lipo-protein cholesterol (LDL-C) was calculated by the formula LDL-C = TC + (TG/5 + HDL-C).

The data were computed using the SAS statistical package [6]. Means, standard deviations, percentile values, the Student's t-test and correlation matrices were used.

RESULTS AND DISCUSSION

Anthropometric measurements

Means of height, weight, body mass and Ponderal indices are presented in Table 1. Means of skinfold thicknesses, upper arm and arm muscle circumferences are presented in Table 2.

All the physical development variables were growing with age. Ethnic differences were significant in height: Estonian pupils were taller than Russian ones, except 14-year-old boys. At the age of 14 all boys were significantly taller than girls: Estonian boys by 2.5 cm and Russian boys by 4.2 cm ($p<0.05$). Weight was gained with age similarly in both sexes and ethnic groups. The mean value of BMI was greater in all girls than in boys at the age of 14, but in Russian girls greater (18.0±2.9) than in Estonians (17.1±1.8) at the age of 10 ($p<0.05$). PI was greater in Russian girls than in Estonian ones ($p<0.05$) aged 10, 11 and 13. Skinfolds (S, T) were thicker in girls than in boys (except in 11-year-olds) and in Estonians thicker than in Russians (except in 10-year-olds). AMC was greater in boys than in girls at both age groups. Comparison of ethnic subgroups showed that AMC was greater in Russians than in Estonians in both sexes (significantly for boys aged 11 and 13; for girls aged 11, 13 and 14).

Table 1

Height, weight, body mass index (BMI) and ponderal index (PI) according to age, sex and ethnic origin
Boys (M) and girls (F); Estonians (E) and Russians (R)

Age, yrs.	Sex	Ethnic origin	N	Height, cm Mean	Height, cm SD	Weight, kg Mean	Weight, kg SD	BMI, kg/m² Mean	BMI, kg/m² SD	PI, kg/m³ Mean	PI, kg/m³ SD
10	M	E	61	144.7[a]	7.3	36.3	7.0	17.4	2.6	12.1	1.7
		R	84	141.7	6.5	35.2	6.2	17.5	2.1	12.3	1.4
	F	E	64	143.5[a]	6.3	35.4	5.6	17.1	1.8	12.0	1.2
		R	131	141.9	6.4	36.4	7.4	18.0	2.9	12.7	2.1
11	M	E	82	147.6[a]	5.9	39.0	7.2	17.8	2.4	12.1	1.4
		R	58	144.8	7.8	38.0	7.4	18.0	3.0	12.1	1.3
	F	E	107	148.8[a]	6.7	38.7	6.7	17.4	2.1	11.7	1.4
		R	64	145.8	7.8	38.1	6.9	17.7	2.0	12.1	1.3
13	M	E	78	163.1[a]	8.4	51.7	9.3	19.2	2.4	11.8	1.4
		R	44	158.9	8.1	49.5	10.0	19.4	2.5	12.2	1.3
	F	E	84	162.3[a]	6.6	51.0	8.9	19.3	2.9	11.9	1.8
		R	52	159.8	5.0	50.9	8.7	19.9	2.8	12.5	1.6
14	M	E	54	166.7	6.9	54.5	8.8	19.6	2.2	11.8	1.2
		R	114	166.3	8.2	55.4	10.2	19.9	2.7	12.0	1.6
	F	E	46	164.2[a]	5.9	55.2	7.8	20.5	2.7	12.5	1.8
		R	104	162.1	5.3	55.3	8.8	21.0	2.8	13.0	1.7

[a] — difference significant between Estonians and Russians ($p<0.05$)

BMI means and percentiles compared with Moscow, Novosibirsk and Ohrenburg (presented in Table 3) turned out to be quite similar in all centres. Mean and median values showed a good coincidence [7]. In this study epidemiologic criteria for estimation of overweightness were given by coordinative centre similar to all cooperative centres: for the ages 10–11 BMI≥20.0 kg/m^2 and for the ages 13–14 BMI≥ 22.0 kg/m^2. According to these criteria 16.3% of boys and 18.5% of girls aged 10–11, and 17.9% of boys and 27.7% of girls aged 13–14 were overweight. Thus the overweightness appeared more often among girls in the period of sexual maturation. Comparing the cooperative centres, overweight prevailed in Moscow and Novosibirsk [8]. In Tallinn schoolchildren metabolic CHD risk factor variables prevailed. They had higher serum TC levels.

Table 2

Subscapular (S), triceps (T) and SUM of subscapular and triceps (S+T) skinfolds, upper arm circumference (UAC) and arm muscle circumference (AMC) grouped according to age, sex and ethnic origin

Boys (M) and girls (F); Estonians (E) and Russians(R)

Age,		Ethnic		S, mm		T, mm		S+T, mm		UAC, cm		AMC, cm	
yrs.	Sex	origin	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
10	M	E	61	7.6	6.3	12.4	6.8	20.0	12.7	21.3	2.8	17.5	1.5
		R	84	7.1	4.0	10.6	4.5	17.7	8.2	21.1	2.3	17.7	1.5
	F	E	63	9.0	4.3	13.9	4.6	23.0	8.4	21.5	2.0	17.1	1.6
		R	130	8.9	5.5	12.8	5.2	21.7	10.4	21.3	2.6	17.3	1.7
11	M	E	82	9.1	5.6	14.5[a]	6.8	23.5[a]	12.0	22.6	3.0	18.0[a]	1.5
		R	58	7.6	6.1	11.2	6.5	18.7	12.3	22.1	2.8	18.6	1.5
	F	E	107	9.5	5.0	15.9[a]	5.7	25.4[a]	10.1	22.3	2.5	17.3[a]	1.8
		R	62	8.4	3.9	12.0	3.7	20.4	7.3	22.1	2.3	18.4	1.8
13	M	E	76	9.5	5.1	14.9[a]	6.6	24.4[a]	11.2	24.8	2.8	20.1[a]	1.9
		R	44	8.4	4.6	10.8	5.0	19.2	9.4	24.4	2.7	21.0	2.1
	F	E	84	13.2	7.4	18.4[a]	6.5	31.6[a]	13.1	24.3	2.8	18.5[a]	1.5
		R	55	11.3	6.1	14.9	6.2	26.1	12.1	24.2	2.7	19.6	1.7
14	M	E	53	9.6	5.4	12.7[a]	5.8	22.3[a]	10.6	25.6	2.8	21.6	2.0
		R	114	8.2	4.3	9.9	4.9	18.0	8.8	25.0	3.0	21.9	2.4
	F	E	46	13.7	4.4	20.4[a]	6.0	34.1[a]	10.9	25.7	3.1	19.3[a]	1.8
		R	104	12.6	5.7	16.7	5.5	29.3	10.7	25.2	2.8	20.0	1.9

[a]— difference significant between Estonians and Russians ($p<0.05$)

The mean concentrations of serum lipids in relation to sexual maturation of girls comparatively in Estonia and Finland [9] are presented in Table 4. TC, HDL-C and LDL-C concentrations were lower in menstruating girls than in girls without menstruation. HDL-C concentrations were similar in Estonian and Finnish girls. In Finland TG concentration was higher in menstruating girls. In our study significant differences in TG concentrations between the girls menstruating and not menstruating were seen only in the age group of 14.

In Table 5 correlations between anthropometric measurements are presented for each sex and age group. The correlations between H and W were highest in 13-year-old boys and 11-year-old girls. H was significantly correlated to skinfolds only in younger age groups. W correlated highly to both BMI and PI and to T and S. At the same time W, BMI, and PI associated more strongly with S than T. It is more likely that thickness of subscapular skinfold expresses the overweightness or body fat mass better than other measurements. Other studies confirm that subscapular skinfold (trunk fat) associates with risk factor variables more strongly than triceps (limb fat) [10]. The correlation between W and the indices (BMI, PI) with skinfold thicknesses were stronger in 10- and 11-year-old boys and in older girls (13- and 14-year-old). PI was not correlated to H but was correlated to skinfolds as well as BMI, especially in the boys aged 14 years. In the Shetland study [11] PI was shown to be better index for estimating overweight in boys (aged 12, 13, 14, 16 year) and BMI in girls (boys only 11 and 15-year-old).

Table 3

Body mass index (BMI) means and percentiles in Tallinn schoolchildren compared with other cooperative centres Moscow, Novosibirsk and Ohrenburg

Age group	Centre	N	Mean	SD	Percentiles 5	10	25	50	75	90	95
					Boys						
10–11	Tallinn	285	17.7	2.5	14	15	16	17	19	21	23
	Moscow	322	17.9	2.6	14	15	16	18	19	21	23
	Novosibirsk	283	17.7	2.8	14	15	16	17	19	21	23
	Ohrenburg	216	17.5	2.3	14	15	16	17	18	20	21
13–14	Tallinn	290	19.6	2.5	16	17	18	19	21	23	24
	Moscow	289	19.8	2.6	16	17	18	20	21	23	25
	Novosibirsk	172	19.6	2.8	16	17	18	19	21	23	27
	Ohrenburg	266	19.8	2.1	17	17	18	20	21	22	24
					Girls						
10–11	Tallinn	366	17.6	2.4	14	15	16	17	19	21	22
	Moscow	267	18.2	2.8	15	15	16	18	20	22	24
	Novosibirsk	274	17.3	2.5	14	15	16	17	18	21	22
	Ohrenburg	228	17.6	2.2	15	15	16	17	19	20	21
13–14	Tallinn	286	20.2	2.9	16	17	18	20	21	24	27
	Moscow	341	20.0	2.9	16	17	18	20	22	24	25
	Novosibirsk	191	20.4	2.9	17	17	18	20	23	25	26
	Ohrenburg	270	20.3	2.4	17	18	19	20	21	23	24

Table 4

Serum lipids (mmol/l) and sexual maturation in estonian and finnish girls. Total cholesterol (TC), HDL-cholesterol (HDL-C), LDL-cholesterol (LDL-C), triglycerides (TG).

Girls without menstruation (M–), girls with menstruation (M+).

Group	Sexual maturation	N	TC Mean	TC SD	HDL-C Mean	HDL-C SD	LDL-C Mean	LDL-C SD	TG Mean	TG SD
Estonia	M–	204	4.9[b]	0.78	4.46[b]	0.28	3.12[b]	0.76	0.77	0.32
	M+	75	4.6	0.72	1.39	0.25	2.90	0.68	0.75	0.40
Finland	M–	82	5.0[a]	0.80	1.46[b]	0.31	3.19	0.71	0.77[b]	0.31
	M+	387	4.8	0.84	1.39	0.25	3.03	0.77	0.84	0.31

t-tests applied between groups M– and M+; a — $p < 0.05$, b — $p < 0.01$

Table 5

Correlation coefficients between height (H), weight (W), body mass index (W/H^2), ponderal index (W/H^3), skinfolds (S=subscapular, =triceps), SUM of skinfolds (T+S)

Variables	H		W		W/H^2		W/H^3		T		S		T+S	
H	*	*	.64	.76	.22	.33	–	–	.25	.21	.26	.20	.26	.22
	*	*	.54	.50	–	–	–	–	–	–	–	–	–	–
W	.70	.61	*	*	.88	.86	.70	.59	.61	.49	.70	.56	.68	.56
	.77	.71	*	*	.90	.90	.77	.76	.66	.70	.70	.74	.71	.75
W/H^2	.28	.17	.88	.88	*	*	.95	.92	.62	.56	.73	.66	.70	.65
	.33	.28	.85	.88	*	*	.97	.97	.71	.73	.79	.80	.78	.80
W/H^3	–	–	.67	.70	.94	.95	*	*	.55	.50	.66	.62	.63	.59
	–	–	.55	.64	.91	.94	*	*	.67	.69	.77	.76	.76	.76
T	.29	.26	.74	.77	.79	.79	.71	.71	*	*	.85	.75	.96	.95
	–	–	.53	.47	.65	.60	.61	.60	*	*	.83	.82	.96	.96
S	.28	.27	.78	.81	.85	.84	.78	.76	.89	.88	*	*	.96	.92
	.26	–	.66	.58	.77	.71	.70	.70	.84	.82	*	*	.96	.95
T+S	–	.27	.78	.81	.84	.84	.76	.75	.98	.97	.97	.96	*	*
	–	–	.61	.55	.73	.68	.68	.67	.97	.96	.95	.95	*	*

In each square there are four correlations: in the upper row for 10, 11 year-olds, in the lower row for 13, 14 year-olds; for boys below the diagonal (left), for girls over the diagonal (right); r is presented with significance $p<0.01$.

The height and weight indices express the extent of body mass, not the amount of fatness. Therefore it is recommended to prefer skinfold data in epidemiological studies of children [11, 12]. But we agree with other authors that lack of calipers and unsuccessful standardization of skinfold measurements limit using skinfold data [13].

Associations with serum lipids and blood pressure

Correlations between physical variables, serum lipids and blood pressure are shown in Table 6. TC as well as HDL-C and LDL-C had very low negative correlations to physical variables. Negative correlations between HDL-C and anthropometric measurements were significant only in boys, not in girls. It was due to decrease of HDL-C of boys

Table 6

Correlation coefficients between physical variables and serum lipids and blood pressure.

Height (H), weight (W), body mass index (W/H^2), upper arm circumference (UAC), arm muscle circumference (AMC), triceps (T), subscapular (S), skinfolds, sum of skinfolds (T+S), total cholesterol (TC), HDL-cholesterol (HDL-C), LDL-cholesterol (LDL-C), triglycerides (TG). Systolic blood pressure (SBP), diastolic fourth phase blood pressure (DBP_{IV}), diastolic fifth phase blood pressure (DBP_V). Boys (M) and girls (F).

Variables	Sex	TC	HDL-C	LDL-C	TG	SBP	DBP_{IV}	DBP_V
H	M	–0.29	–0.20	–0.25	+0.15	+0.53	+0.38	+0.36
	F	–0.15	–	–0.17	–	+0.49	+0.42	+0.39
W	M	–0.25	–0.24	–0.21	+0.16	+0.60	+0.42	+0.40
	F	–0.16	–	–0.17	+0.11	+0.60	+0.43	+0.41
W/H^2	M	–0.12	–0.21	–	+0.14	+0.49	+0.34	+0.33
	F	–0.11	–	–0.13	+0.13	+0.53	+0.33	+0.33
UAC	M	–0.15	–0.22	–	+0.15	+0.53	+0.36	+0.32
	F	–0.12	–	–0.14	+0.13	+0.56	+0.35	+0.33
AMC	M	–0.24	–0.27	–0.17	–	+0.51	+0.28	+0.25
	F	–0.14	–	–0.15	–	+0.44	+0.16	+0.16
T	M	–	–	–	+0.16	+0.22	+0.24	+0.21
	F	–	–	–	–	+0.43	+0.40	+0.37
S	M	–	–	–	+0.17	+0.31	+0.28	+0.26
	F	–	–	–	+0.13	+0.46	+0.37	+0.35
T+S	M	–	–	–	+0.17	+0.37	+0.27	+0.24
	F	–	–	–	+0.12	+0.47	+0.40	+0.38

r — is presented with significance $p<0.01$

during pubertal years, when the level of HDL-C begins to be lower in boys than in girls [14]. TC, LDL-C and HDL-C had no significant correlation with skinfolds. At the same time serum TG had positive correlations to skinfolds, weight and BMI, similarly with the Finnish Multicentre Study [15]. TG are the biochemical markers that express the amount of body fatness. As together with rising serum TG levels antiatherogenic HDL-C level drops, it is evident that overweightness and rising fat amount play an important role in forming biochemical atherogenic changes at the pubertal age [14]. The frequency (percent of the subjects) of elevated serum TC (≥5.5 mmol/l) and TG (≥1.1 mmol/l) levels and lowered HDL-C (≤1.1 mmol/l) level were compared in two groups of different BMI percentile values: in the group of BMI lower than 25th percentile and in higher than 75th percentile. It was considerable that hypertriglyceridemia occurred in children with higher BMI twice as often as with lower BMI (13.9 and 6.5% in the age group 10–11). Hypo-HDL-cholesterolemia was found 1.5 times more often in the subjects with higher BMI values (10.7% of younger and 18.3% of older age groups) than with lower BMI values (7.4% and 11.9%, correspondingly).

Blood pressure age-dependent increase was positively correlated to all physical variables in both sexes. The highest significant correlations were found to weight. The correlations between the mentioned variables in boys from Moscow, Novosibirsk, and Tallinn were practically the same. The stepwise discrimating analysis indicated that elevated BP predictors in Tallinn boys were high plasma lipids (both TC and TG) and high BMI [16].

In conclusion, there exist age, sex and ethnic differences in anthropometric measurements that have an impact on blood lipids and blood pressure of schoolchildren. Growth velocity at pubertal age is higher in boys than in girls.

In girls sexual maturation lowers TC, HDL-C and LDL-C, but concentrations of antiatherogenic HDL-C still remains higher than in boys. High blood lipids (TC, TG) and high BMI predict elevated BP in boys. That means, adolescence would be the most important age for anthropometrical screening of children in connection with potential cardiovascular risk (especially of boys).

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STERNUM IN FORENSIC ANTHROPOLOGY. PART 1. SEX DETERMINATION

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ABSTRACT

To determine the metric parameters of the sternum factor and to elaborate a reliable method for sex determination, we carried out roentgenosteometric studies of 204 male and female sterna, the owners of which had died when they were 20–84 years old without any signs of endocrine or osteoarticular pathology. The isolated sterna were roentgenographed using a contact way. Each roentgenogram was measured (six dimensions). After measuring mathematical methods were used (correlation and regression analysis, cluster and factor analysis). The elaborated computer program (STAT procedure) permits us to determine sex using automatically programmed calculating operations, which reduces the time spent for osteologic examination and guarantees stable, reliable and objective conclusions.
Key words: forensic anthropology, determination of sex, sexual differences, sternum

INTRODUCTION

While examining disfigured corpses and their bone remnants, one faces the problem of determining a group of features characterising the dead person. Differences in the sizes of manubrium sterni [1, 2, 3] and the ratio of the sternum body length to the manubrium length [4] are known as sternum sex markers.

MATERIAL AND METHODS

To determine the metric parameters of the sternum factor and to elaborate a reliable method for establishing the sex of the person not only on the basis of the whole but also of a partially preserved sternum, we carried out roentgenosteometric studies of 204 male and female sterna, the owners of which had died at the age of 20–84 years with no signs of endocrine or osteoarticular pathology. After the removal of soft tissues, the isolated sterna were roentgenographed using a contact way according to the generally accepted procedure. Each roentgenogram was measured using contact millimetre matrices and metal rulers fixed on the negatoscope screen perpendicularly to each other. The program of measurements included:

- reduced sternum length, cm (X1) — the distance from the lowest point along the edge of the jugular notch (a) to the lowest point on the sternum body (b) (taking into account the back edge);
- manubrium sterni length, cm (X2) — the distance from point (a) to the transverse line connecting the lowest points on the manubrium sterni symphyseal surface (c);
- sternum body length, cm (X3) — the distance from the lowest point on the sternum body symphyseal surface (d) to the transverse line connecting point;
- maximum width of manubrium sterni, cm (X4) — the distance between the furthest points of the clavicular notch front edge (e);
- sternum body maximum width, cm (X5) — the distance between the most distant points located on the lateral surfaces of the sternum body (f);
- minimum width of manubrium sterni (X6) — the distance between points (c).

On the basis of absolute roentgenosteometric parameters, the following indices (X7–X17) were calculated:

- sternum width-length index (X7) — the ratio of sternum body maximum width (X5) to reduced sternum length (X1);
- sternum body width-length index (X8) — the ratio of sternum body maximum width (X5) to sternum body length (X3);
- manubrium sterni length index (X9) — the ratio of manubrium length (X2) to reduced sternum length (X1);
- sternum body length index (X10) — the ratio of sternum body length (X3) to reduced sternum length (X1);
- 1st manubrium sterni width-length index (X11) — the ratio of manubrium sterni maximum width (X4) to manubrium length (X5);
- 2nd manubrium sterni width-length index (X12) — the ratio of manubrium sterni maximum width (X4) to reduced sternum length (X1);

- body–manubrium length index (X13) — the ratio of sternum body length (X3) to manubrium length (X2)
- manubrium–body length index (X14) — the ratio of manubrium length (X2) to sternum body length (X3);
- 3rd manubrium sterni width-length index (X15) — the ratio of manubrium sterni minimum width (X6) to reduced sternum length (X1) multiplied by 100;
- 4th manubrium sterni width-length index (X16) — the ratio of manubrium sterni minimum width (X6) to manubrium sterni length (X2) multiplied by 100;
- manubrium sterni width index (X17) — the ratio of manubrium sterni minimum width (X6) to manubrium sterni maximum width (X4) multiplied by 100.

The connection between a person's roentgenosteometric parameters and sex was determined by correlation and regression analysis on an IBM-486 computer using standard programs in BASIC and FOXPRO-2.0 languages; the volume of the programs did not exceed 1 Mbite. The collected statistical material was checked for aggregate homogeneity and correspondence to the normal distribution law. Cluster analysis was made to find the relationship of sex with the sternum roentgenosteometric parameters (ROMP) as well as to set up a basis for an expert-research system. This system would enable us to reconstruct the whole sternum from its fragments by factor analysis and to find factors determining the changeability of the ROMP set investigated. To determine sex, we compiled a STAT computer program operating in three regimes; 1) determining sex by the whole sternum; 2) determining sex by manubrium sterni; 3) determining sex by the sternum body.

RESULTS AND DISCUSSION

Mathematical analysis of 17 ROMP of the sternum (Table 1) revealed a statistically stable sex dimorphism only for a small number of the features studied. Thus, statistically highly reliable differences ($P<0.001$) were established for the reduced sternum length (X1), the 4th manubrium sterni width-length index (X16) and the manubrium sterni width index (X17). The differences were sufficiently reliable ($P<0.01$) for the sternum body length (X3) and the 3rd manubrium sterni width-length index (X15), and poorly reliable (P<0.05) for the manubrium sterni length.

Table 1

Statistical characteristics of the sternum roentgenosteometric parameters (ROMP), M*m

ROMP	Females (n=84)	Males (n=120)	P
X1	14.26 * 0.22	15.71 * 0.67	<0.001
X2	5.06 * 0.42	5.40 * 0.56	<0.05
X3	9.22 * 0.28	10.59 * 0,35	<0.01
X4	5.27 * 0.68	5.75 * 0.91	>0.05
X5	3.35 * 0.48	3.52 * 0.63	>0.05
X6	1.83 * 0.95	2.01 * 0.53	>0.05
X7	0.25 * 0.05	0.22 * 0.03	>0.05
X8	0.38 * 0.08	0.33 * 0.06	>0.05
X9	0.36 * 0.04	0.35 * 0.04	>0.05
X10	0.66 * 0.04	0.67 * 0.03	>0.05
X11	1.05 * 0.14	1.07 * 0.20	>0.05
X12	0.37 * 0.07	0.37 * 0.06	>0.05
X13	1.89 * 0.34	2.30 * 0.30	>0.05
X14	0.54 * 0.08	0.44 * 0.09	>0.05
X15	14.64 * 0.77	12.69 * 0.32	<0.01
X16	40.38 * 0.76	37.28 * 0.40	<0.001
X17	37.91 * 0.27	35.47 * 0.49	<0.001

Correlative analysis of roentgenosteometric parameters revealed a sufficiently polymorphic connection. Thus, a strong correlative connection (r>0.7) was established for 15.55% of male and 22.05% of female features. For 47.79% of male and 39.72% of female roentgenosteometric parameters interpersonal correlative connection was practically absent (r<0.3).

Cluster analysis of all the 17 roentgenosteometric parameters of the sternum showed that parameters X2, X5 and X11 are closely connected with the group of 20–24-year-old females (included into one cluster). Parameters X1, X3, X4, X7, X10, X12, X17 are poorly connected with that group. The group of 45–54-year-old females is closely connected (included into one cluster) with parameters X4, X11, X12; moderately connected with X1, X2, X3, X7, X8, X9, X13, X14, X17; poorly connected with X16. The group of 55–74-year-old females turned out to be in one cluster (moderately connected) with the 1st manubrium sterni width-length index (X11) and the manubrium sterni width index (X17), and poorly connected with X4, X6, X12, X15, X16.

In the male sample X1, X2, X6, X7, X8 turned out to be moderately connected with the group of 20–44-year-olds; X1, X2, X3, X7, X8, X10, X12, X14 with the 45–59-year-olds and X6, X7, X8, X15, X16, X17 with the 60–74 year-olds.

An analysis of the factor decision enables us to identify the first factor as the sex factor (F1). The most loaded on it are the groups differentiated by the sternum reduced length (X1) and the sternum body length (X3).

The data of correlation matrices confirmed that sex results could not be satisfactorily divided according to ROMP values. Therefore, to determine to which sex the objects belonged, a STAT computer program was compiled which permitted sex identification according to a combination of certain linear measures with sex index calculation (IC).

The criterion for sex determination (Table 2) is the correspondence of the sex index to a certain diagnostic value: if IC is less than 122.41 for the reduced sternum, or less than 122.61 for manubrium sterni, or less than 61.83 for the sternum body, the sternum or its fragment should belong to a male. If IC exceeds the above values, it should be considered to belong to a female. The sex index both in the female and in the male sample is in good correspondence with the hypothesis of the normality of their general aggregates with the corresponding selected average and standard deviations.

Table 2

Sex indices in the male and female selection sets (M*s)

Object	Sex index			
	Males		Females	
Reduced sternum	115.16	0.81	133.54	1.25
Manubrium sterni	119.65	*0.20	125.22	0.17
Sternum body	48.06	*1.58	77.74	1.83

To assess the possibilities of practical application of the method to determine the sex of an unknown person, we tested the basic material using the STAT procedure. As a result, for the male aggregate, the correctly identified sex was 89.66% according to the ROMP of the reduced sternum (without the xyphoid processus), 77.80 according to the ROMP of manubrium sterni and 81.19% according to the ROMP of the sternum body. In the male aggregate the percentage of sex identification was 95.19%, 93.33% and 72.96%. The verification of the sex of the base material sterna by the STAT procedure yielded in some cases wrong results, especially when sternum parts were investigated. Therefore the ROMP characterising an reduced sternum are restored using an expert-investigation subprogram by means of linear combination of values X2, X5, X8 or X6, X11, X16, X17.

In the expert material investigation the person's sex was correctly identified while taking into account the ROMP of the reduced sternum (without the xyphoid processus) and the manubrium sterni in 99.9% of cases, using the ROMP of the sternum body — in 80.0%.

The elaborated computer program (STAT procedure) permits to identify sex using automatically programmed calculating operations, reduces the time spent for osteologic examination, guarantees stable, reliable and objective conclusions.

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STERNUM IN FORENSIC ANTHROPOLOGY. PART 2. AGE DETERMINATION

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ABSTRACT

To determine the age-related changes in sternum roentgenosteometric parameters (ROMP) during the period after the skeleton has been completely formed, we studied the corpse sterna of 204 persons who had died at the age of 20–84 years without signs of systemic diseases or osteoarticular pathology. Their multivariate statistical analysis resulted in the compilation of the computer program VIK working in three regimes; 1) age determination (AD) by the ROMP of an incomplete sternum; 2) AD by the ROMP of manubrium sterni; 3) AD by the ROMP of the sternum body. To assess the possibilities of applying the elaborated technique to determine the age using the VIK procedure, we tested the findings of the experimental material. A positive result was obtained in 50% of cases when taking into account the ROMP of an incomplete sternum, in 83.3% according to manubrium sterni and in 33.3% when applying the values of the sternum body ROMP.

MATERIAL AND METHODS

To determine the age-related changes in sternum roentgenosteometric parameters (ROMP) during the period after the skeleton has been completely formed, we studied the corpse sterna of 204 persons who had died at the age of 20–84 years without signs of systemic diseases or osteoarticular pathology. The material was divided into six sex-age groups: 20–44-year-old females (gr. 1), 45–54-year-old females (gr. 2), 55–74-year-old females (gr. 3), 20–44-year-old males (gr. 4), 45–59-year-old males (gr. 5) and 60–74-year-old males (gr. 6).

Soft tissues were peeled from the isolated sterna and roentgenographed using a contact method according to the conventional technique. Each roentgenogram was measured using contact millimetre matrices and metal rulers fixed on the negatoscope screen perpendicularly to each other.

PROGRAM OF MEASUREMENTS

- reduced sternum length, cm (X1) — the distance from the lowest point along the edge of the jugular notch (a) to the lowest point on the sternum body (b) (taking into account the back edge);
- manubrium sterni length, cm (X2) — the distance from point (a) to the transverse line connecting the lowest points on the manubrium sterni symphyseal surface (c);
- sternum body length, cm (X3) — the distance from the lowest point on the sternum body symphyseal surface (d) to the transverse line connecting point;
- maximum width of manubrium sterni, cm (X4) — the distance between the furthest points of the clavicular notch front edge (e);
- sternum body maximum width, cm (X5) — the distance between the most distant points located on the lateral surfaces of the sternum body (f);
- minimum width of manubrium sterni (X6) — the distance between points.

On the basis of the absolute roentgenosteometric parameters we calculated values X7–X14 and indices X15–X17 (see the first report).

The obtained statistical material underwent correlative-regressive, cluster and factor analysis on an IBM-486 computer using standard programs in BASIC and FOXPRO-2.0 languages, and specially created subprograms; the programs' volume did not exceed 1 Mbite.

RESULTS AND DISCUSSION

In the female sample (Table 1) highly reliable differences ($P<0.001$) were established between groups 1–2 in values X3, X10, X12, X13; between groups 2–3 in X1, X3, X10, X12, X13, X14; between groups 1–3 in X16, X17. Sufficiently reliable differences were established between groups 1–2 in values X1, X4, X6, X8, X9, X14, X15, X16, X17; between groups 2–3 in X9 and between groups 1–3 in X%, X&, X11, X15.

Table 1

Age changeability of the sternum roentgenosteometric parameters (ROMP) and indices in the female selection (M*m*s)

ROMP	Age groups (years)								
	1 (20–44)			2 (45–54)			3 (55–74)		
X1	13.75*	0.47	1.33	14.99*	0.24	0.76	14.04*	0.19	*1.12
X2	5.08*	0.12	0.35	4.90*	0.17	0.53	5.19*	0.05	*0.29
X3	8.85*	0.46	1.29	10.44*	0.23	0.73	9.16*	0.19	*1.14
X4	5.69*	0.28	0.79	4.89*	0.16	0.50	5.22*	0.07	*0.40
X5	3.61*	0.13	0.34	3.54*	0.12	0.39	3.27*	0.10	*0.59
X6	2.80*	0.43	1.20	1.65*	0.13	0.42	1.69*	0.09	*0.52
X7	0.20*	0.02	0.04	0.26*	0.02	0.05	0.23*	0.01	0.04
X8	0.42*	0.03	0.09	0.35*	0.02	0.06	0.36*	0.01	0.07
X9	0.37*	0.01	0.04	0.33*	0.01	0.05	0.37*	0.01	0.03
X10	0.64*	0.01	0.04	0.70*	0.01	0.02	0.65*	0.01	0.03
X11	1.22*	0.04	0.12	1.01	0.06	0.19	1.01	0.01	0.08
X12	0.42	0.03	0.08	0.33*	0.01	0.03	0.37	0.01	0.04
X13	1.75	0.10	0.27	2.16*	0.11	0.34	1.77	0.04	0.23
X14	0.58	0.03	0.09	0.47*	0.02	0.07	0.57	0.01	0.07
X15	20.97*	0.56	1.08	10.97*	0.76	2.42	11.98	0.50	*1.02
X16	54.26*	0.46	1.10	34.31*	0.29	1.41	32.58	0.59	*1.55
X17	47.41*	0.39	1.39	33.96*	0.45	1.75	32.36	0.49	*1.95

The analysis of sternum statistical characteristics X1–X17 in the male sample (Table 2) showed that sufficiently reliable differences were established between groups 5–6 in values X2, X5, X7, X8 and between groups 4–6 in X11; poorly reliable differences ($P<0.05$) between groups 4–6 in X4 and between groups 4–5 in X5.

Correlation analysis revealed insufficient connection of sternum ROMP with age. In male sample, a middle correlation connection ($r=0.3$–0.7) was established between age and X4, X11; in the female sample — between age and X4, X5, X6, X7, X8, X11, X12, X15, X16, X17. In the total sample (males + females) an analogous connection was established between age and X1, X2, X3, X7, X8, X15, X16.

We compiled regressive equations according to age groups: for 20–44-year-old females — PP-1, for 45–54-year-old females — PP-2, for 55–74-year-old females — PP-3, for 20–44-year-old males — PP-4; for 45–59-year-old males — PP-5, for 60–74-year-old males — PP-6.

Table 2

Age changeability of the sternum roentgenosteometric parameters (ROMP) and indices in the male selection (M*m*s)

ROMP	Age groups (years)								
	4 (20–44)			5 (45–59)			6 (60–74)		
X1	16.03	0.48	0.93	15.14	0.32	1.28	15.95	0.28	1.34
X2	5.33	*0.12	0.56	5.24	0.10	0.40	5.63	0.13	0.62
X3	10.85	0.36	0.61	10.26	0.29	1.16	10.67	0.24	1.17
X4	6.11	*0.21	0.93	5.55	0.23	0.91	5.59	0.16	0.76
X5	3.57	*0.15	0.69	3.18	0.11	0.45	3.75	0.12	0.60
X6	2.13	0.13	0.59	1.91	0.13	0.52	1.93	0.09	0.44
X5	3.57	*0.15	0.69	3.18	0.11	0.45	3.75	0.12	0.60
X6	2.13	0.13	0.59	1.91	0.13	0.52	1.93	0.09	0.44
X7	0.22	0.01	0.04	0.21	0.01	0.03	0.23	0.01	0.03
X8	0.33	0.01	0.06	0.31	0.01	0.05	0.35	0.01	0.03
X9	0.34	0.01	0.05	0.35	0.01	0.05	0.35	0.01	0.03
X10	0.68	0.01	0.04	0.68	0.01	0.03	0.67	0.01	0.03
X11	1.15	0.05	0.22	1.06	0.05	0.19	1.00	0.03	0.16
X12	0.38	0.02	0.07	0.37	0.02	0.06	0.35	0.01	0.05
X13	2.06	0.09	0.40	1.98	0.08	0.34	1.91	0.05	0.25
X14	0.50	0.02	0.09	0.52	0.02	0.09	0.53	0.01	0.07
X15	13.33	0.77	3.44	12.61	0.81	3.24	12.12	0.55	1.65
X16	40.38	0.63	1.77	36.79	0.90	1.61	34.66	0.79	1.60
X17	35.53	0.33	1.44	35.93	0.95	1.80	34.95	0.95	1.80

PP1=94.02–2.41×X1×X5+2.45×X1×X2–2.58×X4×X6–1.77×X3×X4.
PP2=34.44×X4–18.51×X4×X4–41.34×X5×X5+23.52×X4×X5+17.77×X3×X6+103.60+13.06×X3×X5+24.00×X5×X6+11.14×X1×X4–5.33×X1×X3–79.95×X6×X6.
PP-3=–131.53+27.45×X6×X6+16.03×X1×X6+61.86×X6–2.59×X3×X4+5.69×X4×X5–20.35×X5×X6–7.89×X3×X6+52.47×X2.

The maximum deviation of the experimental findings from the calculated ones does not exceed 2.80% (PP-1), 4.16% (PP-2), 2.90% (PP-3).

PP-4=–0.70×X1×X2+1.04×X2×X6–3.09×X5×X5–1.57×X2×X4+3.57×X2×X3–4.41×X4×X5+6.68×X1×X5–0.65×X1×X1+1.92×X4×X4–4.15×X3×X5–3.45×X2×X5.
PP-5=6.12×X1+25.77×X5×X6+1.06×X2×X6–1.73×X3–21.20×X6×X6–1.12×X2×X2–23.16×X5.
PP-6=571.75+4.06×X2+4.44×X3×X3–92.86×X3–1.97×X1×X5+3.94×X5×X5+2.24×X5×X6.

The maximum deviation of the experimental findings from the calculated ones does not exceed 1.59% (PP-4), 1.01% (PP-5), 0.80% (PP-6).

By cluster analysis data, in females of the 1st group the following signs are moderately connected with age: X2, X5, X11. In females of the 2nd group signs X4, X11, X12 are closely connected with age and signs X1, X2, X3, X7, X8, X9, X13, X14, X17 are moderately connected with age. In the 3rd group a moderate influence of the age factor is noticeable in two signs (X11, X17).

In the male sample, a moderate influence of the age factor is expressed in X1, X2, X6, X7, X8 (the 4th group); X1, X2, X3, X7, X8, X10, X13, X14 (the 5th group) and X6, X7, X8, X15, X16, X17 (the 6th group).

As to the load strength on the age factor, one can distinguish the groups whose representatives differ in manubrium sterni minimum width (X6), the 4th manubrium sterni width-length index (X16) and the manubrium sterni width index (X17).

The carried-out multivariate statistical analysis resulted in the compilation of the computer program VIK which operates in three regimes:

1. age determination by the ROMP of an incomplete sternum;
2. age determination by the ROMP of manubrium sterni;
3. age determination by the ROMP of the sternum body.

Each regime had two subregimes — with taking into account the sex factor and without it.

