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PAPERS  
ON ANTHROPOLOGY

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Dedicated to  
the 95th birthday  
of Prof. Juhan Aul

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Vastutav toimetaja H. Kaarma

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## INTRODUCTION

The present collection of papers is dedicated to the 95th birthday of Prof. Juhan Aul in recognition of the fact that the foundation by him of the Anthropology Section of the Estonian Naturalists' Society in 1937 actually meant the beginning of anthropological research in Estonia. Unfortunately, during the war years and for a long period after that investigations in the field nearly came to a standstill owing to the fact that both genetics and anthropology were banned in the Soviet Union as pseudo-sciences.

In the 1970s, however, besides Prof. Aul ever greater interest was taken in anthropological research also by specialists in other fields active in the Faculties of Medicine, Biology and Physical Education of Tartu University, as well as those outside the University, e.g. at the Institute of History of the Academy of Sciences, the Tallinn Pedagogical Institute and elsewhere. Estonian anthropologists have still preserved their former organisational structure, being members of the Anthropology Section of the Naturalists' Society with Prof. Aul as Honorary Chairman of the Section.

Our spheres of interest are anatomical, age-related, ethnical, medical and clinical anthropology. Tartu University has arranged four conferences on problems of anthropology involving also specialists from other parts of the Soviet Union. Currently preparations are under way for a fifth, international conference on the subject of "Somatotypes of Children" to be held at Tartu University in June 1993. Our Section is in close collaboration with anthropologists in the other Baltic countries and Byelorussia, who have also contributed papers to this collection.

As before, we follow in our research Prof. Aul's principles, according to which anthropological investigations should meet the everyday needs of practical life and the most important subjects of study should be children.

H. Kaarma

PROF. JUHAN AUL - THE DOYEN OF ESTONIAN ANTHROPOLOGY

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Professor Juhan Aul (until 1931 - Klein) was born on 15 February 1897 in Pärnu district, Estonia. His first employment was as a schoolmaster, after that he attended Tartu University. In 1928 he obtained his Master's Degree and in 1938 he was awarded a PhD nat. in zoology (anthropology). In Tartu he also began his academic career as an assistant at the Institute of Zoology. In 1939 he was appointed assistant professor, then full professor of zoology which position he held until 1982 when he retired. In 1958-1969 he was also Head of the Department of Zoology. However, in the gloomiest years of the Soviet occupation he was removed from his post in 1950-1954.

The focus of Aul's lifework is anthropology. His most important studies deal with thorough investigation of physical anthropology of Estonians. His guiding principle is that man as a biological species is an object of zoological research, and accordingly, anthropology is a part of zoology. The narrower aim of anthropology is to study the level of physical development, the physical diversity and specific features of the people or population under research.

In the twenties Estonia was anthropologically nearly terra incognita. There was no anthropological training at the University, so Aul had to teach himself. He became a master of anthropological technique. During his long life, he has managed to measure without help more than 50,000 people.

He began with the island of Saaremaa. This district is of considerable interest as a contact area between the Scandinavian and Finnish ethnic groups.

Thereupon he devoted his attention to the whole of Western Estonia. The anthropological features and racial origin of Western Estonians made the substance of his doctoral dissertation.

Aul's intention, however, was "Anthropologia estonica"

covering the whole Estonian territory. Seeking for homogeneity and representability of the underlying data, the measurements were carried out on servicemen before their release. The results obtained were published in the form of minor papers, and as a whole as a monograph only after the war, in 1964.

Aul has also contributed to the studies of sexual dimorphism. He purposefully collected data concerning not only men, but women, too. One of his major works deals with the anthropology of Estonian women (1957).

He has also made extensive studies of ethnic minorities in Estonia - the Swedes, Votians, Ingrians, Germans - and of the neighbouring peoples - Latvians and North-Western Russians. These studies were undertaken for comparison.

Aul was also the pioneer of Estonian paleoanthropology, investigating, in collaboration with the archeologist R. Indreko, the neolithic skeletons found in Estonia.

Aul's special interest was anthropology of schoolchildren and youngsters. Due to its practical aspects, Aul, taking over the term of Montessori, calls such studies pedagogical anthropology. Aul's publications include papers on the weight and height, on the measurements of the head, on the variability of individual characteristics of Estonian schoolchildren. Analysing the various periods of the physical development of the minors, Aul has paid particular attention to microbaria and puberty. Of great practical value are the tables for the estimation of physical development of Estonian schoolchildren. Aul's contribution to minors' anthropology is summed up in his third monograph "The Anthropology of Estonian Schoolchildren" (1982). Particularly, relying on his long experience, he points out the differences in the children's constitution before and after World War II. Nowadays the schoolchildren are taller, more slender, and weaker. Body height has increased relatively faster than body weight, mental development also lags behind physical acceleration.

Aul's papers on slenderness and stockiness, on the capacity of lungs, on the use of the regressive scale for the estimation of physical development are his contributions to general anthropology as well as his investigations on the dynamics of anthropological sizes.

Aul's interests in social anthropology yielded papers on differences between rural population and townspeople, es-

pecially on the influence of urbanisation.

Aul was the first professor in Estonia who taught anthropology. The scientific progress of Estonian anthropology has been greatly promoted by the Anthropology Section of the Estonian Naturalists' Society, which he founded. A small group of enthusiastic researchers is carrying on Aul's mission.

Aul's merit is that Estonia is one of the anthropologically best explored territories of the world.

Fortunately for Estonian zoology, Aul did not confine himself only to anthropology. As a zoologist he has done field work on anurans and has written a survey on Estonian quadrupeds (1936), which for a long time served as the only reference book on this part of Estonian fauna. Occupying the post of Professor of Zoology he has written textbooks on vertebrate zoology (in cooperation with Prof. H. Ling) and on human anatomy.

Aul has taken great care of Estonian scientific terminology. He has made a considerable contribution to Estonian terminology of anatomy and compiled a lexicon of zoological terms as well (1978).

From the beginning of his educational activities Aul has been a champion of popular education and popular science, writing fascinating comprehensible books on human genetics, anthropology and anatomy, and being an appreciated lecturer at university extension courses. He is the man with the greatest educational experience in Estonia, from a village school to the university chair. On all his posts he has been a schoolmaster in the finest sense of the word.

Aul is Honorary Member of the Estonian Naturalists' Society. He has been awarded the Baer medal of the Estonian Academy of Sciences.

Personally, Aul is a kind and quiet man, but also very tenacious, hard-working and principled. He encountered bravely all the adversities in his personal life or in the fate of our nation. Being the Doyen of Estonian anthropology and zoology he also sets an example to the younger generation how to serve our science and our nation.

## References

J. Aul's monographs on Estonian anthropology:

- Anthropology of Estonians. Tartu, 1964. Acta et Commentationes Universitatis Tartuensis, v. 158. In Russian.
- Anthropology of Estonian Women. Tartu, 1977. Acta et Commentationes Universitatis Tartuensis, v. 438. In Estonian.
- Anthropology of Estonian Schoolchildren. Tallinn : Valgus, 1982. In Estonian.

All the monographs are provided with extensive summaries in German.

The complete bibliography of J. Aul's works can be found in: Tartu Ülikooli Raamatukogu. Professor Juhan Aul. Kirjanduse nimestik 1919-1989. Tartu, 1990, where 321 papers are listed, 217 of them belonging to J. Aul.

PHENETICAL INTERRELATIONS BETWEEN ESTONIANS AND  
KARELIANS ACCORDING TO DISCRETE CRANIAL TRAITS

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A provisory characterisation of discrete cranial traits of Estonians and Karelians has been done previously (Česnys, Mark, 1985). As the next step of investigation of paleophenetics in the Baltic Finns, biological distances (mean measures of divergence) were calculated using well-known methods (Grewal, 1962) between the following samples of skulls:

1. The 11th-13th cc. West Estonians (Karja, Loona, Küti, Pikavere).
2. The 16th-17th cc. South Estonians (Koikküla).
3. The 14th c. South Estonians (Otepää).
4. The 16th-17th cc. North-West Estonians (Varbola).
5. The 17th-18th cc. North-East Estonians (Iisaku).
6. The 19th-20th cc. South Karelians (Kondievuara, Turcha).
7. The 19th-20th cc. North Karelians (Bokonvuara, Ciksa).

Discrete cranial traits (Table 1) were checked on both sides of the skull, counting the skull as a unit (Table 2). The matrix of mean measures of divergence (Table 3) was clusterized and the results were demonstrated on the dendrogram (Figure 1). Two main clusters emerge on it: the first contains both groups from South Estonia and the series from North-West Estonia, the second unites both Karelian samples and the series from North-East Estonia. Both clusters seem to express geographical closeness of the samples investigated and are quite truthful. The selected samples from the western part of Estonia and Saaremaa Island are somewhat remote from the two main clusters. To all appearances they contain precious information on the history of the gene pool of coastal Estonians and can help to elucidate some ethno-genetical processes of this population together with the examination of other anthropological systems, as skull shape and size, odontological peculiarities, etc.

Table 1

## List of discrete cranial traits

No	Trait	No	Trait
1.	Os lambdae	24.	For. frontale
2.	Os bregmae	25.	For. zygomaticofaciale
3.	Os pterii totum	26.	For. ethmoidale post.
4.	Os pterii partiale	27.	For. tympanicum
5.	Os pterii (3+4)	28.	For infraorbitale access.
6.	Os asterii	29.	For. palatinum min. access.
7.	Os interparietale totum	30.	For. mentale access.
8.	Os interparietale partiale	31.	For. ovale incompletum
9.	Os interparietale (7+8)	32.	For. spinosum incompletum
10.	Ossa sut. coronalis	33.	For. mastoideum extrasutur.
11.	Ossa sut. sagittalis	34.	For. ethmoidale ant. extrasuturale
12.	Ossa sut. lambdae	35.	Canalis hypoglossalis septus
13.	Ossa sut. squamosae	36.	Torus palatinus (1 <sup>o</sup> -3 <sup>o</sup> )
14.	Os incisurae parietalis	37.	Torus palatinus (2 <sup>o</sup> -3 <sup>o</sup> )
15.	Sut. frontalis (metopica)	38.	Torus mandibularis
16.	Sut. frontotemporalis	39.	Torus acusticus
17.	Sut. zygomatica	40.	Tuberculum precondylare
18.	Sut. parietalis	41.	Arcus mylohyoideus
19.	Sut. palatina transversa scalaris	42.	Arcus pterygospinosus
20.	For. parietale	43.	Occipitalisatio atlantis
21.	For. mastoideum	44.	Facies articularis condylaris bipartita
22.	Canalis condylaris	45.	Cribrum orbitale
23.	For. supraorbitale		

Table 2

Discrete cranial traits (m/n) in Estonians and  
Karelians (Trait number as in Table 1)

Trait number as in Table 1	Sample number as in the text						
	1.	2.	3.	4.	5.	6.	7.
1.	6/34	12/57	12/49	7/29	8/45	10/56	16/64
2.	0/32	0/68	0/52	1/34	0/45	0/59	0/72
3.	3/17	4/43	8/39	3/26	7/39	5/55	14/58
4.	4/17	10/43	8/39	7/26	7/39	13/55	17/58
5.	7/17	13/43	15/39	9/26	14/39	17/55	27/58
6.	2/28	10/52	8/46	2/31	12/44	12/58	10/64
7.	1/34	0/57	0/49	0/29	1/45	0/56	0/64
8.	1/34	0/57	1/49	3/29	4/45	1/56	3/64
9.	2/34	0/57	1/49	3/29	5/45	1/56	3/64
10.	1/25	1/60	5/49	3/32	2/42	4/58	3/69
11.	4/27	1/46	2/45	4/31	5/42	7/52	2/52
12.	18/31	40/60	35/49	24/31	33/44	37/56	36/60
13.	1/22	3/43	0/43	2/30	3/42	0/59	0/62
14.	5/25	16/55	14/47	3/31	16/44	10/61	17/67
15.	4/38	8/77	2/56	4/32	5/46	4/62	4/72
16.	0/17	2/43	4/39	0/26	2/39	5/55	7/58
17.	0/24	0/40	0/37	0/28	0/43	1/57	0/66
18.	0/30	0/67	0/54	0/34	1/46	0/61	0/69
19.	10/28	22/46	24/47	15/29	20/41	20/54	21/60
20.	18/30	29/67	29/54	18/34	32/46	45/61	49/69
21.	28/28	55/56	44/53	25/30	42/43	57/62	52/63
22.	19/22	46/54	42/50	27/30	41/46	56/59	59/66
23.	10/35	24/69	15/51	10/34	14/45	24/62	24/70
24.	12/35	9/66	6/51	5/33	13/44	15/62	14/69
25.	25/25	37/39	36/39	22/27	40/43	48/57	62/65
26.	12/17	29/32	37/43	18/22	37/42	43/48	41/49
27.	3/29	11/70	11/55	1/31	6/43	8/62	4/68
28.	8/26	10/35	14/43	8/30	8/40	12/51	17/61
29.	19/22	25/38	29/44	18/27	31/41	41/56	43/59
30.	3/30	3/58	3/42	2/21	1/18	4/57	4/69
31.	6/25	4/49	7/49	3/24	6/44	13/59	9/67
32.	9/22	15/52	12/45	8/25	10/43	10/61	13/67
33.	18/28	40/66	32/53	16/30	28/43	43/59	38/66
34.	8/16	7/22	16/33	9/16	16/33	14/24	26/42

Table 2 (continued)

	1.	2.	3.	4.	5.	6.	7.
35.	7/23	11/54	11/51	3/30	11/45	7/60	10/69
36.	19/32	38/61	32/52	17/33	29/44	43/58	40/70
37.	10/32	19/61	20/52	12/33	15/44	27/58	28/70
38.	2/36	2/70	0/43	0/25	0/18	2/57	2/69
39.	0/33	2/77	0/55	0/31	0/43	1/62	3/68
40.	3/24	3/60	1/52	2/33	0/42	1/60	3/71
41.	2/27	5/58	0/36	0/21	4/17	8/57	5/68
42.	2/20	5/51	0/46	3/28	3/44	8/59	9/66
43.	0/21	0/51	0/42	0/21	0/35	0/52	0/58
44.	4/21	4/40	1/38	1/17	2/34	3/49	5/55
45.	6/38	13/74	10/52	7/33	8/46	10/60	17/68

Table 3

Mean measures of divergence between samples  
(their numbers as in the text)

Sample number	Sample number					
	1.	2.	3.	4.	5.	6.
2.	0.100					
3.	0.121	0.070				
4.	0.090	<b>0.070</b>	0.070			
5.	0.082	0.080	0.092	0.090		
6.	0.100	0.101	0.090	0.081	0.070	
7.	0.091	0.081	0.072	0.080	0.08	0.072

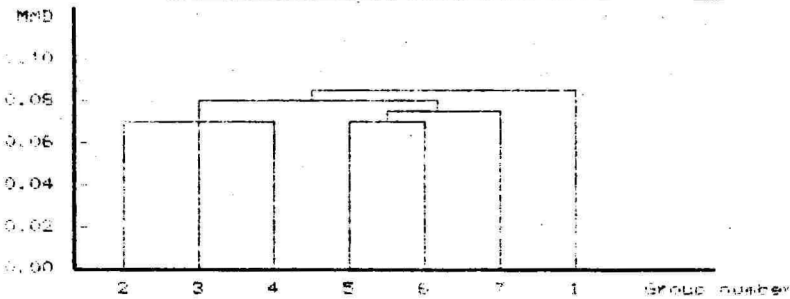


Fig. 1. Distances between groups (their numbers as in the text).

DISCRETE CRANIAL TRAITS IN 11th-17th cc. CRANIOLOGICAL  
SAMPLES FROM ESTONIA

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Non-metric (or discrete, epigenetic) traits have been a popular item for the last two decades in the research of paleopopulations. Investigation on animals (Berry and Berry, 1967) and man reveals that discretely varying traits are inherited, genetically determined, independent of each other and not subjected to selection. Frequencies of the traits should remain constant in time in the given population. Studies on these traits should discover genetical similarity or dissimilarity between different populations, the effect of immigration or gene drift on the given population. These traits are used for estimating the population-genetic parameters, for establishing the groups of close relatives, for individual diagnoses, etc.

Non-metric traits can be explored on skulls as well as on post-cranial skeletons.

The discrete cranial traits of Estonians have been investigated earlier by G. Česnys (1984).

The aim of this work is to give an overview of some medieval skeletal populations of Estonia through the discrete varying traits, to map the morphological traits of the Estonian paleopopulations and to find out the genetical structure of the paleopopulations of Estonia.

#### Material and methods

Craniological material from 14 cemeteries containing 11th-17th-century populations of Estonia were investigated in the Institute of History of the Estonian Academy of Sciences (Table 1, Fig. 1). A total of 298 individuals were studied, and 47 different discrete cranial traits were examined on every skull.

The Latin terms for the investigated traits are pre-

sented in Table 2. In the following tables they are referred to by numbers only.

Discrete traits were diagnosed mostly after A. C. Berry and R. J. Berry (1967), I. M. Movsesyan (1975) and G. Česnys (1977). Ossa sutura lambdae were divided into three groups and sutura sphenomaxillaris was viewed from orbital and temporal sides (according to A. S. Kozintsev, 1988). Sutura zygomaticofaciale was determined if its length was 2 mm or more (after Kozintsev, 1988).

As some of the traits were uni-, some bilateral, the unit of examination was always the individual cranium. Of the 15 different samples explored, only 4 were big enough for further testing, others were grouped together according to their geographic or anthropometric similarities. In this part standard  $\chi^2$ -testing was used. The unit of testing was one side of the cranium (for the sake of exactness).

Significant level of differences of  $\chi^2$  between the observed and expected values was calculated according to the formula:  $x(Qn) = n + Y(1 - \frac{Q}{100}) - 2n + r(Q - \frac{1}{2n})$  (Bolshev and Smirnov, 1965).

To explore the effect of sex and age on the expression of the traits, the material was divided into 5 age groups: infantilis, juvenilis, adultus, maturus and senilis.

Samples of Muuga and Napa were examined, too, and for comparison a sample from Irboska was studied.

### Results and discussion

The distribution of the concrete cranial traits is given in Table 3 (in per cent). The mean values of the seven bigger series which are taken conventionally as the mean values for the Estonian population of that period of time, and the variability of the traits is given in Table 4. It can be seen that the most variable single traits are os wormii suturae lambdae inferior, torus palatinus (1-3), foramen parietale, foramen mastoideum extrasuturale, foramen spinosum incompletum, foramen supraorbitale, foramen zygomatico-faciale and sutura palatina. The variability of F. tympanicum is due to high variance according to sex and age. The traits os wormii suturae lambdoidea inferior, foramen supraorbitale and torus palatinus are varying most of all genotypically, they are determined by the differences of the series, factors of

sex and age are not significant.

As the series studied by us are comparatively small, we could compare only four series (Pada, Jõuga, Makita, Otepää) with each other by the  $\chi^2$ -test method (Fig. 2) as for all the traits and as for every single trait (or variants of the traits) on the scale of time and room as well. It can be seen that the series belonging to the same period of time, and at the same time geographically nearby located series appeared to be quite similar also according to the frequencies of the traits as the series of Otepää and Makita ( $\chi^2 = 165.6$ ). On the level of significance of 0.05 per cent  $\chi^2$  should be 172.9).

During 2-3 centuries in Middle Ages the gene frequencies in settled population did not change noticeably. So the frequency of these traits in the series of Otepää, Makita I and Plaani (belonging to the 11th-14th cc.) does not differ significantly from that of the series of Makita II and Kuuste (belonging to the 15th-17th cc.,  $\chi^2 = 153.5$ ). On the basis of craniometric data (Mark, 1956, 1965 and the data of Heapost) they were compared to the groupings of North Estonia (series Küti, Tammiku, Pada) and to South-Estonian groupings of the same period (Otepää, Makita I, Plaani). The differences between these groupings are significant ( $\chi^2 = 179.6$ ). The difference of the frequency of discrete traits between the series of North Estonia (Vaadu series) and South Estonia (Makita II and Kuuste), both belonging to a later period of time, is not significant ( $\chi^2 = 156.9$ ).

Comparing the four craniological samples (Makita, Otepää, Pada, Jõuga) belonging to the 11th-15th centuries, no significant differences were found in the discrete cranial traits between the populations of Makita and Otepää located geographically nearby ( $\chi^2 = 165.6$ ). There are differences between Otepää and Pada population on one side ( $\chi^2 = 175.7$ ) and between Otepää and Jõuga on the other side ( $\chi^2 = 176.9$ ). The differences are more noticeable between the samples of North and North-East Estonia (Pada and Jõuga series), and South Estonia (Makita).

On the basis of the material consisting of 124 males and 96 females, the sexual differences appeared in the traits of the district of orbit - in respect to the frequency of foramen infraorbitale and cribra orbitalia as well as foramen tympanicum. So our data confirm sexual differences in the

discrete cranial traits.

An analysis of the traits in respect to age showed the differences between the various age groups, especially in the traits on the basis of the skull (foramen mastoideum suturale, foramen mastoideum extrasuturale, canalis condylaris), but also in foramen parietale (Table 5).

As for the single traits, the ossa wormii suturae lambdoidae was divided into three parts according to A. Kozintsev (1988). The lower part of that trait is varying most of all. Canalis condylaris varies highly in age factor, but almost not at all in sex factor and little between the series.

We compared the mean frequencies of the discrete cranial traits of the Estonian population to the mean values of East European and neighbouring populations of the same period (Table 6). It appeared that in Estonian population such traits as canalis hypoglossi, foramen parietale and canalis condylaris appear more rarely than in the other populations compared.

The comparatively high frequency of sutura zygomatica can be explained by the methodological differences in trait examination.

A comparison of the average percentages of traits of the Estonians with those of the Latgals, the Krivichis, the Dregovichis and the Slovenes of Novgorod, and the Zemgals and Selis studied by G. Česnys (1987) proved that the Estonians have many similarities with these neighbouring ethnic groups. Frequencies of most discrete traits were very close to the East-European ones. The frequencies of some traits in comparison with synchronous material were different. Canalis hypoglossalis septus, foramen parietale, foramen palatinum minus accessorium, canalis condylaris had lower, tuberculum precondylare - higher occurrence in Estonian population than in the others.

The skulls of the samples investigated by us belong to various types. The skulls from West Estonia (as in Karja sample) are massive, doliochocranic with a high and narrow face. The East-Estonian samples from Küti and Tammiku belong to the same type, but the face of the Tammiku skulls is shorter. Most samples of skulls of East Estonia belong to another type. That type is mesocranic, more gracile, with a broader and shorter face, as in Jõuga and Otepää samples (Märk, 1965). The skulls of Kuuste sample are quite similar

to Otepää and Jõuga skulls. The Pada sample from North Estonia stands craniologically close to Karja. Makita I and II stand also close to Jõuga and Otepää, but the altitude measurements of the face are similar to Karja and Pada samples. The skulls from Lindora are dolichocranic and narrowfaced.

Cranio-metric similarities in Penrose distance were detected between the samples from Jõuga, Otepää and Kuuste (Table 7). Karja, from Western Estonia, being close to the samples from North Estonia (e.g., Pada) differs cranio-metrically from the East-Estonian samples.

So the variance of Estonian skull samples observed by the cranio-metric data is confirmed by the variance of the discrete characters. As the discrete characters can be used also for partly preserved skull material, these traits are of great importance for studying the anthropological and ethnical features of Estonian paleopopulations.

