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PREFACE

With the current collection we commemorate with deep sadness a long-time member of our International Editorial Board, Professor Hubert Walter (14 April 1930 – 6 December 2008), and publish a list of articles that Estonian anthropologists have published in the journal *Anthropologischer Anzeiger* of which he was the editor.

A new member of our Editorial Board will be Professor Esther Rebato (Spain).

On 19 April 1939 the Anthropology Section of the Estonian Naturalists Society was founded by Juhan Aul. Jaan Kasmel analyzes the activities of the Section during its 70 years of existence.

Increasingly more attention is paid to the use of BMI in classification of body measurements. In the current collection the members of the Centre for Physical Anthropology compare the role of body height, weight and BMI in body build classification.

We thank all the authors for their valuable contribution to our collection and look forward to further cooperation with them.

Prof. Helje Kaarma

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Professor Hubert Walter making a presentation in the festive hall of the University of Tartu on 15 October 1997 at the conference dedicated to Prof. Juhan Aul's birth centenary.

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PROF. DR. RER. NAT. DR. MED H.C. HUBERT WALTER IN MEMORIAM
14 April 1930 – 6 December 2008

Professor Hubert Walter was a German scientist of international renown, long-time head of the Department of Human Biology at the University of Bremen (1974–1995), editor-in-chief (1977 – January 2008) of the journal *Anthropologischer Anzeiger* published by the international German publisher *Schwarzenbart*.

From 1999, when an international editorial board was established for the collection *Papers of Anthropology*, issued by the Centre of Physical Anthropology at the University of Tartu, Professor Hubert Walter was its member.

In 1997 an international anthropological conference was held in Tartu to mark the birth centenary of Professor Juhan Aul, the founder of Estonian anthropology. At its plenary session in the festive hall of the University of Tartu, Professor Hubert Walter made a major presentation on human blood groups. Professor Hubert Walter expressed extremely great interest in the work of Estonian anthropologists, and several professors of the University of Tartu and their doctoral students published their research papers in the journal *Anthropologischer Anzeiger*.

Anthropologischer Anzeiger was the first journal outside the former Soviet Union to publish Professor Helje Kaarma's bivariate SD classification of height and weight. Heino Kees, a researcher of Estonian records and original achievements, calls it the first and until now the only body build classification created by Estonian researchers.

A friend with a broad outlook and an understanding attitude is commemorated by the members of the international editorial board of the collection *Papers on Anthropology*, Centre for Physical Anthropology at the Faculty of Medicine of the University of Tartu, the Anthropology Section of the Estonian Naturalists' Society and all the authors whose papers have been published in *Anthropologischer Anzeiger*. *Sit tibi terra levis!*

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SEVENTY YEARS OF THE ANTHROPOLOGY SECTION OF THE ESTONIAN NATURALISTS' SOCIETY

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In April 70 years ago, the Anthropology Section was founded at the Estonian Naturalists' Society (established in 1853), which is the oldest functioning society of naturalists in Estonia and the Baltic countries.

As known from archive materials and literature, Juhal Aul (one of the founding members of the Anthropology Section) was the Chairman of the Section from 1939–1994, Leiu Heapost from 1996–2004 and Gudrun Veldre from 2005.

During J. Aul's remarkably long chairmanship (55 years and four months), the board of the Section included V. Üprus as deputy chair and S. Kreek as secretary (1939–1940); the records are missing for 1941–1957; from 1958–1959 the secretary was E.-M. Kirhäiding, from 1960–1962 A.-L. Tassa, and from 1963–1994 (for 32 years) L. Heapost.

Thereafter, in 1995, L. Heapost continued to head the Section as secretary, and during her chairmanship from 1996–2004 (for nine years), the secretary was G. Veldre.

In order to show clearly the roles of persons who participated in the activities of the Section during the seventy years, it is expedient to present the overview in two parts. The first part looks at the history of the Estonian Naturalists' Society and the emergence of its specialized structural units. A more detailed overview is given of the establishment of the Anthropology Section in 1939 and the preceding period of 1853–1939 considered from the viewpoint of anthropology. Thereafter, essential details from the reports of the Anthropology Section of 1939–1994 are given.

The second part provides excerpts from the annual reports of the Section from 1995–2009 and a summary of the activities of the Anthropology Section during its 70 years.

PART I

The Estonian Naturalists' Society, which has been operating for more than 156 years, was founded by ten staff members of the then Imperial University of Dorpat (now the University of Tartu) and the owner of Raadi manor C. E. von Liphardt as a branch of the Livonian Common Weal and Economic Society. It was known then under the name of the Tartu Naturalists' Society. The Naturalists' Society had been meant for conducting research in natural sciences in Livonia and the adjoining areas on the Baltic Sea, considering primarily the needs of agriculture.

After its first 15 years of activities, the Naturalists' Society seceded from the Common Weal Society and operated for some time on its own. From 1878 the Society was affiliated to the Imperial University of Dorpat/Yuryev and the University of Tartu, the Estonian Academy of Sciences, then to the University again, and from 1946 to the Academy of Sciences. Having operated meanwhile under the name of Naturalists' Society, from 1974 it bears the name of the Estonian Naturalists' Society.

From the very first meeting, lively activities began at the Society; it united naturalists from many specialities; the number of research areas increased and the activities of the Society spread outside Estonia.

The Naturalists' Society carried out its versatile activities as an integrated unit until the early 20th century. The further broadening of activities and thorough-going research brought about the diversification of the Society into specialized structural units. After extensive investigation of Estonian lakes in 1905, the first specialized section of the Society was founded, which was named the Lakes Commission. In the same year, two more commissions were established – the Library and the Accommodation Commissions – and in 1907 the Educational Commission.

After Estonia become independent, the Sections of Nature Conservation (1920), Ornithology (1921), Botany (1928), Geology (1931), Entomology (1937), Anthropology (1939), and Physics and Chemistry (1940) were founded. In 1930 the Tallinn branch of the Society and in 1937 the Cartography Commission were added. Many structural units were created after the last war [34, 37].

Throughout times, the Naturalists' Society has had 47 different structural units. Several of them have wound up their activities; some have merged with other units; some have been active from the time of their foundation to the present.

The Anthropology Section was created as the 12th subsidiary unit (in the order of their foundation) of the Estonian Naturalists' Society and as its sixth section.

The following is a brief account how this was achieved.

On 19 April 1939 seven members of the Naturalists' Society (H. Haberman, R. Indreko, E. Kumari, K. Pärna, A. Tõnurist, V. Üprus ja J. Aul) gathered on the initiative of J. Aul in order to establish the Anthropology Section [1].

J. Aul who presented a report to his fellow members drew their attention to the anthropological research in progress, the necessity for this kind of studies and the emergence of interest in this branch of science of national and international significance that had been in the doldrums until then.

The aim of the section to be created was to be promotion of anthropological research, capturing public interest in the subject and uniting people who worked in anthropology or its bordering areas [2].

Most probably, the participants in the meeting were aware that on 18 March of the previous year (1938) J. Aul had received the degree of Doctor of Natural Sciences with his dissertation *Anthropological Characteristics and Racial Affiliation of Estonians in West-Estonian Counties*. Before that, he had received the native scholarship of the University on anthropology.

Only recently, early in April, he had returned from an eight-month anthropological research trip to Poland, Germany and Switzerland, and taken up his everyday work as senior assistant at the Institute of Zoology where he had been working for the last ten years after graduation from the University of Tartu with a Master's degree in zoology [30].

If we ask when J. Aul had become a member of the Naturalists' Society, the answer is that he had joined the Society when a student of zoology, in February 1926 [38].

Next summer he already participated in a joint expedition of representatives of different sciences (together with E. Kant, K. Orviku and H. Mühlberg) to Sõrve peninsula in order to conduct anthropological, geomorphological and zoogeographical research. He was engaged in that work for two summers.

J. Aul published the main results of anthropological research of the inhabitants of Sõrve peninsula in 1929 as an article in the *Reports of the Naturalists' Society* [53].

This J. Aul's first paper on anthropology was briefly reviewed by the leading figure of Soviet anthropology Prof. V. Bunak, head of the Department of Anthropology at the University of Moscow, in issue 1/2 1930 of the journal *Russkij antropologicheskij zhurnal* [6].

Thus, the summer of 1927 marked the beginning for J. Aul's annual expeditions, which were mainly anthropological but also dealt with problems of zoology.

He received the necessary financial support for his fieldwork mostly from the Naturalists' Society but also from the University of Tartu and the Estonian Cultural Endowment [32].

Unfortunately, the analysis of Sõrve data showed that anthropological research of the population of such a small area did not yield any essential results when broader background material was missing. Therefore, a similar overview of the whole Saare County (the islands of Saaremaa and Muhu) and mainland Estonia would have been needed. J. Aul reached the understanding that pertinent research should have a much more extensive basis.

From that time onwards, the aim of Juhan Aul was the compilation of *Anthropologica estonica* that would embrace the whole territory of Estonia (Estonian men, women and schoolchildren). To achieve this aim, J. Aul measured in 1932–1936 more than 15,000 men of nearly the same age serving in the Estonian army; thus he received data on the anthropology of young men of the whole of Estonia. During his first expedition to Sõrve peninsula, he had also started anthropological research of Estonian women and schoolchildren and continued it during all those years along with measuring of men.

The amount of anthropological material collected at expeditions within 12 years had gradually increased, but as data processing was time-consuming at that time, it could be done only selectively, but even that enabled J. Aul to disseminate his research results in many presentations and publications [33].

All of this can also be seen in his activities at various events of the Naturalists' Society.

At the general meetings of the Naturalists' Society J. Aul managed to make seven presentations: data on the anthropology of inhabitants of

Sõrve peninsula (1929), Lamarck's life and work (1930), on the anthropological influence of the world war on the inhabitants of Saaremaa (1933), on objective classification of systematic quantitative characteristics and application of the respective method for assessment of the organism as a whole in the shape of individual curves (1934), on the anthropological composition of the population of Viljandi County (1935), an overview of the anthropological composition of the population of West Estonia (1936), on the anthropology of Estonian Swedes and their influence on Estonians (1937).

At research paper presentation meetings in the Tallinn branch of the Society J. Aul made four presentations: on the tasks of anthropology (1933), on racial types in Viljandi and Lääne Counties (1935, 1936), whether and to which extent Swedes have influenced Estonians anthropologically (1937).

At the Zoology Section he made three presentations: on native amphibians (1932), on an interesting find of bones in Estonia (1933), on Stone Age skulls at Lüganuse (a settlement in North-East Estonia) (1934).

From 1926–1939 J. Aul as an active member of the Naturalists' Society made a total of 17 presentations at the general meetings of the Society, in the Zoology Section and the Tallinn branch of the Society. Fifteen of his presentations concerned anthropology.

In the Reports of the Naturalists' Society (which was affiliated to the University of Tartu then) he also issued the following publications: on the anthropology of inhabitants of Muhu island (1932), on the anthropological influence of the World War on the inhabitants of Saaremaa island (1934) [39].

From 1933–1938 he also worked at the editorial office of the popular scientific journal *Eesti Loodus* (*Estonian Nature*) under three chief editors. In this journal, he published two articles and a brief announcement on zoology, three articles on anthropology: on the height of the Estonian man, on Estonians' weight, on slenderness and stockiness, a brief announcement on Estonians' hair colour and information about the 2nd International Congress of Anthropology and Ethnology in Copenhagen in 1937, a palaeoanthropological article on the finds of Neolithic human bones in Estonia. In addition, *Eesti Loodus* carried short summaries of J. Aul's articles published elsewhere (seven on anthropology and one on palaeoanthropology) [29].

In 1929, together with seven other members of the Society, he initiated the idea of the days of Estonian naturalists, in order to encourage naturalists to joint undertakings. During the two first Estonian naturalists' days (1931 and 1934) he was a member of the organizing committee and at three of them (the third in 1937) he made presentations on anthropology.

During the first days, he made a presentation in the Biology Section on the anthropology of the people of Muhu island; at the general meeting of the second days he spoke about Neolithic people in Estonia and during the third days of Estonian Naturalists' in Tallinn he made a presentation on Estonians' anthropology.

In the 1930s he was also engaged in anthropological research of Neolithic skeletons; thus, he became one of our first palaeoanthropologists.

From 1933, J. Aul as a member of the Society counselled those who were interested in amphibians and reptiles.

In 1935 he was elected a member of the London-based International Committee on Unification of Anthropological Technique.

The first public recognition *mag. zool.* J. Aul received for his anthropological research was a prize from Kreenbalt Ltd (500 kroons) in 1937 [39].

After a report by J. Aul, the participants in the founding meeting decided to lay the foundation to the Anthropology Section.

An application for founding the Section was presented to the board of the Society with signatures of all the participants in the meeting. On 27 April 1939, the 776th general meeting of the Naturalists' Society discussed the application and decided to grant it [1].

Thanks to J. Aul's long-term active efforts in the field of anthropology, the Naturalists' Society received its Anthropology Section. In addition to his everyday work as senior assistant at the Institute of Zoology at the University of Tartu, J. Aul had become an anthropologist and the founder of Estonian anthropology.

It is difficult to believe what J. Aul has written, "When entering the University (in 1921), I had heard nothing of anthropology..." [4].

Anthropology had become an independent branch of science by the mid-19th century [55]. Approximately at the same time, the Naturalists' Society was founded in Tartu (1853) [34]. Here we might ask what the

Society had done in the field of anthropology before the beginning of J. Aul's activities, i.e. in nearly three quarters of a century.

Prof. Prof. J. Piiper's research shows that during its first 75 years of operation the Naturalists' Society had arranged 656 meetings and 1309 papers had been presented, most of them had also been printed in the Society's publications. The themes of the presentations concerned zoology (390 presentations, 29.79% of the total), botany (181–13.82%), geology (102–7.79%), chemistry (81–6.18%), medicine (79–6.03%), geography (76–5.80%), geophysics (65–4.96%), physics (63–4.81%), hydrology (44–3.36%), astronomy (31–2.36%), pharmacy (20–1.52%), mathematics (15–1.14%), physiology (14–1.06%), anthropology (13–0.99%), and varia (134–10.23%) [52].

One of the presentations on anthropology (in 1874) was delivered by K. E. von Baer [35], one of the most versatile naturalists of the 19th century. Baer had studied in Tartu and in 1814 he defended here his doctoral thesis *On Estonians' Epidemic Diseases* [5], which gives a brief but good overview of Estonians' anthropological peculiarities. Having returned to Tartu, Baer became President of the Naturalists' Society for 1869–1876. His indirect influence on the development of anthropology in Tartu was considerably stronger than his direct influence. Having read Baer's works, Professor of Anatomy C. H. L. Stieda devoted himself entirely to anthropology [36]. Under his supervision, Doctor of Medicine degrees were defended on the anthropology of Estonians, Livonians, Latvians, Jews, Lithuanians and Ukrainians. Systematic anthropological research at the University began [54]. It was successfully continued by Prof. August Rauber and his two students, R. J. Weinberg and A. E. Landau, but was unfortunately interrupted before World War I [35].

The level the Society had reached in anthropology by 1928 provided the basis for the further activities of J. Aul, the son of a farmhand from Are commune in Pärnu County [30], who in that year completed his first anthropological expedition to Sõrve peninsula.

The Anthropology Section, which was founded at the Naturalists' Society on 27 April 1939, began its activities immediately, or, to be more correct, continued what J. Aul had been doing for the last 13 years. On 11 May1939, the Section held its first research paper presentation meeting as part of the general meeting of the Naturalists' Society. To attract wider interest in anthropology, J. Aul made the presentation *Observations and impressions about anthropological research and teaching of anthropology in some foreign countries*.

On the same day, J. Aul as the provisional chairman of the Section submitted an application to the board of the Naturalists' Society for getting 50 kroons of support to meet clerical expenses and to implement the initial plan of action. The money was immediately allocated.

On 11 May, at the general meeting of the Society, J. Aul was elected Chairman of the Anthropology Section. Now we can say that he headed the Section for more than 55 years, from 1939 to his departure from life in 1994.

On 24 May 1939 he applied for 150 kroons of support from the board of the Naturalists' Society for conducting anthropological research in the communes of Mäetaguse, Iisaku and Illuka. This time the board of the Society asked for an explanation about the amount of actual expenses, which the Chairman of the Section presented immediately. This application was also granted.

In June of the same year, the Section organized its first extensive anthropological expedition with J. Aul's participation – collection of anthropological material in three communes of Iisaku parish during four weeks.

As another undertaking, the Section began registration of scattered anthropo-osteological finds. The registration sheets included data on the age of each find, the place where it was found and where it was deposited, the state of preservation of the skeleton, its different bones and their measurements.

During its first year of activities, the Anthropology Section held another research paper presentation meeting where one paper was presented – J. Aul, *On the impact of age on anthropological characteristics*.

By the end of the year, the Section had 15 members [31, 39].

In 1940, the Section held one research paper presentation meeting where one paper was presented:

18 April – J. Aul, *On anthropological research in Iisaku parish*.

The board of the Section held three meetings.

In June, with financial support from the Society, the Section organized extensive collection of anthropological data at Audru and

Tõstamaa in Pärnu County (in the communes of Sauga, Audru and Seliste) during four weeks. The participants in the expedition were J. Aul and his assistants. Its report mentioned that, as in this region the Nordic race including ancient relict types was preserved, the respective material was of great value. The fieldwork of that year was successful beyond expectations but remained unfinished because of political events [3]. J. Aul published the summary of its results (on 84 pages) in Volume 65 of the *Yearbook of the Estonian Naturalists' Society* as late as in 1977 [8].

Registration of anthropo-osteological finds continued.

On 22 October J. Aul presented to the board of the Naturalists' Society the Section's budget for 1941, which amounted to 685 kroons (420 kroons for anthropological fieldwork, 40 kroons for bibliographing of literature, 25 kroons for clerical expenses, and 200 kroons for systematization of anthropological materials collected earlier.

The financial report of the Anthropology Section for 1940 shows that 175.45 kroons of support was received from the Society, which was spent on fieldwork and clerical expenses.

By the end of the year, the Section had 16 members [31].

In the first half of 1941, the Naturalists' Society continued its activities by arranging general meetings and research paper presentation meetings in its subsidiary units. On 9 April J. Aul was elected Treasurer of the Society.

The last general meeting of the Naturalists' Society before the war was held on 11 June 1941.

For that year, the Anthropology Section had received financial support from Tartu State University, but the fieldwork planned for the summer was cancelled as the war broke out on 22 June [31].

In 1942–1944 the Anthropology Section systematized the materials collected at Audru. The plentiful material made it possible to specify several general anthropological and theoretical questions – sexual dimorphism of some anthropological characteristics, age-related changes in them, etc.

During this period, the Section did not undertake any new activities.

Still, the Chairman of the Naturalists' Society had allocated 75 RM of financial support for the Anthropology Section [31].

In 1944–1946 the subsidiary units of the Naturalists' Society did not operate [37].

In December 1946, the Estonian Naturalists' Society resumed its activities. The Anthropology Section also expressed its wish to continue its work. J. Aul arranged an organizational meeting to resume the activities of the Section. On 27 February, J. Aul was confirmed as Chairman of the Section [2, 37].

On 20 February 1947 the Anthropology Section held its first research paper presentation meeting after the war [3].

In 1948 the Anthropology Section held one research paper presentation meeting as part of the general meeting of the Society – on 29 April J. Aul made a presentation on anthropological activities in the Soviet Union.

The board of the Section held two meetings that year.

No research work was organized [3, 37].

In 1949 the Section had planned to hold one research paper presentation meeting. It was considered impossible to conduct research.

The activities of the Anthropology Section were unfortunately interrupted for 1949–1955 [2, 37].

The report of the Naturalists' Society for 1956 shows that the Society included an Anthropology Section again. The meeting to resume the activities of the Section was held on 3 December when J. Aul spoke about the plans of anthropological activities initiated in that year [2, 37].

The report about the activities of the Anthropology Section in 1957 is missing [37].

In 1958 the Section held four research paper presentation meetings where four papers were presented:

19 March – J. Aul, *On the problems of the last stage of anthropogenesis.*

26 March – K. Mark, *On anthropological characteristics of Mordvinians.*

24 November – E.-M. Kirhäiding, *Impressions from an anthropological expedition to the Volga region.*

22 December – J. Aul, *On anthropological differences between rural and urban dwellers*; K. Mark, *On anthropological research in Central Asia.*

On 20 February, at the general meeting of the Estonian Naturalists' Society, J. Aul made the presentation *On the spread of some anthropological characteristics in the Estonian SSR.*

In cooperation with the Department of Zoology of the University of Tartu, anthropological data were collected in Estonia (E. Remm, V. Kadakas, M. Vare and E.-M. Kirhäiding in Põlva and Räpina districts) and outside it (E.-M. Kirhäiding on Mordvinians in Volga and Kama regions) [40].

In 1959 the Section held two research paper presentation meetings where four papers were presented:

20 April – E.-M. Kirhäiding, *On schoolchildren's physical development in Tartu and Elva districts*; A. Tassa, *On Tartu State University athletes' lung capacity and chest circumference.*

2 December – V. Timm, *On the anthropology of schoolchildren of the town of Tartu*;

J. Aul, *On a new method for differentiating between the Eastern and Western Baltic races.*

The Section contributed to the work of the Department of Zoology at Tartu State University at researching the anthropogenesis of the peoples of the Baltic countries.

Three members of the Section collected anthropological material in Pärnu town and district and at pioneer camps. V. Timm collected material on Udmurts and Maris in Volga and Kama regions [41].

In 1960 no research paper presentation meetings were held.

The Section contributed to the work of the Department of Zoology at Tartu State University at researching the anthropogenesis of the peoples of the Baltic countries. Anthropological data were collected in the town of Pärnu and additionally in Rapla district [42].

In 1961 the Section held three research paper presentation meetings where three papers were presented:

19 April – J. Aul, *On Estonian schoolchildren's physical development and the respective regularities.*

25 October – L. Heapost, *Some anthropological observances from the areas beyond the Volga River.*

14 November – K. Ramul, *On psychic differences between men and women.*

The Section contributed to the work of the Department of Zoology at Tartu State University at collecting anthropological materials in Harju district [43].

In 1962 the Section held three research paper presentation meetings where three papers were presented:

14 March – H. Kruuda, *On Estonian girls' development in the period of postmicrobarity.*

11 April – A.-L. Tassa, *On the development of Estonian school students' legs.*

17 November – L. Heapost, *On anthropological research in the summer of 1962.*

The Section contributed to the work of the Department of Zoology at Tartu State University at researching the anthropogenesis of the peoples of the Baltic countries. Anthropological data were collected near Keila and in Pärnu district. Active Member of the Society L. Heapost participated in an anthropological expedition organized by the Institute of History at the Estonian SSR Academy of Sciences to the area beyond the Volga River [44].

In 1963 the Section held two research paper presentation meetings where four papers were presented:

20 November – A. Virma, *On the formation of body height and weight in schoolchildren of the former Keila district*; J. Aul, *On the disparity of upper and lower extremities' development.*

6 December – V. Tõrv, *Some anthropological data of school students of the town of Pärnu*; J. Aul, *On the history of anthropological research in Estonia.*

L. Heapost systematized the materials collected during the anthropological expedition to the area beyond the Volga River in the previous year [45].

In 1964 the Section held three research paper presentation meetings where three papers were presented:

16 April – L. Heapost, *What is racism*?; J. Aul, *Some critical notes on the Baltic anthropological expedition.*

9 October – J. Aul, *Impressions from the 7th International Congress of Anthropology and Ethnography in Moscow.*

On 30 January, at the general meeting of the Estonian Naturalists' Society (jointly with the Society of Anatomists, Histologists and Embryologists of the Estonian SSR), J. Aul made the presentation *On Izhorians' and Votians' anthropology* [46].

In 1965 the Section held two research paper presentation meetings where three papers were presented:

22 October – K. Mark, *Impressions from the Finno-Ugric Congress in Helsinki*;

J. Aul, *Is Estonian women's weight too big?*

9 December – J. Aul, *Heredity and upbringing* [47].

In 1966 the Section held one research paper presentation meeting where two papers were presented:

9 December – J. Aul, *On blood groups*; L. Heapost, *New data on Estonians' blood groups.*

Active Member L. Heapost participated from 14 July to 22 August 1966 in an anthropological expedition to the Khanty-Mansi and Yamal-Nenets National Districts where she determined the blood groups of 300 Khants, Mansi and Komi [48].

In 1967 the Section held two research paper presentation meetings where three papers were presented:

4 October – J. Aul, *Who are more variable – men or women?*

22 November – K. Mark, *On the anthropological expedition to Finland*;

J. Aul, *Australopitheci and the descent of humans* [48].

In 1968 the Section held two research paper presentation meetings where three papers were presented:

23 February – J. Aul, *On the anthropology of Estonian Germans*; L. Heapost, *On the causes of acceleration in minors.*

13 December – K. Mark, *Impressions from the expedition to Finland.*

Active Member of the Society A. Horn and L. Horn conducted dermatoglyphic research in Hiiumaa (Kärdla and Käina) and in Haapsalu Secondary School No. 1.

L. Heapost completed the article *On school students' physical development in Rapla district* [49].

In 1969 the Section held one research paper presentation meeting where two papers were presented:

4 December – J. Aul, *Is Estonian school students' chest weakly developed?*; L. Heapost, *Some data on daltonism and sensitivity to the taste of phenylthiocarbamide in Estonians.*

A. Horn and L. Horn collected dermatoglyphic material in Kingissepa, Haapsalu, Pärnu and Viljandi districts [50].

In 1970 the Section held two research paper presentation meetings where two papers were presented:

14 May – A. Horn, *On Estonians' finger and palm patterns.*

11 December – E. Koemets, *On psychic differences between people.*

On 16 April, at the general meeting of the Estonian Naturalists' Society, J. Aul made the presentation *On Estonian women's anthropology.*

A. Horn systematized the finger and palm dermatoglyphic materials collected in the previous years [51].

In 1971 the Section held two research paper presentation meetings where two papers were presented:

19 May – L. Heapost, *On the spread of some anthropogenetic characteristics in Estonia*; J. Aul, *News from the USSR conference on age-related morphology, physiology and biochemistry.*

3 December – J. Aul, *On individual variability of anthropological characteristics in minors*; K. Mark, *On the anthropological characteristics of the Sami* [7].

In 1972 the Section held one research paper presentation meeting where two papers were presented:

23 November – J. Aul, *On the anthropological symposium in Moscow*; A. Horn, *On the density of papillary lines on Estonians' fingers*.

J. Aul completed the study *Anthropological data on Estonian school students' development, 1932–1940* [7].

In 1973 the Section held one research paper presentation meeting where one paper was presented:

29 March – J. Aul, *On Estonian women's body weight and obesity.*

On 20 December, at the general meeting of the Estonian Naturalists' Society dedicated to the memory of the former Chairman of the Society and its Honorary Member J. Piiper, J. Aul made the presentation *On J. Piiper's research and educational activities* [8].

In 1974 the Section held one research paper presentation meeting where two papers were presented:

14 November – J. Aul, *Thirty-five years of the Anthropology Section*; K. Mark, *On the origin of the Baltic-Finnic peoples from the viewpoint of anthropology* [8].

In 1975 the Section held two research paper presentation meetings where four papers were presented:

15 May – L. Heapost, *On the connections between school students' physical development and academic achievement*; G. Jagomägi, *Gender differences of lower extremities in athletes.*

21 November – K. Mark, *The 4th International Finno-Ugric Congress in Budapest*;

L. Heapost, *On the differences in urban and rural school students' physical development.*

The Section prepared for publication the manuscript of the consecutive volume of the *Yearbook of the Estonian Naturalists' Society*, which was consisted of articles on anthropological themes [9].

In 1976 the Section held one research paper presentation meeting where two papers were presented:

25 November – L. Heapost, *On blood groups of Finno-Ugric peoples*; J. Aul, *Sexual dimorphism in the treatment of anthropolgy.*

The Section filled with articles the consecutive volume of the *Yearbook of the Estonian Naturalists' Society* on the theme *Problems of Estonian anthropology* [10].

In 1977 the Section held two research paper presentation meetings where four papers were presented:

3 March – L. Heapost, *On the impact of some environmental and genetic factors on school students' physical development*; J. Aul, *On sexual dimorphism in human body proportions*.

17 November – L. Heapost, *On laterality of some anthropological characteristics*;

J. Aul, *Memories from the 2nd International Conference of Anthropology and Ethnography*.

Anthropological research continued. The 65th volume of the *Yearbook of the Estonian Naturalists' Society*, prepared by the Anthropology Section and entitled *Problems of Anthropology in Estonia* was published [11].

In 1978 the Section held two research paper presentation meetings where four papers were presented:

30 March – K. Mark, *On the joint Soviet–Finnish anthropological expedition*; J. Aul, *On the sexual dimorphism index*.

30 November – A. Mikelsaar, *Dimorphism of chromosomes*; L. Heapost, *On the anthropological expedition in Estonia in 1978* [12].

In 1979 the Section held one research paper presentation meeting where two papers were presented:

11 October – H. Kaarma, *On the system of mutual relations between anthropological characteristics*; J. Aul, *The centenary of an anthropological theory*.

Ample material on school students' physical development was collected [13].

In 1980 the Section held one research paper presentation meeting where two papers were presented:

L. Heapost, *Data on Estonians' blood groups*; J. Aul – *Acceleration of Estonian school students*.

The Board of the Section, in cooperation with the Department of Obstetrics and Gynaecology of Tartu State University organized a joint conference of anthropologists and physicians on 25–26 September with the participation of 80 people [14].

In 1981 the Section held two research paper presentation meetings where four papers were presented:

12 March – K. Mark, *On the 5th Finno-Ugric Congress and the anthropology of the Sami*; L. Heapost, *On the distribution of blood groups in Estonia.*

26 November – J. Aul, *On the significance and tasks of present-day anthropology*; L. Heapost, H. Kaarma, V. Kask, *Impressions from the 2nd conference of Soviet anthropologists in Minsk.*

Systematization of anthropometric materials continued. Cooperation was developed with the Anthropology Section of the Society of Estonian Anatomists, Histologists and Embryologists. In the following years, the number and content of presentations made at the meetings changed to some extent [15].

In 1982 the Section held one research paper presentation meeting where two papers were presented:

1 April – G. Sarap, *Anthropological odontology*; J. Aul, *On assessment of body weight* [16].

In 1983 the Section held two research paper presentation meetings where three papers were presented:

28 March – J. Aul, *On temporal increase of body measurements (acceleration)*; L. A. Aleksina (Leningrad, now St. Petersburg), *On anthropological peculiarities of human tubular bones ossification.*

15 December – J. Aul, *The object, content and tasks of anthropology* [17].

In 1984 the Section held two research paper presentation meetings where four papers were presented:

24 May – E. Loone, *Anthropology and sociology*; J. Aul, *Anthropology and the school reform.*

18 October – G. Jagomägi, *Impressions from the USSR conference of functional morphology in Novorossiysk*; P. Tulviste, *Psychology and cultural anthropology* [18].

In 1985 the Section held two research paper presentation meetings where two papers were presented:

21 March – J. Aul, *On temporal increase of human body dimensions.*

17 October – J. Aul, *On the activities of the Anthropology Section in recent years.*

The section developed cooperation with the anthropologists of the Estonian Association of Anatomists, Histologists and Embryologists.

The Section broadened its activities by recruiting new members [19].

In 1986 the Section held two research paper presentation meetings where four papers were presented:

30 April – G. Jagomägi, *A new method for measuring body density*; M. Saag, *On the relationship between dental diseases and anthropological characteristics.*

4 December – J. Aul, *On the relationship between body height and weight*;

M. Thetloff, *Body height structure of Estonian school students* [20].

In 1987 the Section held one research paper presentation meeting where two papers were presented:

8 October – J. Aul, *On updating anthropometric knowledge and measuring techniques in Germany, Poland and Switzerland*; L. Heapost, *Additional data on research of blood groups* [21].

In 1988 the Section held three research paper presentation meetings where six papers were presented (in cooperation with the anthropologists of the Estonian Association of Anatomists, Histologists and Embryologists):

19 May – H. Tapfer, *On the relationship of angioarchitectonics of the kidney with the parameters characterizing the external and internal structure of the organ*; *I. Kolts, Problems of macromorphometry of the lung.*

13 November – M. Ulbrichova (Czechoslovakia), *On the relationship of athletes' body composition structure with their motor abilities*;

M. Prokopec (Czechoslovakia), *On the history of anthropological studies in Czechoslovakia.*

17 November – P. Tulviste, K. Toim, *On the possibilities of cooperation between psychology and anthropology*; E. Lepp, *Impressions from the USSR conference in Tyumen.*

On 4–5 October a conference was held in Tallinn: *Contributions of present-day anthropology to medicine and national economy.*

L. Heapost's article *Anthropological treatment of the distribution of isoserological characteristics in Estonia* was published in Issue 816 of Transactions of Tartu State University (*Труды по антропологии IV*), which was dedicated to J. Aul's 90th birthday [22].

In 1989 the Section held four research paper presentation meetings where three papers were presented and one discussion held:

11 May – M. Thetloff, *Structure of clothes sizes of Estonian preschool children and adolescents (aged 15–19 years)*; H. Kaarma, *Impressions from the USSR Conference of Anthropology in Vinnitsa.*

12 September – L. Saluste, *Impressions from the 3rd European Congress of Anthropology in Czechoslovakia.*

On 15 October a festive meeting was held to celebrate J. Aul's birthday. A discussion was held on trends of anthropological research in Estonia and potentials of cooperation with foreign anthropologists within the European Anthropological Association.

On 9–10 June a seminar of the coordination bureau of anthropologists of the Baltic republics and Belarus was held. Six research papers were presented; a Belarusian educational film on anthropology and ethnography was viewed.

A series of lectures on anthropology was delivered at the University of Tartu.

Members of the Anthropology Section G. Veldre, M. Thetloff, L. Saluste and L. Heapost participated in anthropological congresses and symposiums abroad and made presentations there [23].

In 1990 the Section held two research paper presentation meetings where five papers were presented:

29 March – L. Heapost, *An overview of the Nordic countries' Anthropological Conference in Lund*; M. Thetloff, *On the results of anthropometric measuring of Estonian schoolchildren in 1985–1989.*

5 December – N. Polina (Minsk), *On systematization of pre-school children's body measurements*; H. Kaarma, *On the development prospects of anthropology in 1991;* L. Heapost, *Impressions from the founding meeting of a new society – the Nordic Association for Nutrition in Anthropology (NANA).*

In cooperation with the anthropology section of the Estonian Association of Anatomists, Histologists and Embryologists, two lectures on anthropology were arranged:

L. Kontša (Moscow), *Ergonomic anthropology today and tomorrow*; L. Tegako (Minsk), *Development and prospects of dermatoglyphics at present.*

On 8–9 June a seminar of anthropologists from the Baltic republics and Belarus was held at Kääriku where eight papers were presented.

Section members H. Kaarma, M. Thetloff, G. Veldre, L. Saluste and L. Heapost made presentations at several conferences outside Estonia (in Grodno, Tyumen, Lund, Debrecen).

In 1990 the Anthropology Section of the Estonian Naturalists' Society presented a project for creating an anthropology laboratory at the University of Tartu; the proposal was approved by the University Council.

Members of the Section participated in the compilation of the collection Papers on Anthropology V (Transactions of the University of Tartu, Issue 951) [24].

In 1991 the Section held five research paper presentation meetings.

On 9 and 10 June the coordination bureau of Estonian, Latvian, Lithuanian and Belarusian anthropologists held a meeting at Kääriku with 20 participants.

Section members participated at two USSR conferences (in Tomsk and Minsk) and made presentations there [25].

In 1992 the Section held one research paper presentation meeting.

From that year onwards, J. Aul's birthday has been celebrated in October each year.

The Section held ten information meetings in total.

On 9–10 June the consecutive meeting of anthropologists of the Baltic republics and Belarus was held at Kääriku.

The collection *Papers on Anthropology V* (Transactions of the University of Tartu, Issue 951), dedicated to Prof. J. Aul's 95th birthday, was published [26].

On 14 October 1993 the members of the Anthropology Section filled with presentations the general meeting of the Estonian Naturalists' Society, which was dedicated to J. Aul's 96th birthday. H. Kaarma, L. Saluste, M. Thetloff, G. Veldre, K. Kalling and L. Heapost made presentations on the theme *Topical problems of anthropology in the Republic of Estonia*.

The Section continued arranging information meetings.

On 7–11 June the international conference *Somatotypes of Children* was arranged in cooperation with the University of Tartu. The conference abstracts were published in print.

Methodological instructions *The anthropological method in obstetrics* was published [27].

In 1994 the Anthropology Section of the Estonian Naturalists' Society worked in cooperation with the anthropology section of the Estonian Association of Anatomists, Histologists and Embryologists, and the Centre for Physical Anthropology (founded in 1993) of the University of Tartu.

On 19 October the Section filled with presentations the general meeting of the Estonian Naturalists' Society, which was dedicated to J. Aul's 97th birth anniversary. Presentations were made by L. Heapost, *On the anthropology of South-East Estonians of the 13th–17th centuries*, G. Veldre, *Finding segmental body volumes of 8–9-year-old Tartu schoolchildren from their anthropometric measurements*, M. Thetloff, *Modelling of the dynamics of structure of correlations between anthropometric variables*.

International conference *Somatotypes of Children II* was arranged.

Section members participated in the international conference *Horizons of Anthropology* in Moscow where two presentations were made: L. Heapost, *Anthropology of South-East Estonian population (XIII–XVII cc)* and G. Veldre, *Measuring total and segmental volumes in Estonian 8–9-year-old children*. H. Kaarma presented the abstract *Complete statistical characteristics of the young Estonian female constitution*.