To assess the possibilities of applying the elaborated technique to determine the age using the VIK procedure, we tested the findings of the experimental material. A positive result was obtained in 50% of cases when taking into account the ROMP of an incomplete sternum, in 83.3% according to manubrium sterni and in 33.3% when applying the values of the sternum body ROMP.

Thus, an adequately applied complex of mathematical techniques of analysis and the compiled VIK computer program simplify the investigation procedure and widen the prospects of forensic anthropology, including the forensic medical examination of body remnants and their fragments.

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GLUCOCORTICOID RESPONSES TO CONTINUOUS OR INTERRUPTED MAXIMAL EXERCISE

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ABSTRACT

The aim of the study was to compare cortisol responses in a maximal continuous and a maximal intermittent exercise. 7 physical education students (age 20–23 years) performed: (1) a maximal continuous 6-min exercise with a subsequent 1-min low-intensity exercise (50% VO_2max), (2) 6 one-min bouts of maximal exercise separated by 10-s low-intensity exercise, (3) a submaximal exercise at 75% VO_2max lasting 20 min. Before and after exercise saliva was collected periodically. In 4 persons blood samples were obtained before and 1 and 30 min after exercise. Cortisol was determined with the aid of a radioimmuno-assay. Cortisol in saliva was highly variable and no clear responses to exercise were observed. Blood cortisol responses were similar in both sets of maximal exercises and more pronounced them in submaximal exercise.
Key words: blood cortisol, continuous exercise, intermittent exercise, Saliva cortisol

INTRODUCTION

Rises of serum cortisol concentration take place after short-lasting exercises of maximal intensity, as well long-lasting ones of moderate or low intensity [1]. Some attention was paid to adrenal activity during repeated submaximal exercise [2], and short-lasting post-exercise recovery [3]. In order to evaluation of glucocorticoid status over a longer post-exercise period, salivary cortisol measurement is very usefull due to non-invasive stress-free sampling [4, 5].

The aim of the study was to compare glucocorticoid responses to a maximal continuous and a maximal intermittent exercises, the work outputs being the same.

MATERIAL AND METHODS

Seven physical education students aged 20 to 23 years volunteered to participate in the study and gave their informed consent. They were subjected to the following exercises:

1. A maximal, continuous exercise lasting 6 min with a subsequent one minute of low-intensity exercise (50% VO_2max).
2. A maximal, intermittent exercise consisting of 6 one-minute bouts separated by 10s periods of low-intensity exercise (50% VO_2max).
3. A submaximal exercise at 75% VO_2max lasting 20 min. The total work output in all 3 exercises was identical for each person.

All exercises were performed after a light breakfast, between 10 a.m. and 1 p.m. Saliva was collected from all subjects, sampling times being 10 and 3 min before starting the exercise and 1, 15, 30, 45 and 60 min after the exercise was terminated. Four subjects consented to taking blood samples by fingertip puncture at time points –3, 1 and 30 min.

A week before the main experiment the VO_2max was determined with the aid of an incremental exercise on the bicycle ergometer.

The data were analysed by using 3-way ANOVA and Student's t-test for dependent data. The level of $p<0.05$ was considered significant.

RESULTS

The VO_2max varied from 47.4 to 71.8 $ml \cdot min^{-1} \cdot kg^{-1}$ (mean±SD 61.1±9.6) and power output at VO_2max from 220 to 320 W(mean±SD 289±38 W).

The results of cortisol determinations in saliva and serum are presented in Figs. 1 and 2 and the results of the analysis of variance in Table 1. The concentrations of cortisol in saliva were highly variable and no clear responses to exercise were observed. Serum cortisol responses were better pronounced and revealed no difference between the two maximal exercises. The post-exercise response (3 min) in those two exercises was significantly higher from that in the submaximal exercise. The results obtained by 3-way ANOVA for salivary and serum cortisol were nearly the same — in both fluids significant effects of time and exercise type were demonstrated as well as a high between-subject variability and all interactions (subjects x time, subjects x exercise and time x exercise), the F values for serum and saliva being alike.

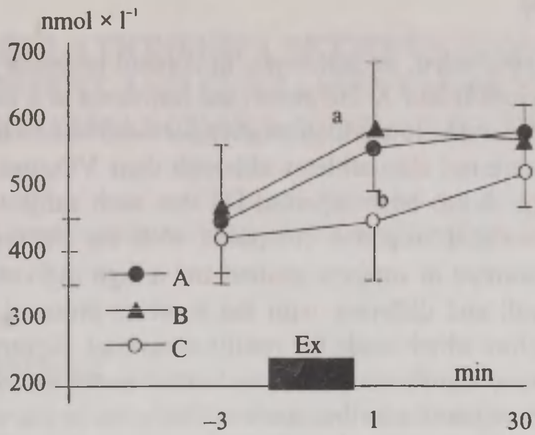

Figure 1. Mean changes in serum cortisol levels in response to 3 different exercises (n=4): A — Continuous maximal 6 min-exercise + 1 min at 50% VO_2max; B — Intermittent maximal 6×1 min-exercise separated by 10-s intermissions; C — Continuous submaximal 20 min-exercise at 75% VO_2max; Ex — Exercise; a — Significantly different from the respective pre-exercise value; b — Significantly different from the respective value in Exercise C ($p<0.05$)

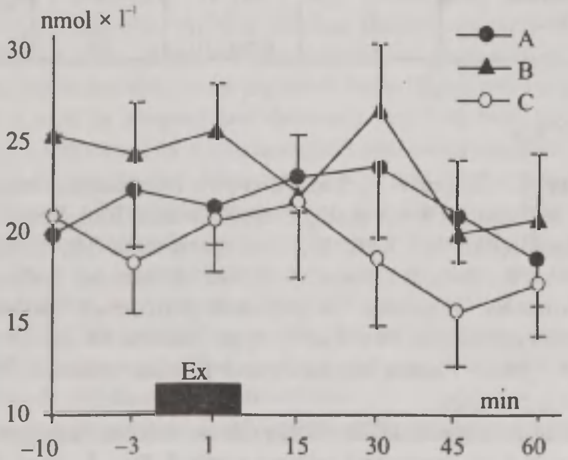

Figure 2. Mean changes in salivary cortisol responses to 3 different exercises (n=7) For explanations of symbols see Fig. 1.

DISCUSSION

Contrary to expectation, no difference in cortisol response was found between exercises B and A. However, the responses to a maximal exercise were, generally, low which might have been due to the fact that the subjects were not elite athletes although their VO_2max was comparatively high. It has been reported [1] that such subjects exhibit a lower adrenocortical response compared with the intensely trained ones. Small number of subjects studied and a high individual varibility, both overall and differing with the exercise protocol (Table 1), were other factors which made the results equivocal. Nevertheless, the exercises differed significantly from each other as shown by ANOVA. Thus, the issue requires a further study.

Table 1

Three-way ANOVA for cortisol values in saliva (n=7) and serum (n=4) of subjects performing 3 different exercise tests

Variance	Saliva		Serum	
	d.f.	F	d.f.	F
Total	146		35	
Subjects	6	70.3***	3	72.2***
Time points	6	5.37**	2	23.0***
Exercise protocol	2	23.5***	2	11.1***
Subjects x Time	36	2.16**	6	2.26
Subjects x Exercise	12	10.7***	6	11.8***
Exercise x Time	12	1.92*	4	1.95
Residual	72	(s^2=11.0)	24	(s^2=17.79)

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THE RELATIONSHIPS BETWEEN SOMATIC DEVELOPMENT AND FUNDAMENTAL MOTOR SKILL PERFORMANCE IN 6-YEAR-OLD CHILDREN

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ABSTRACT

The aim of the present investigation was to study the relationships between anthropometry and basic motor skills development in 6-year-old kindergarten children. In total 294 children (161 boys and 133 girls) from Tartu, Estonia were studied. Three series of anthropometrical measurements were taken according to the O-scale physique assessment system. In total eight skinfolds, 10 girths and two breadths were measured. Three trials of sprint running, overarm throwing and standing long jump were recorded with the help of PANASONIC videocamera. The qualitative evaluation of running, throwing and jumping performance were done by visual observation of the videotypes. Scores for each trial could range from one to four corresponding to stages 1 through 4. Our boys were significantly ($p < 0.05$) taller and heavier than girls. All the skinfold thicknesses were thicker in girls. Only the waist girths were significantly higher in boys. The humerus and femur breadths were higher in boys. There were significantly better results in jumping and throwing stages in boys. Correlations between anthropometric and kinematic parameters indicated that running stage in girls negatively correlated with mid-thigh ($r=-0.26$) and medial calf ($r=-0.19$) skinfold thicknesses. The higher skinfold thicknesses in most used anatomicalpoints influenced negatively the jumping stage in girls. The correlation between throwing stage and triceps skinfold thicknesses was negative ($r=-0.21$) and with chest girths positive ($r=0.22$). Our conclusion was that the relationships between anthropometrical parameters and running, jumping and throwing skills in 6-year-old children was relatively low.

Key words: somatic development, skills, kindergarten children

INTRODUCTION

Several growth grids were prepared and used for the evaluation of the growth level in children [1, 2, 3]. Frequently only the height, body mass and body mass index (BMI) were used [1, 4]. However, we need more information about the anthropometry of the children. For this it is recommended to measure the skinfold thickness, girths and breadths from different anatomical points as a rule. The highly standardized O-scale physique assessment system was presented in the last years [5].

The running, jumping and throwing are the fundamental motor skills in children. Skills were measured in quantitative terms, with little concern to the relative proficiency accomplishing the specific tasks in a progression [6, 7]. However, the identification of qualitative differences in movement patterns provide a more detailed means of assessing of developmental status of skills [8]. Frequently for characterizing of the motor skills development was used the videotyping [9].

The aim of the present investigation was to study the relationships between anthropometry and basic motor skills development in 6-year-old kindergarten children.

MATERIAL AND METHODS

In total 294 6-year-old healthy kindergarten children from Tartu, Estonia were studied (161 boys and 133 girls). The parents of the children gave permission for the testing. The children participated in 2 lessons of physical education a week. The lessons were supervised by a teacher of physical education. Age was expressed in months, height (Martin anthropometer) in cm (±0.1 cm), and body mass (medical balance scale) in kg (±0.05 kg). The BMI (kg/m^2) was calculated.

Three series of anthropometrical measurements were taken by a trained anthropometrist according to the O-scale physique assessment system [5]. The CENTURION KIT instrumentation was used (ROSS-CRAFT, SURREY, BC, CANADA). In total, eight skinfolds, 10 girths and two breadths were measured.

Three trials of sprint running, overarm throwing and standing long jump were recorded with the help of PANASONIC videocamera located to the left of the child. In the recording each child was first videotyped while standing on the running course holding a motor stick which served like a linear scale. The camera objective was placed perpendicular with the running, throwing or jumping direction. The distance between the camera and the child was 20 m. The child's task was to run, throw or jump as far as possible. The qualitative evaluation of running, throwing and jumping performance was done by visual observation of the videotapes. Three specialists of motor development served like observers. Everybody had the previous training containing the evaluation of total body development sequences to assess the fundamental motor skills [6]. Observers rated individually the videos. Scores for every trial could range from one to four corresponding to stages one to four i.e. immature to mature movement patterns, respectively.

Standard statistical methods were used to calculate mean, standard deviation (±SD) and zero order correlations. Statistical significance was set at $p<0.05$.

RESULTS

The physical characteristics of the subjects are presented in Table 1. The boys were significantly ($p<0.05$) taller and heavier than girls. All the skinfold thicknesses were thicker in girls. Only the waist girth was significantly higher in boys. The humerus and femur breadths were higher in boys.

Table 1

Anthropometrical parameters of kindergarten children (X±SD)

	Boys (n=161)	Girls (n=133)	p
Age (months)	75.3±9.7	75.4±4.4	NS
Height (cm)	121.0±5.8	119.6±5.3	<0.05
Weight (kg)	22.1±3.0	21.4±2.9	<0.05
BMI (kg/m^2)	15.1±1.6	15.0±1.4	NS
Skinfolds (mm)			
Triceps	7.9±1.7	8.9±2.1	<0.001
Subscapular	4.7±1.2	5.2±1.3	<0.001
Biceps	4.1±1.5	4.7±1.4	<0.001
Suprailiac	4.2±2.0	5.0±2.0	<0.001
Supraspinale	3.8±1.3	5.0±1.8	<0.001
Abdominal	5.4±2.5	6.7±3.7	<0.001
Mid-thigh	10.4±3.6	12.7±4.1	<0.001
Medial calf	8.4±2.9	10.1±3.2	<0.001
Girth (cm)			
Relaxed arm	17.8±1.5	17.8±1.5	NS
Flexed arm	19.1±1.8	19.0±1.5	NS
Forearm	17.5±1.6	17.2±1.7	NS

Continue

	Boys (n=161)	Girls (n=133)	p
Wrist	13.3±1.2	13.1±1.2	NS
Chest	58.1±6.6	57.1±3.5	NS
Waist	54.5±4.0	53.2±3.8	<0.01
Gluteal	61.7±4.7	62.0±4.8	NS
Thigh	33.7±4.5	34.3±3.8	NS
Calf	24.4±1.8	24.5±2.2	NS
Ankle	17.6±1.6	17.4±1.7	NS
Breadths (cm)			
Humerus	3.9±0.7	3.7±0.7	<0.05
Femur	6.2±0.8	5.9±0.7	<0.01

NS — not significant

Table 2 summarizes the kinematic parameters of running, throwing and jumping. There were significantly better results in jumping and throwing stage in boys.

Table 2

Descriptive statistics of the motor skill performance (X±SD)

	Boys (n=161)	Girls (n=133)	p
Running stage	3.1±0.7	3.0±0.6	NS
Jumping stage	2.6±0.8	2.3±0.7	<0.01
Throwing stage	2.8±0.9	2.1±0.7	<0.001

Correlations between anthropometric and kinematic parameters are presented in Table 3. The running stage was not depending of the girths' and breadths' parameters. The mid-thigh and medical calf skinfold thickness influenced negatively the running stage in girls. The higher skinfold thickness in most used anatomical points influenced negatively jumping stage in girls. The correlation between throwing stage and triceps skinfold thickness was negative (r=–0.21) and between throwing stage and chest girth positive (r=0.22).

DISCUSSION

Our children were taller and had the similar body weight like the same age children in Prague. BMI was lower and most of the skinfold thicknesses were thicker in our children [3]. The stages of running, jumping and throwing were relatively high if compared with our previous studies in older children [9]. The high development of basic motor skills we can explane with circumstances that all of our children participated regularly in the compulsory physical education lessons. The taught frequently different running, jumping and throwing games.

Table 3

Zero-order correlation coefficients between anthropo-metrical parameters and motor skill performance (the girls results in brackets)

	Running stage	Jumping stage	Throwing stage
Age	0.41 (0.23)	0.30 (NS)	0.39 (NS)
Height	NS (NS)	NS (NS)	NS (NS)
Weight	NS (NS)	NS (NS)	NS (NS)
BMI	NS (NS)	NS (NS)	NS (NS)
Skinfolds			
Triceps	NS (NS)	NS (–0.35)	NS (–0.21)
Subscapular	NS (NS)	NS (NS)	NS (NS)
Biceps	NS (NS)	NS (–0.23)	NS (NS)
Suprailiac	NS (NS)	NS (–0.22)	NS (NS)
Supraspinale	NS (NS)	NS (–0.21)	NS (NS)
Abdominal	NS (NS)	NS (NS)	NS (NS)
Mid-thigh	NS (–0.26)	NS (–0.23)	NS (NS)
Medial calf	NS (–0.19)	NS (–0.20)	NS (NS)
Girth			
Relaxed arm	NS (NS)	NS (NS)	NS (NS)
Flexed arm	NS (NS)	NS (NS)	0.17 (NS)
Forearm	NS (NS)	NS (NS)	NS (NS)
Wrist	NS (NS)	NS (NS)	0.17 (NS)
Chest	NS (NS)	NS (NS)	NS (0.22)
Waist	NS (NS)	NS (NS)	0.17 (NS)
Gluteal	NS (NS)	NS (NS)	NS (NS)
Thigh	NS (NS)	NS (NS)	NS (NS)
Calf	NS (NS)	NS (NS)	NS (NS)
Ankle	NS (NS)	NS (NS)	0.18 (NS)
Breadths			
Humerus	NS (NS)	NS (NS)	NS (NS)
Femur	NS (NS)	NS (NS)	NS (NS)

NS — not significant

Information about the relationships between motor skill development and anthropometrical parameters in kindergarten children was not extensive. Our previous laboratory research in one-two year older children indicated that the throwing stage was not correlated significantly with body height, body mass and sum of skinfolds [9]. Other researches also indicated that the influence of biological variables to motor skills development in prepubertal years seemed to be relatively low [10]. We need more systematical studies of relationships between anthropometrical parameters and motor skills [11].

We conclude that the relationships between anthropometrical parameters and running, jumping and throwing skills in 6-year-old kindergarten children is relatively low.

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CHANGES IN THE NUMBER OF POSITIVELY STAINED PARIETAL AND CHIEF CELLS IN RAT'S GASTRIC FUNDIC GLANDS IN THE FIRST MONTHS AFTER TRUNCAL VAGOTOMY

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ABSTRACT

Changes in the number of parietal and chief cells in 80 white male Wistar rats on the 6th, 14th, 25th, 42nd and 70th day after truncal vagotomy with pyloroplasty was investigated. The cells were counted in a round-shaped unit area (0.039 mm^2) between the middle and the lower third of the gastric fundic glands in haemalaun and Congo red stained paraffin sections. Decrease in the number of parietal cells was observed on the 6th postoperative day already, by the 14th day their number was decreased nearly 50% when compared to the control group. Thereafter the number of parietal cells began to rise gradually reaching nearly up to 90% of the initial figures by the 70th postoperative day, the difference from the control group remaining still statistically significant. The number of chief cells was found to be increased temporarily in the early postvagotomy period, but not in the later period. It is concluded that the decrease in parietal cell mass brings along a drop in gastric acid production in the first postoperative days and weeks. The cause for decreased acid production in the late post-vagotomy period lies probably in the functional immaturity of the parietal cells deprived of the vagal innervation. The cause for the temporary increase in chief cell number remains still unclear. Probably cessation of parasympathetic innervation affects parietal cells more than chief cells, so that in the early postvagotomy period their relative number increases. In the later period as the function of parietal cells gradually regains more or less its previous features the number of positively stained chief cells decreases to its usual level.
Key words: vagotomy (truncal), parietal cells, chief cells, cell count.

INTRODUCTION

Both, truncal vagotomy (TV) and proximal selective vagotomy (PSV) decrease gastric basal- and maximal acid output by 65–90% and 40–

75% respectively [1, 2, 3, 4, 5], the figures depending mainly on the time elapsed from the operation, not on the type of vagotomy. The decrease in acid production plays a crucial role in the healing process of duodenal ulcers, yet the exact mechanism of this drop in acid production after vagotomy remains still unclear. In principle, it could be due to the decrease in parietal cell number or function, or both. In this experimental study we have investigated the effect of truncal vagotomy on rat's fundic glands parietal cells up to 10 weeks after the operation. This investigation was also greatly prompted by the fact that the data concerning the fate of parietal cells after cessation of parasympathetic innervation is quite contrary — vagotomy (both TV and PSV) has been found to decrease [3, 6, 7, 8], increase [9, 10] or to have no effect on parietal cell number in rat's gastric fundic glands [2, 4, 11, 12, 13]. In parallel we have also investigated the influence of TV and pyloroplasty on chief cells in gastric fundic glands as the data concerning these cells is surprisingly very limited.

MATERIAL AND METHODS

80 adult white male Wistar rats initially weighing 180–240 g were used in this study. The animals were kept under normal laboratory conditions with free access to water and to a standard pellet diet and according to the treatment they were divided into 7 groups. 15 animals in group 1 served as normal controls, on 9 animals in group 2 only pyloroplasty (after Heinecke-Mickulicz) was performed. The remaining 56 rats, fasted overnight, but allowed free access to water were vagotomized under light aether anaesthesia by cutting anterior and posterior n. vagus truncs about 0.5 cm proximal to cardia. To avoid gastric evacuatory disorders after vagotomy all the operations were completed with pyloroplasty. The animals in group 2 were sacrificed on the 14th postoperative day and vagotomized animals respectively on Day 6, 14, 25, 42 and 70 after vagotomy, thus forming groups from third to seventh (the exact number of animals in each group is brought in Figure 1). After sacrifice the stomach was opened along the great curvature and a 0.5 × 0.5 cm full-thickness specimen was taken from the corpus part of the stomach about 1–1.5 cm aborally from the border-line of the forestomach. The specimens were fixed in 10% neutral formalin and embedded in paraffin. The paraffin sections were stained with haemalaun, rinsed in running water, and for 5 minutes with

Congo red (3 ml of 1% solution per 100 ml distilled water). This original method was first presented by Stintzing [14], staining parietal cells reddish-brown and chief cells blue, so that the cells were easily distinguishable from each other and from the other cells of gastric fundic glands. The number of parietal and chief cells was counted in 10 round-shaped areas (0.039 mm^2) in the ocular field on each histological slide between the middle and the lower third of the fundic glands under light microscopy (magnification 10 × 40). The slides were analyzed and the cells counted randomly and "blindly".

Mann-Whitney test for nonparametric data was used to determine the statistical significance of all the observed differences between means, and $p<0.05$ value was regarded as statistically significant.

RESULTS

The results are presented in Figure 1.

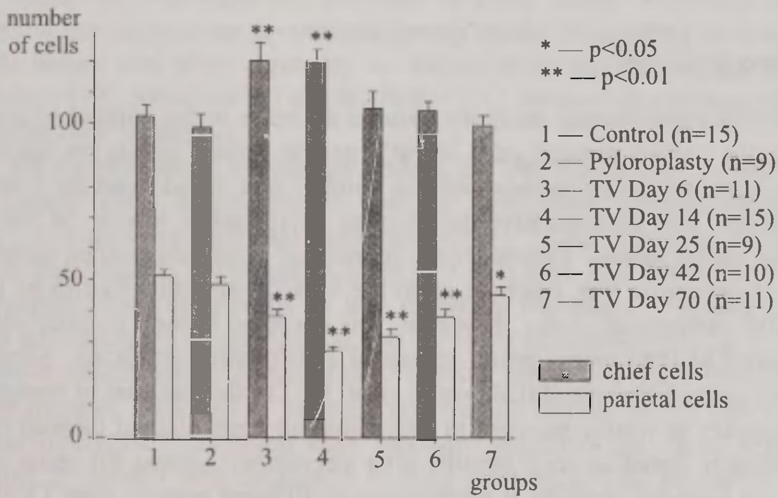

Figure 1. Changes in the number of Congo red stained parietal and chief cells in rat's gastric fundic glands after TV+PP or PP alone. All the data represent mean ± double SEM.

Truncal vagotomy caused a statistically significant decrease in the number of parietal cells in all groups. Reduced number of parietal cells was observed on the 6th postoperative day already, by the 14th postoperative day their number per 0.039 mm^2 unit area was decreased by nearly 50% when compared to the corresponding figures of the control group. Thereafter was observed a gradual increase in the number of positively stained parietal cells, their number reaching nearly up to 90% of the initial figures by the 70th postvagotomy day (the longest period studied). However, this difference in parietal cell number between the latter and control group still proved to be statistically significant ($p<0.05$).

In the first two weeks after TV with pyloroplasty (e.g. on the 6th and 14th day) the number of positively stained chief cells was found to be increased in gastric fundic glands by 17.5% when compared to the control group ($p<0.01$). From the 25th postvagotomy day up to the end of the experiment (70 days) we could not find statistically significant difference in the chief cell number compared to the control group.

Pyloroplasty alone did not cause statistically significant changes in the number of positively stained parietal- and chief cells in rat's gastric fundic glands.

DISCUSSION

In this experimental study we found a decrease in the number of positively stained parietal cells in rat's gastric fundic glands on the 6th postoperative day already and this number was found to be the lowest on the 14th postoperative day, having decreased as low as 54.3% of the initial figures. Thereafter the number of positively stained parietal cells began to rise, reaching up to the 90% of the initial figures by the 70th postoperative day. However, this decrease in their number compared to the control group remained statistically significant. Similar results has also presented Argov *et al.* [15] in the material of mongrel puppies in whom decrease in haematoxylin-eosin stained parietal cell number lasted up to 4 months after vagotomy. Amano [6] using human material obtained at gastroscopy at different periods after TV+PP found that the number of parietal cells stained with haematoxylin-eosin was decreased up to 3 weeks after the operation. Our results are also in good accordance with those presented by Nakamura [16], who has found a decreased number of positively stained parietal cells in rat's fundic glands as early as on the third postvagotomy day, and Baibekov *et al.* [17] according to whom such a decrease lasted for at least 80 days. In the opinion of these authors the drop in acid production after vagotomy can be attributed (at least partly) to the reduced parietal cell mass.

On the other hand many authors have not found changes in the number of stained parietal cells in fundic glands after vagotomy in spite of profound and stable decrease in acid production [2, 4, 11, 13] or have even found increase in parietal cell number after vagotomy [10, 18, 19]. According to Helander [19] the parietal cells become significantly smaller after vagotomy and this brings along a decrease in acid production, though their absolute number was higher than before vagotomy. Äärimaa has also found that in duodenal ulcer patients the relative number of "secretory" parietal cells is much higher than in controls. After vagotomy their number decreases and "resting-state" parietal cells constitute the biggest fraction of parietal cells. At the same time the total number of parietal cells remained unchanged [1].

The explanation for such wide difference in the results of different authors remains unclear. In Helander's opinion [20] only data obtained with the help of stereological method is reliable in such field of investigation. Nevertheless, different authors using stereological method have also come to contradictionary results in counting parietal cells before and after vagotomy — Helander himself has found an increase [19], Mitschke [8] and Baibekov [21] decrease in parietal cell number after vagotomy.

All the previously mentioned authors use the expression "number of parietal cells" synonymously with the expression "positive staining". It is quite unlikely that the actual number of parietal cells could be so significantly decreased as early as 3 or 6 days after cessation of parasympathetic innervation as was found by Nakamura [16] and in this investigation. In our opinion this decrease in stained parietal cell number reflects more change in their staining properties rather than in their number. Decrease in parietal cell function caused by the loss of parasympathetic innervation after vagotomy results in decreased acid output in parallel with decreased staining properties. This hypothesis is confirmed by the fact that a dramatic drop in acid production in rats with gastric fistula is seen 15 minutes after vagotomy already [22]. This period of time is by far too short for developing morphologic changes in the cellular level of parietal cells and this decrease in acid production is probably caused by the direct loss of vagal stimulus to the parietal cells.

Analyzing the time related changes in stained parietal cell number after vagotomy in this and other available studies it occurs that the greatest decrease in the staining properties of the denervated parietal cells is usually found in the first weeks (in animals) and months (in humans) and this finding is in correlation with the findings of gastric secretion studies. Then is usually observed a slight, but gradual increase in the acid production, the figures still remaining on an significantly lower level than before the operation [1, 4, 5]. This gradual increase in acid production seems to be in correlation with the improvement of the staining properties of the parietal cells, observed in this study. Thus, the parietal cells deprived of the parasympathetic innervation in a later period after vagotomy gradually regain their staining- and partly acid secreting properties. In our opinion this could be mainly attributed to the humoral stimuli due to the trophic effect of gastrin on gastric mucosae cells as vagotomy abolishes the vagally mediated inhibition of the gastrin cells in the antral part of the stomach, resulting in gastrin cell hyperplasia and fasting hypergastrinemia [23, 24, 25, 26]. Reinnervation of the gastric mucosa with regenerating vagal branches, another probable cause for an increase in parietal cell function [9], is very unlikely to happen in the first months after truncal vagotomy

One could also speculate that only "pure" vagotomy without draining procedure (SPV) is acceptable in studying the effect of parasympathetic denervation on parietal cells as the regurgitation of duodenal contents, which results from the destruction of pyloric function after pyloroplasty, could also alter gastric mucosal morphology. However, there are no discernible differencies in results of TV and PSV when comparing the data about the number of stained parietal cells, moreover, in this work we did not observe statistically significant difference in the number of positively stained parietal cells of the control group and animals who underwent only pyloroplasty.

There is quite few data about the influence of vagotomy on chief cells in gastric fundic glands. Baibekov [17] has found an increase in the number of positively stained chief cells in case of experimental duodenal ulcers in rats, after vagotomy their number decreased. Decrease in the number of chief cells in the interval from 2 weeks till 4 years is also reported in one human study and this was accompanied with the reduction of the intracellular structures of the chief cells at an electron microscopical level [27].

In this study we found a temporary increase in the number of positively stained chief cells in rat's gastric fundic glands which lasted only for 2 weeks. Thereafter the number of chief cells began to decrease, so that from the 25th up to the 70th postvagotomy day (the longest period studied) we could not find significant changes in the chief cell number when compared to the control group. The cause for this temporary increase in chief cell number remains still unclear. Probably cessation of parasympathetic innervation affects immature regenerating parietal cells more than immature chief cells so that in the acute postvagotomy period the relative number of chief cells increases. In the later period as the function of parietal cells gradually regains more or less its previous features the number of chief cells decreases to it's usual level. The fact that an increase in the number of positively stained chief cells falls into the period when the number of positively stained parietal cells is the lowest (i.e. 1–2 weeks after vagotomy) supports this theory.

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GROWTH AND BIOLOGICAL MATURATION IN YOUNG ATHLETES: WITH SPECIAL CONSIDERATION TO SPORTS DISCIPLINE AND COMPETITIVE LEVEL

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ABSTRACT

It is well established that young athletes of both sexes successful in specific sport, are quite different from their peers nonathletes and from peers successful in another specific kind of sport. Possible causes of this obvious difference in body size, biological maturation characteristics, body composition, functional level, physical performance, etc. has been under debate through years.

The aim of the present study was to obtain some additional knowledge focused on the problems of growth and development of children involved in elite sports.

Retrospective data analysis of growth and maturation in 985 elite young athletes (swimmers, gymnasts, basketball players and some others) of both sexes aged 11–18 (Russian National Team members and Russia Championships winners in their age groups) through the time period of 1970–1995 yrs has been made. Body size and maturity status were determined.

The majority of data obtained in our study showed, that obvious difference in physique and biological maturation between young athletes and nonathletes, and the difference between young athletes related to specific sport and competitive level, took place mainly due to sports selection processes, based on specific criteria. In many sport disciplines some delay in biological maturation seem to accompany success in competitive adult sports.

It is well established that young athletes of both sexes successful in specific sport, are quite different from their peers nonathletes and from peers successful in another specific kind of sport [1–3]. Possible causes of this obvious difference in body size, biological maturation characteristics, body composition, functional level, physical performance, etc. has been under debate through years. The main point of the discussion is the role of sport selection process and whether there is any influence of regular training (in connection to competitive sport

participation) on growth and biological maturation processes in young athletes or not? If there is some effect, than what kind of physical activity pattern could produce it.

Objective data analysis gives no satisfying answer to these questions as experimental investigation in this field face a lot of methodological difficulties. The data obtained in the former SU focused on the problems of growth and development of children, involved in elite sports could provide some additional knowledge for the speculations on this item.

Key words: body size, biological maturation, young athlete, competitive sports

MATERIALS AND METHODS

Retrospective data analysis of growth and maturation in 985 elite young athletes of both sexes aged 11–18 (Russian National Team members and Russia Championships winners in their age groups) through the time period of 1970–1995 yrs has been made. Cross-sectional and longitudinal data on physical growth and biological maturation in young swimmers, basketball players, sport gymnasts etc. has been presented. Control groups were comprised of untrained Moscow school children of respectively the same chronological ages as in young athletes under study. The amount of subjects in each age group (control group) was not less than 25.

Body size [4] and biological age [5, 6] were determined.

Means and standard deviations were calculated for all variables. Student's t-test was used to determine if significance was present between variables in young athletes of different sports disciplines and untrained controls. Statistical significance was defined as $p<0.05$.

RESULTS

Total body size in young swimmers was significantly larger than average in non-athletes of the same chronological age in all age groups under study (Table 1).

Young swimmers of both sexes of early and middle adolescent ages were 1 yr (1.0 ± 0.6) advanced in maturity, while in late adolescence male swimmers tended to be 1 yr (1.1 ± 0.66) delayed in maturity.

Table 1

Body size in young male swimmers and nonathletes of the same chronological age

Chronological age, yr		Body height, cm	Body weight, kg	Chest circumference, cm
10	Sw	146.1±4.5*	35.5±4.1*	70.6±3.3*
	N	137.0±6.0	33.3±3.8	67.0±2.9
11	Sw	150.8±5.4*	39.1±4.7	73.9±2.9*
	N	142.3±5.1	37.0±3.3	70.0±3.2
12	Sw	156.2±4.8	43.0±5.6*	77.4±4.2**
	N	147.1±6.4	40.0±3.9	71.3±3.6
13	Sw	164.2±6.0*	50.2±4.1**	82.4±3.1**
	N	153.1±5.5	45.1±4.2	75.0±4.1
14	Sw	171.9±5.2*	58.7±4.4**	88.1±3.4**
	N	161.0±5.3	51.0±3.6	78.8±4.0
15	Sw	177.4±4.8**	65.2±4.8**	92.7±3.6**
	N	167.0±5.2	56.9±5.1	82.0±4.4
16	Sw	180.8±4.8*	70.7±4.4*	95.8±3.9**
	N	173.0±5.1	62.0±5.0	84.8±5.1

Values are means ±SE. Sw — swimmers; N — nonathletes of the same age. Significantly different from nonathletes *$p<0.05$; **$p<0.01$

Age related differences in maturity status was observed in elite young female swimmers: the amount of early maturing individuals decreased from 60 to 23%, while the amount of late maturiers increased significantly ($p<0.01$) from 0 to 43% in the sample of 16–18 yr old athletes in comparison to the sample of 13 yr old swimmers.

Retrospective study of maturation processes in elite swimmers (National Team of Russia) showed that swimmers with more high competitive level (international level winners) had slightly later maturation (0.5–1.0 yr) through all period of observation — from 10 till 16 years old, than their peers that were the winners inside Russia in their age groups in adolescence.

Young male and female gymnasts were shown to be sufficiently smaller in their body size if compared to nonathletes of the same chronological age in all age groups from 10 to 17 yrs (Table 2, 3). Body weight in gymnasts was highly related to body height ($r=0.82$) and was significantly ($p<0.01$) smaller than in untrained controles.

Those athletes, selected to continue gymnastics training for their success to perform motor task, were usually smaller in their body size (Table 3). It was shown, that the difference in total body size revealed in early adolescence, was present in 18–19 year old gymnasts.

Table 2

Total body size in young female gymnasts and nonathletes of the same chronological age

Chronological age, yr		Body height, cm	Body weight, kg	Chest circumference, cm
10	Gym	133.7±3.3**	27.3±2.3**	63.5±1.3*
	N	139.1±6.1	34.4±2.0	68.0±2.0
11	Gym	137.6±3.8**	29.1±2.1**	65.7±2.7*
	N	144.4±4.3	36.9±2.8	69.0±3.3
12	Gym	143.5±4.0*	32.9±2.5**	68.7±2.5
	N	151.4±5.2	41.0±3.4	72.5±3.8
13	Gym	148.7±2.3**	37.6±2.3**	76.2±1.9
	N	155.8±4.4	46.5±2.9	75.5±5.7
14	Gym	154.5±2.2*	43.3±2.5**	78.1±3.4
	N	158.8±5.1	51.2±4.0	78.4±6.0
15	Gym	155.7±2.4*	46.6±2.0*	80.7±4.0
	N	159.8±3.9	52.8±4.2	79.8±6.2

Values are means ±SE. Gym — female gymnasts; N — female nonathletes. Significantly different from nonathletes *p<0.05; **p<0.01.

Table 3

Somatic growth level in young male gymnasts and success in sports gymnastics

Chronological age, yr		Level of somatic growth			Body height, cm	Body weight, kg
		R%	N%	A%		
11	S	75	25	–	134.6±2.2*	29.5±2.1*
	Un	30	60	10	138.0±3.1	32.4±2.3
13	S	55	45	–	145.0±3.3*	36.2±2.2
	Un	35	60	5	148.4±2.9	38.9±2.0

Values are means ±SE. Successful (S) — means to be selected for further training. Unsuccessful (Un) — means not to be selected for further training (eliminated from sports gymnastics). Amount of boys (%) with average (normal — N), lower than average (retarded — R) and higher than average (accelerated — A) body size. *Significantly different from unsuccessful group p<0.05.

In all age groups young gymnasts of both sexes appeared to be extremely late in maturity. 3-year delay in biological maturation is average value for the sample of the National Team members. In the samples of 18–20 year old male and 16–18 year old female gymnast the delay in biological maturation reached values of 4–5 yrs in comparison to average maturing nonathletes.

The delay in maturity increased in elder groups if compared to younger age groups (Table 4) and appeared to be positively related to competitive level. (Higher competitive level was accompanied by greater delay in sexual maturation).

Table 4

Chronological age and maturity status in elite gymnasts

Chronological age, yrs		Biological age, yrs	Delay, yrs
13–14	n = 4	12.4±0.4	1.1±0.3
15	n = 19	12.8±0.7	2.2±0.6*
16	n = 22	13.1±0.5	3.0±0.3**
17	n = 34	14.5±0.8	2.5±0.5*
18	n = 47	15.0±0.9	3.0±0.4**
19	n = 41	15.1±0.6	4.0±0.6**
21	n = 38	16.2±1.1	4.8±1.0**

Values are means ±SE. Significantly different from control values *p<0.05; **p<0.01.