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Table 1

## Investigated craniological samples

No. of sample	Period cc. A.D.	Sample size			$\Sigma$	Cranio-metrical data, author
		Subad.	♂	♀		
1. Karja	13.	1	11	8	20	Mark, 1956
2. Küti	12.-13.	0	2	3	5	Mark, 1956
3. Tammiku	12.-13.	0	3	4	7	Mark, 1965
4. Vaadu	17.	8	6	3	23	Mark, 1965
5. Pada	12.	23	23	15	61	Heapost
6. Jõuga	11.-14	6	20	24	50	Mark, 1965
7. Otepää	14.	7	11	14	32	Mark, 1965
8. Makita	13.-17	22	23	17	62	Heapost
Makita1	13.-15	7	6	9	22	Heapost
Makita2	15.-17.	6	7	6	19	Heapost
9. Kuuste	16.-17.	1	5	7	13	Heapost
10. Plaani	13.-14.	0	2	0	2	Heapost
11. Lindora	11.-12.	1	5	0	6	Heapost
12. Irboska	11.-17.	0	5	1	6	Heapost
13. Muuksi	I mil.B.C.	3	8	2	13	Mark, 1956
14. Napa	I mil.B.C.	0	0	1	1	Mark, 1956

Table 2

## Investigated non-metric craniological traits

1. pterion
  - 1.1 proc. frontalis squamae temporalis incomp.
  - 1.2 proc. frontalis squamae temporalis compl.
  - 1.3 proc. temporalis ossis frontalis incomp.
  - 1.4 proc. temporalis ossis frontalis compl.
  - 1.5 os epiptericum incomp.
  - 1.6 os epiptericum compl.
  - 1.7 proc. parietalis ossis sphenoidalis
  - 1.8 stenocrotaphia H, K, X
2. sutura metopica
  - 2.1 sutura metopica compl.
  - 2.2 sutura metopica incomp.
3. os incisurae parietalis

Table 2 (continued)

4. os incae
- 4.1 os incae (interparietale) compl.
- 4.2 os incae (interparietale) incomp.
5. os lambdae
6. os (wormii) suturae squamosae
7. os (wormii) suturae lambdoidea
8. os (wormii) suturae lambdoidea inferior
9. os (wormii) suturae lambdoidea superior
10. os asterii
11. os (wormii) suturae coronalis
12. os bregmae
13. os (wormii) suturae sagittalis
14. os zygomaticum bipartium
15. torus tympanicus / acusticus
16. foramen tympanicum
17. torus palatinus
- 17.1 torus palatinus 2-3°
- 17.2 torus palatinus 3°
18. sutura parietalis
19. tuberculum precondylare
20. foramen parietale
21. foramen mastoideum suturale
22. foramen mastoideum extrasaturale
23. foramen mastoideum absens
24. foramen ovale incomp.
25. foramen spinosum incomp.
26. foramen palatinum minus accessorium
27. foramen supraorbitale
28. foramen frontale
29. foramen ethmoidale anterius extrasaturale
30. foramen ethmoidale posterius
31. foramen infraorbitale accessorium
32. foramen zygomaticofaciale
33. cribra orbitalia
34. canalis condylaris
35. canalis hypoglossalis septus
36. foramen mentale accessorium
37. assimilatio atlantis
38. os internasale
39. os prefrontale

Table 2 (continued)

- 40. facies articularis condylaris bipartita
- 41. arcus mylohyoideus
- 42. foramen pterygospinosus
- 43. sutura palatina transversa
  - 43.1 sutura palatina transversa 1
  - 43.2 sutura palatina transversa 2
  - 43.3 sutura palatina transversa 3
  - 43.4 sutura palatina transversa 4
  - 43.5 sutura palatina transversa 5
  - 43.6 sutura palatina transversa 6
- 44. os (wormii) occipito-mastoideum
- 45. sutura sphenomaxillaris (aspectus orbitalis)
- 46. sutura sphenomaxillaris (aspectus temporalis)
- 47. sutura zygomatica



Table 4

Statistical analysis of the traits on five larger samples  
(Pada, Makita, Vaadu, Jõuga, Karja, Otepää)

Trait number	Mean (%)	minimum (%)	maximum (%)	observed $\chi^2(f)$	expected $\chi^2$
1				144.85 (144)	172.9
1.1	1.19	0	7.14		
1.2	1.27	0	3.85		
1.3	0	0	0		
1.4	0	0	0		
1.5	18.38	8.82	26.67		
1.6	12.50	2.94	17.50		
1.7	13.81	2.94	26.92		
1.8	6.53	2.94	12.50		
2				24.32 (24)	36.4
2.1	5.26	0	11.69		
2.2	1.60	0	5.00		
3	26.86	13.33	35.00	15.16 (18)	28.9
4				14.72 (12)	21.0
4.1	5.60	0	13.33		
4.2	7.84	0	15.79		
5	16.47	11.11	22.22	1.15 (6)	12.6
6	6.64	0	17.02	20.09 (18)	28.9
7	46.82	26.67	55.56	21.55 (18)	28.9
8	28.86	8.33	48.84	35.95 (18)	28.9
9	18.95	8.33	36.17	25.95 (18)	28.9
10	20.06	14.29	28.57	10.37 (18)	28.9
11	7.05	0	15.00	16.61 (18)	28.9
12	0.39	0	2.70	3.45 (6)	12.6
13	2.21	0	6.67	6.69 (6)	12.6
14	2.39	0	9.09	6.42 (18)	28.9
15	2.28	0	11.86	19.04 (18)	28.9
16	21.94	11.11	35.00	19.84 (18)	28.9
17				34.61 (12)	21.0
17.1	60.99	33.33	89.47		
17.2	29.48	17.79	53.45		
18	0	0	0	-	-
19	6.31	0	10.42	5.89 (6)	12.6
20	49.66	15.00	68.85	35.03 (18)	28.9
21	67.80	50.00	90.00	24.81 (18)	28.9

Table 4 (continued)

Trait number	mean (%)	maximum (%)	maximum (%)	observed $\chi^2$ (f)	expected $\chi^2$
22	66.91	42.11	83.33	35.82 (18)	28.9
23	23.49	16.67	42.22	27.72 (18)	28.9
24	8.18	5.26	11.54	17.55 (18)	28.9
25	24.46	11.11	37.50	29.69 (18)	28.9
26	49.78	36.84	58.18	17.57 (18)	28.9
27	31.72	19.05	50.88	31.94 (18)	28.9
28	21.88	15.15	27.27	6.66 (18)	28.9
29	74.99	66.67	85.71	17.35 (18)	28.9
30	87.57	81.25	100.00	22.42 (18)	28.9
31	11.73	0	29.17	21.54 (18)	28.9
32	79.43	66.67	94.44	29.90 (18)	28.9
33	20.70	6.67	36.67	22.35 (18)	28.9
34	70.39	59.09	84.21	19.24 (18)	28.9
35	17.42	10.53	27.57	18.46 (18)	28.9
36	5.02	0	13.04	14.92 (18)	28.9
37	0.76	0	4.55	4.51 (6)	12.1
38	0	0	0	-	-
39	0	0	0	-	-
40	3.66	0	10.53	17.95 (18)	28.9
41	3.80	0	9.26	12.43 (18)	28.9
42	4.37	0	13.51	18.06 (18)	28.9
43				56.01 (30)	43.8
43.1	8.25	0	21.95		
43.2	1.69	0	5.88		
43.3	3.13	0	11.11		
43.4	18.57	5.88	37.04		
43.5	35.30	9.52	52.94		
43.6	28.39	5.56	57.14		
44	16.07	8.70	21.65	3.24 (6)	12.1
45	34.83	27.78	46.67	15.66 (18)	28.9
46	38.63	34.09	46.67	28.61 (18)	28.9
47	10.26	2.50	26.67	21.22 (18)	28.9

Occurrence of discrete cranial traits according to age

No. of trait	INF		JUV		AD		MAT		SEN		$\chi^2(f)$
	N	%	N	%	N	%	N	%	N	%	
1											73.50(96)
1.1	33	3.03	18	0	79	0	67	0	4	0	
1.2	33	6.06	18	0	79	1.27	67	1.49	4	0	
1.3	33	0	18	0	79	1.27	67	0	4	0	
1.4	33	3.03	18	0	79	0	67	0	4	0	
1.5	33	27.27	18	22.22	79	17.72	67	14.93	4	25.00	
1.6	33	12.12	18	5.56	79	12.66	67	8.96	4	0	
1.7	33	0	18	16.67	79	11.39	67	16.42	4	25.00	
1.8	33	3.03	18	11.11	79	3.80	67	14.93	4	0	
2											21.72(16)
2.1	46	6.52	23	0	98	11.22	105	5.71	17	0	
2.2	46	2.17	23	4.35	98	0	105	0	17	5.88	
3	40	27.50	21	38.10	90	28.89	97	22.68	16	18.75	9.10(12)
4											7.89(8)
4.1	45	4.44	24	4.17	95	8.42	102	2.94	14	7.14	
4.2	45	2.22	24	16.67	95	6.32	102	7.84	14	7.14	
5	42	21.43	20	30.00	84	13.10	95	14.74	13	0	8.48(4)
6	38	2.63	18	5.56	80	11.25	82	12.20	14	0	13.60(12)
7	43	62.79	17	57.89	83	48.19	93	45.16	12	16.67	15.67(12)
8	31	38.71	17	58.82	59	33.90	67	35.82	13	23.08	14.99(12)
9	32	25.00	15	33.33	72	30.56	76	15.79	11	0	18.11(12)
10	40	20.00	20	15.00	88	29.55	89	23.60	15	6.67	16.31(12)
11	40	0	22	13.64	92	6.52	92	7.61	13	0	16.14(12)
12	45	0	23	4.35	98	0	93	0	13	0	4.98(4)
13	46	2.17	23	4.35	95	5.26	86	0	11	0	7.43(4)
14	29	3.45	16	0	66	1.52	66	1.52	8	0	3.00(12)
15	42	2.38	25	0	93	4.30	103	4.85	17	5.88	9.05(12)
16	25	32.00	22	13.64	58	17.24	80	16.25	15	13.33	16.21(12)
17											4.07(8)
17.1	40	64.10	23	52.17	92	68.48	90	67.78	12	58.33	
17.2	40	35.00	23	43.48	92	31.52	90	27.78	12	30.77	
18	32	0	15	0	53	0	61	0	12	0	0(4)
19	33	9.09	21	4.76	85	18.24	94	10.64	17	5.88	3.82(4)
20	47	61.70	24	37.50	95	64.21	101	50.50	15	46.67	<u>23.63</u> (12)
21	30	76.67	16	56.25	81	76.54	98	73.47	14	64.29	<u>22.09</u> (12)
22	28	50.00	17	70.59	83	65.06	94	70.21	15	80.00	<u>22.82</u> (12)

Table 5 (continued)

No. of trait	INF		JUV		AD		MAT		SEN		$\chi^2(f)$
	N	%	N	%	N	%	N	%	N	%	
23	29	37.93	16	25.00	82	30.49	97	21.65	15	20.00	7.71(12)
24	36	8.33	18	33.33	83	4.82	87	6.90	16	0	8.60(12)
25	34	29.41	17	29.41	82	26.83	85	16.47	14	7.14	13.29(12)
26	36	55.56	20	40.00	81	51.85	79	50.63	12	58.33	19.94(12)
27	42	30.95	23	26.09	84	40.48	97	31.96	16	37.50	11.62(12)
28	42	28.57	23	26.09	85	23.53	94	20.21	16	25.00	8.97(12)
29	30	80.00	12	83.33	55	70.91	50	76.00	9	88.89	8.42(12)
30	27	85.19	10	70.00	53	92.45	54	90.74	9	100.00	12.67(12)
31	38	0	19	15.79	65	20.00	65	12.31	6	16.67	15.94(12)
32	30	86.67	13	61.54	62	91.94	71	80.28	7	85.71	14.45(12)
33	44	29.55	24	25.00	86	29.07	99	8.08	17	17.65	<u>33.26</u> (12)
34	38	68.42	31	66.67	79	72.15	94	70.21	16	75.00	<u>22.11</u> (12)
35	39	17.95	20	15.00	83	20.48	95	24.21	17	5.88	10.29(12)
36	41	0	22	4.55	81	6.17	92	8.70	14	7.14	12.89(12)
37	37	0	23	0	88	0	97	2.06	17	0	4.00(4)
38	21	0	9	0	43	0	47	0	9	0	-
39	24	0	9	0	44	0	44	0	8	0	-
40	31	0	19	0	75	0	88	2.27	16	25.00	16.90(12)
41	36	2.78	22	4.55	73	9.59	83	7.23	13	0	9.89(12)
42	26	7.69	14	0	65	3.08	65	6.15	6	16.67	12.11(12)
43											27.24(20)
43.1	37	8.11	22	4.55	88	6.82	89	14.61	11	0	
43.2	37	0	22	0	88	3.41	89	2.25	11	0	
43.3	37	0	22	13.64	88	3.41	89	2.25	11	18.18	
43.4	37	21.62	22	13.64	88	25.00	89	24.72	11	18.18	
43.5	37	51.35	22	27.27	88	35.23	89	29.21	11	27.27	
43.6	37	18.92	22	40.91	88	26.14	89	25.84	11	36.36	
44	30	0	15	13.33	70	15.71	74	18.92	16	6.25	18.33(12)
45	27	29.63	13	38.46	49	38.78	37	32.43	6	66.67	7.71(12)
46	27	33.33	13	46.15	48	39.58	37	43.24	6	66.67	8.38(12)
47	23	8.70	11	27.27	51	11.76	52	1.92	7	0	10.19(12)

\* underlined numbers indicate variance over expected  $\chi^2(f)$

Table 6

Frequencies of non-metric craniological traits in 11-17th cc. Estonians and  
neighbouring populations

No. of Estonians trait 9-17 cc.	East-Europe*		Latgals*	Zemgals and Selis*	Kriviciis of Polock*	Dregovichis*	Slovenes*	
	mean	range	9-10 cc.	8-12 cc.	10-12 cc.	11-13 cc.	of Novg. 11&14 cc.	
1.5	18.81	21.72	0.00-42.42	10.20	0	25.00	17.14	12.41
1.6	10.40	11.96	0.00-28.00	8.16	28.00	5.00	5.71	10.22
2	7.14	8.33	0.00-14.14	7.83	10.81	0	4.25	6.71
3	26.87	20.73	9.38-39.29	21.21	38.71	23.07	13.95	15.83
5	15.56	14.84	3.13-33.33	17.50	13.33	3.85	24.44	17.16
6	8.97	4.37	0.00-13.89	3.22	8.33	0	8.11	2.46
10	25.14	31.67	16.33-50.00	16.33	12.90	12.50	30.00	17.91
11	6.06	5.41	0.00-15.79	5.15	6.67	3.57	6.97	4.44
12	0.36	0.86	0.00-5.17	0.01	0	0	0	0.73
13	2.64	7.45	0.00-15.22	6.25	7.40	4.54	2.56	10.43
15	3.52	2.19	0.00-17.86	2.09	5.55	0	0	2.09
16	17.72	14.99	0.00-31.31	4.35	5.55	7.14	15.55	16.26
17.1	65.90	54.31	20.93-74.14	56.00	34.28	42.11	66.67	61.26
17.2	31.18	30.86	9.30-51.11	27.00	28.57	15.78	51.11	33.33
18	0	0.10	0.00-2.17	0	0	0	0	0
19	8.66	6.04	0.00-18.52	3.06	12.50	4.00	2.50	2.21
20	55.75	64.24	43.28-86.11	55.71	62.50	51.51	56.52	55.78
21	73.25	86.96	73.68-100.00	91.95	74.07	95.65	85.36	83.70
22	66.39	61.54	45.83-86.96	75.00	50.00	86.96	56.10	53.12
24	7.82	8.01	0.00-24.00	10.53	10.00	0	5.13	11.11
25	22.98	25.32	9.52-78.95	19.40	20.00	9.52	21.62	26.56
26	51.08	71.85	53.62-88.46	72.22	64.28	75.00	77.77	72.04
27	34.21	25.09	7.27-39.66	24.27	12.12	35.71	26.08	22.92
28	23.11	20.82	5.26-36.84	15.38	18.18	28.57	17.39	15.71
29	74.84	49.93	21.88-72.34	50.00	30.76	50.00	33.33	43.42
30	89.74	92.40	70.59-100.00	97.06	92.30	82.35	95.00	92.00

Table 6 (continued)

No. of trait	Estonians 9-17 cc.	East-Europe*		Latgals* 9-10 cc.	Zemgals and Selis* 8-12 cc.	Kriviciis of Polock* 10-12 cc.	Dregovichis* 11-13 cc.	Slovenes* of Novg. 11-14 cc.
		mean	range					
31	13.27	21.34	3.33-38.89	25.00	10.52	30.00	17.95	31.51
32	84.32	87.97	59.30-100.00	72.50	96.15	91.66	94.28	59.30
33	20.44	16.17	0.00-33.33	17.59	20.58	6.25	18.75	12.32
34	70.92	90.35	81.25-100.00	90.91	100.00	86.95	70.83	90.47
35	19.84	30.61	10.00-55.56	38.27	22.72	32.00	34.47	32.06
36	5.88	6.94	0.00-23.81	11.86	5.88	0	3.03	23.81
37	0.75	0.31	0.00-6.67	1.51	0	6.67	0	0
40	2.59	8.46	0.00-27.59	0	12.50	6.00	12.50	4.87
41	6.49	8.61	0.00-40.00	4.34	6.45	16.60	6.45	5.80
42	5.59	9.28	0.00-32.14	11.11	11.11	0	5.13	6.29
43.5	34.13	38.14	14.29-75.00	30.88	28.57	33.33	39.02	30.47
47	8.28	0.40	0.00-7.69	0	0	0	0	1.33

\* by Česnys

Table 7

Penrose's distances of the craniometric traits  
between the samples

	Makita I	Makita II	Otepää	Kuuste	Vaadu	Jõuga	Pada	Karja
Makita II	0.248							
Otepää	0.456	0.361						
Kuuste	0.251	0.237	0.128					
Vaadu	0.572	0.242	0.340	0.299				
Jõuga	0.173	0.247	0.177	0.075	0.280			
Pada	0.419	0.541	0.596	0.408	0.710	0.596		
Karja	0.623	0.804	0.563	0.313	0.536	0.533	0.278	
Tammiku	0.480	0.854	0.472	0.378	0.421	0.415	0.470	0.607

POPULATION GENETIC CHARACTERISTICS  
OF SOUTH-EASTERN ESTONIANS

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Estonian Academy of Sciences

The Estonian people are quite heterogenic in linguistic as well as in anthropologic and genetic aspects /2,6,8,9,10/. If the greatest linguistic differences appear between the northern and southern parts of Estonia, then the anthropologic and genetic differences are the greatest in west-east direction. On the basis of massive study of J. Aul, two main anthropological types can be distinguished among Estonians: the West-Baltic type predominates in West Estonia, while the East-Baltic type is spread mainly in East Estonia, especially in the south-eastern region /6/.

In this paper we have attempted to analyse the population-genetic structure of south-eastern Estonians and to compare the gene frequencies of the subgroups of this population with the other Estonian groups and some neighbouring peoples. In our study, South-East Estonia is considered as a territory between the lakes Peipsi and Võrtsjärv, to the south of the river Suur-Emajõgi; from the south it is bordered by Latvia and from south-east by Russia. Twelve local samples have been studied, which have been joined into four regional groups on the basis of linguistic characteristics: the territory of Tartu dialect (in this study named the Tartu group: the samples from Elva, Rõngu and Otepää), the eastern part of Võru dialect area (East-Võru: the samples from Võnnu, Põlva and Kanepi), the western part of Võru dialect area (West-Võru: the samples from Võru, Antsla and Tsirguliina), and the Setu group (Setu: the samples from Värskä, Meremäe and Petseri). Genetic data are based on the six blood group systems (ABO, Duffy, Kell, MN, P and Rhesus) and the trait of PTC-tasting (22 alleles altogether). This material has been collected by L. Heapost /2, 11/. All the people examined were indigenous Estonians, i.e. their grandparents on both sides had been born in the same region.

The collected data have been analysed by means of the population genetic program package created at the Human Genetics Laboratory of Tartu University /7/. The differences of gene frequencies between the regional populations have been measured by the chi-squared method. The degree of genetic similarity (or diversity) of the groups has been determined by Nei's standard genetic distances /3/ and the grouping of populations on the basis of these distances has been made using cluster analysis by the method of means. The results of clustering have been visualized in the form of clustrograms.

The gene frequencies of south-eastern population groups are presented in Table 1. They are compared with the other main linguistic regions of Estonia on the basis of data collected by the same author /2,11/. These regions were the West-Estonian Islands, West, South-West and North-East Estonia. The total mean gene frequencies of these regions are also shown in the Table ('Non-South-East') as well as the overall mean frequencies of Estonians. As the Setu ethnic group has usually (in linguistic and ethnographic terms) been opposed to other south-eastern Estonians, we have done so too in our section of comparisons. In genetic distance and cluster analysis similar data from non-Estonian populations - the Latvians /1/, Finns /4/ and Russians from Moscow - were also used.

As seen from the gene frequency data given in the Table the regional groups of South-East Estonia are quite dissimilar. Some gene frequency differences between them are as big as these between the large Estonian linguistic groups. But as a rule, these differences have no directed order. Only the West-Võru group seems to have clear differences by several gene frequencies from all the other groups: this group is more similar to the western and north-eastern regions as can be clearly seen from clustering examinations (Fig. 2 a, b). In general, the south-eastern gene frequencies show more strongly expressed East-European characteristics than these of western and north-eastern regions: i.e. high frequencies of genes B, M, cDE, and lower frequencies of genes A<sub>2</sub>, O cde and t. In addition, the frequency of gene Fy<sup>a</sup> is also higher in the South-East, however, this is not typical to East Europe because this allele has extremely low frequency for Europe all over Es-

tonia. On the contrary, the mean south-eastern frequency of gene K has a more expressed western level than West-Estonian one.

Besides these common trends in Estonian south-eastern population structure, there are some cases of contradictory observations. For example, the West-Võru group has, in comparison with the other south-eastern groups, many expressive western features, such as the low frequency of gene B and high frequencies of genes P<sub>1</sub> and K, however, at the same time, it has such eastern features as high frequency of Rhesus haplotype cDE and lower frequency of PTC non-tasting gene t. Such kind of inconsistency reveals random processes of gene drift in these small and in their history relatively isolated populations.

Gene distance and cluster analysis show that south-eastern groups of Estonians are still closely related populations as compared to the other Estonian regional groups and neighbouring non-Estonian peoples (Fig. 1 a,b; 2 a, b). They are also considerably near to South-West Estonians and Latvians, but much more distant from most other Estonian regions and the Finns and Russians. All this is in good accord with the anthropological observations. The only exception is the West-Võru group which exhibits more western or Finnish features. The origin of these properties of that population is not clear yet. It is interesting to note that in that area anthropological traits deviating from the general South-East Estonian type have been noticed as well.

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Table 1

Gene frequencies of Estonians in South-Eastern samples, in other parts of  
Estonia and in the whole of Estonia

System	Allele	Tartu	East- Võru	West- Võru	Setu	Mean South- East	Non- South East	Estonia
ABO	n=	180	106	88	216	590	1636	2722
	A1	0.1608	0.2489	0.2405	0.2189	0.2091	0.2042	0.2020
	A2	0.0660	0.0194	0.0312	0.0273	0.0389	0.0409	0.0392
	B	0.1946	0.1948	0.1355	0.1870	0.1828	0.1499	0.1616
	O	0.5786	0.5369	0.5928	0.5668	0.5692	0.6050	0.5973
MN	n=	395	310	203	323	1231	2196	4899
	M	0.5848	0.6403	0.6404	0.6409	0.6227	0.6068	0.6176
Kell	n=	177	110	87	105	479	709	1614
	K	0.0616	0.0277	0.0778	0.0589	0.0561	0.0404	0.0485
P	n=	177	127	87	216	607	894	1969
	P1	0.3862	0.3725	0.4860	0.3691	0.3916	0.4071	0.3926
Duffy	n=	177	125	86	115	503	611	1535
	Fy <sup>a</sup>	0.3663	0.3868	0.3713	0.3675	0.3725	0.3201	0.3591
Rhesus	n=	160	208	89	101	558	894	2039
	cDe	0.0294	0.0307	0.0309	0.0000	0.0248	0.0379	0.0361
	CDe	0.3796	0.4645	0.3569	0.3634	0.4047	0.3998	0.3928
	C <sup>w</sup> De	0.0406	0.0169	0.0337	0.0545	0.0332	0.0246	0.0280
	cDE	0.1627	0.1700	0.2502	0.1331	0.1740	0.1268	0.1549
	CDE	0.0141	0.0152	0.0139	0.0738	0.0253	0.0104	0.0199
	cde	0.3535	0.2969	0.3144	0.3065	0.3177	0.3472	0.3306
	Cde	0.0000	0.0060	0.0000	0.0578	0.0127	0.0366	0.0255
	cdE	0.0200	0.0000	0.0000	0.0109	0.0077	0.0166	0.0122
PTC	n=	96	291	69	229	685	1469	2796
	t	0.4677	0.5040	0.4170	0.4678	0.4780	0.5143	0.4952

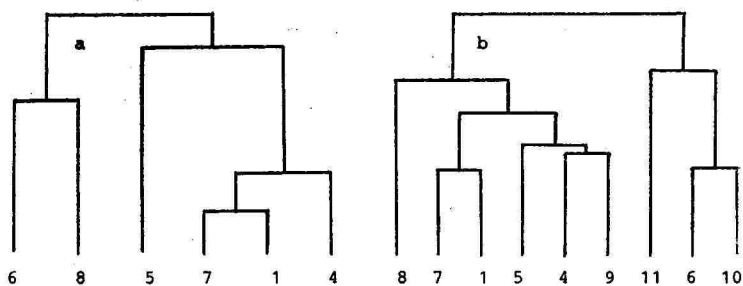


Figure 1. Clustrogram of the grouping of two South-East Estonian populations with the other Estonian and non-Estonian populations based on the cluster analysis of Nei's standard genetic distance matrix. a - the Estonian regional groups only, b - the Estonian regional groups and three neighboring peoples. 1 - South-East Estonians without the Setu group, 4 - Setu, 5 - West-Islands, 6 - West Estonia, 7 - South-West Estonia, 8 - North-East Estonians, 9 - Latvians, 10 - Russians, 11 - Finns.

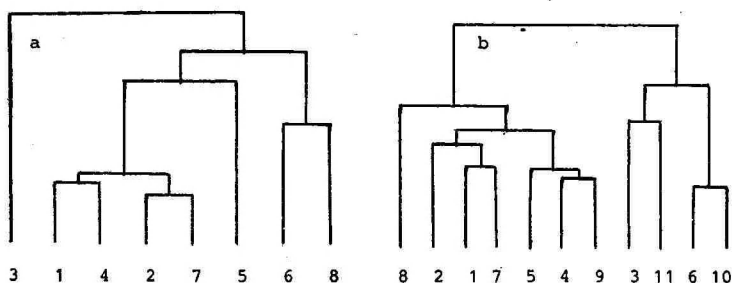


Figure 2. Clustrogram of the grouping of four South-East Estonian populations with the other Estonian and non-Estonian populations based on the cluster analysis of Nei's standard genetic distance matrix. a - the Estonian regional groups only, b - the Estonian regional groups and three neighboring peoples. 1 - Tartu, 2 - East-Võru, 3 - West-Võru; The other populations are the same as on Figure 1.

OSTEOMETRY OF THE 14th-17th CC. CHILDREN'S SKELETONS  
IN LITHUANIAN PALEOOSTEOLOGICAL MATERIALS

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Until recently, studies of the nature and manifestation of growth process among skeletal populations are few in the literature, as traditional physical anthropology is concentrated upon adults (Johnston 1968, 1969). The investigator must be aware of the difficulties and complications that arise in such an exploration: difficulties in sex assessment and impossibility to determine the chronological age at death; numerical restrictions when sample is divided into age groups; unbalanced mortality rates; the fact that skeletal sample cannot be considered as representative of normal population in a strict sense due to factors that interrupted growth and caused death. Notwithstanding these limitations, wide range of information is offered by the study of developmental patterns of paleopopulations, as the growing skeleton still is perhaps the best single system for elucidation of general processes and many environmental effects, and for solving the problem to which extent heredity and environment are responsible for morphological variation in human groups of diverse ecological, nutritional and socioeconomic background (Mensforth, 1985).

**Materials and methods**

Length of clavicle, humerus, radius, ulna, femur, tibia and fibula were measured with the osteometric board in 440 skeletons from Alytus (14th-17th cc.) and some other burial grounds of the same period. Biological age was estimated according to conventional criteria of tooth eruption and epiphyseal union. Body length reconstruction for newborns was performed using A.Garmus (1981), Balthazard and Pineau regression equations, for children - with the help of Stewart tables (cited acc. Malinowski, Strzalko, 1985).

## Results and discussion

Mean diaphysis lengths of bones measured are presented in Tables 1-7, reconstructed body length - in Table 8. Comparison of growth curves with other paleopopulations - ancient Slavs (the 9th c.) (Stloukal, Hanakova, 1978), medieval population at Kulubnarti in Sudanese Nubia (550 - 1450 A.D.) (Hummert, Van Gerven, 1983) and protohistoric Arikara Indians from South Dakota (first half of the 18th c.) (Merchant, Ubelaker, 1977) - was also performed. It revealed that diaphysal growth rates of Lithuanian children, ancient Slavs and Kulubnarti children were generally similar. Bone lengths of ancient Slavs slightly exceeded these of the Lithuanians up to 7 years, were shorter from 7 to 12-13 years, then were slightly longer again. Kulubnarti humerus and femur lengths were shorter up to 13 years, becoming slightly longer at 15; lengths of radius and ulna were similar to Lithuanians up to 12, then increased considerably, tibia was longer in almost all age groups. Arikara Indians had considerably longer diaphyses during all the growth period. The cause of such differences in growth regularities in various populations must be searched both in different genetic background as well as in different ecological conditions. Exact influence of genetic and ecological factors still seems indefinite.