At the 9th Congress of the European Anthropological Association in Copenhagen, H. Kaarma, L. Saluste, G. Veldre, V. Loolaid, M. Thetloff and K. Kuivjõgi presented the abstract *Systematization of anthropometrical data for comparative statistical estimation of women's nutritional state.*

A seminar on anthropometry was arranged in cooperation with the Centre for Physical Anthropology at the University of Tartu on the theme *Anthropological research of the head and the skull*; refresher courses were arranged for school physicians and nurses on the theme *Anthropological research of schoolchildren* [28].

We have completed the presentation of excerpts from the annual reports of the Anthropology Section from 1939–1994. The second part will provide an overview of the work of the Anthropology Section from 1995–2004 and a summary of its activities during the 70 years.

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COMPOSITION OF THE URBAN POPULATION OF PÄRNU IN THE 16TH–18TH CENTURIES

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ABSTRACT

The anthropological material used for craniometric analysis comes from the cemetery of the St. John's church in Pärnu, which was established at the turn of the 16th/17th centuries. It is well known from the history of the cemetery of the St. John's church in Pärnu that the ethnic composition of the people buried there was varied. The idea of the research was to find out if the multifarious composition of the community is also expressed in the osteological material. For this purpose the comparative analysis of the craniometrical features of the Pärnu osteological sample was carried out. The results of the craniological study indicated the varied origin of the community which used the cemetery. The data are in good correlation with the historical ones.

Key words: population history, craniometry, biological distances

INTRODUCTION

We know but little about the history of the formation of the medieval and post-medieval urban population in Estonia although research of the ethnic composition of the urban population of Tartu and Viljandi was carried out on the basis of osteological material [7]. Because of the lack of material no craniological investigation concerning medieval and post-medieval Pärnu has been carried out until now. The present article is the first review of the ethnic formation of the urban population of Pärnu in the 16th–18th centuries, based on the osteological material recovered from the cemetery of the St. John's church in Pärnu.

MATERIAL AND METHODS

The anthropological material used for craniometric analysis comes from the cemetery of the St. John's church in Pärnu which was established at the turn of the 16th/17th centuries. At the beginning the members of the Lutheran congregation were buried there. Since 1617, it also became the burial place for the soldiers of the Pärnu garrison and the members of their families. It is known that besides Estonians Finns and Swedes also belonged to the soldiers. In 1714 the cemetery was handed over to be used by the Russian garrison only; in 1750 the cemetery was already abandoned. The sex of the buried was determined by generally accepted standards [5, 20]. The Age at death of the individuals was determined on the basis of the chronology of the closure of ectocranial sutures [15]. Besides the closure of ectocranial sutures, the age related changes on the surface of pubic symphysis [3, 18] and the degree of tooth wear [4, 21] were estimated. Skulls were measured according to generally accepted methods [13]. Twenty-three measurements of each skull were taken, if possible, and on their basis a classic description of cranial series was composed and comparative analysis performed. For statistical analysis, the method of cluster analysis with average distances and the Euclidian distance was used, and statistically material differences were determined by the t-test. The statistical analysis of the data was performed with the program-package SPSS 11.5.0.

RESULTS AND DISCUSSION

Craniometry and biological distances as a method for the description of the formation of the population

Craniometric, or measurable features of skull have been used to estimate the biological similarity/divergence of different skeletal populations for over a hundred years. Craniometry has also played an important role in the study of the ethnogenesis of Estonians and the formation of the anthropological types [10, 11, 12, 26]. In recent decades research has been carried out to establish whether the biological distances of populations actually can be estimated on the basis of craniometric features. For this purpose the parallel investigations of genetic markers and metric features of skull have been carried out, establishing that it is really possible to estimate distances (similarities, differences) of populations only on the basis of the metric features of skulls [17, 19]. The correlation of craniometric traits with historic and linguistic ones has also been studied, as well as the possibilities of estimating biological distances of populations on their basis, and it was established that the distances of populations appear practically identically on the basis of craniometric features, as well as on the basis of the other above-mentioned data, which means that the craniometric features of a population display its origin and formation [16]. Thus various investigations prove that craniometric features are potentially valuable for estimating the biological distances of populations [14].

Classical description of the cranial series on the basis of the average of metric traits

The male skulls of Pärnu are characterised by medium length (F1) and very large breadth (F8). The length (F1) and the breadth (F8) of female braincase are large. According to the cranial index (F8/F1*100) both male and female skulls are brachycranic, or round-headed (Table. 1, 2).

The basi-bregmatic height of braincase (F17) in women is large or even very large, for men it is also above medium. The length of the basal part of braincase (F5) in men is medium and in women large. Facial length (F40) is medium both in men and women. The smallest breadth of forehead (F9) in women is medium and the largest (F10) is above medium (large). The breadths of forehead (F9 and F10) in men are very large. Facial bizygomatic breadth (F45) in the Pärnu men is medium and in women it is large. Hence, we may say that both men and women have relatively high and broad faces. Other facial breadth measurements (F43, F46) are also above medium, both in men and women. Nasal height (F55) in men is medium, in women rather large. Nasal breadth (F54) is medium, both in men and women. Orbital breadth (F51) is large in men and medium in women.

Orbital height (F52) is small in men, medium in women. Bicondylar breadth (F65) is medium both in men and women, bigonial breadth (F66) is large in men and medium in women. The height of mandibular body (F69.1) is large both in men and women, thickness of mandibular body (F69.3) is medium in men and small in women. The length of maxillary alveolar arc (F60) is medium in men, large in women. The breadth of maxillary alveolar arc (F61) is medium both in men and women. To sum up, we can say that the 16th–18th-century cranial series from Pärnu is characterised as brachycranic or round-headed (F8/F1≥80), medium to large length and breadth measurements of braincase, high braincase, broad and high facial part of cranium, which is mesenic by the index (F48/F45), and the large height of mandibular body.

Table 1. Metric features of the cranial series of the 16th–18th-century women of Pärnu

Feature	F1	F8	F17	F8/F1	F5	F9	F10	F40
N	8	8	8		7	9	7	7
Average	179.1	144.1	135.1	80.5	99.6	96.8	122.9	97.1
STD	7.7	4.8	7.0		3.8	3.8	4.2	5.5
Minimum	167.0	139.0	122.0		95.0	92.0	117.0	90.0
Maximum	187.0	151.0	142.0		105.0	102.0	130.0	105.0
Feature	F45	F48/F45	F48	F43	F46	F55	F54	F50
N	7		8	7	7	8	2	4
Average	130.6	54.6	71.3	104.4	95.3	50.8	24.0	19.3
STD	7.7		5.3	4.6	4.5	3.4	1.4	3.8
Minimum	118.0		65.0	99.0	91.0	45.0	23.0	14.0
Maximum	140.0		79.0	110.0	102.0	56.0	25.0	23.0
Feature	F51	F52	F65	F66	F691	F693	F60	F61
N	4	4	3	2	3	3	3	3
Average	40.5	32.8	113.7	90.5	30.3	10.7	55.0	60.7
STD	2.5	2.1	11.1	9.2	7.0	1.5	2.6	1.5
Minimum	37.0	30.0	102.0	84.0	23.0	9.0	52.0	59.0
Maximum	43.0	35.0	124.0	97.0	37.0	12.0	57.0	62.0

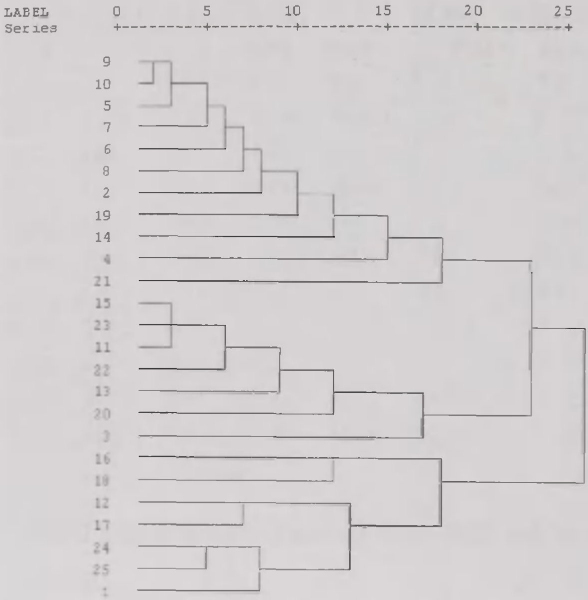
Table 2. Metric features of the cranial series of the 16^{th}–18^{th}-century men of Pärnu

Feature	F1	F8	F17	F8/F1	F5	F9	F10	F40
N	13	13	12		12	14	14	11
Average	180.3	147.2	138.8	81.6	102.3	100.1	124.6	99.2
STD	4.9	3.8	5.4		3.2	3.0	3.7	3.5
Minimum	174.0	140.0	126.0		95.0	96.0	116.0	95.0
Maximum	191.0	153.0	145.0		107.0	104.0	130.0	105.0
Feature	F45	F48	F48/F45	F43	F46	F55	F54	F50
N	11	13		14	14	14	13	14
Average	134.4	73.5	54.7	106.4	95.8	51.2	26.4	22.0
STD	5.0	3.1		3.3	4.1	2.8	3.0	2.6
Minimum	127.0	70.0		100.0	90.0	46.0	23.0	17.0
Maximum	146.0	79.0		112.0	106.0	56.0	35.0	26.0
Feature	F51	F52	F65	F66	F691	F693	F60	F61
N	14	14	8	6	13	13	12	12
Average	43.1	32.7	119.3	105.2	35.0	11.6	54.3	61.4
STD	1.9	1.8	5.1	8.0	2.5	1.8	2.7	4.3
Minimum	41.0	29.0	111.0	92.0	31.0	9.0	52.0	54.0
Maximum	47.0	36.0	126.0	114.0	39.0	14.0	59.0	69.0

Comparative analysis of the 16th–18th-century cranial series from Pärnu

The female and male cranial series from Pärnu were compared with various cranial series from Estonia, Latvia and Russia [1, 6, 7, 10–12, 22–26] by the method of cluster analysis. The following craniometric features were used in comparative analysis: maximum cranial length (F1), maximum cranial breadth (F8), basi-bregmatic cranial height (F17), bizygomatic facial breadth (F45), upper facial height (F48), nasal height (F55), nasal breadth (F54), orbital breadth (F51) and orbital height (F52). The chosen method of cluster analysis (the Euclidian distance, the method of average distances) expresses average distances of objects as the human eye can visually distinguish them. The aim of grouping the series was to find analogues to the Pärnu cranial series from the neighbouring areas, not to classify previously published craniometric data.

In the dendrogram of the cluster analysis (Fig. 1) we can see that the nearest to the male series from Pärnu are the series from Karelia (Suistamo 1, Kurkijoki), similar features can also be observed in the series of the 18th-century Purgaili (Latvia) and Odessa. The main common features of these series are a relatively short, but there is high and broad braincase and a relatively high facial part of the skull. The cluster analysis does not reveal similarities with Estonian and most of

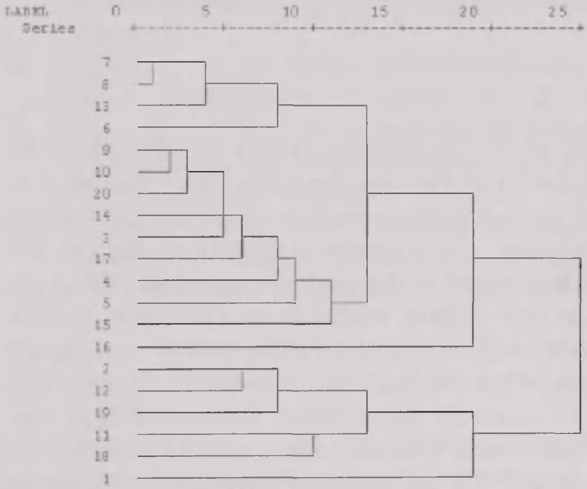


Comparative series (Mark 1956a[10], Mark 156b[26], Mark 1962[11], Mark 1965[12], Aleksejev 1969[22], Aleksejeva 1973[23], Denisova 1977[24], Chartanovich, Tsistov 1984[25], Heapost 1993[6], Khartanovich 1993[8], Kalling 1995[7], Allmäe 1996[1]): 1- Pärnu 16-18, 2- Viljandi 16-18, 3- Tartu 17-18, 4- Tartu 13-14, 5- Tääksi 14-18, 6- Kaberla 15-17, 7- Iisaku 17-18, 8- Kohtla-Järve 17-18, 9- Otepää 14, 10- Jõuga 12-14, 11- Leimani 17-18, , 12- Purgaili 18, 13- Tervete 16-17, 14- Saldus 16-17, 15- Martinsala 14-17, 16- Byelorussians, 17- Odessa, 18- Old Ladoga 17-18, 19- Izhorians, 20- Laskovitsa 11-14, 21- Begunitsa 11-14, 22- Selpils 16-17, 23-Üksküla- 14-15, 24- Suistamo I, 25- Kurkijoki.

Fig. 1. Comparison of the 16^{th}–18^{th}-century male cranial series from Pärnu by the method of cluster analysis

Latvian late medieval series, i.e. definite analogues for the Pärnu series cannot be found from the nearby territories. This result is not surprising, since the graveyard was used by soldiers of different nationalities and their families. Besides Estonians, Finns, Russians, Swedes could have also been buried there, but the ethnic composition of the garrison was even more diverse.

It was more complicated to find analogues to the female cranial series from Pärnu, since mostly male craniometric data are published; the publication of female data is considerably less frequent. The female cranial series from Pärnu joins on a high level (Fig. 2), revealing only few common features, with massive Estonian and Latvian series (Upland, Tervete, Selpils, Makita) and the series from the Izhorian



Comparative series (Mark 1956a [10], Mark 156b [26], Mark 1962 [11], Mark 1965 [12], Aleksejev 1969 [22], Aleksejeva 1973 [23], Denisova 1977 [24], Chartanovich, Tsistov 1984 [25], Heapost 1993 [6], Khartanovich 1993 [8], Allmäe 1996 [1]):

1- Pärnu 16-18, 2- Makita 15-17, 3- Tääksi 14-18, 4- Iisaku 17-18, 5- Kaberla 15-17, 6- Otepää 14, 7- Jõuga 11-1, 8- Leimani 17-18, 9- Purgaili 18, 10- Martinsala 14-17, 11- Upland 13-14, 12- Tervete 16-17, 13- Izhorians, 14- Odessa, 15- Old Ladoga 17-18, 16- Byelorussians, 17- Laskovitsa 11-14, 18- Begunitsa 11-14, 19- Selpils 16-17, 20- Ükskiila 14-15.

Fig. 2. Comparison of the 16^{th}–18^{th}-century female cranial series from Pärnu by the method of cluster analysis

Plateau (Begunitsa 11th–14th cc.). It is noteworthy that the elements of the burial customs and artefacts found in Makita 15th-17th cc. cemetery indicated the Votian origin [9]. Hence we may say that the ethnic composition of the buried women was even more diverse, compared with men. It must be mentioned that the female cranial series was relatively small (Table 2), which also may have influenced the results of the analysis.

We may conclude on the basis of the typology of the 16th–18th-century cranial series that the Pärnu sample belongs to the brachycranic type with high braincase and high and broad face, spread in the 16th–18th centuries in the North-Eastern part of Eastern Europe. Different authors have described such a cranial type in Eastern Latvia [24], but it also occurs among Karelians, Izhorians, Votians and Russians [8, 22, 23].

CONCLUSIONS

The ethnic composition of the community, which was buried in the cemetery of St. John's church of Pärnu in the 16th–18th centuries, was varied. The analysis of craniological as well as odontological features suggests a mixed population which consisted of anthropological and odontological types widely spread in the North-Eastern part of Europe, but it was impossible to find definite analogues to them from Estonia and still less from Pärnumaa [2]. The craniological type of men, buried in the cemetery of St. John's church of Pärnu, most of all resembles Karelians (Suistamo 1, Kurkijoki), the common features being a relatively short but a high and broad braincase and a relatively high facial part of the skull. For female cranial series an analogue could not be found, some similar features with Latvian massive series (Upland, Tervete, Selpils) could be observed, but some features also resemble the series from the Izhorian Plateau (Begunitsa) and Tartumaa (Makita). Most likely we have here a mixture of several anthropological types spread in North-Eastern Europe.

ACKNOWLEDGMENTS

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THE ENDOMETRIUM OF INFERTILE WOMEN: A MORPHOLOGICAL STUDY

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ABSTRACT

Tubal factor infertility (TFI) stems from the tubal damage or occlusion and is the most frequent cause of infertility in females. In this study we investigated the changes in the structure of endometrium and the expression of β_3 integrin of infertile women with TFI. Endometrial biopsies from five women in the reproductive age with normal menstrual cycles were taken in Nova Vita Clinic (Tallinn, Estonia). Subsequently biopsies were subdivided for light microscopy (LM), transmission electron microscopy (TEM) and scanning electron microscopy (SEM) investigations. LM studies showed normal the structure of the endometrial columnar epithelium and in the biopsies of two patients the spiral arteries were seen. The grade of maturity of the endometrial glands was low, not matching with the days of the cycle estimated by the patients. Integrin β_3 was highly expression only in the endometrial epithelium of one patient, in the biopsies of all other patients the expressed was low reflecting possible problems for the implantation of an embryo. The TEM study showed an electron dense membrane covering the cilia of endometrial epithelial cells of two patients. This indicates the altered protein content of the membrane, which requires additional investigations. Endometrial epithelium has an extremely important role in the implantation of an embryo and changes in the structure of the cilia of the surface epithelium may be one of the factors affecting this process. For the interaction between the endometrium and embryo special membrane projections or the pinopodes of the epithelial cells are considered essential. In our SEM study the pinopodes where found in the samples of two patients.

In conclusion, in the endometrium of TFI patients we found the delay in the development of the secretory phase, altered the structure of the ciliated epithelial cells, low integrin β_3 expression in the luminal epithelium and a small number of pinopodes on epithelial cells, which taken together may be responsible for the non-receptivity of the endometrium.

Key words: endometrium, infertility, morphology, integrin β_3, immunohistochemistry, pinopodes

INTRODUCTION

Infertility is defined as the lack of conception after an arbitrary period of 12 months without using any contraception. Approximately 10% of couples suffer from infertility all over the world [14, 16]. Both, females' and males' medical problems may lead to the couples infertility [13]. Infertility is a serious medical problem having its profound negative mental and social health consequences [2]. Despite of numerous improvements, the pregnancy outcome of infertility treatment has remained relatively poor, with only a third of women getting pregnant post treatment. Female infertility per se and the poor pregnancy outcome of assisted reproduction treatments can both be assigned to the abnormalities of the endometrial function [15]. Endometrial receptivity is the indispensable prerequisite to subtle molecular dialogue between the developing embryo and endometrium leading to implantation and pregnancy. Endometrial maturation is a complex physiological process where tissue remodelling results in a permissive environment for semiallogenic embryo invasion [3]. Endometrium goes through proliferative, secretory and menstrual phases during the spontaneous menstrual cycle, controlled by different endo-, para- and autocrine factors. Tubal factor infertility (TFI) stems from the tubal damage or occlusion and is the most frequent cause of infertility in females. TFI is a long-term consequence of the pelvic inflammatory disease, which is most commonly caused by the infection of *Chlamydia trachomatis* – genital chlamydiosis. About 70–80% of chlamydial infections in women occur asymptomatically increasing the chance of the infection to persist and to damage the normal tubal structure [12]. The infertility of TFI patients is often treated with the assisted reproduction treatment – *in* *vitro* fertilization (IVF). During IVF, oocytes are fertilized *in vitro*, embryos are incubated 2–4 days and 1–3 of them are transferred into uterus. In Nordic countries, there has been a decline in the prevalence of TFI as the indication for the infertility treatment over the past ten years and accounts for no more than 10% of the infertility cause among IVF patients today [13]. However, the proportion of TFI in IVF treatment is about 4 times higher in Estonia [5], being probably caused by the high incidence of sexually transmitted diseases here. Approximately 30% of women become pregnant after the IVF treatment. Surprisingly, the success rate of TFI patients is similar to other patients subjected to IVF, but the presence of the severe tubal disease may substantially reduce the pregnancy rate or increase the risk for spontaneous abortion in IVF [1].

The fact that embryo induces through the interleukin 1 (IL-1) mediated pathway the expression of β_3 subunit of $\alpha_v\beta_3$ integrin in endometrium further supports the importance of subtle molecular dialogue between embryo and endometrium. The significance of endometrial $\alpha_v\beta_3$ integrin in the implantation has also been demonstrated in the studies showing impaired $\alpha_v\beta_3$ expression in unexplained female infertility [6] and in luteal phase deficiencies. Furthermore, the extent of endometrial integrin $\alpha_v\beta_3$ expression is in positive correlation with the IVF-ET outcome [15].

The importance of the molecular dialogue between embryo and endometrium at the time of implantation is also supported by the appearance of pinopodes, large and smooth projections of the apical membranes of the epithelial cells lining uterine cavity. The development of pinopodes is progesterone dependent and at least in rhodents coincides strictly with the implantation window. In the human endometrium data on the presence of pinopodes is controversial as they seem do exceed the implantation window [10].

The aim of the present study was to investigate the changes in the endometrium of TFI patients and in particular to determine the expression of β_3 integrins and presents of pinopodes in the endometrial epithelial cells.

MATERIAL AND METHODS

The biopsies of endometrium of five patients in the reproductive age with a normal menstrual cycle were investigated. The biopsies were taken in the Nova Vita Clinic (Tallinn, Estonia) under anaesthesia on the postovulatory days 7–10 of natural menstrual cycle, which corresponds to the implantation phase of the endometrium, i.e. days 21–24 of the menstrual cycle. Endometrial biopsies were obtained by informed women in a protocol approved by the Ethics Review Committee on Human Research of the University of Tartu. The biopsy of endometrial tissue was subsequently subdivided into parts and further processed for light microscopy, transmission electron microscopy (TEM) and scanning electron microscopy (SEM) observations.

Histology

The specimens for LM were fixed in the 10% buffered formalin and embedded in paraffin with a vacuum infiltration processor (Tissue-Tek® VIP™ 5 Jr, Sakura, USA). Specimens were cut with microtome Ergostar HM 200 (Microm, Germany) at four-μm thickness and stained using the H&E and van Gieson methods for general orientation to sections. Slides were observed and photographed by a Zeiss Axiophot 2 microscope (Zeiss, Germany).

Immunohistochemistry

Three-μm thick paraffin sections mounted on poly-L-lysine coated SuperFrost slides (Menzel-Gläser, Germany) were deparaffinized and rehydrated. Peroxidase activity was removed by 0.6% H_2O_2 (Merck, Germany) in methanol (Merck, Germany). Then sections were washed in tap water and in PBS (pH=7.4; Gibco, Invitrogen, USA) for 10 min, treated with normal 1.5% goat serum (Gibco, Invitrogen Corporation, USA) for 30 min at room temperature and incubated with the first antibody integrin β_3 (CD61, Dako) diluted 1:250 overnight at 4°C. In the next day, sections were washed in PBS and incubated with the universal secondary antibody (VECTASTAIN ABC Universal Kit, Burlingame, USA) for 30 min at room temperature. Sections were washed with PBS and peroxidatic activity was detected with DAB (Vector, USA) applied for 10 min at room temperature. Then sections were rinsed, counterstained with hemalaun, dehydrated and mounted with DPX (Fluka, Switzerland). The integrin β_3 labeling was expressed by a subjective scale ranging from 0 to 3 (0 – no staining, 1 – weak staining, 2 – moderate staining, 3 – strong staining). Two independent observers in a blinded fashion performed the evaluation. Immunohistochemistry negative controls were performed by omitting primary antibody.

Electron microscopy

For electron microscopic examination biopsies were fixed in 2.5% glutaraldehyde solution (Sigma-Aldrich Chemie GmbH, Germany) buffered with sodium cacodylate buffer (Sigma-Aldrich Chemie GmbH, Germany) at pH=7.4 for two hours, postfixed for 1 hour in 1% osmium tetroxide solution (Agar Scientific, England) at the same temperature and pH, dehydrated in ethanol (50° → 70° → 90° → 96° → absolute ethanol) and embedded in Epon-812 (Fluka, Germany). The semithin sections stained with methylene blue – azur II were examined using a Zeiss Axiophot 2 microscope (Zeiss, Germany). Ultrathin (80 nm) sections were cut on the Reichert Om U3 ultratome with a diamond knife (Diatome, Switzerland). Then sections were mounted on copper grids mesh size 200 (Sigma-Aldrich Chemie GmbH, Germany) with Perfect Loop (Diatome, Switzerland). Sections were stained with uranyl acetate (Agar Scientific, England) and lead citrate (Agar Scientific, England) according to standard methods. TEM Philips Tecnai-10 with camera Mega View II was used for viewing and photographing.

SEM

For scanning electron microscopic examination biopsies were fixed in 2.5% glutaraldehyde solution buffered with sodium cacodylate buffer at pH=7.4 for two hours, dehydrated in alcohol (50°→100°), in an acetone series and dried using a critical point dryer. After drying, the samples were mounted on an aluminium stub using silver paint. Samples were then introduced into the chamber of the sputter coater and coated with gold. SEM LEO-1430 VPSE was used for viewing and photographing.

RESULTS

Histology

Endometrial epithelium, stroma and glands were identified in hematoxylin-eosin stained slides (Fig. 1). Histological studies showed the normal structure of the endometrial columnar epithelium. In two patients' biopsies the spiral arteries were seen (Fig. 1). The grade of maturity of the endometrial glands was low and did not match with the days of the cycle estimated by the patient. In the biopsy of one patient basal part of glandular cells contained glycogen (Fig. 2), which is characteristic of the beginning of the secretory phase. This finding also did not match with the day of the cycle estimated by the patient. Connective tissue stroma was as a rule rich in cells and contained fibroblasts, macrophages, mast cells and to lesser extent lymphocytes and neutrophilic granulocytes. In three patients' endometrium glands were more developed (glands-stroma ratio 2:1), while in two patients' endometrium more loose connective tissue was present (ratio 1:2).

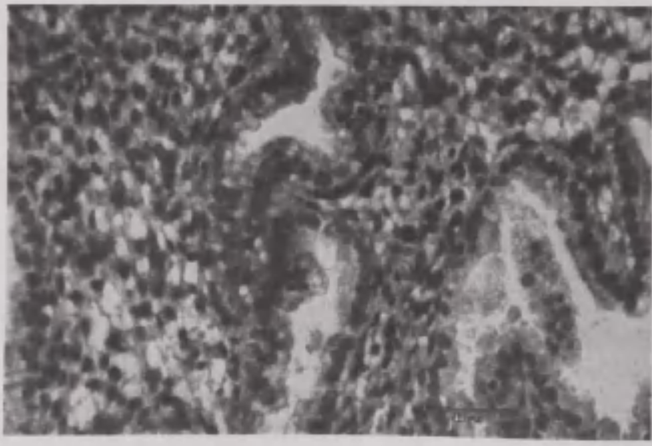

Fig. 1. Endometrium biopsy. Glands-stroma ratio (2:1) and spiral arteries. H&E

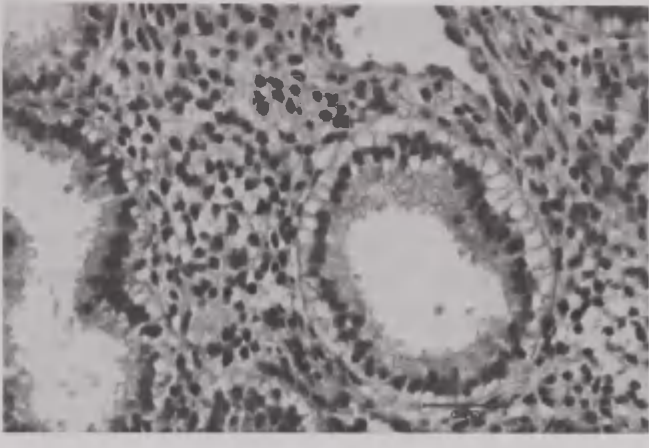

Fig. 2. Glycogen in the basal part of endometrial epithelial cells. H&E.

Immunohistochemistry

Immunohistochemical staining with CD61 showed a very intense reaction (3 grade) in the endometrial luminal epithelium of one patient (Fig. 3) and weak staining (1 grade) in 4 patients' luminal epithelium.

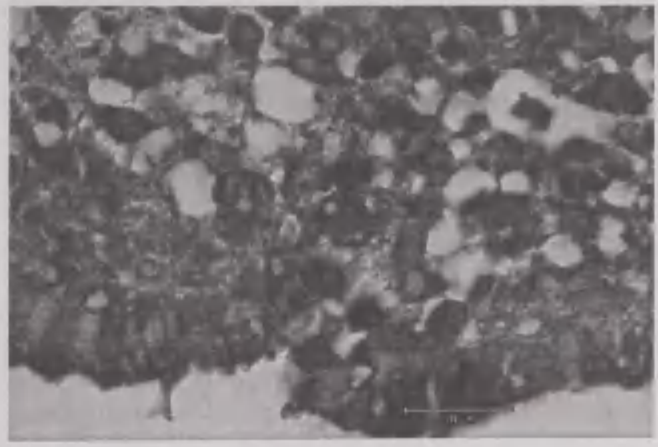

Fig. 3. Very intense CD61 immunohistochemical reaction in endometrial epithelial cells in the biopsy of one patient. DAB+hemalaun.

TEM

The TEM study revealed differences in the structure of the apical part of epithelial cells. In ciliated epithelial cells cilia were either numerous, strong and intact (Fig. 4) or broken and clumpy or were missing at all. In the samples of two patients electron dense membrane covering cilia of endometrial epithelial cells was seen. Epithelial cells contained the regularly developed Golgi complex and endoplasmic reticulum, changes in the shape of the nucleus and the content of chromatin were noted.

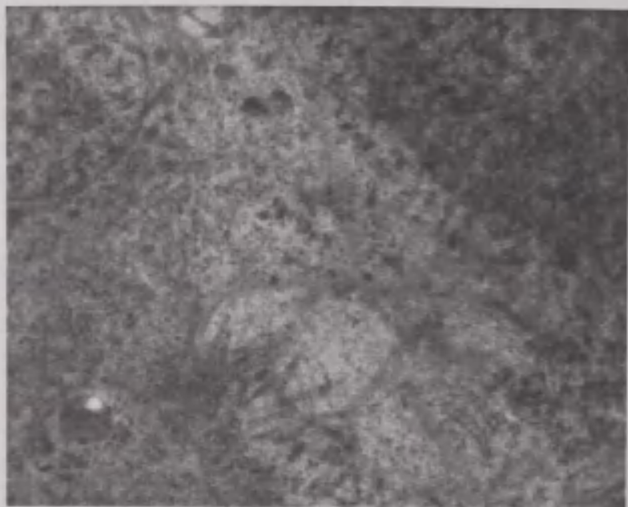

Fig. 4. Endometrial epithelial cells with regular cilia. TEM 10000x.

SEM

In the samples of two patients scanning electron microscopy investigation showed normal endometrial epithelial cells (Fig. 5a). On the apical surface of these ciliated epithelial cells regular long cilia were seen and also essential components for embryonic implantation, pinopodes, were noticed in these samples. The specimens of three other patients showed morphological changes in the ciliated epithelial cells. Ciliated epithelial cells had few cilia, which were broken and sticky or the cilia were missing at all (Fig. 5b). Pinopodes in these samples were not found.

Fig. 5a. Endometrial epithelial cells with regular microvilli and cilia. SEM 8070x.

Fig. 5b. TFI patient epithelial cells with few cilia. SEM 9650x.

DISCUSSION

Uterine endometrium enables the implantation by achieving receptivity 6–8 days after ovulation. The duration of the receptivity period is quite short; this is why the period is called the implantation window (WOI – window of implantation). WOI lasts for about 4 days, between days 20 and 24 of the menstrual cycle and for successful implantation embryo requires fully developed endometrium with no pathological changes. The histology of the endometrium is based on the classical work of Noyes *et al* from 1950 about dating endometrial biopsy, where the development of epithelial and stromal compartments are followed [9]. The most common problem in the pathohistological diagnosis of the endometrial biopsy is the retarded secretory phase, when the histological development of the endometrium is delayed for more than two days from the ovarian cycle [3]. Also, in our studied biopsies the secretory phase was delayed in all the cases. Nevertheless, the backwardness of the secretory phase of the endometrium is reported to occur in half of fertile women [4] and therefore the importance of routine endometrial biopsy in the diagnostics of infertility has significantly decreased. The histology of endometrial biopsy conducted during IVF-procedure does not often agree with the development of the natural cycle. During IVF-procedures it is frequently noticed that development of peri- and post-ovulatory endometrium forestalls the development of the natural cycle. On the other hand in the early secretory phase normal histological structure of the endometrium is seen and in the mid and late secretory phase differences in the development of glandular and stromal compartments are noticed [3]. Thus it is quite essential that routine histological studies are replaced by immunohistochemical investigations [7, 11]. For example, $\alpha_v\beta_3$ integrin expression well correlates with IVF pregnancy results [15]. Integrins are endometrial markers and their expression is important for embryo implantation. In our studies β_3 integrin was strongly expressed only in the endometrial epithelium of one patient, while in case of other patients the expression was weak reflecting possible additional problems for the implantation of an embryo also from this aspect.

We used both transmission (TEM) and scanning electron microscopy (SEM) to investigate ultrastructural changes in the endometrium. No changes in cellular organelles were noticed, but alterations were seen in the coverings of the apical surface of epithelial cells, where cilia were damaged or were lacking completely. In the case of two patients the membrane covering the cilia was electron dense, reflecting altered protein content, which requires additional investigation. Endometrial epithelium has an extremely important role in the implantation of an embryo and changes in the structure of cilia of the luminal epithelium may be one of the factors affecting this process.

By the time of implantation, luminal epithelial cells protrude their apical plasma membranes and form pinopodes. Although the presence of endometrial pinopodes is generally considered as an evident manifestation of a receptive endometrium, the direct involvement of pinopodes in embryo-endometrial interactions has not yet been proven. However, an association between the density of pinopodes on the apical membranes of epithelial cells and the effectiveness of IVF-treatment have been shown [8]. SEM studies have shown that pinopodes appear between days 20–22 of the menstrual cycle and are able to exist for two days [10]. There are only few studies on the presence of endometrial pinopodes in infertile women [11]. In our SEM study the pinopodes where found in the samples of two patients out of five, thus in three cases endometrial epithelium was not fully ready for implantation.

Although there are well characterised morphological and molecular markers of implantation, the complete dynamics of the process as well as the importance of each and every marker is still vague. In our limited study on the endometrial samples of TFI patients we showed in all the cases the delayed development of the secretory phase. In most cases the structure of epithelial cells was altered being characterized by the low integrin β_3 expression and the suppressed formation of pinopodes, which taken together may be responsible for the non-receptivity of the endometrium.

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THE CONTRIBUTION OF SELF-PLANNED LEISURE-TIME PHYSICAL ACTIVITY TO CARDIO-RESPIRATORY FITNESS OF FEMALE ADOLESCENTS

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ABSTRACT

Reduced physical activity becomes a significant risk factor to health-related diseases in all age-categories, therefore the purpose of this study was to evaluate the effectiveness of self-determined physical activity (PA) on the cardio-respiratory fitness of adolescent females. The present study employed the Hellison's Teaching Responsibility through Physical Activity (TRPA) model. Participants (170 adolescent females aged 13.22±0.29) came from three randomly selected urban community schools. An experimental program based on self-determined and personalized planning of leisure-time PA was implemented for fifteen months. Cardio-respiratory fitness was measured using a 20-meter Shuttle Run test (20SRT). The frequency of moderate-to-vigorous physical activity (MVPA) in leisure-time and the assessment of physical activity and fitness were carried out with the use of a self-reported questionnaire. Pre-test and post-test comparisons were made between the groups to determine changes in the self-assessment, frequency of leisure-time MVPA and cardio-respiratory fitness. Female students, attending intervention programs, generally increased the frequency of their leisure-time MVPA, which resulted in a significant ($p=0.0000$) improvement of cardio-respiratory fitness when compared to the control groups. They also had a more accurate self-assessment of their fitness. The effectiveness of the TRPA model has been confirmed, which indicates the need for developing a more personalized approach and individualized tools for promoting long-term commitments towards PA in adolescent youth.

Key words: physical activity; adolescent females; cardio-respiratory fitness

INTRODUCTION

Traditional methods of teaching used in school Physical Education (PE) do not give a pupil a sense of meaningfulness, and the kind of educational stimuli the pupil receives do not develop his/her sense of comprehensibility. The result of this lack is visible in the decreasing number of young people undertaking PA in their leisure time, which influences a worsening condition of populations [25], especially in children [2]. When combined with reduced intensity, insufficient for the stimulation of cardio-respiratory fitness [3, 12] and poor strategies of PA promotion during PE classes. Together it becomes a significant risk factor for numerous cardiovascular diseases [24]. Recent changes in the caloric intake due to an increase in sedentary behaviors worsen the matter further [10].

On the other hand, a well-designed physical education program as an obligatory part of school education has a chance to provide an appropriate dose of stimulating moderate-to-vigorous physical activity (MVPA) for participants. Some studies [20] report the benefits of health-related physical education curricula for 97% of elementary school students. Similar findings in 14 to 19-years-olds have also been confirmed [1]. However, this seems not enough to cause behavioral changes and build long-time commitments to PA.