The majority of data indicate delayed sexual maturation and later ages at menarche in female athletes compared to controls. Age at menarche differ among elite female athletes in relation to sport discipline (Table 5).

Table 5

Age at menarche in female athletes of high competitive level (National Team)

Kind of sports	Age at menarche, yr		
	minimum	average	maximum
Sport Gymnastics	13.5	17.6±1.3**	19.2
Track and Field	12.0	15.1±2.0*	18.0
Figure Skating	12.0	14.5±2.0*	18.5
Swimming	13.0	13.9±0.6*	14.5
Basketball	11.0	13.0±1.1	14.0

Values are means ±SE.
Significance of differences from control value *p<0.05; **p<0.01.

The overview of the data based on assessment of maturation processes in elite young athletes of different sports disciplines (the best in their age groups and Youngster National Team members), and retrospective data on maturity status in adult elite athletes of international competitive level (National Team) presented in Table 6 reflects the difference between two samples: more individuals with later maturation comprise the sample of late adolescent athletes if compared to sample, comprised of early and middle adolescence athletes.

Table 6

Changes in biological maturity in elite young athletes of different age groups (cross-sectional study)

Kind of sports		Biological maturity status	
		in early- and middle-adolescent ages (sample 1)	in the late adolescent ages (sample 2)
Swimming	M	A+N	N+R
	F	A+N	N+R
Basketball	M	A+N	N+R
	F	A+N	N
Gymnastics	M	R	RR
	F	R	RR

A — advanced in maturity (accelerated), N — average maturing (normal), R — late in maturity (retarded), RR — extremely late in maturity (extremely retarded), M — males, F — females.

DISCUSSION

The majority of data obtained in our study as well as in other authors investiga-tions [7] showed, that obvious difference in physique and biological maturation between young athletes and nonathletes, and the difference between young athletes related to specific sport and competitive level, took place mainly due to sports selection processes, based on specific criteria.

In spite of the fact, that selection criteria differ greatly among sport disciplines the tendency in maturation process seemed to be alike: towards the end of adolescence the amount of late maturing individuals (swimming, basketball) or the level of delay in maturation (in gymnastics) was shown to be increased. It looks as if a success in adult sport has been accompanied with later age of biological maturation, while the level of delay in maturation seem to be related to specific sport (Table 5, 6). Maximal rate of delay in biological maturation was observed in gymnastics — 3–5 yrs of delay in maturation in comparison to 0.5–1 yr delay in swimming, both tested at the same chronological age of 16 years old. The degree of delay in biological maturation is related not only to specific sport and age group of young athletes, but also to competitive level. It seems reasonable to propose, that delay in maturation gives some "advantages" to athletes successful in adult sport. These "advantages" manifest when the adolescence approaches its termination [1, 7]. At that time individuals with earlier maturation loose their advantage in body size and muscle strength. In this situation individuals with later maturation, who still continue their functional and somatic growth perform better than early (and average) maturiers.

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ON ANTHROPOLOGICAL RESEARCH AT THE INSTITUTE OF ANATOMY, UNIVERSITY OF TARTU, AT THE TURN OF THE CENTURY

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ABSTRACT

Research work at the Institute of Anatomy of the University of Tartu in anthropology is connected with the name of A. Rauber who has made a remarkable contribution to the development of the science of morphology. By the way, he is the man who has in 1892 founded a Museum of Anatomy which was the first of the kind in the Baltic States.

The students of A. Rauber — R. Weinberg and A.-E. Landau — were studying the anatomy of brain and ethnic peculiarities of the surface od brain. So was R. Werinberg, under the supervision of professor Rauber, studying the surface and skulls of the Estonians. In his dissertation, which he defended in 1894, has R. Weinberg described specific characteristics of the surface of brain peculiar to the Estonians, foremost the abundant fragmentation of parallel convolutions and peculiar build of the grooves of orbital lobe. Although the aim of the research work was to describe the surface of brain of one nationality, has R. Weinberg marked in his conclusions that the described characteristics specific to the Estonians regardless of their abundant occurrence. There have also been taken photos in three projections of the examined preparations. R. Weinberg was also organising the anthropometric studies of Estonian school children.

The other student of professor A.Rauber — A.-E. Landau — was also dealing with the surface of brain, although he was mainly concerned with microanatomy. Thus, his dissertation was dedicated to the anatomy, physiology and pathology of suprarenal gland. Nevertheless, several of his works are dealing with the surface of brain, including works about the variants of orbital grooves where he was comparing the surface of orbital lobe of different nationalities. Likewise, there is an article written by him about the anthropology of the Livonians which is of foremost interest due to its detailed description of methodology. Photography has been used there, too, side by side with measuring and description.

The preserved collection of photographic materials has added interesting facts in the research work of the history of anthropology at the University of Tartu and is inspiring the continuation of the corresponding research work also today.
Key words: surface relief of the brain, ethnic differences, anthropometry, photography

INTRODUCTION

During the second half of the 19th century morphological sciences, including anthropology developed rapidly in Europe. Methods of research were perfected and plentiful factual data were gathered. By the turn of the century the basis branches of anthropology had been established.

The same process also occurred at the University of Tartu, where anthropological research was conducted at the Department of Anatomy under the supervision of Prof. August Rauber.

The present article is dealing with the research work in anthropology carried out at the University of Tartu at the turn of the century and which was now reviewed on the basis of a unique collection of photo plates.

MATERIAL AND METHODS

The review presented in the article is based upon a rare collection of photonegatives that have been preserved in the Institute of Anatomy for more than 100 years. It contains materials used for several anthropological studies, in total more than 700 photo plates. As there is no verbal information enclosed with the negatives we have established the authors and time of completion using archive materials and literature.

RESULTS AND DISCUSSION

Prof. A. Rauber was Head of the Department of Anatomy from 1886–1911. His scientific heritage includes papers on osteology, the nervous system (including the relief of the frontal lobe), experimental embryology, anthropology and philosophy [1]. In 1892 a museum of human anatomy was founded at the Department of Anatomy, which was also replenished with anthropological exhibits. The impact of the museum on medical sciences was invaluable, and, following its example, similar museums were later established at the deparments of anatomy at the universities of Riga and Kaunas (Prof. U. Zilinskas). A. Rauber emphasised the need for complex investigation of the human body build on the basis of natural material, with strong emphasis on anthropological studies. In 1901 A. Rauber attempted to establish a department of anthropology. This, however, was not founded because Prof. Polyakov said, "There is no such department at our (Tartu) university or any Russian university." [2] Nevertheless, A. Rauber had two pupils in the area of anthropology — R. Weinberg and A.-E. Landau, who worked as *Privatdozents* at the Department of Anatomy.

Richard Weinberg was active at the Institute of Anatomy from 1901 as prosector's assistant and from 1903 as *Privatdozent*. Nearly all his research papers deal with the anatomy and anthropology of the brain. [3] In 1894 he defended his dissertation supervised by Prof. A. Rauber *Die Gehirnwindungen bei den Esten. Eine anatomisch-anthropologische Studie.* Using the materials obtained by dissertation, he described the surface relief of the brains of 18 Estonians, calculating the length-width index of the skull and measuring the skull's volume. He found that the variability of convolutions of these brains corresponded to that of mesocephalic skulls with a slight tendency to brachycephaly; one characteristic feature was, for example, the large number of bridges — transverse connections between the longitudinal gyri. To a certain extent, this conclusion was confirmed by craniometric parameters, where the value of the length-width index of Estonian skulls was 77.4–77.6 [4]. After describing the brain convolutions in greater detail, R. Weinberg also noted certain specific features, for example,

1) frequent fragmentation of parallel gyri into 2–4 parts and a slight widening of the upper temporal lobe;

2) continual and complete separation of the arched *gyrus praesylvius* [5] from the distal regions of the orbital part of the frontal lobe; etc. [4]

R. Weinberg was rather cautious in describing ethnic characteristics in the structure of the brain gyri. He even noted in his conclusions that, "the present investigation is in no way essential for studying ethnic differences, as the conditions for proving their existence are completely absent. Still, the original aim of the research was to describe and visualise the brain's sulci and gyri within one nation. Therefore, we should pay attention to the mentioned and relatively often occurring features as characteristic of the Estonians." [4]

R. Weinberg also wrote another paper which was published in Berlin in 1903 — *Die anthropologische Stellung der Esten.* There he, along with studies of the peculiarities of the brain, discusses in greater detail the origin, ethnography, physical anthropology, social statistics and psychology of the Estonians. [6] The paper also includes photographs of the preparations studied (Fig. 1–3). A comparison with the negatives preserved at the Institute of Anatomy refers to their connection (the impression is reinforced by the note on one of the boxes of photo plates: "Dr. Weinbergs Gehirne").

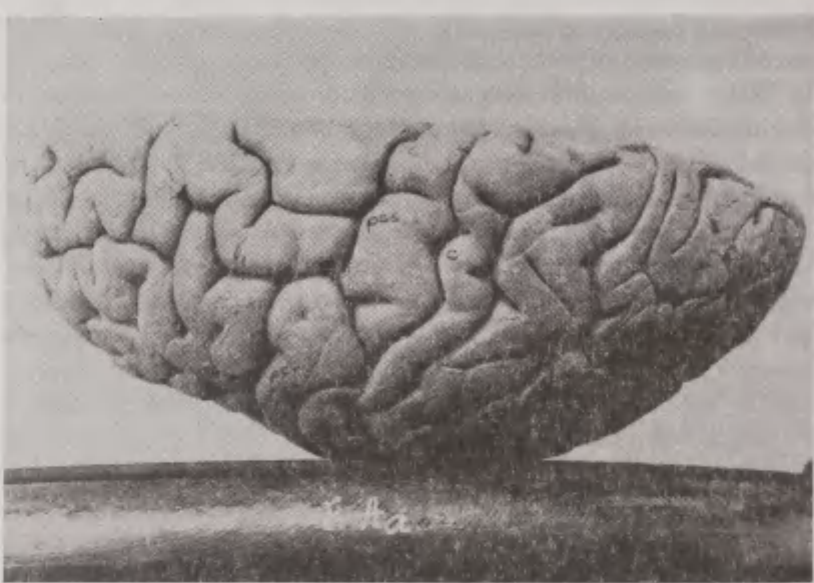

Figure 1. The superolateral surface of the left hemisphere of the brain:
Fissura centralis (sulcus centralis — c) surrounds the expanded geniculate gyri in both the lower and the upper third. Sulcus praecentralis (pc) is in most cases split into two parts — sulcus praecentralis superior (pcs) and sulcus praecentralis (pci). Gyrus frontalis superior is divided on its upper surface into many parts, sulcus frontalis superior (fl) is fragmented. There are plenty of short transverse sulci that are connected with longitudinal frontal sulci.

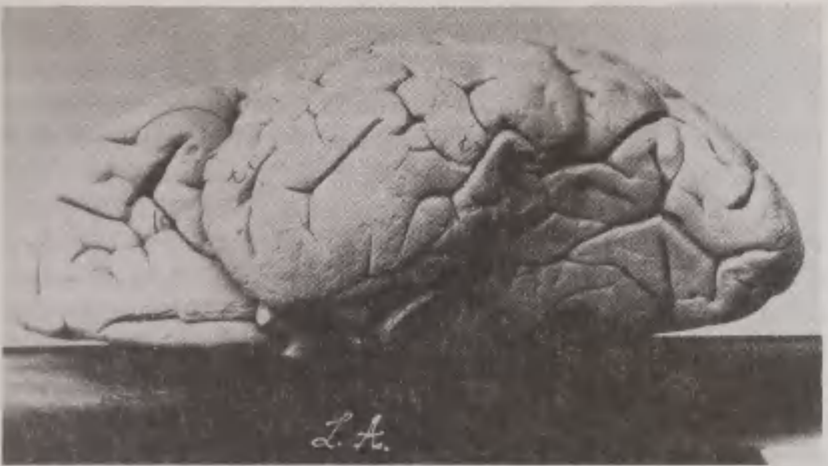

Figure 2. The inferior surface of the left hemisphere of the brain:
Contrary to literature data, where *sulcus temporalis superior* is described as the whole sulcus that reaches over the whole temporal lobe, has R. Weinberg in many cases observed fragmented sulcus *(t1)*, which is divided into 2–4 parts. *Sulcus temporalis inferior (t3)* is fragmented, either. The orbital part of the frontal lobe is characterised by a separate *gyrus praesylvius* from the other orbital gyri because of a transverse orbital sulcus *(f5)*. The surface of the *gyris occipitotemporalis (T4)* is very variable, there are many small gyri and one cannot see big sulci, common to this area.

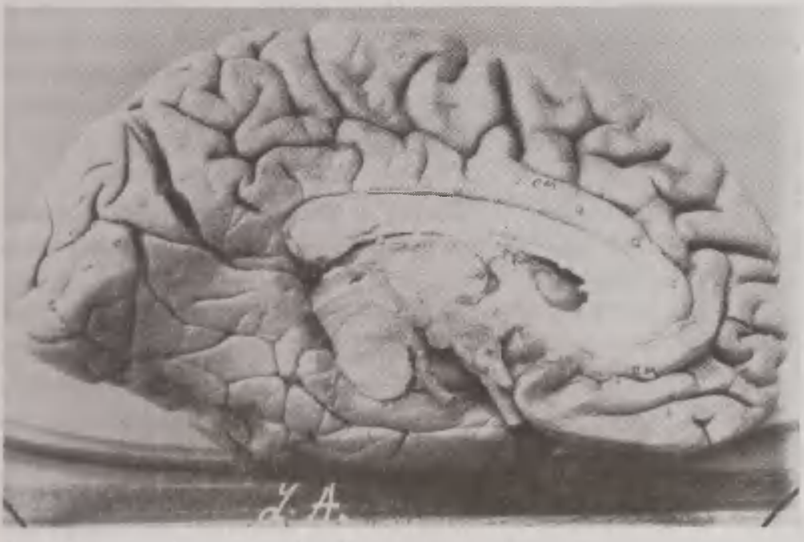

Figure 3. The medial surface of the left hemisphere of the brain:
The structure of *Fissura callosomarginalis (sulcus cinguli — cm)* is described typically, but R.Weinberg has stressed, that this sulcus has parallel parts that proceed from *gyrus fornicatus (gyrus cinguli)* in 2–3 sections.
All marks on photos descend from R.Weinberg.

R.Weinberg did not confine himself to investigating the morphological characteristics of the brain's relief but took a broader interest in physical anthropology of the Estonians. That can be also seen in Weinberg's letter to the pastor V. Reiman of 15 February 1901. It is possible that this letter preceded planning the abovementioned study. In the letter Weinberg states that, "for an anthropological study which would describe the race of the Estonian people, it would be necessary to collect as many observations as possible, primarily about the height and the colour of hair and eyes of Estonian schoolchildren. This task is beyond the powers of one person as the total number of observations should comprise about 1/25 of the whole Estonian people. However, as German and Swiss experience shows, intelligent rural schoolmasters are most capable of collecting the necessary data." And Weinberg expected the pastor's help in informing and supervising the schoolmasters. [7]

In addition to the negatives of brain preparations, the negatives of another anthropological study dating from approximately the same period have been found at the Institute of Anatomy. About 700 men have been studied. They have been photographed against the background of a measuring tape in three projections. Hypothetically, this work also belongs to R. Weinberg, as the negatives have been made at more or less the same time as the others and the person who executed the work indisputably had to be connected with the Department of Anatomy. Moreover, there is a reference from Prof. J. Aul. According him, Weinberg published in 1902–1903 a paper by about the height of men of Tartu county. [8]

Another pupil of Prof. A. Rauber in the area of anthropology was Dr. A.-E. Landau, who worked at the Department of Anatomy from 1906–1909 as prosector's assistant and 1909–1915 as *Privatdozent*, and who has also been listed in the structure of the university as Director of the Museum of Anthropology. A.-E. Landau lectured on methods of anthropological research and on Lamarck's and Darwin's theories as optional courses. [9] Among other publications Landau has also brought out a Russian-language textbook of anthropology.

Dr. Landau defended his dissertation in 1907 under the supervision of Prof. V. A. Afanasyev. It dealt with the anatomy, physiology and pathology of suprarenal glands. A.-E. Landau also studied the peculiarities of the Estonian's brain relief. He has published an article on this theme: "Über die Orbitalfurchen bei den Esten". The research was based on 60 cerebral hemispheres of Estonians who had died of various diseases. First the author described the variants of orbital sulci characteristic of Estonians and then compared them with the variants occurring in Russians, Swedes, Austrians, Latvians, Javanese and anthropoid apes. [10] Thereafter he also published the article "Über die Furchen an der Lateralfläche des Großhirns bei den Esten". [11]

In connection with the photo plates that have reached us, A.-E. Landau's article on the anthropology of Livonians "Ein Beitrag zur Anthropologie der Liven" deserves attention. In the article he dealt briefly with the history of the Livonians and, on the grounds of the impressions of his trip to Livonia, their living conditions. He reached the conclusion that the Livonian nation existed at the given historical moment. To prove this, Landau had made photographs of 30 Livonians, 14 of whom had been anthropologically measured. The author made two photos of each person — full face and in profile (Fig. 4–7), and he mentions the following measuring instruments he used;

1. Topinard's sliding anthropometer or caliper (*Glissière anthropométrique von Topinard)* for the width measurements
2. R. Virchow's tentacular caliper
3. Metal measuring tape with centimetre measure
4. Hartingsch's cephalograph perfected by the author.

The collected data include more than 60 characteristics that were measured and described. On the basis of his investigation Landau concluded that two out of the 14 persons measured had a dolichocephalic shape of the head, the rest were meso- or brachycephalic. He noted that all the Livonians known him (with two expectations) were in good health and had a regular and robust body build. Their body measurements were larger than average. The colour of their hair was mostly light or dark brown, but blonde or slightly reddich hair also occurred. The eyes were small, even very small; the distance between the eyes was wide; the colour of the eyes was mostly grey or brown, less often blue. The subjects had wide oval faces with a wide mandible. The noses were of medium size, straight, with a wide bridge; the lips were usually of medium thickness. Among men baldness could not be noticed. Older women were usually ugly and not attractive; among younger maidens, however, quite nice proportions and physiognomies could be seen. As an appendix to the study, Landau published the description of the cephalograph he had perfected [12]

Figure 4.

Figure 5.

Figure 6.

Figure 7.

A.-E. Landau's publication of Livonian's physical anthropology is an investigation of small capacity which arouses interest primarily because of the research methods used, but it is also extremely important as a proof of continuity of anthropological research at the university of Tartu.

From the beginning of anthropological research in Estonia there has been a certain opposition to these areas of research. Collection of data about the anthropology of Estonians was accompanied by a constant struggle against the anthropologists. For example, all A.-E. Landau's papers were met by destructive criticism by Prof. Polyakov at the meeting of the Faculty Council where Dr. Landau's appointment to *Privatdozent's* post was discussed. Among the rest he said, "I have to note that there is no *history of the Livonians* as such, only a few moments from history which have been borrowed from earlier authors. He (Landau) did not visit the residences of the Livonians, i.e. their villages, but carried out the measurements and took the photographs in a house in the town Ventspils. ... You can imagine what kind of history of the Livonians this study is, if the whole text with the description of the perfected apparatus (cephalograph) and bibliography fit on 45 small-sized manuscript sheets ... [2]

A large part Prof. Polyakov criticism, however, was directed primarily against Prof. Rauber who planned the foundation of the Institute of Anthropology in the rooms of the Department of Histology. [13] Prof. Rauber was also reproached for his German orientation, as can be seen in the following quotation, "I really cannot understand that Prof. Rauber with all his experience and indisputable competence needs the opinion of an assistant of Prof. Waldeyer's to confirm his opinion. Does Prof. Rauber really think that in order to better convince the **Russian** professors a **foreign** opinion, no matter by whom, is necessary, and that they themselves are unable to understand even such simple things." [2]

In conclusions it should be noted that the collection of photo plates mentioned is a unique material from the turn of the century. It includes original data of scientific research, which are of interest nowadays from the viewpoints of both history of science and photography. The photo plates are well preserved and it is possible that they form a singular collection not only in Estonia, but in whole Europe.

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ANTHROPOMETRIC FACTORS AMONG OTHER OBSTETRIC RISK FACTORS

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ABSTRACT

The aim of the study was to measure the effect of mothers' and babies' various anthropometric parameters on deviation from the normal course of pregnancy and labour. For this purpose clinical anthropometric parameters of 532 parturients (primipara) and their newborns, and some additional indices formed from these data were correlated with the sum in points of all individual deviations from the normal course of anamnesis, pregnancy and childbirth as independent risk factors ("birth index" BI). The analysis showed that mothers' and babies' anthropometric data are essential co-factors in the formation of the total risk for mothers' and babies' health. Our investigation has demonstrated that a two-dimensional classification formed from height and parturient's complex body build index (PCBBI) (3×3 SD classes with appropriate statistical data-processing) can form a common methodological basis for using anthropometric characteristics in evaluation of obstetric data. As in the future analogous classifications could be used on obstetric material by different authors, the content of all corresponding classes — the mean values of newborns' birth-weight and the birth index — would also be statistically comparable.
Key words: parturients' anthropometric data; anthropometric classification of parturients and newborns; anthropometric risk factor in obstetrics.

INTRODUCTION

In obstetrics a number of risk factors are known that are classified in different ways. Despite their great variability they are joined by the common aim of prevention, detection and management of situations affecting adversely the health of mothers and babies [1, 2, 3, 4, 5, 6]. In most cases the list of risk factors also includes mothers' and foetus' anthropometric characteristics as risk factors. It is well known, for example, that mother's weight and height are in correlation with the birthweight [5, 7, 8, 9, 10, 11], and maternal age and relation of mother-foetus dimensions are connected with obstetric pathology [11, 12, 13, 14, 15, 16, 17]. Unfortunately, until now we do not have any complex method for measuring the multivariate effect of mothers' and babies' various anthropometric parameters on deviations from the normal course of pregnancy and labour.

Using our previous studies concerning the systematisation of anthropometric parameters of nonpregnant and pregnant women measured at the Department of Obstetrics and Gynecology at the University of Tartu [18, 19, 20, 21, 22, 23], we established such a methodological basis. Our investigations showed that all body measurements of both nonpregnant and pregnant women are statistically sufficiently correlated between each other. The leading characteristics in this system are body height and weight that describe correspondingly about 50% and 45% from the variability of all body measurements of women from both groups. It was proved that no other body measurement can give a reliable description of the general body build of both nonpregnant and pregnant women.

Variations in height-weight relations of the body (different classes in height-weight classification) lead to systemic changes in all anthropometric measurements as well as in body proportions (indices) in the case of both pregnant and nonpregnant women. Therefore, it can be concluded that the clinical anthropometric data of parturients can also be systematised while analysing the risk factors at delivery.

MATERIAL AND METHOD

The study was carried out on 532 primiparous women who were delivered in Tartu Women's Clinic in 1994–1995. They all were delivered of one baby in normal position without perinatal mortality cases. All clinical anthropometric parameters, such as height, weight, wrist circumference, *D. spinarum, D. cristarum, D. trochanterica, Conjugata externa* were taken from parturients. The weight, height, circumferences of the head and the thorax of the baby, and the gestational age were obtained from the newborn's card

To present the mothers' data in an integrated way a new index — the parturient's complex body build index (PCBBI) — was calculated by the following equation:

$$PCBBI = \frac{weight}{height^3} \times \frac{wrist\ c.}{height} \times \frac{D.spin}{height} \times \frac{D.crist}{height} \times \frac{D.troch}{height} \times \frac{Conj.ext}{height} \times 10\,000\,000\,000$$

In addition, some other indices were formed (see Table 1, rows 12, 13 and 15) which described the mother-baby proportions.

For comparative evaluation of the course of pregnancy, labour and the state of health of the newborn of different parturients examined, we systematised the obstetric data in a somewhat different way than usual. We registered all deviations from the normal course of anamnesis, pregnancy and childbirth as independent risk factors. The existence of any kind of obstetric pathology was marked by 1 point, its absence gave 0 points. The mother's age was also considered a risk factor if it was below 18 or over 35 years. The sums of points (deviations) in different areas were registered as values of anamnestic, pregnancy, delivery and newborn's risk indices (AR, PR, DR, NR). Their sum total was taken as common birth index (BI).

The data were processed at the Computing Centre of the University of Tartu using the methods of multivariate statistical analysis. The computations were made by S. Koskel, the consultant was Prof. E.-M. Tiit.

RESULTS

1. Statistical analysis of anthropometric characteristics. The basic clinical anthropometric measurements and the values of several indices of mothers and newborns are presented in Table 1. Correlation analysis of mothers' and babies' body measurements proved our hypotheses about the systemic changes of the values of anthropometric characteristics of both mothers and their newborn babies. Our results showed that

- mother's parameters are in statistically significant relation with one another (r=0.3–0.6);
- the correlation between mother's height and weight is r=0.341;
- mother's external pelvic measurements are dependent on her height (0.184–0.376), weight (0.410–0.666) and also on her wrist circumference (0.306–0.464);
- correlation of mother' external pelvic measurements with the baby's birthweight varies from 0.124 to 0.152;
- newborn's height and weight are highly correlated with each other (r=0.750), and newborn's weight is statistically significantly but weakly correlated with all mother's anthropometric parameters (r=0.124–0.152).

Table 1

Basic statistics of parturients' and newborns' anthropometric variables

No.	Variable	Mean	Min	Max	SD
1	parturient's height (cm)	166.48	150	194	5.96
2	parturient's weight (kg)	73.65	45.5	142	10.92
3	parturient's wrist circumference (cm)	15.61	12	19	0.9
4	parturient's D. spinarum (cm)	24.52	19	31	1.44
5	parturient's D. cristarum (cm)	27.46	22	37	1.64
6	parturient's D.trochanterica (cm)	31.82	21	45	2.03
7	parturient's Conj. externa (cm)	20.57	17	31.5	1.75
8	newborn's weight (g)	3496.22	1472	5302	501.02
9	newborn's height (cm)	49.67	38	56	2.32
10	newborn's head circumference (cm)	34.69	28	51	1.77
11	newborn's breast circumference (cm)	34.04	27	40	1.71
12	$\frac{\text{newborn's weight (kg)} \times 100}{\text{parturient's weight (kg)}}$	4.81	2.14	7.38	0.79
13	$\frac{\text{newborn's weight (kg)}}{(\text{newborn's height(cm)})^2}$	14.12	9.31	24.19	1.42
14	$\frac{\text{parturient's wrist circumference (cm)} \times 100}{\text{Conjugata externa (cm)}}$	75.72	49.21	95	6.22
15	$\frac{(\text{newborn's head circumference (cm)})^2}{\text{Conj. ext} \times 0.5\,(\text{D.crist} + \text{D. troch})}$	1.99	1.07	4.52	0.29
16	parturient's PCBBI	9.224	2.193	27.726	3.73

2. Statistical analysis of risk factors. Table 2 presents all characteristics regarded as risk factors influencing the course of pregnancy, delivery or the newborn's state of health. All risk factors are divided into four subgroups (see Table 2) by their character and summarised in the following way:

- anamnestic risk factors of a parturient (see 1–7 in Table 2); their sum forms the risk factor **AR**;
- pregnancy risk factors (see 8–16 in Table 2); their sum forms the risk factor **PR**;
- delivery risk factors (see 17–32 in Table 2); their sum forms the risk factor **DR**;
- newborn's risk factors (see 33–43 in Table 2); their sum forms the risk factor **NR**.

The sum of all the four characteristics forms the common birth index (**BI**) that was calculated for every mother. According to our data the risk factors varied within the following limits: AR between 0 and 4, PR between 0 and 4, DR between 0 and 6, **NR** between 0 and 9. The integrated birth index **BI** varied between 0 and 14, its mean value being 3.35 (see Table 2).

Table 2

Obstetric risk factors and their frequencies in our material

No.	Risk factor	N	Mean	Frequencies		%	
				0	1	0	1
1	Age (less than 18 or more than 35)	531	0.073	492	39	92.7	7.3
2	Late menarche	531	0.083	487	44	91.7	8.3
3	Disorders of menstrual cycle	531	0.058	500	31	94.2	5.8
4	Infertility prior labour	532	0.024	519	13	97.6	2.4
5	Tumours of female genital tract	532	0.015	524	8	98.5	1.5
6	Number of artificial abortions	532	0.201	425	107	79.9	20.1
7	Number of spontaneous abortions	532	0.096	481	51	90.4	9.6
8	First-half gestosis of pregnancy	532	0.038	512	20	96.2	3.8
9	Pre-eclampsia	532	0.179	437	95	82.1	17.9
10*	Threatened abortion or preterm labour	532	0.071	494	38	92.9	7.1
11	Hypotrophia of foetus	532	0.015	524	8	98.5	1.5
12	Anaemia Hgb <100	532	0.201	425	107	79.9	20.1
13	Cardiovascular pathology	532	0.006	529	3	99.4	0.6
14	Hypertension	532	0.032	515	17	96.8	3.2
15	Pathology of kidneys	532	0.062	499	33	93.8	6.2
16	Acute infection in pregnancy	532	0.071	494	38	92.9	7.1
17	Preterm labour	532	0.066	497	35	93.4	6.6
18	Postmaturity	532	0.034	514	18	96.6	3.4
19	Malpresentation, malposition of fetal head	532	0.038	512	20	96.2	3.8
20	Prolonged duration of labour	532	0.058	501	31	94.2	5.8
21	Dysfunction of uterine contractions	532	0.295	375	157	70.5	29.5
22	Premature rupture of membranes	532	0.143	456	76	85.7	14.3
23	Vaginal operative delivery	532	0.090	484	48	91.0	9.0
24	Cesarean section	532	0.132	462	70	86.8	13.2
25	Placenta praevia	532	0.006	529	3	99.4	0.6
26	Placental abruption	532	0.019	522	10	98.1	1.9
27	Tears of soft tissues	532	0.107	475	57	89.3	10.7
28	Contracted pelvis	532	0.143	456	76	85.7	14.3
29	Disorders of separation of placenta at the III stage of labour	532	0.045	508	24	95.5	4.5
30	Uterine hypotonia	532	0.024	519	13	97.6	2.4
31	Blood loss more than 0.5 % of mother's weight	532	0.154	450	82	84.6	15.4
32	Newborn's weight <2500 g or >4000g	532	0.165	444	88	83.5	16.5
33	Intrauterine fetal hypoxia	532	0.164	445	87	83.6	16.4
34	Newborn's asphyxia at birth (Apgar score 7 or less)	532	0.227	411	121	77.3	22.7
35	Premature newborn	532	0.058	501	31	94.2	5.8
36	Postmaturity of foetus	532	0.039	511	21	96.1	3.9
37	Necessity of intensive care in a special department	532	0.0113	526	6	98.9	1.1
38	Necessity of follow-up treatment after intensive care	532	0.047	507	25	95.3	4.7

Continue

No.	Risk factor	N	Mean	Frequencies		%	
				0	1	0	1
39	Birth trauma	532	0.028	517	15	97.2	2.8
40	Congenital abnormality	532	0.030	516	16	97.0	3.0
41	Disorders of brain blood circulation	532	0.038	512	20	96.2	3.8
42	Disorders of breathing	532	0.320	515	17	96.8	3.2
43	Infections	532	0.008	528	4	99.2	0.8

We used correlation analysis to find the dependencies between 23 most frequent risk factors (the frequencies of the others were too small for making statistical inferences). In 36% cases the dependencies were statistically significant. The weakest correlation (r=–0.087) was between *contracted pelvis* (No. 28 in Table 2) and *premature birth* (No. 35), also between *number of spontaneous abortions* (No. 7) and *premature birth* (No. 35), r=0.094. Most correlations varied between 0.12 and 0.3, the strongest correlation r=0.597 occurred between *intrautrine fetal hypoxia* (No. 33) and *newborn's asphyxia* (No. 34).

3. Interrelations between anthropometric characteristics and obstetric risk factors. Next we correlated mothers' and babies' anthropometric data with risk factors. All statistically significant correlations found are presented in Table 3. As we can see, EPH gestosis and contracted pelvis were most dependent on mother's body dimensions. The most important anthropometric measurement was mother's body height. The negative correlation coefficients in the first row of Table 3 indicate that taller women are somewhat better parturients.

Among babies' measurements the most important ones are body height and weight, and babies' measurements are related with postmaturity, prematurity, hypoxia and asphyxia. Among the indices formed by us for this study the ratio of weights (newborn's weight / parturient's weight × 100) proved to be among the most important ones because it participates in eight risk factors (see Table 3).

Table 3

Statistically significant correlations between parturients' and newborn's anthropometric characteristics and obstetric risk factors

	Birth index	Late menarche	Hypertension	No. s. abortions	Postmaturity	Uterine hypotonia	Disorders of sep. of placenta	Preeclampsia	Anaemia	Premature newborn	Dysfunction of uterine contractions	Cesarean section	Contracted pelvis	Fetal hypoxia	Newborn'sasphyxia	Mother's age
P. height	–0.114											–0.189	–0.3	–0.088	–0.134	
P. weight		–0.09			0.10			0.259	–0.111	–0.098	0.15		–0.31			
P. wrist				–0.12				0.17					–0.25			
D. spin								0.11					–0.35			
D. crist			0.09		0.11			0.141					–0.34			
D. troch					0.09			0.186					–0.33			
Conj. ext								0.191					–0.26			
N. weight	–0.102									–0.429				–0.088	–0.137	–0.1
N. height	–0.113				0.11	0.106				–0.431						–0.09
N. head	–0.089									–0.393					–0.103	
N. breast	–0.088									–0.413						
w. ratio	–0.127		–0.96					–0.44	0.146	–0.299			0.218	–0.099	–0.145	
$Nw/(Nh)^2$							0.116			–0.279			–0.09	–0.121	–0.145	
Wrist/conj. ext				–0.13									0.117			
N. head/pelvis									0.116	–0.241			0.291		–0.099	
CBBI	0.179							0.298			0.12	0.142	–0.15		0.11	

The parturient's complex body build index **PCBBI** is also correlated with 6 important risk factors, such as dysfunctional uterine activity (r=0.124), Cesarean section (r=0.142), contracted pelvis (r=0.152), pre-eclampsia (r=0.298), asphyxia of the newborn (r=0.110), and it has the strongest correlation with the birth index BI. Our investigations demonstrate that this index might be statistically significantly prognosticated by mother's height (row 1 in Table 1) and weight (row 2), and baby's weight (row 8) with the multiple correlation coefficient R=0.216*; see the following equation:

BI = 13.2340 – 0.0646 *height* + 0.0378 *weight* – 0.0006 *newborn's weight*

The role of anthropometric measurements in the formation of particular complications, such as mother's dysfunctional uterine activity and asphyxia of the newborn, is illustrated by Figures 1 and 2.

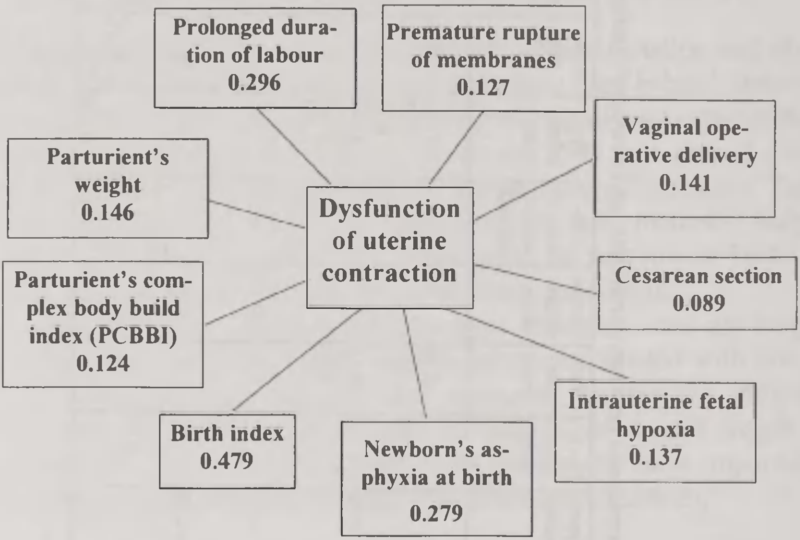

Figure 1. Correlations of dysfunctional uterine activity with anthropometric variables and obstetric risk factors (only statistically significant correlations have been presented).