Children's body length, as compared to contemporary Lithuanian children (boys and girls combined) (Tutkuvienė, 1990) was similar up to 11-12 years. After this age a definite growth retardation was detected. As the comparison of annual increase curves revealed, pubertal growth spurt in the 14th-17th cc. took place later than in contemporary children - at the age of 15-17 years. Growth process continued also longer - at least up to 18-20 years, reaching definite value by this period. Similar conclusions could be found also in literature (Steege, 1985; Komlos, 1986).

## Conclusions

1. Comparison of diaphyseal growth curves of various paleopopulations revealed some differences in growth regularities that could be caused by both genetical and ecological factors.

2. Body length of newborns and children up to 11-12 years was similar to contemporary with growth retardation emerging after this age, pubertal growth spurt took place later and the growth process was longer.

3. It could be considered that the influence of genetic and environmental factors of growth process is not constant: while in the first decade genetic factors prevail, then in the second the environmental factors are more significant.

4. Tables presented in this paper could also be used for approximate child age estimation in paleosteological samples for Central and East European populations.

Table 1

Length of clavicle, mm

Age	N	Mean	S	Min. - Max.
Newb.	21	44.21	4.79	32.0 - 55.0
0-2 mn.	4	43.75	3.34	40.0 - 49.0
2-6 mn.	5	51.75	2.97	47.0 - 56.0
6-12 mn.	2	55.00	2.00	53.0 - 57.0
1.0-1.5 yrs.	16	59.16	4.23	52.0 - 69.0
1.5-2.0 yrs.	7	60.57	2.93	54.0 - 64.0
2.0-2.5 yrs.	15	66.80	4.94	60.0 - 78.0
2.5-3.0 yrs.	17	67.32	4.50	56.0 - 76.0
3-4 yrs.	22	70.59	4.24	64.0 - 80.0
4-5 yrs.	16	75.87	4.69	70.0 - 87.5
5-6 yrs.	21	79.45	4.45	73.5 - 91.0
6-7 yrs.	17	82.85	5.70	69.0 - 92.0
7-8 yrs.	13	92.81	3.85	86.0 - 99.0
8-9 yrs.	8	95.06	6.82	86.0 - 110.0
9-10 yrs.	14	96.64	6.71	88.0 - 113.5
10-11 yrs.	13	103.85	7.68	88.0 - 115.0
11-12 yrs.	10	101.45	7.03	88.0 - 113.0
12-14 yrs.	8	105.50	9.50	90.5 - 117.5
14-16 yrs.	15	110.70	8.14	98.0 - 122.5
16-18 yrs.	11	121.09	7.52	108.0 - 134.5
18-20 yrs.	5	120.60	8.91	110.5 - 135.0

Table 2

## Length of humerus, mm

Age	N	Mean	S	Min. - Max.
Newb.	36	61.75	6.97	48.0 - 85.0
0-2 mn.	9	67.89	4.87	63.0 - 76.0
2-8 mn.	10	80.60	7.24	70.0 - 93.0
6-12 mn.	8	88.62	6.06	79.0 - 98.0
1.0-1.5 yrs.	21	103.45	6.38	90.0 - 114.5
1.5-2.0 yrs.	9	103.39	8.22	86.0 - 114.0
2.0-2.5 yrs.	20	118.80	10.82	99.0 - 138.0
2.5-3.0 yrs.	23	121.09	6.64	107.0 - 133.0
3-4 yrs.	28	129.84	11.52	103.0 - 156.0
4-5 yrs.	19	146.08	9.85	126.0 - 161.0
5-6 yrs.	22	155.86	13.38	121.0 - 183.0
6-7 yrs.	18	165.67	14.32	119.0 - 183.5
7-8 yrs.	18	189.53	14.81	144.0 - 207.0
8-9 yrs.	13	205.85	13.24	180.0 - 227.0
9-10 yrs.	15	205.90	12.25	184.0 - 234.5
10-11 yrs.	16	225.50	16.16	192.0 - 259.5
11-12 yrs.	10	218.55	18.98	191.0 - 245.0
12-14 yrs.	8	231.25	9.98	214.5 - 245.5
14-16 yrs.	12	241.46	14.04	212.5 - 256.5
16-18 yrs.	4	262.00	24.16	227.0 - 295.0
18-20 yrs.	4	287.00	14.14	263.5 - 300.5

Table 3

## Length of ulna, mm

Age	N	Mean	S	Min. - Max.
Newb.	22	60.07	6.58	44.0 - 73.0
0-2 mn.	6	62.25	4.96	57.5 - 73.0
2-6 mn.	6	68.25	4.49	62.0 - 76.0
6-12 mn.	4	76.50	2.87	72.0 - 80.0
1.0-1.5 yrs.	13	84.88	6.49	73.0 - 95.5
1.5-2.0 yrs.	6	88.17	3.89	82.0 - 95.0
2.0-2.5 yrs.	12	98.04	9.27	80.0 - 112.0
2.5-3.0 yrs.	14	102.54	5.00	93.0 - 112.0
3-4 yrs.	19	109.50	10.25	94.0 - 133.0
4-5 yrs.	11	120.45	9.56	100.0 - 134.0
5-6 yrs.	18	129.67	10.55	117.0 - 154.5
6-7 yrs.	15	138.47	9.50	122.0 - 153.0
7-8 yrs.	12	155.71	9.22	138.0 - 175.0
8-9 yrs.	6	164.42	5.10	157.0 - 173.0
9-10 yrs.	14	170.36	12.88	148.0 - 191.5
10-11 yrs.	11	185.73	13.28	154.0 - 201.5
11-12 yrs.	10	183.90	13.18	164.0 - 207.0
12-14 yrs.	8	190.12	16.99	173.0 - 226.0
14-16 yrs.	10	210.00	13.92	190.0 - 240.0
16-18 yrs.	3	228.17	15.06	212.5 - 248.5
18-20 yrs.	1	218.00	0	-

Table 4

## Length of radius, mm

Age	N	Mean	S	Min.-- Max.
Newb.	27	53.54	5.54	40.0 - 64.0
0-2 mn.	7	53.43	2.61	50.0 - 59.0
2-6 mn.	7	62.00	4.69	55.0 - 68.0
6-12 mn.	3	69.00	2.87	65.0 - 72.0
1.0-1.5 yrs.	14	76.57	5.06	68.5 - 86.0
1.5-2.0 yrs.	6	79.58	4.15	72.0 - 86.0
2.0-2.5 yrs.	14	89.89	9.37	70.0 - 102.0
2.5-3.0 yrs.	18	91.56	4.76	82.5 - 100.0
3-4 yrs.	23	98.98	9.42	85.0 - 120.0
4-5 yrs.	16	108.00	8.17	91.0 - 120.5
5-6 yrs.	19	117.21	9.56	102.0 - 141.5
6-7 yrs.	14	127.25	8.35	112.0 - 140.5
7-8 yrs.	14	140.39	8.73	125.0 - 157.5
8-9 yrs.	6	151.83	6.20	141.0 - 160.0
9-10 yrs.	13	152.65	11.77	135.0 - 173.0
10-11 yrs.	17	169.35	10.36	141.5 - 190.0
11-12 yrs.	10	166.00	14.27	145.0 - 188.0
12-14 yrs.	8	166.37	9.92	151.0 - 184.5
14-16 yrs.	12	191.50	16.02	156.0 - 212.0
16-18 yrs.	10	199.20	19.69	167.0 - 241.0
18-20 yrs.	5	217.40	9.57	202.0 - 230.0

Table 5

## Length of femur, mm

Age	N	Mean	S	Min. - Max.
Newb.	30	78.50	9.58	52.5 - 102.0
0-2 mn.	8	81.19	8.99	72.0 - 100.0
2-6 mn.	10	98.40	10.53	84.5 - 112.5
6-12 mn.	6	105.92	8.78	95.0 - 118.0
1.0-1.5 yrs.	20	129.52	9.54	114.0 - 147.0
1.5-2.0 yrs.	5	127.90	11.83	106.5 - 139.0
2.0-2.5 yrs.	14	153.82	15.06	124.0 - 177.5
2.5-3.0 yrs.	24	153.81	8.60	135.0 - 167.0
3-4 yrs.	29	170.74	16.86	141.0 - 205.0
4-5 yrs.	21	191.00	17.05	156.0 - 234.0
5-6 yrs.	24	207.44	20.29	152.0 - 248.5
6-7 yrs.	21	227.02	13.35	196.5 - 250.0
7-8 yrs.	22	257.70	20.22	204.0 - 294.0
8-9 yrs.	13	280.38	18.63	246.0 - 314.5
9-10 yrs.	13	287.50	23.79	258.0 - 328.0
10-11 yrs.	21	315.83	21.20	267.5 - 343.5
11-12 yrs.	10	312.90	26.86	259.0 - 350.0
12-14 yrs.	9	327.50	21.47	299.0 - 360.5
14-16 yrs.	17	345.23	25.20	299.0 - 393.5
16-18 yrs.	12	384.12	27.45	346.5 - 437.5
18-20 yrs.	7	397.07	22.39	347.5 - 420.0

Table 6

## Length of tibia, mm

Age	N	Mean	S	Min. - Max.
Newb.	28	66.57	7.84	46.0 - 83.0
0-2 mn.	6	70.75	7.94	63.5 - 87.0
2-6 mn.	9	82.00	7.22	72.0 - 90.5
6-12 mn.	5	90.40	7.61	78.0 - 97.0
1.0-1.5 yrs.	18	102.89	8.29	84.0 - 120.0
1.5-2.0 yrs.	4	107.12	4.77	99.0 - 111.0
2.0-2.5 yrs.	15	122.73	12.26	102.5 - 142.5
2.5-3.0 yrs.	19	126.10	6.44	116.0 - 138.0
3-4 yrs.	27	135.50	16.41	103.0 - 171.0
4-5 yrs.	17	152.65	13.93	128.5 - 182.0
5-6 yrs.	23	167.13	15.83	138.0 - 207.0
6-7 yrs.	18	179.78	11.93	156.0 - 197.0
7-8 yrs.	20	203.32	15.87	162.0 - 231.0
8-9 yrs.	9	215.94	13.31	193.5 - 236.5
9-10 yrs.	10	222.90	15.59	206.0 - 254.0
10-11 yrs.	17	248.44	19.85	205.5 - 286.0
11-12 yrs.	9	247.72	28.05	204.0 - 283.0
12-14 yrs.	8	255.69	14.63	229.5 - 273.5
14-16 yrs.	15	276.43	19.74	232.0 - 310.0
16-18 yrs.	11	305.04	19.69	272.5 - 333.5
18-20 yrs.	5	324.80	14.60	306.0 - 348.5

Table 7

## Length of fibula, mm

Age	N	Mean	S	Min. - Max.
Newb.	12	60.79	8.28	44.0 - 76.0
0-2 mn.	2	66.00	4.00	62.0 - 70.0
2-6 mn.	3	77.00	6.98	69.0 - 86.0
6-12 mn.	1	77.00	0	-
1.0-1.5 yrs.	6	102.75	6.80	97.0 - 115.0
1.5-2.0 yrs.	2	99.50	5.50	94.0 - 105.0
2.0-2.5 yrs.	9	116.72	15.33	92.0 - 141.0
2.5-3.0 yrs.	7	125.64	6.54	117.0 - 137.5
3-4 yrs.	8	131.06	15.62	99.0 - 150.0
4-5 yrs.	10	148.40	13.69	124.5 - 165.0
5-6 yrs.	16	163.91	13.15	142.0 - 188.0
6-7 yrs.	8	179.06	13.72	155.0 - 197.0
7-8 yrs.	14	200.75	10.98	185.0 - 220.0
8-9 yrs.	4	214.62	11.28	202.5 - 231.0
9-10 yrs.	6	223.42	14.78	204.0 - 250.5
10-11 yrs.	11	244.14	16.94	199.0 - 265.0
11-12 yrs.	8	240.75	19.57	200.0 - 270.0
12-14 yrs.	6	252.17	16.40	255.5 - 268.0
14-16 yrs.	12	267.54	18.67	231.0 - 297.0
16-18 yrs.	6	288.67	17.57	266.0 - 313.0
18-20 yrs.	3	307.83	8.62	298.0 - 319.0

Table 8

## Estimated stature, cm

Age	N	Mean	S	Min. - Max.
Newb. <sup>*</sup>	41	51.78	4.80	39.2 - 63.5
Newb. <sup>***</sup>	42	53.00	5.46	37.5 - 66.8
Newb. <sup>****</sup>	42	52.47	5.16	38.3 - 65.5
0-2 mn.	10	54.40	4.67	49.4 - 64.5
2-6 mn.	10	63.43	6.42	55.0 - 71.5
6-12 mn.	6	68.30	5.83	61.5 - 77.8
1.0-1.5 yrs.	20	81.38	4.89	73.0 - 90.9
1.5-2.0 yrs.	5	80.56	6.62	68.3 - 86.5
2.0-2.5 yrs.	15	93.79	7.19	78.5 - 104.5
2.5-3.0 yrs.	24	94.00	4.07	84.5 - 100.0
3-4 yrs.	29	101.42	7.19	87.5 - 115.0
4-5 yrs.	21	109.59	6.41	95.0 - 123.5
5-6 yrs.	24	115.01	6.83	93.5 - 127.4
6-7 yrs.	21	121.41	4.03	111.9 - 127.5
7-8 yrs.	22	129.72	5.53	114.8 - 139.3
8-9 yrs.	13	135.86	4.98	126.5 - 144.8
9-10 yrs.	13	137.64	6.27	129.4 - 148.4
10-11 yrs.	21	145.15	5.68	132.2 - 153.4
11-12 yrs.	10	144.20	6.98	130.0 - 153.8
12-14 yrs.	9	147.93	5.43	140.8 - 156.2
14-16 yrs.	17	152.66	6.73	140.8 - 166.8
16-18 yrs.	12	165.02	10.37	152.8 - 187.0
18-20 yrs.	7	169.96	8.36	153.1 - 180.0

<sup>\*</sup> - Balthazard; <sup>\*\*\*</sup> - Pineau; <sup>\*\*\*\*</sup> - Garbus

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## BODY COMPOSITION OF TARTU UNIVERSITY STUDENTS

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Skinfold thickness is used as an index for estimating obesity because a large proportion of body fat is subcutaneous /1,2/ and measures of its thickness can provide valuable information concerning the amount of total and percental body fat. An individual whose fat is concentrated on the trunk and upper body is at a significantly greater risk of developing cardiovascular diseases than an individual whose fat is distributed around the lower body and extremities /9/. In the ideal body weight adipose tissue accounts for up to 14% in men /8/ and up to 20-25% in women /10/.

Different protocols have been recommended for measuring subcutaneous fat thickness. Relatively popular is J. Parizkova's /6/ method. She recommends to measure skinfold thicknesses at 10 points of body surface.

The purpose of this investigation was to measure the body composition with the help of skinfold thickness method in healthy moderately trained students of Tartu University.

### Methods

A total of 471 male and 650 female students of Tartu University (from all faculties except physical education) volunteered as subjects. They visited official physical education classes twice a week. Stature was measured to the nearest millimetre and body weight with the help of medical scales ( $\pm 50$  g). Skinfold thicknesses were measured on the right side of the body with the subject standing relaxed with a calibrated calliper (pressure  $10 \text{ g/mm}^2$ ) at the cheek, chin, thorax I, triceps, subscapular, abdomen, thorax II, subrailiac, thigh and calf /6/. According to this method the measurement error of individual skinfold

measurements varies from 3.3-9.6 %, the sum of ten skinfolds is 2.0% /5/. Fat percentage was calculated with the help of J. Parizkova's nomographs /6/. Fat weight = body weight x % of body fat /100, and lean body mass (LBM) = body weight - fat weight.

### Results and discussion

Detailed physical characteristics of the two investigated groups are presented in the Table. The mean body fat percentage in males ( $13.9 \pm 4.3\%$ ) and females ( $24.1 \pm 5.2\%$ ) was similar to that found in literature for university students of equivalent ages /3,4/. In Bulgarian female medical students the body fat percentage was somewhat lower and in male students higher than in our students /7/. Only 10.2% of our male students and 12.9% of female students were overweight (percentage of body fat higher than 20 or 30% respectively). On the other hand, we measured only healthy students.

The distribution of subcutaneous fat is presented in the Figure. The body fat topography indicates that in male students adiposity is largely deposited in the abdomen and subscapular and in female students in the abdomen and suprailiac.

The body fat percentage correlated significantly with all 10 skinfold thicknesses. In males the correlation coefficients were from 0.57 to 0.877 and in females from 0.362 to 0.823. Body fat percentage is not dependent on body height (correlation coefficients -0.053 and -0.026 in males and females), on the other hand, body weight is of significant relation ( $r=0.520$  and  $r=0.539$  respectively).

In conclusion the body composition of our students is similar to that of students of other countries. Adiposity is mostly deposited in the abdomen.

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Table

Physical characteristics of students (Means  $\pm$  SD)

	Males (n=471)	Females (n=650)
Age (yrs)	20.7 $\pm$ 2.2	20.1 $\pm$ 1.6
Stature (m)	1.80 $\pm$ 0.08	1.67 $\pm$ 0.06
Body weight (kg)	73.2 $\pm$ 8.7	62.9 $\pm$ 8.3
% body fat	13.9 $\pm$ 4.3	24.1 $\pm$ 5.2
Fat weight (kg)	10.3 $\pm$ 4.1	15.4 $\pm$ 4.8
LBM (kg)	62.9 $\pm$ 6.5	47.5 $\pm$ 5.3

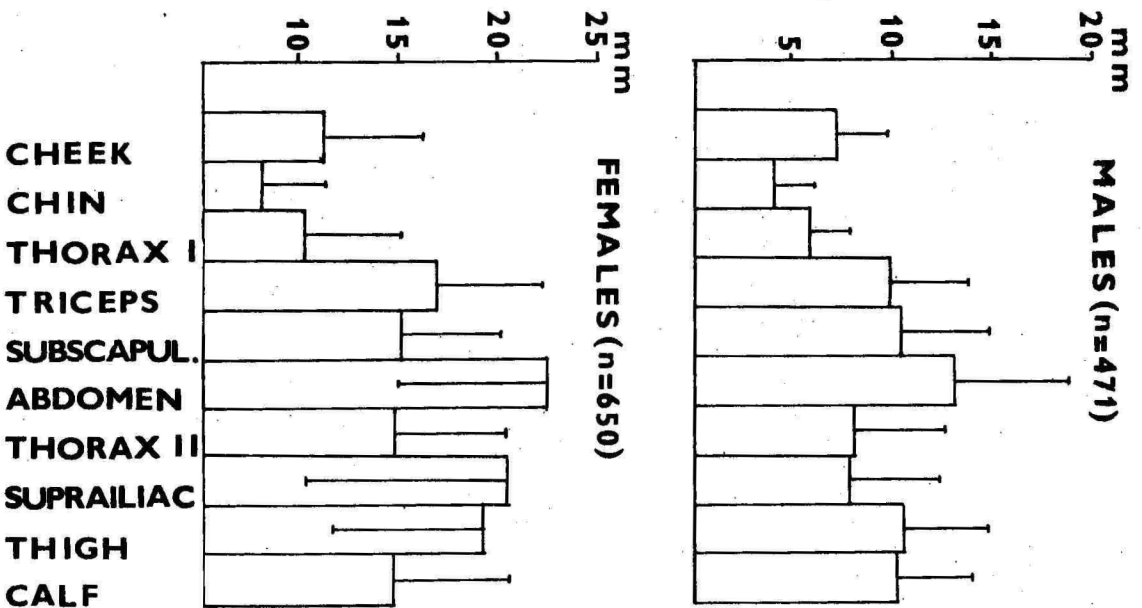


Figure. Skinfold thicknesses in students (Means  $\pm$  SD).

## A STUDY OF STUDENTS' NUTRITION HABITS

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In the present economic situation problems connected with nutrition habits have gained more and more social interest. As nutrition plays an important role in a nation's health, there is a need to analyze the facts in order to evaluate the present situation.

Lately there has been some polemics about standardization of the ingredients and calorific value of the daily menu. Here one must surely consider different somatotypes, person's physical and emotional load and other data. So far such data have been monitored only about pregnant women /4/.

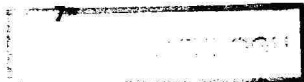
The data of the present article are based on a questionnaire among the students of Tartu University and reflect the nutrition habits of the students. The characteristics of this contingent are homogeneous: aged 19-23, with similar physical and emotional load, healthy young people.

The questionnaire was administered in November 1991 by Dr. Luule Tanning from the Department of Hygiene, Tartu University. The data were processed and analyzed by postgraduate student of the Department of Zoology Kaja Kuivjõgi. A special original program meant for nutrition studies has been used for processing the data /2/. For statistical analysis the statistics packet 'STATGRAPHICS' has been used. Basic data for analyzing the menus are tables of chemical consistence and calorific values /1/. Data for comparison have been taken from the physiological norms confirmed by the Ministry of Health of the Soviet Union in 1991 /3/.

Such an analysis has been carried out for the second year.

In this article a closer look has been taken at the female students. 74 students were questioned and their 10 days' menu was monitored.

The basic nutrition elements as protein, carbohydrates and fat and calorific value have been examined. The main fea-



ture to be underlined, is the rather large intake of fat and protein. The intake of protein is satisfying, but the intake of fats is by far too large. The role of carbohydrates is impermissibly small, about 1/3 of the supposed norm. One of the reasons for that is the shortage of sugar and chocolate in Estonia, also the poor choice of fruits and vegetables must be considered. Therefore the basic nutrition elements in one's menu are not in proportion: protein - 1; fat - 1; carbohydrates - 4. In the present contingent they are 1; 1.3; 2.6. At that fats give 45% of all the calorage (must be 30%), and carbohydrates 41% (must be 58%).

In addition it can be mentioned that the lack of carbohydrates is compensated for with pastry and other refined foods. Due to that there is a lack of energy which cannot be compensated for with a large intake of fat.

Such tendencies were present in last year's (1990) questionnaire as well. There were no significant differences between boys and girls. As all the students who were questioned studied at the Faculty of Medicine, this is a sign of the lack of nutrition knowledge among students.

The main nutrition elements and their calorific values are presented in Table 1.

A general research has been made to find a correlation between the main nutrition elements and the main types of body constitution. To characterize the body we could use the the height and weight of the students.

Rohrer index has been used: 
$$\frac{\text{weight in grams}}{(\text{height cm})^3} \times 100.$$

Height, weight and index have been correlated with the main nutrition elements and calorific values in the menu. A relevant correlation matrix is presented in Table 2.

Correlation reiteration between height and basic nutrition elements is between 0.05 and 0.17. It shows that the taller the person, the more she uses fats, protein and carbohydrates. Correlation between weight and basic nutrition elements is negative (-0.05 to -0.17), which shows that if the weight gets heavier, the main nutrition elements are reduced in nutriment. Correlation reiteration between Rohrer index and main nutrition elements is also negative (-0.11 to -0.27). One can conclude that if the weight increases, the intake of fats, protein and carbohydrates does not grow.

The index that shows the substantiality of statistical probability is smaller than 0.03 (except for carbohydrates:  $p = 0.3$ ), the level of substantiality is  $\alpha = 0.05$ . Therefore correlations of the characteristics are statistically relevant in the case of general complex. All indexes of body (height, weight and Rohrer index) characterize the types of body constitution from different aspects. The results of the analysis confirm that people with different types of body constitution eat differently, the type of metabolism has an important role here. Therefore, in every nutrition study one must consider the types of body constitution and metabolism. Thus, the standardization of nutrition elements in food can be very individual or is valid only in the case of "average" persons.

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Table 1

## Main nutrition elements and calorific values. Female 1991

Appellation of reading	PROTEIN	FAT	CARBO-HYDRATES	ENERGY
Space of the readings of majority	50-80 g	66-110 g	130-225 g	1240-2010 kcal
Percentage of persons in majority	49%	48%	46%	51%
below majority	26%	26%	28%	23%
above majority	24%	25%	25%	25%
Average	66 g	89 g	185 g	1753 kcal
Minimum	23 g	32 g	46 g	654 kcal
Maximum	147 g	215 g	660 g	4081 kcal
Reading used for comparison	61 g	67 g	289 g	2000 kcal
below 'norm'	48%	26%	92%	73%
above 'norm'	51%	73%	7%	26%
Trusted limits $\alpha = 0.05$	61-71 g	82-95 g	166-203 g	1621-1884 kcal
Percentage of persons in trusted limits	16%	16%	17%	21%
Below trusted limits	48%	47%	48%	45%
Above trusted limits	36%	36%	34%	34%
T - statistic	2.2196	6.6850	-11.1598	-3.7250
Std.devariation	25.1	32.4	90.73	646.1
Std.error	2.6	3.3	9.3	66.2

Table 2

Correlation matrix: correlations between main nutrition elements and calorage with height, weight and Rohrer index

	HEIGHT	WEIGHT	ROHRER INDEX	PROTEIN	FAT	C/H	ENERGY
HEIGHT	1.0000 (.74)	.5018 (.74)	-.3515 (.74)	.1136 (.74)	.1716 (.74)	.0500 (.74)	.1414 (.74)
	.0000	.0000	.0021	.3350	.1438	.6722	.2295
WEIGHT	.5018 (.74)	1.0000 (.74)	.6291 (.74)	-.1648 (.74)	-.1116 (.74)	-.0864 (.74)	-.1371 (.74)
	.0000	.0000	.0000	.1605	.3437	.4644	.2442
ROHRER INDEX	-.3515 (.74)	.6291 (.74)	1.0000 (.74)	-.2581 (.74)	-.2523 (.74)	-.1199 (.74)	-.2527 (.74)
	.0021	.0000	.0000	.0264	.0301	.3090	.0298
PROTEIN	.1136 (.74)	-.1648 (.74)	-.2581 (.74)	1.0000 (.74)	.8167 (.74)	.7666 (.74)	.8957 (.74)
	.3350	.1605	.0264	.0000	.0000	.0000	.0000
FAT	.1716 (.74)	-.1116 (.74)	-.2523 (.74)	.8167 (.74)	1.0000 (.74)	.7033 (.74)	.8807 (.74)
	.1438	.3437	.0301	.0000	.0000	.0000	.0000
CARBO- HYDR.	.0500 (.74)	-.0864 (.74)	-.1199 (.74)	.7666 (.74)	.7033 (.74)	1.0000 (.74)	.9105 (.74)
	.6722	.4644	.3090	.0000	.0000	.0000	.0000
ENERGY	.1414 (.74)	-.1371 (.74)	-.2527 (.74)	.8957 (.74)	.8807 (.74)	.9105 (.74)	1.0000 (.74)
	.2295	.2442	.0298	.0000	.0000	.0000	.0000

AGE CHARACTERISTICS OF THE SKULL OF CHILDREN  
WITH BLOCKED-DEEP BITE (ANGLE CLASS II, DIVISION 2)

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There have been rather few papers dealing with cephalographic studies of the blocked-deep bite (A. A. Anikienko et al, 1983; V.V. Reva, 1984; W.J.S. Kerr, 1979, A. Ruhland, 1964).