Some try to enhance physical education curricula with after school sports programs [5] with results indicating that pupils extend their engagement in MVPA for more than 50% of their sports practice time across the course of the season. But, according to Curtner-Smith et al. [7] "critically oriented readers could wonder if this was not due to an exclusive entertainment/performance model of extra-curricular sport, often focused on the production of athletes for big university sport." Therefore a change towards more inclusive models focused on health and participation for all considering social and environmental factors. Affecting participation in PA should be implemented [8].

In a study [21], which used a multi-theory approach (with a tested transcontextual model) to investigate the influence of urban adolescents' perceived autonomy and competence in PE on their PA intentions and behaviors during leisure-time a direct connection between the perceived competence in PE and leisure-time PA was found with the significant path coefficient from the perceived competence to MVPA, which suggests that it has a direct effect on the involvement in PA. The authors of the study suggest that two theoretical frameworks (The Self-Determination Theory and The Theory of Planned Behavior) can be integrated to further interpret the ties, but at the same time raise additional research questions concerning the origins of pupils' motivation and the influence of an urban setting on the designation and implementation of learning-oriented and autonomy supportive PE. In another study [14] authors proved effective a program based on the Hellison's Teaching Responsibility through the Physical Activity (TRPA) model [15] in improving the skills of Urban Youth Leaders. This has also been confirmed in relation to sport-based programs in school [9].

Therefore this research was undertaken to test the effectiveness of the self-determined Teaching Responsibility through the Physical Activity (TRPA) model in promoting moderate-to-vigorous physical activity (MVPA). The major aim of the study was to examine the behavioral changes in the leisure-time MVPA and its influence on the cardio-respiratory fitness of 13-year-old Polish females.

MATERIAL AND METHODS

Subjects

Participants included 170 girls assigned to randomly selected either experimental (N=76) or control groups (N=94). All the measures were adjusted for the baseline biological age of the mean maturation rate, assessed by a qualified physician. The average age of girls was 13.22±0.29 years.

Instruments

A pre-test/post-test, two-group design was employed. It was hypothesized that if an appropriate approach to setting of individual targets and objectives in the area of health-related activities is applied to every pupil employing the Hellison's Teaching Responsibility through the Physical Activity (TRPA) model, this will cause changes in the attitude, which will result in an increase of the frequency of undertaking leisure-time MVPA and thus improve cardio-respiratory fitness. The changes of cardio-respiratory fitness were measured by the number of minutes completed in the 20-meters Shuttle Run test (20SRT) from the battery of the Eurofit test [11]. Girls were tested twice in a school gymnasium during regular PE classes. Pre-testing took place in the first month of the school year and a post-test examination was carried out after three semesters (fifteen months).

Other variables were obtained by the administration of the "Self-reported Physical Activity" questionnaire with a previous month frequency of MVPA recall [18]. In its Polish adaptation a question on the last month MVPA recall was verified in an experimental study on 13–15-year students' daily PA [4], where questionnaire's reliability was evaluated by repeating the same procedure of administration with the same group of students within two weeks time – a test-retest design. The questionnaire included also close-cafeteria questions on self-assessed fitness – the question had four categories: "more fit than peers", "as fit as peers", "less fit than peers" "unfit" and the self-assessed level of physical activity – the question had four categories: "very good PA", "good PA", "insufficient PA" and "bad PA".

Procedure

An experimental intervention with a comparison of experimental groups, randomly selected and allocated for the purpose of the study parallel control groups, was used with the duration of fifteen-months. In the experimental groups during 4 lessons of Physical Education a week a teacher used at least one activity a lesson including the following teaching strategies: teacher talk, modeling (being), reinforcement, reflection time and student sharing to adjust tasks to the self-control, involvement, self-responsibility and caring levels of the responsibility of pupils. Additionally a specially self-designed, personalized form "Planning of Leisure-time Physical Activity" was used. Every girl from the experimental group could plan the amount of time and choose, from a provided range of choices including 5 team and 5 individual sports, forms of leisure-time out-of-school PA she was willing to commit herself to undertaking for each two-week period. It was checked and evaluated every two weeks by a teacher and a pupil together for the concordance of the planned and practically undertaken activities with responsibility relying on the pupil for the accuracy of the plans and its accomplishments as a part of the Hellison's model of TRPA. Those girls who fulfilled their self-obligation on undertaking PA as planned in their out-of-school time received an extra rewarding grade once every month.

Because pupils were considered to undertake activities of moderate-to-vigorous intensity, thus all the girls were informed what activity could be considered MVPA and instructed how to measure the heart-rate (taken manually with two fingers at the carotid artery in the neck) to assess the intensity of an activity.

Questionnaires were distributed in the pre-test and the post-test examinations parallel to the 20SRT testing. The examined sample was classified by the mean values of 20SRT and by BMI.

Statistical Analyses

Both quantitative and qualitative data were collected and analyzed to explore the relationships between dependent and intervening variables. Test-*t* and chi-square analyses were employed to determine the contribution of the specially designed intervention to assess the changes of cardio-respiratory fitness by means 20SRT. The level of significance was set at $p<0.05$.

For the purpose of this paper the relationship between the self-assessment and the self-determined and planned frequency of undertaking leisure-time MVPA and cardio-respiratory fitness both before and after experimental program was analyzed.

RESULTS

The pre-test examination of attitudes indicated that 34.2% of the girls declared undertaking MVPA in their leisure-time 5–7 times a week in the category of "very good" PA. The lowest frequency went down to 6.2% in the category of "insufficient" PA. However, it turned out to be 100% of those who assessed their level of PA as "bad" – Fig. 1 ($p=0.0321$). In the case of the self-assessment of physical fitness the pre-test examination proved no statistically significant differences between the categories. Generally the less frequent MVPA per week in their leisure-time – the worse assessment of one's fitness the examined girls had – Fig. 2. The initial analysis showed that it was only one third of female participants who believed they were "more fit than their peers" and 11.1% in the category of "unfit" who exercised MVPA 5–7 times a week. In this last category 77.7% declared undertaking leisure-time MVPA less frequently than once a week.

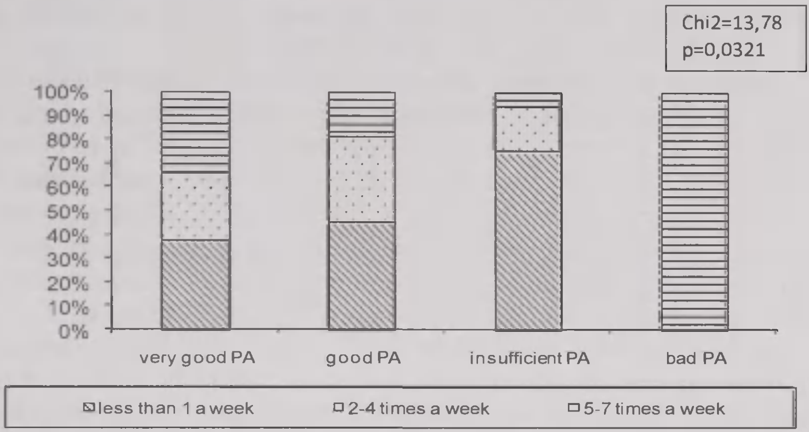

Figure 1. Self-assessment of Physical Activity and Frequency of the leisure-time MVPA pre-test (N=170; χ^2=13.78; p=0.0321)

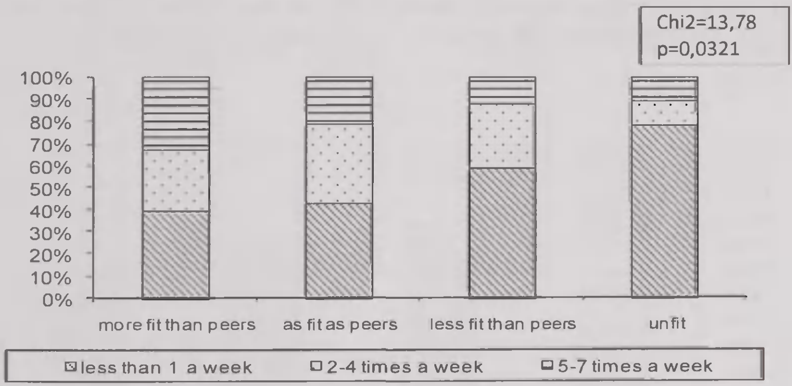

Figure 2. Self-assessment of Physical Fitness and Frequency of the leisure-time MVPA pre-test (N=170; χ^2 =7.87; p=0.2477)

The post-test analysis revealed that in the control group 42.8% in the category of "very good" PA up to 67.8% in "good" PA spent less than once a week of their leisure-time exercising with MVPA. There were no girls exercising MVPA 5–7 times a week in the categories of "insufficient" PA and "bad" PA – Fig. 3 (p=0.0122).

Apparently the frequency of undertaking leisure-time MVPA did not have a significant influence on the self-assessment of physical fitness in this group. Still 40.0% of the girls considered themselves "more fit than peers" and 61.9% from the category of "as fit as peers" participated in MVPA less than once a week – Fig. 4. Contrary 75.0% of the girls from the experimental group who evaluated their level of PA as "very good" participated in MVPA 5–7 times a week and it was 37.5% among those who assessed their level of PA as "good". There were no girls who would describe their level of PA as "bad" – Fig. 5 (p=0.0014). The girls from the experimental group were also more critical in assessing their own fitness. Half of those who assessed themselves as "unfit" declared practicing in leisure-time MVPA 5–7 times a week and 16.6% exercised with such intensity 2–4 times a week. In the "less fit than peers" category it was 50% for those who were active 2–4 times a week and 50% for less than once a week of MVPA in their leisure-time MVPA. Among those who believed themselves to be "more fit than peers" 92.3% declared MVPA 5–7 times a week – Fig. 6 (p=0.0021).

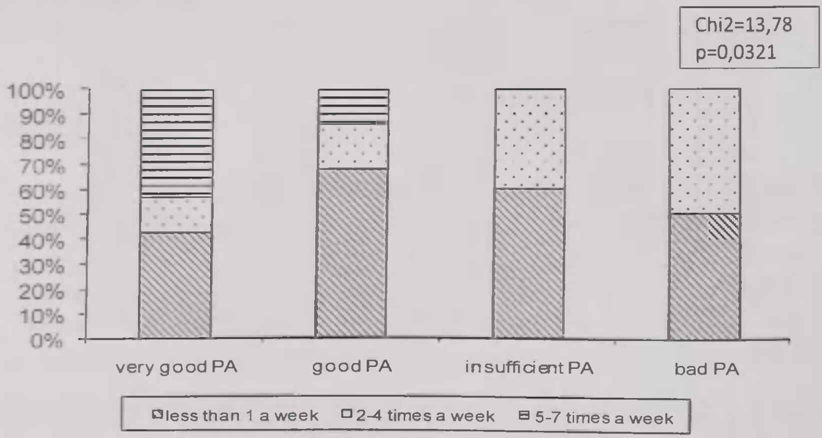

Figure 3. Self-assessment of Physical Activity and Frequency of the leisure-time MVPA in the Control Group post-test (N=94; χ^2 =16.29; p=0.0122)

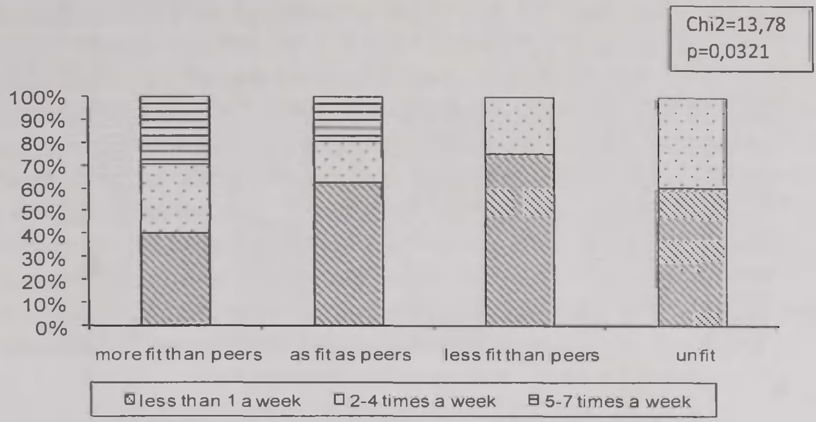

Figure 4. Self-assessment of Physical Fitness and Frequency of the leisure-time MVPA in the Control Group post-test (N=94; χ^2 =5.76; p=0.2487)

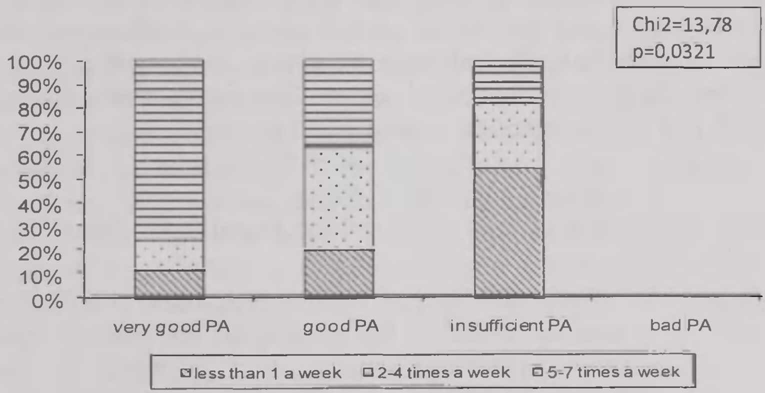

Figure 5. Self-assessment of Physical Activity and Frequency of the leisure-time MVPA in the Experimental Group post-test (N= 76; χ^2 =18.28; p=0.0014)

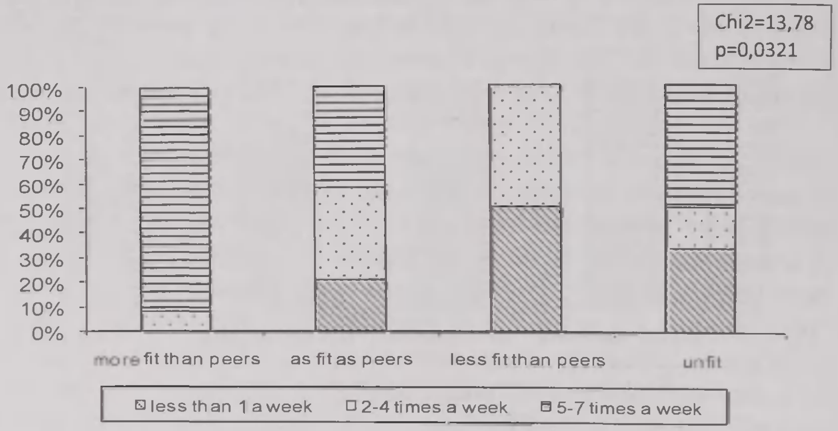

Figure 6. Self-assessment of Physical Fitness and Frequency of the leisure-time MVPA in the Experimental Group post-test (N=76; χ^2 =20.58; p=0.0021)

This generally low participation in the leisure-time MVPA noticed in the first examination and also in the control group in the final test (after fifteen months) has resulted in a relatively low level of cardio-respiratory fitness in the control group. Descriptive statistics and *p* values for all the measures are presented in Table 1.

Table 1. Comparison of the Control and the Experimental Groups in the pre-test/post-test.

Variable	Pre-test			Post-test		
	Control	Experi-mental	*p*	Control	Experi-mental	*p*
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
Height (cm)	160.6±6.57	160.4±6.12	0.8780	163.9±5.94	163.7±6.59	0.7957
Weight (kg)	49.7±8.45	48.0±7.31	0.1574	54.5±9.14	53.0±7.15	0.2540
BMI (kg/m2)	19.4±3.10	18.6±2.42	0.8171	20.4±2.99	20.0±2.50	0.3619
20m SRT (mean/min)	4.5±1.77	4.6±1.87	0.6721	4.1±1.44	5.5±1.73	0.0000

As shown in Table 1, generally there are no statistical differences between groups in the pre-test and post-test comparison in height, weight nor BMI. The pre-test mean values of both groups were placed at approximately the 50th percentile for this age-category of the Polish female population [23]. The only significant difference ($p<0.000$) was observed in the 20SRT in the post-test examination for a number of completed stages (min). The female respondents participating in the intervention program completed significantly more stages in the 20SRT and their mean value was placed between the 50th–75th percentiles for the age-related population of Polish female adolescents, while it was below the 10th percentile in the control group.

DISCUSSION

The findings from the research on health effectiveness of physical education programs prove different interventions to be effective in providing multiple health benefits. The studies [1, 7, 20] report the positive effects gained through the enhancement of health-related activities in a PE lesson. On the other hand, at times it does not work out as expected, like in the case of the study [17], in which the Fullan's multi-dimensional framework of the Meaning of Educational Change was tested. An intervention program aimed at increasing activity caused no discernable change in health behaviors in youth. The findings confirmed the predictions of the tested model, which indicated that, when challenged, technological and material innovations are more easily changed than attitudes, beliefs and values (especially those held by teachers). Thus, while it is acknowledged that existing studies and research provide selected positive findings on a number of health-related issues they are still insufficient and limited in the promotion of leisure-time PA. According to the research on health-promotion strategies [7] teachers spent very little of their lesson time promoting (0.52%) health-related PA, demonstrating (0.18%) fitness or providing fitness knowledge (2.54%). Thus some guidelines for the school-based PA intervention are recommended [6].

Another research [16] describes the changes in a number of positive social behaviors of at-risk adolescent youth during the implementation of a sport education season. Accurate self-monitoring and positive peer interaction were observed and supported the view that a curriculum model that places specific positive social action in the foreground can effect change in pupil's positive social behavior. The results [13] support stating that the deliberate practice of positive social behavior (e.g., fair play behavior) needs to take place before any other significant changes will become evident.

The pupils of this age category (aged 12–15) engage in some PA, but increasing sedentary periods of daily timetables are likely to interfere and gradually reduced the level of motivation and this drastically reduces engagement figures. It is also proved that PA levels are lower in the adolescent females than the adolescent males and therefore it becomes particularly important to consider all the possibilities and look for the most effective ways of motivating adolescent females through PE programs. Studies [19] confirm that the adolescent females who, enrolled in PE, were more physically active than those not enrolled. The authors suggest that the expanded enrollment in PE may increase the American adolescent's females PA level. Moreover, findings [22] from the Trial of Activity for Adolescent Girls (TAAG) point at the need of using audience segmentation for targeting persuasive communication and developing targeted promotional tools, which may increase motivation and participation in PA programs. Thus the findings of our own research presented in this paper and the analysis of behavioral and cardio-respiratory positive changes are encouraging. An increase in the declared frequency of undertaking MVPA during leisure-time, the improved self-assessment of activity and fitness levels, as well as better 20SRT results proved the intervention to be successful. Especially important seems to be the improvement of cardio-respiratory fitness as one of the most important indicator of health-related fitness. The level of the gained result places the examined females above the average level of their peers from the control group but also the European peers of the same age category and as such is promising since it was achieved not due to obligatory PE classes (conditions were the same in both control and experimental classes) but through a specially designed personalized program with an approach based on the model of building of one's responsibility for health and the quality of life.

To sum up, the data confirms the Hellison's model of TRPA to be effective in both, the change of health-related behaviors and its possible influence on the increase of cardio-respiratory fitness, achieved through the self-planned leisure-time PA program based on a system of individualized challenges. Further research exploring the ways of influencing or changing health-related behaviors in the school setting should include the measures of lasting effects. It is also worth studying the effectiveness of teaching strategies in promoting changes on health-related behaviors when combined with the use of teaching styles at different age categories. As suggested earlier, the need of audience segmentation for targeting persuasive communication may also play a crucial role in developing targeted promotional tools in youth (e.g. activity calendars for the children and planners or organizers for adolescents). Nevertheless, it seems that these findings may be useful for the promotion of health in a school setting, especially for PE teachers but health educators and youth coaches may find it helpful as well.

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CHANGES IN THE HEAD GROWTH – ONE OF THE PARAMETERS OF THE MORPHOLOGICAL STATUS IN THE STUDY OF RIGA SCHOOLBOYS FROM 2005–2007

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ABSTRACT

Head size is one of the parameters of a human's morphological status. Growth and development of the head differs from the growth of the body. It can be explained by the fact that the growth of the head is closely connected to the development of the brain.

The researchers have the aim to investigate the anthropometrical measurements in boys at the age of 7 to 18 years and to compare them with the literature data.

Anthropometrical measurements acquired in the study within 2005–2007 of the Riga secondary school, primary school and pre-school children were used for the basis of this research. The anthropometrical data of 1,359 boys, aged 7–18 years, were analyzed. The boys had been divided into twelve age groups, The analysis included the following anthropometrical parameters: head perimeter, the biggest head length and width, the biggest face width, length of mandible, morphological face length and the head index.

Analyzing the acquired data on the anthropometrical parameters of the head in boys at the age of 7 to 18 years, we can conclude that:

1) the studied head parameters in boys grow till 18 years, but the biggest mean value growth is observed at the age of 14–15 years;
2) if by the head index variations, the boys are seen to have from hyperdolichocephalic up to brachiocephalic heads, then according to the head index parameter, they on average fit into the group of mesocephalic head forms, the fact which is observed in all age groups of boys, as well as in girls (Duļevska, 2002);

3) boys of all age groups fit into the group range of peoples of Northern Europe.

Key words: anthropology, boys, head perimeter, head index.

INTRODUCTION

Head size is one of the parameters of a human's morphological status. Growth and development of the head differs from the growth of the body. It can be explained by the fact that the growth of the head is closely connected to the development of the brain. Thus, the skull, which envelops the brain, reaches its final size earlier than other skeletal parts.

The greatest brain growth is observed in the first years of a child's life. At the age of four the mean value of the brain part reaches 90% of its size at the age of 17 years. A slight increase of this size is seen at puberty. The growth rate of the facial part differs from the growth rate of the brain. The size of the facial width at the age of four years reaches 80–85% of the size of an individual at 17 years, but the facial height – 75–80% of the defining size.

AIM OF STUDY

To investigate the anthropometrical measurements in boys at the age of 7 to 18 years and to compare them with the literature data.

MATERIAL AND METHODS

Anthropometrical measurements acquired in the study within 2005–2007 of the Riga secondary school, primary school and pre-school children were used for the basis of this research. The anthropometrical data of **1,359** boys, aged 7–18 years, were analyzed. The boys had been divided into twelve age groups, The analysis included the following anthropometrical parameters: head perimeter, the biggest head length and width, the biggest face width, length of mandible, morphological face length and the head index.

RESULTS

During the study several anthropometrical parameters of the head were analyzed: head perimeter, the biggest head length and width, the biggest face width, length of mandible, morphological face length, the mean values of which are depicted in Table 1, and the head length and width index (see Table 2).

1) head perimeter at the age of seven years varies from 49.7 to the 56.0 cm, mean value is 52.7 cm, which in the further age groups gradually increases, reaching its maximum at the age of 18 years, i.e., 57.2 cm. The fastest and maximum growth is seen at the age of 14–15 years, when the boys' head perimeter grows by 0.8 cm. The increase of the mean value of the head perimeter in boys at the age 7–18 years is 4.5 cm;
2) the biggest head length in boys at 7 years on average is 181.0 mm, which varies from very short – 156.0 mm to very big – 196.0 mm. At 18 years this size is 194.0 mm, but its variations are seen from 155.0 mm to 216.0 mm. At the age 7–18 years it may on average increase in boys by 13.0 cm. Up to 14 years this size on average increases from 1.0 to 2.0 mm per year. At 15, the highest growth rate difference per year is observed, it increases by 4.0 mm. After that this size keeps gradually growing by 1.0 mm per year, reaching its maximum at 18 years, which on average is 194.0 mm, which can be called as a very long head;
3) the biggest head width at the age of 7 years on average is 142.2 mm. At 18 years the biggest head width varies from very narrow – 100.00 mm to very broad – 167.0 mm, on average reaching 150.5 mm, which corresponds to a moderately broad head. At the age of 12 and 13 years, one can observe the fastest increase in the head width – 2.0 mm, which keeps growing till 17 years by 0.1–0.7 mm per year, reaching its maximum – 150.5 mm;
4) head index at the age of 7 years varies within very narrow limits from 81.41–81.63, making on average 78.56. At the age of 18 years it varies from 64.51–77.31, making on average 77.57. If, by the variation of the head index the boys are seen to have hyper-dolichocephalic to even brachiocephalic heads, they, however, by the head index value on average, fit into the group of mesocephalic head forms, which are seen in all age groups of boys;

Table 1. Mean indices of anthropometrical parameters of the head

Age of the boys	N	Head perimeter, cm	The biggest head length, mm	The biggest head width, mm	Face width, mm	Length of mandibule, mm	Morphological face length, mm
7	73	52.7	180.6	142.2	119.9	92.2	97.5
8	105	53.3	182.9	142.3	122.2	94.1	97.6
9	112	53.3	182.4	143.9	123.4	94.7	98.3
10	79	54.0	184.5	144.8	125.1	96.6	100.4
11	108	54.5	185.9	145.4	127.2	98.5	102.9
12	113	54.8	186.9	145.9	128.6	99.6	104.5
13	106	55.4	188.0	147.9	130.5	99.9	107.4
14	138	55.8	188.1	148.9	132.5	101.5	110.1
15	131	56.6	192.1	150.0	135.5	103.8	113.4
16	154	56.8	193.1	150.1	136.2	103.5	112.8
17	103	56.8	193.1	150.8	137.8	104.6	114.8
18	137	57.2	194.1	150.5	139.0	107.4	115.5

Table 2. Length – width index of the head (%)

Age of the boys (years)	N	Mean	SD	Min	Max
7	73	78.8	4.24	68.9	91.4
8	105	77.9	4.99	62.7	94.6
9	112	79.0	4.34	68.7	91.7
10	79	78.5	4.16	68.8	88.4
11	108	78.2	4.10	69.9	89.7
12	113	78.1	4.41	62.6	88.8
13	106	78.7	3.88	70.8	89.9
14	138	79.2	3.72	71.8	90.9
15	131	78.1	3.28	70.5	87.3
16	154	77.8	3.72	68.4	86.8
17	103	78.1	4.19	69.2	97.5
18	137	77.6	4.64	51.3	88.9

5) face width at the age of 7 years varies from 10.5 cm to 13.2 cm. At 18 years this size varies from 150.0 mm to 160.0 mm, reaching on average 139.0 mm. The fastest increase of this size is seen at the age of 15 years, which has grown in a year by 3.0 mm. Then it continues gradually growing from 0.7 mm – 1.6 mm per year, reaching its maximum at the age of 18 years, which is 139.0 mm;
6) length of mandible is characterized by pronounced gender dimorphism and different growth rate in boys and grils. At 7 years the variations of this size are from 83.0 to 102.0 mm, the mean size being 92.2 mm. At 18 years these variations make 91.0–130.0 mm, on average – 107.4 mm. The most intensive growth of mandible is seen at the age from 14 to 15 years, when it grows on average by 2.3 mm per year, reaching its maximum at 18 years, when its mean size is 107.4 mm;
7) morphological face length at 7 years on average is 97.5 mm, which can be characterized as a low face. At the age of 18 years its size on average is 115.5 mm. Stabilization of the growth of this size is observed in boys at the age of 16 years. Morphological length of the face objectively depicts the dynamics of longitudinal parameters. From 17–18 years this size increases by 18.0 mm. According to L. Saller's classification, the boys' morphological length of the face fits into the standards between the moderate and big sizes.

DISCUSSION

Comparing the results of the study of 2005 / 2007 (Table 1) to those of 1997 study data of 7–18 -year-old girls [4], we can see that the growth rate of the head is similar (Table). Both in boys and in girls one can see the gradual growth of the head in all age groups. Accelerated growth period at puberty in girls is seen at the age from 11 to 13 years, when, for instance, the greatest increase in the head length is seen at the age of 10–11 years, the greatest increase in the head width and head perimeter – at the age of 13 years. Head perimeters reach their maximum on average at the age of 16–17 years. In boys an accelerated growth of the head parameters is seen from 12 to 15 years, the greatest increase in the head length and perimeters is seen from 14–15 years, the greatest increase in the head width is seen at the age 12–13 years. Head parameters reach their maximum size on average at the age of 17–18 years, for instance, the biggest head length 19.4 cm, the biggest head width – 15.05 cm, head perimeter – 57.2 cm.

According to the study data of 1991/92 [3], the fastest growth rate of the head perimeter of boys is seen at the age of 12–13 years (Table 3), and the further increase of these parameters is seen.

According to the study data of 2004 [6], the boys' heads grow on average till 17–18 years, for instance, the biggest head length at the age of 18 years is 19.31 cm, the biggest head width – 15.42 cm, head perimeter – 57.37 cm, which is very similar to the study data of 2005/2007 (Table 4).

Table 3. Mean indices of Head perimeter in the investigation of the Study of 1991/1992 (Āboltiņa M.)

Anthropo-metrical parameters	Age of the boys (years)									
	7	8	9	10	11	12	13	14	15	16
Head peri-meter (cm)	52.6	52.6	53.8	53.9	54.0	54.3	55.3	55.4	55.4	55.5

Table 4. Anthropometrical Indices of Head in the investigation of the 18-year-old in the Study of 2004 (Nagle E.)

	Anthropometrical parameters (cm)	Mean	SD
1.	The biggest head length	19.31	0.68
2.	The biggest head wigth	15.42	1.01
3.	Face width	13.31	0.98
4.	Length of mandibule	10.54	0.63
5.	Morphological face length	12.41	0.60
6.	Head perimeter	57.37	1.49

CONCLUSIONS

Analyzing the acquired data on the anthropometrical parameters of the head in boys at the age of 7 to 18 years, we can conclude, that:

1) the studied head parameters in boys grow till 18 years, but the biggest mean value growth is observed at the age of 14–15 years;

2) if by the head index variations, the boys are seen to have from hyperdolichocephalic up to brachiocephalic heads, then according to the head index parameter, they on average fit into the group of mesocephalic head forms, the fact which is observed in all age groups of boys, as well as in girls [4];
3) boys of all age groups fit into the group range of peoples of North Europe.

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COMPLEX SEGREGATION ANALYSIS OF HORIZONTAL AND VERTICAL HEAD SIZE COMPONENTS IN 373 ETHNICALLY HOMOGENEOUS PEDIGREES, INDIA, WEST BENGAL

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ABSTRACT

It is well established that genetic factors contribute substantially to craniofacial traits determination. However, the mode of inheritance of these phenotypes is poorly studied. The aim of this research was to test the hypothesis of a major gene involvement in the determination of head size horizontal (HOC) and vertical (VEC) components by means of uni- and bivariate complex segregation analyses. Two synthetic phenotypes, HOC and VEC, were derived from 11 head size measurements assessed in 1,263 individuals (373 nuclear families). Prior to genetic analyses, HOC and VEC were adjusted for the confounding effects of sex, age and adult height. The hypothesis of the Mendelian transmission was accepted for VEC. Both, the Mendelian and the multifactorial model could not be rejected in the case of HOC. The putative major genes explained 28.3% and 31.4% of the adjusted HOC and VEC variability, respectively. The results of the bivariate analysis did not support the hypothesis of a common major gene simultaneously affecting HOC and VEC. Our findings suggest that head growth in horizontal and vertical dimensions is influenced by two independent major genes, with only

small and moderate effect genes being partially shared by HOC and VEC. While we obtained the strong evidence of a major gene affecting VEC, the results and conclusions involving HOC should not be considered confident and require further thorough investigation.
Key words: Anthropometry, horizontal and vertical head measurements, bivariate

INTRODUCTION

Over the last several decades extensive research has been conducted to characterize the involvement of genetic factors to determination of craniofacial phenotypes. The estimates of genetic effects on craniofacial traits variability differ considerably among the head traits and among the studies. This is probably due to a combination of factors, including a variety of study designs and measurement techniques implemented, as well as population heterogeneity. Generally, however, the results obtained in animal models (Deol et al., 1957; Leamy, 1974) [7, 19], twin studies (Naini and Moss, 2004; Savoye et al., 1998; Watnick, 1972) [28, 32, 36] and family based studies (Johannsdottir et al., 2005; Livshits and Kobyliansky, 1984; Sharma, 1998; Susanne, 1977) [14, 23, 33, 35] suggest a substantial contribution of genetic factors to head size traits determination. The majority of studies in the field, including those mentioned above, were focused mainly on the heritability estimation and/or the analysis of familial correlations. On the other hand, the more specific issues concerning the mode of inheritance of craniofacial phenotypes have been addressed by only a very limited number of studies (Ermakov et al., 2006) [9]. Thus, Ermakov et al. (2006) [9] demonstrated the involvement of major genes in head size determination in a sample of 357 ethnically homogeneous Chuvashian pedigrees. Moreover, the results obtained by Ermakov et al. (2006) [9] suggested that horizontal (HOC) and vertical (VEC) components of head size are influenced independently by two different major genes.

We recently reported the results of the quantitative genetic study of a number of craniofacial traits in a large sample of ethnically homogeneous Indian pedigrees (Karmakar et al., 2007) [16]. That study adopted the general strategy to consider horizontal and vertical head measurements separately, which has been implemented previously by other research groups (e.g. Carels et al., 2001; Harris and Johnson, 1991;

Lundstrom and McWilliam, 1987; Manfredi et al., 1997) [3, 13, 24, 26]. Similarly to Ermakov et al. (2006) [9] two principal components were derived from the 11 original head size traits. These were referred to as HOC, reflecting the horizontal component of the overall head growth, and VEC, reflecting the overall head growth in vertical dimension. We demonstrated the significant genetic contribution to both these components. Thus as reported in Karmakar et al. (2007) [16] after accounting for the effects of sex and age, the portion of the total variance attributable to the putative additive genetic factors was 68.3% and 70.3% for HOC and VEC, respectively. Moreover, the results of bivariate variance decomposition analysis strongly suggested the existence of common genetic factors simultaneously affecting HOC and VEC, 41.8% of the two traits' total residual variance was attributable to the effect of these common genetic factors. These findings lead to the question about the nature of these common genetic influences and suggest the possibility that head development in horizontal and vertical dimensions could be influenced by a single major gene together with genes having minor and modest effects.

In the light of the above considerations, the aims of this study were to examine the mode of inheritance of HOC and VEC, and to test the hypothesis of a single major gene simultaneously affecting these two phenotypes, by means of univariate and bivariate complex segregation analyses.

MATERIALS AND METHODS

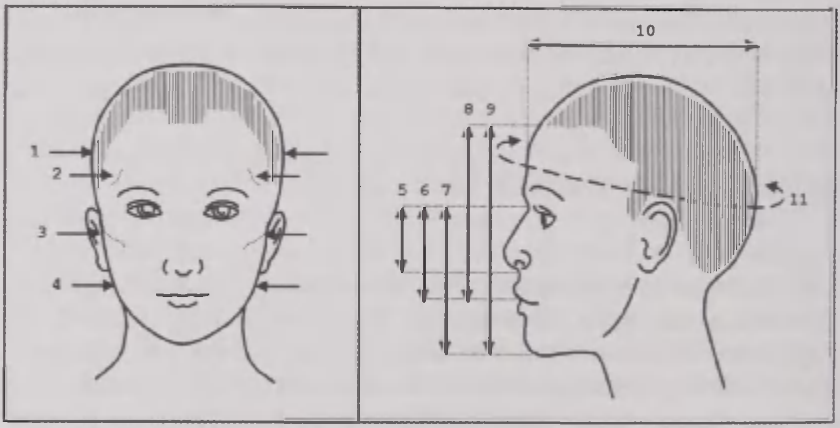
Sample

The study sample included 1,263 individuals (686 males and 577 females), belonging to 373 pedigrees. The data were collected from five populations: Brahmin (Rarhi), Mahisya, Padmaraj, Muslim (Sunni), and Lodha, residing in the rural areas of Howrah and the Midnapore districts of West Bengal, India. These populations are appropriate for the purposes of this study due to their following characteristics: 1) each population practices monogamy and is strictly endogamous (without intercaste marriage); 2) a demographically stable family structure with traditional relations between family members; 3) and similar environmental conditions. An informed consent was received from each individual who participated in the study. Further details on the studied populations have been reported by us recently (Karmakar et al., 2005) [15].

Measurements

Using the standard anthropometric procedure (Martin, 1928) [27], 11 head size measurements were assessed in each study individual (Fig. 1). The measurements were taken by the same investigator (the first author) to eliminate the possibility of inter-investigator error. These 11 original head traits included (the anthropological landmarks corresponding to each measurement are given in parentheses): head length (glabella – opisthocranion), breadth (euryon – euryon) and circumference (glabella – opisthocranion), minimum frontal (frontotemporale – frontotemporale), bizygomatic (zygion – zygion), and bigonial breadths (gonion – gonion), physiognomic facial height (trichion – gnathion), physiognomic superior facial height (trichion – stomion), morphological facial height (nasion – gnathion), morphological superior facial height (nasion – prosthion), and nasal height (nasion – subnasale).

Figure 1. Schematic representation of the 11 original craniofacial measurements.



1. head breadth; 2. minimum frontal breadth; 3. bizygomatic breadth; 4. bigonial breadth; 5. nasal height; 6. morphological superior facial height; 7. morphological facial height; 8. physiognomic superior facial height; 9. physiognomic facial height; 10. head length; 11. head circumference.

Statistical analysis

1) Pooling of the data from five populations

To reduce the number of statistical tests in the subsequent analyses, and to substantially increase the overall power of the study, the data were standardized in each population separately and then combined to form the joint data sample.