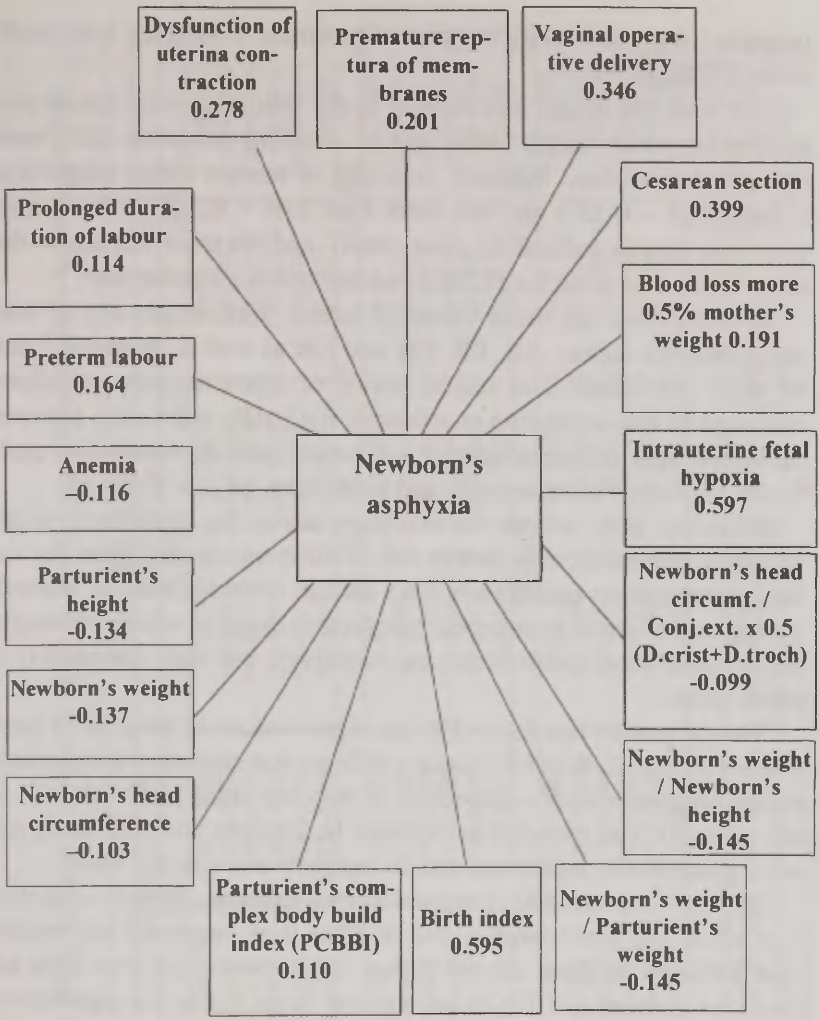

Figure 2. Correlations of newborn's asphyxic with obstetric risk factors and anthropometric characteristics of mothers and newborn (only statistically significant correlation have been presented).

4. Use of mother's body build classification in the investigation of obstetric risk factors.

In order to study and simultaneously compare the role of mothers' and babies' body measurements in the course of pregnancy and labour and also to evaluate newborns' health we used the following methodology. A bivariate classification, consisting of 3×3 classes, was defined for patients, using their body height and parturient's complex body build index (PCBBI).

The scale for height was defined in the following way: for all parturients the mean height (MH) and its standard deviation (SD) were calculated. The class 'Medium' consisted of women whose height was at least MH – 0.5SD and not more than MH + 0.5SD. The women who were shorter formed the class 'Short' and the taller women — the class 'Tall'. The scale for PCBBI was defined in a similar way.

In every class the mean values of babies' birthweight and of four integrated risk factors AR, PR, DR and NR as well as the birth index BI were calculated. The second series of characteristics calculated consisted of the correlation coefficients r(A), r(P), r(D), r(N) between the birthweight and all integrated risk factors, and the correlation coefficient between the birthweight and birth index BI (see Table 4).

From this table we can see that there are no big differences in the values of anamnestic risk factors AR in different classes. From the values of correlation coefficients r(A) we can conclude that, in general, the higher values of anamnestic risk factors cause smaller birthweight (most correlation coefficients are negative), but this connection is rather weak.

The pregnancy risk factor PR has higher values in the case of large women (classes 7, 8 and 9), hence it follows that corpulent women have higher pregnancy risk — especially if they are either short (class 7) or tall (class 9). The correlations between birthweight and pregnancy risk are not statistically significant and do not show any specific trend.

The delivery risk DR is highest in two extreme classes — in class 1 of short and small women and in class 9 of large and tall women (see Table 4). In these classes higher risk is connected with light babies (the correlation r(D) has a negative value but is not significant). The situation is similar in class 2 (slim women of medium height), where high delivery risk is connected with small babies (the value of r(D) is –0.614, being statistically significant). In other classes the correlation between birthweight and delivery index is positive, indicating more complications in the case of large babies.

The newborn's risk factor NF does not depend on mother's size or body build, but in some classes significant negative correlations between this index and babies' birthweight indicate a higher risk for smaller babies (see class 1, where r(N)=–0.676, class 2, where r(N)=–0.278 and class 9, where r(N)=–0.555).

Table 4

Correlations between labour index and newborn's weight in elasses formed by parturient's height and PCBBI

Parturient's Complex Body Build Index PCBBI	PARTURIENT'S HEIGHT					
	SHORT		MEDIUM		TALL	
	CLASS 1		CLASS 2		CLASS 3	
Class 1 (SMALL)	n=20 AR=0.25 PR=0.50 DR=2.35 NR=1.10 BI=4.25	bw=3078 r(A)=–0.172 r(P)=0.122 r(D)=–0.146 r(N)=–0.676* r (B)=–0.469*	n=51 AR=0.37 PR=0.61 DR=1.08 NR=0.67 BI=2.69	bw=3442 r(A)=–0.035 r(P)=–0.020 r(D)=–0.614* r(N)=–0.278* r=–0.453*	n=77 AR=0.47 PR=0.51 DR=1.06 NR=0.78 BI=2.82	bw=3528 r(A)=–0.05 r(P)=–0.04 r(D)=0.02 r(N)=–0.11 r=–0.08
	CLASS 4		CLASS 5		CLASS 6	
Class 2 (MEDIUM)	n=52 AR=0.54 PR=0.48 DR=1.60 NR=1.07 BI=3.69	bw=3435 r(A)=0.133 r(P)=–0.155 r(D)=0.090 r(N)=0.216 r=0.180	n=85 AR=0.54 PR=0.59 DR=1.16 NR=0.73 BI=3.02	bw=3508 r(A)=–0.096 r(P)=0.129 r(D)=0.064 r(N)=0.074 r=0.082	n=51 AR=0.35 PR=0.47 DR=1.61 NR=1.16 BI=3.59	bw=3638 r(A)=–0.024 r(P)=–0.215 r(D)=0.126 r(N)=0.067 r=0.043
	CLASS 7		CLASS 8		CLASS 9	
Class 3 (LARGE)	n= 49 AR=0.55 PR=0.86 DR=1.78 NR=0.80 BI=3.98	bw=3490 r(A)=–0.010 r(P)=–0.040 r(D)=0.147 r(N)=–0.132 r = 0.020	n=27 AR=0.41 PR=0.67 DR=1.41 NR=1.30 BI=3.78	bw=3580 r(A)=0.041 r(P)=0.222 r(D)=–0.059 r(N)=0.015 r=0,042	n=19 AR=0.47 PR=1.00 DR=2.00 NR=0.95 BI=4.42	bw=3518 r(A)=–0.276 r(P)=–0.064 r(D)=–0.348 r(N)=–0.555* r=–0.625*

Each cell includes two subcells. The first gives the sample size (n), and the average values of risk factors AR, PR, DR and NR. The last number shows the value of the birth index BI. The second subcell presents the mean birthweight of newborns (bw), and the correlations of risk factors and the index BI with the birthweight, calculated for all parturients belonging to the given class. Statistically significant correlations are indicated by an asterisk (*).

As we see, the most problematic classes are class 1 of short and light women and also class 9 of tall and corpulent women. In both classes the birth index BI is higher than in other classes. In high risk classes the correlation between birthweight and risk factors is negative, indicating that higher values of risk factors are connected with small babies.

DISCUSSION

The analysis given above showed that mothers' and babies' anthropometric data are notable co-factors in the formation of the total risk for mothers' and babies' health. Therefore it would be necessary to establish a common methodological basis (including appropriate statistical data-processing) for using these data in evaluation of obstetric data. Our investigation has demonstrated that using a two-dimensional Height—Parturient´s Complex Body Build Index (PCBBI) classification for parturients is a helpful tool for discovering anthropometric risk factors which influence women with different body builds and sizes in different ways.

Using the data, systematised by Height—PCBBI classification into 3×3 classes (where the values of standard deviation have been used to determine the class limits), we calculated the mean values of four different obstetric risk factors (anamnestic, pregnancy, delivery and newborn's risk factor) for women belonging to all classes and found the birth index as the sum of four risk factors. Additionally, we found the averages of newborn's birthweight and calculated the correlations between the birthweight and all indices. On the basis of these data we established that

- corpulent women have higher pregnancy risk;
- the women belonging to extreme classes (small and short and also large and tall) have the highest delivery risk;
- in the classes with the highest newborn's risk the correlation between newborn's risk and birthweight is strongly negative, indicating that high risk is connected with low birthweight.

It follows from here that systematisation of data by Height—PCBBI classification enables the researcher to find how women with different individual peculiarities in body build act in delivery, and how the correspondence between the measurements of the mother and the foetus influences the course of pregnancy and delivery. If more statistical data are available, we recommend to increase the number of classes to 5×5 instead of the 3×3 classification described here. The advantage of this classification is that it can be used independently in different countries and women's clinics in order to compare the obstetric data gathered after delivery from parturients of different cultural and ethnic backgrounds.

On the basis of our study, all the clinical anthropometric data of the mother and the baby have been included into the new format of the in-patient's card and a special computer program, which, along with routine obstetric analysis, enables us also to analyse the anthropometric data.

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BODY FATNESS AND PHYSICAL ACTIVITY IN CHILDREN

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ABSTRACT

The purpose of this study was to assess the relationship between physical activity and fatness in prepubertal girls. The subjects of study were 34 prepubertal girls (mean age 8.2±0.4 yrs). Sum of five skinfolds (biceps, triceps, subscapular, abdominal, medial calf) was used as an indicator of body fatness. Physical activity was assessed by parental 7-day physical activity recall. The validity of 7-day physical recall was controlled using Caltrac accelerometer. The results revealed significant negative correlations between moderate-to-vigorous physical activity (MVPA) and subcutaneous fatness ($r=-0.43$, $p<0.05$). When controlling for body height, the association between MVPA and body fatness remained significant ($r=-0.35$). Total weekly physical activity score and low intensity physical activity were non significantly related with fatness ($r=-0.11-0.18$, $p>0.05$). It was concluded that only MVPA was significantly associated with body fatness in prepubertal girls.

Key words: fatness, physical activity, girls.

INTRODUCTION

Regular physical activity is generally viewed as having a favourable influence on the growth and biological maturation of children and youth [1]. Physical activity and training for sports are associated with a decrease in fatness in both sexes and occasionally with an increase in fat-free mass in boys [2, 3]. Longitudinal data an changes in body composition associated with activity are limited. The study by Beunen *et al.* [4] is important because it controlled for several possibly confounding variables (e.g. maturation) in Belgian adolescents, who were followed for 3 years. This revealed no relationship between separate skinfold thicknesses and self-reported participation in sports.

Cross-sectional data indicate an inverse relationship between physical activity and fatness in children [5, 6, 7]. However, other studies

[8, 9] did not confirm such a relationship. One reason for such a discrepancy is that energy expenditure has often been presented in absolute energy units, without correction for the large body mass of the obese [10].

The purpose of this study, therefore, was to assess the relationship between physical activity and fatness in prepubertal girls.

MATERIAL AND METHODS

The subjects for this study were 34 girls (mean age 8.2±0.4 years). All subjects were healthy and participated regularly in the school physical education program twice a week. Informed consent was obtained from the parents of each child.

Body fatness was determined as the sum of the following skinfolds: biceps, triceps, subscapular, abdominal, medial calf. Three measurements were taken and mean skinfold thickness were used of calculate the sum of skinfolds. In addition, body height and body mass were measured using Martin metal anthropometer and medical scales.

Physical activity was assessed by 7-day physical activity recall modified by Godin and Shephard [11]. In the present study, the parents reported in the written from in the evenings of each day during one week how much time their child spent on activities outside of school. Activities were classified as low (3METs), moderate (5 METs), or vigorous (9 METs). Examples of activities most frequently used by the children (sports, games, home activities) were selected and provided in the written from. The validity of 7-day recall was controlled using Caltrac accelerometer (Hemokinetics, Inc., Madison, WI). The correlation between Caltrac counts and 7-day physical activity recall were moderate (r=0.52–0.66).

Descriptive statistics included means and standard deviations. Pearson and partial correlations (adjusting for body height) were used to determine the relationship between fatness and physical activity. Significance was set at the 0.05 level.

RESULTS

Table 1 provides descriptive statistics for anthropometric characteristics and physical activity scores. Zero-order correlations between sum of skinfolds and physical activity are given in Table 2. Only correlation between moderate-to-vigorous physical activity and fatness is significant ($p<0.05$). Total weekly and low intensity physical activity are non significantly associated with body fatness ($p>0.05$). When controlling for the effects of body height (Table 3), the relationship between moderate-to-vigorous physical activity and sum of skinfolds remained significant ($p<0.05$).

Table 1

Anthropometric characteristics and physical activity (M±SD)

Variables	M	SD
Height (cm)	129.5	5.2
Body mass (kg)	26.3	3.8
Skinfolds (mm)		
Triceps	6.8	1.2
Biceps	6.1	1.4
Subscapular	6.7	1.7
Abdominal	7.7	2.2
Calf	9.5	2.5
Sum of 5 skinfolds	36.8	5.6
TPA (h/week)	27.4	5.7
MVPA (h/week)	7.5	2.8
LPA (h/week)	20.3	4.8

TPA — total weekly physical activity; MVPA — moderate-to-vigorous physical activity; LPA — low intensity physical activity

Table 2

Zero-order correlation between fatness and physical activity

Variables	TPA	MVPA	LPA
Sum of 5 skinfolds	–.18	–.43*	–.11

*p<0.05

Table 3

Second-order partial correlation between fatness and physical activity (adjusting for body height)

Variables	TPA	MVPA	LPA
Sum of 5 skinfolds	.08	–.35*	–.03

*p<0.05

DISCUSSION

This study considered associations between physical activity and subcutaneous fatness in prepubertal girls. Moderate-to-vigorous physical activity was significantly related with body fatness. After controlling for body height, relationship between moderate-to-vigorous physical activity and sum of skinfolds remained significant. Total weekly as well as low intensity physical activity were non significantly related with body fatness.

The results of present study provide some insight into relationship between physical activity (environmental stimuli) and subcutaneous fatness (genetic component of physique). The results of previous studies concerning the association between activity and fatness in children have equivocal. Some studies [5, 6, 7] have demonstrated a significant relationship between physical activity and fatness, whereas others have not [8, 9]. However, these studies have varied on a number of dimensions including sample size, sample selection, research design (longitudinal, cross-sectional), measures and assessment of physical activity, as well as type of physical activity assessed. Others reason for such a discrepancy in results is that energy expenditure has often been presented in absolute energy units, without correction for the large body mass of obese. In addition, previous studies [12, 13, 14, 15] were all conducted after the subjects had become obese, and, thus, could not address whether hypoactivity is part of the etiology of obesity or simply reflects less activity induced by more weight [10].

The results of this study also indicated that the intensity of physical activity is important while explaining the activity-fatness relationship in children. Numerous studies have also shown that aerobic exercises can induce a reduction in adiposity and, to a lesser extent, an increase in fat-free mass [10]. For example, Sasaki *et al.* [16] reported a long-duration (2 years) intervention in which 11-year-old obese Japanese girls and boys were involved in a school-based running program. The intervention resulted in a continuos decrease in excess body mass throughout the program.

In conclusion, the results of this study indicated that only moderate-to-vigorous physical activity was significantly negatively related with subcutaneous fatness in prepubertal girls.

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A COMPARATIVE STUDY OF WEIGHT, HEIGHT, PHYSICAL ABILITIES AND SUCCESS AT PERFORMING TECHNICAL ELEMENTS BY ESTONIAN, SWEDISH AND DANISH VOLLEYBALL TEAMS AT THE WORLD CHAMPIONSHIP PREQUALIFICATION TOURNAMENT

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ABSTRACT

A comparative study of weight, height, physical abilities and success at performing technical elements by Estonian, Swedish and Danish volleyball teams at the World Championship Prequalification Tournament was provided. The Estonian team was weaker than the Swedish team in functional capability and mastery in game. Danish team resembled those of the Estonian team. It is necesary to test the top-level players repeatedly.
Key words: volleyball, weight, height and physical ability of volleyball players.

INTRODUCTION

For the first time some games of the Volleyball World Championship Prequalification Tournament were held in Estonia [1, 2, 3]. The Estonian team played Swedish and Danish teams on 26–27 April 1997. The Estonian team lost both matches, to Sweden 0:3 and to Denmark 1:3. The aim of the present study is to find connections between the body build, physical abilities and success in game.

MATERIAL AND METHODS

The research material was obtained by studying the individual characteristics of players and from statistical data recorded during the matches. To record the games FIVB Volleyball Information System for DOS Software, Version 2.51 was used [4], by which the success of each member of all the three teams at attack, block, serve, dig, set and reception was recorded in the matches Estonia—Sweden and Estonia—Denmark [5, 6].

Additional data were gathered about players' age, height, weight, and highest reach during spike and 2-hands block.

The data gathered about 12 Estonian, 12 Swedish and 12 Danish male volleyballers were processed by methods of multivariate statistical analysis at the Institute of Mathematical Statistics, University of Tartu. The data were processed by Säde Koskel.

RESULTS

Table 1 presents the mean data of Estonian, Swedish and Danish teams concerning their physical characteristics and highest reach. As it can be seen here, the Estonians are the oldest, the lightest and the shortest. Their average highest reach at spike and two-hands block are the lowest. A check-up of statistical significance of the characteristics by Scheffe test revealed that the difference in age, weight and height was not significant, but there was a significant difference in highest reach. As for their highest reach at spike and two-hands block, Estonians are considerably weaker than Swedes, but do not differ greatly from Danes.

Next, we were interested in the correlations between individual bodily characteristics, highest reach and age.

Table 1

Mean characteristics of physical development and higest reach of Estonian, Swedish and Danish teams

No	Team	Age (years)		Weight (kg)		Height (cm)		Spike (m)		2-hands block (m)	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
1	Estonia	29,0	4,8	87,2	5,6	193,5	3,7	3,31	0,06	3,18	0,09
2	Sweden	27,1	3,6	88,0	6,4	195,2	6,6	3,44	0,08	3,27	0,09
3	Denmark	26,3	3,5	90,8	7,9	197,0	5,5	3,38	0,08	3,23	0,08

We found statistically significant correlations between the following characteristics: age—weight (0.355; $p<0.05$); height—weight (0.675; $p<0.05$); height—spike (0.462; $p<0.05$) and two-hands block

(0.490; $p<0.05$); weight—spike (0.477; $p<0.05$) and two-hands block (0.494; $p<0.05$).

As individual attack and block were in significant correlation with body build, it is possible to predict them on the basis of age, weight, height and nationality.

The corresponding regression formulae for Estonians were the following:

Highest reach at spike=2.35–0.0009 (age)+0.005 (weight)+0.002 (height), (R=0.60; $p<0.05$).

Highest reach at two-hands block=1.97–0.00049 (age)+0.0048 (weight)+0.0041 (height), (R=0.435; $p<0.05$).

Next, we are going to discuss the percentage of success of different teams in the matches between Estonia—Sweden and Estonia—Denmark (see Table 2).

Table 2

Mean characteristics of success in matches Estonia—Sweden and Estonia—Denmark

Match	Team	Attak		Block		Serve		Dig		Set		Reception	
		N	Succes %	N	Succes %	N	Succes %	N	Succes %	N	Succes %	N	Succes %
Estonia-Sweden	E	130	42,31	48	18,75	105	9.52	73	30,14	119	58,82	94	52,13
	S	141	53,19	49	44,90	121	8,26	84	46,43	131	78,63	85	82,35
Estonia-Denmark	E	172	44,19	69	34,78			92	40.22	164	64,63	125	63.20
	D	188	53,19	62	20,97			95	31,58	169	59,17	111	63,06

We see that the Swedish team was considerably more successful at attack, block, dig, set and reception. The significant success of Sweden as compared to Estonia was also proved by Scheffe test.

The percentage of success of the Danish team did not differ essentially from that of the Estonian team. The Danes were more successful only at attack.

Finally, we investigated how the percentage of success in game depends on the physical development of the players and their highest reach. The study was carried out about all the teams summarily. Using the method of regression, we found, for example, that success at attack depends significantly on weight and age (R=0.485; $p<0.05$).

Success % of attack=–44.771–1.173 (age)+1.366 (weight)

The success of block depends significantly on weight and height.

Success % of block=–100.270–1.832 (weight)+1.525 (height).

DISCUSSION

The tournament was of special interest for general public in Estonia and for volleyballers in particular. It was the first time the World Championship Prequalification Tournament was held in Estonia. Despite the defeat in both matches, we tried to analyse in detail which factors in the physique of the players or their preparation caused the loss.

The material presented is an original material of this tournament, and here we tried to correlate anthropometric characteristics, functional abilities and special preparation. As could be expected, height and weight are connected both with functional capability and mastery in game. The Estonian team was weaker than the Swedish team in both components; the data of the Danish team, however, resembled those of the Estonian team.

Consequently, it is necessary to pay greater attention to the physical development of top-level players and to test it repeatedly.

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PHYSICAL AND MOTOR DEVELOPMENT OF GIRLS WITH TURNER'S SYNDROME AGED 12–14 YEARS*

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ABSTRACT

Turner's syndrome is the result of one of the X-chromosomes being damaged or absent. It is manifested by a short, sturdy stature, delayed growth and, usually, no growth spurt, ovarian dysgenesis, etc. Although the somatic growth has been extensively studied, no reports on the development of physical and motor capacity have been found in the available literature and this prompted us to undertake this study. Eighteen girls aged 12.0 to 14.8 years, with cytologically confirmed Turner's syndrome, were studied. Apart from basic anthropometric measurements (body height and mass, 3 skinfolds), the girls were subjected to standard EUROFIT tests: plate tapping, sit-and-reach, standing broad jump, handgrip strength, sit-ups, bent arm hang, shuttle run 5×10 m. The results were compared with those recorded in 21 control girls in the same age range, selected for short stature (below the 20th percentile) and low ponderal index (below 43.5). Turner girls were considerably shorter, lighter and contained less fat tissue than control girls, although mean values of the ponderal index were comparable (41.5±1.7 and 42.5±1.0, respectively). Turner girls attained significantly lower results in the sit-and-reach test, standing broad jump, handgrip and in the number of sit-ups. They did not differ in the shuttle run, while in plate tapping and bent arm hang were significantly better than the controls.
Key words: body dimensions, Eurofit, Motor abilities

INTRODUCTION

Turner's syndrome is the result of one of the X-chromosomes being damaged or absent. It is manifested by a short, sturdy stature, delayed

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growth and, usually, no growth spurt, ovarian dysgenesis, etc. Although the somatic growth has been extensively studied [1, 2], no reports on the development of physical and motor capacity have been found in the available literature and this prompted us to undertake this study.

MATERIAL AND METHODS

The study was conducted at a summer vacation camp after having obtained parents' informed consent and the approval of the local Commission of Ethics. All girls (n=18) age 12.0 to 14.8 years were found healthy at the preliminary medical examination. Anthropometric measurements and EUROFIT tests [3] were carried out in the first days of the camp. The following standard tests were applied: plate tapping (PLT), sit-and-reach (SAR), standing broad jump (SBJ), handgrip (HGR), bent arm hang (BAH), shuttle run 5×10 m (SHR) and sit-ups (SUP). As control group served 21 Warsaw schoolgirls of the same age, selected for low stature (below the 20th percentile) and low ponderal index (below 43.5) from a large cohort studied under the project of Wilczewski *et al.* [4]. The anthropometric measurements and EUROFIT tests were conducted identically as in case of Turner girls. Body fat content was estimated from 3 skinfolds (subscapular, abdominal and triceps), measured wit a Holtain caliper and by using the formula of Piechaczek [5]:

Body fat (kg) = 3.25·(triceps + subscapular + abdominal skinfolds).

Conventional statistical methods were employed to process data — Student's t-test for independent data and Pearson's correlation coefficients, the level of $p \leq 0.05$ being considered significant.

RESULTS

The results (means ±SD) of anthropometric measurements and of EUROFIT tests are presented in Table 1. Turner girls were considerably shorter and lighter than the control girls selected for short stature ($p<0.001$) but, interestingly, their body fat content was lower ($p<0.01$) although they were slightly more robust ($p<0.05$).

With regard to the mean values of individual EUROFIT tests, Turner girls attained, in general, significantly lower values in the sit-and-reach test (SAR), standing broad jump (SBJ), handgrip strength

(HGR) and in the number of sit-ups (SUP). There was no difference in the speed/agility test (shuttle run 5×10 m; SHR), while in the plate tapping speed (PLT) and bent arm hang (BAH) Turner girls proved considerably better than the control ones ($p<0.001$).

Table 1

Mean values (±SD) of anthropometric measurements and of the results of EUROFIT tests recorded in girls with Turner's syndrome and in the control ones selected for low stature and low ponderal index, all girls aged 12–14.8 years

Variable	Control girls n=21	Turner girls n=18
Body height (cm)	150.6±6.7	135.7±8.5***
Body mass (kg)	45.3±7.4	35.8±8.2***
Ponderal index	42.4±0.9	41.5±1.7*
Body fat content (%)	33.2±8.0	25.4±7.2**
Plate tapping (n)	100.8±15.6	155.1±27.0***
Sit-and-reach (cm)	24.7±5.5	19.4±4.5***
Standing broad jump (cm)	148.9±21.9	127.4±20.9**
Handgrip (kg)	22.6±5.2	17.8±3.5*
Bent arm hang (0.1 s)	54.1±32.7	173.9±143.3***
Shuttle run (0.1 s)	221±15	221±23
Sit-ups (n)	22.4±5.9	17.8±4.5**

Significantly different from the respective value in control girls:
* $p<0.05$; ** $p<0.01$; *** $p<0.001$

Coefficients of correlation between individual EUROFIT tests and age or somatic variables are presented in Table 2. In the control group, PLT and HGR results were strongly correlated with age, body height and body mass (all, $p<0.001$), SBJ — with age ($p<0.01$) and body height ($p<0.05$) and SUP negatively with body fat content ($p<0.05$). In Turner girls, the correlations were much weaker (all, $p<0.05$) and no variable correlated with body mass. In contrast to the control group, SBJ and BAH were correlated negatively only with body fat content.

DISCUSSION

No data have been found in the available literature concerning the development of motor abilities in girls with Turner's syndrome. Therefore, the results presented here could be compared only with a reference population of Polish girls in the same age range [4], from which those of a short stature and relatively low ponderal index were selected. In spite of the fact that Turner girls were considerably shorter and lighter than the reference ones, some of their physical abilities were not lower than in normal girls. The agility/speed test (shuttle run 5×10 m, SHR) is an example. In another test associated with agility — PLT (the speed of plate tapping with one hand) — Turner girls attained considerably better results than control girls (by 55%). They displayed also an over 3-fold higher static strength endurance measured by the bent arm hang test (BAH). In other motor tests — SBJ (standing broad jump), SAR (sit-and-reach) and HGR (handgrip strength), Turner girls attained lower values and those abilities increased much slower with age than in control girls (cf. Tables 1 and 2). In the number of sit-ups, which remained constant in both groups throughout the age range studied, Turner girls were also inferior (by 20%) to control girls.

Table 2

Correlation coefficients between selected variablesin girls with Turner's syndrome and in the control ones selected for low stature and low ponderal index, all girls aged 12–14.8 years

	Control girls n=21				Turner's syndrome n=18			
Correlated variables	Age	Body height	Body mass	Fat content (%)	Age	Body height	Body mass	Fat content (%)
PLT	–0.813***	–0.712***	–0.685***	0.243	–0.511*	–0.167	–0.086	0.082
SAR	0.059	–0.016	0.066	–0.252	–0.030	–0.234	–0.300	–0.321
SBJ	0.631**	0.536*	0.413	–0.312	0.110	0.279	–0.136	–0.502*
HGR	0.818***	0.730***	0.714***	–0.126	0.489*	0.494*	0.287	–0.460
SUP	0.360	0.274	0.092	–0.535*	0.152	0.000	–0.059	–0.172
BAH	–0.391	–0.366	–0.394	0.373	0.001	0.084	–0.288	–0.509*
SHR	0.055	0.084	0.064	0.165	–0.109	–0.193	0.232	0.405

PLT — Plate tapping; SAR — Sit-and-reach test; SBJ — Standing broad jump; HGR — Handgrip strength; SUP — Sit-ups; BAH — Bent arm hang; SHR — Shuttle run 5×10 m; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

The results of PLT, SHR and BAH tests may suggest that in Turner girls the motor control differs to some extent from that in normal girls which would require further studies. In general, however, EUROFIT tests are not only highly useful in monitoring the normal course of motor development in children but seem to provide a tool to follow up the process of therapy and/or rehabilitation.

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ASSESSMENT OF HEALTH-RELATED FITNESS IN MALE STUDENTS AND SERVICEMEN

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ABSTRACT

Objectives: to assess the health related fitness (HRF) in 9th grade male students and servicemen.

Key words: health-related fitness, students, servicemen

MATERIAL AND METHODS

Randomly chosen students (n=31) and servicemen (n=51) from Tallinn. The modified HRF test battery used to assess: the physical activity and smoking habits, health limitations, musculosceletal and cardiorespiratory fitness level and lung function.

RESULTS

The mean age of male students was 15.2±0.6 years and 19.4±0.7 years in servicemen. The high prevalence of smoking habits was cleared out: 42.1% of students and 74.5% of servicemen. The most of youngsters had health limitations (81.4% of students and 93.9% of servicemen). Overweight (BMI>24) was found in 2.6% of students and in 13.7% of servicemen. Systolic hypertension (SBP>140 mmHg) was found in 5.3% of students and 2.0% of servicemen. Diastolic hypertension (DBP>90 mmHg) was correspondingly found in 7.9% and 3.0%. The used HRF test battery cleared out a rather low level of the musculosceletal fitness level. Although the. cardiovascular endurance was in moderate/ high level, the recovery period showed the high prevalence of dysbalance of the postexercise recovery period in 2/3 of studied persons. The impaired lung function was probably related to smoking habits in servicemen.

CONCLUSION

The young people had the high prevalence of health risks (smoking, lack of fitness-enhanced physical activity, hypertension and overweight), the rather low musculosceletal fitness and the irrational function of cardiovascular system in 2/3 of them.

Health-related fitness (HRF) refers those components of fitness that are favourably or unfavourably affected by habitual physical activity and relate to the health status. Physical fitness (PF) is "a set of attributes,which people have or achieve that relates to the ability to perform physical activity" [1]. Physical activity and physical fitness are inversely related to cardiovascular and other diseases and some psychosocial problems.

Among the conscripts 7.4%–48.2% have been attested as not good for the military service at the peacetime in Estonia [2]. At the same time 6% of the Finnish conscripts had serious illnesses [3]. Most commonly the conscripts were invited to the military service after the graduation of a high school in Estonia. Although the schools should deliver comprehensive health and physical education programs that provide and promote physical activity at every opportunity, currently in practice it hasn't happened. School physicians demonstrated that 2/3 of children had fallen ill within the schoolyear and more than 80% of adolescents from the 12^{th} grade had different health disorders [4]. Epidemiological studies have cleared out that more than 63% of the adolescents in the 9^{th} grade had one or more main noncommunicable disease risk factors: more often there were hypodynamia (39%), smoking in 40.3% of boys [5] and dyslipoproteidemia in 39.8% of 6–16 years old children [6]. The assessment of HRF has been started in Tallinn Nõmme Children's Hospital on 1995. Excellent HRF was shown by 6.6% of examined 7–13 years old children [7]. No studies have accurately been reported on the assessment of HRF among the adolescents in the high school or among the conscripts in Estonia. Therefore the assessment of the HRF in adolescents from the 9^{th} to 12^{th} grade compared with the servicemen was our special interest.

The objectives of the study were: 1) to assess the HRF in the 9^{th} grade male students and servicemen using the modified test battery from UKK-Institute (Finland) [8]; 2) to compare the HRF level in male students with servicemen.

The study cohort included 38 boys from the 9^{th} grade and 51 servicemen from Tallinn. Adolescents were chosen randomly in

3 schools of Nõmme area (every second from the list of male students). Servicemen were included to the study after the finishing of ordinary 3 month period randomly too (every second from the list) from an armed forces in Tallinn.

Test battery included: 1) three self-reported questionnaires to assess current physical activity status, smoking habits and health limitations by modified Physical Activity Readiness (PAR-Q) Questionnaire [9]; 2) anthropometric measures (weight, height); 3) assessment of body composition by body mass (Quetelet') index; 4) ECG at rest; 5) musculosceletal and motor fitness tests: static balance, push-up, sit-up, back extension, side-bending; 6) evaluation the cardiorespiratory fitness by peak oxygen consumption (VO_2 max) by the cycle ergometry and postexercise recovery period on the 7^{th} minute; 7) pulmonary function by spirometry before and after exercise test. For all variables descriptive statistics (mean and standard deviation (SD)) were calculated. Differences between the means were evaluated, using paired t-test, adopting a 5% significance level.

Male students' age was 14–17 years (M=15.2±0.6) and servicemen's age — 17–20 (M=19.4±0.7) years. The level of physical activity was assessed by self — administered questionnaire. The results are shown in table 1. The servicemen had more often heavy everyday physical work (39.2%) compared with 10.5% in the 9^{th} grade adolescents. Servicemen made 3 or more exercise sessions a week almost twice as often (62.7%) as male students (39.4%). At the same time more than a half of the respondents in both groups (52.6% male students and 56.8% servicemen) had a duration of exercise session 40 minutes or more. Brisk exercise four or more times a week had 39.2% of the servicemen and 18.4% of the male students.

Among servicemen there were 74.5% and among male students 42.1% regular smokers ($p<0.05$).

The health limitations were cleared up by the questionnaire,which contained 9 questions about illnesses in previous period and/ or about symptoms at the time of the study. The results are shown in Table 2. The most often health limitations in male students were a back pain (42.1%), feeling light-headed or having dizzy spells (36.8%) Among servicemen there were a shortness of breathing during physical activity (76.5%), back pain (43.1%) and feeling light-headed or having dizzy spells (37.3%). Almost to 1/3 of the male students (28.9%) and to 13.7% of the servicemen a doctor has once told about the high blood pressure.

Table 1

Assessment of the current physical activity and the exercise habits

Physical activity/ Exercise habits	Male students (n=38)	Servicemen (n=51)
	% of respondents	
1. Heavy physical every day work	10.5	39.2*
2. 3 or more sessions of exercise a week	39.4	62.7
3. Duration of exercise session 40 min or more a day	52.6	56.8
4. Brisk exercise at least 3 times a week	36.8	19.6
5. Brisk exercise 4 or more times a week	18.4	39.2

* $p<0.05$ — difference between male students and servicemen

Table 2

PAR-Q Questionnaire

Health limitations	Male students (n=38)	Servicemen (n=51)
	% of respondents	
1. A doctor has ever diagnosed as having respiratory, heart or cardiovascular disease	26.3	19.6
2. Has experienced shortness of breath:		
— at rest	15.8	41.2
— during physical activity	18.4	76.5
3. A doctor has told, that the blood pressure is too high	28.9	13.7
4. Have felt light-headed or have dizzy spells	36.8	37.3
5. Doctor has diagnosed a bone or joint problems	2.6	7.8
6. Have experienced a back pain	42.1	43.1
7. Have any other health-related reason for not followed an activity programme	5.3	2.0
8. Were on medication	5.3	2.0
9. Experienced some form of inflammatory disease during the past two weeks	10.5	11.8

The prevalence of health limitations was high — only 18.6% of male students and 6.1% of the servicemen had no health limitations. One-two limitations had 52.6% of male students and 54.9% of servicemen. Five to seven limitations had 5.2% of male students and 8.7% of servicemen.

Anthropometric measures (weight, height) and BMI have showed in Table 3.

Table 3

Physical characteristics of the subjects and the results of the musculosceletal fitness tests (Mean and SD)

Test	Male students (n=38)	Servicemen (n=51)
Age (years)	15.2±0.6	19.4±0.7*
Height (m)	175.6±7.1	182.4±5.6*
Weight (kg)	60.9±9.3	75.0±8.6*
BMI (kg/m^2)	19.7±2.2	22.5±2.0
Standing on one foot (sec)		
— on right foot	13.0±16.0	20.1±19.7
— on left foot	18.0±25.0	23.5±21.9
Push-up(times)	35.0±12 .0	40.0±12.0
Sit- up (times in 30 sec)	24.0±2.0	22.0±4.0
Back extension (min:sec)	1:55±0:35	1:56±0:50
Side bending (cm):		
— to right side	23.2±3.9	24.6±4.3
— to left side	24.1±4.9	24.1±4.0

* $p<0.05$ — differences between male students and servicemen

The mean age, weight and height revealed significant differences ($p<0.05$) in male students and in servicemen. Body mass indexes did not differ in two group ($p>0.05$).

Motor fitness, musculosceletal strength and endurance was assessed through the whole body static balance by standing on one foot, by modified push-up, sit-up, back extension and side-bending tests. The results of these tests are shown in table 4. The upper limit for the time of standing on one foot with the eyes closed was 30 seconds. Among male students 3 from 38 (7.9%) and 9 from 51 servicemen (17.6%) were able to stand on one foot with closed eyes 30 seconds or more. Musculosceletal tests that measure balance, trunk muscle endurance and flexibility did not differ in average in male students and in servicemen ($p>0.05$).