Knowing of the growth regularities of different skull zones in the case of normal and abnormal bites helps dentists to influence the process of growth. It also helps them to better understand the etiology and pathogenesis of a certain abnormality, to determine the beginning and termination of orthodontic treatment, to appropriately choose orthodontic appliances, prognosticate the results of treatment, and to avoid relapses after cessation of treatment.

In order to find out age-dependent changes, a number of researchers have compared the mean values of skull parameters of 7-12-year-old children with mixed dentition and 12-17-year-old teenagers with permanent dentition. W. J. S. Kerr (1979) studied skull parameters in the age groups of 5-10, 10-15, and 5-15 years; A. Ruhland's (1964) studies embraced the following age groups: 5-9, 10-13, 14-21 years.

Since the average values of skull parameters of different age groups have been compared, it does not show us well enough what kind of changes take place in the morphological parameters of brain and facial zones of the skull in the case of the children having blocked-deep bite.

Comparison of the mean values of different age groups is not the only method for studying age-dependent changes in skull parameters. They can also be investigated by finding correlative dependencies between children's ages and values of certain parameters. On the basis of the correlation coefficients found, we can establish the percentage of age-de-

pendent changes in certain skull parameters.

As far as the correlation method has been rather neglected, we can claim that the methodology for finding out age-dependent changes in the skull parameters of the children with the blocked-deep bite has not been complete and thus, the knowledge of orthodontists of those changes is also incomplete.

Our research was based on the cephalograms of 26 children with orthognathous bite and 56 children with blocked-deep bite. In each cephalogram five brain zone and thirty-six facial zone parameters were measured. The distribution of children according to their bite types and dentition types is given in the Table.

Table

Distribution of children according to their bite  
and dentition types

Dentition type	Number of children according to their bite types	
	orthognathous	blocked-deep
Mixed dentition	14	27
Permanent dentition	12	29
Total	26	56

The analysis of the data showed that age-dependent changes in the brain and facial zone parameters of the skull are different in the cases of mixed and permanent dentition. There are such parameters which do not practically change at the age of 7-15. Their correlation coefficients are big ( $K = 0.97 - 1.0$ ) and the average parameters do not vary with the change in dentition type. Such parameters are the following: the angle of the base of the skull; the length of the apical base of the maxilla; the angle of the upper incisors relative to the maxillary surface; the length of the upper teeth line; the position of the posterior zone of the maxilla relative to the sella turcica of the skull; the angle of the maxillary surface relative to the anterior zone of the base of the skull; the length of the apical base of the mandible; the angle of the lower incisors relative to the mandibular surface; the length of the lower teeth line; the overjet and overbite.

A number of parameters show increases in their values during the mixed dentition period. It is highly probable that they statistically depend on age, their mean values being different in different dentition periods. The age effect on the variability of these parameters is rather different. Determination coefficient  $R = 30.3\%$  denotes the height of the maxillary dentoalveolar process in its posterior zone. Determination coefficient  $R = 18.5\%$  denotes the parameter characterizing the sagittal position of the mandibular chin relative to the anterior zone of the base of the skull. Owing to a rather insignificant age effect ( $R = 13.0 - 20.3\%$ ), the values of the following parameters decrease during the mixed dentition period: the angle between the anterior surface of the base of the skull and mandibular surface; the angle between the Frankfurt horizontal and mandibular surface; the angle between the maxillary and mandibular surfaces.

During the period of mixed dentition, there also exists a correlation between the parameter characterizing the vertical and sagittal positions of the mandible relative to the anterior zone of the base of the skull and the age factor, though the mean values of that parameter will not probably vary in different dentition periods. The determination coefficient of the parameter is  $R = 23.0\%$ .

During permanent dentition, there should be certain statistical dependences upon a person's age. The mean values of those parameters can probably vary in different dentition periods. The following parameters have determination coefficients with the average intensity ( $R = 26.0 - 43.6\%$ ): a distance between the posterior zone of the maxilla and of the anterior zone of the base of the skull; the height of the mandible in its posterior zone; the distance between the anterior zone of the base of the skull and the angle of the mandible; the upper anterior face height.

The following parameters have small determination coefficient values ( $R = 14.4 - 32.0\%$ ): the length of the posterior zone of the base of the skull; the distance between the subnasal point A and the anterior zone of the base of the skull; the anterior mandible height.

There probably are such parameters which have age-dependent correlation coefficients within the period of

permanent dentition. In such cases, determination coefficient values are small ( $R = 16.0 - 19.4 \%$ ), but their average parameters do not normally vary statistically in different age-dependent dentition periods. Such parameters are the length and height of the cerebral cranium.

Certain parameters are age-dependent both during the mixed and permanent dentition periods. Their values vary statistically in different dentition periods. The determination coefficient value is either small ( $R = 12.3 - 24.0 \%$ ) or average ( $R = 28.1 - 32.5 \%$ ). In the case of the following parameters the determination coefficient effect increases during transition from the mixed to the permanent dentition: the length of the mandibular process; the distance between the sella turcica and the chin; the height of the posterior zone of the face.

The determination coefficient effect upon the length of the mandible decreases.

A number of parameters are probable to increase statistically between the ages of 7 and 15. Their values should be statistically related to age and their averaged parameters are statistically different in different age periods. The corresponding determination coefficient values are either small ( $R = 11.6 - 20.3 \%$ ) or average ( $R = 28.2 - 32.5 \%$ ). Such parameters are: the anterior zone of the base of the skull; the length of the maxilla; the sagittal position of the first molar relative to the sella turcica; the position of the apical base of the maxilla relative to the nasion-point of the anterior zone of the base of the skull; the upper anterior face height.

During this age period the angle showing the interrelation of the anterior surface of the base of the skull with the mandibular surface is decreasing. Its determination coefficient value is small ( $R = 20.3 \%$ ).

Some parameters also have probable statistical age-dependent features in the age period of 7-15 years, though their mean values do not vary in different age groups. The determination coefficient values are small ( $R = 7.3 - 16.8 \%$ ). This group includes such parameters as the dentoalveolar height of the anterior zone of the maxilla; the mandibular angle; the lower anterior face height; the angle between incisors.

By comparing the average skull parameters of children having the blocked-deep bite with the norm, we found out the

skull zones revealing more serious growth disorders. They are the following: excessive growth of the posterior zone of the base of the skull; the anterior mandibular surface is lifted upwards relative to the anterior zone of the base of the skull towards the Frankfurt horizontal and maxillar surface, which refers to a decrease in lower anterior face height; the oral angle of the upper front teeth and the angle between incisives increase.

All these abnormalities are age-dependent, showing a tendency towards becoming more expressed. Thus, an explicit increase in the covering of incisives refers to the aggravation of bite pathology.

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PARAMETERS OF PHYSICAL DEVELOPMENT OF NEONATES  
AND SOME FACTORS AFFECTING THEM

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Physical development of newborns depends to a large extent on socio-economic and genetic factors (1-5). The improvement of economic and health conditions in developed countries has led to the acceleration of growth and development of children, including neonates (6-8). Economic crises with poor nutritional conditions before and during pregnancy have a profound effect upon the growth and development of the fetus (7, 9-10). Therefore the investigation of anthropometric parameters of newborns at the period of socio-economic crises may have a prognostic significance for health conditions of human population.

The aim of this study was to investigate the growth status of the full-term neonates at birth by sex and birth weight groups of infants as well as by the age, parity and dwelling-place of the mother. For this purpose the parameters of birth weight, body length and body weight/length index (WLI) were retrospectively found from birthcases. For this analysis all women who had delivered a liveborn singleton full-term infant of 38-42 weeks of gestation in Tartu Women's Clinic in 1990 were eligible. The number of subjects of that investigation was 2676 (1392 male and 1284 female neonates).

In statistics we used one- and two-dimensional analyses, T- and Chisquare Tests.

The parameters of birth weight, body length, body weight/length index (WLI) of neonates and age of mother in connection with sex of infants and parity of mother are presented in Table 1.

Our data demonstrate that the parameters of physical development of male neonates are significantly higher than those of female ones. Thus, the mean birth weight of males was  $3699 \pm 479$  g, that of females -  $3557 \pm 445$  g ( $p < 0.001$ ), body length was  $50.5 \pm 1.9$  cm and  $49.7 \pm 1.8$  cm respectively ( $p < 0.001$ ),

and WLI was  $73.1 \pm 7.6$  g/cm and  $71.4 \pm 7.6$  g/cm, respectively ( $p < 0.001$ ). The mean age of the mother was similar in both sex groups ( $25.5 \pm 5.5$  and  $25.1 \pm 5.4$  years respectively,  $p > 0.1$ ). The values of body weight, length and WLI of neonates as well as the age of the mother were significantly ( $p < 0.001$ ) higher at the subsequent deliveries than at the prime ones.

Our results are in agreement with the parameters of neonates of North Estonia (10). The birth weight of our male neonates is similar with the weight of Kharkov and Leningrad neonates, but our female neonates are heavier than theirs (11-12). In comparison with the data of different ethnic groups of West and East Europe, Asia and North America (9, 12, 14), the birth weight of Estonian neonates exceeds theirs by 219-469 g. At the same time the body length of Estonian neonates is a little shorter than in other West and East European neonates (9, 12, 15). Relatively heavy body weight and short body length determine the relatively high values of WLI in our infants.

We also studied the connection between the physical development of neonates and the dwelling-place of their mothers. Of the subjects of investigation 1645 lived in Tartu, 554 in Tartu district, 246 in other towns of Estonia and 231 in other rural districts. Our analysis showed (Table 2) that the body weight, length and WLI of neonates, and the age of mothers were similar in urban and rural patients. Rural women had on the average two or more deliveries, town women had less than two deliveries (the women from Tartu 1.76 and the women from other towns 1.85).

There were no territorial differences between the anthropometric parameters of neonates of North and South Estonia, as well as between the data of urban and rural neonates.

To evaluate the structure of physical development of the whole population of full-term neonates, an analysis of frequency of infants by body weight and length groups in  $\pm$ SD (standard deviation) classes was performed. The results obtained were compared with the expected values of normal distribution data of Gauss's curve by frequency histograms and by chisquare tests (Fig. 1).

The analysis revealed that the division of neonates by body weight in  $\pm$ 1SD classes, and particularly in  $\pm$ 2SD classes was not symmetrical. The -1SD class had the highest frequency (35.3% in boys and 36.8% in girls). The frequency of neonates

in  $-1SD$  and  $-2SD$  classes together exceeds the values of  $+1SD$  and  $+2SD$  classes both in male (49.1% and 46.1% respectively,  $p < 0.03$ ) and in female neonates (49.9% and 45% respectively,  $p < 0.0001$ ). The curve of body length (distributed by  $1/2SD$  classes) did not differ from Gauss's curve in neonates of both sexes.

Consequently, the rise of frequency of neonates in the minus zone of normal distribution of birth weight classes may serve as an early evidence of decrease of body weight and subsequently in a few years we may anticipate the decrease of birth weight of neonates.

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Table 1

The anthropometric parameters of neonates  
depending on the sex of infants,  
age and parity of their mothers

In- di- ces	Sex	Mean values			Parity 0			Parity > 0		
		M	SD	m	M	SD	m	M	SD	m
n	m	1392			659			733		
	f	1284			573			711		
Birth weight (g)										
	m	3699	479	12.8	3603	482.5	17.6	3785*	486.1	18.0
	f	3557*	445	12.4	3462*	419.3	17.5	3635**	450.4	16.9
Body length (cm)										
	m	50.5	1.9	0.1	50.3	1.8	0.1	50.6*	1.9	0.1
	f	49.7*	1.9	0.1	49.5*	1.6	0.1	49.9**	1.9	0.1
WLI (g/cm)										
	m	73.1	7.6	0.2	71.5	7.2	0.3	74.6*	7.7	0.3
	f	71.4*	7.6	0.2	69.8*	7.0	0.3	72.7**	7.3	0.3
Age of mother										
	m	25.3	5.5	0.1	22.3	4.1	0.2	27.7*	5.2	0.2
	f	25.1	5.4	0.1	22.1	4.0	0.2	27.5*	5.1	0.2

Note: \*  $p < 0.001$  between the values of male and female neo-  
nates

#  $p < 0.001$  between the values of parity 0 and parity 0

Table 2

The parameters of physical development of neonates  
in connection with the dwelling-place of mother

Indices	Tartu	Tartu district	Other towns	Other rural districts
n	1645	554	246	231
Birth weight (g)				
M	3621.1	3657.3	3644.1	3626.8
SD	462.4	477	452.5	504.8
m	11.4	20.3	23.9	33.2
Body length (cm)				
M	50.1	50.1	50.3	50.1
SD	1.82	1.95	1.9	2.01
m	0.04	0.08	0.12	0.13
WLI (g/cm)				
M	72.2	72.8	72.4	72.3
SD	7.45	7.5	7.23	8.31
m	0.18	0.32	0.46	0.55
Age of mother				
M	25.2	25	25.2	25.4
SD	5.34	5.44	5.42	5.91
m	0.13	0.23	0.35	0.39
Parity				
M	1.76	2.15	1.85	2.02
SD	0.99	1.31	1.02	1.19
m	0.02	0.06	0.07	0.08

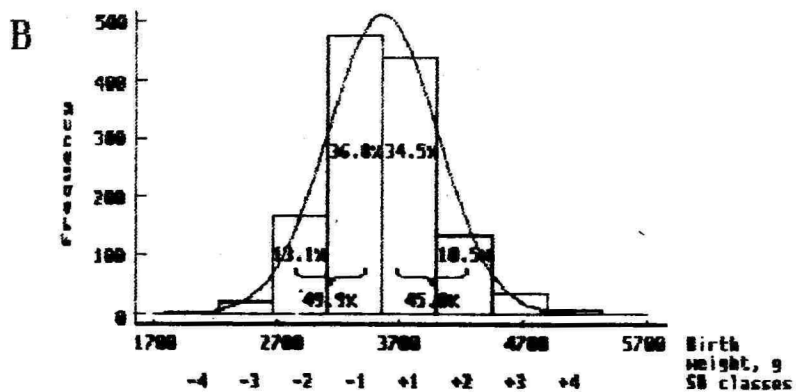
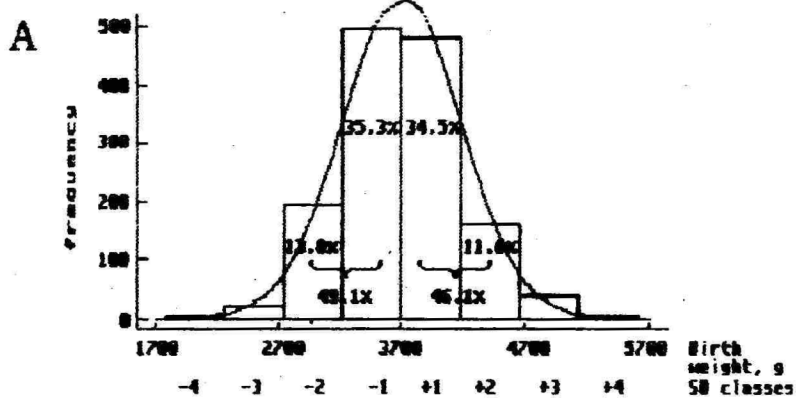


Fig. 1. The frequency histogram of male (A) and female (B) neonates by birth weight groups in standard deviation classes (observed frequency - by columns, expected frequency - by curve)

ON HAEMODYNAMICS AND THE PECULIARITIES OF ITS  
ADAPTATION REACTIONS IN HEALTHY YOUNG SUBJECTS  
DEPENDING ON SEX AND SOMATOTYPE

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In healthy persons the peculiarities of adaptation processes are to a large extent determined genetically (11). So far clinical and practical medicine has paid little attention to this. Only a few references about the dependence of morphofunctional qualities of heartblood circulation on personal somatometrical peculiarities are available (1,2,3,8,10, 11).

Some most important parameters of haemodynamics are cardiac output (QS) and stroke volume (Q) whose great variability is well-known (5,6). In clinical practice Q and QS are compared with the so-called "deal circulation". According to that eu-, hyper- and hypokinetic variants of haemodynamics are distinguished. They may occur both in sick and healthy persons. The haemodynamical type in healthy young adults is considered to be stable (7). The purpose of our study was to find out to what extent the human somatogenetical peculiarities determine the type of haemodynamics and Q and QS reaction during orthostasis and exercise.

We determined the somatotype by the 6-classification modified by H. Kaarma (9) and by V. P. Chtetsov's classification (12) in 192 healthy young subjects aged 17-26 years with normal body weight and not engaged in systematic sports training. We measured the morphofunctional parameters of heart by two-dimensional echocardiograph MK-600 in both supine and sitting position. All subjects performed veloergometric exercise loading 1 W per 1 kg weight for 5 minutes. During exercise Q and QS values were determined by tetrapolar rheography (by Kubiček) (4) and gas-exchange was measured with the gasanalyser "Spirolyt".

The results were statistically analyzed by multidimensional dispersion and correlation tests.

In Table 1 we can see that most healthy physically non-trained young persons (82%) have a eu- and hyperkinetic type of circulation. Teenage females have more often hyperkinetic ( $p < 0.01$ ) than other types of haemodynamics. In young males the eukinetic type is prevailing.

In adults the role of hyperkinetic type of haemodynamics decreases considerably. Haemodynamic shift towards eukinesia is present in females and towards hypokinesia in males.

Correlation analysis shows positive correlation between the type of haemodynamics, the person's weight and the internal length of thorax ( $r=0.4-0.5$ ) and negative correlation between the diastolic diameter of the left ventricle, body weight, left ventricle weight and also heart-chest and Kethle indices.

Comparing the types of haemodynamics to somatotypes, we found that hyperkinetic circulation-type is common to asthenic and stenoplastic women both of high and small stature and with underdeveloped muscles. They have slender bones and normal or underdeveloped adipose tissue. Their heart volume and weight are small and heart mass has both small absolute and relative values. We must point out that the cross-section of the septum is relatively small in comparison with the ventricular posterior wall.

The hyperkinetic type of circulation also occurred in men of muscular type with a well developed skeleton and muscles. They have relatively large heart volume and big left ventricle weight. We observed that they have a considerably higher consumption of  $O_2$  per 1 kg of body weight.

At rest no significant relation was found between the somatotype and eu- and hypokinetic type of circulation. Obviously, the parasympatic influence plays the main role in hypokinesia. There was no correlation between the type of haemodynamics and objective vegetative symptoms. There is no perfect conformity to the consumption of  $O_2$  at rest. But the intensity of gas-exchange depends on the degree of expression of vegetative disturbances ( $r=0.768$ ). The hyperkinetic type had considerably lower  $C_2$  pulse at rest ( $4.69 \pm 0.16 C_2$  l/min  $p < 0.02$ ) than the eu- ( $5.18 \pm 0.17 C_2$  l/min) and hypokinetic type ( $5.29 \pm 0.2 C_2$  l/min). In orthostasis  $QS$  and  $Q$  do not depend on the type of haemodynamics, but on the height-weight class. Figure 1 shows that in women the cross-diameter of the left ventricle depends mainly on body weight ( $p < 0.01$ ).

The decrease of the cross-section of the heart is percentally the smallest in heavy tall women with well-developed muscles ( $5\% \pm 1.1$ ) and light short women ( $17.8\% \pm 2.8$ ) as compared to women of other weight-classes ( $p < 0.01$ ). In orthostasis the decrease of the cross-diameter of the left ventricle is the highest in heavy short women and light taller women ( $12.1\% \pm 0.9 \dots 11.1\% \pm 1.2$ ).

We observed a greater decrease of volume of the left ventricle ( $17.6\% \pm 0.09 \dots 19.2\% \pm 0.1$ ) in shorter heavy men and those with middle weight, and the smaller decrease ( $< 3\%$ ) in tall heavy men ( $p < 0.05$ ). We must note that in light men, not depending on their height, the shortening of cross-size of the left ventricle was very stable, ranging from 8.5 to 10.2%.

At moderate exercise the increase of cardiac output per minute in absolute values does not depend on somatotype, sex, age and the type of haemodynamics at rest. The increase in cardiac output in absolute values during exercise depends only on the capacity of the work accomplished.

In adults with well-developed muscles and medium-sized left ventricle, regardless of the type of haemodynamics, the increase in cardiac index proceeds in a balanced way, i.e. the requisite size is guaranteed both by cardiac output and acceleration of heart rate. The percental rise of cardiac output during exercise is the larger, the more the cardiac output decreases in orthostasis ( $p < 0.01$ ).

Cardiac output absolute values correlated with the size of the cross-diameter of the left ventricle in supine position.

Persons of hyperkinetic type with small muscle mass and a small volume of the heart in orthostasis have dysbalanced adaptation of circulation to exercise - the cardiac index is gained mainly on account of the chronotropic reserve. The increase in cardiac output does not exceed 10% from the initial level. Administration of obsidan increases the role of Frank-Starling mechanism in optimizing haemodynamics, but the general tendency of adaptation reactions remains unchanged.

Probably insufficient venous return to nondeveloped peripheral muscle pump is one reason that determines the type of heart's optimizing reaction to exercise (1). Those subjects are to be paid special attention to in prophylaxis as

even during light exercise dysbalanced adaptive reactions of haemodynamics occur. The addition of supplementary risk-factors may cause dysadaptation.

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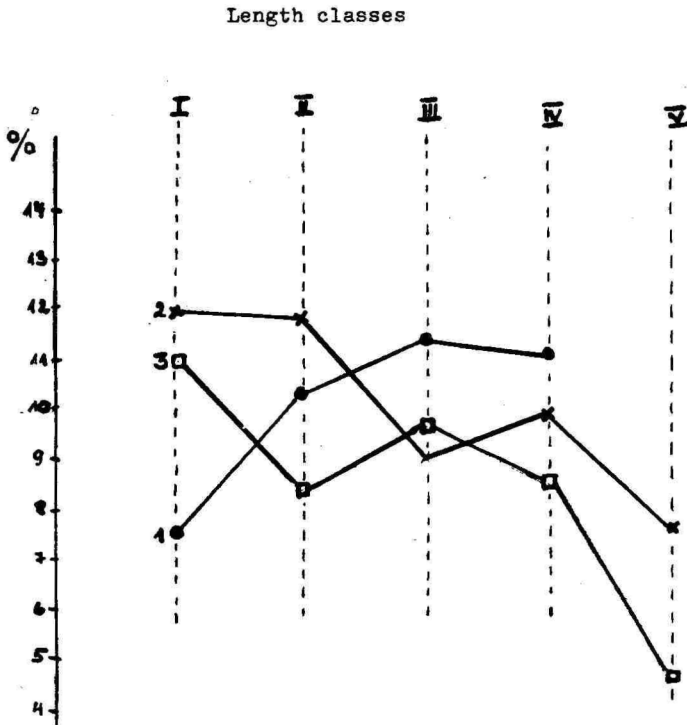
Table 1

Frequency (%) of type of haemodynamics depending on age and sex

Type of haemo- dynamics	total n=192	age		total	men		total	women	
		20	20 and more		20	age 20 and more		20	age 20 and more
1. Hypokinetic	18	15	18.8	18.4	11.7	20.3	17.1	17.1	17.8
2. Eukinetic	45	37.5	47	51.3	53.0	50.9	40.7	26.4	44.4
3. Hyperkinetic	37	47.5	34.2	30.3	35.3	28.8	41.6	56.5	37.8

Figure 1

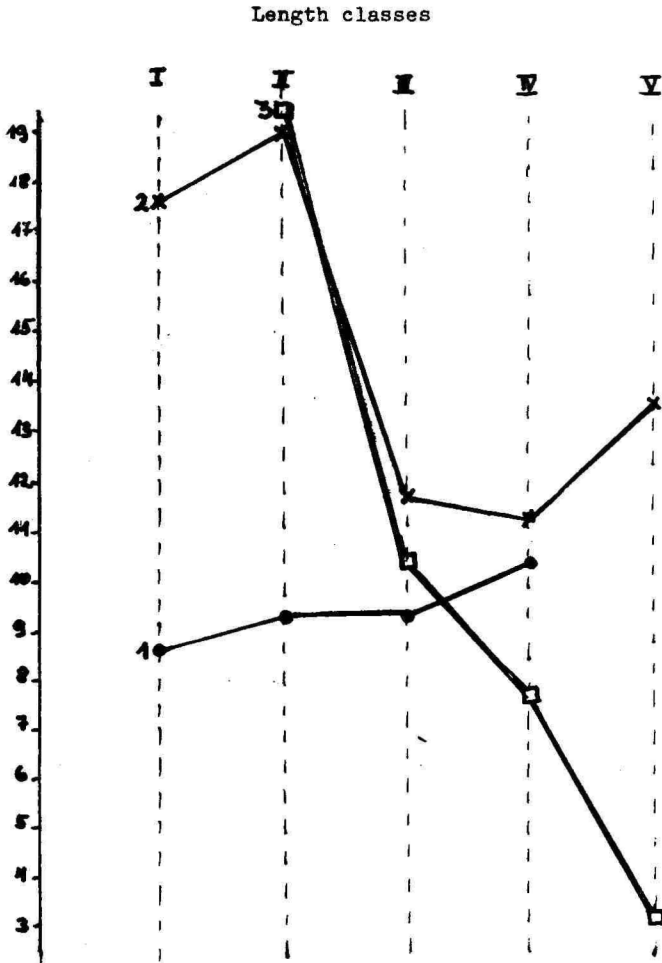
Shortening of the cross-diameter of the left ventricle in orthostasis of women depending on length-weight classes



- 1st weight class
- × 2nd weight class
- 3rd weight class

Figure 2

Shortening of the cross-diameter of the left ventricle in orthostasis of men depending on length-weight classes



- 1st weight class
- × 2nd weight class
- 3rd weight class

THE SYSTEM OF BODY SIZES AND FEASIBILITY OF SOMATOTYPING  
(Girls aged 8 to 11 years from central regions of Belarus)

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Despite the vast amount of literature in which somatotyping and children's constitutionology are investigated, we cannot think that the problems connected with definition of body types have been solved. Most of the researches in this domain were developed in the first third of this century. However, some of them have not lost their attraction for researchers because of successful selection of general categories for body build. Among these are the schemes of E. Kretschmer, I. B. Galant, V. G. Shtefko, A. D. Ostrovsky and others /2, 4/. At that time somatotyping was visual. Later classifications of W. H. Sheldon, B. H. Heat and L. Carter /1, 3/ appeared which were based on measuring indicators.