2) Statistical analysis

All the preliminary statistical procedures, i.e. descriptive statistics, principal component and multiple regression analyses, were conducted using the Statistica 7.1 package for Windows (Statsoft Inc., Tulsa, Oklahoma, USA). The principal component analysis with an eigenvalue of 1 criterion and a varimax rotation was carried out on the 11 original head traits. Two components were extracted. Based on the distribution of the corresponding load scores, we interpreted the first principal component as predominantly the horizontal head size component (HOC), and the second principal component (VEC) as corresponding to the vertical head size. HOC and VEC were adjusted for the effects of sex, age and stature. The outcome standardized residuals of the two synthetic traits were used as primary phenotypes in the subsequent complex segregation analysis.

3) Univariate complex segregation analysis (UCSA)

UCSA as implemented in the MAN-7 package for Windows (Malkin and Ginsburg, 2007) [25] was carried out to test a hypothesis of the Mendelian transmission of adjusted HOC and VEC. The effects of a potential major gene, as well as the possible multifactorial effects (residual familial correlations), were estimated assuming the mixed model of inheritance (e.g. Ginsburg and Livshits, 1999; Lalouel, 1983) [10, 18].

The general model assumes the existence of a single autosomal locus affecting the trait of interest, and the Hardy-Weinberg equilibrium of the corresponding hypothetic genotypes, A1A1, A1A2, and A2A2 (denoted by $g = 1, 2$, and 3, respectively). It encompasses the major gene, multifactorial (polygenic), and environmental effects. The parameters estimated in the general model are presented in Table 1. Additionally, we assumed the intergenerational stability of the studied population, i.e. a constant putative major gene alleles' frequency among generations. This condition implies that p, the population frequency of allele A1, is equal to the sum of products of frequency of each genotype times the probability of transmission of the allele A1 to the offspring generation for each genotype: $p = \tau_{A1A1}\, p^2 + \tau_{A1A2}\, 2p(1-p) + \tau_{A2A2}\, (1-p)^2$. Accordingly, the accepted univariate general model contained 12 free parameters.

Table 1. Definitions of parameters estimated in the general model of univariate segregation analysis.

Parameter	Explanation
p	population frequency of the first of two putative major gene alleles (A1 and A2); $p = \tau_{A1A1}\, p^2 + \tau_{A1A2}\, 2p(1-p) + \tau_{A2A2}\, (1-p)^2$
τ_g	probability of transmission of the allele A1 to the offspring generation, by each of three possible genotypes
μ_g	genotypic mean of the trait in all individuals with genotype g at the major gene locus
σ^2_g	genotype specific variance; estimates the residual trait variation owing to the effect of all possible environmental factors and potential minor genes
ρ	partial correlation between the trait residuals for major gene effect in spouses
β	partial correlation between the trait residuals for major gene effect in parents and offspring
ε	partial correlation between the trait residuals for major gene effect in sibs

The general (unrestricted) model adjusts all the parameters to the empirical data without restrictions, and thereby provides the best fit to the data. With different restrictions to the above parameters, it is possible to model various genetic and non-genetic models. These nested models are then tested against the general one. Four main submodels were compared with the general model, i.e. sporadic model, the multifactorial model, the environmental (no major gene effect) model, and the mendelian (major gene) model. The details on these models' formulation and the respective hypotheses tested are provided in Table 2. The presence of the major gene effect was accepted when two conditions were met simultaneously: the Mendelian model could not be rejected when compared to the general model, and the environmental model fitted data significantly worse than the general model. Additional models were formulated to test the significance of multifactorial effects and to determine the mode of inheritance of the major gene effect, i.e., dominant, additive, or recessive alleles' interaction.

Table 2. Formulation of the four major submodels tested in univariate segregation analysis.

Parameter	Sporadic	Multifactorial	Environmental	Mendelian
p	ignored	ignored	Fixed: $p = \tau_{A1A1} = \tau_{A1A2} = \tau_{A2A2}$	estimated
τ_g	ignored	ignored		Fixed: $\tau_{A1A1} = 1$, $\tau_{A1A2} = 0.5$, $\tau_{A2A2} = 0$
μ_g	Fixed: $\mu_{A1A1} = \mu_{A1A2} = \mu_{A2A2}$	Fixed: $\mu_{A1A1} = \mu_{A1A2} = \mu_{A2A2}$	estimated	estimated
σ^2_g	Fixed: $\sigma^2_{A1A1} = \sigma^2_{A1A2} = \sigma^2_{A2A2}$	Fixed: $\sigma^2_{A1A1} = \sigma^2_{A1A2} = \sigma^2_{A2A2}$	estimated	estimated
ρ	Fixed to zero	estimated	estimated	estimated
β	Fixed to zero	estimated	estimated	estimated
ε	Fixed to zero	estimated	estimated	estimated
Hypothesis	no familial aggregation and intergenerational transmission of the trait	familial correlations best explain the intergenerational transmission	no intergenerational transmission of the major factor; environmental and polygenic effects are allowed.	intergenerational transmission follows the Mendelian rules

A maximum likelihood ratio test (MLRT) was used to compare the general model and the nested models, i.e. the models where one or more parameters were constrained to the expected value. MLRT was calculated as twice the negative difference of the natural log likelihoods (–2lnLH) between the two models. This statistic is asymptotically distributed as a $\chi 2$ distribution with degrees of freedom equal to the difference in the number of parameters estimated in the two models. The best-fitting and most parsimonious model (MPM) was established after dropping all the non-significant parameters from the general model.

Additionally, we used the Akaike's Information Criteria (AIC) for the comparison of competing models. The AIC is defined as –2lnLH + 2N, where N is the number of estimated parameters (Akaike, 1987) [2].

4) Bivariate complex segregation analysis (BCSA)

To check the hypothesis of one common major gene simultaneously affecting both, HOC and VEC, BCSA was conducted using the MAN-7 package for Windows (Malkin and Ginsburg, 2007) [25]. The values estimated in the univariate MPMs for the two traits were used as the starting points in this analysis. Bivariate models included additional parameter ω, which corresponds to partial residual correlation of the two analyzed traits in the same individual. General, environmental and Mendelian bivariate models were tested. These were formulated similar to the corresponding univariate models. Again, the hypothesis of the common for HOC and VEC major gene effect was accepted when the Mendelian bivariate model could not be rejected when compared to the general model, while the environmental bivariate model fitted the data significantly worse than the general model.

RESULTS

Preliminary statistical analysis

The male subjects were on average a little older (40.80±14.67) than the females portion (36.69±11.13), but the two age distributions were mostly overlapped. The mean values of adult height and the 11 original head size phenotypes were higher in males compared with females.

11 available head traits were subjected to the principal component analysis. The resultant two principal components, PC1 and PC2, explained 25.4% and 31.6% of the total variability of the raw traits, respectively. PC1 was loaded predominantly by the horizontal head measurements and was interpreted as the horizontal head size component (HOC). PC2 was loaded mainly by vertical head phenotypes and was interpreted as the vertical head size component (VEC). Specifically, for HOC the load scores of head length, head breadth, head circumference, as well as minimum frontal, bizygomatic, and bigonial breadths were all higher 0.5 and ranged from 0.53 to 78, while the load scores for the five vertical craniofacial measurements were all below 0.26, except for physiognomic facial height that had a load score of 0.41. On the

other hand, VEC was loaded predominantly by the vertical phenotypes. Thus, the corresponding load scores were between 0.63 and 0.87 for physiognomic facial height, physiognomic super facial height, morphological facial height, morphological superior facial length, and nasal height. The load scores of horizontal measurements were all below 0.36 for VEC.

The multiple regression models, including sex, age and adult height as predictor variables, explained 29% and 36% of the total HOC and VEC variance, respectively. Accordingly, these traits were adjusted for covariates, and the resultant standardized residuals were used in the further analysis.

After accounting for significant confounders, the maximum heritability estimates (Rice et al., 1997) [30] equaled 0.72 and 0.67 for HOC and VEC, respectively.

Further details on the preliminary statistical and principal components analyses, as well analysis of familial correlations and variance decomposition analysis were reported recently elsewhere (Karmakar et al., 2007) [16].

Univariate complex segregation analysis (UCSA)

Tables 3 and 4 present the results of UCSA for HOC and VEC, respectively. The tables provide parameter estimates and corresponding maximum likelihood and the AIC values for the general model, sporadic, multifactorial, environmental, and Mendelian submodels, and MPM. As it is seen, the sporadic submodel was strongly rejected ($p < 0.001$) by the likelihood ratio test for both head size components. These results suggested that the distribution of HOC and VEC values were not random in the studied population, and that familial effects were significant for both phenotypes. The multifactorial model for VEC fitted data significantly worse than the general model ($p < 0.05$). However, in the case of HOC, this model could not be rejected ($p = 0.131$). For both traits, the Mendelian model demonstrated practically perfect data fit, and the corresponding values of the parameters estimated in the respective general models were very similar to those of the Mendelian models. On the other hand, the environmental model, denying the intergenerational transmission of the major gene alleles, was rejected for both traits ($p < 0.05$). Thus, the results clearly indicated the presence of the major gene effect for VEC. The evidence obtained for HOC was somewhat controversial. Although both, multifactorial and Mendelian models could not be rejected at 0.05 significance threshold, the Mendelian model appeared to fit the data much better than the multifactorial as indicated by the lower AIC value for the Mendelian model and a great extent of similarity among parameter estimates by this model and the respective general model. Consequently, we *assumed* the existence of a major gene effect on both traits determination and proceeded to the univariate MPM formulation for both phenotypes.

Table 3. Univariate segregation analysis of HOC.

Parameter	General	Sporadic	Multifactorial	Environmental	Mendelian	MPM
p	0.322[a]	–	–	0.043[d]	0.322	0.530 ± 0.099
μ_1	–1.003	0.049	0.042	–0.033	–1.003	–0.241 ± 0.108
μ_2	–0.384	0.049[b]	0.042[b]	–0.200	–0.384	–0.241[b]
μ_3	0.681	0.049[b]	0.042[b]	0.062	0.681	1.063 ± 0.233
σ_1^2	1.171	1.057	1.040	1.253	1.171	1.301 ± 0.255
σ_2^2	0.475	1.057[b]	1.040[b]	0.140	0.475	0.523 ± 0.087
σ_3^2	0.732	1.057[b]	1.040[b]	1.111	0.732	0.523[b]
p	0.208	[0.000][c]	0.063	0.069	0.208	[0.000][c]
β	0.183	[0.000][c]	0.264	0.268	0.183	0.282 ± 0.004
ε	0.087	[0.000][c]	0.014	0.009	0.087	[0.000][c]
τ_1	1.000[a]	–	–	0.043[d]	[1.000][c]	[1.000][c]
τ_2	0.500[a]	–	–	0.043[d]	[0.500][c]	[0.500][c]
τ_3	0.000[a]	–	–	0.043[d]	[0.000][c]	[0.000][c]
LH	–949.38	–999.48	–954.97	–953.09	–949.38	–952.10
AIC	1922.75	2002.96	1919.94	1926.18	1918.75	1916.19
χ^2	–	100.20	11.18	7.42	0.00	5.44
d.f.	–	10	7	2	2	6
p-value	–	<0.001	0.131	0.024	1.000	0.489

[a] Parameters p, τ_1, τ_2, τ_3, are related by the equation $p = \tau_{A1A1} p^2 + \tau_{A1A2} 2p(1-p) + \tau_{A2A2} (1-p)^2$. [b]Parameter is constrained to the value above. [c]Parameter is constrained to the value given in the brackets. [d]$p= \tau_1= \tau_2= \tau_3$. MPM – best fitting and most parsimonious model. LH – likelihood. AIC – Akaike's Information Criteria.

The parameter estimates of the MPMs for HOC and VEC are presented in the last columns of Tables 3 and 4, respectively. The MPM for HOC indicated a possible dominance effect of an allele predisposing to lower values of adjusted HOC. The additive model of alleles' interaction was suggested for VEC. For both traits, spouse and sibling residual correlations could be set to zero without a substantial loss of data fit. On the other hand, for both phenotypes, models, where parent-offspring residual correlations were constrained to zero, were significantly rejected. In case of both, HOC and VEC, the AIC values were the lowest for MPMs.

The inferred major genes explained 28.3% and 31.4% of the residual HOC and VEC variance, respectively (for calculation procedure see Ginsburg and Livshits, 1999) [10].

Table 4. Univariate segregation analysis of VEC.

Parameter	General	Sporadic	Multifactorial	Environmental	Mendelian	MPM
p	0.203[a]	–	–	0.711[d]	0.202	0.197 ± 0.117
μ_1	–2.105	0.030	0.022	–0.050	–2.110	–1.600 ± 0.465
μ_2	–0.600	0.030[b]	0.022[b]	0.126	–0.596	–0.58865[e]
μ_3	0.479	0.030[b]	0.022[b]	–0.050	0.474	0.423 ± 0.198
σ_1^2	0.393	1.042	1.014	1.174	0.392	0.708 ± 0.106
σ_2^2	0.439	1.042[b]	1.014[b]	0.760	0.444	0.708[b]
σ_3^2	0.667	1.042[b]	1.014[b]	1.173	0.674	0.708[b]
ρ	0.056	[0.000][c]	–0.048	–0.041	0.056	[0.000][c]
β	0.153	[0.000][c]	0.271	0.271	0.152	0.243 ± 0.046
ε	0.133	[0.000][c]	0.004	0.002	0.133	[0.000][c]
τ_1	1.000[a]	–	–	0.711[d]	[1.000][c]	[1.000][c]
τ_2	0.493[a]	–	–	0.711[d]	[0.500][c]	[0.500][c]
τ_3	0.003[a]	–	–	0.711[d]	[0.000][c]	[0.000][c]
LH	–945.38	–993.16	–954.41	–954.00	–945.39	–948.399
AIC	1914.77	1990.33	1918.82	1928.00	1910.78	1906.80
χ^2	–	95.56	18.06	17.24	0.02	6.03
d.f.	–	10	7	2	2	7
p-value	–	<0.001	0.012	<0.001	0.992	0.536

[a]Parameters p, p, τ_1, τ_2, τ_3, are related by the equation $p = \tau_{A1A1}\, p^2 + \tau_{A1A2}\, 2p(1-p) + \tau_{A2A2}\,(1-p)^2$. [b]Parameter is constrained to the value above. [c]Parameter is constrained to the value given in the brackets. [d]$p = \tau_1 = \tau_2 = \tau_3$. [e]Additive model: $\mu_2 = (\mu_1 - \mu_3)/2$. MPM – best fitting and most parsimonious model. LH – likelihood. AIC – Akaike's Information Criteria.

Bivariate complex segregation analysis (BCSA)

Given the strong evidence in support of a major gene hypothesis for VEC and *assuming* major gene effect for HOC, we tested the hypothesis of a common major gene simultaneously affecting the two studied phenotypes. The results of the corresponding BCSA are presented in Table 5. The Mendelian bivariate model fitted the data as well as the general bivariate model, while the environmental bivariate model was rejected at a high level of significance ($p < 0.001$). We estimated that the common gene inferred by the bivariate model explained 12.1% and 30.5% of the adjusted HOC and VEC variance, respectively. When comparing the major gene effect estimates for HOC obtained from uni- and bivariate analyses, a substantial reduction (28.3% vs. 12.1%) was apparent. We further tested the significance of the effect of the major gene inferred by the bivariate model on HOC genotype-specific means. Practically, two additional models were tested (the last two columns in Table 5). The Mendelian bivariate model, constructed on the basis of the parameters estimated in univariate MPMs (the Mendelian MPM model), was tested against the bivariate model where HOC genotypic mean values were estimated via the optimization process (Mendelian A model). Secondly, we estimated the model where the three HOC genotypic mean values were constrained to be equal to one another. assuming no effect of the putative common major gene on HOC (Mendelian B model). The latter model was rejected when compared to the Mendelian A model ($p = 0.005$). Of the total of five bivariate models tested, Mendelian models based on univariate MPMs had the lowest AIC value.

DISCUSSION

There is a wealth of published quantitative genetic studies that firmly establish the significance of genetic factors' contribution to the determination of craniofacial traits' normal variability (Johannsdottir et al., 2005; Livshits and Kobyliansky, 1984; Naini and Moss, 2004; Savoye et al., 1998; Watnick, 1972) [14, 23, 28, 32, 37] However, the mode of inheritance of head phenotypes in healthy populations remains largely undetermined.

Table 5. Bivariate segregation analysis of HOC and VEC.

Parameter	General	Environmental	Mendelian MPM	Mendelian A	Mendelian B
p	0.735[a]	0.741[d]	0.735	0.749	0.721
HOC					
μ_1	–0.055	–0.039	–0.055	–0.107	0.045
μ_2	–0.055[b]	–0.039[b]	–0.055[b]	0.033	0.045[b]
μ_3	1.321	1.270	1.321	1.376	0.045[b]
σ_1^2	1.126	1.157	1.126	1.112	0.910
σ_2^2	0.638	0.586	0.638	0.652	1.177
σ_3^2	0.638[b]	0.586[b]	0.638[b]	0.652[b]	1.177[b]
ρ	[0.000][c]	[0.000][c]	[0.000][c]	[0.000][c]	[0.000][c]
β	0.281	0.276	0.281	0.282	0.268
ε	[0.000][c]	[0.000][c]	[0.000][c]	[0.000][c]	[0.000][c]
VEC					
μ_1	0.499	0.276	0.499	0.487	0.528
μ_2	–0.402[e]	–0.211[e]	–0.402[e]	–0441[e]	–0.366[e]
μ_3	–1.302	–0.698	–1.302	–1.368	–1.261
σ_1^2	0.718	0.907	0.718	0.712	0.704
σ_2^2	0.718[b]	0.907[b]	0.718[b]	0.712[b]	0.704[b]
σ_3^2	0.718[b]	0.907[b]	0.718[b]	0.712[b]	0.704[b]
ρ	[0.000][c]	[0.000][c]	[0.000][c]	[0.000][c]	[0.000][c]
β	0.246	0.258	0.246	0.249	0.214
ε	[0.000][c]	[0.000][c]	[0.000][c]	[0.000][c]	[0.000][c]
τ_1	1.000[a]	0.741[d]	[1.000][c]	[1.000][c]	[1.000][c]
τ_2	0.500[a]	0.741[d]	[0.500][c]	[0.500][c]	[0.500][c]
τ_3	0.000[a]	0.741[d]	[0.000][c]	[0.000][c]	[0.000][c]
ω	–0.027	–0.044	–0.027	–0.011	–0.124
LH	–1892.05	–1903.38	–1892.05	–1891.76	–1897.03
AIC	3810.1	3828.76	3806.1	3807.52	3814.06
χ^2	–	22.66	0.00	0.58	10.54
d.f.	–	2	2	1	2
p-value	–	<0.001	1.000	0.446	0.005

[a]Parameters p, τ_1, τ_2, τ_3, are related by the equation $p = \tau_{A1A1}\, p^2 + \tau_{A1A2}\, 2p(1-p) + \tau_{A2A2}\,(1-p)^2$. [b]Parameter is constrained to the value above. [c]Parameter is constrained to the value given in the brackets. [d]$p = \tau_1 = \tau_2 = \tau_3$. [e]Additive model: $\mu_2 = (\mu_1 - \mu_3)/2$. MPM – best fitting and most parsimonious model. LH – likelihood. AIC – Akaike's Information Criteria.

In this study, we examined the two synthetic indices, constructed on the basis of principal component analysis of 11 raw head phenotypes. These two complex traits were interpreted as two components of head growth, horizontal (HOC) and vertical (VEC). To account for the effects of potential confounders, HOC and VEC were adjusted for sex, age, and adult height, and the resultant standardized residuals were used in the consequent analyses. Importantly, as this study and the research reported by Ermakov et al. (2006) [9]were very similar with respect to the properties of the samples and the research objectives, we adopted the same methodology as in Ermakov et al. (2006) [9]. In order to make cross-reference between the findings of the two studies convenient, we followed closely the format and structure of data presentation used in Ermakov et al. (2006) [9].

The results of the complex segregation univariate analysis of VEC provided a strong evidence of the Mendelian type of transmission for VEC (Table 4). All the three submodels assuming no major gene effect, i.e. sporadic, multifactorial, and environmental, could be rejected at $p < 0.05$, while the Mendelian model fitted data almost as well as the general model ($p = 0.992$). The additive model of allele interaction was suggested for VEC.

The univariate segregation analysis of HOC yielded somewhat controversial results (Table 3). Thus, while sporadic and environmental models fitted the data significantly worse than the general model ($p < 0.05$), both, the Mendelian and the multifactorial, models could not be rejected when compared with the general one. This does not allow to accept or to reject the hypothesis of a major gene affecting HOC unambiguously. However, there is some supportive evidence in favor of the major gene hypothesis. The Mendelian model was practically identical to the general model with respect to the data fit ($p = 1.000$) and the values of parameter estimates. Moreover, according to the AIC criterion, the Mendelian model was superior over the multifactorial one. Assuming the existence of a major gene affecting HOC, the MPM suggested a possible dominance effect of an allele predisposing to lower values of adjusted HOC.

The putative major gene explained 28.3% and 31.4% and of the adjusted HOC and VEC variability. These estimates are comparable with those obtained by the complex segregation analyses of other anthropometric phenotypes, e.g. adult height (Ginsburg et al., 1998; Li et al., 2004) [11, 20], spine (Liu et al., 2004) [22] and hand (Cohen et al., 2003) [5]bone size. Interestingly, our estimates are lower than those reported by Ermakov et al. (2006) [9] . Thus, in the study of 357 ethnically homogeneous Chuvashian pedigrees, Ermakov et al. (2006) [9] have shown that major genes explained 54.0% and 45.6% of HOC and VEC residual variance, respectively. The studied phenotypes were derived via the principal component analysis, similar to the present study. Such considerable difference between Indian and Chuvashian populations with respect to the extent of major gene involvement in the overall head development might emerge from the greater relative contribution of environmental factors to the variability of craniofacial size and the shape in the Indian population. In case of HOC, the mentioned difference might also be caused by not accounting for the confounding effect of weight in the present study, as this phenotype was not available. This circumstance could lead to the underestimation of the putative major gene effect on HOC in the Indian sample.

Despite the controversial results of the univariate analysis for HOC, we conducted the bivariate complex segregation analysis of HOC and VEC (Table 5). The environmental model, where no major gene common for the two phenotypes was assumed, was highly significantly worse than the general model ($p < 0.001$). Notably, the Mendelian bivariate model, where the effect of the common major gene on the HOC genotype specific means was set to zero (Mendelian B model), was also rejected ($p = 0.005$), when compared with the Mendelian model where HOC genotype-specific means were estimated via optimization process (Mendelian A model). On the other hand, the Mendelian bivariate model, formulated on the basis of the univariate MPMs for HOC and VEC (Mendelian MPM model), did not differ significantly from the general Mendelian model ($p = 1.000$) or from Mendelian A model ($p = 0.446$). From the five tested bivariate models, Mendelian MPM model was the most parsimonious and the best fitting model according to the AIC as well.

Importantly, the estimate of the portion of the HOC residual variance explained by the putative common major gene inferred by the bivariate model differed substantially from the respective estimate obtained from the univariate model, i.e. 12.1% vs. 28.3%. On the other hand, the corresponding estimates of the major gene effect on VEC were similar in bivariate and univariate models, 30.5% and 31.4%, respectively. This may be an indication of the fact that VEC was a dominating phenotype in the bivariate models. These results also suggest that there is no common major gene simultaneously affecting HOC and VEC, but rather, the two phenotypes are influenced independently by different major effect genes, and the bivariate analysis implies that the putative gene acting as a major gene in the case of VEC has only a moderate effect on HOC. Interestingly, this hypothesis based on the results of BCSA in the Indian sample is similar to the conclusions drawn by Ermakov et al. (2006), based on their findings in Chuvashian population.

During the past two decades tremendous progress in the study of craniofacial development has been made, and the molecular factors, crucial for the patterning and formation of craniofacial structures, have been discovered and extensively investigated (Chai and Maxson, 2006; Rice, 2005) [3, 31]. However, we are aware of an extremely limited number of publications devoted to the search for specific genetic factors involved in the determination of the normal variability of cranial size and shape in human population. The studied genes included the growth hormone receptor (Yamaguchi et al., 2001; Zhou et al., 2005) [38, 40], insulin (Ong et al., 2004) [29], and the fibroblast growth factor receptor 1 (Coussens and van Daal, 2005) [6]. Thus, there is still much more to learn about the genes affecting craniofacial phenotypes' variability in healthy individuals. The findings of this research provide important points to consider for the future studies of linkage and association of HOC, VEC, and other craniofacial phenotypes, as well as for molecular studies of skull development.

Although the distinction between the horizontal and vertical craniofacial phenotypes is an oversimplification of the biological phenomena, to some extent it accounts for the modular organization of the cranium. Thus, the skull is made up of three partially independent units of embryologically different origin, i.e. the basicranium (cranial base), the neurocranium (cranial vault), and the viscerocranium (face) (Hallgrimsson et al., 2007; Lieberman et al., 2000) [12, 21]. As it has been shown in humans and in animal models, these units have different maturity gradients (Abed et al., 2007; VandeBerg et al., 2004; Yavuz et al., 2004) [1, 36, 39], where viscerocranium is the latest element to mature. This generally results in vertical measurements mature later than the horizontal phenotypes. Correspondingly, in the biological sense, HOC can be viewed as a proxy for basicranium and neurocranium development, while VEC can be a considered to represent the development of viscerocranium. Such interpretation is in agreement with the previous studies (Krogman, 1979; Sinclair and Dangerfield, 1998; Yavuz et al., 2004) [17, 34, 39]. Given the partial functional and ontogenic independence of the cranial components represented by HOC and VEC, the results of the present study and the corresponding hypothesis of two different major genes and a number of shared small and moderate effect genes determining these two phenotypes variability, seem to fit well the biological context of craniofacial development.

Our study is not free from limitations. The study was conducted on the data pooled from five populations. This was done in order to obtain the sufficient sample size and greater power. Although, the effect of stratification was accounted for by pooling the data which was standardized in each subsample separately, it still could be a source of a bias. Another potential limitation of this study is a modest number of raw head size traits, from which the two synthetic indices, i.e. HOC and VEC, were derived. Yet, HOC and VEC collectively explained some 57% of the 11 original head traits variability. This allows us to believe that the two examined phenotypes adequately reflected the overall head development in horizontal and vertical dimensions. Perhaps the most important limitation of the study was reflected in the apparent controversy of the univariate results for HOC, which did not allow us to make clear cut conclusions on the mode of inheritance of this phenotype. One possible reason of this could be not accounting for the significant confounding effect of weight on the horizontal craniofacial traits (Ermakov et al., 2005) [8]. Although, the UCSA generally favored the hypothesis of a major gene for HOC, we emphasize that the results obtained in the univariate and bivariate analyses involving this phenotype should be considered with caution.

CONCLUSION

The results of this study provide convincing evidence of the major gene involvement in the vertical head size component determination. The inferred major gene explained some 31% of the residual VEC variability. Our findings provide some support of the hypothesis of the major gene affecting HOC in the studied population. However, no straightforward conclusion could be drawn on that matter, and this remains a subject for further thorough investigation. Based on the obtained results, we hypothesize that in the ethnically homogeneous population from West Bengal, India, there is no common major gene simultaneously affecting head growth in horizontal and vertical dimensions, but rather HOC and VEC are influenced by two different major genes, and share only small and moderate effect genes.

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ACTUAL VERSUS PREDICTED MAXIMAL OXYGEN UPTAKE IN INTERMITTENT SPORT ATHLETES (Comparative values of VO_{2max} in basketball players)

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ABSTRACT

Aim: We attempted to test whether a previously published equation for prediction of maximal oxygen uptake corroborated on endurance athletes could also allow to determine VO_{2max} in intermittent team sport athletes.
Methods: Thirty-nine high-level, male, intermittent sport game athletes (age = 24.59± 3.372 years) performed a cardiopulmonary exercise test on a cycle ergometer to determine their VO_{2max}. A ramp (25–30W/min) protocol was employed for this goal. Conventional criteria were used for attaining VO_{2max}.
Further, the equation introduced by Storer et al. and shown to be applicable for athletic population by Malek et al. was used for prediction of VO_{2max}. The paired t-test was used to compare measured and predicted VO_{2max}.
Results: The results of the paired t-test revealed significant differences between VO_{2maxM} (4801.1±759.7 ml/min/kg) and VO_{2maxC} (5126.4±546.5 ml/min/kg) in intermittent team game representatives ($t=|-4.4|>2.042$, $df=38$, $p<0.05$). The difference between VO_{2maxM} and VO_{2maxC} exceeded standard deviation for VO_{2maxM} in 17.9% of the cases (7/39). Individual differences between VO_{2maxM} and VO_{2maxC} were larger than 10% of VO_{2maxM} in 51.3% of cases (20/39).
Conclusions: We concluded that prediction of VO_{2max} by using the equation valid for endurance athletes is limited for intermittent team

sport representatives. This finding could be related to the anthropometric characteristics of the studied subjects.

Key words: maximal oxygen uptake, exercise testing, intermittent exercise, athlete

INTRODUCTION

Low level of aerobic fitness is associated with increased risk of cardiovascular morbidity and mortality. Regular physical activity could be recognized as the most powerful non-pharmacological agent, which alters cardiorespiratory fitness [2, 12]. Maximal oxygen uptake (VO_{2max}) reflects the maximal capacity of the cardiovascular system to increase blood flow to the exercising muscle, which is generally considered the golden standard measure of aerobic fitness [3, 14]. The status of aerobic fitness is important for correct planning of training process or for avoiding overtraining. There are various methods to determine VO_{2max}, from using several tests and measures to calculation without direct measurement of breathing gases [3, 6, 10, 13, 14]. Indirect determination of aerobic fitness seems beneficial saves time and resources. Although a number of formulas have been proposed for determination of aerobic fitness [8–10, 13, 14], the plausibility of such determination is still a matter of discussion.

The studied athletes can be regarded as a particular segment of general population because of their specific anthropological features required for basketball as well as because of the influences of the quantity and quality of training. The applicability of conventional VO_{2max} predicting formulas to heterogeneous athletic population was researched by Malek et al. [8, 9]. However, their study did not include representatives of intermittent sports. Hence the aim of the current study was to check the appropriateness of indirect determination of VO_{2max} for basketball players using the equation, that has proved valid for endurance sports athletes.

MATERIAL AND METHODS

Participants. All thirty-nine investigated athletes were professional basketball players with international experience (at least European Cups for clubs). All subjects were apparently healthy and physically active to a similar degree. The subjects were free of cardiovascular and chronic respiratory conditions, had no history of sleep apnoea, central or peripheral nervous system disorder and were not taking any medication at the time of the study. Written informed consent for participation in this testing was obtained from each athlete in accordance with the code of ethics. Cardiorespiratory exercise testing was part of biomedical examination before signing or extension of the player's contract.

Design. We assessed cardiodynamic and metabolic variables for the subjects using incremental exercise on a cycle ergometer. All cardiopulmonary exercise tests (CPET) were carried out under laboratory conditions complying with the regulations of the American Thoracic Society (ATS) [1]. The subjects completed a maximal continuous graded exercise test on an electronically braked ergometer Ergometrics 800 (Ergoline, Bitz, Germany). Power output was increased by 25–30 Watts (W) at every minute and pedalling cadence was kept constant at 60–70 revolutions per minute (rpm). The exercise tests were terminated upon exhaustion, or when the conventional criteria established for test termination were met [14]. Gas exchange data were collected continuously using an automated breath by breath system VMAX229C (Sensormedics Corps., Yorba Linda, CA, USA). Calibration of the flow/volume sensor was achieved immediately before each test. Samples were formed for each 20 s interval for evaluation of lung ventilation indicators, heart activity, oxygen uptake, and work rate. The data were analysed using the Marquettecardiosys 3.01d diagnostic algorithm.

The VO_{2max} was predicted using the equation introduced by Storer et al. [13]:

$VO_{2max} = (10.51 * W_{max}) + (6.35 * BW) - (10.49 * age) + 519.3$. Thus in such calculation the values of maximal work rate (W_{max}) in Watts, body weight (BW) in kg, and age in years are required.

Statistical analysis. The results are presented as the mean ± standard deviation of mean (m±SD). We set a priori that the margin of satisfactory prediction is exceeded if the difference between the values of measured (VO_{2maxM}) and calculated maximal oxygen uptake (VO_{2maxC})

is larger than 10% of individual VO_{2maxM}. The paired t-test was employed to compare VO_{2maxM} and VO_{2maxC} of the studied subjects. Statistical significance was set at $p = 0.05$ for all analyses. All calculations were made with SPSS 11.0.

RESULTS

The main anthropometric features of the studied athletes are presented in Table 1. According to these data, the studied athletes can be described as tall and heavy subjects. The results of their maximal continuous graded exercise test are presented in Table 2. The descriptive statistics of measured and calculated values of VO_{2max} are presented in Table 3. The results of CPET are consistent with relevant literature data [4, 5, 11]. All individual differences between the measured and calculated values of VO_{2max} are shown in Fig. 1. As is evident, the calculated values of VO_{2max} are higher than the values of VO_{2max} measured during CPET in the majority of the cases (76.9%). The difference between VO_{2maxM} and VO_{2maxC} exceeds the standard deviation of VO_{2maxM} in 17.9% of the cases (7/39). The difference between VO_{2maxM} and VO_{2maxC} exceeds 10% of VO_{2maxM} in 51.3% of cases (20/39). The results of the paired *t*-test confirm significant differences between VO_{2maxM} and VO_{2maxC} in intermittent team game representatives ($t=|-4.4|>2.042$, $df=38$, $p<0.05$).

Table 1. Anthropometric characteristics of the study subjects (n = 39).

Parameter	Minimum	Maximum	Mean	Std. deviation
Age (years)	19	31	24.59	3.37
Height (cm)	179	215	198.56	8.44
Body mass (kg)	72	127	97.81	11.92
Body mass index (kg/m^2)	20.45	28.31	24.73	1.84

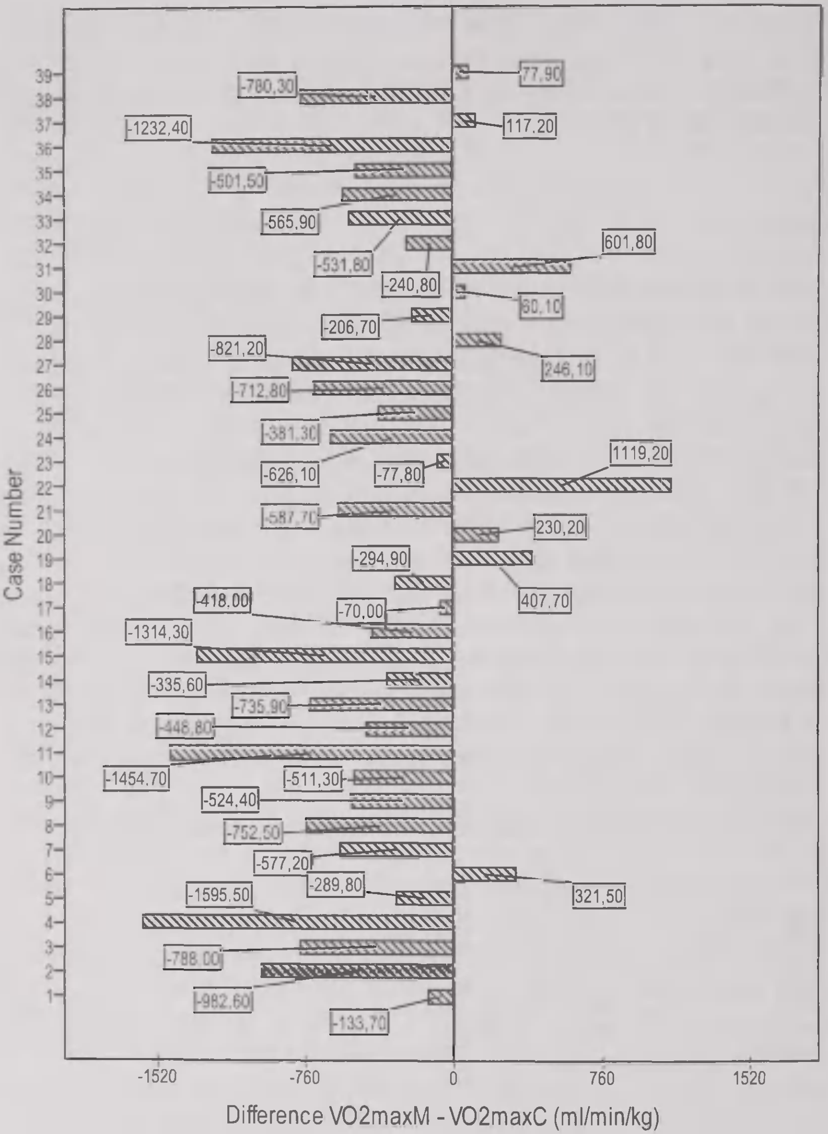

Fig 1. Actual individual differences between measured and calculated VO_{2max} (n = 39).

Table 2. Cardiopulmonary testing parameters of the study subjects (n = 39).

Parameter	Mean	Minimum	Maximum	Std. deviation
Heart rate max (bpm)	177.5	151	199	12.2
Ventilation max (l/min)	141.2	83.4	203.6	26.6
Work rate max absolute (W)	354.7	250	453	50.8
Work rate max relative (W/kg)	3.67	2.29	4.82	0.62

Table 3. Comparison of the descriptive statistics of VO_{2maxM} and VO_{2maxC} (n = 39).