One of the components HRF is the cardiorespiratory fitness. The oxygen consumption on the top of exercise was expressed in METs [10]. Data about preliminary, after exercise and recovery period are shown in table 5. Although the age of studied young men was statistically different ($p<0.05$), the average value of METs was the similar: 12.5 (range 7.5–16.2) in male students and 13.9 (range 9.8–17.6) in servicemen. The exercise level was assessed as the next: very low level — 1.0–3.9 METs, low level — 4.0–6.9 METs, mean level — 7.0–10.9 METs, high level — 11.0–13.9 and very high level — 14.0–16.0

METs. The cardiorespiratory fitness in all surveyed was a mean level in 18.4% among male students and 5.9% among servicemen. All the rest persons had high or very high level and no one had a low or very low fitness level. The adaptation of the cardiovascular system to the exercise test should be evaluated by the recovery period. The adaptation expresses those mechanisms which help to maintain homeostasis in the organism. In the untrained person the adaptation to the exercise could not be completed to the desired time period (up to 7^{th} minutes).

Table 4

The oxygen consumption on the top of exercise and data about the recovery period (Mean and SD)

Characteristics	Male students (n=38)	Servicemen (n=51)
Age (years)	15.2±0.6	19.4±0.7*
METs	12.5±2.2	13.9±1.7
HR at rest (beats/min)	96.4±16.6	76.0±15.0
Max HR (beats/min)	186.1±11.5	172.0±10.0
SBP at rest (mmHg)	115.6±14.4	120.4±10.5
DBP at rest (mmHg)	70.4±11.1	75.3±11.6
Max SBP (mmHg)	165.5±23.2	183.4±21.0
Max DBP (mmHg)	15.7±29.9	27.6±33.1
SBP (mmHg) 7^{th} min	114.9±12.8	125.0±11.6
DBP (mmHg) 7^{th} min	68.0±10.9	67.5±10.4

Notes: HR — heart rate; SBP — systolic blood pressure; DBP — diastolic blood pressure; * $p<0.05$ — difference between male students and servicemen

In 2 from 38 (5.3%) male students had a hypertension — systolic blood pressure (SBP) at rest >140 mmHg and in 3 from 38 (7.9%) — diastolic blood pressure (DBP) >90 mmHg. Among the servicemen the data were next: in 1 from 51 (2.0%) had a systolic hypertension and in 2 from 51 (3.9%) had a diastolic hypertension. In average the resting heart rate was higher in male students (96±17 beats/min) than in servicemen (76±15 beats/min) ($p>0.05$). Maximum HR on the top of exercise was 186±12 beats/min in male students and 172±10 beats/min in servicemen ($p>0.05$). Maximum values of systolic blood pressure were in male students 165.5±23.2 mm Hg and in servicemen 183.4± 21.0 mmHg. The diastolic blood pressure immediately after the exercise test fell markedly and was in average 15.7±29.9 mmHg in male students and 27.6±33.1 mmHg in servicemen. In 29 from 51 servicemen (56.9%) and in 27 from 38 male students (71.5%) the DBP has fallen to 0 value. The postexercise lowering of the diastolic blood pressure was more (50–90 mmHg in male students and 50–120 mmHg in servicemen) than expected (5–10 mmHg) at the submaximal level of the dynamic exercise.

The recovery period was assessed by blood pressure and by heart rate at the 7^{th} minute. SBP and DBP showed almost the same data on the 7^{th} minutes as the rest BP in both groups. Servicemen's recovery SBP was in average some higher (125.0±11.6) than in male students (114.9±12.8 mmHg) ($p>0.05$). The DBP at the 7^{th} minutes of recovery time in male students was lower (68.0 mmHg–70.4 mmHg). Than at the rest period as in servicemen. (67.5mmHg–75.3 mmHg). The mean data of the recovery HR in male students was 104.2±8.9 and in servicemen 93.0±10.0 per minute ($p>0.05$). Only in 31.6% of the male students the recovery HR was lower than 90 beats/minute to the 7^{th} minutes. Among the servicemen the recovery HR up to the 7^{th} minute was lower than 90 beats/minute in. 33.3% of the surveyed. These data showed that the hyperkinetic reaction of the cardiovascular system to the exercise, which is known as the irrational coordination of cardiovascular extra — and intracardial mechanisms.

The lung function values are determined genetically and have the relationship with smoking habits. The male students had a smaller vital capacity (VC) value (5.2±0.7 l) as compared with servicemen (6.0± 0.6 l) ($p>0.05$). In both groups the actual VC versus predicted values had no statistical differences: in male students it was 113.8±12.5% and in servicemen 115.4±10.8% ($p>0.05$). The FEF 25–75% mean value in male students was higher (137.0±27.5%) than in servicemen (97.9±23.2%) ($p<0.05$) It was a subject of speculation that the smaller FEF25–75 was induced by the more often smoking habits in servicemen.

The regular physical activity is important through the life cycle, from the childhood to the old age. In young child, the main effects are upon attitudes and habit information. During adolescence, intensity of physical activity often increases, which results in more physical risks, but also counters the developing of cardiac risk factors. The quality physical education programs should expose the child to a good balance of sport and individual activities. The aerobic power often deteriorates over the course of schooling [11]. The main arguments for encouraging of children to engage in regular physical activity are the establishment of good health habits, the avoidance of smoking and other behavioural risks and enhance fitness. The prevalence of health — enhancing physical activity (3 or more weekly occasions of leisure — time physical activity) appears to vary from 20% to 50% among adult population in different countries. One third of surveyed adult people in western countries had the physical activity 4 or more times a week [12]. In our study 39.4% among male students and 62.7% among servicemen had 3 or more exercise sessions of the physical activity a week. Brisk exercise at least 3–4 or more time a week was mentioned in some more than among a half respondents as among the male students (55.2%) so in servicemen (58.8%). Four and more times a week the brisk exercise had less of respondents: 18.4% of male students and 39.2% of servicemen. These data are comparable with data P. Oja (1995).

The smoking habit was spread in both groups but statistically more often in servicemen (74.5%) than in male students (42.1%) ($p<0.05$) Overweight (BMI>24) as one of the predictor of HRF, was found in 2.6% of male students and in 13.7% of servicemen. High SBP (>140 mmHg) was found in 5.3% of male students and in 2.0% of servicemen and DBP was increased (>90 mmHg) in 7.8% of male students and in 3.9% of servicemen. The prevalence of the hypertension was markedly lower than it was mentioned in self-reported health limitations questionnaire.

Coordination test by standing on one foot with closed eyes up to 30 seconds was performed by 7.9% male students and by 17.6% servicemen. These data were markedly lower than it was the aim of the test — 30 seconds. The coordination test tended to be some better in servicemen. HRF assessment take into account both the strength and endurance of the trunk musculature. The muscular strength may function as an indicator of the adequacy of the habitual level of physical activity that coincides with the well-being. The good self-related health and intensity of exercise was positively related with the muscular strength in youngster [13]. The substantial increase in muscle strength as a result of training in young individuals is well known [14] The purpose of back extension is to measure the isometric endurance capacity of the trunk extensor muscles. The aim is to keep the unsupported upper part of the body horizontal as long as possible for up to 4 minutes. Zero is recorded if the subject is unable to reach the correct position or cannot hold it for 1 second [8]. Back extension time in male students and servicemen was in average almost the same value (1 min 55 sec and 1 min 56 sec respectively). The maximum data of back extension in male students was 3 minutes 30 seconds and 4 min in servicemen. Thus no one students was not able to hold the position as the standard and it was done by 3 servicemen. The flexibility of the trunk was measured by side-bending test. In adult men (older than 30 years) the side — bending 19.5–23.2 cm was estimated as moderate and 23.3–27.1 cm as good level of muscular fitness [10]. In our study the range of side-bending was from 18cm to 33.5 cm (average 23.6 cm) in male students and from 16.5cm to 36.0 cm (average 24.3 cm) in servicemen ($p>0.05$).

These data shows that the musculosceletal fitness level in young men is rather low / moderate and had no differences by age.

Cardiorespiratory fitness was assessed by the cycle ergometer test. The level of fitness, expressed by value of METs was in most cases as moderate /good (7.0–13.9 METs) in 71.1% of male students and very good (14.0–16.0 METs) in 28.9% of students. The corresponding data for servicemen were: moderate/good in 47.1% and very good in 52.9% respectively.

Although the level of cardiorespiratory fitness was rather high, the dysbalance of the functioning of cardiovascular system in both groups was found. Among male students in 68.3% of cases there was found out the hyperkinetic type of circulation on the 7^{th} minute of the recovery period. The responding data in servicemen was in 66.7% of cases. The good adaptation level is the prerequisite to the good coping with everyday demands as in male students so in servicemen and it was not on the satisfactory level in 2/3 of surveyed young men.

The used HRF test battery cleared out the high level of health limitations; rather low level of musculosceletal fitness, the high level of cardiovascular fitness in studied young persons but dysbalance in postexercise recovery period in 2/3 of the respondents.

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PATHOMORPHOLOGIC RESPONSES IN EXPERIMENTAL SEPSIS

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ABSTRACT

The purpose of our study was to set up the model of sepsis with live bacteria E. coli administration intraperitoneally in rats. In order to evaluate the systemic lesion of organs, we compare many different organ parameters, to study the morphological signs of damage, to find the morphological features of multiorgan failure in early stage. The rats were infected with 2.5 ml suspension 1.5×10^8 bacteria/ml with different amounts. We have revealed the systemic disorder — multiple organ damage by using infection with gram-negative bacteria. The changes of the macrophageal activity and in the leucocytary formula — neutrophilia, lymphopenia, vacuolation and hyperthrophia of lymphocytes, the pathomorphological changes in all organs, in relative organ weights have been achieved. The morphological changes such as hyperemia, intestitial and perivascular edema, lymphocytary infiltration occur with different frequency and of different extent in all examined organs in acute and chronic experiment, have been accentuated in the lungs, liver and kidneys, whereas these damages in gastrointestinal tract, sceletal muscles, heart and brain were much less pronounced. Considerable increases of organ weights were found in pancreas, adrenals and kidneys, much less in large intestine, sceletal muscles. In no other organs significant differences were found. We have found that macrophages activity has fallen in all organs, in the kidneys and liver in particular, much less in the lungs on the second day of experiment, and has shown some increase on the fifth day.

INTRODUCTION

The general concept of septic shock and "multiple organ failure syndrome" (MOFS) that exists today is a complex sequence of pathophysiological-biochemical and pathomorphological changes leading to death [1, 2, 3, 4, 5]. The pathogenetic mechanism, the causative factors of organ failure, the pathomorphological changes, remain inadequately understood. Only few reports have been published on the morphological changes of MOF in various organs [1, 3, 6]. In order to evaluate the systemic lesions, the histological changes of organs, the experimental model of sepsis was used [1, 2, 3] .

MATERIALS AND METHODS

The next aims were set up:

1. to work out sepsis model with live bacteria administration intraperitoneally
2. determination of differential leucocyte count in blood
3. the relative organ weights evaluated of
4. the macrophageal activity was estimated
5. the macropathological and histological changes in various organs determined

25 white Wistar rats (220–270 g) were investigated. They were divided into four groups:

1) 5 rats — the control group
2) 6 rats, infected intraperitoneally with 2.5 ml suspension 1.5×10^8 bacteria/ml together with 2 ml hemolyzed human red cells, died within the first 24 hr.
3) 6 rats, infected with 1 ml suspension 1.5×10^8 bacteria/ml together with 2 ml hemolyzed human red cells, were sacrified by the decapitation on the second day of experiment.
4) 8 rats, infected with the same sceme, sacrified on the fifth day of experiment.

E. coli used were isolated from the urine of patients with acute urinary tract infection (pyelonephritis) to reach maximal and reproducible bacterial virulency as follows. The culture of E. coli was isolated from a single colony grown on Mc Conkey agar plate and identified by means of conventional tube biochemical tests for enterobacteriaceae [7]. The suspension of bacterial, reached by turbid standard (10 Mc Farlandi) 3×10^9 bacteria/ml. together with 2 ml hemolyzed human blood cells were injected intraperitoneally into the rats. On the fifth day of experiment the rats were sacrified by decapitation and the blood from heart was taken, using aseptic surgical technique and spread on the endo agar plates. The culture was adopted after 24 hr of incubation at 37°C. Live suspension E. coli was used for intraperitoneal infection of the rats described above.

To evaluate the character of pathological changes of the organ failure the blood samples for analysis from the tails of the rats for leucocytary count (tail punch) before the infection and on the second and fifth days after the infection were taken.

Starting from the hypothesis that MOF is characterized by the increasing of the relative organ weights, all organs were dissected and weighed. All weights of the 12 organs of rats were reviewed and compared with normal weights obtained in our experiment. Content of water in organs slices was calculated from difference of wet and dry weight (g), drying slices during 48 h in 38°C.

For estimation of the macrophageal activity, 25% 3 ml solution of lithium- carmine was injected intraperitoneally to each rat three hours before sacrified by decapitation, followed by laparotomy. The morphometric data of the histological slides concerning the macrophages, which had stored lithiumcarmine, were counted and the average number of active macrophages was calculated in 25 fields of views.

For histological evaluation of the pathological changes, tissue samples were taken and fixed in 10% buffered formalin for light microscopic sections from heart, lung, liver, spleen, kidney, adrenals, small intestine, brain, pancreas, musles, ventriculus, large intestine. The histological morphometrical analyses were performed.

The heart blood was utilized for determination of differential leucocyte count.

RESULTS

Evaluation of organ weights

The weight findings are summarised in Table 1. Rising of the weights was not common to all organs. A moderate increase of weights in the kidneys, adrenals, pancreas, sceletal muscles and large intestinum was identified.

The wet weights of the lungs, heart, brain showed minimal changes.

Peripheral blood

The analysis of the leucocytary formula of the stained blood smears of peripheral blood in rats of III and IV groups (Table 2) showed the marked increase in the number of circulating segmented neutrophils (1.6 times). The number of immature granulocytes myeloblastst (promyelocytes, mesomyelocytes) had increased three times in comparison with control group.

The falling of the number of lymphocytes could be identified, mainly concerning the middle lymphocytes.

The hypertrophic lymphocytes and the lymphocytes with cytoplasmatic vacuolation could be found (18.4% in III group and 4.4% in IV group). The lymphocytes with large azurophils granules were distinguishable (1.5% in IV group). The number of monocytes and eosinophils had risen twice in the III group.

Macrophages

Macrophages have been counted in 25 fields of view under the magnification of 1000× (Table 3). The macrophages activity on the second day of experiment has shown the fallen in the kidneys, liver and lungs. Considerable increase of activity in the lungs has been shown on the 5-th day of experiment, but remained in lower level compared with control in liver and kidneys.

Morphologic findings

All the morphological changes of the organs are given in Table 4. The pathological changes, such as hyperemia, interstitial edema, dilatation of the capillaries were found in the majority of organs in all groups of experiment. The destructive changes — necrosis, hemorrages, trombi were found in organs of rats who died within 24 hours, and have been pronounced in kidneys, lungs, liver, spleen and pancreas.

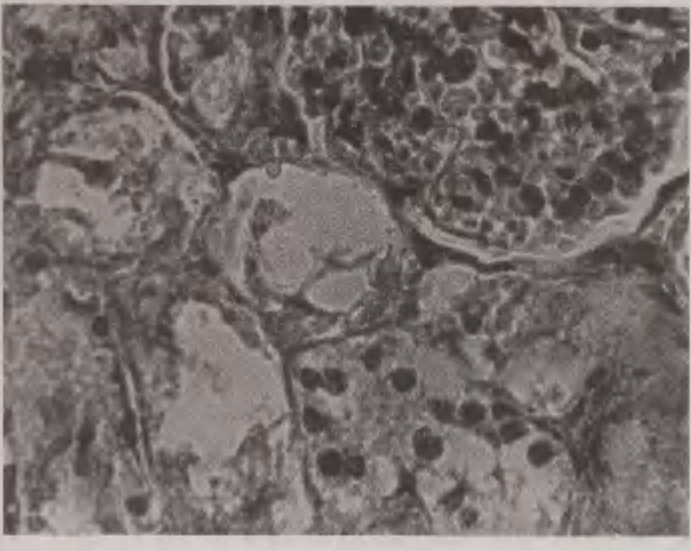

Figure 1. Niere. Necrosis of tubular epithelium. HE 500×

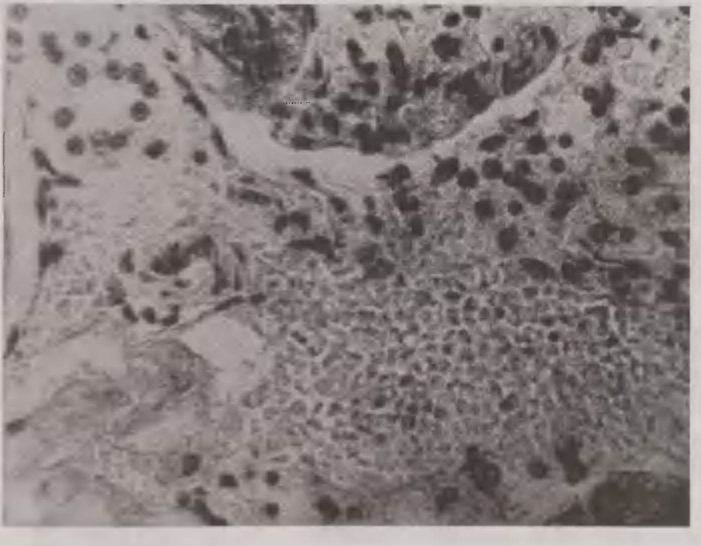

Figure 2. Niere. Interstitial hemorrhage. HE 400×

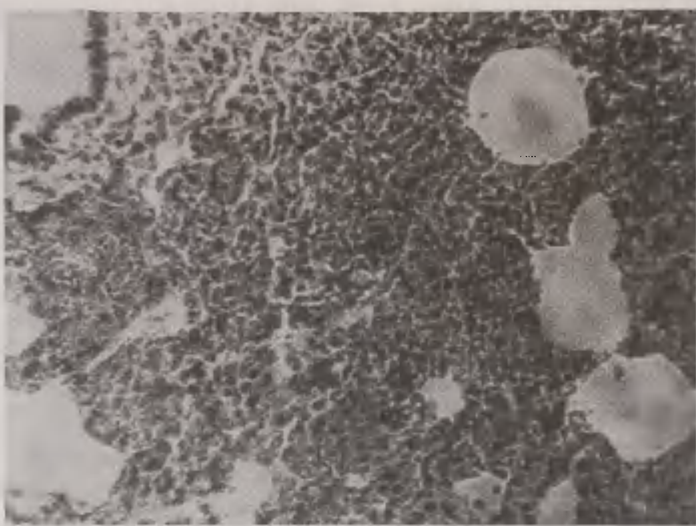

Figure 3. Lungs. Alveolar hemorrhage. HE 400×

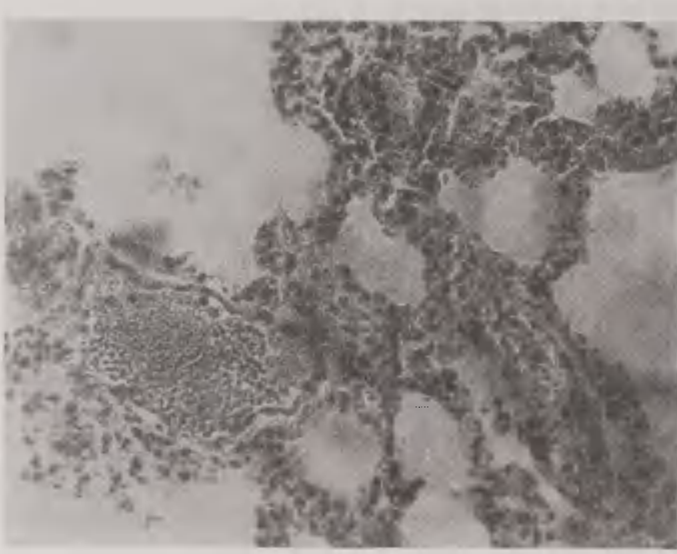

Figure 4. Lungs. Hyperemia, edema, thickening of interalveolar septa. HE 200×

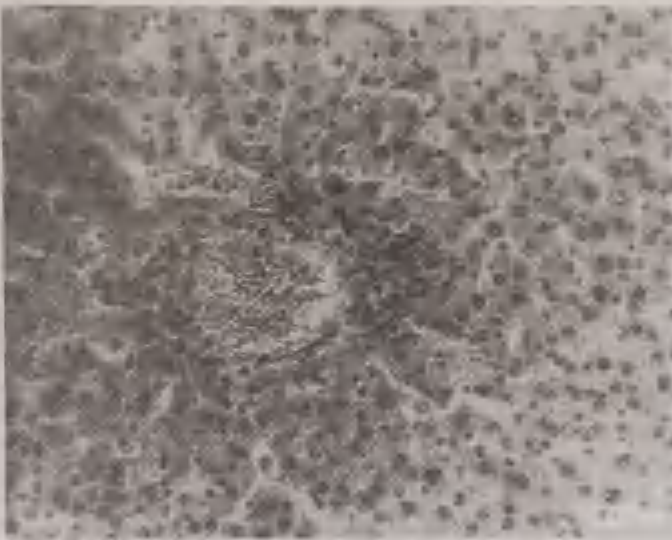

Figure 5. Liver. Dilatation of sinusoids. Perivascular (v. centralis) lymphocytary infiltration.HE 200×

Figure 6. Spleen. Disappearing of germ-centers, destruction of folicles. HE 100×

DISCUSSION

Accoding to hypothesis we have revealed the systemic disorder — multiple organ damage by using infection with gram-negative bacteria. The changes of the macrophageal activity and in the leucocytary formula — neutrophilia, lymphopenia, vacuolation and hyperthrophia of lymphocytes, the pathomorphological changes in all organs, in relative organ weights have been achieved.

The infection with gram-negative bacteria E.coli appears to play a pathogenetic role in the process which causes the multiorgan failure and its systemic manifestation [1, 2, 3]. Therefore, we have got evidence that the multiorgan damage was clearly dependent on the amount and concentration of the bacterial challenge and on the time of experiment — the acute phase (24 a) or chronic phase (2–5 days).

The morphological changes such as hyperemia, intestitial and perivascular edema, lymphocytary infiltration occur with different frequency and to different extent in all examined organs in acute and chronic experiment, have been accentuated in the lungs, liver and kidneys, whereas these damages in gastrointestinal tract, sceletal muscles, heart and brain were much less pronounced (Table 4).

The higher E.coli dosage in the acute phase at $5{\times}10^8$ 2.5 ml (24 h) produses severe and overhelming organ damage, destructive changes — atelectasis, hemorrhages, trombi, collapsed alveoli in lungs; necrosis of hepatocytes and its vacuolation in liver; the foci of necrosis, collapsed glomeruli, vacuolation of tubular epithelium in kidneys.

The results of our experiment did not show considerable increase in weight of organs of rats as compared to data in literature [1, 3], according to which the organ weight in the patients with MOF increases significantly. Considerable increases of organ weights were found in pancreas, adrenals and kidneys, much less in large intestine, sceletal muscles. In no other organs significant differences were found. As a consequence, the great differences in the weights of the rats may be caused by using the massive therapheutic complexity (infusion-therapy) in patients with MOFS.

Considerable interest has been focused on an activation of macrophages of the organs which may be implicated in the pathogenesis of multiple organ failure [6, 9]. It has recently been suggested that MOF is caused by activation of inflammatory cells, however morphologic data of literature are not sufficient to sypport this hypothesis [6, 8, 10] We have found that macrophages activity has fallen in all organs, in the kidneys and liver in particular, much less in the lungs on the second day of experiment, and has shown some increase on the fifth day. One explanation would be that the gram- negat. infection reduces the macrophages activity in the acute phase to such an extent which might be generally accompanied by decrease of the immunoreactivity.

Table 1

Relative organ weight

		died in the 24 h	second day of experiment	fifth day of experiment
Organ	Control	II group	III group	IV group
Lungs	3,3±0,1	3,4±0,1	3,7±0,3	3,4±0,3
Heart	3,2±0,1	3,3±0,2	3,2±0,3	3,2±0,2
Lien	3,0±0,3	3,3±0,3	3,3±0,1	3,0±0,3
Pancreas	1,0±0,1	**2,2±0,2**	**1,6±0,1**	**2,0±0,2**
Liver	2,5±0,2	2,8±0,1	2,6±0,3	2,1±0,1
Adrenals	1,6±0,1	**2,5±0,2**	**1,8±0,2**	**2,4±0,2**
Kidney	2,3±0,2	**3,3±0,2**	**3,3±0,1**	**3,6±0,2**
Brain	3,0±0,2	3,1±0,4	3,1±0,3	3,2±0,4
Stomach	3,3±0,5	3,3±0,4	3,3±0,5	2,8±0,6
Small intest.	1,9±0,3	1,5±0,3	2,3±0,2	2,4±0,5
Large intest.	**2,5±0,2**	**4,0±0,3**	**3,3±0,3**	**3,2±0,1**
Muscle	**2,4±0,1**	**3,0±0,2**	**3,1±0,2**	**3,0±0,1**

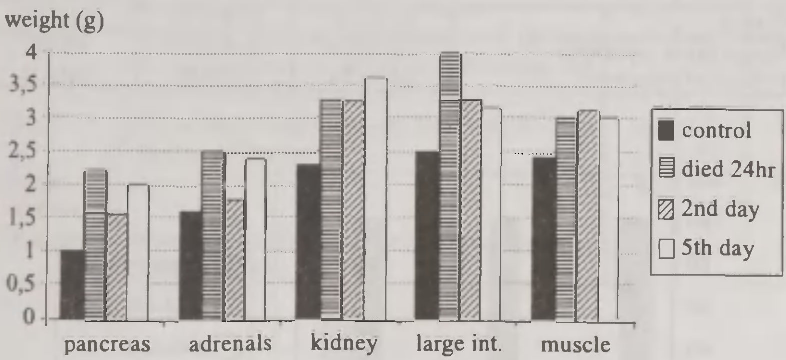

Table 2

Differential leucocyte count

	groups		
	control	III	IV
lymphocytes			
contain large azurophilic granules	0,7	0,2	1,5
hypertrophia and vacuolized cytoplasma	1,4	18,4	4,4
lymphoblasts	1,3	1,0	0,8
small lymphocytes	14,1	11,2	22,8
middle lympocytes	58,8	31,4	33,5
total	76,3	52,2	63,0
monocytes	2,7	5,6	3,1
neutrophil leucocytes			
myeloblast	0,2	1,0	0,8
unilobed form	0,5	0,2	0,3
band form	4,1	2,2	3,1
segmented form	13,9	24,4	25,8
total	18,7	27,8	30,0
eosinophil leucocytes			
myelocytes	–	0,6	–
band form	1	3,4	1,9
segmented form	0,7	–	0,4
total	1,7	4	2,3
basophil leucocytes	0,3	0,2	1,3
destructive leucocytes	0,3	0,2	0,3

Table 3

The macrophageal activiti

	Liver	Kidney	Lungs
Control	33,5±5,80	6,75 ±1,66	3,0±0,94
Second day of experiment	1,0 ±0,35	0,67±0,40	1,5±0,7
Fifth day of experiment	4,6 ±1,54	2,2±0,96	3,4±0,52

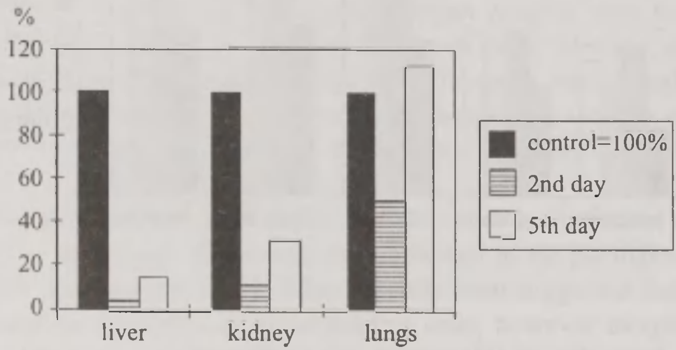

Table 4

Morphologic findings in organs

Organ	Pathologic findings	Group (number of rats)		
		II	III	IV
Lungs	Dilatation of capillaries, hyperemia, polymorphonuclear and lymphocytary infiltration, thrombi, interstitial and alveolar edema, thickening of septa interalveolaria, minor atelectasis	6	6	8
Kidneys	Dilatation of the capillaries, hyperemia, hemorrhage, trombi; vacuolation and necrosis of epithelium of the renal tubules, some tubular lumens is filled with homogenous hyalinlike eosinophilic masses.	6	4	6
Liver	Dilatation of sinusoids, hyperemia, hemorrhages congestion, bleeding; degeneration and vacuolation of hepotocytes, necrosis.	6	5	7
Spleen	Hyperemia, dilatation of sinusoids, foci of hemorrhage, falling of the number of follicles.	6	5	5
Pancreas	Hyperemia, interstitial edema, islets apparantly disappear — irregular in shape; vacuolation and necrosis of the cells of exocrine ducts.	5	3	4
Adrenals	Hyperemia, hemorrhages in the cortex and medulla (small foci)	5	3	4
Heart	Hyperemia, minor hemorrhages, perivascular lymphocytary infiltration, intestitial edema, vacuolation of muscle cells.	3	2	3
Brain	Hyperemia, thromboses, hemorrhages	2	2	2
Stomach	Hyperemia, hemorrhages,vacuolation of the cells of the cpithelium, lymphocytary infiltration, falling of mucoid secret, necrosis.	1	1	–
Small intestine	Edema, hemorrhagic necrosis, focal lymphocytary infiltration.	3	1	2
Large intestine	– " –	5	4	6
Muscle	Hyperemia, interstitial edema, a small lymphocytary infiltrates.	4	2	3

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BIRTHWEIGHT OF ESTONIAN CHILDREN ACCORDING TO MOTHER'S AGE, ETHNIC ORIGIN AND SOME SOCIAL FACTORS

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ABSTRACT

The birthweight of all term children born in Estonia in 1995 (11,958 children in total) was studied according to mother's age, ethnic origin, education, residence, marital and socioprofessional status. The information about the children was received from the database of the Estonian Medical Birth Register. The average birthweight of the term newborns in Estonia was 3,531.2 g (3,606.8 g for boys and 3,452.1 g for girls). Generally the child's birthweight increased with increasing mother's age and educational level, it was higher for ethnic Estonian mothers (average 3,553.5 g) than for mothers from other ethnic origin (average 3,472.5 g). The birthweight of the married mothers' children was higher than that of cohabiting and unmarried. According to the socioprofessional status the birthweight was highest for working mothers, followed by housewives, students and pupils, unemployed mothers. lowest birthweight belonged to The children of pensioners, the disabled or prisoners had the lowest birthweight. The birthweight varied significantly according to counties. The highest birthweight was in Hiiumaa (followed by Võrumaa and Järvamaa) and the lowest in Ida-Virumaa. The newborns of rural mothers had a slightly higher birthweight than the newborns of urban mothers.

It is generally acknowledged that size at birth is an important indicator of fetal and neonatal health. Birthweight in particular is strongly associated with fetal, neonatal, and postneonatal mortality, and with infant and child morbidity [1, 2].

The aim of this study was to analyse the birthweight of Estonian children according to the mothers' age, ethnic origin, residence, education, marital and socioprofessional status.

Key words: birthweight, mother's age, ethnic origin, social factors

MATERIAL AND METHODS

The object of this study were all the term children born from single birth on the territory of Estonia in 1995 (gestational age 37–41 weeks).

The information about the children was received from the database of the Estonian Medical Birth Register.

According to the Estonian Medical Birth Register 11,958 term children from single birth (11,927 live births and 31 stillbirths) were born in Estonia in 1995. Among the 11,958 newborns under study, 6,121 (51.2%) were boys and 5,836 (48.8%) girls, one child's sex was uncertain. The average age of the children's mothers was 25.6 years (the youngest mother was 14, the oldest 47); 72.5% of mothers (8,664) were Estonians and 27.6% (3294 mothers) were of other ethnic origin. The computer program NSDstat was used for statistical analysis.

RESULTS

The average birthweight of the newborns in Estonia was 3,531.2 g, standard deviation 459.4 g. The minimum birthweight was 1,640.4 g and maximum was 5,800.0 g.

A. Biological factors

1. **Newborn's sex.** The average birthweight of the boys was 3,606.8 g (standard deviation 463.0 g) and of the girls — 3,452.1 g (standard deviation 442.0 g). Thus, the average birthweight of the boys was 154.7 g (*ca* 4%) heavier than that of the girls. The boys' birthweight varied more than the girls birthweight (the standard deviation of the boys' weight of the boys was *ca* 5% greater).
2. **Gestational age.** The mean birthweights of the newborns according to gestational age are presented in Table 1. The higher the gestational age, the higher was the child's birthweight. There was a positive correlation between gestational age and birthweight ($r=0.35$; $p<0.001$).
3. **Mother's age.** Correlation analysis showed that the child's birthweight increased together with an increase in the mother's age ($r=0.12$; $p<0.001$). Still, the child's birthweight increased together with mother's age till the age of 39 years, after that it began decrease (Fig. 1). Leaving aside 40-year-old and older women, a regression formula can be written:

$$y = 3235.0 + (11.7 * x),$$

where y marks the child's birthweight in grams and x denotes mother's age in years. Thus, each year in mother's age adds 11.7 grams to the child's birthweight.

Table 1

Birthweight (in grams) according to gestational age

Gestational age (weeks)	Boys			Girls			All newborns		
	n	Mean	SD	n	Mean	SD	n	Mean	SD
37	346	3174,0	456,4	277	3029,6	435,8	623	3109,8	452,7
38	873	3372,7	403,0	778	3224,8	412,1	1651	3303,0	413,8
39	1558	3563,0	417,7	1496	3427,3	420,3	3055	3496,7	424,4
40	2349	3694,5	434,2	2266	3532,5	413,9	4615	3615,0	431,9
41	995	3822,8	453,0	1019	3598,2	416,4	2014	3709,2	449,0

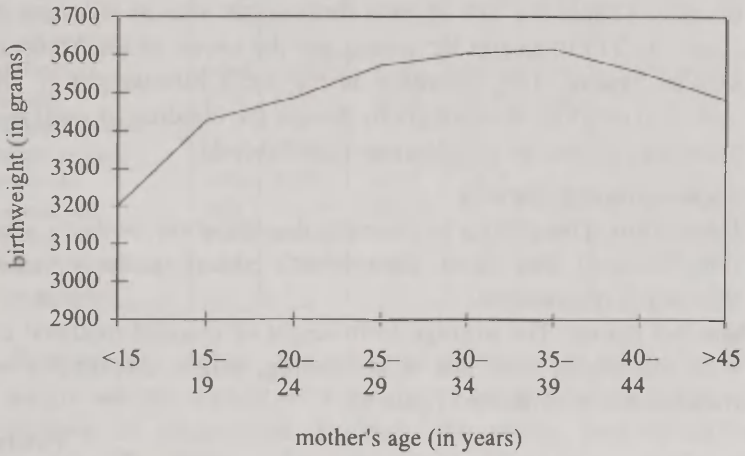

Figure 1. Birthweight according to mother's age.

4. **Parity.** The birthweight increased with increasing number of parity, being the highest among women delivering their 4th child, after that it began to decrease (Table 2).

Table 2

Child's birthweight and mother's age according to parity

Birth order	Birthweight (in grams)		Mother's age (in years)		Correlation between birthweight and mother's age
	Mean	SD	Mean	SD	
1st	3462,3	434,8	23,0	4,3	r=0.04; P<0.01
2nd	3587,5	455,6	26,6	4,5	r=0.06; P<0.001
3rd	3626,6	483,5	30,0	4,9	r=0.07; P<0.05
4th	3649,0	525,0	31,8	4,8	r=0.13; P<0.01
5th	3591,1	539,2	33,1	4,9	r=0.04; P>0.05
6th +	3579,7	517,5	34,9	4,6	r=0.16; P<0.05

B. The ethnic factor

5. **Ethnic origin.** The child's birthweight also depended on mother's ethnic origin. The average birthweight was 3,553.5 g (standard deviation 460.5 g) for the children of ethnic Estonian mothers and 3,472.5 g (standard deviation 451.1 g) for the children whose mothers were of other ethnic origin. Thus, on average, Estonian mothers' children were 81 g heavier at birth.

C. Geographic factors

6. **County.** The analysis of the birthweight according to mother's residence showed that the average birthweight varied according to counties (Table 3). The highest birthweight was in Hiiumaa (followed by Võrumaa and Järvamaa) and the lowest in Ida-Virumaa.
7. **Urban / rural.** The difference in the mean birthweight of urban and rural children was not great, though the children of rural mothers were on average 13 g heavier (see Table 3).

D. Socio-economic factors

8. **Education.** The child's birthweight depended on mother's education (Table 4). The higher the mother's education, the higher was the child's birthweight.
9. **Marital status.** The average birthweight of married mothers' children was higher than that of cohabiting, single, divorced or widowed mothers' children (Table 4).