Now, the development of computer data processing allows us to use new approaches to solve somatotyping problems. We tried to analyse anthropometric data and their derivatives with respect to types with the help of mathematical statistical methods.

Anthropometric data and indicators of body composition (43 characteristics in total) served as a research material. We measured 278 schoolgirls, aged 8-11 years, who live in the central regions of Belarus. At the same time, all the children were somatotyped visually according to Shtefko-Ostrovsky scale. In the analysis the somatotypes of this scheme were combined into four cohorts. They are: thin-framed cohort (asthenoid, thoracal and thoraco-muscular types), muscular cohort (musculo-thoracal and muscular types), digestive cohort (musculo-digestive, digestive-muscular and digestive types) and unidentified cohort.

At the beginning of our examination we analysed the internal structure of body sizes on the anthropometric material as a whole without somatotyping division. Then, we compared the general relationships with those in different somatotype cohorts.

The data processing was performed in the Computing Centre of Tartu University (TU), using the methods of multivariate statistical analysis. Ene Tiit, Cand. Phys.-Math. Sc., Associate Professor, Head of the Mathematical Statistics Department, TU, was advisor to this study.

Bivariate statistic analysis showed (Table 1) that separate anthropometric characteristics have statistically significant relations with age. In order to study age-dependent changes, it proved necessary to divide all the data into three age classes: 8.8-10.1 (the average) < 8.8 (below the average) and 10.1 < (above the average) ( $r=0.122-0.724$ ).

After that we studied the relations between the separate body dimensions both for the whole material and for the three abovementioned age classes with linear correlative analysis. It was found that integrity of the body build consisted of statistically significant well-intercorrelated separate characteristics, body height and weight being correlated more closely with other characteristics. There were no basic differences between the correlative matrices of different age classes.

This result confirmed again the authors' conclusion (H. Kaarma, 1981) on the leading role of body height and weight among other features in the system of body dimensions. Therefore we suggested that it is possible to predict significantly the relationships in the system of body dimensions of girls of different ages in terms of weight, height and age alone.

This suggestion was confirmed by linear regression analysis. The coefficient of multivariate correlation  $R$  (Table 1) varies from 0.8 to 0.9. Consequently, 60-80% of variability of any studied characteristic is determined by the girls' weight, height and age.

It is obvious that increasing the number of argument characteristics will raise the precision of predicting any characteristic. Hence, another conclusion follows. Probably there is no other system except for the height, weight and age which could describe the general relationships of the

girls' body build. The indicators of body composition are predicted by the weight, height and age rather accurately too:  $R=0.948$  for absolute mass of osseous tissue,  $R=0.846$  for absolute mass of adipose tissue,  $R=0.886$  for absolute mass of muscular tissue.

Our next objective was a more detailed study of the changes in the girls' body proportions in connection with age. For this purpose we developed 35 simple indices which describe the interrelations between the dimensions of body height, depth and breadth. After that we carried out bivariate statistical analysis of the indices and the age in three age classes (Table 2).

During the ontogenetic period observed, the changes in body proportions manifested themselves to a relatively smaller extent as compared with the increase of weight, height and all separate dimensions.

The child's length dimensions increase to the greatest extent. The relative length of leg increases most of all ( $r=0.413$ ), but the relative length of the trunk ( $r=-0.258$ ) decreases. The relative breadths and circumferences of the chest, waist, pelvis and extremities decrease or remain unchanged. The absolute mass indicators of osseous, adipose and muscular tissues rise, but in such a way that the relative masses of these tissues (to body weight) do not change essentially. The body surface area grows too.

Having completed the proportion analysis on the whole data, let us pass to comparative alterations of separate dimensions and indices in the cohorts of somatotypes. The averages of the characteristics studied and statistical significance of the differences in the correlation ratio ( $r$ ) were found (Table 3).

The results obtained testify that the somatoscope typing carried out proved to be effective. The overwhelming majority of separate body dimensions, indices and body composition indicators differed essentially in the cohorts. Contrasting cohorts - thin-framed and digestive - differed especially significantly. Their height, weight, Rohrer index, indicators of body composition, relative circumferences of the trunk and extremities, index of shoulders' breadth, chest circumference and other characteristics were different. These features are characteris-

tic of the body build types in Kretschmer's classification too. Kretschmer's scheme, which is meant for adults, stipulates that the contrasting types are distinguished in relative length indicators of the trunk and the leg. We did not obtain such differences in our results. This can be ascribed to intensive age-related changes inherent in the period of study. The values of the other somatotype cohorts - muscular and unidentified - were intermediate between the contrasting types.

In conclusion, we can say that the body build of the girls studied is a well-correlated system of various body dimensions in which the body weight and height are leading. Variability of the other signs is determined by the weight, height and age of the girls within 60-80%. Despite the age-related changes in body proportions the girls retained their typical features and we can carry out visual typing. It is possible to fix successfully the contrasting somatotypes analogous to adult women. In future we may compare various typing procedures by a comparative study of the girls' body build structure, separate dimensions and body proportions by means of multivariate statistical analysis.

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Table 1

Correlation  $r$  between age and different body measurements.Multiple correlation coefficient  $R$  between body weight, height and age of girls.

Somatic characteristic	n	$\bar{x}$	Age groups (by years)			$r$	R	
			<8.8	8.8-10.1	10.1<			
1	2	3	4	5	6	7	8	9
5 height (cm)	276	134.6	9.1	126.8	133.5	142.5	0.712 <sup>*</sup>	
6 weight (kg)	278	29.38	6.58	24.889	28.39	34.26	0.596 <sup>*</sup>	
8 trunk length (mm)	269	395	27.8	376.0	393.6	413.4	0.537 <sup>*</sup>	0.814 <sup>*</sup>
9 upper limb length (mm)	270	575	44.1	538.9	571.2	610.6	0.671 <sup>*</sup>	0.935 <sup>*</sup>
10 lower limb length (mm)	269	730.1	58.9	678.6	726.3	779.7	0.712 <sup>*</sup>	0.972 <sup>*</sup>
11 biacromial breadth (mm)	269	285.3	20.6	270.6	283.5	300.3	0.61 <sup>*</sup>	0.877 <sup>*</sup>
12 pelvic breadth (mm)	269	193	15.3	182.6	190.9	204.2	0.60 <sup>*</sup>	0.812 <sup>*</sup>
13 chest breadth (mm)	269	195.4	13.7	186.4	195.0	204.1	0.519 <sup>*</sup>	0.803 <sup>*</sup>
14 chest depth (mm)	269	139.6	10.7	134.0	139.0	145.1	0.452 <sup>*</sup>	0.726 <sup>*</sup>
15 biceps skinfold (mm)	270	5.75	2.1	5.22	5.86	6.12	0.167 <sup>*</sup>	
16 triceps skinfold (mm)	278	11.43	3.38	10.74	11.74	11.76	0.122 <sup>*</sup>	
17 forearm skinfold (mm)	270	6.07	2.17	5.89	6.17	6.16	0.058	
18 thigh skinfold (mm)	270	12.5	4.2	11.39	12.92	13.22	0.169 <sup>*</sup>	
19 upper leg skinfold (mm)	270	12.9	2.9	12.3	12.98	13.52	0.168 <sup>*</sup>	
20 subscapular skinfold (mm)	278	7.22	2.6	6.67	7.36	7.59	0.133 <sup>*</sup>	
21 chest skinfold (mm)	270	6.51	3.2	5.93	6.56	6.97	0.148 <sup>*</sup>	
22 abdomen skinfold (mm)	270	10.6	5.3	9.45	10.73	11.64	0.167 <sup>*</sup>	
23 mean limb skinfold (mm)	270	9.75	2.5	9.13	9.92	10.16	0.164 <sup>*</sup>	0.657 <sup>*</sup>
24 mean skinfold (mm)	270	9.36	4.3	8.45	10.00	9.63	0.122 <sup>*</sup>	0.417 <sup>*</sup>
25 wrist width (mm)	278	44.6	3.3	42.4	44.2	46.8	0.560 <sup>*</sup>	0.776 <sup>*</sup>
26 humerus width (mm)	278	53.8	3.8	51.19	53.2	56.7	0.586 <sup>*</sup>	0.829 <sup>*</sup>
27 femur width (mm)	278	79.3	4.6	76.3	79.0	82.0	0.524 <sup>*</sup>	0.821 <sup>*</sup>
28 bimalleolar leg width (mm)	278	61.9	4.2	59.24	61.7	64.3	0.495 <sup>*</sup>	0.742 <sup>*</sup>
29 mean bone width (mm)	278	59.9	3.6	57.3	59.5	62.5	0.599 <sup>*</sup>	0.876 <sup>*</sup>
30 hand breadth (mm)	270	63.1	4.7	59.9	62.9	66.3	0.559 <sup>*</sup>	0.802 <sup>*</sup>
31 hand length (mm)	225	137.9	10.2	131.3	135.5	146.8	0.631 <sup>*</sup>	0.846 <sup>*</sup>

Table 1 (continued)

	1	2	3	4	5	6	7	8	9
32 chest circumf. (mm)		277	662.9	54.4	629.5	659.7	695.9	0.507*	0.911*
33 waist circumf. (mm)		277	582.3	44.2	565.4	582.2	597.4	0.299*	0.817*
34 buttocks circumf. (mm)		270	720.2	66.1	675.1	719.3	761.8	0.546*	0.924*
35 arm circumf. (mm)		270	200.2	21.1	188.7	200.2	210.7	0.432*	0.872*
36 forearm circumf. (mm)		270	195.5	16.1	186.2	194.6	204.7	0.464*	0.890*
37 wrist circumf. (mm)		270	139.3	10.9	133.7	139.0	144.7	0.391*	0.821*
38 thigh circumf. (mm)		270	432.5	44.9	405.8	432.8	456.6	0.467*	0.893*
39 upper leg circumf. (mm)		270	282.5	25.7	265.9	279.0	300.4	0.542*	0.895*
40 lower leg circumf. (mm)		270	195.8	15.8	186.2	193.3	206.5	0.503*	0.833*
41 body surface area (m <sup>2</sup> )		278	1.051	0.148	0.946	1.030	1.165	0.620*	0.933*
42 abs. mass of osseous tissue (kg)		278	5.851	1.079	5.002	5.718	6.725	0.660*	0.948*
43 rel. mass of osseous tissue (%)		278	20.03	2.15	20.22	20.21	19.72	-0.088	0.604*
44 abs. mass of adipose tissue (kg)		270	5.92	2.46	4.88	5.901	6.874	0.335*	0.846*
45 rel. mass of adipose tissue (%)		270	19.68	4.97	19.26	20.13	19.69	0.032	0.536*
46 abs. mass of muscular tissue (kg)		270	10.61	2.53	8.85	10.24	12.486	0.592*	0.886*
47 rel. mass of muscular tissue (%)		270	36.16	4.13	35.76	36.05	36.66	0.081	0.377*

\* statistically significant relation

Table 2

Mean values of indices (%) in age groups  
of girls, correlation coefficients  $r$  be-  
tween indices and corresponding ages

Somatic characteristic	Age groups (by years)			$r$	
	< 8.8	8.8-10.1	10.1<		
	1	2	3	4	5
49 Rohrer index	1.22	1.18	1.17	-0.160*	
50 rel. trunk length	29.65	29.35	29.02	-0.258*	
51 rel. upper limb length	42.51	42.58	42.83	0.110	
52 rel. lower limb length	53.50	54.16	54.67	0.413*	
55 rel. biacromial breadth	21.35	21.13	21.09	-0.097	
56 rel. chest breadth	14.71	14.54	14.35	-0.224*	
57 rel. pelvic breadth	14.42	14.22	14.33	-0.025	
58 rel. chest circumf.	49.68	49.37	48.81	-0.128*	
59 rel. waist circumf.	44.62	43.61	41.96	-0.363*	
60 rel. buttocks circumf.	53.26	53.62	53.46	0.030	
61 rel. thigh circumf.	32.02	32.22	32.05	0.003	
62 rel. upper leg circumf.	20.99	20.80	21.09	0.016	
63 rel. lower leg circumf.	14.70	14.42	14.51	0.133*	
64 rel. arm circumf.	14.89	14.93	14.79	-0.031	
65 rel. forearm circumf.	14.69	14.50	14.37	-0.168*	
66 rel. wrist circumf.	10.55	10.38	10.16	-0.280*	
67 <u>chest depth</u> trunk length	35.71	35.39	35.18	-0.041	
68 <u>trunk length</u> chest circumf.	59.86	59.51	59.55	-0.061	
69 <u>arm circumf.</u> upper limb length	35.07	35.08	34.52	-0.072	
70 <u>forearm circumf.</u> upper limb length	34.60	34.11	33.54	-0.202*	
71 <u>wrist circumf.</u> upper limb length	24.85	24.38	23.72	-0.303*	
72 <u>thigh circumf.</u> lower limb length	59.93	59.63	58.60	-0.112	
73 <u>upper leg circumf.</u> lower limb length	39.27	38.45	38.56	-0.135*	
74 <u>lower leg circumf.</u> lower limb length	27.51	26.64	26.52	-0.266*	
75 <u>chest depth</u> chest breadth	71.98	71.42	71.22	-0.023	
76 <u>waist circumf.</u> chest circumf.	89.86	88.33	85.94	-0.391*	

Table 2 (continued)

	1	2	3	4	5
77 <u>biacromial breadth</u> chest circumf.		43.07	42.84	43.29	-0.063
78 <u>biacromial breadth</u> upper limb length		50.25	49.66	49.24	-0.160*
79 <u>biacromial breadth</u> lower limb length		39.95	39.05	38.56	-0.284*
80 <u>mean skinfold</u> mean limb skinfold		92.08	103.07	94.29	-0.034
81 <u>mean trunk skinfold</u> mean limb skinfold		237.78	245.68	254.29	-0.122*
82 <u>mean bone width</u> body height		45.23	44.62	43.85	-0.338*
83 <u>hand breadth</u> hand length		45.83	45.98	45.06	-0.127

\*statistically significant relation.

Table 3

Mean values of anthropometric measurements, data of body composition and indices of girls in different cohorts of somatotypes, and correlation ratio between somatotypes and corresponding measures

Somatic characteristic	Cohorts of somatotypes				Correlation ratio ( $\eta$ )	
	I thin-framed	II diges-tive	III mus-cular	IV uniden-tified		
	1	2	3	4	5	6
5 height (cm)	134.79	137.67	140.16	130.39	0.322*	
6 weight (kg)	28.05	36.65	34.15	26.87	0.493*	
8 trunk length (cm)	39.48	41.01	40.47	38.39	0.287*	
9 upper limb length (cm)	57.59	58.63	59.72	55.53	0.287*	
10 lower limb length (cm)	73.28	73.80	75.86	70.45	0.272*	
11 biacromial breadth (cm)	28.37	29.72	29.81	27.76	0.344*	
12 pelvic breadth (cm)	19.23	20.50	20.02	18.59	0.367*	
13 chest breadth (cm)	19.35	20.77	20.11	19.54	0.345*	
14 chest depth (cm)	13.80	15.19	14.49	13.56	0.445*	
15 biceps skinfold (cm)	0.53	0.86	0.68	0.52	0.560*	
16 triceps skinfold (cm)	1.06	1.66	1.29	1.09	0.813*	
17 forearm skinfold (cm)	0.55	0.94	0.72	0.55	0.255*	
18 thigh skinfold (cm)	1.12	1.88	1.44	1.23	0.540*	
19 upper leg skinfold (cm)	1.22	1.69	1.42	1.25	0.472*	
20 subscapular skinfold (cm)	0.66	1.25	0.85	0.66	0.640*	
21 chest skinfold (cm)	0.57	1.17	0.78	0.58	0.566*	
22 abdomen skinfold (cm)	0.89	2.00	1.39	0.93	0.639*	
23 mean limb skinfold (cm)	0.89	1.40	1.11	0.93	0.609*	
24 mean skinfold (cm)	0.82	1.42	1.07	0.95	0.409*	
25 wrist width (cm)	4.41	4.66	4.72	4.36	0.386*	
26 humerus width (cm)	5.33	5.63	5.66	5.25	0.374*	
27 femur width (cm)	7.88	8.42	8.24	7.74	0.443*	
28 bimalleolar leg width (cm)	6.16	6.38	6.49	6.07	0.316*	

Table 3 (continued)

	1	2	3	4	5	6
29 mean bone width (cm)	5.94	6.27	6.27	5.85	0.418*	
30 hand breadth (cm)	6.28	6.66	6.52	6.14	0.329*	
31 hand length (cm)	13.79	14.11	14.04	13.49	0.191*	
32 chest circumf. (cm)	64.57	73.78	70.02	64.48	0.575*	
33 waist circumf. (cm)	56.46	65.13	61.07	57.56	0.622*	
34 buttocks circumf. (cm)	70.34	80.73	77.27	69.76	0.549*	
35 arm circumf. (cm)	19.35	23.38	21.58	19.45	0.612*	
36 forearm circumf. (cm)	19.16	21.74	20.65	19.02	0.535*	
37 wrist circumf. (cm)	13.67	15.34	14.66	13.63	0.513*	
38 thigh circumf. (cm)	41.81	49.67	46.96	42.19	0.586*	
39 calf circumf. (cm)	27.69	31.10	30.04	27.49	0.469*	
40 lower leg circumf. (cm)	19.28	21.00	20.61	19.17	0.402*	
41 body surface area (m <sup>2</sup> )	1.013	1.20	1.16	0.99	0.474*	
42 abs. mass of osseous tissue (kg)	5.77	6.56	6.66	5.41	0.387*	
43 rel. mass of osseous tissue (%)	20.66	17.96	19.68	19.95	0.375*	
44 abs. mass of adipose tissue (kg)	5.16	10.25	7.52	5.15	0.644*	
45 rel. mass of adipose tissue (%)	18.08	27.95	22.11	18.96	0.591*	
46 abs. mass of muscular tissue (kg)	10.40	11.85	12.20	9.77	0.315*	
47 rel. mass of muscular tissue (%)	36.76	32.08	35.91	36.49	0.324*	
49 Rohrer index	1.13	1.39	1.23	1.20	0.634*	
50 rel. trunk length	29.26	29.95	29.02	29.42	0.195*	
51 rel. upper limb length	42.63	42.78	42.79	42.54	0.071	
52 rel. lower limb length	54.20	53.82	54.37	53.93	0.143	
55 rel. biacromial breadth	21.02	21.68	21.43	21.28	0.274*	
56 rel. chest breadth	14.35	15.18	14.46	14.75	0.358*	
57 rel. pelvic breadth	14.24	14.97	14.38	14.23	0.295*	
58 rel. chest circumf.	47.92	53.71	49.99	49.42	0.627*	
59 rel. waist circumf.	41.97	47.42	43.68	44.22	0.559*	
60 rel. buttocks circumf.	52.09	58.94	55.41	53.45	0.672*	
61 rel. thigh circumf.	30.96	36.30	33.69	32.31	0.669*	
62 rel. upper leg circumf.	20.51	22.71	21.55	21.08	0.544*	
63 rel. lower leg circumf.	14.29	15.34	14.79	14.72	0.401*	
64 rel. arm circumf.	14.33	17.11	15.50	14.92	0.662*	

Table 3 (continued)

	1	2	3	4	5	6
65 rel. forearm circumf.		14.20	15.90	14.83	14.58	0.582*
66 rel. wrist circumf.		10.13	11.22	10.53	10.46	0.504*
67 <u>chest depth</u> <u>trunk length</u>		35.02	37.13	36.05	35.37	0.252*
68 <u>trunk length</u> <u>chest circumf.</u>		60.87	55.12	57.60	59.56	0.515*
69 <u>arm circumf.</u> <u>upper limb length</u>		33.63	40.04	36.24	35.09	0.609*
70 <u>forearm circumf.</u> <u>upper limb length</u>		33.51	37.20	34.66	34.32	0.500*
71 <u>wrist circumf.</u> <u>upper limb length</u>		23.77	26.25	24.63	24.59	0.438*
72 <u>thigh circumf.</u> <u>lower limb length</u>		37.12	67.46	62.01	60.13	3.640*
73 <u>upper leg circumf.</u> <u>lower limb length</u>		37.83	42.22	39.67	39.16	0.527*
74 <u>lower leg circumf.</u> <u>lower limb length</u>		26.36	28.52	27.21	27.33	0.390*
75 <u>chest depth</u> <u>chest breadth</u>		71.48	73.32	72.21	70.58	0.156
76 <u>waist circumf.</u> <u>chest circumf.</u>		87.58	88.36	87.36	89.39	0.183*
77 <u>biscromial breadth</u> <u>chest circumf.</u>		43.71	39.90	42.54	43.08	0.500*
78 <u>biscromial breadth</u> <u>upper limb length</u>		49.30	50.71	50.12	50.08	0.225*

Table 3 (continued)

	1	2	3	4	5	6
79 <u>biacromial breadth</u>						
<u>lower limb length</u>		38.77	40.29	39.44	39.53	-
80 <u>mean skinfold</u>						
<u>mean limb skinfold</u>		92.23	100.97	95.72	104.60	0.107
81 <u>mean trunk skinfold</u>						
<u>mean limb skinfold</u>		236.65	311.86	265.79	232.33	0.413*
82 <u>mean bone width</u>						
<u>body height</u>		44.12	45.61	44.80	44.52	0.305*
83 <u>hand breadth</u>						
<u>hand length</u>		45.29	47.19	45.80	45.61	0.236*

Indices are presented in %

\* statistically significant relation

ANTHROPOLOGICAL CHARACTERIZATION OF THE EXTERNAL ABDOMEN  
OF PREGNANT WOMEN AT THE END OF PREGNANCY

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Although the practice of obstetrics has proved the essential role of the pregnant woman's body build in the course of pregnancy and delivery, relatively few systematic anthropometric studies of pregnant women have been made/2, 6, 10/. Anthropological methodology of measuring the pregnant women's external abdomen is missing; such measures as the circumference of the abdomen at the height of the navel, uterus top height, breadth and depth of the abdomen, which enable best to predict the weight of the newborn, have been used to a small extent /1,3,4,5,7,8,9,12/. As these few measurements did not yield a very good prognosis of the child's weight, the anthropometric method has not been considered very promising.

The abovementioned induced the Department of Obstetrics and Gynaecology of Tartu University and the Tartu Women's Clinic to carry out a special study on general body build of pregnant women and anthropometry of the external abdomen.

The subjects of the investigation were 305 women at the age of 18-33 giving birth for the first time. None of them had had any complications during pregnancy and all of them had one fetus in normal position.

Anthropometric measurements were made during the 38th-40th weeks of pregnancy according to the classical methods of R. Martin (1928) and V. N. Bunak (1941) which were supplemented by our own original methods of measuring the abdomen (see below). Skin folds were measured with special callipers (B. Skerlj et al., 1953) at 5 places on body surface (abdomen, side, chest, back, uterus top) the pressure being 10 g per 1 cm<sup>2</sup> of body surface.

The pregnant women's height and weight were measured. The sc. "framework measures" included biacromial breadth, chest breadth, pelvic breadth, abdomen length, lower chest

depth, circumferences of the lower part of the chest, wrist, upper arm and thigh. The measurement of the abdomen was begun by measuring with tape the uterus top height, this was followed by circumferences of the abdomen at the height of the uterus top, upper abdomen, navel and lower abdomen. At every height both the total circumference and partial circumference at the back part of the abdomen as far as the central axillary line were measured. At the same heights the sagittal measurements were measured with pelvic callipers while the pregnant woman was lying on her side. Additionally, the abdomen breadth at the height of the navel and the length of the uterus were measured with callipers. As the uterus is always situated in the abdomen in a slanting position, the distance between the horizontally projected points of lower abdomen and the uterus top was measured with a tape along the vertebral column.

In the present paper an attempt was made to estimate directly the size of the uterus with the help of the area where the uterus meets the front wall of the abdomen. To do this, a gadget for measuring the outer measurements of the pregnant woman's uterus, which has been registered as an invention (Talviste, E. K. et al., 1989), was used for the first time. This is pelvic callipers with a stationary measuring tape between its lower legs and so it enables us simultaneously with measuring the abdomen to fix the lengths of the chord and arc between any two points measured. The mentioned callipers were used to measure the chord of the part of uterus leaning to the abdomen front wall on the horizontal plane of the upper abdomen, navel and lower abdomen and vertically to estimate the chord and arc of uterus height.

To the abovementioned concrete measures of the abdomen calculated ones were added. The proportional size of the abdomen was compared with the circumference of the lower part of the chest (the differences of the circumferences: chest - upper abdomen, chest - navel and chest - lower abdomen), and the relation of the differences of these circumferences to the chest lower circumference was calculated in percentage.

After that the differences of the originally measured total circumferences at the height of upper abdomen, navel and lower abdomen and the partial posterior circumferences were found (frontal measures of upper abdomen, navel and lower abdomen) and the relation of these differences to the

original total circumferences was calculated in percentage (the relative frontal measures of upper abdomen, navel and lower abdomen).

The same was done with the sagittal measures of the abdomen and the differences of sagittal diameters were calculated (upper abdomen - chest, navel - chest and lower abdomen - chest) and the relations of the differences found to the sagittal diameter of the chest were calculated in percentage. In order to enable to summarize the most significant measures of the abdomen and to calculate the average measures, the notions of mean sagittal measure, mean circumference and mean skin fold were taken into use.

Additionally, by means of the abovementioned chords and arcs, we calculated the radii and circle areas for the upper abdomen, navel, lower abdomen and vertical section characterizing the uterus and total cross-section areas. With the help of the cross-sections and areas of circles characterizing the uterus and the difference between the planes horizontally projected on the vertebral column we calculated the volume of the uterus.

We also adopted the original body structure index which consists of the sum of the Rohrer index, relative biachromial breadth, chest and pelvic breadth, relative circumference of the wrist, upper arm and thigh and the relative average skin-fold for every subject investigated.

Altogether 80 anthropometric characteristics were used in the paper.

In order to study the mutual connections between the characteristics measured, we used linear correlation analysis. About 70% of the characteristics has statistically positive correlations whereas the leading characteristic was the mother's weight ( $r=0.3-0.8$ ). The newborn's weight which we used to characterize the weight of the fetus at the end of pregnancy also correlated with most mother's principal body and abdominal measures ( $r=0.2-0.4$ ).

Relying on all that we have reason to believe that the variability of all the characteristics measured could be statistically essentially determinable on the basis of the total effect of mother's and child's weight. A three-dimensional statistical analysis (mother's weight - child's weight - other anthropometric characteristics) proved this supposition. Thus we can recommend the abovementioned method in

after-birth analysis in order to classify the general body measurements and abdominal measurements of the pregnant women at the end of pregnancy - the investigation of variability of mother's body measurements simultaneously in weight classes of mothers and children.