Parameter	Mean	Median	Minimum	Maximum	Std. deviation
VO_{2maxM} (ml/min/kg)	4801.1	4975.5	3043.8	6071.7	759.7
VO_{2maxC} (ml/min/kg)	5126.4	5040.1	4085.3	6215.7	546.5

DISCUSSION

The values of measured maximal oxygen consumption in the studied subjects are closer to the corresponding values for general population than to the corresponding values for aerobically trained subjects or endurance athletes. The difference between actual and predicted values of VO_{2max} is larger than 10% of VO_{2maxM} in the majority of cases in intermittent team game representatives. The tendency to overestimate the real value of VO_{2max} in case the equation proposed by Storer et al. [13] was noted in a previous research of Malek et al. [8]. Our results confirm this tendency.

The study subjects can be regarded as a relatively homogeneous yet a specific population segment as they are tall, heavy and represent one field of sport with comparable training modes. In this respect, the present study differs from that of Malek et al. [8].

An aerobically trained individual has been defined as someone who has participated in continuous aerobic exercise three or more sessions per week for a minimum of 1 h per session, for at least the past 18 months [8]. For the subjects of the present study the duration of weekly training sessions (9 hours or more) exceeds significantly the above criterion. The players are involved in 1–3 games each week but the playing times for individual athletes are highly different. Despite their high weekly involvement in practice and competition, they are not typical representatives of endurance disciplines where high oxygen consumption is a favourable condition for success. This is another feature which distinguishes the present study from that of Malek & al. [8] and which could be associated with poor prediction of VO_{2max} in intermittent team game representatives when the equation Storer's et al. is used.

The in-season variation of VO_{2max} fluctuates in the range of 10% or less in basketball [5]. As was suggested by Cormery et al. [4] and partially confirmed in our previous study [7], the contribution of aerobic metabolism to energy expenditure during a basketball game tends to increase and precise determination of maximal oxygen uptake will be more important. If the accuracy of prediction fluctuates more than in-season variation of VO_{2max}, the practical benefit of such prediction is doubtful.

In general, the accuracy of determination of VO_{2maxC} among the studied athletic population by using Storer's formula was not satisfactory sufficient as the values of calculated VO_{2max} differed more than 10% from the real values in the majority of cases. Prediction of VO_{2max} by using the equation of Storer et al. equation requires anthropometric, demographic and physical data. It seems that the differences between VO_{2maxM} and VO_{2maxC} in this case are not related to metabolic properties but to some other characteristics of the study subjects. We can only suggest that phenotypic or anthropometric characteristics should be taken into account when VO_{2max} is calculated for tall and heavy persons.

CONCLUSION

Prediction of VO_{2max} in the homogeneous group of intermittent team-game athletes was carried out using the equation of Storer et al. The validity of this equation was confirmed by Malek et al. on a mixed athletic population. In contrast to the finding of Malek et al., prediction of VO_{2max} is not sufficiently precise in intermittent team game representatives. Despite the progress in estimation of VO_{2max} without collecting breathing gases, practical use of these methods in modern basketball seems highly questionable. The need for correction of existing formulas not only for persons with high metabolism but also for those with specific anthropometric characteristics is evident. Studies on a larger sample of tall and heavy athletes would allow to improve existing equations in the future.

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PHYSICAL ACTIVITY OF THE SUBJECTS ATTENDING FITNESS CLUBS

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ABSTRACT

A representative sample (n = 54) of the population of Tychy, a medium-size industrial town, was studied with respect to their declared physical activity by using the International Physical Activity Questionnaire (IPAQ). The subjects attending regular fitness club activities were significantly more active than the untrained control ones. No significant gender-related differences were found but the energy output significantly decreased with age ($r = -0.509$; $p<0.001$). The median values of energy expenditure amounted to 4,506 and 1,626 MET·min/ week for fitness-practicing and untrained subjects, respectively.

Key words: physical, activity, fitness club

INTRODUCTION

Physical activity, one of the principal elements of a healthy life style, is of paramount importance for maintaining health and immunity and reduces stress. The daily practices of motor activities improve the psycho-emotional well-being and reduce the risk of many civilisation-related diseases. The engagement into physical activities ought to be adjusted to one's needs, interests and work mode. Yet, job-oriented populations are deficient in physical activities [10]. The technological progress brought about the changes in human attitudes including a loss of interest in proper motor fitness. This made many world organisations, like CDDS, FIMS or WHO, appeal for promoting physical activities as a preventive measure [9, 11, 14, 15].

The American College of Sports Medicine and American Heart Association published recommendations regarding the frequency, intensity and duration of physical exertions [7, 8]. According to those recommendations, adult subjects ought to spend at least 30 min daily on moderate intensity activities like fast walks, carrying not too heavy objects, or performing house jobs [5].

The questionnaire techniques are usually employed in determining physical activity, one of the most popular ones being the International Physical Activity Questionnaire (IPAQ) [www.ipaq.ki.se], recommended by many international projects, e.g. the European Health Interview Survey (EUROHIS) or (European Physical Activity Surveillance System (EUROPASS) [16]. The IPAQ enables a reasonable assessment of various intensities of physical activity and their impact on the health status. The aim of this study was to conduct such a pilot assessment of a random group of subjects attending fitness clubs vs. their mates not engaged in regular physical activities.

MATERIAL AND METHODS

Subjects: A total of 54 randomly selected subjects aged 17–36 years, the inhabitants of the industrial town Tychy, were interviewed; 27 of them (8 men and 19 women; Group F) regularly participated in fitness activities, the other ones (7 men and 20 women; Group C) were not engaged in regular physical activities and served as a control group. The study was conducted in September 2007.

Methods: the Polish version of the short IPAQ form [2] was applied to all the interviewed subjects. The questionnaire contained 7 questions about the kind, duration and frequency of physical activities in the last 7 days; intense and moderate activities, walking and sitting were discerned, the total declared activity being expressed in MET·min/week. Intense activities were defined as those inducing high heart and breathing rates and including e.g. carrying heavy weights, digging, jogging, rapid running or cycling. Moderate activities were defined as those inducing somewhat increased heart and breathing rates and including e.g. normal cycling, playing volleyball or very fast walking. Walking activity was associated with the job and the household activities and leisure walking.

The subjects were eventually classified into the following activity categories:

High – Intense activities undertaken at least 3 times a week, the total activity amounting to at least 1500 MET·min/week, or the activities of various intensities undertaken every day, totalling 3,000 MET·min/week [17];

Moderate – Intense activities undertaken at least 3 times a week, 20 min each time, or moderate activities undertaken at least 5 days a week or walking at least 30 min a day, or activities of various intensities undertaken every day, the total activity exceeding 600 MET·min/week;

Low (insufficient) – the total activity not exceeding 600 MET·min/week.

The Chi-square function in the logarithmic form [13] was used in the data analysis. Besides, standard statistical procedures were used including the Pearson's correlation, the level of $p \leq 0.05$ being considered significant.

RESULTS

The percentages of fitness clubs members and of untrained subjects, classified into 3 categories of declared physical activity undertaken within the recent 7 days, are presented in Fig. 1. The majority of subjects from Group F (nearly 80%) met the criteria of high activity in contrast to only 20% control subjects ($p<0.001$). None of the F subjects was classified as having low activity. He median values of energy expenditure on physical activities (in MET·min/week) are presented in Table 1. Those median values amounted to 4,506 and 1,626 MET·min/week for fitness-practicing and untrained subjects, respectively.

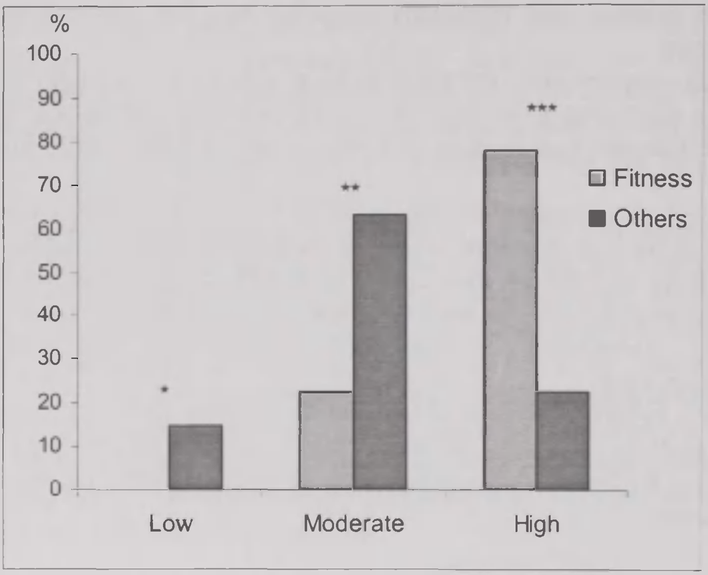

Fig. 1. Percentages of the subjects practicing fitness (n = 27) and of the control ones (n = 27), aged 17 – 36 years, classified as having low, moderate or high declared physical activity (below 600, 600 to 1,500 or 3,000, and above 1,500 or 3,000 MET· min/week, respectively)
Significant between-group difference: * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Table 1. Mean age (±SD) and energy expenditure (median and range) of male and female subjects practicing or not fitness activities

Group	Gender	n	Age (years)	Energy expenditure (MET· min/week)
Fitness	Male	8	22.4 ± 7.8	4,413 (1,320 – 8,136)
	Female	19	21.6 ± 6.1	4,506 (960 – 8,040)
Untrained	Male	7	19.3 ± 4.5	2,880 (480 – 6,216)
	Female	20	23.5 ± 7.0	1,596 (240 – 9900)

When classified by age, significantly ($p<0.05$) fewer subjects aged over 25 years had higher physical activity than those aged below 25 years (Fig. 2), the percentages of the subjects from those age categories being in both groups alike (72 and 28%, respectively). A negative correlation between energy expenditure on physical activity, expressed in MET· min/week, and the age of subjects irrespectively of their engagement in fitness activities, was shown directly in Fig. 3. That correlation was fairly high and amounted to r = –0.509.

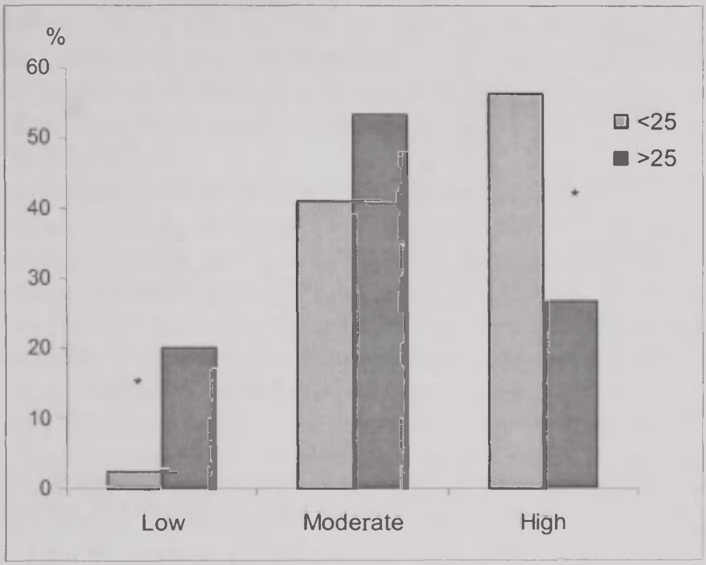

Fig. 2. Percentages of subjects aged below or above 25 years (n = 39 and 15, respectively) classified as having low, moderate or high physical activity (below 600, 600 to 1500 or 3000, and above 1,500 or 3,000 MET· min/week, respectively)
* Significant ($p<0.05$) difference between the percentages of older and younger subjects

The mean time spent on sitting was in both groups alike and amounted to about 5.4 h/day. However, the subjects aged over 25 years spent significantly ($p<0.05$) less time on sitting than those below 25 years of age (4.1 and 6.1 h/day, respectively).

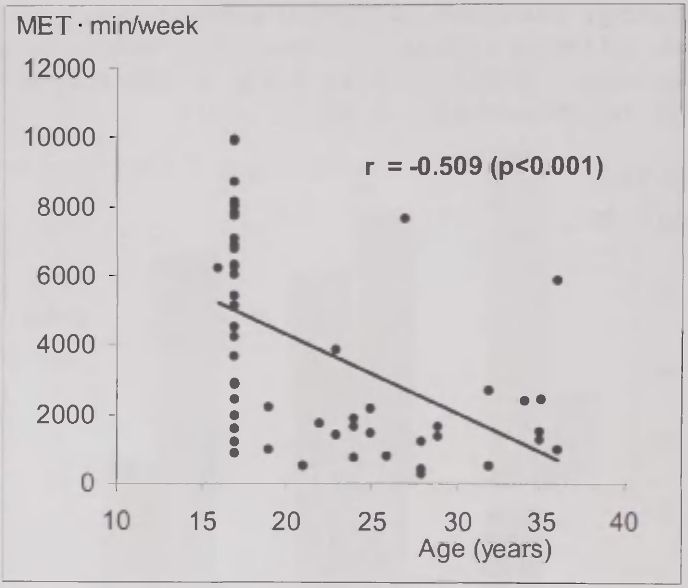

Fig. 3. Relationship between the declared energy expenditure on physical activity (MET· min/week) and the age of subjects engaged or not in fitness activities (n = 54)

DISCUSSION

The attempts at determining the level of physical acivity of a population have become popular in many countries [12]; the regular monitoring of physical activity conducted in e.g. Great Britain, Finland or United States may serve as an example. According to Drygas [6], no such data are available for the Polish adult population. Some authors [1, 3, 6], however, applied the IPAQ technique for that purpose.

Leisure activities, together with the job-related and social ones, are considered the determinants of the ageing process. Some elements of that process may be delayed and other ones temporarily arrested, especially when the functional components of physical fitness had been attained at a young age. Our data show that 80% of the subjects practicing fitness activities met the criteria of high physical activity in contrast to only about 20% of the untrained subjects. As compared with other towns, the percentage of the adult population of Tychy declaring high physical activity was much higher than in e.g. Lublin (about 50%) [6]. Furthermore, the percentage of the untrained ones declaring low (insufficient) activity (14%) was much lower than in one of the South-Western regions where the percentage of the population having insufficient activity was as high as 38% [6].On the other hand, the untrained subjects in our study expended much less energy (1,626 MET· min/week) than those from Norway, Germany or Luxembourg [12] but more than those from Sweden (1,119), Ireland (693) or France (1,173 MET· min/week).

The marked decrease of energy expenditure with age may be due to differences in family and job-related duties, the people above 25 years of age having usually less leisure time than younger ones, the latter, in turn, paying more attention to being attractive in order to increase the chances for finding a partner. Moreover, the locomotor apparatus deteriorates with age but the habitual physical activities practised by children and adolescents tend to persist at older age [4].

It may be concluded that the attitudes of the inhabitants of Tychy, which may be regarded as representative for medium-size industrial towns, towards an active life need stimulation in accordance with the National Health Programme of 1996. This would, in consequence, improve the preventive measures taken against the most widely spread diseases. The stimulation of attitudes is indispensable as the participation in the activities offered by fitness clubs is by far insufficient regarding the population needs.

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OSTEOMETRIC DATA AND THE STATURE OF THE POPULATION OF EASTERN SETUMAA (PECHORY AND IZBORSK DISTRICTS) IN THE 11TH–15TH CENTURY

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ABSTRACT

The aim of the study was to publish, for the first time, the stature and osteometric characterisation of the population in the districts of Izborsk and Pechory in the 11th–15th century. The study is based on the analysis of the paired or single long limb bones, obtained during the archaeological rescue excavations by Estonian archaeologists from the cemeteries of the 11th–13th century (Maly, Sloven's Pole, Novaya, Verepkovo, Lavry) and Viski (14th–15th cc), in the 1920s and 1930s (a total of 20 individuals –15 males, 5 females).

Results: The long limb bones of the population of Izborsk and Pechory districts in the 11th–15th centuries are characterised by massiveness and big length measurements. The males of all territorial groups are characterised by the tall mean stature (173.9 cm, variation by cemeteries 172.9–175.0 cm, according Trotter and Gleser [15]), while females were of medium mean stature (159.2 cm, var. 156.8–162.3 cm).

Key words: Osteometry, stature, 11th–15th cc, Eastern Setumaa, Russians, Estonians

We have a comparatively good overview of the osteometry and the stature of the Estonian population, including South-East Estonia, in the 11th–15th cc [1, 4–9, 15, etc.]. The osteometric data concerning the population of the nearest Eastern neighbouring territory of present-day Estonia, like Pechory and Izborsk the districts of the Pskov province, are very few or missing up to now. These districts formed a part of the ethnic territory of Setumaa or the Pechory county, the southernmost county of Estonia between the two World Wars (1920–1945). During that period, in the 1920s and the 1930s, in the course of archaeological rescue excavations, carried out by Estonian archaeologists, some osteological material, broadly dated to the 1st half of the 2nd millennium, was collected mainly from Eastern Setumaa.

That anthropological material was first described and the craniological material was partly analysed by Karin Mark [15]. The author also measured and analyzed some of the craniological material and used it as a comparative material for the characterisation of South-East Estonian Late Iron Age and early medieval populations [8].

The aim of the present study is to give for the first time an osteometric characterisation and the reconstructed stature of the population of the 11^{th}–15^{th} century of the former Setumaa.

MATERIAL AND METHODS

The osteological material from separate cemeteries of Eastern Setumaa, mainly from the Izborsk district, dating from the 11^{th}–15^{th} century is analysed (Fig.1): 1) Maly (Mõla in Estonian) – barrow cemetery, situated near the village Maly, excavated in 1921 by A. M. Tallgren; 2) Novaya, 7 km South-East of Izborsk and Sloven's Pole in Izborsk excavated in 1929 by R. Indreko. Later excavations in 1970s and the 1980s have dated these cemeteries to the 11th–13th century [13, 19]. 3) Viski, North of the Izborsk railway station, excavated in 1928, 1929 by H. Moora and dated to the 14^{th}–15^{th} century; 4) Lavry (Laura in Estonian), in South-West Setumaa near the Estonian border, excavated in 1935 by M Schmiedechelm and dated to the 11^{th}–12^{th} century AD (oral information from the archaeologist H. Valk). 5) Verepkovo, 9 km South of Pechory excavated in 1937 by O. Saadre and dated to the 11^{th}–12^{th} century.

Skeletal remains appeared to be in the varying state of preservation. The osteological material is deposited in the Institute of History, Tallinn University.

Fig. 1. Location of the cemeteries.

In this paper, the paired or single long limb bones from a total of 20 individuals (15 males, 5 females) were analysed.

The osteological material was measured according to the methodology of Martin and Saller [10]. The individual stature for each skeleton of the populations (and the average stature) based on the measurements of long limb bones of both sides of the body (humerus, radius, femur, tibia) using the methods of Trotter and Gleser [11] and Gerhards [3] was calculated. The application of the Gerhards' method to the material from Estonia provides a smaller variability of features [6], but since the Trotter-Gleser method has been more widely used, it offers more comparative data.

In the analysis of the material, the skeletal bones of Novaya and Sloven's Pole were grouped together owing to their morphological similarity and small number.

In the tables the following measurements (with numbers of traits after Martin) are given:

Humerus: 1– maximum length, 2 – total length, 3 – width of upper epiphysis, 4 – width of lower epiphysis, 5 – maximum mid-diaphysis diameter, 6 – minimum mid-diaphysis diameter, 7 – minimum diaphysis circumference, 7a – mid-diaphysis circumference, 8 – circumference of humeral head, 9 – horizontal diameter of humeral head, 10 – vertical diameter of humeral head.

Radius: 1 – maximum length, 2 – physiological length, 3 – minimum diaphysis circumference.

Ulna: 1 – maximum length, 2 – physiological length, 3 – minimum diaphysis circumference.

Femur: 1 – maximum length, 2 – total length in natural position, 6 – sagittal mid-diaphysis diameter, 7 – transverse mid-diaphysis diameter, 9 – upper transverse diaphysis diameter, 10 – upper sagittal diaphysis diameter, 18 – vertical diameter of femoral head, 19 – horizontal diameter of femoral head, 21 – width of lower epiphysis, 8 – mid-diaphysis circumference, 20 – circumference of femoral head.

Tibia: 1a – maximum length, 1 – total length, 3 – maximum width of upper epiphysis, 6 – maximum width of lower epiphysis, 8 – sagittal mid-diaphysis diameter, 8a – upper sagittal diameter, 9 – transverse mid-diaphysis diameter, 9a – upper transverse diameter, 10 – mid-diaphysis circumference, 10a – circumference at foramen nutritium, 10b – minimum diaphysis circumferences.

The following indexes are given:

H7/1 – massiveness of humerus; R3/2 – massiveness of radius, F8/F2 – massiveness of femur, T10b/T1 – massiveness of tibia; H6/5 – cross-sectional mid-diaphysis shape of humerus, F6/7 – cross-sectional mid-diaphyses shape of femur (index pilastricus), F10/9 – cross-sectional higher part diaphysis shape of femur (index platymericus).

RESULTS AND DISCUSSION

Osteometrical data. The average measurements of long limb bones (except fibula) of males by cemeteries are presented in Table 1. In Table 2 individual measurements of limb bones of females by cemeteries and their averages are given. Table 3 gives an average length of limb bones for every studied population. As it appears from the tables 1–3, the average length of all long limb bones in the studied male populations is big. Males from Viski are characterized by the longest femur (average 470 mm) and males from Maly by the shortest (451 mm). The tibial length, *vice versa*, is the biggest among studied populations in Maly, and the smallest in Viski. So, the proximal part of the lower limb is bigger in Viski, that of the distal part – in Maly.

The numerical values of the proximal part of upper limbs are biggest in Viski; however, the comparison of the population samples is not quite correct because the samples are small and separate long bones studied unequally preserved, especially in the case of upper limbs. Still one can notice that the ratio of distal and proximal parts of upper and lower limbs is greater in the males of Maly and Verepkovo and smaller – in Viski and Novaya & Sloven' Pole (Table 3).

Table 1. Osteometric measurements of males (mm)

Trait nr	Side	Populations												
		Maly (11th–13th cc)				Novaya&Sloven's Pole (11th–13th cc)				Verepkovo (11th–12th cc)	Viski (14th–15th cc)			
		M(n)	Min	Max	s	M(n)	Min	Max	s	M(n)	M(n)	Min	Max	s
Humerus														
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	l	317.00(1)	–	–	–	338.50(2)	338	339	–	–	344.33(3)	336	351	7,6
	r	323.00(2)	320	326	–	345.00(2)	339	351	–	–	352.33(3)	344	365	11
2	l	313.00(1)	–	–	–	330.00(3)	324	335	5.57	–	338.67(3)	330	344	7,6
	r	322.00(1)	–	–	–	336.67(3)	332	344	6.43	–	346.67(3)	341	357	9
3	l	–	–	–	–	63.00(1)	–	–	–	–	66.00(3)	65	68	1,7
	r	64.00(1)	–	–	–	64.00(2)	63	65	–	–	64.67(3)	58	68	5,8
4a	l	49.00(1)	–	–	–	49.50(2)	48	51	–	–	48.67(3)	45	52	3,5
	r	50.00(1)	–	–	–	49.33(3)	48	52	2.31	–	49.00(2)	45	53	–
5	l	25.00(1)	–	–	–	23.67(3)	23	25	1.15	–	23.75(4)	22	26	1,7
	r	25.00(1)	–	–	–	24.00(3)	23	26	1.73	–	23.50(4)	22	25	1,3
6	l	21.00(1)	–	–	–	18.00(3)	17	19	1	–	18.75(4)	18	19	0,5
	r	20.00(1)	–	–	–	18.67(3)	18	19	0.58	–	18.75(4)	18	20	1
9	l	–	–	–	–	–	–	–	–	–	43.00(3)	41	45	2.0
	r	48.00(1)	–	–	–	–	–	–	–	–	44.00(1)	–	–	–
10	l	48.00(1)	–	–	–	46.00(3)	44	47	1.73	–	45.33(3)	41	52	5,9
	r	48.00(1)	–	–	–	47.00(2)	47	47	–	–	46.33(3)	44	48	2,1
7	l	67.00(1)	–	–	–	65.33(3)	64	67	1.53	–	68.00(4)	63	75	5.0
	r	69.00(1)	–	–	–	67.00(3)	65	69	2	–	68.25(4)	65	74	3,9

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7a	l	76.00(1)	–	–	–	69.33(3)	66	74	4.16	–	70.8(5)	66	77	4,5
	r	77.00(1)	–	–	–	72.33(3)	70	77	4.04	–	73.00(3)	69	77	4.0
8	l	–	–	–	–	140.00(1)	–	–	–	–	143.00(3)	133	153	10
	r	–	–	–	–	144.00(1)	–	–	–	–	148.00(1)	–	–	–
Radius														
1	l	250.00(3)	238	257	10	254.00(3)	242	263	10.8	268.00(1)	258.00(3)	253	262	4,6
	r	–	–	–	–	251.00(2)	242	260	–	–	258.75(4)	253	266	5,9
2	l	242.50(2)	242	243	–	240.00(3)	227	251	12.1	252.00(1)	243.33(3)	237	247	5,5
	r	–	–	–	–	236.00(2)	226	246	–	251.00(1)	242.75(4)	236	251	7
3	l	41.50(2)	37	46	–	44.00(3)	43	45	–	44.00(1)	46.67(3)	43	49	3,2
	r	–	–	–	–	46.50(2)	46	47	–	40.00(1)	47.00(4)	46	49	1,4
Ulna														
1	l	285.00(1)	–	–	–	272.50(2)	260	285	–	279.00(1)	279.25(4)	268	290	11
	r	–	–	–	–	272.00(3)	259	281	11.5	–	278.67(3)	270	289	9,6
2	l	252.00(1)	–	–	–	243.00(2)	232	254	–	249.00(1)	248.00(4)	237	259	11
	r	–	–	–	–	244.00(3)	231	251	11.3	248.00(1)	245.67(3)	237	255	9
3	l	38.00(1)	–	–	–	37.00(2)	37	37	–	–	41.25(4)	38	47	3,9
	r	–	–	–	–	37.67(3)	36	40	2.08	–	41.00(3)	38	43	2,6
Femur														
1	l	451.00(1)	–	–	–	466.50(4)	452	476	10.2	464.00(1)	471.00(4)	457	493	16
	r	451.33(3)	446	455	4,7	468.75(4)	459	474	6.7	458.00(1)	469.80(5)	456	488	15
2	l	449.00(1)	–	–	–	460.75(4)	446	469	10.1	460.00(1)	467.75(4)	455	489	15
	r	449.00(3)	443	454	5,6	464.25(4)	454	471	7.23	454.00(1)	468.00(5)	455	486	15

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6	1	30.00(1)	–	–	–	30.50(4)	28	33	2.08	26.00(1)	30.00(4)	28	33	2,2
	r	29.33(3)	28	30	1,2	29.75(4)	29	31	0.96	26.00(1)	28.20(5)	26	31	1,9
7	1	32.00(1)	–	–	–	28.75(4)	26	30	1.89	28.00(1)	30.25(4)	28	32	1,7
	r	33.00(3)	29	35	3,5	28.25(4)	25	30	2.22	27.00(1)	31.20(5)	29	33	1,6
9	1	35.00(1)	–	–	–	32.50(4)	28	37	3.7	29.00(1)	33.25(4)	32	34	1
	r	35.33(3)	34	37	1,5	31.75(4)	29	35	2.75	28.00(1)	33.60(5)	31	35	1,7
10	1	29.00(1)	–	–	–	27.50(4)	26	31	2.38	26.00(1)	27.00(4)	26	29	1,4
	r	27.67(3)	26	29	1,5	27.50(4)	25	29	1.91	27.00(1)	27.00(5)	25	31	2,3
18	1	48.00(1)	–	–	–	49.50(4)	48	51	1.29	47.00(1)	48.75(4)	46	50	1,9
	r	49.00(2)	47	51	–	49.25(4)	48	50	0.96	48.00(1)	48.40(5)	45	50	2,1
19	1	49.00(1)	–	–	–	48.50(4)	47	50	1.29	–	48.25(4)	45	50	2,4
	r	48.50(2)	46	51	–	49.00(4)	48	50	0.82	–	48.40(5)	45	50	2,1
21	1	–	–	–	–	83.67(3)	81	85	2.31	–	81.75(4)	78	83	2,5
	r	83.00(1)	–	–	–	82.00(3)	80	85	2.65	–	83.00(4)	81	85	1,6
8	1	97.00(1)	–	–	–	92.75(4)	85	98	5.74	85.00(1)	94.75(4)	92	98	2,5
	r	97.67(3)	92	101	4,9	91.25(4)	86	94	3.59	82.00(1)	94.80(5)	93	97	1,6
20	1	154.00(1)	–	–	–	155.25(4)	151	160	4.43	–	155.00(4)	145	160	7,1
	r	160.00(1)	–	–	–	155.00(4)	151	158	2.94	150.00(1)	154.20(5)	144	160	6,7
Tibia														
1a	1	386.00(2)	381	391	–	383.67(3)	363	395	17.9	393.00(1)	381.00(5)	369	394	12
	r	390.00(3)	383	397	7	381.00(2)	364	398	–	389.00(1)	381.00(5)	367	393	10
1	1	378.50(2)	373	384	–	378.00(3)	359	388	16.5	383.00(1)	375.00(5)	362	388	11
	r	379.00(4)	363	390	12	375.50(2)	360	391	–	384.00(1)	375.60(5)	361	388	10

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3	l	73.00(1)	–	–	–	76.50(2)	75	78	–	–	76.00(3)	73	78	2,6
	r	79.00(1)	–	–	–	79.00(1)	–	–	–	–	77.00(4)	73	79	2,7
6	l	53.00(1)	–	–	–	52.33(3)	50	54	2.08	–	54.20(5)	51	57	2,3
	r	53.50(2)	51	56	–	54.00(2)	53	55	–	–	54.33(3)	53	55	1,2
8	l	31.50(2)	31	32	–	30.00(3)	30	30	0.0	26.00(1)	32.40(5)	30	34	1,5
	r	30.67(3)	29	32	1,5	29.50(2)	29	30	–	26.00(1)	31.40(5)	30	33	1,1
9	l	25.00(2)	25	25	–	23.33(3)	23	24	0.58	21.00(1)	23.20(5)	21	25	2
	r	24.33(3)	23	25	1,2	23.50(2)	23	24	–	20.00(1)	24.20(5)	22	26	1,8
8a	l	37.00(2)	37	37	–	32.33(3)	32	33	0.58	32.00(1)	37.50(4)	37	38	0,6
	r	34.67(3)	33	36	1,5	32.50(2)	31	34	–	30.00(1)	36.00(5)	34	38	1,6
9a	l	26.50(2)	26	27	–	25.33(3)	24	27	1.53	23.00(1)	27.00(4)	25	29	2,3
	r	26.67(3)	25	28	1,5	25.50(2)	25	26	–	23.00(1)	27.20(5)	24	30	2,7
10	l	89.50(2)	88	91	–	83.33(3)	83	84	0.58	74–00(1)	90.20(5)	81	96	6,5
	r	87.67(3)	85	90	2,5	84.50(2)	84	85	–	75.00(1)	91.40(5)	86	95	4,9
10a	l	101.00(2)	100	102	–	93.00(3)	90	95	2.65	87.00(1)	104.75(4)	99	110	5,1
	r	97.67(3)	97	98	0,6	93.00(2)	90	96	–	87.00(1)	102.20(5)	93	110	6,7
10b	l	77.50(2)	77	78	–	73.33(3)	70	76	3.06	67.00(1)	81.20(5)	74	93	7,3
	r	78.67(3)	76	82	3,1	72.00(2)	70	74	–	68.00(1)	83.75(4)	77	94	7,4

Table 2. Osteometric measurements of females (mm)

Trait nr	Side	Populations								
		Maly (11th–13th cc)	Novaya, Sloven's Pole (11th–13th cc)	Verepkovo (11th–12th cc)	Lavry (11th–13th cc)	Viski (14th–15 cc)	M l+r/2	Min	Max	s
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Humerus										
1	l	299	294	–	309	300				
	r	–	295	–	310	306	301.86(7)	294	310	6.5
2	l	295	293	–	305	297				
	r	–	293	–	307	300	298.57(7)	293	307	5.7
3	l	49	–	–	–	58				
	r	–	–	55	58	55	55.00(5)	49	58	3.7
4a	l	–	40	–	39	43				
	r	–	–	–	42	43	41.40(5)	39	43	1.8
5	l	–	21	20	21	23				
	r	–	–	22	21	24	21.71(7)	20	24	1.4
6	l	–	17	18	18	16				
	r	–	–	18	18	17	17.43(7)	16	18	0.8
9	l	–	37	–	35	37				
	r	–	–	–	37	36	36.40(5)	35	37	0.9
10	l	–	38	41	38	39				
	r	–	–	–	38	38	38.67(6)	38	41	1.2

1	2	3	4	5	6	7	8	9	10	11
7	l	–	58	60	60	61				
	r	–	–	60	60	62	60.14(7)	58	62	1.2
7a	l	–	64	68	66	67				
	r	–	–	68	66	68	66.71(7)	64	68	1.5
8	l	–	–	–	115	120				
	r	–	–	–	120	120	118.75(4)	115	120	2.5
Radius										
1	l	–	–	234	–	216				
	r	–	221	235	–	216	224.40(5)	216	235	9.4
2	l	–	–	223	–	204				
	r	–	207	223	–	203	212.0(5)	203	223	10.1
3	l	–	40	–	–	36				
	r	35	–	–	–	37	37.00(4)	35	40	2.2
Ulna										
1	l	–	–	–	252	235				
	r	–	242	253	252	236	245.00(6)	235	253	8.4
2	l	–	–	–	226	208				
	r	–	214	227	–	208	216.60(5)	208	227	9.4
3	l	–	–	–	40	34				
	r	–	38	31	–	35	35.60(5)	31	40	3.5
Femur										
1	l	409	411	414	432	402				
	r	–	404	418	431	403	413.78(9)	402	432	11.3

1	2	3	4	5	6	7	8	9	10	11
2	l	408	407	410	428	397				
	r	–	398	414	429	399	410.00(9)	397	429	12.0
6	l	23	25	22	25	26				
	r	22	26	22	25	26	24.20(10)	22	26	1.8
7	l	24	27	25	26	27				
	r	25	26	24	26	27	25.70(10)	24	27	1.2
9	l	28	31	26	29	30				
	r	30	31	26	29	31	29.10(10)	26	31	1.9
10	l	20	22	21	22	22				
	r	21	22	20	25	24	21.90(10)	20	25	1.6
18	l	39	41	40	45	46				
	r	40	41	40	45	43	42.00(10)	39	46	2.5
19	l	39	40	–	–	42				
	r	39	40	41	45	42	41.00(8)	39	45	2.0
21	l	–	72	–	75	68				
	r	–	72	–	76	68	71.83(6)	68	76	3.4
8	l	76	82	77	80	83				
	r	76	81	73	81	85	79.40(10)	73	85	3.7
20	l	125	128	–	–	134				
	r	125	128	128	146	134	131.00(8)	125	146	7.0
Tibia										
1a	l	333	338	–	341	–				
	r	332	334	–	345	–	337.17(6)	332	345	5.1

1	2	3	4	5	6	7	8	9	10	11
1	l	329	333	–	333	–				
	r	–	330	–	339	–	332.80(5)	329	339	3.9
3	l	–	65	–	–	64				
	r	–	65	–	–	–	64.67(3)	64	65	0.6
6	l	40	45	–	45	–				
	r	–	49	–	50	–	45.80(5)	40	50	4.0
8	l	24	26	–	27	23				
	r	24	26	–	28	–	25.43(7)	23	28	1.8
9	l	20	22	–	21	21				
	r	20	22	–	21	–	21.00(7)	20	22	0.8
8a	l	28	30	–	31	28				
	r	28	29	–	32	–	29.43(7)	28	32	1.6
9a	l	20	24	–	23	22				
	r	22	22	–	23	–	22.29(7)	20	24	1.3
10	l	68	75	–	78	71				
	r	74	75	–	80	–	74.43(7)	68	80	4.0
10a	l	76	82	–	90	81				
	r	83	81	–	90	–	83.29(7)	76	90	5.1
10b	l	61	69	–	72	66				
	r	66	68	–	74	–	68.00(7)	61	74	4.3

Table 3. Average measurements of long bones (mm), (numbers in brackets – amount of bones)

Trait	Males				Females
	Maly (11th–13th cc)	Novaja& Sloven's Pole (11th –13th cc)	Verepkovo (11th–12th cc)	Viski (14th–15th cc)	Izborsk (average) (11th–15th cc)
	X(n)	X(n)	X(n)	X(n)	X(n)
H1 Maximum length of humerus	321.0(3)	341.8(4)	–	348.3(6)	301.9(7)
R1 Length of radius	250.0(3)	252.8(5)	268.1(1)	258.4(7)	224.4(5)
U1 Length of ulna	285.0(1)	272.2(5)	279.0 (1)	279.0(7)	245.0(6)
F1 Maximum length of femur	451.3(4)	467.6(8)	461.0(2)	470.3(9)	413.8(9)
T1 Total length of tibia	378.8(6)	377.0(5)	383.5(2)	375.3(10)	332.8(5)

Indices of massiveness and cross-sectional diameters of the diaphyses of long bones.