Table 3

Birthweight (in grams) according to mother's residence

County	n	Mean	SD
Harjumaa	3936	3535,3	444,6
Hiiumaa	144	3650,5	425,7
Ida-Virumaa	1388	3456,3	449,5
Jõgevamaa	399	3563,2	471,6
Järvamaa	334	3585,9	472,2
Läänemaa	273	3585,8	499,5
Lääne-Virumaa	635	3526,6	476,0
Põlvamaa	331	3515,8	463,6
Pärnumaa	770	3536,7	466,0
Raplamaa	399	3531,8	434,5
Saaremaa	388	3488,8	451,3
Tartumaa	1383	3560,1	473,1
Valgamaa	332	3572,4	468,6
Viljandimaa	565	3479,2	469,5
Võrumaa	452	3594,4	467,1
Urban area	7810	3526,9	454,7
Rural area	4059	3540,1	468,4

Table 4

Child's birthweight and mother's age according to socio-economic factors

Mother's socio-economic factors	n	Child's birth-weight (in grams)		Mother's age (in years)		Correlation between birthweight and mother's age
		Mean	SD	Mean	SD	
Education						
primary or basic	1814	3428,6	452,1	22,0	5,3	r=0.06; P<0.01
secondary	4504	3529,5	457,8	25,1	5,2	r=0.10; P<0.001
vocational	3951	3552,2	454,6	26,2	4,8	r=0.10; P<0.001
higher	1643	3598,5	462,4	29,6	4,6	r=0.10; P<0.001
Marital status						
single (incl. divorced and widowed)	1007	3415,9	449,2	24,5	6,1	r=0.05; P>0.05
cohabiting	4160	3501,2	453,8	24,8	5,4	r=0.08; P<0.001
married	6791	3566,7	460,2	26,3	5,3	r=0.14; P<0.001
Professional status						
student or pupil	653	3484,5	422,4	20,7	3,3	r=0.15; P<0.001
housewife	2460	3505,3	464,1	24,4	5,5	r=0.08; P<0.001
unemployed	864	3442,4	465,4	24,7	5,7	r=0.13; P<0.001
working	7919	3553,6	458,1	26,5	5,2	r=0.12; P<0.001
disabled, pensioner or prisoner	32	3351,7	529,2	27,3	6,7	r=0.11; P>0.05

10. Professional status. According to professional status the birthweight was the highest for working mothers' children, followed by children of housewives, students and pupils, and unemployed mothers. The children of pensioners, disabled and prisoner mothers had the lowest birthweight (Table 4).

DISCUSSION

Earlier information about the birthweight of term newborns in Estonia comes from L. Saluste [3] and V. Loolaid [4]. According to L. Saluste the mean birthweight of term newborns was 3,463.4 g (3,551.0 g for boys and 3,393.0 g for girls), which is lower than in the present study. According to V. Loolaid the mean birthweight was 3,699.0 g for boys and 3,557.0 g for girls, which is higher than in the present study. But it must be mentioned that the above-mentioned researches were carried out only in one part of Estonia and only Estonian mothers' children were under investigation, and therefore their results are not entirely comparable with those of this study. Taking into consideration only Estonian mothers' children, the birthweights published by V. Loolaid are closer to the outcome of the present study.

While comparing the average birthweigth of the children born in the 41st week of pregnancy in Estonia (using the results of the present study) to those in the United States of America [5], Sweden [6] and Canada [7], the Estonian children appear to be the heaviest.

The aim of the study was to analyse the influence of several factors on the child's birthweight. The analysis of biological and ethnic factors confirmed well-known facts that birthweight depends on the child's sex, mothers gestational age, parity and nationality.

While analysing the connection of birthweight with mother's age, the question arose whether the increase in the child's birthweight with increasing mother's age is not caused by the fact that while mother's age increases, the number of former births increases as well. For that reason the correlation between birthweight and mother's age was determined in groups of women who had the same number of parity (see Table 2). The conclusion was that in most cases the positive correlation between mother's age and the birthweight of the child was significant also in the case of the same number of parity. The correlation also remained stable after grouping the mothers according to their education, marital and professional status (see Table 4).

Thus, it may be suggested that the correlation of the birthweight with mother's age is caused primarily by biological factors. The relationship of the birthweight to mother's education and marital status can also be explained by the higher age of educated and married mothers (see Table 4).

The influence of biological factors is also obvious in the link between the birthweight and mother's ethnic origin. Still, as the unemployment rate in Estonia is higher in the regions with non-Estonian inhabitants, the difference in the birthweight of children birthweight by Estonian and non-Estonian mothers was also studied in groups of women with similar professional status (Table 5). The conclusion was that the Estonian women's newborns had higher average birthweight in all groups.

The link between the birthweight and mother's professional status can partly be explained by the higher income and better nutrition of working mothers. According to literature, birthweight depends on gestational nutrition [8, 9], whereas the link between the birthweight and geographic factors points to the associate influence of biological and social factors. In order to exclude the influence of ethnic origin as a biological factor and unemployment as a social factor, the mean birthweights were estimated by counties for both Estonian and Russian mothers, and for employed and unemployed mothers .

Table 5

Birthweight (in grams) according to mother's professional status and ethnic origin

Mother's professional status	Ethnic origin					
	Estonian			Other nationality		
	n	Mean	SD	n	Mean	SD
Working	5933	3568,9	460,1	1986	3507,9	449,1
Unemployed	456	3497,3	478,7	408	3381,2	442,7
Student or pupil	481	3494,4	413,6	172	3456,9	445,9
Housewife	1747	3535,8	466,0	713	3430,5	451,0
Disabled, pensioner or prisoner	22	3358,4	538,1	10	3336,9	537,5

The conclusion was that taking into consideration both the mother's ethnic origin and employment the order of counties according to the children's mean birthweights changed, but regional differences did not disappear. Nevertheless, the consideration of ethnic origin lessened regional differences, the average birthweight of Russian mothers' children appeared to be significantly different only in Harjumaa and Ida-Virumaa (the children of the women of Harjumaa were heavier). It must be mentioned that unemployment rate in Harjumaa in 1995 was smaller than in Ida-Virumaa [10].

So it is obvious, that the lowest birthweight of children in Ida-Virumaa can partly by explained by ethnic differences (a relatively big share of non-Estonians), but the relatively high unemployment rate in this region should also be considered. In other counties the differences in the birthweight need additional investigation. It is possible that they are caused by socio-economic factors, but it is difficult to understand that in Võrumaa, where the economic conditions are the most difficult in the country, children's birthweight was among the highest (whereby the number of newborns was great). It is also difficult to explain the highest birthweight in Hiiumaa (although there were few newborns), and one of the lowest in nearby Saaremaa while the unemployment rate in these counties was approximately the same [10].

In conclusion, the results of the present study suggest that birthweight depends on mother's age, nationality, residence, education, marital and socioprofessional status. Generally the child's birthweight increases together with mother's age and educational level, it is higher for married mothers than for cohabiting or unmarried mothers, it is higher for working mothers than for unemployed mothers.

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HEALTH VARIABLES AND OVERWEIGHT PREVALENCE AND TRENDS FOR ADOLESCENTS IN TALLINN

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ABSTRACT

The weight, height, body mass index and prevalence of obesity in adolescents aged 14–15 was estimated in three surveys performed within the WHO co-ordinated CINDI Children's Programme (1988, 1992, 1996) in Tallinn. Obesity was defined as a body mass index (weight/height^2) at above 24 in both sexes. From 1988 to 1996 mean height values were increased in boys and girls, mean weight values were increased in boys and decreased in girls. In three surveys body mass index in girls was higher than in boys. There were no differences in BMI percentiles (10%) between I and III surveys on girls. Over the period 1988–1996 the obesity prevalence increased in boys and decreased in girls. From public health point of view continued effort for early identification and prevention of obesity among childrens and adolescents in Estonia are warranted.
Key words: body mass index, childhood obesity, height, paediatric antropometry, weight.

INTRODUCTION

Monitoring the child health and risk factors, as well conducting of the growth studies has been considered necessary even in developed countries. The obesity and overweight are associated with increased mortality, coronary heart disease, hypertension, dyslipidemia, diabetes mellitus and some cancers in adults [1]. It has been shown, that the youth obesity is strongly predictive of the obesity in adult [2, 3]. In general, the risk of overweight in adulthood is greater with higher degrees of overweight in youth and with overweight during the later adolescents years. The obesity and overweight in childhood have also been linked to subsequent morbidity and mortality in adulthood [4, 5, 6]. This concern has been heightened by a high coronary heart disease mortality rate and high prevalence of obese adults in Estonia [7, 8]. Defining of the obesity or overweight for children and adolescents is difficult, and there is no generally accepted definition for this [9, 10]. A variety of criteria for overweight and obesity have been used to evaluate prevalence and trends among children and adolescents [11, 12]. This study used body mass index (BMI) for estimation the prevalence of overweight for adolescents. One of the purposes of the present work was to evaluate the prevalence of the obesity among adolescents in Tallinn during the period 1988–1996 and evaluate possible changes in its prevalence. In this report presentation of data limited to height, weight, BMI and their changes through follow-up period among 14–15 year-olds boys and girls.

MATERIAL AND METHODS

The study was carried out in the framework of the WHO co-ordinated Countrywide Integrated Noncommunicable Disease Intervention (CINDI) Children's Programme. The subjects were selected at random from secondary schools in Tallinn (where are now living about 1/3 of the Estonian population). The ninth grades (14–15 years old) schoolchildren have been examined with the interval of 4 years (1988, 1992, 1996 accordingly I, II, III surveys). The total number 2376 schoolchildren from 17 schools participated in this study. The numbers of sample persons on whom the anthropometric measurements were performed are presented in sex groups by surveys in Table 1. All subjects were examined using a standard protocol. Anthropometric measures were performed by using the calibrated balance beam type scale with rigid vertical height measure. The precision for height reading was 1 cm and for weight measure 0,1 kg. To obtain the estimation of body mass BMI=weight (kg)/height $(m)^2$ was calculated for each subject. The obesity was defined as a BMI at or above 24 in 14–15 year olds in both sexes (Protocol of CINDI Children's Programme). Statistical analysis was carried out with SPSS.

Table 1

Number of sample persons in sex-age groups by surveys

Sex	I survey	II survey	III survey
Boys	601	505	422
Girls	587	527	477
Total	1188	1032	899

I survey 1988 year, II survey 1992 year, III survey 1996 year

RESULTS AND DISCUSSION

Age mean and standard deviation of weight, height and BMI by surveys are presented in Table 2. In all surveys weight values were greater in boys than in girls ($p<0.001$) except the I survey were the

Table 2

Average weight (kg), height (cm) and body mass index among adolescents in Tallinn by surveys

Sex	I survey			II survey			III survey		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
					Weight (kg)				
Boys	601	54.6	10.3	505	55.9	9.4	422	58.8**	10.6
Girls	587	55.3**	9.6	527	53.9^{++}	9.8	477	54.3^{++}	9.2
					Height (cm)				
Boys	601	170.5^{++}	8.5	505	170.9^{++}	7.7	422	172.9^{**++}	8.1
Girls	587	164.5	5.9	527	164.5	5.9	477	165.8*	6.0
					Body mass index				
Boys	601	19.0^{++}	2.5	505	19.0^{++}	2.4	422	19.6**	2.7
Girls	587	19.8	3.1	527	19.8	3.2	477	19.7	3.0

* $p<0.05$ — differences by surveys, $^{++}$ $p<0.001$ — differences by sex,
** $p<0.001$ — differences by surveys

differences were opposite. For boys all the follow-up period the weight values increased, differences among three surveys were significant ($p<0.001$). For girls the changes were opposite. They were most heavy in the I survey and then weight values decreased, but differences were statistically significant only between I and II surveys ($p<0.001$). In all surveys' boys were taller than girls ($p<0.001$). This difference was greater in the last survey (7.1 cm). For boys height values did not differ in I and II surveys. In the III survey boys were taller (+2 cm) than at ones before ($p<0.001$). The same height differences by surveys were in girls ($p<0.05$). BMI percentiles for boys and girls by I and III surveys are shown in Table 3. The median and the 10^{th}

Table 3

Body mass index percentiles in adolescents in Tallinn by I and III surveys

Sex	I survey				III survey			
	N	10%	50%	90%	N	10%	50%	90%
Boys	601	16.5	19.0	22.5	422	16.9	19.1	22.8
Girls	587	16.5	19.0	23.5	477	16.5	19.3	23.1

percentiles of BMI for boys and girls were similar in I survey (16.5 kg/m^2). The 90th percentiles of BMI were 22.5 kg/m^2 for boys and 23.5 kg/m^2 for girls. In III survey the median and 90th percentiles values for girls were a little higher than for boys (the differences 0.2 and 0.3 kg/m^2). The 10th percentiles were opposite higher for boys (0.4 kg/m^2) in last survey. For boys the 10th and 90th percentiles values increased from I to III survey (0.4 kg/m^2). For girls there were no differences between 10th percentiles values of I and III surveys. The median values increased (+0.3 kg/m^2) and 90th percentiles values decreased (–0.4 kg/m^2) from I to III surveys. The prevalence of obesity in different sex groups by surveys is presented in Table 4. The prevalence of obesity for girls was higher than for boys in I ($p<0.05$) and II surveys ($p<0.001$). These differences were greater in II survey when boys had the lowest prevalence values (3.8%) whereas girls had the highest (10.8%). There were no sex differences in the prevalence of obesity in III survey. For boys the prevalence of obesity did not change significantly between I and II surveys. From II to III survey prevalence values among them increased from 3.8% to 6.9%, although differences were not statistically significant. For girls the changes were opposite. During the period between I and II survey the prevalence of obesity increased slightly (from 8.5% to 10.8%). In III survey girls were significantly less often obese than in II survey ($p<0.05$).

Table 4

The prevalence of obesity (%) among adolescents in Tallinn by surveys

Sex	I survey		II survey		III survey	
	N	%	N	%	N	%
Boys	601	4.3^{+}	505	3.8^{++}	422	6.9
Girls	587	8.5	527	10.6*	477	6.1

$^{+}$ $p<0.05$ — differences by sex, * $p<0.05$ — differences by surveys,
$^{++}$ $p<0.001$ — differences by sex

These results showed, that over the period 1988–1996 the height increased in both sexes, the weight increased in boys and decreased in girls. However the weight changes for girls between I and III surveys were not statistically significant.

We compared our data with those from some other centres, which participated in the CINDI Children's Programme [13]. The weight values in Estonian boys aged 14–15, resembled to those of Lithuanian boys and girls, were lower than of Czech boys and girls, but higher than of Russian ones. The height values of Estonian girls had the same differences as the weight values, but Estonian boys were the tallest ones. BMI values in Estonian boys were similar to those of Lithuanian and Czech boys. There was no difference in BMI among girls from those countries. In this survey the BMI was higher in girls than in boys. It has also been reported by other studies, that during the childhood and adolescents' BMI is higher in girls [14, 15].

According to our results the prevalence of obesity slightly increased in boys and decreased in girls. It should be mentioned, for adolescents the pattern differed from that in adults in Tallinn. The studies in the framework of the CINDI Programme in the adult population showed the decrease of overweight in both sexes [16]. The authors connect those trends with the changes in dietary habits and nutrition during the last years in Estonian population. The data from nutrition survey that have been done in Estonia on the last years among 9–15 years old schoolchildren showed as well the decrease of dietary saturated fat intake, without sex differences in those changes [17]. It seems, that changes in nutrition cannot explain totally the changes in the obesity prevalence trends.

Problem of overweight and obesity for youth is largely a question of definition. To estimate the number of overweight or obese children and adolescents the definition must be chosen that specify the measures to be used and the corresponding threshold values above which overweight or obesity is present. There is no clear consensus on what that definition should be. The definition based on height and weight is desirable because these measures can be obtained with reasonable precision in field, clinical and research settings. Comparison among various weight-for-height indexes for adult and children have led to the selection of BMI as most desirable [18]. However, BMI as not as reliable as measure of fatness of children, especially across varying ages and degrees of maturity [19]. Therefore overweight and obesity criteria that use BMI must be age-specific. Children and adolescents with BMI above higher cut-off are more likely to be obese and at risk for continuing overweight and future adverse outcomes than those, as classified as obese by lower percentile cut-off. Sometime characterisation as being obese leads to stigmatisation and undue attention to body size may increase the incidence of eating disorders on adolescents. In light of this and the considerations noted above, the 95th percentile may be a more appropriate criterion of obesity for children and adolescents than the lower percentiles cut-off. In our surveys the obesity was defined as a BMI at or above 24 kg/m^2 in 14–15 years old adolescents of both sexes. The values of the 95^{th} percentile in boys and girls were 25 and 24 accordingly, which confirms that our criterion was acceptable and appropriate for identification of obesity among adolescents.

The precise definition of overweight and obesity for children and adolescents and relative importance of factors contributing to changes in prevalence of them may be difficult to resolve. However, from public health point of view further studies are needed for clearing this problem among children and adolescents in Estonia.

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SKELETAL DIMENSIONS AND PROPORTIONS OF 8 TO 9-YEAR-OLD ESTONIAN SCHOOLCHILDREN IN TARTU

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ABSTRACT

In the current work we focused our attention on the skeletal dimensions and to the proportions of skeletal variables of 8 to 9-year-old Tartu schoolchildren.

The aim of this study was:
to determine the most important skeletal characteristics of 8 and 9-year-old Tartu schoolchildren in 1990–1992;
to investigate the intersexual differences of these body characteristics;
to compare the data with earlier research;
to find out the tendencies of changes of skeletal dimensions in 8 to 9-year-old Estonian schoolchildren in Tartu.

The sample were 203 Estonian girls and 179 Estonian boys of age 8 and 9.

Basic statistics of variables by sex and age-groups, index of Rohrer, relative sitting height, relative biacromial width, relative bicristal width, acromiocristal index, cephalic index and index of sexual dimorphism (ISD) were calculated.

Comparisons of values with the earlier Estonian data were given.

The results indicate that head measurements (length and width) have decreased compared to Estonian children of the same age measured in 1977.

In comparison with earlier Estonian data in addition to the decreased index of Rohrer, the cephalic index and relative bicristal width have decreased at the age of 8 and 9 in both sexes.Thus, the subjects have become more longicephalic and narrow-hipped.
Key words: 8–9-year olds children, body lenghts, body widths, relative body lenghts, relative body widths, intersexual differences.

INTRODUCTION

Estonians are regarded as being slender among other Europeans, with wide shoulders, but relatively narrow hips. Besides big skeleton dimensions, Estonians generally have well developed soft tissues, adults are corpulent and brawny people.

In the current work we focused our attention on the skeletal dimensions and to the proportions of skeletal variables of 8 to 9-year-old Tartu schoolchildren.

In anthropometry, age 8 to 9 have traditionally been considered to be the time where signs of maturity have not as yet appeared and where there are no major intersexual differences. Nevertheless, there are some differences in skeletal dimensions due to gender.

The aim of this study was:

1) to determine the most important skeletal characteristics of 8 and 9-year-old Tartu schoolchildren in 1990–1992;
2) to investigate the intersexual differences of these body characteristics;
3) to compare the data with earlier research;
4) to find out the tendencies of changes of skeletal dimensions in 8 to 9-year-old Estonian schoolchildren in Tartu.

MATERIAL AND METHODS

The sample were 203 Estonian girls and 179 Estonian boys of age 8 and 9. Measurements of body height and weight and skeletal variables were carried out by the author according to methods developed by R. Martin (1928).

The data was analysed using the SAS-system.

The following characteristics were calculated:

1) Basic statistics (mean, standard deviation (SD)) of variables by sex and age-groups;
2) Index of Rohrer, relative sitting height, relative biacromial width, relative bicristal width, acromiocristal index, cephalic index and index of sexual dimorphism (ISD) (for each variable the mean for girls is divided by the mean for boys in %);
3) t-test for determination the differences between sexes and for comparison of mean values with the earlier data.

RESULTS AND DISCUSSION

Arithmetic means (mean) and standard deviations of selected variables are presented in Table 1, 2.

Table 1

Means and standard deviations (SD) of selected anthropometric variables in 8-year-old boys and girls

Variable	Boys (n = 83)		Girls (n = 95)	
	Mean	SD	Mean	SD
weight (kg)	27.38	5.57	26.85	4.96
height (cm)	131.43	4.71	130.48	5.72
head-plus neck length (cm)	26.93	1.03	26.15*	2.28
length of the lower limb (cm)	70.84	3.15	70.58	3.69
length of the upper limb(cm)	57.94	2.85	56.66*	2.85
sitting height (cm)	70.98	2.74	70.36	2.78
biacromial width (cm)	28.08	1.48	27.61	1.83
chest width (cm)	20.19	1.19	19.62*	1.18
bicristal width (cm)	20.35	1.28	20.26	1.35
chest depth (cm)	14.60	1.18	13.98*	1.29
head length (cm)	17.77	0.67	17.46*	0.60
head width (cm)	13.96	0.65	13.51*	0.51
elbow width (cm)	5.41	0.33	5.20*	0.31
wrist width (cm)	4.51	0.26	4.31*	0.24
knee width (cm)	8.07	0.45	7.75*	0.43
ankle (bimalleolar) width (cm)	6.11	0.37	5.82*	0.32

* — Statistically significant intersexual difference ($p<0.01$)

Results of calculated indexes of sexual dimorphism (ISD) (for each variable the mean for girls divided by the mean for boys in %) are presented in Table 3.

Measurements other than just weight and height indicate that there are intersexual differences even in this age. But intersexual differences in height and weight have no statistical significance for ages 8 and 9.

Statistically reliable ($p<0.01$) intersexual differences in 8 and 9-year-old children indicate bigger head-plus-neck length, length of upper limb, chest width, chest depth and all bicondylar diameters (elbow, wrist, knee and ankle width) in boys. In sitting height ($p<0.05$), biacromial width ($p<0.05$) and bicristal width ($p<0.01$) statistically significant sexual differences only occur in age 9.

Table 2

Means and standard deviations of selected anthropometric variables in 9-year-old boys and girls

Variable	Boys (n = 96)		Girls (n = 108)	
	Mean	SD	Mean	SD
weight	30.25	5.76	28.83	5.26
height	135.35	5.89	134.00	5.68
head-plus neck length	27.13	1.32	26.57*	1.09
length of the lower limb	73.42	3.67	72.89	4.05
length of the upper limb	59.53	3.58	58.37*	3.00
sitting height	72.79	3.22	71.92*	2.77
biacromial width	28.87	1.51	28.36*	1.47
chest width	20.69	1.40	20.10*	1.19
bicristal width	21.20	1.34	20.81*	1.28
chest depth	15.16	1.15	14.40*	1.13
head length	17.95	0.65	17.50*	0.66
head width	13.91	0.60	13.47*	0.54
elbow width	5.60	0.34	5.31*	0.28
wrist width	4.64	0.26	4.43*	0.25
knee width	8.28	0.44	7.86*	0.42
ankle (bimalleolar) width	6.31	0.35	6.00*	0.33

* — Statistically significant intersexual difference (p<0.01)

In age 8 and 9 reliable statistics (p<0.01) indicate bigger head measurements in boys.

Compared with 8–9-year-old Tartu children measured in 1978 [2] the weight and height as measured in this study have not undergone statistically significant changes. Biacromial width has increased in comparison with 1956–67 data by Aul (1982), but has decreased a bit compared to measurements by Silla, Teoste in 1984–85 [1]. Changes in bicristal width compared to earlier data [1, 2] have no statistical significance for ages 8 and 9.

Head measurements of the children measured in the framework of the current study (head length and head width) were smaller than in Estonian children of the same age measured in 1956–67 by J. Aul (2) and in 1977 by R. Silla and M. Teoste (1) ((see Table 4). This change was also reflected in head circumference which also has decreased in all 8 and 9-year-olds (4, 5).

Table 3

Indexes of sexual dimorphism (ISD) in age of 8–9

Variable	ISD for 8-year-olds	ISD for 9-year-olds
weight	98.06	95.31
height	99.28	98.99
head-plus neck length	97.10*	97.94*
length of the lower limb	99.63	99.28
length of the upper limb	97.79*	98.05*
sitting height	99.13	98.80**
biacromial width	98.33	98.23**
chest width	97.18*	97.15*
bicristal width	99.60	98.16*
chest depth	95.75*	94.99*
head length	98.26*	97.49*
head width	96.78*	96.84*
elbow width	96.11*	94.82*
wrist width	95.57*	95.47*
knee width	96.03*	94.93*
ankle (bimalleolar) width	95.25*	95.09*

* — Statistically significant intersexual difference (p<0.01).
** — Statistically significant intersexual difference (p<0.05).

Table 4

Comparison of head measurements in Estonian children of the same age carried out in 1990–1992 with head measurements carried out by R. Silla and M. Teoste in 1977 (Silla, Teoste, 1989).

Variable	8-year-old boys				8-year-old girls			
	1977		1990–92 (n=96)		1977		1990-92 (n=108)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
head length (cm)	18.12	0.60	17.77	0.67	17.81	0.67	17.46	0.60
head width (cm)	14.96	0.62	13.96	0.65	14.61	0.60	13.51	0.51
Variable	9-year-old boys				9-year-old girls			
	1977		1990–92 (n=96)		1977		1990–92 (n=108)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
head length (cm)	18.30	0.62	17.95	0.65	18.08	0.65	17.50	0.66
head width (cm)	15.00	0.61	13.91	0.60	14.80	0.66	13.47	0.54

* — All differences of head measurements (1977 vs. 1990–92) are statistically significant (p<0.01).

Comparing relative dimensions (Table 5), intersexual differences in age 8 and 9 are revealed in bigger relative head+neck length, relative upper limb length and relative chest depth in boys. Children of age 8 and 9 have no intersexual differences in relative lower limb length, relative biacromial width and relative bicristal width.

Table 5

Some indexes (in per cents) in 8–9-year old boys and girls

Variable	8-year-old boys		8-year-old girls		9-year-old boys		9-year-old girls	
	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD
rel. head-plus neck length	20.50	0.68	20.06'	1.68	20.05	0.82	19.84'	0.81
rel.length of the lower limb	53.89	1.14	54.08	0.94	54.23	1.14	54.37	1.20
rel. length of the upper limb	44.07	1.20	43.39'	1.22	43.98	1.80	43.56'	1.28
rel. sitting height	54.02	1.22	53.96	1.15	53.80	1.50	53.66	1.34
rel. biacromial width	21.36	0.90	21.16	1.07	21.34	0.84	21.17	0.76
rel. bicristal width	15.48	0.73	15.53	0.78	15.66	0.68	15.53	0.70
rel. chest depth	11.11	0.80	10.71'	0.86	11.20	0.68	10.75'	0.71
thoracal index	71.29	5.47	71.69	4.82	73.36	4.15	71.69'	4.82

' — Statistically significant intersexual difference ($p<0.01$)

'' — Statistically significant intersexual difference ($p<0.05$)

In comparison with earlier Estonian data [2] all observed indexes have decreased, though not all differences are statistically reliable (Table 6). Statistically significant ($p<0.01$) noticeable decrease for 8–9-year-olds is in indexes of Rohrer, cephalic indexes, relative bicristal width (for 9-year olds $p<0.05$). Thoracal index and relative chest depth have also statistically significantly ($p<0.05$) decreased except for in 9-year-old boys. For 8-year-old boys and girls relative sitting height and relative biacromial width show a trend to decrease.

The tendency of decreasing body weight compared to height in Estonian schoolchildren has also been revealed in the survey conducted in 1996 [6].

Some authors also indicate the correlation between index of Rohrer or BMI and some measurements of head and face [7, 8]. The tendency of decreasing head dimensions in Estonian students, especially the head width, has been indicated in stomatological studies [9].

Like the decreasing index of Rohrer, the decrease of relative sitting height also indicates the tendency of slendering in 8–9-year-olds of Tartu. Diminishing acromiocristal index (bicristal width divided by biacromial width in %) is statistically reliable ($p<0.05$) only for 8-year-old boys.

Table 6

Comparison of some indexes in 8–9-year-old boys and girls with earlier Estonian data — J. Aul, 1982

Variable	1982, J. Aul	1990–1992	Mean	SD
	Mean	SD	1.20*	0.16
Indexes in 8-year old boys				
Index of Rohrer	1.287	0.106	54.02*	1.22
rel.sitting height	54.53	1.19	21.36**	0.90
rel.biacromial width	21.56		15.48*	0.73
rel. bicristal width	16.00		11.11*	0.80
rel. chest depth	11.39		72.54*	4.06
acromiocristal index	74.24	3.31	71.29**	5.47
thoracal index	73.65	3.72	78.69*	5.03
cephalic index	83.09	4.18		
Indexes of 9-year old boys				
Index of Rohrer	1.250	0.105	1.21**	0.15
rel.sitting height	54.00	1.24	53.80	1.50
rel.biacromial width	21.52		21.34	0.84
rel. bicristal width	15.90		15.66**	0.68
rel. chest depth	11.24		11.20	0.68
acromiocristal index	74.00	3.27	73.49	3.82
thoracal index	73.41	3.66	73.36	4.15
cephalic index	83.06	4.10	77.59*	4.33
Indexes of 8-year old girls				
Index of Rohrer	1.280	0.114	1.20*	0.14
rel.sitting height	54.36	1.20	53.96*	1.15
rel.biacromial width	21.51		21.16*	1.07
rel. bicristal width	16.05		15.53*	0.78
rel. chest depth	11.07		10.71*	0.86
acromiocristal index	74.50	3.44	73.58	5.39
thoracal index	73.60	4.70	71.69*	4.82
cephalic index	82.73	3.95	77.46*	3.87
Indexes of 9-year old girls				
Index of Rohrer	1.256	0.119	1.19*	0.14
rel.sitting height	53.91	1.19	53.66	1.34
rel.biacromial width	21.45		21.17	0.76
rel. bicristal width	15.97		15.53**	0.70
rel. chest depth	10.90		10.75**	0.71
acromiocristal index	74.47	3.40	73.43	3.53
thoracal index	73.38	4.64	71.69*	4.82
cephalic index	82.66	3.80	77.09*	4.53

* — Statistically significant difference ($p<0.01$)

** — Statistically significant difference ($p<0.05$)

The skeletal dimensions of 382 Tartu schoolchildren (179 Estonian boys and 203 girls) aged 8 and 9 indicated the following major changes during the past 10–20 years:

1. Head measurements (length and width) have decreased compared to Estonian children of the same age measured in 1977 (1).
2. In comparison with earlier Estonian data (1,2) in addition to the decreased index of Rohrer, the cephalic index and relative bicristal width have decreased at the age of 8 and 9 in both sexes.Thus, the subjects have become more longicephalic and narrow-hipped.

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EXCESSIVE BODY MASS IN INHABITANTS OF TALLINN: YEARS 1981–1994 (CROSS-SECTIONAL AND PROSPECTIVE POPULATION STUDIES)

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ABSTRACT

The aim of the study was to investigate the prevalence of excessive body mass and to assess the significance of excessive body mass as a risk factor for cardiovascular and noncommunicable disease in inhabitants of Tallinn.

Two independent random samples of the population of Tallinn aged 20 to 54 were examined in 1984...1987 and in 1992...1994; 2477 men and 851 women were examined at the first survey and 921 men and 678 women — at the second survey. The screening procedure included standard epidemiological methods. A cohort of 4654 men aged 20 to 59 examined between 1981 and 1985 was followed-up during 11 years in average; all death cases were registered and the causes of death were verified by an expert commitee. In the early 1990-th 41.1% of men and 39.5% of women were overweight (BMI≥ 25); BMI exceeded 27 in 24.5% of men and 26.0% of women. 9.2% of men and 12.0% of women had BMI above 30. The mean values of BMI were significantly higher at the first survey than at the second survey, especially in women. At the first survey women had a higher BMI than men, at the second survey the sex differences disappeared. Drastic nutrition changes during the observation period are regarded as the main reasons for the described trends in BMI. The relationship between quintiles of BMI and mortality due to CHD and all CVD was U-shaped. BMI was found predictive only for cancer mortality (negative relationship).

Key words: excessive body mass, trends, mortality, population study

INTRODUCTION

Data concerning the significance of excessive body mass as risk factor for cardiovascular disease (CVD) are still controversial. Numerous epidemiologic studies have demonstrated a strong relationship between obesity and coronary heart disease (CHD) incidence and mortality [1–5], especially in younger age [6] and longer duration of follow-up [7]. At the same time other investigators failed to confirm the independent role of excessive body mass for the development of CHD [8–9].

The aim of this study was to investigate the prevalence of excessive body mass in inhabitants of Tallinn and to assess its significance as a risk factor for CVD and some other noncommunicable diseases.

MATERIAL AND METHODS

Two independent random samples of the free living population of Tallinn aged 20 to 54 were examined in 1984–1987 (first survey) and in 1992–1994 (second survey). The first sample was drawn from lists of electors, the second one from the recently established Estonian Population Register; both sources were formed on similar basis.

3328 inhabitants of Tallinn, 2477 men and 851 women, were examined at the first survey with response rates of 72.2% and 70.5%, accordingly. The number of examinees at the second survey was 1599 (921 men and 678 women) and the response rates were 44.9% and 50.6%, accordingly.

Standard epidemiologic investigation methods were used: blood pressure, weight and height measurements, determination of total cholesterol, triglycerides and high density lipoprotein cholesterol, a questionnaire survey concerning smoking habits, alcohol consumption and other socio-demographic data; the screening procedure has been described by us in more details elsewhere [10–11]. Body weight and height were measured according to the protocol of the Countrywide Integrated Noncommunicable Disease Intervention Program (CINDI) coordinated by the WHO Regional Office for Europe [12].The body mass index (BMI) calculated as body weight, (kg)/(body height (m))^2 was used for the assessment of overweight.

At the second survey the widely recognized modern classification of excessive body mass was used: BMI values 20–25 were considered as being normal, BMI 25–30 as I grade overweight, 30–40 as II grade overweight and above 40 as III grade overweight [13].According to this classification BMI ranging from 20 to 27 is considered as being acceptable.

As at the time of the first survey another classification of excessive body mass was accepted in the former USSR [14], only mean values of BMI, but not prevalence data by classes, were used for comparison of the results of the first and the second survey. Data of the both surveys were standardized according to the age-by-sex distribution of the population of Estonia.

4654 men aged 20 to 59, who underwent the initial epidemiologic examination in 1981–1985 , were followed up 11 years in average. During the follow-up period all death cases were registered and the causes of death were verified by an expert committee according to WHO criteria [15]. The relationship between BMI and mortality from CHD, cerebrovascular disease, all CVD , oncologic diseases, external causes and all causes was studied by means of quantile analysis: the age-adjusted mortality rates were analyzed in five equal parts (quintiles) of the sample distribution according to BMI values. The Cox proportional hazards model [16] was used for the analysis of the predicting power of BMI for different causes of death in 3434 men aged 35 to 59. The methodology of this analysis has been described by us elsewhere [17].

RESULTS

Tables 1 and 2 demonstrate the proportion of men and women residing in Tallinn having excessive body mass in the early 1990-s. It was

Table 1

Excessive body mass in men: years 1992–1994

Age, years	n	BMI					
		≥ 25		≥ 27		≥ 30	
		abs.	%	abs.	%	abs.	%
20–29	170	49	28.8	23	13.5	3	1.8
30–39	195	84	43.1	55	28.2	22	11.3
40–49	247	127	51.4	79	32.0	37	15.0
50–54	309	141	45.6	86	27.8	34	11.0
20–54 (age-standardized)	921	401	41.1	243	24.5	96	9.2

found that 41.1% of men and 39.4% of women aged 20 to 54 are overweight (BMI>25). In 24.5% of men and in 26.0% of women BMI exceeds 27; the corresponding figures for BMI>30 are 9.2% in men and 12.2.% in women. The prevalence of overweight increases with age, especially in women: more than in one out of five women over 40 years old BMI exceeds 30.

Table 2

Excessive body mass in women: years 1992–1994

Age, years	n	BMI ≥ 25		≥ 27		≥ 30	
		abs.	%	abs.	%	abs.	%
20–29	117	25	21.4	18	15.4	4	3.4
30–39	217	60	27.6	34	15.7	17	7.8
40–49	199	116	58.3	81	40.7	41	20.6
50–54	145	98	67.6	63	43.4	33	22.8
20–54 (age-standardized)	678	299	39.4	196	26.0	95	12.0

Mean values of BMI in inhabitants of Tallinn in 1984–1987 and in 1992–1994 are shown in table 3. The analyzed age groups were similar at both surveys with the exception of women aged 20 to 29; this age group was missing at the first survey.

The mean values of BMI were significantly lower at the second survey, in comparison to the first one. The age-standardized mean values of BMI decreased in men aged 20 to 54 from 25.1 to 24.2 ($p<0.01$), while in women aged 30 to 54 a decline from 27.7 to 25.0 ($p<0.001$) was observed. At the first survey women had significantly higher BMI than men in all age groups. At the second survey BMI mean values in women exceeded those in men only in the age group 50 to 54; in the age group 30 to 39, vice versa, men had higher BMI than women.

An analysis of BMI values according to ethnic origin is shown in the figure. At the first survey Estonian women had lower BMI values than their Russian counterparts; by the time of the second survey the ethnic differences disappeared.

During the 11-years follow-up of the male cohort 470 death cases were registered. The age-adjusted mortality rates from different causes of death were analyzed according to quintiles of BMI, which were as follows: I quintile<23.0; II quintile 23.0–24.9; III quintile 25.0–26.6; IV quintile 26.7–29.0;V quintile>29.0. The relationship between BMI and CHD, CVD and total mortality was U-shaped (tab. 4). A tendency for inverse relationship was found between BMI and cancer mortality. The Cox regression model confirmed the predictive power of BMI for cancer mortality (tab. 5). None of the other causes of death analyzed in this study were related to BMI according to the Cox regression model.