We also studied the prognostic value of mother's body measurements, and particularly the abdominal measurements, for estimating the child's weight by means of linear regression analysis. We chose the formula of Prof. Zordania - the product of uterus top height and abdominal circumference (characteristic No. 114) as the first argument characteristic. The multiple correlation coefficient ( $R=0.4811'$ ) showed that in approximately 22% of cases this formula gives exact results.

We also checked the possibilities of using this formula in different mothers' weight classes (6 classes, women of small, average and big weight). This proved the fact well known in practice that using this formula a more exact prognosis can be achieved in mothers of small weight ( $R=0.5234'$ ), in mothers of average weight ( $R=0.3946'$ ) the results are less exact, but in women of big weight no statistically valid result can be achieved at all.

Consequently, it is necessary for practical purposes to search for possibilities of improving this formula and, on the whole, to analyze the prognostic value of mothers' body measurements used in this paper for establishing the child's weight, which were in a statistically essential correlation with the weight of the newborn.

As can be seen in Table 1, the multiple correlation coefficient  $R$  increases constantly when more argument characteristics are added into the list. In Formula 2 where the vertical measure of the uterus (8), total circumference of the upper abdomen (11) and total circumference of the lower abdomen (15) have been added to the multiplication of uterus top height and abdominal circumference (characteristic 114)  $R$  is already as big as  $0.5215'$ . If we add three sagittal measures of the abdomen (Formula 3),  $R=0.6008'$ . Thus the prognostic value of only one characteristic, i.e. 114 (Formula 1) has been improved by 14%.

It is possible to improve the prognosis even more, by adding the measures of abdominal width, lower chest sagittal diameter and lower chest circumference (Formulae 4 and 5).

We can notice another interesting phenomenon in these two formulae which is understandable from the anthropological viewpoint. When comparing Formulae 4 and 5, we can see that both of them have 11 argument characteristics in common, only the mother's weight has been added in Formula 5. Let us compare multiple correlation coefficients ( $R=0.6440^*$  and  $R=0.06443^*$ ). Consequently, in the case of a certain number of anthropometric characteristics these features themselves are able to describe the body as a whole, and adding body weight does not increase the value of  $R$  essentially any more.

We checked this circumstance with a separate regression, trying to predict mother's weight by means of 8 characteristics of her body. We succeeded in 82% of cases ( $R=0.9035'$ ).

When we supplemented the list of argument characteristics even more (Formulae 6 and 7) with the differences of the circumferences of abdomen and the lower part of the chest, and corresponding sagittal measures (characteristics 96, 97, 102, 103, 104) and the differences of the total circumference of upper abdomen measured at the height of the navel and the posterior partial circumference (characteristics 99 and 100), the multiple correlation coefficient will increase ( $R=0.6718^*$ ). This means, however, that we could raise the prognostic value of the original characteristic 114 (see above) from 22% to 45%, i.e. twofold. The comparison of regression formulae 6 and 7 shows that in the case of sufficient number of argument characteristics the addition of mother's weight (8) and characteristic 114 is not essential. With 20 argument characteristics (Formula 8) it is possible to increase the accuracy of the prognosis ( $R=0.72118^*$ ) to 52%.

To the various combinations of abovementioned argument characteristics we can still add (Formula 9) the cross-sections of upper abdomen, navel and lower abdomen, which characterise the uterus (see methods), the volume of the uterus (characteristic 95) and other measures like the radius of the upper abdomen (characteristic 60), body structure index (characteristic 59), etc., altogether 29 characteristics (multiple correlation coefficient  $R=0.7573^*$ ). When using this formula we get an exact prognosis in 57% of cases and in 88% of cases the prognostic error does not exceed  $\pm 500$ .

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Table 1

Linear regression models used for prognosticating the newborn's weight (in grams)

No.	n	list of argument characteristics	linear regression coefficients (in brackets the no. of argu- ment) and absolute term	multi- dimensional correlation coefficient R
1.	282	114(4x13)	0.481(114)+2009.583	0.4811*
2.	265	8(uterus vertical measure) 11 (upper abdomen total circumference) 15 (lower abdomen total circumference) 114 (4x13)	8.065(8)+24.800(11)-14.866(15)+ +0.341(114)+1359.275	0.5215*
3.	253	8 (uterus vertical measure) 11 (upper abdomen total circumference) 15 (lower abdomen total circumference) 31 (upper abdomen sagittal diameter) 32 (umbilical sagittal diameter) 33 (lower abdomen sagittal diameter) 114 (4x13)	8.156(8)+10.938(11)-19.820(15)+ +67.307(31)-23.865(32)+34.106(33)+ +0.345(114)+981.588	0.6008*
4.	247	8 (uterus vertical measure) 11 (upper abdomen total circumference) 15 (lower abdomen total circumference) 31 (upper abdomen sagittal diameter) 32 (umbilical sagittal diameter) 33 (lower abdomen sagittal diameter) 39 (abdomen breadth) 42 (chest lower sagittal diameter) 43 (chest lower circumference) 76 (middle skin fold) 114 (4x13)	-3.829(8)+7.616(11)-18.736(15)+ +48.016(31)-10.111(32)+38.548(33)+ +12.938(39)-2.372(42)+19.439(43)- -257.028(76)+0.311(114)+62.547	0.6440*

Table 1 (continued)

5. 247	3 (body weight)	2.049(3)-3.967(8)+7.227(11)-20.174(15)+	0.6443*
	8 (uterus vertical measure)	+48.470(31)-10.308(32)+38.757(33)+	
	11 (upper abdomen total circumference)	+12.902(39)-2.464(42)+18.059(43)-	
	15 (lower abdomen total circumference)	-256.805(76)+0.314(114)+198.585	
	31 (upper abdomen sagittal diameter)		
	32 (umbilical sagittal diameter)		
	33 (lower abdomen sagittal diameter)		
	39 (abdomen breadth)		
	42 (chest lower sagittal diameter)		
	43 (chest lower circumference)		
	76 (middle skin fold)		
	114(4x13)		
6. 245	8 (uterus vertical measure)	7.381(8)+12.293(39)+150.106(42)+	0.6718*
	39 (abdomen breadth)	+108.833(43)-107.751(74)-83.136(75)-	
	42 (lower chest sagittal diameter)	-261.442(76)+49.318(96)+35.879(97)-	
	43 (lower chest circumference)	-16.050(99)+17.884(100)+93.734(102)+	
	74 (mean abdominal sagittal measure)	+3.846(103)+53.622(104)+0.152(114)-	
	75 (mean abdominal circumference)	-821.925	
	76 (medial skin fold)		
	96 (difference between upper abdomen and chest circumferences)		
	97 (difference between umbilical and chest circumferences)		
	99 (upper abdomen frontal measure)		
	100 (umbilical frontal measure)		
	102 (difference between upper abdomen and chest sagittal diameters)		
	103 (difference between umbilical and chest sagittal diameters)		
	104 (difference between lower abdomen and chest sagittal diameters)		
	114 (4x13)		

Table 1 (continued)

7. 245	3 (body weight)	1.059(3)+7.038(8)+12.330(39)+	0.6718*
	39 (abdomen breadth)	+148.909(42)+108.662(43)-106.087(74)-	
	42 (lower sagittal diameter)	-84.883(75)-260.723(76)+49.779(96)+	
	43 (lower chest circumference)	+35.707(97)-16.083(99)+18.081(100)+	
	74 (mean abdominal sagittal measure)	+93.629(102)+3.338(103)+53.072(104)+	
	75 (mean abdominal circumference)	+0.155(114)-740.329	
	76 (medial skin fold)		
	96 (difference between upper abdomen and chest circumferences)		
	97 (difference between umbilical and chest circumferences)		
	99 (upper abdomen frontal measure)		
	100 (umbilical frontal measure)		
	102 (difference between upper abdomen and chest sagittal diameters)		
	103 (difference between umbilical and chest sagittal diameters)		
	104 (difference between lower abdomen and chest sagittal diameters)		
	114 (4x13)		
8. 201	3 (body weight)	6.913(3)+4.155(4)+14.274(8)+24.938(9)+	0.7211*
	4 (uterus top height)	+8.979(38)-4.939(39)+15.733(41)+	
	9 (uterus top circumference)	+103.945(42)+140.466(43)-0.491(57)-	
	38 (chest breadth)	-105.950(74)-132.649(75)-272.689(76)+	
	39 (abdomen breadth)	+55.543(96)+61.664(97)-14.909(99)+	
	41 (abdomen length)	+15.320(100)+149.286(102)-31.651(103)+	
	57 (number of days till delivery)	+57.569(104)-1239.345	
	74 (mean abdominal sagittal measure)		
	75 (mean abdominal circumference)		
	76 (medial skin fold)		
	96 (difference between upper abdomen and chest circumferences)		

Table 1 (continued)

	97 (difference between umbilical and chest circumferences)	
	99 (upper abdomen frontal measure)	
	100 (umbilical frontal measure)	
	102 (difference between upper abdomen and chest sagittal diameters)	
	103 (difference between umbilical and chest sagittal diameters)	
	104 (difference between lower abdomen and chest sagittal diameters)	
<hr/>		
9. 146	59 (body structure index)	-0.399(3)+4.134(4)+78.495(8)+
	60 (upper abdomen radius)	+13.008(9)+19.880(38)-108.244(39)-
	70 (abdomen circle area)	-0.840(41)+12.212(42)+66.795(43)+
	71 (abdomen total area)	+7.779(57)+0.313(59)+380.732(60)+
	72 (mean abdominal depth measure)	+0.305(70)+1.181(71)-119.173(74)-
	75 (mean circumference)	-39.033(75)-251.316(76)-5.308(79)+
	76 (mean skin fold)	+2.300(86)+2.371(89)-2.893(92)+
	79 (upper abdomen circle area)	+0.018(95)+51.763(96)-10.417(97)+
	86 (upper abdomen total area)	+0.913(99)+13.948(100)+51.894(102)+
	89 (lower abdomen total area)	+30.214(103)+6.782(104)-1786.452
	92 (vertical total area)	
	95 (uterus volume)	
	96 (difference between upper abdomen and chest circumferences)	
	97 (difference between umbilical and chest circumferences)	
	99 (upper abdomen frontal measure)	
	100 (umbilical frontal measure)	
	102 (difference between upper abdomen and chest sagittal diameters)	
	103 (difference between umbilical and chest sagittal diameters)	
	104 (difference between lower abdomen and chest sagittal diameters)	

\* statistically significant relation

AN ANTHROPOLOGICAL MODEL FOR RESEARCH  
INTO THE DIETARY REGIME OF PREGNANT WOMEN

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Research into the actual dietary regime of pregnant women and the estimation of its rationality for the given individual requires a specific method for comparative classification of women with different constitutions and in different stages of pregnancy. This problem has been paid rather little attention to in pertinent literature. The bodily structure of pregnant women has mostly been estimated on the basis of only their body weight /1, 3, 5, 7/ or indirectly on the basis of body skinfolds /2, 4, 8/.

The aim of the present paper is to discuss the results of a comparative investigation into the actual dietary regime, different biochemical and clinical indices and anthropometrical parameters of pregnant women during three trimesters of their pregnancy with a view to systematisation of the anthropometrical characteristics.

The subjects were 329 women aged 17-31 years (mostly 20.0-23.0 years) expecting their first confinement. During their pregnancy they underwent three examinations at the Centre of Anthropometry of the Department of Obstetrics and Gynaecology of Tartu University. The investigation established the women's dietary regime, the chemical composition of their daily food ration (23 parameters) and its calorificity after ten days of research by the method of questionnaire-based patient's menu analysis. The clinical indicators established by laboratory tests included the haemoglobin content, the number of erythrocytes, the haematocrit, the colour index, the red blood picture, the total protein in the blood serum, the protein fractions, the blood iron content, the cholesterol and the  $\beta$ -lipoproteid levels. The anthropometric measurements were taken by using the classical methods of P. B. Martin (1928) and V. V. Bunak (1941). The following anthropometric characteristics were measured: body weight, body height, sitting,

height, upper limb length, trunk length, height of head, sternum length, abdomen length, biacromial breadth, chest breadth and depth, waist breadth and depth, pelvic breadth, head circumference, neck circumference, waist circumference, abdomen circumference, pelvic circumference, thigh circumference, calf circumference, arm circumference, forearm circumference, wrist circumference, and in addition ten skinfolds.

The changes in those characteristics were registered in relation to the progress of pregnancy. Statistically significant changes were revealed in body weight ( $r=0.487$ ), abdomen breadth ( $r=0.410$ ), waist circumference ( $r=0.405$ ), and abdomen circumference ( $r=0.510$ ). Noticeable changes were also recorded in the skinfolds of the thigh, waist, abdomen, back and calf.

In order to be able to compare the bodily structure of women with different body builds examined at different trimesters of pregnancy, it is necessary to base the classification on such body measurements which undergo no essential changes during pregnancy /6/. Accordingly we worked out 16 body structure indices characterising the differences between the proportions of a woman's body. These were as follows:

1.  $\frac{\text{biacromial breadth}}{\text{upper limb length}}$
2.  $\frac{\text{chest depth}}{\text{chest breadth}}$
3.  $\frac{\text{wrist circumference}}{\text{upper limb length}}$
4.  $\frac{\text{wrist circumference}}{\text{body height}}$
5.  $\frac{\text{upper arm circumference}}{\text{body height}}$
6.  $\frac{\text{calf circumference}}{\text{body height}}$
7.  $\frac{\text{head circumference}}{\text{trunk length}}$
8.  $\frac{\text{biacromial breadth}}{\text{body height}}$
9.  $\frac{\text{head-neck height}}{\text{body height}}$
10.  $\frac{\text{D. trochanterica}}{\text{body height}}$
11.  $\frac{\text{D. cristarum}}{\text{body height}}$
12.  $\frac{\text{D. spinarum}}{\text{body height}}$
13.  $\frac{\text{pelvic breadth}}{\text{body height}}$

14. sitting height  
body height
15. wrist circumference  
D. trochanterica
16. wrist circumference  
D. cristarum

We worked out a special body structure index for pregnant women. On the basis of this index and the subject's body height we formed 3x36 classes which could be applied in statistical comparison of all other physiological parameters and changing anthropometric characteristics.

A woman's body as a whole should be described by using the changing and unchangeable characteristics together. Therefore, the multivariate statistical analysis of a pregnant woman's bodily structure should be based on her body height, weight and body structure index all taken together. The multivariate statistical analysis of the characteristics of the body height and body structure index classes (the dietary regime, the biochemical and clinical data on the blood and the weight of the baby) revealed their correlations. The correlations of the above-mentioned body structure characteristics with other parameters were as follows: proteins, fats and carbohydrates  $\eta = 0.549^* - 0.688^*$ , the mother's blood indicators  $\eta = 0.649^* - 0.751^*$ , and the weight of the newborn  $\eta = 0.558^* - 0.687^*$ . The weight of the newborn baby was in direct relation to the pregnant woman's skin-folds on her back, chest, abdomen and upper arm.

In conclusion we can say that the variability of a woman's individual anthropometric characteristics during the different trimesters of her pregnancy is directly dependent on her body weight, height and body structure index. The peculiarities of a woman's bodily structure are related to the main indicators of her food rations, the clinical parameters of her blood, and the weight of her newborn.

Therefore, in investigating her dietary regime it is necessary to take into account the interrelations of these indicators during the different trimesters of her pregnancy.

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ANTHROPOMETRIC CHARACTERIZATION OF ESTONIAN GIRLS  
FROM 7 TO 17 YEARS OF AGE

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During the last decades anthropometric measurements of Estonian children have been carried out for different reasons /1, 2, 3/. The aim of the present research is to study the structure of Estonian girls' body.

Anthropometric data were gathered from 1985 to 1989 in Central and East Estonia. Using the classical method of anthropometria, we measured 1920 girls at the ages of 7-17 years. From each girl 84 measurements were taken. The descriptive statistics of all the measured variables are given in Table 1. The mean height of 7-year-old girls is 124.3 cm and their mean weight is 24.2 kg. The mean height of 17-year-old girls is 164.8 cm and their mean weight is 60.5 kg. Comparing these data with the data of J.Aul /1/ gathered in 1978 we can see that in 20 years the mean height of girls has increased by 1 cm.

In future the author is planning to carry out a research for investigating the body structure.

The first stage of this work was observing the possibilities for prediction of variable anthropometric measurements by body height, weight and age in different age groups (7-11 years, 12-15 years, 16-17 years). The distribution into age groups is based on the investigations of R.Silla /2/ about the limits of physical and sexual development of Estonian girls. The multiple regression equation of each observed variable by age, weight and height and also the multiple coefficient of correlation equation ( $R^2$ ) are given in Table 2. All the obtained regressions are statistically significant ( $p < 0.01$ ).

The accuracy of prediction of variables is 13-96% in all age groups. The following variables in all age groups have predictive possibilities over 70%: cervical, acromial and waist height, lower limb length, chest, waist, pelvis

and arm circumferences. We see that for main variables the degree of predictive possibilities decreases in older age groups. Comparing the 16-17-year-old girls with the 7-11-year-olds the accuracy of prediction decreases over 30% for the following variables: wrist circumference, biacromial, chest and pelvis breadth, foot and flat width and foot length.

The statistical significance of all the prognoses obtained confirms that the most important variables in the body structure of 7-17-year-old girls in all age groups are weight, height and age.

A further more detailed research is needed for investigating the different variation of the multiple coefficient of correlation equation in different age groups. The problem what kind of variables in addition to weight, height and age may be useful for improving the prognoses of body dimensions also needs explanation in future.

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Table 1

## Main anthropometric characteristics of 7-17-year-old girls

Age (years)	7 n=168		8 n=193		9 n=112		10 n=165		11 n=154		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Variable	1	2	3	4	5	6	7	8	9	10	11
1 Weight (kg)	24.21	3.52	27.43	4.80	30.90	4.69	33.62	5.70	38.09	7.28	
2 Height (cm)	124.33	5.13	130.92	6.06	136.59	5.80	141.22	6.38	147.16	7.33	
3 Cervical height	104.56	4.60	109.70	5.08	115.64	5.25	120.87	6.37	125.64	6.68	
4 Waist height	76.61	4.37	81.06	5.38	85.84	5.06	89.86	4.92	94.15	5.24	
5 Acromial height	98.98	4.62	103.90	4.98	109.54	5.13	114.10	5.38	119.24	6.38	
6 Head circumf.	51.83	1.50	52.14	1.35	52.43	1.50	52.95	1.46	53.26	1.60	
7 Neck circumf.	25.75	1.26	26.50	1.21	27.10	0.41	27.75	1.32	-	-	
8 Chest circumf.	59.27	3.56	61.52	4.37	63.50	4.09	66.24	5.04	66.65	6.58	
9 Lower chest circumf.	57.26	3.57	59.22	4.00	60.85	3.58	63.44	4.43	65.59	5.09	
10 Waist circumf.	51.70	3.71	53.60	4.17	54.04	3.76	56.23	4.30	57.99	4.93	
11 Pelvis circumf.	65.64	4.48	68.58	5.46	70.92	4.85	74.32	5.53	78.13	6.87	
12 Arm circumf.	18.55	1.78	19.42	2.25	20.02	2.08	20.85	2.31	21.94	2.53	
13 Wrist circumf.	12.74	0.73	13.02	0.84	13.38	0.79	13.82	0.85	14.35	0.87	
14 Thigh circumf.	38.22	3.51	40.06	4.05	41.84	3.95	43.78	3.94	45.78	4.67	
15 Upper leg circumf.	25.53	1.86	26.79	2.15	27.67	2.17	28.84	2.30	30.48	2.73	
16 Foot circumf.	18.57	0.94	19.49	1.40	20.10	0.41	21.03	1.18	-	-	
17 Biacromial breadth	27.04	1.60	28.36	1.58	29.53	1.60	30.32	1.76	31.57	2.02	
18 Chest breadth	18.75	1.04	19.46	1.20	20.15	1.21	20.73	1.46	21.40	1.55	
19 Waist breadth	16.10	1.29	16.78	1.25	-	-	18.09	1.30	-	-	
20 Pelvis breadth	19.56	1.08	20.34	1.16	21.21	1.20	22.05	1.41	23.14	1.95	
21 Abdomen depth	13.01	1.31	13.55	1.43	13.70	1.33	13.77	1.50	14.14	1.60	
22 Chest depth	13.47	1.06	13.90	1.00	14.12	1.02	14.59	1.14	15.01	1.39	
23 Foot width	7.61	0.48	7.91	0.57	8.20	0.57	8.51	0.59	8.90	0.61	
24 Foot length	19.79	1.13	20.76	1.16	21.69	1.17	22.48	1.26	23.35	1.22	
25 Hand height	12.83	0.87	13.45	0.77	13.94	0.67	14.47	0.85	15.10	0.97	

Table 1 (continued)

	1	2	3	4	5	6	7	8	9	10	11
26 3rd finger height		5.59	0.35	5.88	0.33	-	-	6.56	0.39	-	-
27 Thumb height		4.33	0.30	4.63	0.37	-	-	5.09	0.41	-	-
28 Flat width		6.12	0.42	6.35	0.36	6.55	0.35	6.72	0.36	6.98	0.42
29 Sitting height		66.69	2.64	69.54	2.91	71.75	2.92	73.57	3.04	76.45	3.74
30 Lower limb length		66.17	3.75	69.97	4.08	74.56	3.83	77.69	4.53	81.42	4.58
31 Head-neck height		25.40	1.82	25.68	3.08	26.32	2.22	27.23	1.58	27.69	2.21
32 Upper limb length		54.29	3.51	56.70	3.18	59.98	3.28	62.14	3.42	64.83	3.75
33 Trunk length		36.11	2.41	37.93	2.85	39.13	2.67	39.83	2.54	41.22	2.76
34 Abdomen length		25.84	2.52	26.66	2.40	27.36	1.88	27.79	2.19	28.84	2.67

	12 n=133		13 n=142		14 n=125		15 n=181		16 n=297		17 n=249		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age (years)	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Weight (kg)	45.03	10.34	48.46	8.96	54.58	10.12	57.53	9.65	60.18	9.57	60.52	8.15	
2 Height (cm)	154.52	7.70	159.24	6.75	162.35	6.68	164.35	5.95	165.49	5.75	164.83	6.12	
3 Cervical height	132.33	7.19	136.75	6.17	139.92	5.64	141.68	5.77	142.57	5.36	142.10	5.67	
4 Waist height	98.93	5.44	101.97	4.97	104.21	4.64	104.82	4.50	105.62	4.84	104.65	5.27	
5 Acromial height	125.80	6.97	130.16	6.07	132.27	5.69	134.80	5.27	135.85	5.50	135.38	6.02	
6 Head circumf.	53.94	1.45	54.25	1.45	54.43	5.30	54.70	1.35	54.76	1.47	54.87	1.47	
7 Neck circumf.	-	-	-	-	-	-	31.38	1.75	32.47	1.83	32.27	1.84	
8 Chest circumf.	75.19	8.03	78.66	7.10	82.53	7.43	85.84	6.80	87.75	7.41	87.95	6.33	
9 Lower chest circumf.	69.28	6.23	70.82	5.26	73.44	5.88	75.51	5.83	76.62	6.24	76.51	5.83	
10 Waist circumf.	61.08	6.45	62.31	5.67	64.69	5.99	66.38	5.67	67.74	6.32	67.79	5.54	
11 Pelvis circumf.	83.69	8.15	86.44	7.11	91.58	7.81	94.26	7.35	96.92	7.28	96.95	6.44	
12 Arm circumf.	23.41	2.95	24.04	3.11	25.63	3.07	26.83	3.10	27.80	3.38	27.68	2.99	
13 Wrist circumf.	14.95	0.99	15.19	0.89	15.50	0.82	15.58	0.83	15.72	0.87	15.67	0.82	
14 Thigh circumf.	49.54	5.44	51.00	5.39	54.28	5.66	56.18	5.07	57.59	5.37	58.36	4.77	
15 Upper leg circumf.	32.18	2.82	33.11	2.62	34.70	3.13	35.60	2.77	36.32	2.96	36.39	2.58	
16 Foot circumf.	-	-	-	-	-	-	23.31	0.91	23.84	1.43	23.71	1.23	

Table 1 (continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13
17 Biacromial breadth	33.16	2.03	33.85	1.88	34.79	1.91	35.54	2.02	35.64	1.92	35.88	1.78	
18 Chest breadth	22.55	1.90	23.31	2.08	24.07	1.92	24.45	1.45	24.96	1.73	24.87	1.72	
19 Waist breadth	-	-	-	-	-	-	-	-	22.17	1.93	22.10	2.03	
20 Pelvis breadth	24.62	2.08	25.24	1.77	26.34	1.80	27.24	1.79	25.57	1.78	27.63	1.76	
21 Abdomen depth	14.78	2.09	14.64	1.60	15.30	1.93	15.77	1.86	15.85	1.94	15.78	1.60	
22 Chest depth	15.99	1.80	16.39	1.49	16.83	1.42	17.18	1.65	17.28	1.67	17.35	1.51	
23 Foot width	9.25	0.59	9.43	0.59	9.46	0.52	9.64	0.52	9.67	0.57	9.62	0.49	
24 Foot length	23.98	1.18	24.41	1.21	24.58	1.10	24.78	1.18	24.94	1.26	24.77	1.17	
25 Hand length	15.85	1.03	16.28	0.95	16.55	0.87	16.61	0.90	16.79	0.87	16.71	0.89	
26 3rd finger height	-	-	-	-	-	-	7.63	0.39	7.54	0.42	7.49	0.53	
27 Thumb height	-	-	-	-	-	-	5.79	0.30	5.90	0.36	5.79	0.34	
28 Flat width	7.30	0.43	7.48	0.42	7.56	0.37	7.56	0.36	7.61	0.38	7.60	0.38	
29 Sitting height	1.30	0.11	1.32	0.11	1.34	0.10	1.36	0.10	1.35	0.10	1.34	0.09	
30 Lower limb length	79.96	4.73	82.40	4.19	84.59	3.33	85.52	3.42	86.32	3.06	86.49	3.41	
31 Head-neck height	28.71	3.42	29.83	2.54	29.73	3.54	30.76	2.33	30.86	1.52	30.87	2.00	
32 Upper limb length	68.14	4.34	69.98	4.09	71.84	3.43	71.99	3.37	72.26	3.36	71.97	3.56	
33 Trunk length	43.91	4.53	45.01	3.72	46.73	3.14	46.86	3.90	47.92	2.86	48.43	4.33	
34 Abdomen length	30.23	3.67	31.08	3.16	31.68	3.08	31.90	2.66	32.44	3.17	32.38	4.12	