All the male populations of Setumaa are characterized by quite a high massivness of bones as it is also shown in numerical values of traits (Table 1). The ratio of bone circumference and length gives a good imagination about the bone massiveness (Table 4). Among the studied populations the males of Maly are characterised by a higher massiveness of humerus and femur, while distal segments of limb bones (radius, tibia) are more gracile. Massiveness of humerus is quite similar in the studied populations of Viski, Novaya & Sloven' Pole, being close to that of North-Estonian Pada (12th–13th cc), and South-Estonian Makita (13th–17th cc) populations. The same can be said about the massiveness of femur in these populations. The massiveness of tibia in the studied populations is highest in Viski, being close to that of the South-Estonian Makita population (Table 4). The similarity between the male populations of Viski and Sloven's Pole from Eastern Setumaa and Makita can also be observed in the ratio of the tibial and femoral length (approximately 80) [5] (Table 3).

The cross-sectional shape of the diaphysis of femur depends greatly on the development degree of the *linea aspera*. If it is strongly developed, it comprises a bony ridge – pilaster. By the index below 100 the pilaster, as a rule, is absent. The cross-sectional shape of the middle part of the femur (index pilastricus) is similar in the male populations of Viski and Maly, having no pilaster; in the male populations of Novaja & Sloven's Pole index pilastricus is higher, being similar to that of the South-Eastern Estonian Lindora (11th–12th cc) population.

The cross-sectional shape of the higher part of diaphyses (index platymericus) is one of the most characterising morphological details of femur. The upper parts of the thighbones are somewhat flattened in the sagittal direction in Viski and Maly from Eastern Setumaa, as it is also common in the Estonian populations of Pada and Makita, and belong to the category "platymer" (index below 85). Index platymericus (with a higher numerical value) in Novaja & Sloven's Pole is similar to that of South-Eastern Estonian Lindora (11th–12th cc) male population and belong to the category "eurymer". So, according to the indices of cross-sectional diaphysis shape of femur (index pilastricus and index platymericus) the male populations of the 11th–13th centuries from Eastern Setumaa – Novaya & Sloven's Pole – and South-Eastern

Table 4. Indices of massiveness and cross-sectional diaphysis diameters of bones

	Males						Females
	Maly (11^{th}–13^{th} cc)	Novaya& Sloven's Pole (11^{th}–13^{th} cc)	Viski (14^{th}–15^{th} cc)	Pada (12^{th}–13^{th} cc)	Makita (13^{th}–17^{th} cc)	Lindora (11^{th}–12^{th} cc)	Izborsk (average) (11^{th}–15^{th} cc)
H7/1	21.2(1)	**19.5**(4)	**19.7(6)**	**19.9**	20.5	16.7	19.9(7)
R3/2	17.1(2)	18.9(5)	19.3(7)	18.7	19.8	–	17.2(3)
F8/F2	21.4(3)	**19.9(8)**	**20.3(9)**	**20.5**	**20.2**	18.2	19.5(9)
T10b/T1	20.0(2)	19.3(5)	**21.9(9)**	20.9	**21.4**	19.6	20.7(5)
H6/5	82.0(2)	77.0(6)	79.5(8)	**77.5**	82.5	71.2	80.7(7)
F6/F7	**94.3(3)**	105.9(8)	**94.8**(9)	99.0	98.6	104.8	94.1(10)
F10/F9	82.7(3)	**86.1(8)**	81.0(9)	78.4	83.3	**86.9**	75.4(10)

Estonian Lindora are similar. However, males from Lindora have more gracile femur among the compared male populations, but massiveness of tibia in Novaya, Sloven's Pole and Lindora is also quite similar (Table 4).

Thus, one can observe similarities in the massiveness of the proximal part of limb bones between Viski (14^{th}–15^{th} cc), Novaya & Sloven's Pole (11^{th}–13^{th} cc) from the Izborsk district on the one side and Pada (12^{th}–13^{th} cc) from Northern Estonia, also Makita (13^{th}–17^{th} cc) from Southern Estonia on the other side. A higher massiveness of tibia is typical of males from Viski and Makita.

Similarities in the cross-sectional diaphysis shape of femur can be noticed especially between the males of Viski and Maly, which also resemble the males of Makita and Pada; the respective features of males from Novaya & Sloven's Pole (11^{th}–13^{th} cc) are similar to those of Lindora (11^{th}–12^{th} cc).

Stature. The studied male populations are characterised by a tall stature, varying in the averages of local groups (according to the Trotter and Gleser method) between 173 cm to 175 cm, with the tallest in Viski (14^{th}–15^{th} cc) (Table 5). The Gerhards' method [3] gives an approximately 1.0–1.5 cm shorter stature for the male population, with the average of 172.6 cm (var. by local groups 171.7–173.5 cm), and also a smaller individual variation in every local group studied. The average body height for Viski males (14^{th}–15^{th} cc) was typical also of a man of Verepkovo (175.1–173.5 cm). The average stature of males in Novaya & Sloven's Pole and Maly of the 11^{th}–13^{th} century was almost equal, but two centimeters shorter than in Viski, – approximately 173–172 cm.

The females from Novaja & Sloven's Pole and Maly (11^{th}–13^{th} cc) had quite a similar body height (~ 157 cm) as was the case of males in these localities. The female from Viski (14^{th}–15^{th} cc) was also of the same stature. However, the females' body height from Laura and Verepkovo exceed the others approximately by 5–3 cm. In comparison, the average measurements of separate long limb bones, as well as the stature of males from Eastern Setumaa in the 11^{th}–15^{th} centuries, slightly exceed those of the Estonian male population in Pada (12^{th}–13^{th} cc) and Makita (13^{th}–17^{th} cc) (Table 6) [6, 5]. However, the length of females' long bones, as well as their average stature in Eastern Setumaa was a little shorter than those in Pada and Makita. The large average body height of males of Viski (14^{th}–15^{th} cc) and Verepkovo (11^{th}–12^{th} cc) was similar to South-Eastern Estonian males of the 12^{th}–13^{th} cc from Siksälä [9] and Lindora (11^{th}–12^{th} cc) [8]. The similar body height also characterized the Late Iron Age male population of western Estonia, as well as the West-Estonian male population also in the 1930s.

Table 5. Stature (cm). The stature on upper lines (bold) according Trotter and Gleser [11], on lower lines – Gerhards [3]

Population	Century	Males			Females	
		n	X	var.	n	X
Viski	14–15	5	**174.9** 173.3	**172.7–178.7** 171.4–176.0	1	**157.2** 155.5
Novaya& Sloven's Pole	11–13	4	**173.5** 172.5	**171.0–176.1** 170.0–174.0	1	**157.4** 155.8
Maly	11–13	5	**172.9** 171.7	**168.9–176.9** 168.9–174.4	1	**156.8** 156.0
Verepkovo	11–12	1	**175.1** 173.5	– –	1	**162.3** 158.5
Lavry	11–12	–	–	–	1	**161.7** 158.3
Total	**11–15**	**15**	**173.9** 172.6	**168.9–178.9** 168.9–176.0	5	**159.1** 156.8

The sexual difference in body height in Eastern Setumaa populations in the 11th–15th century, regardless of the small quantity of studied material, resembled that of Latvian, Lithuanian and North-Western Byelorussian populations between the 6^{th} and the 12^{th} century (approximately 14.5–15.5 cm). That difference was smaller among the compared populations of Old Ladoga, Pada and Westerhus (11th–12th–13th cc) (12–13 cm), being the smallest in the Makita medieval population (Table 6).

In the first half of the 2^{nd} millennium tall stature characterized men in the Pskov province near Petchory and Izborsk, as well as the men of the present-day territories of Estonia, Latvia and Lithuania. The 11^{th}–13^{th} century population was tall also in Scandinavia, e.g. in Westerhus, as well as in the 12^{th}–13^{th} centuries in Novogrudok in North-Western Byelorussia (Table 6).

Table 6. The stature of the studied populations and comparative data (cm)

Population	Century	Males		Females	
		n	X	n	X
Izborsk (in total)	11–15	15	173.9	5	159.1
Old Ladoga [18]	11–12	47	172.6	5	159.1
Pada [6]	12–13	37	172.1	31	160.1
Makita [4]	13–15	7	168.6	8	159.1
Makita [4]	15–17	9	169.5	6	160.5
Lindora [8]	11–12	5	175.3	–	–
Livonians [3]	10–12	15	173.3	10	157.8
Latgallians [3]	8–12	39	174.2	14	158.7
Lithuania [20]	6–12	15	172.7	9	158.5
Novogrudok [17]	11–12	20	174.6	6	159.8
Westerhus [2]	11–13	66	174.3	73	161.6

It is well known that temporal changes have taken place in the stature of different populations through centuries [3, 7, 20 etc.]. In Estonia, for excample, the body height in the Middle Ages was somewhat smaller than in the Latest Iron Age [7]. Unfortunately we do not have sufficient data about the stature of the population to compare secular changes in the Izborsk district. In Eastern Setumaa, tall body height characretized the single man (and also the woman) we have from Verepkovo (11th–12th cc). The same can be said about men in South-Eastern Estonian Lindora and Siksälä of the Late Iron Age (11th–12th and 12th–13th cc). Men from Viski were still tall in the 14th–15th century.

However, according to somatological data from the second half of the 1970s, the tall stature and the massiveness of their anthropometric measurements were very typical of Russians of the Western shore of Lake Pskovskoye [12]. The body height of the Russians of the Western shore of Lake Pskovskoye remains within the range of the variation of the stature of the population of the Eastern Baltic areas. The mean stature of the Russians of Lake Pskovskoye (173.1 cm) [12] is very similar to that of Latvians (172.9 cm) [14] and Estonians 173.2 cm [16]. The stature of Russians in Kallaste (the Western shore of Lake Peipus) – 169.1cm [12] is considerably smaller than in Russians of the Western shore of Lake Pskovskoye, although it exceeds the mean stature of Russians on their main distribution territory [12:7]. The stature of Setu, the nearest Estonian neighbours to Russians in that Lake Pskovskoye region, is slightly smaller, 172.3 cm [12], than in Latvians, Russians on the Western shore of Lake Pskovskoye, and average for Estonians in the 1970s.

So the stature of the inhabitants of the Izborsk region, reconstructed on the basis of the long limb bones of the skeletons of the 11^{th}–15^{th} cc, broadly coincides with the stature of the present-day inhabitants, as reflected by somatological measurements at the end of the previous century.

However, to shed light on the genesis of the morphological types of the population of Eastern Setumaa (the Izborsk district of the Pskov province) additional data and a more detailed analysis are necessary.

CONCLUSIONS

1. It is the first publication of the stature and osteometric data of the population of Eastern Setumaa (the Pechory and Izborsk districts) in the 11^{th}–15^{th} century.
2. Long limb bones of the population are generally characterised by their massiveness.
3. Some local differences occur in the proportions and the indices of long limb bones.
4. Similarities in osteometric data and the stature of the 11^{th} –15^{th} cc populations from the Izborsk district and of some contemporaneous Estonian populations, especially from South-Eastern Estonia, can be observed.
5. Males of all territorial groups of the earlier Setumaa in the 11^{th}–15^{th} centuries were characterised by tall mean stature (173.9 cm), while females were of medium mean stature (159.1 cm).

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POST-TRAUMATIC BONE REPAIR AND GROWTH PLATE OSSIFICATION IN RATS TIBIA. EFFECTS OF TRAINING AND IMMOBILIZATION

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ABSTRACT

Bone developmental histology, computerized histomorphometry of callus and growth plate of the tibia after bicortical perforation in 105 growing male Wistar rats (200–220 g b.w.) has been investigated. The ossification has been studied in normal and affected animals (training, immobilization) during 4–42 days after operation. Primary intramembranous ossification with endosteal callus formation in bone cavity; secondary periosteal chondrous ossification with repair “mosaic” (mixture of cartilage and bone cells) has been observed in the perforation site and growth plate development has been characterized with certain cell-zones. During experiments wound healing and growth plate ossification were increased moderately after training whereas the immobilization of animals inhibited remarkably the processes.

The post-traumatic bone repair and growth plate ossification after the perforation of rat tibia in general recapitulates embryohistogenesis, but repair in callus has certain differences, adaptive environmental epigenetic characters (direct desmal ossification, primary callus formation in bone marrow).

Key-words: Post-traumatic bone repair and growth plate ossification in rats tibia. Effects of training and immobilization

INTRODUCTION

The post-traumatic bone healing has been characterized as a specialized postnatal repair process that recapitulates embryological skeletal development [4, 6] which closely resembles those described in the normal epiphyseal growth plate ossification [15]. However, there are some peculiarities in both processes, caused by differences in the environmental factors in which the regenerative process of fracure healing takes place. Among the environmental factors which influence bone repair and growth plate ossification are training and immobilization. The alterations undergoing the proximal growth plate during bone fracture of normal, exercized and immobilized animals are well studied microscopically, yet there are no reports in the literature which discuss the comparable computerized histomorphometrical as well as biochemical changes that accompany this process.

In our experiments the comparable histological features by the tissue histomorphometry of callus of perforated tibia and the proximal growth plate of normal, trained and immobilized rats has been investigated.

MATERIAL AND METHODS

Male growing Wistar rats 200–220 g b.w. (105) were used. Animals were housed at a constant temperature (22°C) with a 12-h light-dark cycle, allowed water and food(“Dimela” – Finland) was given. The experiments outlined below were conducted in accordance with the Guidelines for Animal Experimentation by the Ethical Committee at Tartu University. The repair was studied in normal and affected (training, immobilization) animals at 4–42 days after the bicortical perforation of tibia. The rats were randomly assigned into control, training and immobilization groups, 35 animals in each group. The swimming training was performed in a special swimming-pool with the size of 40x40x70 cm, at the water temperature 22±2°C. In the immobilized group rats were separated in narrow boxes (cages), one animal in each box.

Operative technique

Under anesthesia, induced by an intramuscular injection of ketamine 50 mg/kg b.w. and diazepam 5 mg/kg, on the anterior surface of tibia, a perforation hole 1.5 mm in diameter was bored through the bone cortex between the diaphysis and proximal epiphysis, 1 mm below the tibial tubercle so that the growth plate was not injured. The profylaxis of infection was carried out with ampicillin of 7.5 mg/kg i.m.

Rats were sacrificed by ketamine and diazepam overdose at days 4, 7, 14, 21, 28, 35 and 42 post-operatively. The right proximal tibia with perforation and the epiphyseal growth plate cartilage were harvested. The perforated tibia with the growth plate were fixed in 2% paraformaldehyde for 48 h, and decalcified with 14% EDTA in 0.1 M phosphate buffer at 4°C for about 2–3 weeks, bisected longitudinally, and processed for paraffin embedding. Thereafter paraffin sections with 6 µm-s in thickness were cut for histological analysis followed by computerized histomorphometry. For routine histology and histomorphometry, the sections were stained with hematoxylin-eosin, van Gieson and safranin-O.

Computerized histomorphometry

The microanatomical pictures of the callus tissue and the growth plate were photographed by the light-microscope Olympus BX-50 and saved electronically. Further the process was performed with the computer program Adobe Photoshop 5.0 under the simultaneous visual control of the light-microscope. The total area of callus as well as areas of bone, chondrous and soft tissues (connective tissue, degenerative and inflammatory tissues) and zones of GP were measured and marked in different colours as the following: a) in the trauma site: the bone tissue – red; the chondrous tissue – yellow; the connective tissue – light blue; the degenerative and inflammatory tissues – green; b) in the growth plate: the zone of chondrocyte proliferation and reserve – blue; the zone of chondrocyte hypertrophy and columns – yellow; the zone of endochondral ossification with cartilage destruction – red. The painted areas of different colours were summarized in pixels which enabled us to calculate the proportions of different tissues of the callus area in percentage [9].

Statistical analysis
Statistical analysis was performed using one sample t test and the unpaired t-test (GraphPad Quick Calcs: Analyze continuous data) at the level of significance p less than 0.05 ($p<0.05$) with the Newman-Keuls multiple comparison test.

RESULTS

The bone repair after perforation is an ordinary process of skeletal tissues and has well known stages – inflammation, callus formation, remodelling.

The periosteal callus after perforation does not have a certain zonal orientation of cells, but a "mosaic" of chondrous and osseous cells (Fig.1) On the contrary, the cells of GP have a strong zonal differentiation with the following zones: the zone of reserve cartilage and the zone of chondrocyte proliferation (ZPR), the hypertrophic zone with chondrous cells columns (ZH), the zone of cartilage calcification and destruction with endochondral ossification (ZO). This zonal differentiation reveals a typical GP containing cartilage cells characteristic of various stages of development: small, less mature chondrocytes of the proliferation zone; enlarged, active mature chondrocytes of the hypertrophic zone and destroyed chondrocytes of the cartilage destruction and the endochondral ossification zone.

The histomorphometry with the measurement of osseous and chondrous tissues in callus and GP areas was carried out (Fig. 2). 28 days after the perforation areas of hard callus of total callus area are: the osseous tissue –57.9±8.7%; the chondrous tissue –5.3±1.2%; respectively in the exercized animals group –58.5±4.1% and 5.8±1.3%. In the immobilized animals' group the osseous callus repair is inhibited significantly –29.5±3.1% of the total callus area (Table 1).

On the 35^{th}–42^{nd} post-traumatic days the areas of hard callus, especially the osseous callus, is decreased –34.3±3.2% and 37.4±5.6% (the callus replacement and remodeling, the recanalization of the bone cavity). In trained animals these processes are a bit elevated and in immobilized animals – inhibited (Table 1).

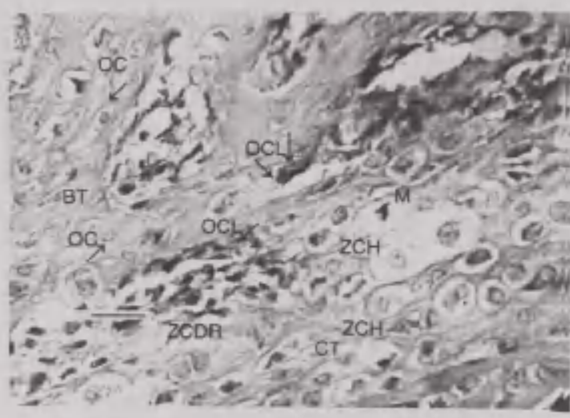

Figure 1. Intramembranous bone formation in periosteal callus 21 days after the perforation of tibia. Actively proliferating chondrous tissue (CT) with mitoses (M) replaced by forming osteoid. Note the lacunas containing capillary sprouts with precursor cells and cartilage zones (ZCH-zone of chondrocyte hypertrophy; ZCDR-zone of cartilage degeneration and removal). Hematoxylin and eosin. Bar: 50 μm.

Figure 2. Epiphyseal growth plate of perforated tibia. Long section. Zonal painting for morphometry: the zone of chondrocyte proliferation and reserve (blue); the zone of chondrocyte hypertrophy and columns (yellow); the zone of endochondral ossification with cartilage destruction (red). Hematoxylin and eosin staining followed by computer painting in RGB scale. Bar: 1000 μm.

Table 1. Areas of tibial callus tissue 4 – 42 days after perforation in normal (N), trained (T) and immobilized (I) rats (percentage of total callus area ± SD)

Day	Osseus tissue(N)	Chondrous tissue**(N)	Osseus tissue** (N)	Chondrous tissue**(T)	Osseus tissue(I)	Chondrous tissue**(I)
4 ***						
7	15.2±2.4	16.7±3.7	17.8±4.2	12.7±3.1	8.9±3.2*	11.7±2.8
14	24.7±4.3	20.4±3.6	29.5±4.5	25.4±3.7	15.8±3.7*	8.4±2.3
21	48.4±9.2*	15.8±2.3	57.4±6.7*	14.8±2.2	36.4±4.2	14.5±3.8
28	57.9±8.7*	5.3±1.2*	58.5±4.1*	5.8±1.3	29.5±3.1	8.6±3.1
35	34.3±3.2	2.7±1.3*	22.4±3.5	2.9±1.13	7.9±4.5	9.8±2.4
42	37.4±5.6	2.4±1.5*	25.6±2.7	1.8±0.8	39.1±3.8	12.4±1.8

*differences between the values of this group are significant ($p < 0.05$)
**periosteal chondrous tissue
*** 4 days after perforation the perforation site is fulfilled with soft tissues

The areas of the growth plate 4–42 days after the perforation of tibia have the constant zonal relations. The perforation of tibia have no influence on the growth plate development process. After exercises the area of endochondral ossification is increased significantly. After immobilization the area of chondrocyte hypertrophy is increased and the zone of ossification – decreased significantly (Table 2).

The comparable study using light microscopy and computerized histomorphometry in normal, trained and immobilized rats after the perforation of tibia in the perforation site and growth plate has been carried out. On the contrary to general similarities in bone formation, some peculiarities have been noticed. Comparing post–traumatic and growth plate ossification, the significant differences in zonal differentiation – cellular "mosaic" in periosteal callus in wound healing versus cell zones during the growth plate ossification – and different stages of bone formation (inflammation, callus formation etc.) in wound healing versus ossification without the stages during the growth plate ossification has been noticed. The training does not influence significantly the post–traumatic callus repair, but accelerates markedly the growth plate ossification.

Table 2. Areas of epiphyseal growth plate tissues 4 – 42 days after perforation in in normal (N), trained (T) and immobilized (I) rats (percentage of total callus area ± SD)

Day	ZPR(N)	ZH(N)	ZO(N)	ZPR(T)	ZH(T)	ZO(T)	ZPR(I)	ZH(I)	ZO(I)
4	45.2±6.4	37.4±4.7	17.4±2.4	41.1±5.3	34.2±4.1	24.7±3.4	49.2±5.4	42.4±4.3	8.4±1.5*
7	42.4±4.8	32.2±3.8	25.4±3.8	32.7±4.2	38.1±3.4	29.2±4.1	50.9±5.7	37.7±3.6	11.4±1.9*
14	57.5±8.7	30.4±6.2	13.3±2.7	42.0±4.4	26.6±3.7	31.4±3.5*	49.7±4.8	43.6±4.2*	6.7±1.2*
21	51.6±6.4	31.5±5.4	16.9±3.3	44.3±5.2	27.2±3.5	28.5±3.6*	51.1±6.2	39.8±4.1	9.1± 2.4
28	46.7±6.4	34.9±5.8	18.4±3.9	35.6±3.7	31.5±4.6	32.9±3.1*	45.2±5.4	44.5±4.8	10.3±1.5*
35	57.3±7.8	22.3±3.6	20.4±3.2	52.4±5.9	21.8±3.4	25.8±3.4	49.1±6.1	36.7±3.2*	14.2±1.6*
42	52.4±7.2	24.4±4.5	23.2±3.5	44.0±5.6	29.3±3.8	26.7±3.2	46.1±4.5	41.8±4.7*	12.1±1.3*

ZPR - zone of chondrocyte proliferation and reserve
ZH – zone of chondrocyte hypertrophy
ZO – zone of endochondral ossification, includes the zone of cartilage destruction and removal, replacement with bone.
* differences in comparison to control (N) are significant ($p < 0.05$)

DISCUSSION

The fracture repair is an interesting phenomenon in vertebrate biology [2, 3, 6]. According to the conception of developmental biology skeletal tissues arise from similar embryonic derivatives – somites and are capable of (re) differentiating into bone, cartilage, and even into muscle tissues [8, 13]. The developmental program is not stabilized, or has been experimentally destabilized by injury (the trauma before the bone repair). The differentiation of such kind of tissues is reversible. The reversible peculiarities in the differentiation of the post–traumatic bone repair compared to embryohistogenesis and growth plate ossification, are inflammation and callus formation [1, 9, 10, 12, 14, 7].

Our data suggest that bone repair after the perforation of tibia in rats begins in the central part of injury, forming internal callus on 7–14 days by desmal (direct) ossification. External (periosteal) callus forms later, on 14–21 post-traumatic days by chondral (indirect, secondary) ossification. Hereby, the initial phase of post–traumatic ossification after perforation, is desmal, without presumptive chondral or neo-perichondral cells and does not resemble with endochondral ossification in the growth plate which may be caused by the much more primitive progenitor cells of post–traumatic bone repair compared to the cells that preform embryonic chondrous skeleton.

There is a number of similarities and peculiarities in post-traumatic repair callus and the growth plate structure detected in normal and affected rats. After the bicortical perforation a new, repair organ – post-traumatic repair callus is formed in the perforation site, in which the cells are without a certain zonal location ("mosaic" of chondrous and osseous cells) [11]. Training does not influence significantly the bone/cartilage ratio in repair callus. In immobilized animals the total process of repair is inhibited. Our data suggest that the relation of bone/cartilage in the control and the training group in growing Wistar rats 28 daya after tibial perforation is on an average 10:1.

Our data suggest that 4–42 day after the tibia perforation the areas of the epiphyseal growth plate in growing Wistar rats have constant zonal relations. One half of the growth plate area constitutes the zone of chondrocyte reserve and proliferation. After exercices the area of endochondral ossification is increased significantly. After the immobilization of rats the area of chondrocyte hypertrophy is increased and the zone of endochondral ossification is decreased significantly compared to the control group.

The bone/cartilage relation in the growth plate 28 days after the perforation of tibia is in the control group 1:4, after the training 1:3 and after the immobilization 1:10 whereas at the same time it is 10:1 in the perforation site and 3:1 after osteotomy [12]. Probably the repair after resection osteotomy and perforation uses a more primitive mechanism to achieve the very rapid growth, in comparison with the growth plate ossification.

Our data suggest that although post-traumatic bone repair is similar to the growth plate ossification and in general recapitulates the skeletal formation similarly to the results of the majority of authors [2, 4, 6], this process includes not only genetic factors, but also some epigenetic adaptive environmental factors (bone formation without chondrous stage, etc.). Inflammation with the presence of cytokines and growth factors, and intensive vascularity, are not define and ubiquitous for bone/cartilage cell differentiation, because they appear only after different injury. Defining both the similarities and differences between fracture healing and bone endochondral development on the growth plate is essential to further unerstanding of skeletal development, its growth and relationship to skeletal adaptive biomechanics.

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THE ROLE OF BODY HEIGHT, WEIGHT AND BMI IN BODY BUILD CLASSIFICATION

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ABSTRACT

The article compares the share of height, weight and BMI as leading characteristics in an anthropometric classification. The analyzed sample consisted of 331 female students (aged 17–23 years) of the University of Tartu (31 basic anthropometric measurements, 11 skinfolds, 5 body composition characteristics). Linear correlation between height, weight, BMI and all the other characteristics revealed that body height was in essential correlation with most basic anthropometric measurements and the amount of subcutaneous adipose tissue; it did not correlate, however, with BMI, skinfolds and body density. Weight correlated with all the variables studied. BMI did not correlate significantly with body height, sternum length, abdominal length and extremities length but was in correlation with all the other characteristics and indicators of body fat content. Therefore, the authors conclude that, although BMI forms a part of the body as a whole, being connected not only with body fat content indicators but many other characteristics, it alone cannot represent the body as a whole as it does not represent an essential component of body structure – height. Neither can BMI alone represent the body as a whole as it is a dependent variable, a relation, and from BMI one cannot derive or compare the absolute values of height and weight that it consists of. Next, a 3×3 SD=9 classification of height and weight was analyzed – how anthropometric variables change in different height classes when weight increases and vice versa, how anthropometric variables change in fixed weight classes when height increases. Systemic differences between classes were found in basic anthropometric variables as well as in the mean values of BMI.

BMI can be considered an essential addition to anthropometric classifications.

Key words: Female students' anthropometric measurements, height-weight classes, BMI in body build classification.

INTRODUCTION

One of the far-reaching aims of theoretical medicine is establishment of constitutional peculiarities of healthy and sick people and application these research results in treatment and health promotion.

To reach this aim, constitutional classifications are needed that would satisfy all requirements for systematization and comparison of research results of anthropologists and medical professionals.

Although the final aim has not been achieved yet, research into peculiarities of body build has been going on for a long time; basic anthropometric variables and body proportions have been assessed and classifications of constitutional types developed. Some best-known classifications have been proposed by E. Kretschmer [10], G. Viola [21, 22], W. H. Sheldon [19], K. Conrad [1, 2], R. W. Parnell [13], B. H. Heath and J. E. L. Carter [4], H. Greil [3]. At the University of Tartu, studies of whole body anthropometric structure have been conducted over a long time. By multivariate statistical analysis of many samples, we have demonstrated that the human body as a whole is a linearly well correlated system. Its leading measurements are height and weight, which account for 50% of the variability of all the other measurements, while individual variability makes up 50%. Variations in body height-weight sizes lead to systematic changes in length, breadth and depth measurements, circumferences and body proportions. Comparative changes of body proportions in the general contingent and in the groups of purely pycnic and leptosomic women are based on respective values of their body height and weight [5, 7, 11].

These findings lead to the conclusion that the anthropological whole body primary model may be based on a classification of body height and weight. This classification has been considered a novel system of Estonian sport and constitutional typology [17].

In recent decades, greatest attention has been paid in medicine to BMI and its various modifications. BMI has been found to have significant correlations with body fat content and adiposity [18, 12, 20].

Considering the above mentioned, the authors of the current study attempted to compare height, weight and BMI with all the other body measurements and body fat content and to establish their role in the classification of basic anthropometric variables.

MATERIAL AND METHODS

Subjects

The sample consisted of 331 female students of the University of Tartu (aged from 17–23 years).

Anthropometric research

The methodology of anthropometric study of these students relied on long-term research carried out on many populations, initially at the Department of Obstetrics and Gynecology and later at the Centre for Physical Anthropology, both at the University of Tartu [5, 6, 15].

Anthropometric measurements were taken personally by the second author of the article, Jana Peterson. Students were measured according to the classical method of Martin [9]. Measuring of skinfolds followed the methodology provided in Knußmann's handbook [9: 274]. Thirty-one anthropometric variables and 11 skinfolds were taken. For body composition analysis, body mass index [16], body density [23], mass and relative mass of subcutaneous adipose tissue, and relative mass of fat by Siri were calculated.

Statistical analysis

Statistical analysis was performed using the SAS program. First, the mean values (x), standard deviations (SD) and minimum and maximum values of all anthropometric values were found. As age-related anthropometric differences were mostly insignificant, the students were further analyzed as one group (Table 1).

Thereafter, correlations of body height, weight and BMI with all the other body measurements were found.

Table 1. Means, standard deviations, minimal, maximal values of body measurements of Estonian female students aged 17–23 (n=331)

No	Variable	Mean	SD	Min	Max
1.	Body height (cm)	167.19	5.99	149.60	185.30
2.	Body mass (kg)	60.395	8.901	39.000	98.850
3.	BMI	21.57	2.70	14.09	34.59
4.	Sternum length (cm)	16.53	2.28	8.40	23.00
5.	Abdomen length (cm)	33.99	2.80	26.20	54.80
6.	Trunk length (cm)	50.52	2.81	42.20	67.80
7	Upper limb length (cm)	72.21	3.53	61.40	81.80
8.	Lower limb length (cm)	89.15	4.28	68.70	101.40
9.	Biacromial breadth (cm)	35.80	1.67	30.50	41.00
10.	Chest breadth (cm)	24.47	1.46	21.00	29.50
11.	Waist breadth (cm)	23.59	2.08	19.00	32.00
12.	Pelvis breadth (cm)	26.78	1.55	22.50	32.00
13.	Chest depth (cm)	17.21	1.55	14.00	24.00
14.	Abdomen depth (cm)	18.99	1.76	12.00	26.00
15.	Femur breadth (cm)	8.98	0.62	7.20	11.20
16.	Ankle breadth (cm)	6.60	0.61	5.10	9.60
17.	Humerus breadth (cm)	6.03	0.59	4.50	8.70
18.	Wrist breadth (cm)	4.91	0.50	4.00	6.60
19.	Head circumf. (cm)	55.95	1.41	51.40	59.80
20.	Neck circumf. (cm)	32.27	1.62	28.10	40.40
21.	Upper chest circumf. (cm)	84.18	5.43	70.8	107.20
22.	Lower chest circumf. (cm)	76.05	5.93	63.00	104.70
23.	Waist circumf. (cm)	69.54	6.31	57.50	98.00
24.	Pelvis circumf. (cm)	84.69	7.39	57.30	118.40
25.	Hip circumf. (cm)	92.87	7.53	75.50	120.20
26.	Upper thigh circumf. (cm)	58.38	4.97	42.30	88.20
27.	Middle thigh circumf. (cm)	49.57	4.13	36.80	63.80
28.	Upper leg circumf. (cm)	35.92	2.73	27.50	48.30
29.	Lower leg circumf. (cm)	22.50	1.79	18.40	36.80
30.	Arm circumf. (cm)	26.26	2.57	19.20	39.80
31.	Forearm circumf. (cm)	22.77	1.70	16.00	28.90
32.	Wrist circumf. (cm)	15.60	1.02	13.40	26.30
33.	Chin skinfold (cm)	0.69	0.23	0.20	1.50
34.	Side skinfold (cm)	0.82	0.30	0.20	2.30
35.	Chest skinfold (cm)	1.03	0.48	0.30	3.10

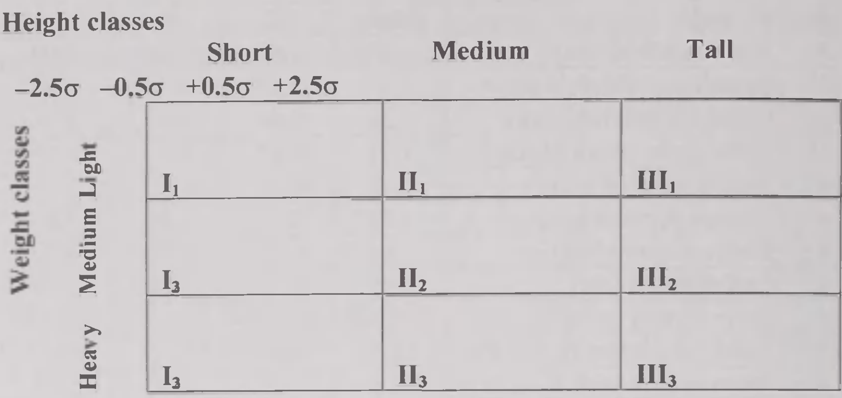
No	Variable	Mean	SD	Min	Max
36.	Waist skinfold (cm)	1.43	0.60	0.40	3.90
37.	Suprailiacal skinfold (cm)	1.07	0.48	0.30	2.90
38.	Umbilical skinfold (cm)	1.36	0.60	0.40	4.40
39.	Subscapular skinfold (cm)	1.31	0.61	0.50	4.30
40.	Biceps skinfold (cm)	0.78	0.31	0.20	2.20
41.	Triceps skinfold (cm)	1.58	0.43	0.50	3.60
42.	Thigh skinfold (cm)	2.64	0.71	0.70	4.70
43.	Calf skinfold (cm)	1.49	0.44	0.60	3.10
44.	Body density (g/cm^3)	1.06048	0.00063	1.05738	1.06175
45.	Relat. fat content by Siri (%)	16.77	0.28	16.21	18.14
46.	Mean skinfold (cm)	1.29	0.39	0.45	2.98
47.	Mass of subcutaneous adipose tissue (kg)	9.86	3.62	2.81	26.68
48.	Relat. content of subcut. adipose tissue (%)	15.99	3.91	6.37	30.27

The basis for creating the height-weight classification was the mean height, weight and their standard deviations of all young women. From these data 3×3 = 9 SD classes of height and weight were formed (see Fig. 1).

The subjects were placed into the classes of this classification according to their individual heights and weights (Tables 3 and 4). Thereafter, the mean values of all anthropometric variables were calculated for all classes.

Using the Scheffé test, the class means of all anthropometric data were compared in two ways. Firstly, in Table 3 we compared the means of body measurements in different weight classes when the height class is fixed. Secondly, in Table 4 we compared the means of body measurements in different height classes when the weight class is fixed. The significance level a=0.05.

Statistical analysis was performed by one of the authors of the paper, Säde Koskel MSc.