Table 3

Mean values of BMI by survey

Sex	Survey	Age, years	M±SE
Men	I	20–29	23.5±0.12
		30–39	25.4±0.13
		40–49	26.1±0.13
		50–54	26.4±0.18
		20–54 (age-standardized)	25.1±0.07
	II	20–29	22.8±0.27*
		30–39	24.6±0.30*
		40–49	25.3±0.27*
		50–54	24.9±0.25*
		20–54 (age-standardized)	24.2±0.14*
Women	I	20–29	–
		30–39	26.9±0.37#
		40–49	27.5±0.23#
		50–54	29.7±0.38#
		30–54 (age-standardized)	27.7±0.19#
	II	20–29	22.2±0.35
		30–39	23.3±0.27#*
		40–49	26.0±0.32*
		50–54	26.8±0.41*#
		20–54	24.2±0.32
		30–54 (age-standardized)	25.0±0.18*

* (p<0.02) between I and II survey; # (p<0.01) between men and women)

DISCUSSION

The mean values of BMI in men residing in Tallinn are similar to those in Eastern-European populations and lower than in Northern and Western Europe [18] and in the USA [19]. Ten years ago women residing in Tallinn were significantly more obese than men. This phenomenon is typical for Southern and Eastern European popula tions [18]. At present female inhabitants of Tallinn have higher BMI mean values only in the older age group (50 to 54); the situation is

Table 4

Age — adjusted death rates in relation to BMI (4 654 men aged 20 to 59; 11 years follow-up)

BMI, quintiles	Age — adjusted death rates per 1,000 person — years (M±SE)						
	CHD	Cerebrovascular diseases	All CVD	Oncologic diseases	External causes	Others	All causes
I	2.79±0.89	1.04±0.37	4.33±1.27	3.62±1.34	1.93±0.25	1.94±0.35	11.81±2.96
II	1.44±0.44	1.16±0.53	3.18±1.11	1.56±0.48	2.70±0.45	1.27±0.31	8.72±1.80
III	1.32±0.29	0.94±0.39	2.92±0.75	2.09±0.56	1.81±0.47	1.53±0.35	8.36±1.52
IV	3.02±0.80	0.59±0.20	3.90±0.13	1.95±0.58	1.07±0.38	1.37±0.6	8.30±2.24
V	2.94±0.70	1.94±0.62	5.17±1.19	1.46±0.44	1.38±0.28	0.98±0.35	8.98±1.78

Table 5

Cox regression model for cancer mortality (3434 men aged 35 to 59; 11 years follow-up)

Variable	β-coefficient	SE	Wald Chi-square	p	RR	95% confidence limit	
						lower	upper
Age	0.102519	0.01648	38.70545	0.0001	1.108	1.073	1.144
Blue collar work	0.621981	0.21051	6.72975	0.0031	1.863	1.233	2.814
BMI	–0.060791	0.02814	4.66634	0.0308	0.941	0.891	0.994
Number of cig/day	0.018556	0.00988	3.52692	0.0604	1.019	0.999	1.039

opposite in the age group 30 to 39. Thus, the female population of Tallinn is nearing Northern and Western European populations where men are more obese than women.

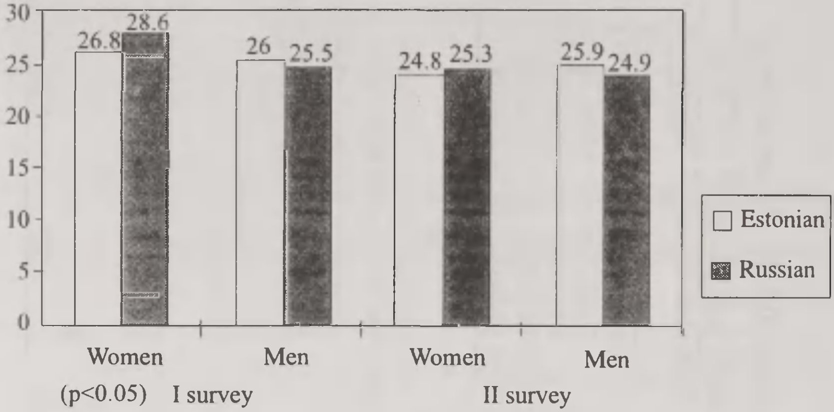

Figure. Mean values of BMI in inhabitants of Tallinn aged 30 to 54 of Estonian and Russian origin at the I and II survey.

In spite of favourable BMI trends, which occurred in the population of Tallinn during the last ten years, excessive body mass is still prevalent among men and women residing in the capital of Estonia, representing one third of the total population of the country. Two out of five are overweight, one out of four has BMI exceeding generally accepted values, one out of ten is obviously obese.

Favourable BMI trends can be explained by favourable nutrition changes during the observation period. Among the participants of the second survey 39.9% reported that they had changed their dietary habits during the last 12 months: 23.9% had switched from animal to vegetable fat, 25.9% had used less fat and 17.1% — less sugar [20].

Data of the 11-years follow-up study of a cohort of male residents of Tallinn indicated that BMI was predictive only for cancer mortality (inverse relationship). However it is possible that a part of the participants had already the oncologic disease at entry. BMI had no predictive power for any CVD. It has been found by other investigators that the role of BMI as a risk factor for CVD appears after longer observation periods [3]. It also should be mentioned that according to our previously published data neither prevalence nor incidence of CHD were related to BMI. Stepwise discriminant analysis showed that BMI was not among independent factors distinguishing men and women with epidemiologic signs of CHD from those who were free of the disease [21]. In a 3-years follow-up study no difference has been found in BMI mean values between men revealing new cases of CHD and those who remained healthy in that respect [22].

Doubtless, excessive body mass is closely related to arterial hypertension and dyslipidemia which are generally known "major risk factors" for CHD. Our previous studies also confirmed it: according to multiple regression analysis BMI proved to be the most common correlate for systolic and diastolic blood pressure, total cholesterol and triglycerides mean values [23].

It should be mentioned that along with the favourable trends in BMI mean values in the population of Tallinn during the last ten years, systolic and diastolic blood pressure [24] as well as total cholesterol mean values [25] also decreased.

CONCLUSION

Weight correction should be regarded as an important way of CVD risk reduction. But our previous studies have demonstrated insufficient activity of the health personnel in lifestyle counselling: only 4% of inhabitants of Tallinn reported having been advised by a physician to correct their weight during the last 12 months [26]. The primary health care staff should pay more attention to this kind of work.

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GENETIC DIFFERENTIATION PROCESSES IN MAN. RESULTS AND PROBLEMS OF HUMAN POPULATION GENETICS

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ABSTRACT

Basing on several polymorphic systems of the blood the importance of genetic markers to the understanding of the genetic variability within the present-day human species is demonstrated. This variability is caused by the operation of various genetic differentiation factors, the effects of which, however, cannot be distinguished sharply from each other in many cases. These factors are selection, gene flow in connection with migration and mixing of populations as well as genetic drift and founder effects, which play an important role especially in small, geographically and/or socio-culturally isolated populations. Examples for the meaning of selectively acting factors are the distribution of the *AB0*B* allele of the AB0 blood group system, the distribution of the *FY* allele of the Duffy blood group system and the distribution of the *HB*S* allele. Examples for the meaning of migration processes and gene flow are the distribution of the *DI*A* allele of the Diego blood group system, the distribution of specific haplotypes of the GM serum protein system and the distribution of the *HB*E* allele in South East Asia and India. Founder and genetic drift effects have to be considered concerning the genetic peculiarities of small isolated populations such as those of the Pacific islands or the isolated populations of Europe as e.g. Saami, Sardinians, Basques and Roma. Beyond that genetic distance measurements make it possible to detect genetic relations between human populations and contribute thus to the reconstruction of population history processes. It is safe to say that the increasing incorporation of DNA polymorphisms into population genetic studies will contribute considerably to the understanding of genetic variation within the human species.

Key words: genetic markers, distribution patterns, differentiation factors

INTRODUCTION

One of the most important research problems of human biology is without doubt the reconstruction of the human evolution and the spread of the anatomically modern man over almost the whole world, which was connected with the emergence of marked differences in man's physical appearance. This has been described in detail e.g. by Jones *et al.* [1] and Cavalli-Sforza *et al.* [2]. In this paper the genetic variability within the present-day human species will be discussed, based on some genetic markers of the blood. These markers are therefore highly suited for population genetic studies as in comparison with anthropometric etc. traits they 1. are well defined and demonstrable with reproducible laboratory methods, they 2. are independent from environmental and age factors, they 3. are genetically cleared up completely, and 4. basing on observed phenotype frequencies it is possible to calculate allele or haplotype frequencies, respectively, so that population comparisons are possible on a genetic level.

The first genetically determined blood group system was discovered in 1900 by Karl Landsteiner (1868–1943), the so-called AB0 blood group system [3]. The Polish serologists Ludwig and Hanna Hirschfeld (1964–1954 and 1884–1964) were the first, who could demonstrate population differences in the distribution of the AB0 blood groups [4]. Since this time not only numerous further blood group systems could be discovered, but also many polymorphic serum protein and red cell enzyme systems, and moreover also many genetically determined haemoglobin variants and last but not least the so-called HLA system. The discovery of nuclear and mitochondrial DNA polymorphisms has also to be mentioned in this context. It is not possible, however, to discuss here the population genetic impact of all these polymorphic systems. Only some examples can be given in the following in order to demonstrate this. For further details see Walter [5].

BLOOD GROUP POLYMORPHISMS

The first example, which can be discussed here briefly, is the *AB0 system*. From many family studies it is known that this polymorphic system is controlled by four autosomal allelic genes. The gene locus is located on chromosome 9q34.1–q34.2. The frequencies of the four AB0 alleles reveal remarkable distribution patterns, which are shown in Figs. 1–4. Thus the *AB0*A1* allele is obviously more frequent in all

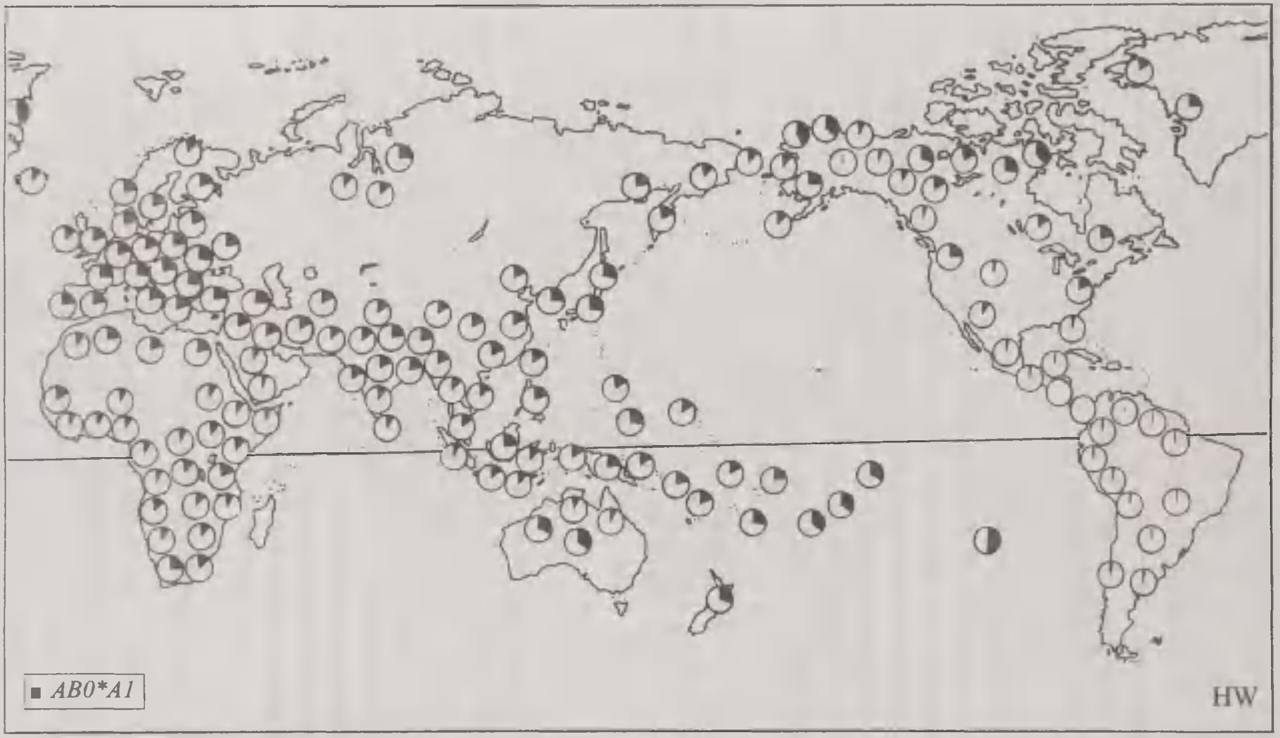

Figure 1. Geographical distribution of *AB0*A1* allele frequencies (from Walter 1997 [5]).

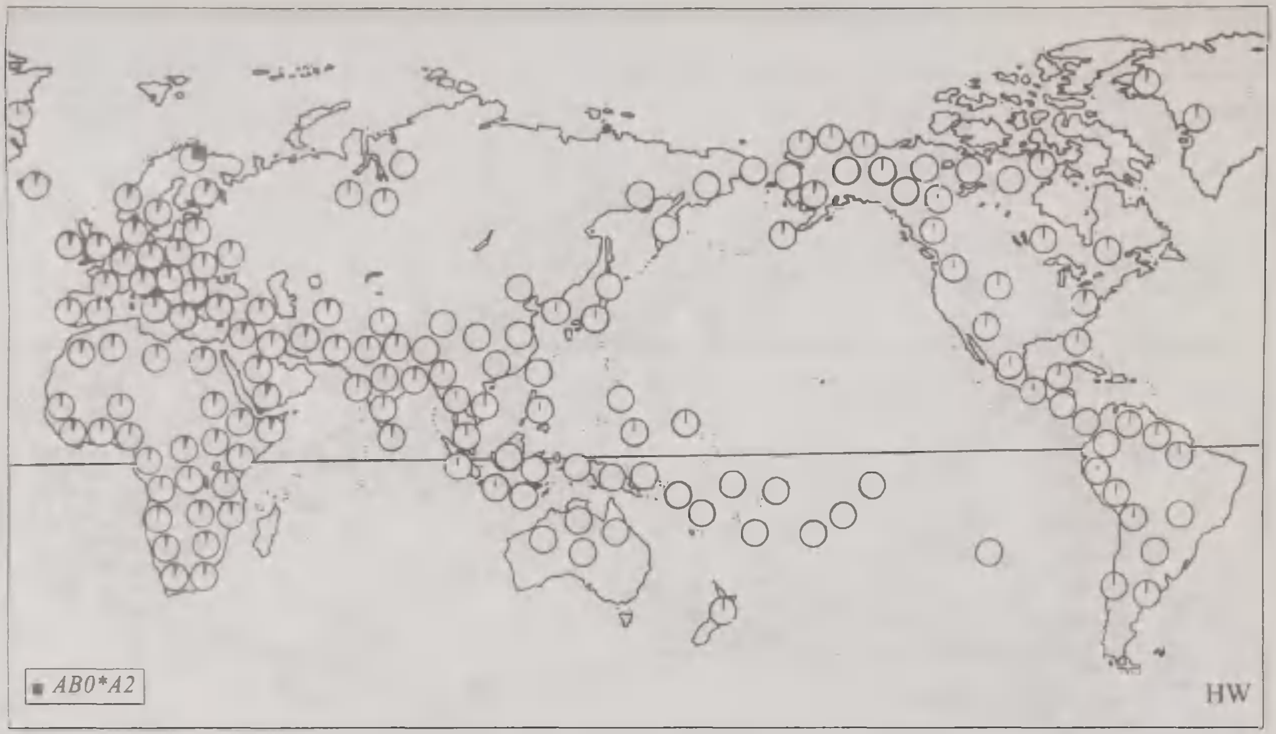

Figure 2. Geographical distribution of *AB0*A2* allele frequencies (from Walter 1997 [5]).

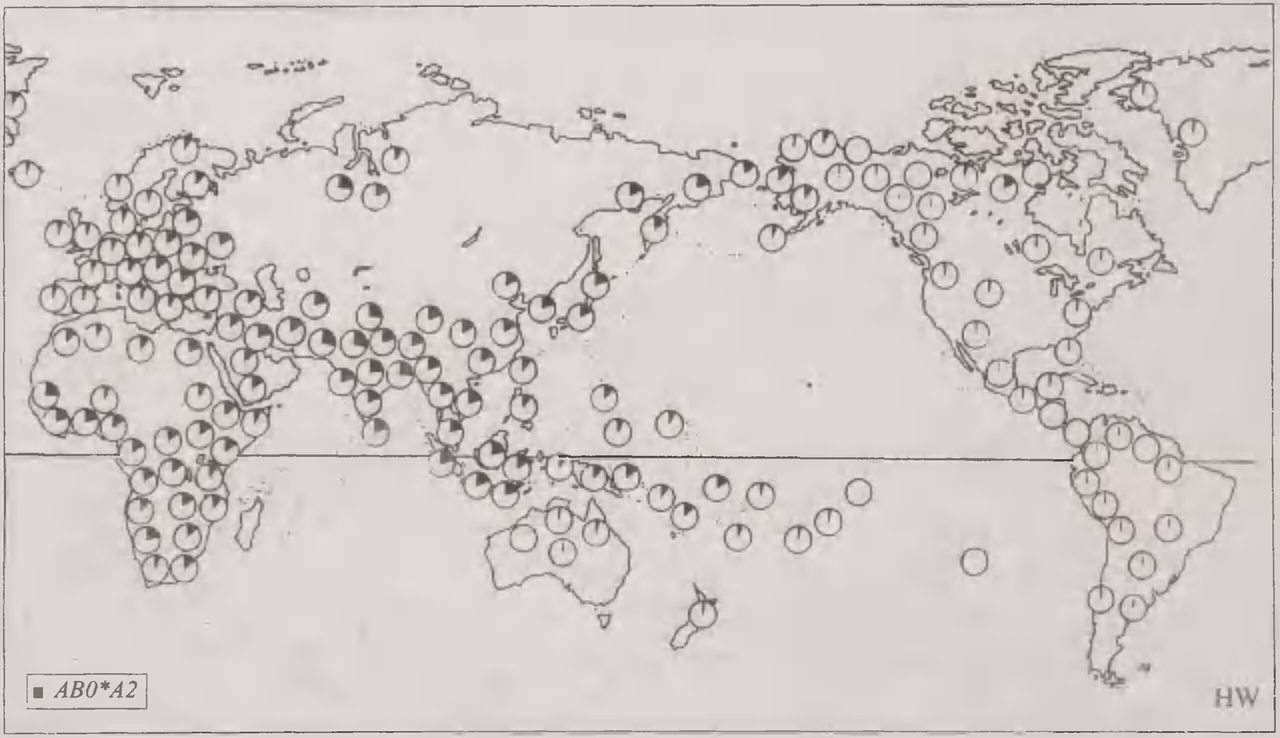

Figure 3. Geographical distribution of *AB0*B* allele frequencies (from Walter 1997 [5]).

Figure 4. Geographical distribution of *AB0*0* allele frequencies (from Walter 1997 [5]).

European, Asiatic and Pacific populations as compared with African populations, and especially with Central and South Amerindian populations. The generally rare *AB0*A2* allele is found in particular among European, Southwest Asiatic and African populations. The *AB0*B* allele reveals the highest frequencies in Asia, followed by Africa and Eastern Europe. Finally, the *AB0*0* allele is quite frequent in all populations, but shows extremely high values especially in Central and South American Amerindians. One can assume that all these distribution patterns are not due to chance effects but reflect the results of several genetic differentiation processes among which selection seems to play an important role. This shall be demonstrated concerning the distribution pattern of the *AB0*B* allele.

It is seen from Fig. 3 that the *AB0*B* allele is rather frequent in many parts of Asia, especially in the eastern, southeastern and southern regions of this continent. It was the German human geneticist Friedrich Vogel, who pointed out that the geographical distribution pattern of this allele and that of the smallpox show remarkable similarities [6]. It could be shown furthermore, that the small pox causing virus (Variola) possesses an antigen, which is similiar to that of the blood goup antigen A. From these observations it was concluded that individuals possessing the blood groups A and AB would therefore not be able to recognize this virus so quickly and to start corresponding immunbiological reactions as compared with individuals possessing the blood groups B and 0, who have in their serum antibodies against the blood group A antigen and would thus be able to to recognize the smallpox virus earlier und could react correspondingly. This would mean that individuals with blood group B would have a greater chance to survive a smallpox infection. By detailed investigations in India and Pakistan this assumption could be confirmed [7–9]; see Fig. 5. As the *AB0*B* allele is very frequent especially in those geographical regions, where smallpox were epidemically until this century one can suppose that the present-day distribution pattern of this allele reflects at least partially the results of selectively acting processes, which took place for many generations in the populations of the old smallpox regions.

Another example for the effects of selection on the geographical distribution of blood groups is the *Duffy system*, discovered by Cutbush *et al.* [10]. By family studies three different phenotypes could be demonstrated: FY (A+B–), FY (A+B+) and FY (A–B+), caused by

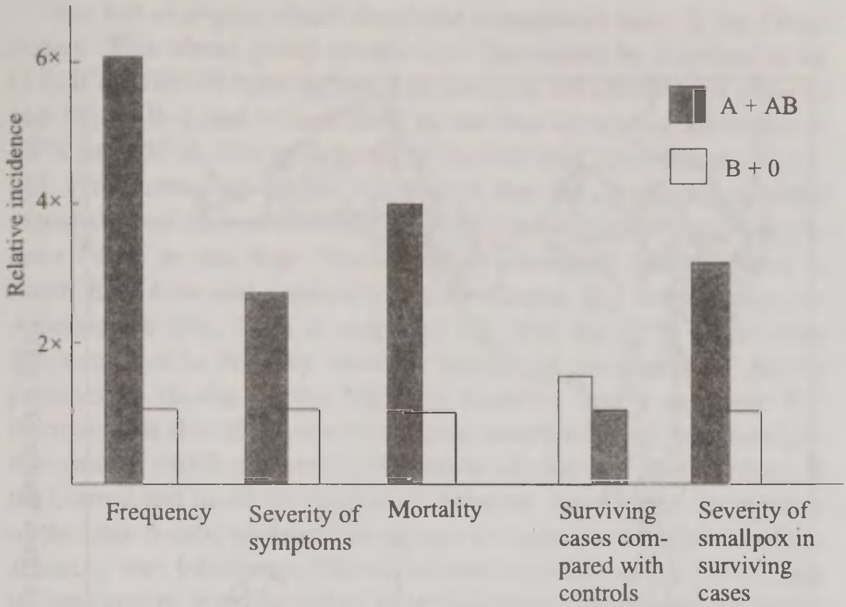

Figure 5. Relative incidence of smallpox in blood group A + AB and B + 0 patients (from Vogel & Motulsky 1997 [8]).

the two autosomal allelic genes *FY*A* and *FY*B*. The gene locus is located on chromosome 1q21–q25. However, in addition to these three phenotypes a fourth one could be observed, namely FY (A–B–), which is caused by homozygosity of a third Duffy allele: *FY*. In most of the populations this third Duffy allele is very rare or even completely absent. In some parts of Africa, however, the frequency of the allele *FY* is rather high (Fig. 6). How can this be explained? It could be shown [11–12] that the phenotype FY (A–B–) has an obvious biological advantage in those regions of Africa, where the plasmodium vivax caused malaria tertiana or malaria vivax is frequent, as individuals possessing this Duffy phenotype proved to be largely resistent against this type of malaria. The reasons for this can be seen in the fact, "that Duffy determinants (Fy^a or Fy^b or both) on the erythrocyte surface are required for invasion of erythrocytes by vivax merozoites" [12: p. 302]. Insofar one can suppose that in such regions of Africa, where malaria vivax was or is even now endemic selection took place against *FY*A* and *FY*B* alleles and favoured in the course of time the increase of *FY* alleles. For further details see Walter [5].

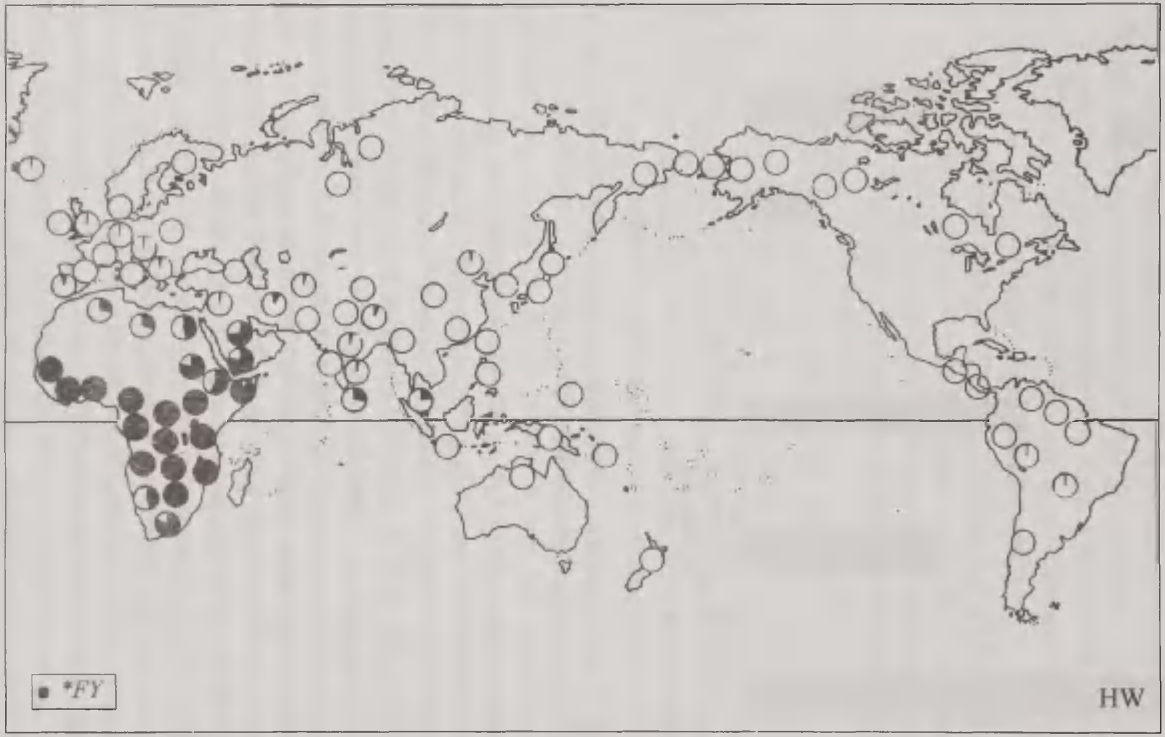

Figure 6. Geographical distribution of *FY* allele frequencies (from Walter 1997 [5]).

The last example, which should be considererd here, is the *Diego system*. This blood group system was discovered by Layrisse *et al.* [13]. It consists of three different phenotypes: DI (A+B–), DI (A+B+) and DI (A–B+) and is controlled by the two autosomal allelic genes *DI*A* and *DI*B*. The gene locus is located on Chromosome 17q12–q21. From numerous studies it is known, that the *DI*A* allele is either extremely rare or even completely absent in the most human populations. More or less high frequencies of this allele are only seen in South East Asia and especially among Central and South American Amerindians (Fig. 7). It is supposed (14) that the *DI*A* allele came into existence in Asia by mutation *before* the emigration of Asiatic populations via the Bering Street to America, and it supposed furthermore that this allele was brought to America by the *first* immigration groups, which migrated in the course of time from the Northern to the Central and Southern regions of America. Among the descendants of the later Asiatic immigration groups to America this allele is either absent or very infrequent. The occasional occurence of the *DI*A* allele in these groups is explained by gene-flow between between the earlier and later immigration groups. The distribution gradient of the *DI*A* allele in Asia could be connected with migration and/or gene flow effects, and as far as India is concerned it could be pointed out, considering the history of the various population groups living in the Indian sub-continent, that the distribution of the *DI*A* allele reflects more or less marked gene flow from the Mongoloid side, which affected in particular tribal populations of the eastern, central and western parts of India [15]. Thus this polymorphic blood group system is an especially good example for the importance of migration and/or gene flow effects concerning the understanding of the geographical and ethnic variability of gene frequencies.

SERUM PROTEIN POLYMORPHISMS

By intensive research work during the last decades the polymorphic nature of many serum proteins could be demonstrated. Most of them show remarkable differences concerning their allele frequencies, which are also caused by various genetic differentiation factors such as selection, geographical and/or socio-cultural isolation, founder and/or genetic drift effects, gene flow etc. This applies e.g. to the haptoglobin system, the Gc system, the transferrin system or the PI

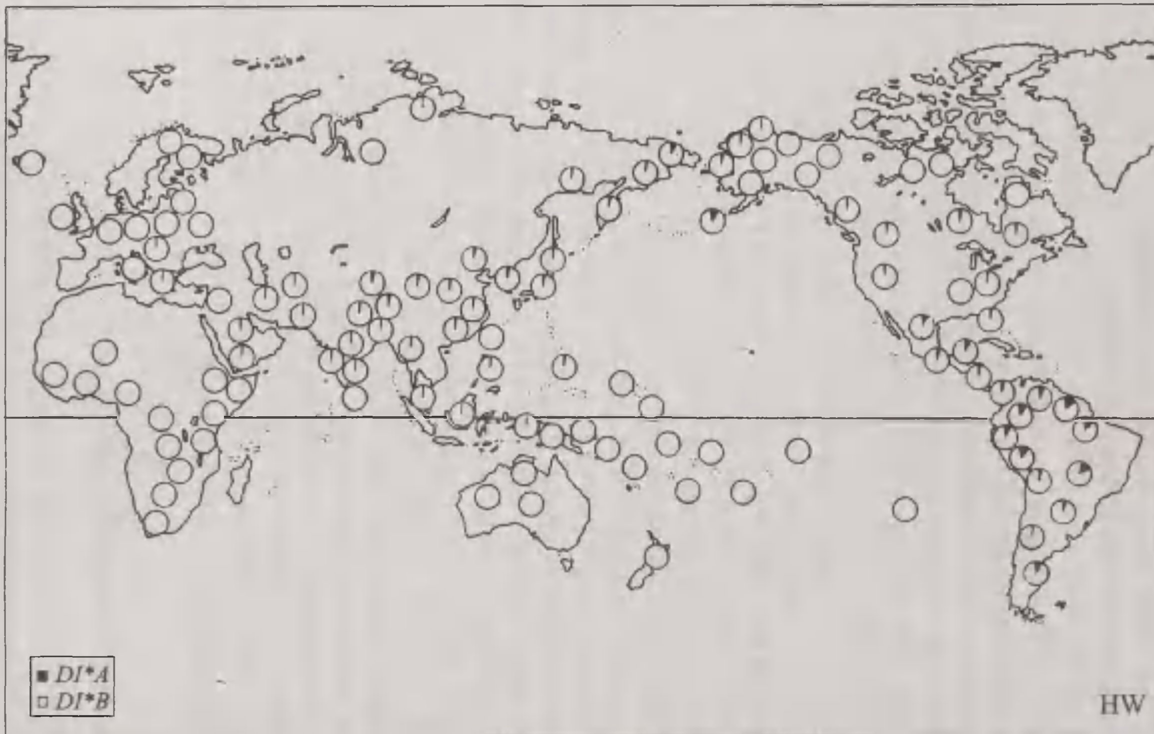

Figure 7. Geographical distribution of *DI*A* and *DI*B* allele frequencies (from Walter 1997 [5]).

system, which can be typed by means of electrophoresis. The population genetic value of all these polymorphic systems increased yet considerably, when the technique of isoelectrofocusing was introduced into serum protein genetics. It is not possible, however, to discuss here all the numerous serum protein polymorphisms, which are known today. Their importance to population genetics can be demonstrated here only by the so-called *GM-system*. For further details concerning the population genetics of the serum protein polymorphisms see Walter [5].

The *GM system* was discovered by Grubb [16]. Today 18 different GM factors are known. These factors are determined by a series of autosomal alleles, which are inherited in so-called haplotypes. The gene locus is located on chromosome 14q32.33. Some of these haplotypes (*GM*1;21*, *GM*1,2;21* and *GM*3;5,13*) are present in almost all human populations, showing, however, clear distribution frequencies. Other GM haplotypes are found in distinct populations or population groups only, such as e.g. *GM*1;13,15,16*, *GM*1,3;5,13*, *GM*1;5,13* and *GM*1;5,6*. Figures 8–11 show the distribution patterns of these four GM haplotypes. The first of them (*GM*1;13,15,16*) could be observed especially in North and Northeast Asiatic populations, but is present also among Inuits as well as among Amerindians. In the other geographical regions this haplotype is either complety absent or occurs only sporadically, e.g. in some parts of Eastern and Southern Europa (Fig. 8). The second one (*GM*1,3;5,13*) is very frequent in Southeast Asia as well as in the whole Pacific region. This haplotype is completely absent or even quite rare in all the other geographical regions (Fig. 9). One can agree to the assumption that these distribution patterns reflect the existence of long-standing gene flow from East Asia to Southeast Asia, South Asia, the Pacific region and even to Europe [17].

Against that the other two GM haplotypes considered here — *GM*1;5,13* and *GM*1;5,6* — could be observed only among African populations (Figures 10–11). It has been suggested that they came into existence by mutation in Subsaharan Africa and spread through this continent by migration and/or gene flow.

It is not possible, however, to discuss here the highly interesting distribution patterns of these four GM haplotypes in detail; for this see Walter [5]. But it is clear from these examples that GM haplotypes are also excellent genetic markers for the analysis of migration and gene flow processes in man.

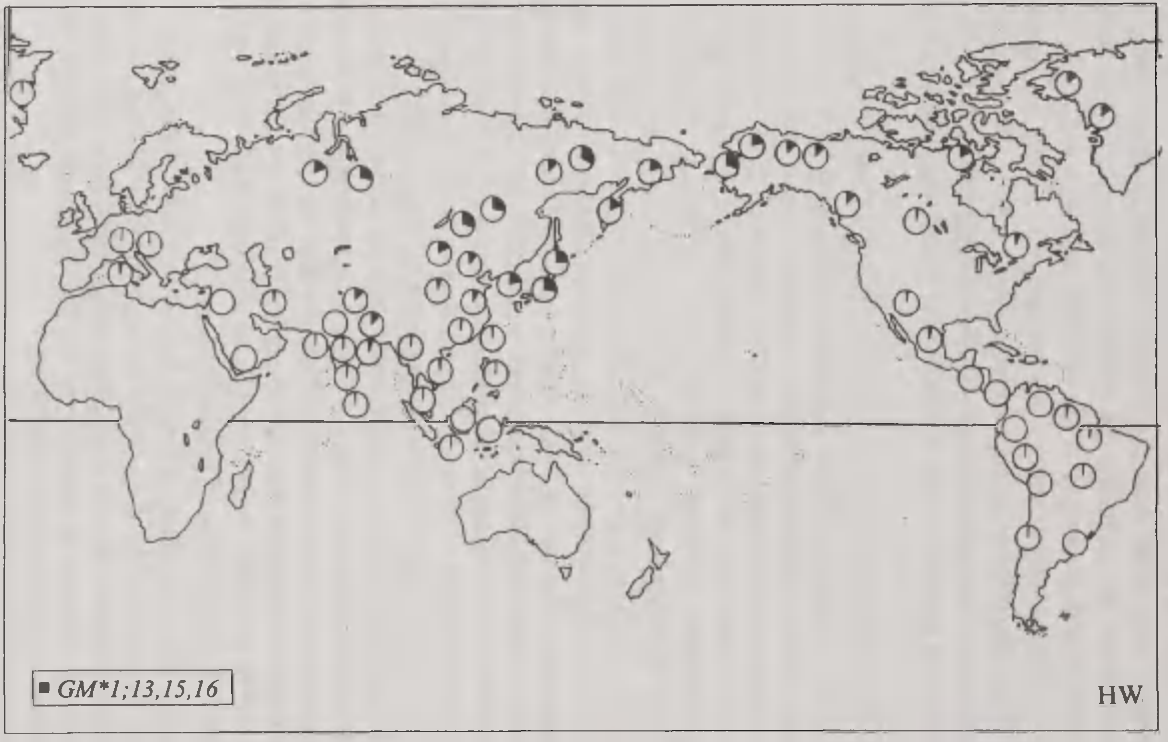

Figure 8. Geographical distribution of *GM*1;13,15,16* haplotype frequencies (from Walter 1997 [5]).

Figure 9. Geographical distribution of *GM*1,3;5,13* haplotype frequencies (from Walter 1997 [5]).