Table 2

Multiple linear regression equations for estimating various anthropometric measurements of 7-11, 12-15 and 16-17-year-old girls by body height, weight and age

Criterion variable	Multiple regression equation	Multiple R <sup>2</sup> (%)
3 Cervical height		
I	$-1.234+0.402(A''')+0.095(1)+0.807(2)$	96.6
II	$4.230+0.247(A)+0.069(1)+0.790(2)$	89.0
III	$-2.158-0.177(A)+0.045(1)+0.876(2)$	92.8
4 Waist height		
I	$-7.032+0.388(A)+0.098(1)+0.633(2)$	91.5
II	$4.429-0.226(A)+0.049(1)+0.615(2)$	85.1
III	$2.501-0.406(A)+0.063(1)+0.669(2)$	73.7
5 Acromial height		
I	$-2.651+0.448(A)+0.087(1)+0.772(2)$	96.0
II	$2.234+0.262(A)+0.058(1)+0.763(2)$	88.4
III	$1.142-0.375(A)+0.074(1)+0.824(2)$	82.5
6 Head circumf.		
I	$45.752-0.149(A)+0.105(1)+0.035(2)$	35.2
II	$44.400-0.112(A)+0.044(1)+0.057(2)$	28.4
III	$38.501+0.248(A)+0.063(1)+0.050(2)$	25.3
8 Chest circumf.		
I	$52.748+0.151(A)+0.936(1)-0.138(2)$	89.4
II	$53.796+0.773(A)+0.739(1)-0.134(2)$	86.3
III	$77.396+0.296(A)+0.725(1)-0.231(2)$	77.6
9 Lower chest circumf.		
I	$54.388+0.211(A)+0.768(1)-0.136(2)$	84.2
II	$61.837-0.015(A)+0.572(1)-0.117(2)$	80.9
III	$62.757+0.223(A)+0.565(1)-0.146(2)$	64.0
10 Waist circumf.		
I	$55.965-0.268(A)+0.801(1)-0.172(2)$	80.2
II	$60.721-0.327(A)+0.600(1)-0.145(2)$	78.7
III	$64.480+0.007(A)+0.594(1)-0.198(2)$	71.6
11 Pelvis circumf.		
I	$52.726+0.207(A)+0.977(1)-0.095(2)$	87.7
II	$48.870+0.523(A)+0.735(1)-0.029(2)$	89.4
III	$77.062-0.274(A)+0.697(1)-0.108(2)$	77.0
12 Arm circumf.		
I	$22.904-0.027(A)+0.444(1)-0.118(2)$	83.3
II	$24.675+0.131(A)+0.321(1)-0.112(2)$	84.6
III	$42.453-0.277(A)+0.328(1)-0.181(2)$	74.4

I - 7-11 years

II - 12-15 years

III - 16-17 years

A - Age (years)

Table 2 (continued)

	1	2	3
13 Wrist circumf.			
I	9.660+0.007(A)+0.110(1)+0.002(2)		71.2
II	12.401-0.080(A)+0.066(1)+0.003(2)		60.2
III	10.231+0.018(A)+0.062(1)+0.008(2)		48.8
14 Thigh circumf.			
I	37.209+0.005(A)+0.776(1)-0.140(2)		88.2
II	40.202+0.300(A)+0.554(1)-0.125(2)		87.2
III	51.842+0.042(A)+0.503(1)-0.152(2)		68.0
15 Upper leg circumf.			
I	18.604-0.047(A)+0.378(1)-0.013(2)		85.8
II	22.475+0.122(A)+0.265(1)-0.024(2)		81.6
III	28.232+0.115(A)+0.250(1)-0.054(2)		64.0
17 Biacromial breadth			
I	11.176+0.155(A)+0.132(1)+0.092(2)		73.4
II	16.508+0.074(A)+0.097(1)+0.073(2)		51.5
III	12.955+0.405(A)+0.091(1)+0.063(2)		30.9
18 Chest breadth			
I	13.603+0.087(A)+0.166(1)+0.004(2)		65.4
II	14.373+0.117(A)+0.111(1)+0.011(2)		47.2
III	13.087+0.164(A)+0.110(1)+0.013(2)		37.9
20 Pelvis breadth			
I	7.630+0.087(A)+0.129(1)+0.064(2)		75.2
II	7.876+0.238(A)+0.110(1)+0.056(2)		63.9
III	9.430+0.155(A)+0.080(1)+0.065(2)		26.7
21 Abdomen depth			
I	15.730-0.157(A)+0.220(1)-0.055(2)		49.8
II	21.634-0.187(A)+0.188(1)-0.083(2)		62.9
III	21.387-0.195(A)+0.149(1)-0.068(2)		48.2
22 Chest depth			
I	13.059+0.0006(A)+0.165(1)-0.029(2)		59.7
II	12.674-0.090(A)+0.125(1)-0.007(2)		57.1
III	11.694+0.001(A)+0.126(1)-0.011(2)		44.4
23 Foot width			
I	3.385+0.026(A)+0.048(1)+0.023(2)		64.9
II	6.227-0.048(A)+0.025(1)+0.015(2)		35.9
III	8.192-0.079(A)+0.025(1)+0.007(2)		20.8
24 Foot length			
I	3.710+0.071(A)+0.055(1)+0.114(2)		82.4
II	10.058-0.149(A)+0.023(1)+0.094(2)		49.0
III	6.127-0.098(A)+0.035(1)+0.109(2)		49.0
25 Hand height			
I	3.381+0.050(A)+0.027(1)+0.068(2)		62.5
II	4.306-0.047(A)+0.014(1)+0.074(2)		43.6
III	0.681+0.012(A)+0.010(1)+0.092(2)		41.3
28 Flat width			
I	3.956+0.049(A)+0.034(1)+0.007(2)		57.2
II	5.498-0.028(A)+0.019(1)+0.008(2)		35.8
III	4.488-0.0009(A)+0.019(1)+0.021(2)		25.8

Table 2 (continued)

1	2	3
29 Sitting height		
I	$22.781+0.107(A)+0.136(1)+0.319(2)$	84.8
II	$15.809+0.246(A)+0.107(1)+0.365(2)$	74.1
III	$20.211+0.083(A)+0.026(1)+0.399(2)$	57.2
30 Lower limb length		
I	$-8.435+0.419(A)+0.028(1)+0.572(2)$	91.9
II	$2.982-0.185(A)-0.010(1)+0.552(2)$	74.2
III	$-11.187-0.019(A)+0.034(1)+0.602(2)$	78.2
31 Head-neck height		
I	$-2.321-0.436(A)-0.106(1)+0.266(2)$	46.8
II	$-6.584+0.134(A)-0.056(1)+0.233(2)$	21.8
III	$2.876+0.127(A)-0.028(1)+0.167(2)$	26.0
32 Upper limb length		
I	$3.423+0.353(A)+0.071(1)+0.374(2)$	84.7
II	$3.575-0.117(A)+0.024(1)+0.420(2)$	64.9
III	$-5.848+0.102(A)+0.024(1)+0.453(2)$	63.6
33 Trunk length		
I	$13.431-0.022(A)+0.090(1)+0.165(2)$	58.6
II	$9.097-0.109(A)+0.106(1)+0.207(2)$	38.1
III	$10.249-0.220(A)+0.022(1)+0.242(2)$	32.4
34 Abdomen length		
I	$8.869-0.018(A)-0.024(1)+0.142(2)$	26.2
II	$10.785-0.080(A)+0.056(1)+0.116(2)$	15.8
III	$9.029-0.374(A)-0.020(1)+0.184(2)$	13.9

# SEXUAL DIMORPHISM OF FACTOR PATTERN OF MORPHOFUNCTIONAL STATUS OF LITHUANIAN CHILDREN

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Each individual is characterized by a wide range of morphofunctional indices which have specific intercorrelations. Factor analysis enables us to discover the hierarchy of various correlations and the diagnostic value of many traits for a complex evaluation of the general condition of health of the growing organism. Although multiple analyses of morphological measures of children have been published (Deriabin, 1983; Becque et al., 1986; Devor et al., 1986; Barabas, 1984; Paganini-Hill et al., 1981; Sharma et al., 1984; Szczotka, 1985), no complex analysis of the relationships between various morphological and physiological traits, sexual development and morbidity has been made. Therefore, the present study examines these relationships, describes the sexual dimorphism of factor pattern of morphofunctional status of children at various age periods.

## Materials and methods

Data on 39 different anthropometric and physiological traits, sexual maturation and morbidity were obtained from a total of 2657 7-18-year-old children of Vilnius secondary schools. Standard anthropometric methods (Martin, Saller, 1957) were used. Body fat was evaluated by assessing skin folds thickness at 8 sites of the body (Möhr, Johnsen, 1979) using the Holtain calliper. The data were processed using factor analysis by principal component method.

## Results and discussion

Means, standard deviations, skewness, intercorrelations for each of 39 indices were calculated for every age-sex group. The squared multiple correlations (SMC) are the high-

est for active and passive body mass, weight, relative indices of strength and height. The values of final communality are the highest for active body mass and relative indices of strength. Consequently, these indices of children are the main traits describing growth and development.

Orthogonally rotated factor loadings for the traits were revealed using the inclusion criterion of a minimum eigenvalue of 1.00. We obtained from 7 to 10 factors (according to age and sex) which accounted for 75-85% of total variance. As it was confirmed previously (Deriabin, 1983; Devor et al., 1986), the interpretation of these factors is self-evident. The first two factors make up 44-62% of total variance, all the others have low eigenvalues and influence the total variance insignificantly. Hence, the alteration in this part of factor pattern does not change the essence of the model.

There are no sex differences in the factor pattern of physical development till adolescence begins (Table 1). Factor 1, with high loadings on body fat, girths of the body, some transverse indices, is clearly a body fatness factor. Factor 2 is the body size factor heavily loaded on the active body mass, height, the other length measurements, biacromial and bicristal diameters. The other factors describe strength indices of skeletal robustness, blood pressure, physical activity and morbidity. In 12-year-old girls Factor 1 influences body size while body fatness depends on Factor 2. The cause for this is the spurt of androgens and STH in females - adrenarche, which has its maximum at the age of 12 (Marshall, 1978). Later, from 13 to 18 years in girls Factor 1 affects fatness (the excretion of oestrogens rises sharply in girls after the 13th year) and the factor pattern does not differ from the previous one. In boys from the age of 13 to 18 the factor pattern of physical development differs radically from that of the girls (Table 2). Owing to excretion spurt of androgenic substances in boys, the first place in factor pattern is occupied by the body size factor. Body fatness is under the control of the second or the third factor. The other part of the factor model differs insignificantly from the previous one. It is necessary to emphasize that maximal variation of sexual maturation is from 12 to 13 years in girls and from 14 to 15 years in boys when sexual indices are under the control of Factor 1. At this time sexual maturation is closely related to other indices of growth and development.

Our findings are in agreement with the considerations of Devor et al. (1986), Beuen et al. (1982).

### Conclusions

1. There are no sex differences in the factor pattern of physical development of children till adolescence begins.

2. After the age of 12 in girls and 13 in boys main attention should be paid to the indices of fatness in girls and to body size characteristics in boys while until this moment the indices of body bulk have the greatest value for both sexes.

3. With some exceptions, separate and not connected factors influence morphological and functional characteristics and morbidity.

Table 1

Sorted rotated factor loadings for all 39 indices at the age of 9 in girls (loadings less than 0.25 have been replaced by zero)

Index	Factors							
	1	2	3	4	5	6	7	8
Passive mass, kg	0.94	0.25	-	-	-	-	-	-
Sum of 8 skinfolds	0.94	-	-	-	-	-	-	-
Body fat, %	0.93	-	-	-	-	-	-	-
Active mass, %	-0.93	-	-	-	-	-	-	-
Rohrer index	0.87	-0.30	-	-	-	-	-	-
Hip girth	0.86	0.35	-	-	-	-	-	-
Forearm girth	0.85	0.32	-	-	-	-	-	-
Thigh girth	0.85	0.35	-	-	-	-	-	-
Upper arm girth	0.84	-	-	-	-	-	-	-
Weight	0.82	0.49	-	-	-	-	-	-
Chest circumference	0.80	0.30	-	-	-	-	-	-

Table 1 (continued)

	1	2	3	4	5	6	7	8
Abdomen girth	0.79	0.28	-	-	-	-	-	-0.38
Femur width	0.68	0.43	-	-	-	-	-	-
Calf girth	0.66	0.32	-	-	-	-	-0.26	-
Humerus width	0.63	0.34	-	-	0.27	-	-	-
Wrist girth	0.59	0.35	-	-	-	-	-	-
Chest depth	0.58	-	-	-	0.40	-	-	-
Chest width	0.56	0.41	-	-	0.38	-	-0.26	-
Wrist width	0.55	0.37	-	-	0.27	-	-	0.37
Height	0.30	0.91	-	-	-	-	-	-
Arm length	-	0.86	-	-	-	-	-	-
Leg length	0.29	0.76	-	-	-	-	-	-
Trunk length	-	0.73	-	-	-	-	-	-
Active mass, kg	0.52	0.65	-	-	0.39	-	-	-
Shoulder width	0.37	0.65	-	-	0.42	-	-	-
Ankle width	-	0.59	-	-	0.29	-	-	0.26
Hip width	0.42	0.57	-	-	0.29	-	-	-
Strength/act. mass	-	-	0.97	-	-	-	-	-
Strength/weight	-0.32	-	0.93	-	-	-	-	-
Strength	0.26	0.31	0.90	-	-	-	-	-
Systolic B.P.	-	-	-	0.87	-	-	-	-
Diastolic B.P.	-	-	-	0.86	-	-	-	-
Morbidity	-	-	-	-	-0.66	-	-0.31	-
Vital cap./weight	-0.36	-	-	-	-	0.87	-	-
Vital capacity	0.37	0.30	-	-	-	0.87	-	-
Physical activity	-	-	-	-	-	-	0.77	-
Head height	-	-	-	-	-	-	-0.56	-
Head circumference	0.25	0.37	-	-	-	-	-0.53	-
Sexual maturation	-	-	-	-	-	-	-	0.87

Table 1 (continued)

	1	2	3	4	5	6	7	8
Eigen-values	13.0	6.4	2.9	1.9	1.8	1.8	1.8	1.4
Cumul. proport. of total variance (%)	43	53	61	66	70	74	77	80

Table 2

Sorted rotated factor loadings for all 39 indices at the age of 13 in boys (loadings less than 0.25 have been replaced by zero)

Index	Factors							
	1	2	3	4	5	6	7	8
Shoulder width	0.86	-	-	-	-	-	-	-
Height	0.83	-	0.39	-	-	-	-0.29	-
Active mass, kg	0.83	-	0.38	-	-	-	-	-
Weight	0.73	0.44	0.39	-	-	-	-	-
Trunk length	0.72	-	0.37	-	-	-	-	-
Head height	0.72	-	-	-	-	-	-	-0.29
Arm length	0.65	-	0.25	-	-	-	-0.31	-
Leg length	0.64	0.25	-	-	-	-	-0.53	-
Wrist width	0.57	-	0.39	-	0.36	-	-	-
Sexual maturation	0.56	-	-	-	-0.27	-	-	0.29
Hip width	0.53	-	0.33	-	-	-	-	-
Chest width	0.56	-	0.46	-	-	-	-	-
Chest depth	0.52	0.36	0.30	-	-	-	0.43	-
Body fat, %	-	0.96	-	-	-	-	-	-
Active mass, %	-	-0.96	-	-	-	-	-	-
Sum of 8 skinfolds	-	0.94	-	-	-	-	-	-
Passive mass, kg	0.33	0.86	0.27	-	-	-	-	-
Upper arm girth	0.28	0.64	0.59	-	-	-	-	-

Table 2 (continued)

	1	2	3	4	5	6	7	8
Abdomen girth	0.27	0.60	0.54	-	-	-	-	-
Hip girth	0.42	0.56	0.43	-	-	-	-	-
Wrist girth	0.32	-	0.71	-	-	-	-	-
Chest circumference	0.31	0.39	0.68	-	-	-	-	-
Forearm girth	0.42	0.41	0.66	-	-	-	-	-
Head circumference	0.35	-	0.58	-	-	-	-	-
Thigh girth	0.34	0.40	0.55	-	-	-	-	-
Calf girth	0.39	0.45	0.54	-	-	-	-	-
Strength/act. mass	-	-	-	0.96	-	-	-	-
Strength/weight	-	-0.30	-	0.92	-	-	-	-
Strength	0.49	-	0.30	0.77	-	-	-	-
Morbidity	-	-	-	-	-0.70	-	-	-
Ankle width	0.40	-	0.36	-	0.61	-	-	-
Vital cap./weight	-	-0.49	-	-	-	0.80	-	-
Vital capacity	0.58	-	0.32	-	-	0.65	-	-
Rohrer index	-	0.52	-	-	-	-	0.69	-
Systolic B.P.	-	-	-	-	-	-	-	0.76
Diastolic B.P.	-	-	0.34	-	-	-	-	0.68
Physical activity	-	-0.34	-	-	-	-0.47	-	-
Femur width	0.49	-	0.33	-	0.48	-	-	-
Humerus width	0.29	-	0.44	-	0.45	-	-	-
Eigenvalues	8.5	6.7	5.4	2.7	1.9	1.7	1.6	1.6
Cumul. proport. of total variance (%)	40	52	59	64	68	71	74	77

## References

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DEPENDENCY OF FREQUENCY OF OCCURRENCE OF STOMATOLOGICAL  
DISEASES ON SOME ANTHROPOMETRIC FEATURES

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Anthropometric methods of research have gained more and more importance in the field of medicine in recent years. The history of medicine has repeatedly proven the close connection between man's physical development and anatomical and physiological peculiarities of inner organs, but also between various diseased statuses.

Thus anthropometrics has been recognized as a method of research in the field of obstetrics and gynaecology (13, 16, 21), in orthopaedic stomatology (17, 14, 23), in the case of in-born anomalies (5, 19, 18) and elsewhere.

Anthropometric aspects of tooth caries have been investigated by V. P. Okushko in his doctoral dissertation (22). In this investigation data have been given about the connection between the intensity of tooth caries and such features as height of body, weight and girth of thorax. Craniometric research by the author has not been carried out.

The purpose of the present work is to find out on the basis of anthropometric investigations the possible risk groups in formation of stomatological diseases.

The material of investigation comprises 835 randomly chosen Tartu University students of Estonian nationality between the ages of 18-33. 615 of them (73.6%) are female and 220 (26.4%) male students. On the basis of recommendation by experts of World Health Care Organization we divided the students into 3 age groups:

- I - 18-19-year-olds (289)
- II - 20-24-year-olds (501)
- III - 25-30-year-olds (45)

The material has been collected during the period of 1981-1983. Measurements were carried out according to R. Martin's generally known prescripts taking into account J. Aul's recommendations. In the investigation of students, the follow-

ing measurements were made: height of body (cm), weight (kg), girth of head (mm), length of head (mm), width of head (mm), width of face (mm), physiognomic height of face (mm), morphologic height of face (mm).

Individually, morphological face index was calculated (MNI). Additionally, we determined the students' intensity of tooth caries (DMF index), hygienic index of oral cavity (HI) according to Fyodorov and Volodkina, status of parodontal tissues (PMA index) and frequency of occurrence of teeth congestion due to teeth and jaws' anomalies.

Empirical material has been processed statistically in Tartu University's Computation Centre

### Results and discussion

It appears from the results of the analysis of data that the medium height of the young men investigated is  $180.36 \pm 0.59$  and young women's medium weight is  $62.87 \pm 0.42$  kg. On the basis of the above-given data the students investigated can be considered tall and physically well developed. The dynamics of height and weight in age groups is not statistically important.

Analyzing the values of craniometric features, we found that the girth of head of female students is  $559.5 \pm 14.7$  mm on the average, that of male students being  $579.2 \pm 15.4$  mm. The length of head is correspondingly  $181.8 \pm 7.1$  and  $189.1 \pm 7.5$  and width of head  $149.2 \pm 6.8$  and  $155.0 \pm 7.0$  mm. The width of head of male students increases after 20 years of age. Thus the width of head in the age group 18-19 is  $154.4 \pm 0.81$  mm on the average, but that of 20-24-year-olds is  $154.8 \pm 0.13$  mm (p 0.02). The width of forehead of young women is  $124.1 \pm 7.5$  mm and that of young men  $128.4 \pm 8.0$  mm. In the case of the latter ones, we observed the increase of this measurement in 20-year-olds and older ones (p 0.01). The width of face equals to  $125.4 \pm 8.1$  mm in female students and  $132.8 \pm 8.6$  in male students respectively. In female students, a remarkable increase of the width of face can be observed in the second age group (I -  $124.08 \pm 0.57$  mm, II -  $126.2 \pm 0.43$  mm). The same tendency was noted concerning the morphological height of face both in young women (p 0.001) and young men (p 0.01). The medium morphological height of face in young women equals to  $129.7 \pm 7.5$  mm and in young men  $128.5 \pm 8.6$

mm. The physionomic height of face is 11.6 mm less in female students than in male students ( $175.5 \pm 8.0$  and  $187.1 \pm 9.8$ ).

The craniometric features analyzed by us correlate with height and weight (Table 1).

The analysis of anthropometric features of head shows that all the measurements of head and face are bigger in men than in women, i.e. a strongly expressed gender dimorphism occurs.

When comparing our data with the results of J. Aul's investigations (1956-1957), it can be seen that the face of 18-year-old Estonians has become longer and narrower - the width of face has diminished and the morphological height of face has increased.

Thus it is peculiar to contemporary man that the skeleton of face has become more graceful, whereas at the same time height of body has considerably increased (Table 2).

The dominant type of Estonians' face is narrow and long, the indications of which are high values of morphological face index both in young women (95.5%) and young men (97.1%).

We can conclude from the data that it is peculiar to 88.5% of the investigated students to have leptoprasopy (84.5% of male and 89.9% of female students). Only 4.5% of students are wide-faced and 7.0% are with medium width of face.

The intensity of tooth caries according to KPE index is high in students, constituting  $9.47 \pm 0.18$  on the average. One cannot be satisfied with the hygienic status of oral cavity in the investigated students - the medium hygienic index is  $2.18 \pm 0.04$  points.

The pathology of parodont occurs  $53.0 \pm 0.5\%$  whereas the medium value of PMA index is  $4.73 \pm 0.37$ .

The frequency of occurrence of teeth and jaws' anomalies in the investigated students is 59.2, the congestion of teeth was noted in 33.1%.

Searching for connections between the frequency of occurrence of stomatological diseases and the values of anthropometric features, we found that one important feature is the morphological face index the size of which is in its turn determined by the width of face and the morphological height of face.

On the basis of the values, we divided the morphological face index into 3 sub-groups according to H. Kaarma's (1981) recommendation:

- 1) mesoprosopic (MNI  $x \pm 1/26$ )
- 2) europrosopic (MNI  $x - 1/26$ )
- 3) leptoprosopic (MNI  $x + 1/26$ )

In the mentioned sub-groups we carried out the analysis of hygienic, PMA and KPE indices, the results of which have been given in Table 3.

In the case of occurrence of marginal parodont's pathology the morphological index is bigger when compared with the group of healthy people ( $p < 0.001$ ). It can be accounted for by the circumstance that in the case of a narrow face, teeth-jaws' anomalies are diagnosed more frequently ( $p < 0.005$ ), in the connections are created for the stratification of teeth cement ( $p < 0.01$ ) and for the worse selfcleansing of teeth that favour the formation of inflammatory process in parodontal tissues (Table 4).

In the case of a narrow face we noted also the risk in the intensity of tooth caries ( $p < 0.05$ ). The role of the microbic factor in the ethiopathogenesis of tooth caries and parodontal diseases has been proven by many authors (3, 8, 2, 7, 6, 9, 11).

R. V. Katz (4) proved that tall people have longer teeth crowns and deeper gum furrows when compared to shorter people.

From here a thought appears that the factor favouring the formation of parodontal diseases might also be the change of transmission of chewing pressure from tooth curve to parodont and further to jaws. The changes in the angle of inclination of teeth can also be caused by their anomalic position.

It can be concluded from the analysis of data that the investigation of morphological features enables to find out the persons disposed to parodontal diseases. The smaller the width of face and girth of head of tall persons, the stronger the probability in the formation of parodontal pathology. The complex of the mentioned indicators can be recommended for early diagnosing of parodontal diseases and taking young people under medical care.