Weight classes: Light –2.5σ — –0.5σ
Medium –0.5σ — +0.5σ
Heavy +0.5σ — +2.5σ

Fig. I. Classification by height and weight

Table 2. Linear correlation coefficients of body measurements with body height, weight and BMI

No	Variable	Body height	Body weight	BMI
1.	Body height (cm)	1.000*	0.522*	0.037
2.	Body mass (kg)	0.522*	1.000*	0.869*
3.	BMI	0.037	0.869*	1.000*
4.	Age	–0.070	0.032	0.004
5.	Sternum length (cm)	0.319*	0.205*	0.052
6.	Abdomen length (cm)	0.361*	0.263*	0.104
7.	Trunk length (cm)	0.618*	0.427*	0.145*
8.	Upper limb length (cm)	0.788*	0.417*	0.032
9.	Lower limb length (cm)	0.876*	0.431*	–0.01
10.	Biacromial breadth (cm)	0.491*	0.531*	0.341*
11.	Chest breadth (cm)	0.354*	0.635*	0.542*
12.	Waist breadth (cm)	0.326*	0.771*	0.717*
13.	Pelvis breadth (cm)	0.451*	0.633*	0.481*

No	Variable	Body height	Body weight	BMI
14.	Chest depth (cm)	0.344*	0.652*	0.560*
15.	Abdomen depth (cm)	0.177*	0.717*	0.740*
16.	Femur breadth (cm)	0.418*	0.656*	0.529*
17.	Ankle breadth (cm)	0.363*	0.299*	0.142*
18.	Humerus breadth (cm)	0.290*	0.275*	0.159*
19.	Wrist breadth (cm)	0.354*	0.316*	0.17*
20.	Head circumf. (cm)	0.367*	0.481*	0.354*
21.	Neck circumf. (cm)	0.311*	0.740*	0.694*
22.	Upper chest circumf. (cm)	0.319*	0.857*	0.821*
23.	Lower chest circumf. (cm)	0.305*	0.852*	0.823*
24.	Waist circumf. (cm)	0.219*	0.830*	0.847*
25.	Pelvis circumf. (cm)	0.241*	0.804*	0.803*
26.	Hip circumf. (cm)	0.331*	0.779*	0.722*
27.	Upper thigh circumf. (cm)	0.249*	0.809*	0.807*
28.	Middle thigh circumf. (cm)	0.310*	0.831*	0.795*
29.	Upper leg circumf. (cm)	0.258*	0.694*	0.665*
30.	Lower leg circumf. (cm)	0.250*	0.572*	0.529*
31.	Arm circumf. (cm)	0.144*	0.803*	0.859*
32.	Forearm circumf. (cm)	0.236*	0.695*	0.678*
33.	Wrist circumf. (cm)	0.403*	0.622*	0.499*
34.	Chin skinfold (cm)	0.038	0.515*	0.582*
35.	Side skinfold (cm)	–0.043	0.447*	0.551*
36.	Chest skinfold (cm)	0.058	0.640*	0.713*
37.	Waist skinfold (cm)	0.072	0.615*	0.675*
38.	Suprailiacal skinfold (cm)	0.039	0.619*	0.701*
39.	Umbilical skinfold (cm)	0.105	0.634*	0.678*
40.	Subscapular skinfold (cm)	0.026	0.651*	0.747*
41.	Biceps skinfold (cm)	0.022	0.579*	0.664*
42.	Triceps skinfold (cm)	0.026	0.615*	0.704*
43.	Thigh skinfold (cm)	0.043	0.585*	0.663*
44.	Calf skinfold (cm)	0.021	0.450*	0.516*
45.	Body density (g/cm^3)	–0.032	–0.699*	–0.799*
46.	Relat. fat content by Siri (%)	0.033	0.699*	0.799*
47.	Mean skinfold (cm)	0.052	0.718*	0.810*
48.	Subcut. adip. tissue (kg)	0.206*	0.829*	0.849*
49.	Relat. content of subcut. adipose tissue (%)	–0.013	0.576*	0.681*

• – Statistically significant ($p<0.05$) difference with body height, weight and BMI

Table 3. Comparison of means of body measurements in different weight classes, when the height class is fixed

Height classes	I Short class							II Medium class							III Tall class						
Weight classes Variable	1. Light n=61		2. Medium n=38		3. Heavy n=6		Significance	1. Light n=41		2. Medium n=49		3. Heavy n=28		Significance	1. Light n=9		2. Medium n=47		3. Heavy n=52		Significance
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Body height (cm)	160.37	2.91	160.22	3.25	162.80	1.32	–	166.95	1.66	166.94	1.61	167.67	1.68	–	173.11	1.77	173.05	2.63	174.63	3.70	+
2. Body mass (kg)	50.70	3.44	59.08	2.39	71.48	9.93	+	52.73	3.28	60.16	2.60	70.84	6.67	+	54.89	0.99	60.89	2.49	72.60	6.94	+
3. BMI	19.72	1.38	23.05	1.42	26.98	3.79	+	18.92	1.20	21.59	0.97	25.21	2.44	+	18.32	0.37	20.35	1.03	23.83	2.37	+
4. Sternum length (cm)	15.57	2.06	16.45	1.88	15.45	1.71	–	16.02	1.69	16.39	2.10	15.95	2.50	–	15.54	3.70	17.75	1.78	17.75	2..51	+
5. Abdomen length (cm)	32.70	2..39	32.21	2.07	34.65	2.92	–	34.15	3.89	34.32	1.88	35.38	3.14	–	34.83	4.38	34.64	1.98	34.83	2.53	–
6. Trunk length (cm)	48.27	1.76	48.66	2.40	50.10	1.84	–	50.16	3.49	50.71	1.76	51.34	2.45	–	50.38	3.73	52.39	1.93	52.58	2.67	+
7. Upper limb length (cm)	69.16	2.50	68.27	2.23	70.03	2.38	–	72.35	2.05	72.10	2.24	72.59	2.37	–	74.50	3.84	75.09	2.44	75.70	2.46	–
8. Lower limb length (cm)	85.11	2.44	84.53	3.27	85.61	1.80	–	89.07	2.61	88.82	2.01	89.18	2.99	–	93.47	2.52	92.80	2.36	93.97	2.68	–
9. Biacromial breadth (cm)	34.52	1.41	34.97	1.39	35.58	1.39	–	35.50	1.33	36.03	1.31	36.41	1.13	+	35.61	0.96	36.20	1.71	37.30	1.55	–
10. Chest breadth (cm)	23.37	1.27	24.45	1.33	25.00	0.84	+	23.75	1.29	24.40	1.19	25.70	1.16	+	24.33	0.75	24.53	1.05	25.67	1.39	+
11. Waist breadth (cm)	21.99	1.31	23.71	1.42	26.25	3.39	+	21.94	1.60	23.44	1.43	25.50	2.13	+	22.89	1.14	23.42	1.19	25.74	1.61	+
12. Pelvis breadth (cm)	25.44	1.18	26.25	1.15	28.00	1.05	+	26.43	1.25	26.66	1.28	27.66	1.54	+	26.62	1.18	27.13	0.92	28.23	1.60	+
13. Chest depth (cm)	16.25	1.21	16.99	0.82	17.83	1.69	+	16.31	1.30	17.13	1.25	18.23	1.33	+	17.00	1.15	17.13	1.14	18.76	1.77	+

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
14. Abdomen depth (cm)	14.90	1.05	16.03	1.58	19.33	3.60	+	15.31	1.07	15.72	1.36	17.63	1.61	+	15.06	1.04	15.52	1.03	17.37	1.87	+
15. Femur breadth (cm)	8.43	0.43	8.91	0.43	9.38	0.51	+	8.67	0.50	8.94	0.41	9.48	0.60	+	8.92	0.45	9.14	0.47	9.53	0.63	+
16. Ankle breadth (cm)	6.28	0.47	6.31	0.37	6.48	0.48	–	6.59	0.52	6.64	0.70	6.93	0.71	–	6.70	0.44	6.71	0.50	6.89	0.69	–
17. Humerus breadth (cm)	5.74	0.49	5.86	0.40	6.17	0.45	–	6.02	0.61	6.04	0.57	6.16	0.69	–	6.00	0.57	6.19	0.63	6.30	0.56	–
18. Wrist breadth (cm)	4.59	0.39	4.75	0.37	4.92	0.51	–	4.98	0.58	4.91	0.45	5.13	0.58	–	4.98	0.33	5.03	0.52	5.12	0.40	–
19. Head circumf(cm)	55.02	1.27	55.69	1.15	56.48	1.37	+	55.11	1.43	56.33	1.20	56.71	1.35	+	55.69	1.20	56.17	1.17	56.94	1.15	+
20. Neck circumf(cm)	31.18	1.22	32.17	1.30	35.28	2.73	+	30.95	0.99	32.23	1.14	33.69	1.38	+	31.82	1.02	32.17	1.12	33.79	1.28	+
21. Upper chest circumf (cm)	79.81	3.31	84.45	3.84	91.52	8.54	+	79.27	3.24	84.15	2.73	89.69	4.88	+	81.20	2.81	83.71	2.53	90.12	4.73	+
22. Lower chest circumf(cm)	71.59	3.28	75.95	3.81	85.13	10.37	+	71.49	2.96	75.33	3.55	82.74	5.39	+	73.34	2.01	74.87	2.75	82.50	5.66	+
23. Waist circumf(cm)	65.07	3.84	70.18	3.91	79.82	10.64	+	64.55	2.81	68.92	4.26	76.65	6.61	+	65.32	1.74	67.85	3.38	76.10	5.12	+
24. Pelvis circumf(cm)	79.32	4.09	85.97	4.86	94.08	13.18	+	79.19	4.90	84.16	4.71	91.65	7.54	+	80.28	4.33	83.27	5.68	92.12	6.26	+
25. Hip circumf(cm)	86.79	4.76	94.03	4.54	100.57	11.11	+	86.92	5.79	92.19	4.92	99.40	7.52	+	89.28	4.74	92.98	5.49	100.61	5.97	+
26. Upper thigh circumf(cm)	54.39	2.85	59.37	2.99	64.05	5.50	+	54.17	2.99	58.83	5.18	63.70	4.01	+	53.62	1.63	57.72	2.72	63.13	3.42	+
27. Middle thigh circumf(cm)	45.89	2.83	50.49	2.00	53.12	3.33	+	45.52	2.57	49.73	2.61	54.23	2.88	+	45.24	1.93	49.87	2.42	53.81	3.13	+
28. Upper leg circumf(cm)	33.70	2.15	36.41	1.41	37.98	2.24	+	33.86	1.84	36.42	2.19	38.28	3.24	+	33.18	0.99	36.35	2.23	37.90	2.15	+

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
29 Lower leg circumf(cm)	21.08	1.07	22.90	1.39	22.43	0.50	+	21.57	1.18	22.99	2.29	24.08	2.60	+	21.33	0.62	22.56	1.02	23.46	1.19	+
30.Arm circumf(cm)	24.57	1.64	27.19	1.73	30.05	4.92	+	23.90	1.86	26.09	1.36	29.24	2.13	+	23.82	0.54	25.69	1.17	28.49	2.34	+
31.Forearm circumf(cm)	21.57	1.14	23.30	1.12	23.52	2.28	+	21.47	1.37	22.83	1.39	24.31	1.96	+	21.38	0.40	22.63	0.92	24.25	1.54	+
32.Wrist circumf(cm)	14.80	0.58	15.55	0.68	16.03	1.04	+	14.96	0.55	15.67	0.62	16.23	0.70	+	15.37	0.80	15.72	0.48	16.57	1.54	–
33.Chin skinfold (cm)	0.60	0.17	0.71	0.21	0.98	0.28	+	0.56	0.16	0.70	0.22	0.91	0.23	+	0.56	0.15	0.62	0.17	0.81	0.27	+
34.Side skin-fold (cm)	0.72	0.23	0.95	0.30	1.22	0.26	+	0.68	0.22	0.79	0.23	1.14	0.40	+	0.60	0.21	0.71	0.23	0.91	0.31	+
35.Chest skinfold (cm)	0.86	0.36	1.12	0.37	2.00	0.66	+	0.68	0.19	0.90	0.26	1.59	0.60	+	0.71	0.19	0.83	0.25	1.38	0.52	+
36. Waist skinfold (cm)	1.23	0.36	1.48	0.54	2.60	0.83	+	1.00	0.36	1.30	0.44	2.03	0.61	+	0.99	0.23	1.19	0.29	1.90	0.59	+
37. Suprai-liacal skinfold (cm)	0.90	0.31	1.24	0.46	1.73	0.59	+	0.76	0.31	0.95	0.33	1.50	0.54	+	0.72	0.20	0.89	0.27	1.42	0.54	+
38.Umbi-lical skinfold (cm)	1.11	0.40	1.47	0.53	2.40	1.14	+	0.37	0.28	1.27	0.47	1.88	0.65	+	0.92	0.16	1.17	0.29	1.82	0.68	+
39.Subs-capular skinfold (cm)	1.08	0.36	1.46	0.48	2.55	1.09	+	0.92	0.33	1.18	0.38	2.01	0.73	+	0.89	0.19	1.02	0.26	1.73	0.66	+
40.Biceps skinfold (cm)	0.65	0.24	0.85	0.25	1.52	0.42	+	0.62	0.22	0.75	0.25	1.06	0.28	+	0.47	0.10	0.67	0.18	0.97	0.34	+
41.Triceps skinfold (cm)	1.36	0.39	1.78	0.42	2.13	0.60	+	1.26	0.41	1.49	0.35	2.09	0.56	+	1.21	0.24	1.42	0.27	1.89	0.50	+

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
42. Thigh skinfold (cm)	2.23	0.61	3.02	0.61	3.42	0.68	+	2.09	0.59	2.63	0.45	3.16	0.62	+	1.84	0.45	2.63	3.53	3.03	0.71	+
43. Calf skinfold (cm)	1.30	0.41	1.70	0.41	2.28	0.35	+	1.20	0.32	1.39	0.36	1.76	0.37	+	1.04	0.26	1.50	0.40	1.70	0.38	+
44. Body density (g/cm^3)	1.0608	0.0004	1.06026	0.00047	1.05916	0.00103	+	1.06095	0.00039	1.06059	0.00039	1.05977	0.00063	+	1.06109	0.00018	1.06073	0.00032	1.06003	0.00066	+
45. Relat. fat content by Siri (%)	16.63	0.18	16.87	0.21	17.35	0.46	+	16.56	0.17	16.72	0.16	17.08	0.28	+	16.50	0.081	16.66	0.14	16.97	0.29	+
46. Mean skinfold (cm)	1.09	0.27	1.43	0.27	2.08	0.53	+	0.98	0.25	1.21	0.23	1.74	0.37	+	0.91	0.12	1.15	0.19	1.60	0.39	+
47. Mass of subcutaneous adipose tissue (kg)	7.45	1.91	10.41	2.08	16.68	5.29	+	6.97	1.83	9.15	1.86	14.13	3.44	+	6.74	0.89	8.94	1.47	13.52	3.81	+
48. Relat. content of subcut. adipose tissue (%)	14.63	3.38	17.57	3.08	22.96	4.26	+	13.17	3.16	15.16	2.71	19.82	3.80	+	12.27	1.53	14.68	2.23	18.45	3.82	+

Significance is positive (+) if there exists significant difference between 3 means in given class

Table 4. Comparison of means of body measurements in different height classes when the weight class is fixed

Weight classes	1. Light class							2. Medium class							3. Heavy class						
Height classes Variable	I Short n=61		II Medium n=41		III Tall n=9		Sig-nifi-can-ce	I Short n=38		II Medium n=49		III Tall n=47		Sig-nifi-can-ce	I Short n=6		II Medium n=28		III Tall n=52		Sig-nifi-can-ce
	x	SD	x	SD	x	SD			SD	x	SD	x	SD		x	SD	x	SD	x	SD	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
1. Body height (cm)	160.37	2.91	166.95	1.66	173.11	0.177	+	160.22	3.25	166.94	1.61	173.05	2.63	+	162.80	1.32	167.67	1.68	174.63	3.79	+
2. Body mass (kg)	50.70	3.44	52.73	3.28	54.89	0.99	+	59.08	2.39	60.16	2.60	68.89	2.49	+	71.48	9.93	70.84	6.67	72.60	6.94	–
3. BMI	19.72	1.38	18.92	1.20	18.32	0.37	+	23.05	1.42	21.59	0.97	20.35	1.03	+	26.98	3.79	25.21	2.44	23.83	2.37	+
4. Sternum length (cm)	15.57	2.06	16.02	1.69	15.54	3.70	–	16.45	1.88	16.39	2.07	17.75	1.78	+	15.45	1.71	15.95	2.50	17.75	2.51	+
5. Abdomen length (cm)	32.70	2.39	34.15	3.89	34.83	4.38	–	32.21	2.07	34.32	1.88	34.64	1.98	+	34.65	2.92	35.38	3.14	34.83	2.53	–
6. Trunk length (cm)	48.27	1.76	50.16	3.49	50.38	3.73	+	48.66	2.40	50.71	1.76	52.39	1.93	+	50.10	1.84	51.34	2.45	52.58	2.27	+
7. Upper limb length (cm)	69.16	2.50	72.35	2.05	74.50	3.84	+	68.27	2.23	72.10	2.24	75.09	2.44	+	70.03	2.38	72.59	2.37	75.70	2.46	+
8. Lower limb length (cm)	85.11	2.44	89.07	2.61	93.47	2.52	+	84.53	3.27	88.82	2.01	92.80	2.36	+	85.61	1.80	89.18	2.99	93.97	2.68	+
9. Biacromial breadth (cm)	34.52	1.41	35.50	1.33	35.61	0.96	+	34.97	1.39	36.03	1.31	36.20	1.71	+	35.58	1.39	36.41	1.13	37.30	1.55	+
10. Chest breadth (cm)	23.37	1.27	23.75	1.29	24.33	0.75	–	24.45	1.33	24.40	1.19	24.53	1.05	–	25.00	0.84	25.70	1.16	25.67	1.39	–
11. Waist breadth (cm)	21.99	1.31	21.94	1.60	22.89	1.14	–	23.71	1.42	23.44	1.43	23.42	1.19	–	26.25	3.39	25.50	2.13	25.74	1.61	–
12. Pelvis breadth (cm)	25.44	1.18	26.43	1.25	26.62	1.18	+	26.25	1.15	26.66	1.28	27.13	0.92	+	28.00	1.05	27.66	1.54	28.23	1.60	–
13. Chest depth (cm)	16.25	1.21	16.31	1.30	17.00	1.15	–	16.99	0.82	17.13	1.25	17.13	1.14	–	17.83	1.69	18.23	1.34	18.76	1.77	–
14. Abdomen depth (cm)	14.90	1.05	15.31	1.07	15.06	1.04	–	16.03	1.58	15.72	1.36	15.52	1.03	–	19.33	3.60	17.63	1.61	17.37	1.87	–

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
15. Femur breadth (cm)	8.43	0.43	8.67	0.50	8.92	0.45	+	8.91	0.43	8.94	0.41	9.14	0.47	–	9.38	0.51	9.48	0.60	9.53	0.63	–
16. Ankle breadth (cm)	6.28	0.47	6.59	0.52	6.70	0.44	+	6.31	0.37	6.64	0.70	6.71	0.50	+	6.48	0.48	6.93	0.71	6.89	0.69	–
17. Humerus breadth (cm)	5.74	0.49	6.02	0.61	6.00	0.57	+	5.86	0.40	6.04	0.57	6.19	0.63	–	6.17	0.45	6.16	0.69	6.30	0.56	–
18. Wrist breadth (cm)	4.59	0.39	4.98	0.58	4.98	0.33	+	4.75	0.37	4.91	0.45	5.03	0.52	+	4.92	0.51	5.13	0.58	5.12	0.40	–
19. Head circumf. (cm)	55.02	1.27	55.11	1.43	55.69	1.20	–	55.69	1.15	56.33	1.20	56.17	1.17	+	56.48	1.37	56.71	1.35	56.94	1.15	–
20. Neck circumf. (cm)	31.18	1.22	30.95	0.99	31.82	1.02	–	32.17	1.30	32.23	1.14	32.17	1.12	–	35.28	2.73	33.69	1.38	33.79	1.28	+
21. Upper chest circumf. (cm)	79.81	3.31	79.27	3.24	81.20	2.81	–	84.45	3.84	84.15	2.73	83.71	2.53	–	91.52	8.54	89.69	4.88	90.12	4.73	–
22. Lower chest circumf. (cm)	71.59	3.28	71.49	2.96	73.34	2.01	–	75.95	3.81	75.33	3.55	74.87	2.75	–	85.13	10.37	82.74	5.39	82.50	5.66	–
23. Waist circumf. (cm)	65.07	3.84	64.55	2.81	65.32	1.74	–	70.18	3.91	68.92	4.26	67.85	3.38	+	79.82	10.64	76.65	6.61	76.10	5.12	–
24. Pelvis circumf. (cm)	79.32	4.09	79.19	4.90	80.28	4.33	–	85.97	4.86	84.16	4.70	83.27	5.68	–	94.08	13.18	91.65	7.54	92.12	6.26	–
25. Hip circumf. (cm)	86.79	4.76	86.92	5.79	89.28	4.74	–	94.03	4.54	92.16	4.92	92.98	5.49	–	100.57	11.11	99.40	7.52	100.61	5.97	–
26. Upper thigh circumf. (cm)	54.39	2.86	54.17	2.99	53.62	1.63	–	59.37	2.99	58.83	5.18	57.72	2.72	–	64.05	5.50	63.70	4.01	63.13	3.42	–
27. Middle thigh circumf. (cm)	45.89	2.83	45.52	2.57	45.24	1.93	–	50.49	2.00	49.73	2.61	49.87	2.42	–	53.12	3.33	54.23	2.88	53.81	3.13	–
28. Upper leg circumf. (cm)	33.70	2.15	33.86	1.84	33.18	0.99	–	36.41	1.41	36.42	2.19	36.35	2.23	–	37.98	2.24	38.28	3.24	37.90	2.15	–
29. Lower leg circumf. (cm)	21.08	1.07	21.57	1.18	21.33	0.62	–	22.90	1.39	22.99	2.29	22.56	1.02	-	22.43	0.50	24.08	2.60	23.46	1.19	–

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
30. Arm circumf. (cm)	24.57	1.64	23.90	1.86	23.82	0.54	–	27.19	1.73	26.09	1.36	25.69	1.17	+	30.05	4.92	29.24	2.13	28.49	2.34	–
31. Forearm circumf. (cm)	21.57	1.14	25.43	1.69	21.38	0.40	–	23.30	1.12	22.83	1.39	22.63	0.92	+	23.52	2.28	24.31	1.96	24.25	1.54	—
32. Wrist circumf. (cm)	14.80	0.58	21.47	1.37	15.37	0.80	+	15.55	0.68	15.67	0.62	15.72	0.48	–	16.03	1.04	16.23	0.70	16.57	1.54	–
33. Chin skinfold (cm)	0.60	0.17	14.96	0.55	0.56	0.15	–	0.71	0.21	0.70	0.23	0.62	0.17	–	0.98	0.28	0.91	0.23	0.81	0.27	–
34. Side skinfold (cm)	0.72	0.23	0.56	0.16	0.60	0.21	–	0.95	0.30	0.79	0.23	0.71	0.23	+	1.22	0.26	1.14	0.40	0.91	0.31	+
35. Chest skinfold (cm)	0.86	0.36	0.68	0.22	0.71	0.19	–	1.12	0.37	0.90	0.26	0.83	0.25	+	2.00	0.66	1.59	0.60	1.38	0.52	+
36. Waist skinfold (cm)	1.23	0.46	0.68	0.19	0.99	0.23	–	1.48	0.54	1.30	0.44	1.19	0.29	+	2.60	0.83	2.03	0.61	1.90	0.53	+
37. Suprailiacal skinfold (cm)	0.90	0.31	1.00	0.36	0.72	0.20	–	1.24	0.46	0.95	0.33	0.89	0.27	+	1.73	0.59	1.50	0.54	1.42	0.54	–
38. Umbilical skinfold (cm)	1.11	0.40	0.76	0.31	0.92	0.16	–	1.47	0.53	1.27	0.47	1.17	0.29	+	2.40	1.14	1.88	0.65	1.82	0.68	–
39. Subscapular skinfold (cm)	1.08	0.36	0.97	0.28	0.89	0.19	-	1.46	0.48	1.18	0.38	1.02	0.26	+	2.55	1.03	2.01	0.73	1.73	0.66	+
40. Biceps skinfold (cm)	0.65	0.24	0.92	0.33	0.47	0.10	–	0.85	0.25	0.75	0.25	0.67	0.18	+	1.52	0.42	1.06	0.28	0.97	0.34	+
41. Triceps skinfold (cm)	1.36	0.39	0.62	0.22	1.21	0.24	–	1.78	0.42	1.49	0.35	1.42	0.27	+	2.13	0.60	2.09	0.56	1.89	0.50	–
42. Thigh skinfold (cm)	2.23	0.61	1.26	0.41	1.84	0.45	–	3.02	0.61	2.63	0.45	2.63	0.53	+	3.42	0.68	3.16	0.62	3.03	0.71	–
43. Calf skinfold (cm)	1.30	0.41	2.09	0.59	1.04	0.26	-	1.70	0.41	1.39	0.36	1.50	0.40	+	2.28	0.35	1.76	0.37	1.70	0.38	+
44. Body density (g/cm^3)	1.06080	0.00040	1.06095	0.00039	1.06109	0.00018	–	1.06026	0.00047	1.06059	0.00037	1.06073	0.00032	+	1.05916	0.00103	1.05977	0.00063	1.06003	0.00066	+

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
45. Relat. fat content by Siri (%)	16.63	0.18	16.56	0.17	16.50	0.08	–	16.87	0.21	16.72	0.16	16.66	0.140	+	17.35	0.46	17.08	0.28	16.97	2.92	+
46. Mean skinfold (cm)	1.09	0.27	0.25	0.91	0.91	0.12	-	1.43	0.27	1.21	0.23	1.15	0.19	+	2.08	0.53	1.74	0.37	1.60	0.39	+
47. Mass of subcutaneous adipose tissue (kg)	7.45	1.91	1.83	6.74	6.74	0.89	–	10.41	2.08	9.15	1.86	8.94	1.47	+	16.68	5.29	14.13	3.44	13.52	3.81	+
48. Relat. content of subcut. adipose tissue (%)	14.63	3.38	3.16	12.27	12.27	1.53	–	17.57	3.08	15.16	2.71	14.68	2.23	+	22.96	4.26	19.82	3.80	18.45	3.82	+

Significance is positive (+) if there exists significant difference between 3 means in given class

RESULTS

Table 1 presents primary statistics on height, weight, BMI and all the other basic anthropometric variables ($\bar{x}$, SD, min, max). The most variable characteristics were weight ($\bar{x}$ = 60.395, variation range 59.85 kg), height ($\bar{x}$ = 167.19, variation range 35.7 cm) and BMI ($\bar{x}$ = 21.57, variation range 20.5 units). The amount of subcutaneous adipose tissue also varied greatly ($\bar{x}$ = 9.86, variation range 23.87 kg).

Next, using linear correlation analysis, we related age, height, weight and BMI (Quetelet, W/H^2) [16] with 29 basic anthropometric variables, 11 skinfolds and 5 body composition indicators. These data are presented in Table 2.

First, we can state that the sample did not reveal any significant differences caused by age.

As could be expected, height, weight as well as BMI were in statistically significant correlation with most basic anthropometric variables.

Body height was in statistically significant correlation with most basic anthropometric variables and the amount of subcutaneous adipose tissue, but did not correlate with BMI, skinfolds and body density.

Weight correlated significantly with all the analyzed anthropometric variables.

BMI did not show any significant correlation with body height, sternum length, abdominal length and extremities length, but was in correlation with all the other anthropometric variables and indicators of body fat content.

From that we can conclude that, although BMI is a characteristic of the body as a whole, being related not only to body fat content but also to many other anthropometric variables, in our opinion, BMI alone cannot represent the body as a whole as it does not represent an essential structure of body structure – height. Neither can BMI alone represent the body as a whole as it is a dependent variable, a relation, from which it is impossible to derive the absolute values of height and weight so that they could be compared.

Considering all that, we suggest that the basis for a classification of body measurements should still be height and weight.

Next, in Tables 3 and 4, we present in 3×3 SD classes the mean values of all the variables studied and compare them statistically.

We analyzed these data in two ways. First, in Table 3, we observed the weight classes in three height classes and tracked the changes in basic anthropometric variables when weight classes gradually increased.

Next, in Table 4 we observed the changes in basic anthropometric variables, if we took three weight classes (small, medium and large) and found the changes in body measurements in each weight class when height gradually increased. For all the classes the mean values of BMI were calculated.

As can be seen in Table 3, systematic increases can be noticed in all breadth and depth measurements, circumferences and body fat content in all height classes in the direction of increase of height classes. There is also a significant gradual increase in BMI.

In Table 4 we can see that in all three weight classes, a gradual increase in height is accompanied by greater length measurements, but most other measurements do not change significantly, and body fat content decreases. In all three weight classes, BMI decreases significantly when height increases.

DISCUSSION

Until now, literature has not offered any completely satisfactory solutions for classification of basic anthropometric measurements and body fat content indicators.

At the University of Tartu, after long-term research, we have reached the conclusion that the most appropriate anthropometric classification is a height-weight classification of SD classes. A 5×5 classification and a five-class system of height and weight have been applied. A general increase of interest in BMI, which is related to body fat content, compelled the authors of the present article to analyse connections of BMI not only with body fat content but also with all other body measurements in order to find the place of BMI in anthropometric classifications.

As BMI is an index expressing a relation and it is impossible to classify the absolute values of height and weight by means of BMI only, and as BMI is not related to body height and other length measurements, we are of the opinion that BMI alone cannot serve as a basis for an anthropometric classification. A proof of this could be our previous article [15], which used the same material as the current article (females aged 17–23 years, n = 331). Here, in order to study nutrition, a classification of body measurements into 5 SD classes of height and weight was applied: (1) small weight – small height, (2) medium weight – medium height, (3) big weight – big height, (4) pyknics, (5) leptosomes. In all classes, BMI was also calculated. The study revealed that in two extreme classes – (1) small weight – small height and (5) leptosomes, the difference in the subjects' mean height was 11 cm and the difference in their mean weight was 7 kg. The subjects differed greatly in their body size, shape and type, but their BMI was quite similar – in the small class 19.88 and in the class of leptosomes 19.66.

Therefore, we conclude that, in our opinion, the basis for anthropometric classification of body build should still be height and weight, regardless if we use this classification to analyze length, breadth and depth measurements or body fat indicators. BMI, however, can serve as a valuable addition to height-weight classes.

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FOOD ENERGY AND MAIN NUTRIENT CONTENTS IN 24-HOUR MENUS OF 15–16-YEAR-OLD ESTONIAN SCHOOLGIRLS

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ABSTRACT

Body build and nutrition of 170 Tartu schoolgirls aged 15–16 years were studied. Thirty-three body measurements and 11 skinfolds were measured and 6 body composition characteristics calculated. The girls were asked to submit descriptions of their 24-hour menus and from these, using the Micro-Nutrica program, the content of food energy (kcal), proteins (9), fats (9) and carbohydrates (9) in their menus was calculated.

Correlation analysis of nutrition and anthropometric characteristics revealed that 74 correlation coefficients (r=0.17–0.266) were in significant but negative correlation with nutrition. Significant positive correlations existed only between body density and food energy (r=0.191*), proteins (r=0.205*) and fats (r=0.209*) and between abdominal length and protein content in food (r=0.186*).

In order to characterize the connection between nutrition and the body as an anthropometric whole by many individual correlations, we applied a 5 SD classification consisting of the following classes: (1) small height, small weight; (2) medium height, medium weight; (3) big height, big weight; (4) pycnomorphs – big weight, small height, and (5) leptomorphs – small weight, big height.

The girls were placed into this classification according to their individual heights and weights. Mean values of all anthropometric variables and nutrition characteristics were calculated for all classes.

In nutrition data, a statistically significant difference was revealed only between pycnomorphs and leptomorphs. Leptomorphs consumed considerably more food energy and carbohydrates.

Systemic differences between all classes appeared when in all classes the mean values of all nutrition characteristics were calculated per 1 kg of body weight. In classes 1–3, consumption was the highest in the class of small subjects and diminished gradually in the medium and big classes. Leptomorphs surpassed pycnomorphs in all aspects.

The body types classification used by us characterizes a very essential component of nutrition assessment – differences in metabolism type– and can be recommended for individual rational food consumption research in medical practice.

In conclusion, different body measurements can be applied in anthropometric characterization of nutrition, but this must always be accompanied by a characterization of the peculiarities of the body as a whole by height and weight. No other measurement, e.g. abdominal circumference, is appropriate for it, as it does not represent the peculiarities of the body as a whole, and the numerical value of the same characteristic can have a different meaning for different body types.

Key words: Body build, nutrition, anthropometry, daily energy and nutrient consumption, height and weight classification.

INTRODUCTION

In the whole world, healthy nutrition of men and women of all ages is receiving increasing attention. This is testified by the recommendations published by the WHO [1, 3], the Commission of the European Communities [4] and other publications [2, 14].

Anthropometric data are an essential component in assessment of nutrition habits. Unfortunately, no common agreement has been reached, which of the body measurements are the most informative and how many of them should be used.

Estonia has particularly long experience in studies of girls' and young women's body build [5, 9, 13] and in nutrition [7, 10, 11].

The authors of the current article attempted to continue the anthropometric trend in nutrition research and analyze the role of schoolgirls' basic anthropometric measurements, some body composition characteristics and classifications in nutrient intake.

MATERIALS AND METHODS

The subjects of our research were 170 Tartu schoolgirls aged 15–16 years who were studied in 1996 and 1997.

Anthropometric research and collection of nutrition data
Anthropometric measuring (33 body measurements and 11 skinfolds) was done personally by one of the authors of the article, Liidia Saluste Cand. Med.

The classical method of Martin was used [6]. Measuring of skinfolds followed the methodology provided in Knussmann's handbook [6: 254]. Eleven skinfolds were taken. For body composition analysis body mass index, body density according to Wilmore and Behnke [15], mean skinfold, mass of subcutaneous adipose tissue, relative mass of subcutaneous adipose tissue (%) and relative mass of fat by Siri were calculated.

The subjects were also asked to submit descriptions of their 24-hour menus.

Statistical analysis of the material was carried out using the SAS program by one of the authors of the article, Master of Statistics Säde Koskel.

First, the mean values ($\bar{x}$) and standard deviations of all anthropometric variables were calculated for the age groups of 15 and 16 years. However, as age-related anthropometric differences were mainly insignificant, the girls were further analyzed as one group.

Nutrient intake was determined using the Micro-Nutrica software and the food composition database [8]. The collected data were used to calculate the most essential food energy and nutrient contents of individual 24-hour menus: food energy (kcal), proteins (9), fats (9) and carbohydrates (9). Thereafter correlations were found between all the body measurements and food energy and nutrients content in the menu.

Table 1 lists all the anthropometric variables and body composition characteristics and shows their correlations with nutritional data.

Table 1. Mean values. standard deviations of anthropometric variables and correlation coefficients with nutrients consumption in Estonian schoolgirls aged 15–16 years (n=170)

No	Variable	$\bar{x}$	SD	Energ (kcal)	Proteins (g)	Fats (g)	Carbohydrates (g)
1.	Age	15.95	0.47	–0.093	–0.085	–0.056	–0.111
2.	Weight	57.664	7.680	–0.136	–0.130	–0.146	–0.106
3.	Height	165.78	5.46	–0.082	0.065	0.051	0.099
4.	Sternum length (cm)	14.07	2.28	–0.025	–0.089	0.007	–0.037
5.	Abdomen length (cm)	26.65	5.33	0.109	0.186*	0.060	0.117
6.	Trunk length (cm)	50.32	3.21	0.088	0.047	0.026	0.136
7.	Upper limb length (cm)	71.75	3.97	0.061	0.069	0.065	0.045
8.	Lower limb length (cm)	89.46	4.47	0.019	–0.024	0.06	0.037
9.	Biacromial breadth (cm)	34.63	1.59	0.107	0.092	0.095	0.104
10.	Chest breadth (cm)	25.17	16.25	–0.08	–0.009	–0.07	–0.09
11.	Waist breadth (cm)	22.50	1.75	–0.100	–0.067	–0.082	–0.106
12.	Pelvis breadth (cm)	26.71	1.62	–0.021	–0.066	–0.005	–0.022
13.	Chest depth (cm)	16.47	1.57	–0.106	–0.133	–0.166*	–0.031
14.	Abdomen depth (cm)	15.47	1.30	–0.080	–0.078	–0.088	–0.059
15.	Femur breadth (cm)	9.29	6.09	–0.048	–0.033	–0.089	–0.008
16.	Ankle breadth (cm)	6.73	0.36	–0.029	0.069	0.000	0.041
17.	Humerus breadth (cm)	6.09	0.38	0.070	0.032	0.055	0.079
18.	Wrist breadth (cm)	4.96	0.28	0.076	0.090	0.019	0.110
19.	Head circumference (cm)	55.07	1.39	–0.02	0.009	–0.009	–0.032

No	Variable	$\bar{x}$	SD	Energ (kcal)	Proteins (g)	Fats (g)	Carbohydrates (g)
20.	Neck circumference (cm)	31.51	1.76	0.001	–0.029	–0.006	0.014
21.	Upper chest circumference(cm)	81.86	7.43	0.015	0.033	0.016	0.008
22.	Lower chest circumference(cm)	74.44	4.85	–0.125	–0.85	–0.128	–0.110
23.	Waist circumference(cm)	67.97	5.52	–0.109	–0.079	–0.099	–0.106
24.	Pelvis circumference(cm)	83.97	6.72	0.223*	–0.221*	–0.205*	–0.200*
25.	Hip circumference(cm)	89.02	6.17	–0.220*	–0.198*	–0.198*	–0.206*
26.	Upper thigh circumference(cm)	56.89	4.45	–0.122	–0.123*	–0.139	–0.085
27.	Middle thigh circumference(cm)	47.66	4.12	–0.170*	–0.161*	–0.169*	–0.144
28.	Upper leg circumference(cm)	34.92	3.03	0.079	0.016	0.059	0.098
29.	Lower leg circumference(cm)	21.95	1.26	–0.122	–0.103	–0.130	–0.097
30.	Arm circumference(cm)	25.49	2.32	–0.206*	–0.209*	–0.211*	–0.166*
31.	Arm circumference flexed and tensed (cm)	27.34	2.34	–0.224*	–0.222*	–0.218*	–0.191*
32.	Forearm circumference(cm)	22.42	1.43	–0.114	–0.081	–0.099	–0.116
33.	Wrist circumference(cm)	15.48	0.86	–0.119	–0.112	–0.125	–0.096
34.	Chin skinfold (cm)	0.66	0.22	–0.144	–0.168*	–0.168*	–0.093
35.	Side skinfold (cm)	0.76	0.31	–0.169*	–0.206*	–0.171*	–0.132
36.	Chest skinfold (cm)	0.99	0.42	–0.242*	–0.241*	–0.253*	–0.794*
37.	Waist skinfold (cm)	1.33	0.60	–0.201*	–0.209*	–0.197*	–0.169*
38.	Suprailiac skinfold (cm)	0.97	0.47	–0.254*	–0.285*	–0.260*	–0.199*

No	Variable	$\bar{x}$	SD	Energ (kcal)	Proteins (g)	Fats (g)	Carbohydrates (g)
39.	Umbilical skinfold (cm)	1.24	0.55	–0.230*	–0.248*	–0.248*	–0.173*
40.	Subscapular skinfold (cm)	1.13	0.51	–0.217*	–0.222*	–0.214*	–0.182*
41.	Biceps skinfold (cm)	0.80	0.39	–0.188*	–0.187*	–0.186*	–0.157*
42.	Triceps skinfold (cm)	1.53	0.46	–0.198*	–0.246*	–0.241*	–0.116
43.	Thigh skinfold (cm)	2.38	1.23	–0.055	–0.078	–0.096	–0.004
44.	Calf skinfold (cm)	1.57	0.73	–0.226*	–0.249*	–0.238*	–0.173*
45.	Body mass index (BMI)	20.97	2.52	–0.209*	–0.188*	–0.202*	–0.184*
46.	Body density (g/cm^3)	1.06	0.00	0.191*	0.205*	0.209*	0.140
47.	Relative fat content by Siri (%)	16.69	0.28	–0.191*	–0.205*	–0.209*	–0.140
48.	Mean skinfold (cm)	1.22	0.41	–0.230*	–0.255*	–0.253*	–0.165*
49.	Subcut.adip. tissue (kg)	9.07	3.53	–0.211*	–0.233*	–0.232*	–0.151*
50.	Relative mass of subcut. adipose tissue (%)	15.36	4.43	–0.230*	–0.266*	–0.260*	–0.157*

* Statistically significant variables

For anthropometric classification of the body as a whole, we applied a 5 SD classification of mean height, weight and their standard deviations [10]. Initially 3×3=9 SD classes of height and weight were formed. From these nine classes, three classes of concordant height and weight (small height – small weight, medium height – medium weight, big height – big weight) were taken. The remaining six classes were joined into two classes of disconcordant height and weight (pycnomorphs with big weight and small height, and leptomorphs with small weight and big height; see Fig. 1). Thus, finally five height-weight SD classes were created according to the following rules:

Class 1 (small):
weight < $\bar{x}_w - 0.5\ SD_w$ and height < $\bar{x} - 0.5\ SD_h$

Class 2 (medium):
$\bar{x}_w - 0.5\ SD_w \leq$ weight < $\bar{x} + 0.5\ SD_w$ and $\bar{x}_h - 0.5\ SD_h \leq$ height < $0.5\ SD_h$

Class 3 (large):
weight ≥ $\bar{x}_w + 0.5\ SD_w$ and height ≥ $\bar{x}_h + 0.5\ SD_h$

Class 4 (pyknomorphs):
weight ≥ $\bar{x}_w - 0.5\ SD$ and height < $\bar{x}_h - 0.5\ SD_h$ or
weight ≥ $\bar{x}_w + 0.5\ SD$ and height < $\bar{x} + 0.5\ SD_h$

Class 5 (leptomorphs):
weight < $\bar{x}_w - 0.5\ SD$ and height ≥ $\bar{x}_h - 0.5\ SD_h$ or
weight < $\bar{x}_w + 0.5\ SD$ and height ≥ $\bar{x}_h + 0.5\ SD_h$ (see Fig. 1).