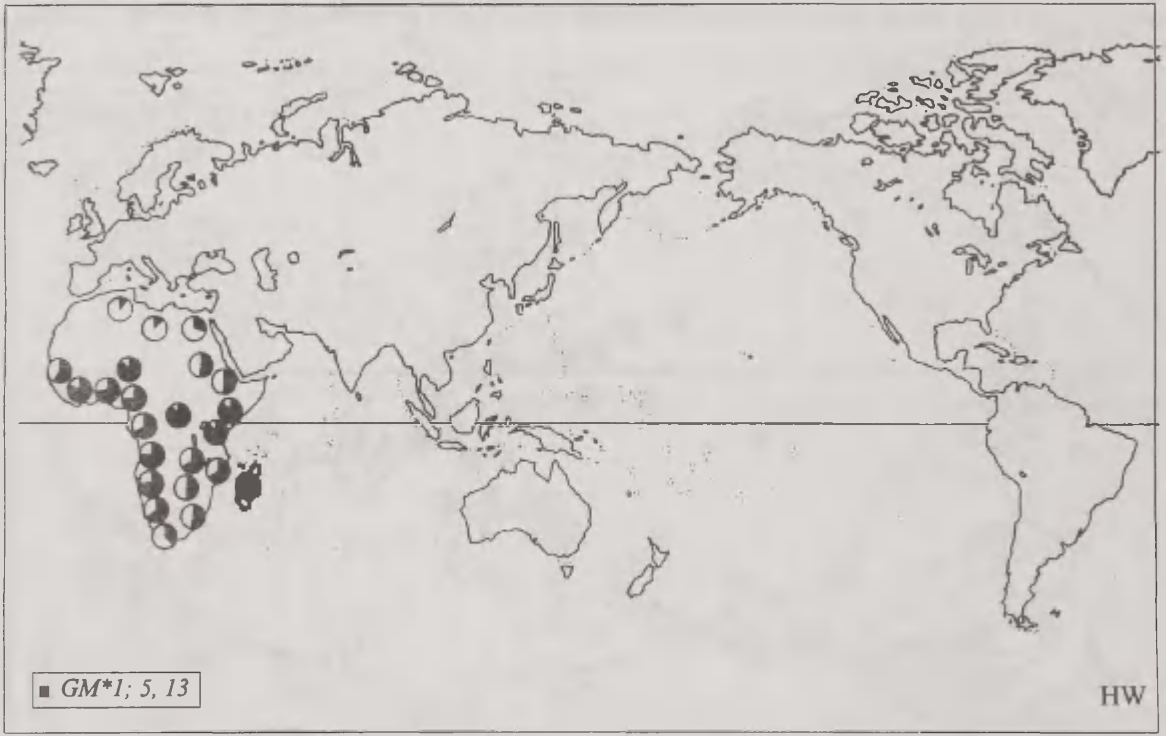

Figure 10. Geographical distribution of *GM*1;5,13* haplotype frequencies (from Walter 1997 [5]).

Figure 11. Geographical distribution of *GM*1;5,6* haplotype frequencies (from Walter 1997 [5]).

HEMOGLOBIN VARIANTS

According to Honig & Adams III [18] up to now more than 470 genetically controlled hemoglobin variants are known. Most of them are characterized by single amino acid replacements in the α- or β-chains. The gene locus of the α-chains is located on chromosome 16p13.3, that of the β-chains on chromosome 11p15.5. However, only some of these hemoglobin variants, namely HB S, HB C and HB E, are of particular population genetic interest. Two of them — HB S and HB E — should be considered here briefly; for details see Walter [5].

Fig. 12 depicts the geographical distribution pattern of *HB*S* allele frequencies. The highest frequencies of this allele are to be seen in Central Africa, but it occurs also in North and South Africa, in Southwest and South Asia and even in South Europe this allele was observed. As the distribution pattern of this allele is very similar to that of malaria tropica, caused by plasmodium falciparum, a causal connection between these two distribution patterns has been suggested. It could be shown that in regions with endemic malaria tropica HB AS heterozygotes have a considerable biological advantage, as in comparison with HB AA homozygotes the malaria mortality of HB AS heterozygotes is obviously lower. Without going into details the present stage of discussion can be summarized as follows: "1. The homozygous sickle-condition is virtually lethal in Africa. The rate of elimination of the gene could not be compensated by recurrent mutations. 2. Balanced polymorphism has resulted because the sickle cell heterozygote is at advantage, mainly as a consequence of protection against Falciparum malaria. 3. Malaria exerts ist selective effect mainly through different viability of subjects with and without the sickle cell gene between birth and reproductive age, and to a much lesser extent through different fertility. 4. High frequencies of the sickle cell gene are found only in regions where Falciparum is, or was until recently, endemic" [8: p. 523].

However, this geographical variability in the distribution of *HB*S* allele frequencies was not only caused by different selection pressures, but one has also to consider the effects of migration and/or gene flow. It was suggested "that the sickle cell gene is a relatively recent introduction into Western Africa, apparently via a migratory flow originating east of Ghana", and furthermore, "that this gene was introduced into Africa in comparatively recent times, perhaps about the seventh century A.D., i.e. after the South African Bantu-speaking groups, who

Figure 12. Geographical distribution of *HB*S* allele frequencies (from Walter 1997 [5]).

are non-sicklers, had crossed the Zambesi, and that possibly the people who introduced and first spread the sickling gene prior to its selective advantage had been established were the people who were accompanied by the short-horn zebu cattle. These cattle are highly successful in tropical areas and possible the fact that the groups who accompanied them had a selective advantage in respect of malaria led to their migratory success" [19: 157–158]. The presence of the *HB*S* allele on Madagascar can also be explained by such processes as it is known that great numbers of Negroe slaves were taken from Africa to Madagascar from the twelfth to the nineteenth century [19].

By the application of molecular genetic methods to hemoglobin genetics it was possible to demonstrate the existence of five different β^S-globin haplotypes, which were caused by independent mutations. One of these five haplotypes was observed in Southwest Asia and India, the so-called "Indo-Arabian haplotype". The other four haplotypes were observed in different regions of Africa, the "Senegal haplotype", the "Benin haplotype", the "Cameroon haplotype" and the "Congo haplotype". It was suggested that the β^S gene might be the result of a single mutation in Southwest Asia and could spread therefore so fast over many regions of the Old World, because it was of considerable selective advantage in all regions with endemic malaria tropica. It was furthermore suggested that the various haplotypes observed in Africa resulted from gene conversion and/or recombination processes, respectively [20]. It seems that the spread of the β^S gobin gene and its different haplotypes into and within Africa is a relatively younger process, and most likely the introduction of this gene into Africa is connected with the Arabian-Islamic expansion since the 7. century A.D. It is interesting to state that the distribution of the Senegal, Cameroon and Congo haplotypes seems to be restricted to Africa, in particular to these specific regions, whereas the Benin haplotype is showing a much larger distribution pattern, because it could be observed also in Nigeria, Togo, Algeria, and even in Sicily, Greece, Albania, Turkey and the Middle East. That means that this haplotype is as well a good genetic marker for the recording of migration and gene flow processes in man [5].

It should be mentioned in this context that many conventional hemoglobin variants as well proved to be good genetic markers for the recognition of such processes. In China e.g. many rare hemoglobin variants could be observed along the ancient Silk Road, which can be considered as indicators for gene flow, "because during the centuries the Silk Road was travelled by numerous persons of different racial or ethnic backgrounds" [21: 235].

Of considerable population genetic interest is also the distribution pattern of the *HB*E* allele, which shows high frequencies only in Southeast Asia, whereas it is very rare or completely absent in all the other geographical regions (Fig. 13). Though its distribution in Southeast Asia reflects also the results of selectively acting processes, which, however, cannot be discussed here in detail, the distribution pattern of the *HB*E* allele is therefore interesting, because it is obviously connected with the distribution of the Mon-Khmer languages (Figures 14–15). It could be shown [22], that the *HB*E* allele appears to be centered in a focus of maximal frequency in the Khmer population of northern Cambodia and adjacent regions of northeastern Thailand. From this focus the *HB*E* allele frequencies decrease obviously in all directions, showing clear connections with the distribution of the so-called Austro-Asiatic languages. To explain this the following explanation was given: "If the well documented distribution of the austroasiatic languages in early historical times is taken as a starting point it is obvious that a diffusion of austroasiatic languages must have occured, most likely during the the late neolithics or the bronze-iron period. It is not necessary to assume mass migrations; the diffusion may have been a slow process of continual short-distance migration (e.g., in search of arable landd), the superior culture and language being superimposed on preexisting forms. The most likely explanation for the congruence of the distribution of austroasiatic languages and the of HbβE would seem to be a concominant diffusion process: emergence of HbβE in a hypothetical original austroasiatic group and diffusion of both HbβE and austroasiatic language and associated culture throughout mainland Southeast Asia" [22: 226]. Such processes can also explain the occurence and the distribution of the *HB*E* allele in India, especially in the eastern and northeastern regions of this country [23]. Thus the distribution pattern of the *HB*E* allele is another good example for the usefulness of genetic markers of the blood for the recognition of migration and gene flow processes in man. In this connection it is worth mentioning, that the *HB*E* allele is absent not only among the indigenous populations of New Guinea and Australia, but also among those of the Pacific region, though the Pacific islands were peopled for the most part from mainland Asia, and to a great extent from areas where populations now have high frequencies of hemoglo-

Figure 13. Geographical distribution of *HB*E* allele frequencies (from Walter 1997 [5]).

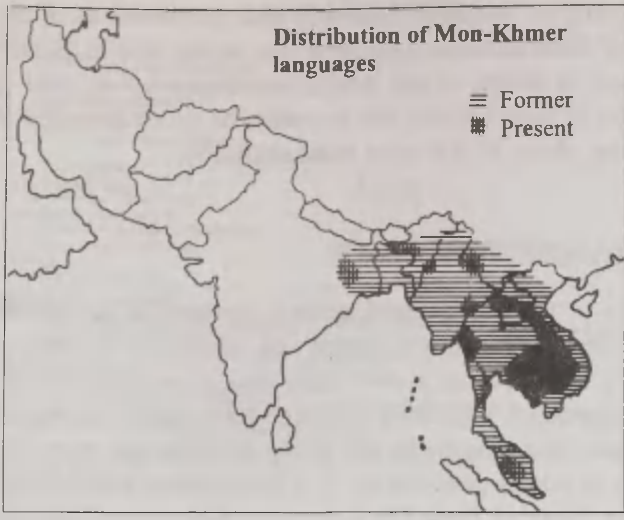

Figure 14. Former and present distribution of Mon-Khmer languages (from Flatz 1967 [22]; modified).

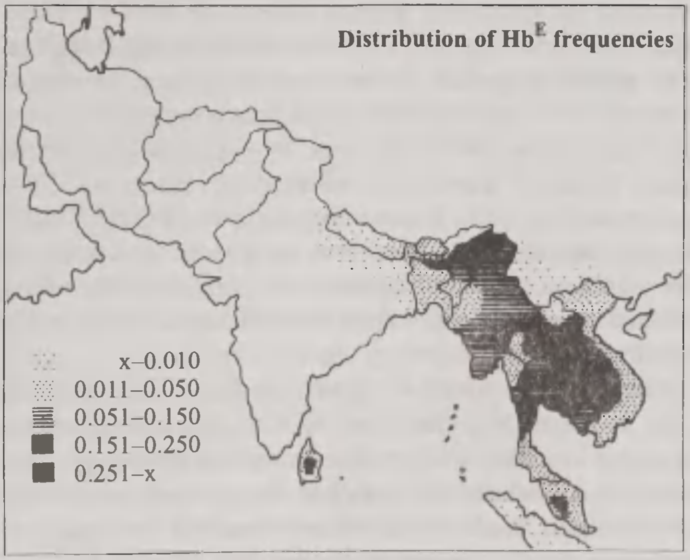

Figure 15. Distribution of *HB*E* allele frequencies in Southeast Asia and India (from Flatz 1967 [22]; modified).

bin E. It was suggested that the *HB*E* allele came into existence and could spread over Southeast Asia only after the ancestors of the Pacific populations have left Asia [24], and this would also explain, why the *HB*E* allele is absent in the Australian Aborigines as well as in the populations of New Guinea, the ancestors of which have left Asia still much earlier, about 30.000 years before now [5].

DNA POLYMORPHISMS

In addition to the conventional genetic markers of the human blood, now the extremely numerous nuclear and mitochondrial DNA polymorphisms are also becoming also more and more important to human population genetics, especially concerning the understanding of migration and gene flow processes, and thus concerning the reconstruction of the history of human populations. It is not possible, however, to go here into details. Some of these DNA polymorphisms have been mentioned already above. Only two examples can ge given here in order to demonstrate the usefulness of population genetic DNA studies.

Investigations on the two STR (short tandem repeat) loci *HUMT01* and *HUMVWA31* in several Asiatic, African and European populations revealed not only clear genetic differences between these three geographical groups, but also within the Chinese and European samples. The observed genetic variations within these two population groups are in line with those observed concerning conventional genetic markers of the blood and can be explained considering the population historical processes, which took place in China and Europe, respectively [25]. Concerning the Loci *DYS19*, *D12S67* and *D1S80*, too, considerable differences within European populations could be observed [26], and in particular, *D1S80* allele frequencies distinguished clearly the Finns from other European groups (Spanish, Germans, Italians and Greeks).

The last example considers a genetic marker of the mitochondrial DNA, the so-called *9-bp-deletion*. Fig. 16 shows its distribution in Asia, America and the Pacific region. It was suggested, that this deletion came into existence by mutation “in a region extending from China to Southeast Asia”, from where it reached by migration other Asiatic regions, the Pacific region and America [27–28].

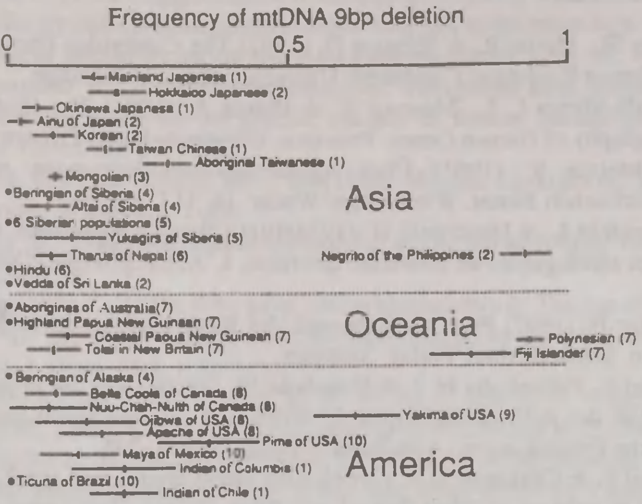

Figure 16. Geographical and ethnic distribution of the mitochondrial *9-bp-deletion* (from Saitou 1995 [28]).

CONCLUSIONS

It was not possible to discuss here in detail the importance of the numerous genetic markers of the blood to the understanding of genetic variation in and between human populations. And is was also not possible to deal exhaustively with the various factors, which caused this variation. This could be demonstrated only on the basis of very few examples. The reasons for these differences are to be seen in the effects of many genetic differentiation factors: selection, migration, gene flow, genetic drift and founder effects, geographical and socio-cultural isolation. They contributed in different ways to the emergence of the genetic variability of modern man. Though in the past decades human population genetics could contribute considerably to our understanding of genetic differentiation processes in the human species, which took place during the spread of the anatomically modern man over almost all parts of the world, much more work has yet to be done before these processes including the mechanisms responsible for them will be understood in all details. Apart from the numerous conventional genetic polymorphisms of the blood in future without doubt DNA polymorphisms will play a more and more increasing role in this context.

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THE ANALYSIS OF CEPHALOMETHRICAL PARAMETERS OF CHILDREN WITH ANKYLOGLOSSIA

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ABSTRACT

26 children with ankyloglossia (age 3 to 10 years) were studied. The abnormal cephalomethrical parameters (bigonial breadth, upper face height) in children with ankyloglossia were found. Abnormal tongue activities were also related to dental deformities (in 57.7%) and speech disorder (in 8.4% of children).
Key words: ankyloglossia, cephalomethrical parameters, children

INTRODUCTION

Embrionically, the tongue is derived from the hyoid arch, with additions from the third and fourth bronchial arches. The genioglossus muscles of the tongue meet at the midline in a distinct fold covered by mucous membrane forming the lingual frenum [1]. The congenitally short lingual frenum unites the tongue to the lingual mucosa of the mandible and floor of the mouth. Some authors regard ankyloglossia's occurrence in the newborn as a normal variant [8], others hold that ankyloglossia is a very rare anomaly [3].

Early studies report the incidence of ankyloglossia to be as low as 0,04% to 0,4% of population [6]. Later studies show that the incidence of those abnormalities is between 2,2% and 6,83% [9].

The tongue is an accessory organ with its importance in mastication, deglutition and speech. At birth, the tongue unconfined by teeth extends outward between the maxillary and mandibular occlusal gum pads. With the eruption of the teeth, the tongue remains confined within the oral cavity. The tongue also act has a stimulating impact on the development of the dental arches. Abnormal tongue activities can produce dental and facial deformities and dysarthria ("speech disorder") [10].

The aim of the study was an estimation of some cephalomethrical parameters as the elements of ankyloglossia syndrome.

MATERIAL AND METHODS

The study population included 26 children (19 boys and 7 girls) aged 3–10 years with tongue-tie. There were determined height and body mass and 4 cephalomethrical parameters by Cieœlak's et al. methods [2]:

a) total face height (distance between points nasion-gnation),
b) bizigomatic breadth (distance between points zigion-zigion),
c) bigonial breadth (distance between points gonion-gonion),
d) upper face height (distance between points zigion-gnation).

The cephalomethrical parameters were related in relation to normal values for children of the same height.

The frequency of speech disorder and dental deformities were estmated after speech-pathologist and orthodontist examination.

RESULTS

Frequency of facial abnormalities are presented in Table 1.

Table 1

Frequency of facial abnormalities in children with tongue-tie

Cephalomethrical parameter	Normal		Abnormal	
	n	%	n	%
Total face height	16	61,5	10	38,5
Upper face height	12	46,2	14	53,8
Upper face breadth	16	61,5	10	38,5
Bigonial breadth	8	34,6	18	65,4

Analysis of cephalomethrical parameters showed that abnormality of one (or more) examined parameter(s) had 92,3% of children with ankyloglossia. The most frequent abnormal cephalomethrical parameters were bigonial breadth and upper face height (Table 1).

Frequency of dental abnormalities and speech disorders are presented in Table 2.

Table 2

Frequency of dental abnormalities and speech disorder in children with tongue-tie

Abnormality	Number of children	%
Dental abnormality	15	57.7
Speech disorder	22	84.6
Dental abnormality and speech disorder	13	50.0

Twenty two examined children (84,6%) had speech disorder and 15 (57,7%) had dental deformities and dysarthria (Table 2).

DISCUSSION

Though many authors thought that ankyloglossia was more frequent deformation of children and adults [4, 8, 10], there were only few reviews about anthropological consequences and dental deformities of tongue-tie. We found that almost all children with tongue-tie had at least one abnormal cephalomethrical parameter, the most frequent being bigonial breadth or upper face height.

Tuerk and Lubit described the abnormal position and perverted use of the tongue in ankylogkossia which resulted in a malocclusion, such as anterior open bite, or bilateral posterior open bite [10].

We found dental deformities in over 50% of examined patients.

Polish authors paid attention to the speech problems of children with ankyloglossia. Mackiewicz thought the tongue-tie did not interfere with correct speech [5], but Pruszewicz found that ankyloglossia caused incorrect articulation of sounds: “s”, “l”, and “r” [7]. In our study we found that 84,6% of children with ankyloglossia had dysarthria, and 13 (50,0%) of them had both dysarthria and dental deformities.

CONCLUSIONS

1. The abnormal face morphology may be an element of clinical syndrome of ankyloglossia.

2. High frequency of dental deformities and speech disorder in children with ankyloglossia indicates that diagnosis and therapy should be realised as soon as possible.

3. Anthropological and clinical estimation of children with ankyloglossia should be repeated after the surgical correction.

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STATISTICAL DISTINCTION OF CONSTITUTION TYPE BY ANTHROPOMETRIC INDICES AND ITS PRACTICAL APPLICATION

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ABSTRACT

All the biological characteristics are traditionally (since the XVIII century) considered to be distributed by Gaussian statistical law. This principle was assumed as a basis of the norm conception widely used in biology and medicine. But some authors reported of opposite data concerning with anthropometrical indices and motorics. The purpose of present investigation was to analyse statistical distribution of some anthropometric indices in young males. Basing data of representative samples of juniors (15-year; n=122 and 16-year; n=172) as well young adult males (n=260) it was revealed that the distribution law for simple anthropometric indices differs from normal. Statistical distinction was proved for constitutional types indicated by Shtefko-Ostrovsky 3-component scheme including asteno-thoracal, musculine and diggestive types (ectomorph, mesomorph and endomorph). Moreover the distribution of ectomorphy index as well of chest and waist girth (normalized by body height) were shown to fit Gaussian law inside every constitution type group that could be an evidence to using a constitutional type mean as a norm in some situations. As a particular, constitutional typology is offered to be used as a basis for an individual approach in sports, physical education, professional orientation and professional selection.

Key words: human constitution; statistical distribution; anthropometry, physical culture.

INTRODUCTION

Most conceptions of biology, medicine and health-caring physical exercise are based traditionally (since A. de Moivre (1718) and L. A. Quetelet (1835)) on the notion that all the human population characteristics are obeyed to Gaussian distribution law. This principle was assumed as a basis of the norm conception widely used in biology and medicine. Norm is usually considered the range M±σ or M±0.67σ, where M and σ are the parameters of Gaussian distribution law. At the same time many authors have noticed asymmetry of probability distribution in anthropometric indices [1,2] as well test results [3]. Therefore the opinion was expressed that existing system of physical fitness evaluation based on the comparison of individual physical abilities with populational mean value couldn't be considered satisfactory enough becuse it didn't account individual peculiarities of organism development [4].

Anthropologists know the fact of different somatotype existence which characteristichs are not mixed in a continious raw and are manifestated steadily from generation to generation [5, 6]. Somatotype component stability was proved during the ontogenesis from infant to maturity (including retraced by generations) [7, 8]. Moreover, determining of somatotype formula by 7-point Heath-Carter scale makes it possible to observe theoretically 343 combinations; but really only 76 of them were met during long observations of different authors [9]. May be that is the same reason why motor abilities and their ranges are quite different in athletes of different somatotype [10, 11].

These facts make it urgent to check the distributive law of human constitutional characteristics because the number of permitted statistical procedures could be decreased significantly if empiric law differs from Gaussian. This could also entail serious consequences like revision of some traditional conceptions which seem to be true only due to their traditional nature.

Moreover, central tendencies can exist inside the borders of every somatotype with random deviation from mean value and the somatotype distinction may have random nature. This hypothesis requires checking. So the purpose of the investigation was to analyse the statistical distribution for simple anthropometric indices-markers suitable to rough somatotype identification by 3-component scheme by Shtefko-Ostrovsky [12] for needs of physical education practice.

MATERIALS AND METHODS

The subjects were schoolboys of one of Moscow secondary schools and university male students selected randomly by scholar groups. They formed 3 age groups: juniors of 15 years of age (n=122); juniors of 16 (n=172); adults 18–22 years (n=260). All the subjects were tested by qualified anthropologists from the Moscow University Anthropology Institute. Experts measured length and girth sizes and skinfolds, and determined the somatotype by the well known Schtefko-Ostrovsky method [12]. Asteno-thoracal, musculine and digestive groups were picked out in every age category. Group structure and physical characteristics of the subjects are presented in Tables 1 and 2.

Table 1

Physical development characteristics of young adult males of different somatotype (M±σ)

Index	Somatotype and percent content		
	Ectomorph — 40%	Mesomorph — 28%	Endomorph — 32%
Body height, cm	174.5±5.	175.3±4.2	169.2± 8.2
Body weight, kg	59.6±7.	71.3±3.9	470.4±5.1
Chest girth, cm	88.7±3.1	98.6±2.9	104.5±1.8
Waist girth, cm	69.8±2.1	78.2±3.8	88.7±2.8

Table 2

Physical development characteristics of juniors of different somatotype (M±σ)

Index	Age, somatotype and percent content					
	Ectomorph		Mesomorph		Endomorph	
	15 years, 39%	16 years, 41%	15 years, 46%	16 years, 44%	15 years, 15%	16 years, 15%
Body height, cm	175.3±6.4	177.1±6.9	174.3±7.0	177.6±5.8	177.3±3.4	176.3±3.8
Body weight, kg	56.6±7.4	61.0±8.4	59.9±9.2	67.8±6.3	74.5±9.9	75.2±4.4
Chest girth, cm	81.0±5.6	84.6±4.6	84.9±6.1	89.8±3.5	92.0±5.7	93.5±3.2
Waist girth, cm	68.8±5.8	70.3±3.3	69.5±5.0	73.7±3.1	81.9±8.4	82.7±4.8

Ectomorphy index equal to body height/(weight)$^{1/3}$ (by(13)) was calculated as well standardized (by body height) chest and waist girth, distributive histograms were built. Significance level corresponding with critical values of consent criteria Chi-square and λ (by A. Kolmogorov) were determined. Statistical calculations and distribution curves were got using statistical computer software package STATGRAF.

RESULTS AND DISCUSSION

The main results are presented in Tables 1–4. As can be seen from Tables 1 and 2, subjects of different somatotype differ significantly in their physical characteristics. This fact in itself shows that they belong to different totalities. The somatotype structure of all the age groups is similar and slightly shifted to ectomorphy side — asteno-thoracal and musculine type males account by nearly 40%. Differences between somatotype groups in juniors are visible but statistical significance of them is not as high as in adults.

Table 3

Statistical distribution characteristics of morpho-functional indices in young adult males of different somatotype

Index	Somato-type	n	M	σ	Significance level by criteria		Significance of differences between types		
					χ^2	λ	Types	t	p
Ectomorphy coefficient	A	46	89880	4186	0.016	0.9996	A – M	18.08	<0.001
	M	38	77172	2080	0.131	0.338	M – D	13.29	<0.001
	D	36	68624	3284	0.070	0.320	–	–	–
Relative chest girth	A	46	0.507	0.021	0.257	0.9988	A – M	13.55	<0.001
	M	38	0.561	0.016	0.053	0.9994	M – D	10.02	<0.001
	D	36	0.605	0.020	0.299	0.478	–	–	–
Relative chest+waist girth	A	46	0.911	0.029	0.390	0.9995	A – M	16.25	<0.001
	M	38	1.007	0.024	0.112	0.473	M – D	13.02	<0.001
	D	36	1.114	0.043	0.204	0.9998	–	–	–

Notes: 1) somatotypes: A — asteno-thoracal, M — musculine, D — digestive; 2) significance of difference between A — D types apriory is known to be higher than two other

The possible reason for this phenomena is that from a biological point of view young adults are the most representative population sample because their body building reflects laws of "zenith" physical state of modern representatives of biological species. This age group is characterized by complete sex maturation but still without any changes and pathology caused by social, environmental and slightly expressed hereditary factors.

Table 4

Statistical distribution characteristics for relative value of chest + waist girth in total and typological samples of 15- and 16-year male juniors

Age, years	Somatotype	n	M	σ	Significance level by criteria:		Significance for differences between types		
					χ^2	λ	Type	t	p
15	A	48	0.852	0.048	0.084	0.99999	A – M	3.65	<0.001
	M	56	0.886	0.046	0.170	0.996	M – D	5.73	<0.001
	D	18	0.980	0.064	-	0.311	–	–	–
	**	122	0.887	0.064	0.0137	0.266	–	–	–
16	A	70	0.875	0.029	0.432	1.0	A – M	10.01	<0.001
	M	76	0.921	0.026	0.064	0.99997	M – D	9.90	<0.001
	D	26	1.000	0.038	-	0.356	–	–	–
	**	172	0.914	0.051	0.060	0.337	–	–	–

Notes: 1) somatotypes: A — asteno-thoracal, M — musculine, D — digestive; 2) significance of difference between A — D types apriory is known to be higher than two other

All the distribution histograms for standardized girth values (Fig. 1) as well ectomorphy index (Fig. 2) in the total population samples show expressed polimodality. This fact is known to be connected with mixing several groups having different features in one sample. It is confirmed by distribution curves constructed separately for every somatotype (Fig. 3). These curves are fitting Gaussian law very close, especially in the ectomorph group (p=0.9996). The differences between two other curves and Gaussian distribution are also not significant, which is confirmed by statistical criteria calculation both for juniors and adults (Table 3, 4).

Table 3 includes the results of local sampling of young males aged 19–20 years (n=120) by ectomorphy index and relative girth values (chest girth and ½ (chest girth + waist girth)) divided by body height. The three indices are non-equivalent by the criteria which determine both capability and significance of dividing a voluntary single-aged sample into three typologic groups. Statistical distribution law for indices seems to be the main because it is that permits (or doesn't permit) to use parametric methods of confidence interval evaluation for differences even if formally calculated t-criterium value is satisfactory. From the distribution law point of view the ectomorphy index is less favourable accounting significance level by χ^2 and λ criteria (Table 3).

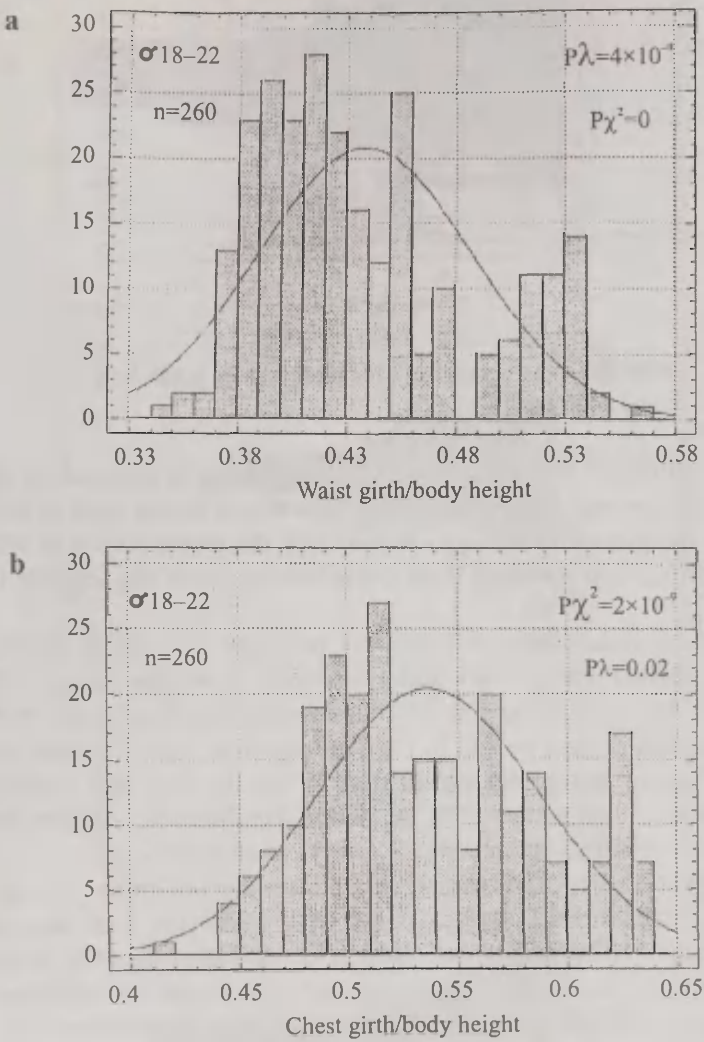

Figure 1. Distributive histogram for ectomorphy index in the total sample of young adult males (n-260).

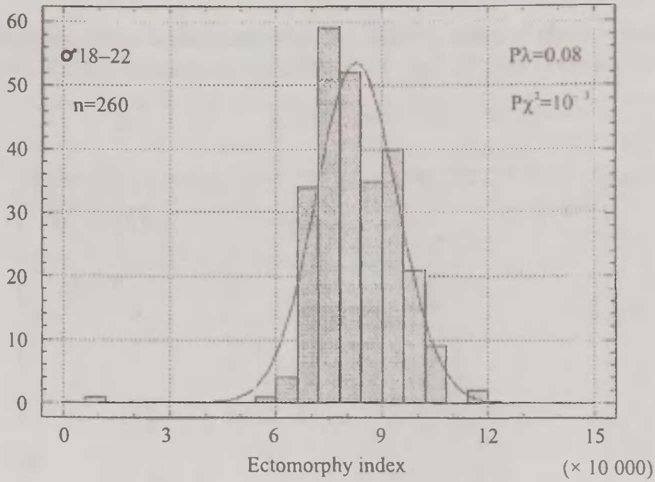

Figure 2. Distributive histogram form for girth indices in the total sample of young adult males (n-260).

It is significant that the Null-hypothesis cannot be rejected for all three indices in any typological group. This means that in spite of limited (but representative enough) sample size the Gaussian law is true inside every group, i.e.these three constitutional types are separate in nature.

To check rightfulness of using this principle in dividing juniors into typological groups we made for them a similar calculation (Table 4). As can be seen, in two of three groups the significance level by λ-criterium is close to 1.0. In the 3-d (digestive type) the Null hypothesis cannot be rejected also in spite its smaller size, and is much higher than in total sample. So, the above mentioned conclusion for adults was confirmed completely for juniors of 15 and 16 years.

Meanwhile type constitutional differences are not taken into account in most scientific and practical tests where the total sample mean is calculated which cannot characterize real physical state of the individuum. Anthropologists point out that (like in our investigation) three main constitutional types are presented in a population nonequally [14, 15]. Therefore, "arithmetical mean" in this situation is much closer to mode value of distribution that causes certain limitations in this data statistical reduction [16] and effects negatively on result reliability.

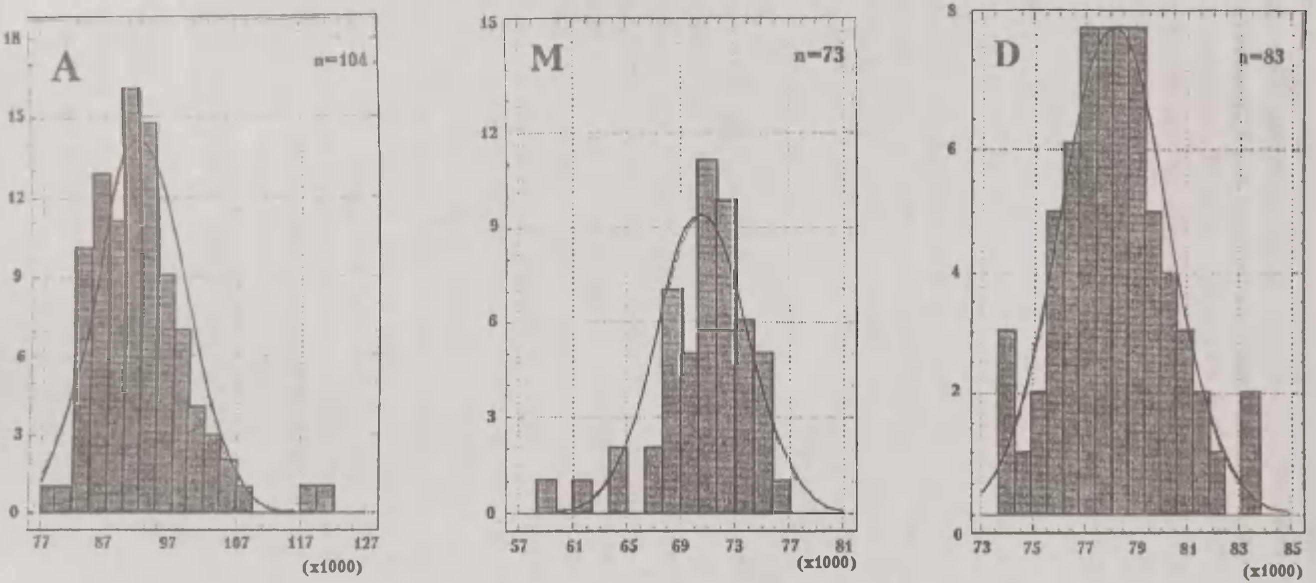

Figure 3. Distributive histograms for ectomorphy index in young adult male groups of different body somatotype: A — asteno-thoracal (p=0.9996), M — musculine (p=0.338), D — digestive (p=0.320).

The difference of characteristics, being true for anthropometric ones, probably should be applicated to motor abilities which are connected closely with body and muscle system building. This idea was widely used in sport selection but almost never in physical fitness and health-caring [17, 18, 19, 20]. Correspondingly, it could be true that optimal ways of physical improvement as well the best motor activity results are quite different for humans of different connstitutional types [21].

CONCLUSION

1. Statistical analysis of size body indices showed the existence of three submultitudes in general sampling noncrossing statistically ($p<0.001$). At the same time these indices demonstrated Gaussian distributive law inside every constitutional type, i.e. they are random and independent within the type.

2. Variability of certain somatic characteristics within the general totality of healthy humans of one and the same age and sex was proved not to be a random event but probably the manifestation of biological adaptation of the Homo sapiens species. The somatotype, being evaluated qualitatively, is characterized by a set of quantitatively measured morpho-functional indices, every of which showing its own norm reaction within the type. Thus, somatotype is characterized by norm reaction of morpho-functional features which are can be varied within the type by random law near certain central position.

3. The ability was shown to distinguish three somatotypes (astenothoracal, musculine and digestive) out of total single-aged sample of junior and young adult males using simple somatometric methods. The best index — the sum of chest and waist girth. This method of somatotype identification can be used as a basis in individual approach methodology for physical education and health-caring physical culture [21]:

— to improve the system of physical state diagnostics including physical fitness level;

— to develop type-specific training methods basing account of organism hereditary constitutional features.

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