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Table 1

## Anthropometrical features according to age and sex

Feature	The medium value of the feature		Age groups			P		
			17-19	20-24	25-33			
			$\bar{x} \pm m$	$\bar{x} \pm m$	$\bar{x} \pm m$			
1. height of body (cm)	F	600	166.39 $\pm$ 0.28	166.69 $\pm$ 0.45	166.30 $\pm$ 0.40	163.89 $\pm$ 1.95	0.009	1.00
	M	200	180.36 $\pm$ 0.59	179.97 $\pm$ 1.11	180.80 $\pm$ 0.79	178.85 $\pm$ 0.83	1.010	1.00
2. weight (kg)	F	600	62.87 $\pm$ 0.42	62.97 $\pm$ 0.59	62.89 $\pm$ 0.61	61.41 $\pm$ 3.30	-0.071	1.00
	M	188	76.38 $\pm$ 1.17	76.84 $\pm$ 2.85	76.25 $\pm$ 1.28	75.87 $\pm$ 3.74	0.078	0.25
3. girth of head (mm)	F	600	559.54 $\pm$ 0.60	560.34 $\pm$ 0.48	558.79 $\pm$ 0.81	562.79 $\pm$ 3.61	-0.01	0.25
	M	201	579.18 $\pm$ 1.09	580.25 $\pm$ 1.01	578.25 $\pm$ 1.41	582.50 $\pm$ 3.81	0.079	1.00
4. length of head (mm)	F	680	181.81 $\pm$ 0.31	181.05 $\pm$ 0.41	182.05 $\pm$ 0.41	182.30 $\pm$ 1.74	0.025	1.00
	M	198	189.11 $\pm$ 0.58	189.00 $\pm$ 0.97	189.01 $\pm$ 0.63	190.50 $\pm$ 1.49	0.075	1.00
5. width of head (mm)	F	588	149.15 $\pm$ 0.35	149.10 $\pm$ 0.44	149.28 $\pm$ 0.39	147.86 $\pm$ 0.89	0.002	1.00
	M	204	155.04 $\pm$ 0.53	154.39 $\pm$ 0.81	154.84 $\pm$ 0.13	159.93 $\pm$ 3.37	0.176	0.02
6. width of forehead (mm)	F	598	124.05 $\pm$ 0.35	123.98 $\pm$ 0.48	124.04 $\pm$ 0.42	124.82 $\pm$ 1.83	0.031	0.25
	M	202	128.39 $\pm$ 0.53	127.48 $\pm$ 1.00	128.96 $\pm$ 0.73	128.50 $\pm$ 1.69	0.206	0.01
7. width of face (mm)	F	567	125.35 $\pm$ 0.34	124.08 $\pm$ 0.57	126.24 $\pm$ 0.43	124.83 $\pm$ 1.66	0.112	1.00
	M	204	132.83 $\pm$ 0.62	131.68 $\pm$ 1.16	133.11 $\pm$ 0.75	135.64 $\pm$ 1.94	0.077	1.00
8. morphological height of face (mm)	F	567	129.73 $\pm$ 0.32	119.93 $\pm$ 0.47	121.60 $\pm$ 0.44	121.70 $\pm$ 1.43	0.001	0.01
	M	204	126.50 $\pm$ 0.61	126.83 $\pm$ 0.79	129.83 $\pm$ 0.80	128.29 $\pm$ 2.82	0.202	0.01
9. physiognomic height of face (mm)	F	569	175.62 $\pm$ 0.34	175.46 $\pm$ 0.52	175.72 $\pm$ 0.46	175.70 $\pm$ 1.55	0.014	1.00
	M	187	187.12 $\pm$ 0.72	187.06 $\pm$ 0.98	186.94 $\pm$ 0.94	189.00 $\pm$ 3.35	0.015	1.00
10. morphologic index of face (%)	F	581	95.46 $\pm$ 0.25	96.46 $\pm$ 0.42	96.38 $\pm$ 0.40	97.67 $\pm$ 1.13	0.045	1.00
	M	203	97.14 $\pm$ 0.50	96.11 $\pm$ 0.97	97.94 $\pm$ 0.79	94.85 $\pm$ 2.65	0.118	70.10

Table 2

Comparison of anthropometric features on the basis  
of J. Aul's data 1956-1957 and our data 1982

sex	men		women		
	years		years		
	1956-1957	1981-1983	1956-1957	1981-1983	
feature	age	18	18-19	18	18-19
1. body height		174.1	179.9	162.5	166.7
2. weight		66.2	76.8	50.0	62.9
3. head length		192.1	189.0	184.6	181.4
4. head width		156.8	154.4	151.8	149.1
5. face width		140.3	131.7	134.5	124.0
6. morphological height of face		119.4	126.8	111.1	199.9

Table 3

Dependence of hygienic, PMA and KPE indices  
on the type of face ( $\bar{x} \pm M$ )

Type of face indi- ces	europrosopic (74.65-89.21)	mesoprosopic (89.22-100.27)	leptoprosopic (100.28-123.15)	t	r
HI	2.05 $\pm$ 0.08	2.17 $\pm$ 0.05	2.30 $\pm$ 0.09	0.08	0.065
PMA	2.83 $\pm$ 0.89	3.91 $\pm$ 0.04	4.15 $\pm$ 0.58	0.114	0.091
KPE	9.17 $\pm$ 0.33	9.43 $\pm$ 0.27	9.90 $\pm$ 0.39	0.062	0.036

Table 4

The medium values of the morphological face index in the case of teething anomalies and parodont

	total	MNI value				T	R
		in the case of pathology		in the group of healthy people			
		n	$\bar{x} \pm m$	n	$\bar{x} \pm m$		
1. the anomalies of the development of teeth and jaws	807	478	97.18 $\pm$ 0.34	329	95.77 $\pm$ 0.38	0.072	0.094 <sup>†</sup>
2. the anomalies of the position of teeth	808	245	97.22 $\pm$ 0.44	563	96.34 $\pm$ 0.31	0.079	0.055
3. the occurrence of parodontical diseases	809	448	97.55 $\pm$ 0.33	361	95.40 $\pm$ 0.39	0.119	0.146 <sup>†</sup>
4. soft cement	801	332	97.52 $\pm$ 0.39	469	95.94 $\pm$ 0.34	0.060	0.106

## MEASUREMENTS OF 9-YEAR-OLD TARTU SCHOOLCHILDREN

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Measuring of body volume, particularly of children, is very labour-consuming. There are many procedures for determining the volume of the body or its segments - water displacement, underwater weighing, helium dilution, plethysmometric measurement, etc. /1/. In some cases the simultaneous measurement of residual air remains a stumbling-block.

In the present paper we used a method available to us, which consists in measuring the partial volume without counting the residual air. As measuring of body volume is complicated in comparison with anthropometry, we tried to find out relationships between anthropometric variables and partial volumes of the body, with the aim to work out regression equations for estimating the segmental body volume from anthropometric measurements.

The contingent of the investigation was homogeneous: all 52 subjects were healthy 9-year-old Estonian boys and girls (22 and 30 respectively) from Tartu secondary schools. The reasons for choosing the subjects of the age of 9 were the following:

- 1) at this age the first signs of maturity have not appeared yet;
- 2) this is the earliest age when the children are not afraid of the procedures;
- 3) at this age there are no big differences between the measurements of both sexes.

For measuring partial body volume we used a special water tank with the area 60x40 cm, made by the Experimental Laboratory of Tartu University.

The procedure involved sequential determination of the volume of seven body segments. The amount of the water raised by the immersed body was determined by weighing.

The partial volume was fixed at the following levels:

- 1) volume below the knees (below the tibial point)

- 2) volume below the groin (nates on the level of water)
- 3) volume below the umbilicus
- 4) volume below the suprasternal point (with hands)
- 5) gross body volume
- 6) volume of the right hand

For measuring the hand volume we have used a separate vessel of smaller diameter. The temperature of the water was  $+36^{\circ}$  (body temperature).

Anthropometric measurements were carried out by the author in Tartu in 1991-1992 according to the methods developed by R. Martin /2/ and the suggestions of V. Bunak /3/, and A. Stavitskaya and D. Aron /4/.

The anthropometric measurements included several heights, circumferences, diameters, skinfold thicknesses in addition to the usual height and weight (see Table 1). Body diameters were measured with a large metal sliding calliper, body circumferences with the measuring tape.

Skinfolds were taken with a special constant pressure calliper (10 g/mm) designed by the Experimental Laboratory of Tartu University. Skinfold measurements were made according to the suggestions of J. Parizkova /5/ and E. Martirosov /6/. Some of the measurements (e. g. head facial circumference) were taken according to the methods of anthropometric ergometric research issued by the coordination centre of Comecon countries for scientific principles of ergonomic norms and requirements /7/. All skinfolds were measured vertically and on the right-hand side of the body, except abdomen 2 skinfold (umbilicus), which was measured horizontally, and the subscapula skinfold, measured at a 45 degree angle to the vertical.

Statistical analysis of the total sample (boys and girls together) was done at the Computing Centre of Tartu University by multivariate statistical analysis.

The mean values and standard deviations of selected anthropometric variables are given in Table 1.

The linear correlation coefficients between main measurements are presented in Table 2. These correlation coefficients show statistically significant relationships between 75% of measurements. The linear correlation analysis revealed that the body weight and height and segmental body volumes had the greatest number of close links with the other anthropometric parameters.

Body weight has, as usual, relationships mainly with circumferences, but also with the bideltoid diameter and total thigh diameter as well as waist breadth and segmental body volumes. Body height has very close relationships with other height measurements as well as with bone measurements, such as biacromial width, bicristal width and foot length.

Diameters are in stronger correlation with waist circumference and abdomen circumference.

In addition to being in close connection between themselves, the circumferences have close links with body weight, bideltoid diameter and total thigh diameter, with waist breadth, also with some of the skinfolds such as subscapular skinfold, side skinfold and abdomen skinfold.

The segmental body volumes which have very close relationships between themselves and with the body weight and height are of interest, too.

On the ground of the existence of very close correlations between anthropometric characteristics we are led to the opinion that different combinations of anthropometric parameters may possibly represent different partial volumes.

Table 3 presents the prediction equation resulting from the regression analysis of the sample. These values correspond to multiple Rs from 0.738 to 0.993.

A closer examination of the analyses suggests that body weight and body height are able to prognosticate 53.73-96.83% from the variability of separate segmental body volumes.

Comparing the other body measurements, we see that their combinations similarly give us relatively good approximately equivalent prognoses for estimating segmental body volumes as in case of body weight and height. Combinations of the other measurements prognosticate 63.36-97.42% from the variability of separate segmental body volumes.

This indicates that accuracy of anthropometric measurements is a requisite in such work.

Our results demonstrate once again the principle of the body as a whole according to which third measurements can be predicted by weight and height or other body parameters /8/.

As anthropometric characteristics are able to describe accurately the variability of the segmental body volumes, it is evidently possible in the future to continue this work to develop equations for a wider age range contingent for estimating segmental body volumes on the basis of anthropometric measurements.

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Table 1

## Main anthropometric characteristics of subjects

Variable	Mean	SD*	min	max
1. Weight (kg)	31.60	5.34	21.50	46.65
<b>H e i g h t s (cm)</b>				
2. Height	137.22	5.49	123.20	148.10
3. Suprasternal height	110.20	5.11	96.70	121.30
4. Proc. xiph. height	98.64	4.77	87.10	108.20
5. Umbilic height	81.52	4.44	71.10	91.20
6. Symphysis height	70.21	3.69	61.00	78.40
7. Tibiale height	38.69	2.32	33.40	43.80
8. Sitting height	72.87	2.96	66.10	79.20
<b>D i a m e t e r s (cm)</b>				
9. Bideltoid diameter	33.12	2.32	28.10	40.00
10. Total thighs diameter	25.02	2.00	21.30	29.90
11. Biacromial width	29.07	1.53	25.70	32.50
12. Chest breadth	20.71	1.38	18.00	24.70
13. Waist breadth	19.63	1.43	17.00	23.90
14. Bicristal width	21.51	1.41	18.30	24.60
15. Flat height	14.11	0.93	12.30	17.20
16. Flat width	6.80	0.36	5.90	7.90
17. Flat thickness	2.18	0.19	1.70	2.60
18. Foot length	21.65	1.16	18.10	24.20
19. Foot width	7.75	0.51	6.60	8.80
<b>C i r c u m f e r e n c e s (cm)</b>				
20. Head circumference	52.75	1.48	48.90	56.00
21. Head facial circumf.	61.00	1.45	57.80	64.00
22. Chest circumference	66.24	4.80	58.50	81.00
23. Waist circumference	58.80	4.68	51.40	75.90
24. Abdominal circumf. (umbilicus)	61.05	5.29	51.30	78.30
25. Abdominal circ.(pubis)	65.43	5.64	54.70	83.20
26. Gluteal circumf.	70.76	5.69	59.40	87.60
27. Thigh circ. (upper)	42.15	4.39	33.50	55.50
28. Thigh circ. (median)	37.84	3.59	31.10	48.60
29. Knee circumference	29.59	2.08	24.90	35.30
30. Calf circ. (maximum)	27.84	2.10	23.10	35.50
31. Calf circ. (below)	19.23	1.42	16.20	22.90
32. Upper arm circ.(contr.)	21.67	2.11	18.20	30.00
33. Upper arm circ.(rel.)	20.38	2.20	17.10	29.30
34. Forearm circ.	19.76	1.39	17.00	25.00
35. Wrist circumference	13.60	0.78	11.80	15.70
36. Circ. of the flat of the hand	16.44	0.87	14.60	18.80
37. Foot circumference	20.30	1.17	18.20	22.80
<b>S k i n f o l d s (cm)</b>				
38. Subscapular	0.70	0.33	0.40	2.10
39. Side (vertically)	0.79	0.47	0.35	2.90
40. Side (horizontally)	0.66	0.34	0.30	2.00
41. Abdomen (umbilicus)	0.83	0.48	0.30	2.60
42. Triceps	1.10	0.37	0.40	2.20
43. Biceps	0.72	0.33	0.30	2.10
44. Thigh (median)	1.81	0.71	0.70	3.75
45. Calf	1.22	0.41	0.60	2.70

Table 1 (continued)

	Mean	SD*	min	-	max
V o l u m e (dm)					
46. below knees	3.82	0.99	2.00	-	5.85
47. below the groin	9.61	2.64	5.50	-	16.20
48. below the umbilicus	15.20	3.26	8.40	-	24.95
49. below the breast nipples	21.36	4.63	13.45	-	34.90
50. below the suprasternal point (with hands)	26.50	5.37	16.75	-	42.45
51. of the gross body	31.42	5.66	20.80	-	46.80
52. of the right hand	1.24	0.30	0.70	-	2.35
53. hand length (cm)	61.07	3.29	52.20	-	68.10
54. foot length (cm)	75.43	4.06	66.15	-	85.25
55. calf length (cm)	31.13	2.09	26.80	-	36.30

\* SD Standard deviation

Table 2

## Coefficients of correlation between main measurements

Number of variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1.													
2.	0.72												
3.	.72	99											
4.	.70	97	98										
5.	.62	94	95	95									
6.	.60	95	96	94	97								
7.	.58	90	90	90	90	92							
8.	.64	82	79	78	73	71	68						
9.	.90	69	70	69	66	62	56	64					
10.	.93	69	69	68	61	58	52	67	83				
11.	.72	83	84	84	83	83	76	65	82	63			
12.	.69	57	57	56	54	51	48	49	72	64	62		
13.	.86	59	59	57	50	49	49	50	78	80	64	79	
14.	.79	79	78	75	71	69	70	74	75	79	75	69	76
15.	.48	72	69	70	67	66	66	64	47	49	63	40	44
16.	.55	58	57	54	51	52	50	53	51	46	60	45	63
17.	.26	20	20	19	18	21	19	20	31	18	32	31	40
18.	.68	88	87	85	83	83	80	69	59	65	73	54	59
19.	.75	63	64	62	55	57	55	53	64	66	65	55	69
20.	.53	34	32	31	25	28	32	26	36	43	30	40	55
21.	.61	43	40	38	33	35	32	29	46	54	40	51	65
22.	.91	61	62	61	51	51	47	49	84	82	67	68	87
23.	.89	48	48	47	40	39	35	39	80	81	57	65	88
24.	.92	52	53	50	42	40	39	44	81	86	54	66	86
25.	.93	56	56	56	48	44	42	57	83	93	55	60	75
26.	.95	66	66	65	59	54	51	60	84	96	63	66	82
27.	.88	53	53	52	45	40	38	57	78	87	49	71	72
28.	.91	58	58	57	50	47	41	61	82	87	58	66	72
29.	.90	65	65	63	57	55	53	57	79	82	62	60	77
30.	.91	55	56	55	47	43	45	53	78	81	58	62	74
31.	.81	51	54	53	40	40	42	46	69	72	56	64	79
32.	.90	44	45	45	38	33	31	41	82	84	53	60	82
33.	.88	39	39	39	32	26	25	40	77	83	45	57	77
34.	.90	58	59	57	48	46	43	50	81	81	62	65	87
35.	.74	57	57	57	49	47	47	55	63	66	59	54	76
36.	.55	54	54	50	44	48	44	44	52	45	58	42	63
37.	.71	58	60	56	52	53	49	50	60	60	58	50	68
38.	.72	19	20	19	12	06	03	24	72	69	26	45	53
39.	.73	20	20	19	13	07	13	22	70	70	29	43	58
40.	.55	0	002	01	-03	-11	-12	02	43	54	10	34	50
41.	.75	28	29	28	22	15	12	34	67	77	29	45	56
42.	.57	13	15	16	07	02	01	28	43	58	10	34	37
43.	.63	09	17	15	11	04	-01	34	55	64	15	33	47
44.	.62	26	26	28	20	13	06	43	52	70	15	32	42
45.	.62	22	28	28	20	13	14	35	55	57	25	40	47
46.	.73	47	52	51	44	40	37	44	72	67	59	52	60
47.	.91	63	65	64	57	54	48	57	82	87	62	57	70
48.	.90	64	65	62	56	55	54	66	82	84	60	63	76
49.	.97	69	70	67	60	60	53	62	87	92	70	63	82
50.	.99	69	70	68	60	58	54	64	89	93	69	66	84
51.	.98	64	64	51	53	49	45	63	89	93	65	66	83
52.	.85	51	52	51	43	43	39	51	79	75	63	57	76

\* Statistically untrustworthy

Table 2 (continued)

	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27..
1.														
2.														
3.														
4.														
5.														
6.														
7.														
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.	54													
16.	53	74												
17.	23	25	53											
18.	69	78	64	14										
19.	67	56	69	42	66									
20.	42	30	41	20	42	47								
21.	50	28	47	31	45	46	81							
22.	71	38	54	31	56	74	47	58						
23.	64	34	54	31	49	69	51	65	91					
24.	65	35	51	24	51	69	53	64	90	96				
25.	73	32	36	18	49	63	43	49	83	86	90			
26.	79	39	43	21	60	68	47	57	87	86	89	95		
27.	68	28	29	10	50	57	45	49	75	76	84	91	87	
28.	69	35	39	13	58	66	46	50	75	76	82	87	87	94
29.	74	45	52	35	59	70	58	62	80	78	82	84	87	94
30.	69	35	42	18	57	70	54	56	78	81	85	88	86	87
31.	62	45	52	38	52	71	64	68	73	74	77	70	74	72
32.	66	25	42	28	43	64	45	53	85	89	90	91	90	85
33.	61	20	35	26	39	58	44	50	81	86	88	92	89	87
34.	70	39	58	39	56	73	49	57	86	85	85	82	87	77
35.	64	59	77	54	59	77	53	59	68	70	69	63	69	55
36.	52	66	91	51	59	76	44	43	57	57	54	39	44	29
37.	60	40	63	45	58	80	56	59	63	64	65	59	65	57
38.	41	-07	04	07	12	38	25	35	70	71	75	82	75	83
39.	42	-04	14	15	17	44	33	43	73	77	79	82	77	79
40.	31	-17	8	11	03	36	25	36	63	68	69	70	63	64
41.	42	09	18	06	22	43	30	36	70	74	82	86	79	84
42.	34	-12	-09	-07	12	34	21	20	52	53	61	72	64	76
43.	34	-03	06	08	11	25	23	22	55	58	65	76	68	76
44.	41	-02	-05	-09	21	26	32	40	48	54	63	75	71	82
45.	36	-0	08	09	18	38	32	31	40	55	64	68	62	75
46.	50	23	26	18	45	53	23	29	65	58	64	68	72	69
47.	65	38	39	12	58	66	46	50	80	75	80	86	90	85
48.	72	40	46	23	59	63	50	55	80	76	83	86	87	83
49.	76	45	50	23	64	72	47	56	90	85	87	87	93	84
50.	76	46	53	25	65	74	50	58	92	89	92	93	96	88
51.	73	45	48	19	62	68	58	68	89	89	91	94	95	88
52.	65	39	42	24	50	59	39	38	79	75	76	79	79	74

Table 2 (continued)

	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
1.													
2.													
3.													
4.													
5.													
6.													
7.													
8.													
9.													
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20.													
21.													
22.													
23.													
24.													
25.													
26.													
27.													
28.													
29.	83												
30.	90	86											
31.	76	81	85										
32.	87	84	89	77									
33.	88	83	89	75	98								
34.	82	91	84	82	91	87							
35.	64	81	71	78	70	66	84						
36.	39	58	46	56	46	38	63	77					
37.	64	72	64	67	60	55	72	74	72				
38.	75	61	73	55	81	84	64	32	08	38			
39.	73	62	75	59	84	88	68	41	17	42	95		
40.	55	49	61	46	74	79	56	31	13	32	87	90	
41.	80	66	74	58	82	86	66	40	18	38	91	90	81
42.	70	54	70	50	69	77	50	27	-04	28	83	78	79
43.	74	61	66	49	76	82	64	37	07	28	84	81	72
44.	77	57	68	54	71	75	57	32	-07	34	83	76	70
45.	70	60	72	65	70	74	60	39	11	39	77	73	67
46.	71	65	76	67	70	70	67	51	31	46	62	61	47
47.	88	84	84	74	82	82	81	63	39	60	70	69	50
48.	85	84	87	74	81	81	81	67	44	63	65	66	49
49.	86	86	84	74	84	81	85	67	50	67	68	68	51
50.	90	90	89	79	90	88	89	72	53	68	74	75	58
51.	89	88	91	81	89	89	89	71	49	62	73	74	60
52.	78	74	77	68	85	82	83	64	47	52	67	69	53

Table 2 (continued)

41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51.

|     |    |    |    |    |    |    |    |    |    |       |
|-----|----|----|----|----|----|----|----|----|----|-------|
| 1.  |    |    |    |    |    |    |    |    |    |       |
| 2.  |    |    |    |    |    |    |    |    |    |       |
| 3.  |    |    |    |    |    |    |    |    |    |       |
| 4.  |    |    |    |    |    |    |    |    |    |       |
| 5.  |    |    |    |    |    |    |    |    |    |       |
| 6.  |    |    |    |    |    |    |    |    |    |       |
| 7.  |    |    |    |    |    |    |    |    |    |       |
| 8.  |    |    |    |    |    |    |    |    |    |       |
| 9.  |    |    |    |    |    |    |    |    |    |       |
| 10. |    |    |    |    |    |    |    |    |    |       |
| 11. |    |    |    |    |    |    |    |    |    |       |
| 12. |    |    |    |    |    |    |    |    |    |       |
| 13. |    |    |    |    |    |    |    |    |    |       |
| 14. |    |    |    |    |    |    |    |    |    |       |
| 15. |    |    |    |    |    |    |    |    |    |       |
| 16. |    |    |    |    |    |    |    |    |    |       |
| 17. |    |    |    |    |    |    |    |    |    |       |
| 18. |    |    |    |    |    |    |    |    |    |       |
| 19. |    |    |    |    |    |    |    |    |    |       |
| 20. |    |    |    |    |    |    |    |    |    |       |
| 21. |    |    |    |    |    |    |    |    |    |       |
| 22. |    |    |    |    |    |    |    |    |    |       |
| 23. |    |    |    |    |    |    |    |    |    |       |
| 24. |    |    |    |    |    |    |    |    |    |       |
| 25. |    |    |    |    |    |    |    |    |    |       |
| 26. |    |    |    |    |    |    |    |    |    |       |
| 27. |    |    |    |    |    |    |    |    |    |       |
| 28. |    |    |    |    |    |    |    |    |    |       |
| 29. |    |    |    |    |    |    |    |    |    |       |
| 30. |    |    |    |    |    |    |    |    |    |       |
| 31. |    |    |    |    |    |    |    |    |    |       |
| 32. |    |    |    |    |    |    |    |    |    |       |
| 33. |    |    |    |    |    |    |    |    |    |       |
| 34. |    |    |    |    |    |    |    |    |    |       |
| 35. |    |    |    |    |    |    |    |    |    |       |
| 36. |    |    |    |    |    |    |    |    |    |       |
| 37. |    |    |    |    |    |    |    |    |    |       |
| 38. |    |    |    |    |    |    |    |    |    |       |
| 39. |    |    |    |    |    |    |    |    |    |       |
| 40. |    |    |    |    |    |    |    |    |    |       |
| 41. |    |    |    |    |    |    |    |    |    |       |
| 42. | 81 |    |    |    |    |    |    |    |    |       |
| 43. | 84 | 79 |    |    |    |    |    |    |    |       |
| 44. | 80 | 89 | 85 |    |    |    |    |    |    |       |
| 45. | 77 | 83 | 79 | 84 |    |    |    |    |    |       |
| 46. | 58 | 60 | 56 | 52 | 67 |    |    |    |    |       |
| 47. | 73 | 62 | 63 | 66 | 65 | 80 |    |    |    |       |
| 48. | 70 | 59 | 65 | 59 | 68 | 76 | 87 |    |    |       |
| 49. | 72 | 52 | 59 | 58 | 56 | 72 | 91 | 90 |    |       |
| 50. | 77 | 60 | 66 | 64 | 64 | 76 | 93 | 92 | 98 |       |
| 51. | 76 | 64 | 70 | 65 | 62 | 77 | 91 | 92 | 95 | 98    |
| 52. | 66 | 54 | 68 | 55 | 62 | 70 | 75 | 77 | 79 | 84 85 |

Table 3

Multiple regression equations for estimating segmental body volumes of 9-year-old children

| Criterion variable                                | Multiple regression equations  | Multiple R |
|---|--|------------|
| volume below the knees                            | $0.153(x_1) - 0.020(x_2) + 17.969$   | 0.738      |
|   | $0.052(x_{18}) + 0.143(x_{19}) - 0.035(x_{29}) + 0.233(x_{30}) + 0.036(x_{31}) - 0.081(x_{37}) + 0.783(x_{45}) + 0.047(x_{55}) - 53.418$   | 0.796      |
| volume below the groin                            | $0.468(x_1) - 0.023(x_2) - 19.639$   | 0.915      |
|   | $0.345(x_{18}) + 0.209(x_{26}) - 0.066(x_{27}) + 0.337(x_{28}) + 0.134(x_{29}) - 0.1099(x_{30}) - 0.222(x_{37}) + 0.153(x_{54}) - 216.639$ | 0.933      |
| volume below the umbilicus                        | $0.561(x_1) - 0.012(x_2) - 8.030$  | 0.902      |
|   | $0.090(x_5) - 0.108(x_{10}) + 0.079(x_{24}) + 0.042(x_{25}) + 0.164(x_{26}) + 0.098(x_{28}) + 0.551(x_{30}) - 0.018(x_{37}) - 237.607$     | 0.910      |
| volume below the breast nipples                   | $0.838(x_1) + 0.017(x_2) - 72.196$   | 0.966      |
|   | $0.086(x_4) + 0.345(x_{22}) + 0.018(x_{23}) - 0.098(x_{25}) + 0.318(x_{54}) + 0.389(x_{28}) + 0.202(x_{29}) - 0.181(x_{30}) - 427.979$     | 0.960      |
| volume below the supra-sternal point (with hands) | $1.023(x_1) - 0.041(x_2) - 1.455$  | 0.993      |
|   | $0.034(x_3) + 0.154(x_{10}) - 0.055(x_{11}) + 0.424(x_{22}) + 0.309(x_{26}) + 0.351(x_{28}) + 0.266(x_{32}) - 1.78(x_{40}) - 473.192$      | 0.987      |
| volume of the gross body                          | $1.079(x_1) - 0.067(x_2) - 58.023$   | 0.984      |
|   | $0.495(x_9) + 0.554(x_{10}) + 0.220(x_{22}) + 0.206(x_{26}) - 0.044(x_{28}) + 0.848(x_{30}) + 0.046(x_{33}) - 0.232(x_{39}) - 496.247$     | 0.978      |
| volume of the right hand                          | $0.0563(x_1) - 0.011(x_2) + 9.197$   | 0.856      |
|   | $0.031(x_{15}) - 0.142(x_{16}) - 0.025(x_{17}) + 0.069(x_{33}) + 0.096(x_{34}) - 0.091(x_{35}) + 0.037(x_{36}) + 0.025(x_{53}) - 23.568$   | 0.886      |