<table>
<tr><td colspan="5">Weight classes</td></tr>
<tr><td rowspan="4">Height classes</td><td></td><td>Light</td><td>Medium</td><td>Heavy</td></tr>
<tr><td>Short</td><td>Small</td><td></td><td rowspan="2">Pycno-morphic</td></tr>
<tr><td>Medium</td><td rowspan="2">Lepto-morphic</td><td>Medium</td></tr>
<tr><td>Tall</td><td></td><td>Large</td></tr>
</table>

Fig. 1. Body build classes

Table 2. Mean values of anthropometric variables and nutrients consumption in height-weight classes in schoolgirls aged 15–16 years (n=170)

No	Variable	1. Small n=28 $\bar{x}$/SD	2. Medium n=31 $\bar{x}$/SD	3. Large n=21 $\bar{x}$/SD	Statistics 1–3	4. Pycnomorphs n=30 $\bar{x}$/SD	5. Lepto-morphs n=54 $\bar{x}$/SD	Statistics 4–5
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.	Weight	48.002/4.016	58.095/2.343	68.079/5.284	+	62.759/5.999	53.820/3.578	+
2.	Height	158.98/3.27	166.07/1.59	173.01/3.15	+	162.73/3.57	169.19/3.62	+
3.	Sternum length (cm)	14.02/2.26	14.37/2.04	14.37/1.87	–	13.29/2.54	14.47/2.28	–
4.	Abdomen length (cm)	25.75/4.20	26.48/5.20	26.93/5.99	–	26.14/5.13	27.63/5.90	–
5.	Trunk length (cm)	48.95/2.31	50.57/4.42	51.34/2.07	+	49.48/3.68	51.29/2.11	+
6.	Upper limb length (cm)	68.59/2.62	73.21/5.42	74.86/2.35	+	69.96/2.86	72.92/2.90	+
7.	Lower limb length (cm)	85.37/3.02	89.33/2.82	94.95/4.55	+	87.52/3.55	91.31/3.39	+
8.	Biacromial breadth (cm)	33.36/1.57	34.66/1.27	35.60/1.20	+	34.49/1.59	35.06/1.50	–
9.	Chest breadth (cm)	23.17/1.40	23.87/1.32	24.69/1.47	–	24.27/1.41	23.76/1.22	–
10.	Waist breadth (cm)	21.20/1.39	22.82/1.69	23.88/1.60	+	23.46/1.52	21.61/1.18	+
11.	Pelvis breadth (cm)	25.72/1.33	27.10/1.06	27.57/1.42	+	26.64/2.08	26.70/1.41	–
12.	Chest depth (cm)	15.54/1.35	16.77/1.20	17.29/1.42	+	17.02/1.70	15.96/1.45	+
13.	Abdomen depth (cm)	14.45/0.96	15.86/0.97	16.17/1.06	+	16.26/1.47	14.79/0.78	+
14.	Femur breadth (cm)	8.38/0.46	8.94/0.40	9.15/0.36	+	8.93/0.43	10.46/11.56	–
15.	Ancle breadth (cm)	6.44/0.32	4.98/0.28	6.99/0.39	+	6.70/0.26	6.79/0.35	–
16.	Humerus breadth (cm)	5.89/0.36	55.07/1.29	6.35/0.26	+	5.98/0.46	6.19/0.27	+
17.	Wrist breadth (cm)	4.82/0.23	31.27/1.82	5.19/0.20	+	4.91/0.29	4.98/0.26	–
18.	Head circumference (cm)	53.99/1.24	82.82/3.27	56.02/1.34	+	55.31/1.32	55.05/1.26	–
19.	Neck circumference (cm)	30.67/1.59	86.19/10.08	32.68/1.12	+	32.14/2.24	31.09/1.00	+
20.	Upper chest circumference(cm)	77.58/3.30	78.68/3.49	83.72/17.62	–	85.29/4.17	79.82/3.12	+

1	2	3	4	5	6	7	8	9
21.	Lower chest circumference (cm)	69.96/2.97	74.60/3.29	78.47/4.29	+	78.39/4.14	71.47/2.65	+
22.	Waist circumference (cm)	63.12/4.52	68.27/3.62	72.36/4.10	+	72.09/5.56	64.83/2.69	+
23.	Pelvis circumference (cm)	77.71/3.97	84.28/4.73	89.17/5.11	+	88.81/7.15	80.76/3.90	+
24.	Hip circumference (cm)	82.89/5.77	88.98/4.12	94.76/3.71	+	93.34/5.88	86.07/2.87	+
25.	Upper thigh circumference (cm)	52.71/3.22	56.94/2.36	61.73/3.11	+	60.31/3.54	54.07/2.65	+
26.	Middle thigh circumference (cm)	44.03/3.54	47.68/2.30	51.14/3.08	+	50.99/3.39	45.20/2.63	+
27.	Upper leg circumference (cm)	33.36/5.23	35.14/1.61	36.78/2.16	+	36.61/2.11	33.32/1.26	+
28.	Lower leg circumference (cm)	20.71/0.90	22.10/0.71	23.22/1.04	+	22.74/1.02	21.31/0.94	+
29.	Arm circumference (cm)	23.42/1.35	25.48/1.18	27.33/1.90	+	27.74/1.85	23.86/1.23	+
30.	Arm circumference flexed and tensed (cm)	25.41/1.59	27.47/1.28	29.13/2.17	+	29.46/1.82	25.67/1.29	+
31.	Forearm circumference (cm)	21.29/0.97	22.24/1.36	23.55/1.30	+	23.55/1.03	21.68/0.94	+
32.	Wrist circumference(cm)	14.86/0.55	15.45/0.57	16.15/1.19	+	15.83/0.89	15.26/0.60	+
33.	Chin skinfold (cm)	0.57/0.17	0.66/0.21	0.81/0.27	+	0.78/0.20	0.55/0.17	+
34.	Side skinfold (cm)	0.58/0.20	0.79/0.28	0.94/0.25	+	0.96/0.35	0.59/0.20	+
35.	Chest skinfold (cm)	0.70/0.19	0.98/0.32	1.25/0.31	+	1.34/0.45	0.74/0.25	+
36.	Waist skinfold (cm)	0.89/0.21	1.31/0.54	1.74/0.48	+	1.79/0.64	1.01/0.33	+
37.	Suprailiac skinfold (cm)	0.670/0.25	1.00/0.45	1.24/0.48	+	1.31/0.48	0.71/0.28	+

1	2	3	4	5	6	7	8	9
38.	Umbilical skinfold (cm)	0.88/0.27	1.24/0.46	1.49/0.45	+	1.66/0.67	0.96/0.29	+
39.	Subscapular skinfold (cm)	0.83/0.21	1.04/0.41	1.14/4.99	+	1.57/0.56	0.83/0.22	+
40.	Biceps skinfold (cm)	0.58/0.23	0.79/0.32	0.91/0.31	+	1.08/0.47	0.62/0.26	+
41.	Triceps skinfold (cm)	1.26/0.33	1.55/0.35	1.78/0.42	+	1.89/0.43	1.24/0.34	–
42.	Thigh skinfold (cm)	1.87/0.43	2.47/0.43	2.56/0.51	+	2.67/0.69	2.26/2.12	+
43.	Calf skinfold (cm)	1.15/0.55	1.67/0.65	1.81/0.72	+	1.87/0.75	1.37/0.71	+
44.	Body mass index (BMI)	18.98/1.37	21.08/1.03	22.77/2.05	+	23.68/1.90	18.79/0.93	+
45.	Body density (g/cm^3)	1.061/0.000	1.061/0.000	1.060/0.001	+	1.060/0.001	1.061/0.001	+
46.	Relative fat content by Siri (%)	16.50/0.13	16.67/0.17	16.82/0.22	+	16.90/0.27	16.56/0.27	+
47.	Mean skinfold (cm)	0.91/0.23	1.23/0.30	1.45/0.31	+	1.54/0.41	0.99/0.33	+
48.	Subcut.adip. tissue (kg)	6.00/1.61	9.08/2.29	11.88/2.82	+	11.68/3.60	7.20/2.48	+
49.	Relative mass of subcut. adipose tissue (%)	12.46/2.97	15.56/3.57	17.34/3.36	+	18.34/4.22	13.30/4.21	+
50.	Energy (kcal)	1988.14/818.97	1743.23/998.37	1822.00/772.05	–	1527.42/590.95	1938.72/1011.22	+
51.	Proteins (g)	57.12/25.66	50.12/24.77	50.38/19.91	–	48.52/19.79	58.65/29.68	–
52.	Fats (g)	78.93/43.68	63.75/41.39	67.42/40.57	–	57.12/34.50	71.76/49.77	–
53.	Carbohydrates (g)	255.68/111.30	236.45/143.02	247.37/101.15	–	199.73/65.15	257.70/120.21	+
54.	Energy/body weight (kcal/kg)	42.30/21.48	30.10/17.36	26.86/11.24	+	24.62/10.04	36.09/18.44	+
55.	Proteins/body weight (g/kg)	1.21/0.59	0.87/0.44	0.74/0.29	+	0.78/0.33	1.09/0.54	+
56.	Fats/body weight (g/kg)	1.68/1.04	1.10/0.73	0.99/0.59	+	0.93/0.59	1.34/0.9	+
57.	Carbohydrates/body weight (g/kg)	5.45/2.91	4.07/2.47	3.65/1.49	+	3.21/1.07	4.80/2.22	+

The subjects were placed into the classification according to their individual heights and weights (Table 2). Thereafter, the mean values of all their anthropometric characteristics were calculated for five classes of subjects. Then the mean values of food energy, proteins, fats and carbohydrates in the food consumed were calculated for each class.

Using the Scheffé test, the class means of body composition characteristics and nutrient data were compared between classes 1–3 but also between classes 4 and 5, using the significance level a=0.05.

RESULTS

The study of relations between body build and nutrition started with correlation analysis. Table 1 presents the mean values and standard deviations of the measured anthropometric variables and their correlations with nutrition data. Statistically significant correlations are marked by an asterisk (*).

The variables not significantly related to nutrition were body height, sternum length, trunk length, upper and lower limb length, biacromial, chest, waist and pelvis breadth, abdomen depth, femur, ankle, humerus and wrist breadth. Out of the length, breadth and depth measurements, only abdomen length was related to nutrition.

The circumferences related to nutrition were pelvis, hip, upper and middle thigh and arm circumference.

Body mass index as well as other body composition characteristics all correlated with nutrition.

Correlation coefficients of basic anthropometric variables varied between 0.17–0.266, which means that basic anthropometric variables can describe from 2.89 to 7.08% of the amount of food energy and nutrients.

It is interesting to note that all significant correlation coefficients were negative, except body density, which was in positive correlation with food energy (r=0.191*) as well as with proteins (r=0.205*) and fats (r=0.209*). Abdomen length was also in positive correlation with protein content in food (r=0.186).

In order to give a detailed characterization of the role of body build in food consumption, we need a classification that would characterize the body as a whole and would enable us to systematize and evaluate the differences between classes in body measurements related to nutrition. In the current study, we applied a 5 SD classification of height and weight for this purpose (see Material and Methods).

In Table 2 we present this classification where the mean values of all body measurements and food consumption characteristics in five classes were calculated.

Here we can see that according to gradual increase of height and weight in classes 1, 2 and 3, most breadth and depth measurements, circumferences and all body fat content indicators also increase, but body density decreases.

Opposite changes appear in classes 4 and 5, which are characteristic of classical body types – pycnics and leptosomes.

In nutrition data, there were no statistically significant differences between classes 1, 2 and 3. Statistically significant differences were revealed, however, between classes 4 and 5. Leptomorphs consumed considerably more food energy and carbohydrates than pycnomorphs.

In order to describe more precisely the individual differences in the amount of food consumed by schoolgirls with different body build, the mean amount of food energy and nutrients per 1 kg of body weight was calculated for all the five body build classes (see Table 2). Here systematic differences were revealed. The mean amount of food energy, proteins, fats and carbohydrates consumed per 1 kg of body weight was the largest in the class of small subjects and diminished gradually in the medium and big classes. In leptomorphs, the amount of energy, proteins, fats and carbohydrates consumed per 1 kg of body weight was significantly greater than in pycnomorphs.

DISCUSSION

The results of our research showed that a great number of basic anthropometric variables are in correlation with nutrition. A clear difference was revealed concerning body composition – while skinfolds, circumferences and other body fat indicators were in negative correlation with nutrition, then correlations with body density were all significant and positive.

As the 5 SD classification that we used to differentiate between body types showed, the most informative indicators are mean amounts of food energy, proteins, fats and carbohydrates consumed per 1 kg of body weight in each body build class. Food consumption was different in the class of small subjects compared with the medium and big classes. Leptomorphs differed from pycnomorphs.

It is generally known in practice that tall and slim women eat relatively more without needing to keep a diet. In our material, leptomorphs' food consumption was the highest, their indicators of body fat content were lower and body density greater than in pycnomorphs.

Consequently, the body types classification used by us also characterizes a very essential component for nutrition assessment – metabolism type differences in the girls studied – and it can be recommended to be used for studying rational food consumption in medical practice.

Christoph Raschka in his monograph *Sportanthropologie* [12] has called our classification a new innovative classification from Tartu, an Estonian system of sport and constitutional typology.

In conclusion, we can state that different body measurements can be applied in anthropometric characterization of nutrition, but this must always be accompanied by a characterization of the model of the body as a whole by height and weight. No individual body measurement, for example abdominal circumference, is appropriate for it, as it does not represent the peculiarities of the body as a whole, and the same numerical value of the same characteristic can have a different meaning for different body types.

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USING THE HEIGHT-WEIGHT CLASSIFICATION MODEL FOR THE SYSTEMATIZATION OF THE ANTHROPOMETRICAL VARIABLES OF THE BODY COMPOSITION IN LATVIAN WOMEN

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ABSTRACT

A study of 349 women aged 18–20 years from Latvia was performed. Body height and weight, 4 measurements of length, 3 measurements of breadth, 4 circumferences and 4 skinfolds were measured, and 8 indices were calculated. The subjects were divided into five standard deviation classes according to height and weight applying the Estonian reference values [11, 12]. There were 3 classes with conformity between height and weight class: I – small (small height and small weight), II – medium (medium height and medium weight), III – large (large height and large weight), IV – weight class dominating (pyknomorphic) and V – height class dominating (leptomorphic). In the first three classes height and weight were proportional. It was found that a statistical difference existed between the opposite classes-the fourth and the fifth class. It was also revealed that the three proportional classes differed from each other significantly. Increase in body height and weight also showed to an increase in the length and breadth measurements, circumferences and skinfolds. In IV (pyknomorphic) class circumferences and skinfolds were bigger. In V (leptomorphic) class all the heights were bigger. The present study showed that the five height-weight mean and SD classification model applying the Estonian reference values for anthropometrical variables systematization was usable for Latvian women.

Key words: height-weight SD classification, women, anthropometrical measurements

INTRODUCTION

The human body structure, composition and shape reach the adult status in the course of growth and maturation under the interactive effects of hereditary and environmental factors [3]. The study of the body shape and performance is central to the human biology, biological anthropology, medicine and physical education. Physique refers to an individual's body form, the configuration of the entire body rather than its specific features [19]. The study of physique is a single aspect of an area of study sometimes labelled human constitution, which involves the inter-relationships and inter-dependency among an individual's structural, functional, and behavioural characteristics [5, 6]. Physique or body build, is probably the single aspect of constitution that is most amenable to the systematic study because it can be readily observed.

Body composition is also increasingly used as a primary indicator of healthy growth and development [1, 4]. The methods for the assessment of body build have a long history [9, 10]. The body height and body weight are the most commonly used measurements in growth studies. The body composition of young women, and its relationships with anthropometric variables and their performance have been studied less extensively in Latvia. Several Estonian studies have used the body model based on a bivariate body height-weight SD classification [11]. In this study the model of SD-classes was used for the first time for Latvian women aged 18–20 years. The aims of the study were: 1) to construct a model of the bodily structure of 18–20-year-old Latvian women; 2) to describe and compare the anthropometrical variables of body composition using the height-weight SD classification.

MATERIAL AND METHODS

A total of 349 women aged 18 – 20 years took part in the data collection between 2001 and 2005 in Latvia. All of them were definitely of Latvian origin and were healthy at the time of investigation.

Body height and weight, 4 measurements of length, 3 measurements of breadth, 4 circumferences and 4 skinfolds were measured for every person. All the anthropometrical measurements were carried out according to the metheodological recommendations by R. Martin and K.

Saller [17]. The anthropometrical measurements were measured by the author of this study together with the Institute of Anatomy and Anthropology (IAA) medical nurses of the anthropology unit. The Swiss company`s "Siber-Hegner and Co" anthropometric set, the skinfold caliper, the steel measuring tape and the same electronic weight scale were used during the investigation. From the data we calculated 8 indices, including the body mass index (BMI).

The body build of our subjects was estimated by the bivariate body height-weight SD classification. Its application has been used more often by the investigators of Estonia [13, 15].

For women, body height and weight values were divided into three SD classes. The medium class was situated between –0.5 SD and 0.5 SD with respect to the age group mean (M ± 0.5 SD). The other classes contained the respective outer values. All the women were classified into one of five categories with three height/weight categories: I – small (small height and small weight), II – medium (medium height and medium weight), III – large (large height and large weight), IV – pyknomorphous, and V – leptomorphous.

Data analysis was performed using SPSS 14.0 for Windows method in Riga Stradiņš University at the Institute of Anatomy and Anthropology and Physics Department. The means (M) and standard deviations (SD) of all the measured and calculated anthropometrical variables were determined for these five height-weight classes, and also the minimum (min) and maximum (max) scores were determined as descriptive statistics. The statistical differences between height-weight SD-classes were evaluated using ANOVA. The level of significance was set at $p<0.05$; $p<0.01$ and $p<0.001$.

RESULTS

The mean age of women at the time of investigation was 19.28±0.51 years. The results of basic statistics for anthropometrical data were summarised in Table 1.

Table 1. Basic statistical analysis of anthropometrical measurements and indices of 18–20-years old Latvian women (n=349).

Anthropometrical value or index	M	SD	min	max
Body height, cm	166.77	6.37	150.00	182.30
Body weight, kg	59.91	8.84	41.00	120.10
Suprasternale length, cm	135.80	5.50	121.20	150.30
Trunk length, cm	50.22	3.01	42.40	57.30
Upper limb length, cm	72.18	3.73	63.00	80.60
Lower limb length, cm	89.30	4.36	76.90	104.70
Biacromial breath, cm	35.30	1.92	28.50	39.70
Waist breath,cm	25.37	1.70	20.70	33.10
Bicristal breath, cm	28.46	2.00	23.50	37.00
Head circumference, cm	55.26	1.48	50.80	59.40
Chest circumference, cm	83.00	5.36	57.00	117.20
Waist circumference, cm	66.78	6.06	53.50	101.00
Hip circumference, cm	93.02	6.33	79.80	133.20
Biceps skinfold, mm	6.80	2.35	2.60	17.00
Triceps skinfold, mm	12.52	3.68	4.20	25.60
Subscapular skinfold, mm	12.33	3.82	6.00	32.00
Suprailiac skinfold, mm	13.33	4.37	5.60	36.00
BMI, kg/m^2	21.52	2.83	16.55	44.38
Relative trunk length	29.99	1.45	26.01	37.75
Relative upper limb length	43.24	1.32	39.14	47.22
Relative lower limb length	53.55	1.49	46.75	57.85
Relative biacromial breath	21.18	1.10	18.16	24.21
Relative chest breath	49.81	3.33	33.01	71.25
Relative bicristal breath	17.08	1.13	14.57	22.25
Biacromial breath/bicristal breath	124.47	8.99	94.86	149.15

n – number of women; M – mean; SD – standard deviation; min – minimum; max – maximum; BMI – body mass index

The mean height of 18–20-year-old women was 167.77±6.37 cm, but their body weight was 59.91±8.84 kg. The height of all the subjects ranged from 150.00 cm to 182.30 cm. Differences between the minimum and maximum individual weights were very large. The individual weight scores ranged between 41.00 kg and 120.10 kg. The largest standard deviation (SD) was observed for weight than for body height (8.84 and 6.37).

As the first step towards evaluating the use of anthropometrical indicators in women aged 18–20 years, we undertook a comparison of the distribution of height and weight. There were some common findings relating to the patterns of height and weight. The present study demonstrated that body height was most strongly correlated with body weight. This correlation was 0.456 ($p<0.01$). Both variables correlated with other parameters. Height correlated better with body length measurements (r = 0.985–0.627), but lower with breadth (r = 0.422–0.385) and with circumferences (r = 0.366–0.220). Weight correlated better with circumferences (r = 0.868–0.465), with skinfolds (r = 0.607–0.426), with breadth measurements (r = 0.574–0.383) and lower with length measurements (r = 0.459–0.283).

In continuation we calculated the mean values (±SD) of all the anthropometrical variables and indices for all the five height-weight classes (Tables 2–5). We started with the changes in small (I) – medium (II) – large (III) classes (Table 2). The three proportional classes differed from each other significantly. Body height and weight increased in the classes from small to medium to large. These changes were accompanied by different changes in length, breath, circumferences and skinfolds.

The largest part indices were stable in the last three classes (Table 4). The body mass index (BMI) increased gradually and significantly. The biacromial breadth/bicristal breadth index was smaller in the large class, but it was bigger in the small class.

In the next two classes (pyknomorphic IV) and (leptomorphic V) were different variations between anthropometrical variables (Table 3) and indices (Table 5). The statistical analysis by the sign test revealed statistically significant differences.

Pyknomorphous women were heavier, and they had greater circumferences and skinfolds. Leptomorphous women were taller and had bigger length measurements.

The body mass index (BMI) was bigger in pyknomorphous women than in leptomorphous women. Pyknomorphous women had a smaller biacromial breadth/bicristal breadth index.

In all the five classes women were similar in the proportion of the trunk and limbs to body height.

Table 2. Basic statistical analysis of anthropometrical measurements of 18–20-years old Latvian women into I, II and III height-weight classes.

Anthropometrical value	I – small (n=75)		II – medium (n=60)		III – large (n=38)		p		
	M	SD	M	SD	M	SD	I–II	I–III	II–III
Body height, cm	158.90	1.76	167.84	1.47	176.55	1.66	***	***	***
Body weight, kg	48.83	2.02	60.64	2.46	72.79	2.69	***	***	***
Suprasternale length, cm	129.11	1.48	136.62	1.39	143.93	1.92	***	***	***
Trunk length, cm	48.09	1.57	50.31	2.65	53.43	2.57	**	***	**
Upper limb length, cm	68.03	2.16	72.60	2.61	76.58	1.64	***	***	***
Lower limb length, cm	84.85	2.47	90.03	2.60	94.41	1.82	***	***	***
Biacromial breath, cm	33.66	1.55	35.45	1.70	36.83	1.63	***	***	**
Waist breath,cm	23.81	1.30	25.61	1.46	27.22	1.14	***	***	***
Bicristal breath, cm	26.58	1.60	28.78	1.82	30.29	1.57	***	***	***
Head circumference, cm	54.11	1.22	55.43	1.35	56.67	0.87	ns	***	***
Chest circumference, cm	77.75	2.68	83.33	2.90	87.48	4.00	***	***	***
Waist circumference, cm	61.33	3.11	67.51	3.58	71.58	3.82	***	***	***
Hip circumference, cm	86.04	2.66	93.79	3.54	100.27	2.78	***	***	***
Biceps skinfold, mm	5.78	1.47	6.97	1.71	14.58	3.19	**	***	***
Triceps skinfold, mm	11.41	3.17	12.84	2.86	14.58	3.19	ns	***	**
Subscapular skinfold, mm	10.19	1.97	12.45	2.73	13.25	2.61	***	***	***
Suprailiac skinfold, mm	11.57	2.94	13.58	3.34	16.16	3.63	**	***	***

n – number of women; M – mean; SD – standard deviation; p – statistically significance ** $p<0.01$; ** *$p<0.001$; ns – not significant

Table 3. Basic statistical analysis of anthropometrical measurements of 18–20-years old Latvian women into IV and V height-weight classes.

Anthropometrical value	IV – pyknomorphic (n=80)		V – leptomorphic (n=96)		p
	M	SD	M	SD	IV–V
Body height, cm	162.87	1.44	173.74	1.62	***
Body weight, kg	74.48	2.62	55.59	1.65	***
Suprasternale length, cm	132.84	1.72	141.87	1.98	***
Trunk length, cm	49.42	2.02	50.49	1.83	*
Upper limb length, cm	70.78	2.90	76.06	1.87	***
Lower limb length, cm	84.94	2.32	95.12	2.42	***
Biacromial breath, cm	35.80	1.73	36.16	2.02	ns
Waist breath,cm	26.39	1.21	26.17	1.26	ns
Bicristal breath, cm	29.83	1.59	29.73	1.33	ns
Head circumference, cm	55.72	1.13	55.29	1.23	ns
Chest circumference, cm	91.70	3.78	81.13	2.26	***
Waist circumference, cm	75.55	3.88	65.14	2.58	***
Hip circumference, cm	103.36	3.58	77.73	2.51	***
Biceps skinfold, mm	8.96	2.23	4.90	1.31	***
Triceps skinfold, mm	15.59	3.90	10.18	3.18	***
Subscapular skinfold, mm	17.82	3.34	9.40	2.08	***
Suprailiac skinfold, mm	19.70	3.58	10.20	2.94	***

n – number of women; M – mean; SD – standard deviation; p – statistically significance * $p<0.05$; ** $p<0.01$; *** $p<0.001$; ns – not significant

Table 4. Basic statistical analysis of anthropometrical indices of 18–20-years old Latvian women into I, II and III height-weight classes.

Anthropometrical index	I – small (n=75)		II – medium (n=60)		III – large (n=38)		p		
	M	SD	M	SD	M	SD	I–II	I–III	II–III
BMI, kg/m^2	19.34	0.83	21.53	0.94	23.35	0.82	***	***	***
Relative trunk length	30.26	1.28	29.97	1.51	30.26	1.14	ns	ns	ns
Relative upper limb length	42.81	1.25	43.25	1.45	43.38	1.00	ns	ns	ns
Relative lower limb length	53.40	1.36	53.64	1.52	53.47	1.07	ns	ns	ns
Relative biacromial breath	21.18	1.02	21.12	0.98	20.86	0.91	ns	ns	ns
Relative chest breath	48.93	1.56	49.65	1.82	49.55	2.40	ns	ns	ns
Relative bicristal breath	16.72	0.97	17.14	1.12	17.16	0.94	ns	ns	ns
Biacromial breath/bicristal breath	126.64	8.49	123.18	9.58	121.59	8.03	***	***	**

n – number of women; M – mean; SD – standard deviation; BMI – body mass index; p – statistically significance ** p<0.01; ***p<0.001; ns – not significant

Table 5. Basic statistical analysis of anthropometrical indices of 18–20-years old Latvian women into IV and V height-weight classes.

Anthropometrical index	IV – pykno-morphic (n=80)		V – lepto-morphic (n=96)		p
	M	SD	M	SD	IV–V
BMI, kg/m^2	28.08	1.06	18.42	0.58	***
Relative trunk length	30.34	1.20	29.06	1.02	**
Relative upper limb length	43.46	1.48	43.78	0.98	ns
Relative lower limb length	52.15	1.34	54.75	1.19	***
Relative biacromial breath	21.98	1.05	20.81	1.11	**
Relative chest breath	46.39	2.45	46.70	1.50	ns
Relative bicristal breath	18.32	0.93	17.11	0.82	**
Biacromial breath/bicristal breath	120.01	8.55	121.63	9.06	**

n – number of women; M – mean; SD – standard deviation; BMI – body mass index; p – statistically significance ** $p<0.01$; *** $p<0.001$; ns – not significant

DISCUSSION

Human populations consist of the individuals who differ widely in the body shape and size. The age dependent changes are known for the majority of dimensions. In the constitution of growth trends, age is usually regarded as the independent variable. The estimation of biological development plays a significant part in anthropology and its applications, and also in practical medicine. The field of body composition research is a multidisciplinary effort that serves multiple goals [7].

During the 20th century the body size in the human populations changed rapidly first in the industrialised countries and later in the majority of the developing countries, too [2]. This change of the body measurements and proportions is called the secular trend or the secular growth change and its most remarkable phenomenon is the increase of adult height in each following generations [8, 16]. Taking into account the above summarised results and facts, it seems to be obvious that the correct evaluation of the human biological status of a given population requires the results of the previous investigations. There are more studies where different anthropometrical and/or body composition parameters have been investigated using different measurement methods [14, 18].

In contrast, specific studies about the model for the systematization of anthropometrical variables of the body composition in Latvian women are not so well documented. The physical status of women has central importance in the study of growth and performance. Young women constitute a very interesting group of population for the study in Latvia. We used the height-weight classification [12] based on a bivariate model to analyse some anthropometrical variables of the body composition in Latvian women. In the current study this new method for the systematization of anthropometrical variables of the body composition has been used for the first time in our country.

Our results indicated that the relationship of one measurement to another was useful in comparing the individuals who otherwise differed in size or various body measurements.

The relationships between body size and performance are confounded in partly by age. Age, height and weight are related, so it is necessary to control for relationships among these variables when evaluating their specific contributions to variation in performance [20]. With this procedure, the relationship between height and performance can be evaluated while statistically controlling for age and weight. The same can be done for weight, controlling for age and height, and for age, controlling for height and weight.

Our study showed that height and weight were two of the most easily obtained anthropometrical measurements. Other investigators have shown that in combination they have been used extensively in screening and monitoring programmes [21].

The using of the height-weight SD classification showed differences in the body build of the Latvian women aged 18–20. Our findings indicated that the women belonging to the small class differed from the women of the large class by an essentially greater increase in their measurements. All three proportional classes differed from each other significantly. It was found that a statistical difference existed between the opposite classes (pyknomorphic and leptomorphic).

In conclusion, our results suggest that the anthropometrical variables of women with different body build can be studied by the help of the height and weight model classification. This method could be used for the comparison of different anthropometrical parameters and the analysis of the physical status of Latvian women. We can also see that this model is usable as a systematization of all the anthropometrical parameters and indices.

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CORRELATION ANALYSIS BETWEEN VARIABLES OE BODY BUILD AND FOOD CONSUMPTION OF ENERGY, MACRO- AND MICRONUTRIENTS CALCULATED BY 3- DAY MENUS IN KIDNEY TRANSPLANT PATIENTS

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ABSTRACT

The study is performed in the Department of Internal Medicine the University of Tartu where group consisted of 12 males (mean age 42.8±16.1 years) and 16 females (mean age 47.0±14.9 years). Clinically stable consecutive nondiabetic renal transplant patients (n=28) were studied twice: 1.2 years after the transplantation and then after 1.5-year follow-up. The present data constitute the initial stage of investigation because the second correlation analysis of body build and menus was made 1.5 years later together with the patients` nutritional conselling.

Anthropometrical measurements were carried out as follows: body weight (kg), height (cm), body mass index (kg/m^2), body fat mass (%) and total body fat mass (kg) by hand-to- hand bioimpedance, 8 breadth and 2 depth measurements, 13 circumferences and 11 skinfolds.

The mean values of the consumption of food energy and the main nutrients were determined on the basis of the 3-day menu. The Micro-Nutrica Program was used.

Correlation analysis was performed between anthropometrical parameters and 3-day menu indices of macro- and micronutrients.

The aim of the study was to determine the anthropometrical and nutritional habits in kidney transplant patients and to compare with the data analysis of the 3- day menus after kidney transplantation.

The results of our work indicated that the amount of consumed food was generally little connected with the anthropometrical variables of the studied renal transplant patients.

Key words: body composition, 3-day menu, nutrition, kidney transplantation

INTRODUCTION

In the posttransplantation period the patients` health state improved. Prognostic results depend on the patients` prior preparation which starts in the period of pre-dialysis.

Diet, the content of food, muscle mass, fat tissue mass, the systemic inflammatory status, the serum lipid profile and medicament treatment influence the health state and the nutritional status of the patients with the transplanted kidney.

Screening must be high priority in people considered to be at high risk of kidney disease. Various modalities have been used for the primary and secondary prevention of progressive renal disease: low-protein diet, antihypertensive therapy, reno- and vasoprotective therapy [9]. When kidney disease progresses, chronic kidney disease patients have a tendency for vascular and cardiac calcification that is related to hyperphosphataemia and secondary hyperparathyroidism. Nutritional status is important in the complex rehabilitation of kidney transplant patients [10].

All patients with stage 4–5 chronic kidney disease should undergo regular nutritional screening by a dietician. The dietitian can organize the optimal monitoring of parameters kidney transplant patients. Dietary counselling may be indicated in patients with excessive posttransplant weight gain and dyslipidemia as well as with changes in calcium-phosphate balance [1, 3]. Nutritional counselling should be continued to avoid overweight [8]. Coroas et al. observed in their study the differences between genders: compared with healthy subjects, uremic males presented body water disturbances and transplant females had no differences as compared with the healthy group [2]. Guidelines suggest that protein content of the diet should not be lower than 0.75g/kg/day and should not exceed 0.8–1.0g/kg/day. Sodium, total fat, cholesterol, carbohydrate, protein, phosphorus and potassium are restricted for all patients. Calorie restriction and an exercise programme can be highly effective but are often difficult to achieve because of the lack of motivation on the part of chronic kidney disease patients [1, 4, 8, 10]. The aim of the study was to determine the anthropometrical and nutritional habits in kidney transplant patients and to compare with the data analysis of the 3-day menus after kidney transplantation.

MATERIAL AND METHODS

The study was carried out during the years 2003–2005 at the Department of Internal Medicine the University of Tartu. Clinically stable consecutive nondiabetic renal transplant patients were studied: 12 males the age of 42.8±16.1 (min 18, max 70) years, and 16 females the age of 47.0±14.9 (min 21, max 71). The study is focused on correlation analysis of anthropometrical variables and the analysis of the 3-day menu main nutrient intake after the renal transplantation period.

All the study, including anthropometry, biochemistry, densitometry and the 3-day menu analysis of nutrient intake were performed in the patients twice: 1.2 years after the transplantation and then after 1.5-year follow-up.

Anthropometry

The anthropometrical variables were measured methodology by R. Martin [5, 6].The measured anthropometric variables were body height (cm), weight (kg), 8 breadths (cm), 2 depths (cm), 13 circumferences (cm) and 11 skinfold thicknesses (mm). For the study of body weight each patient was weighed with a SECA (USA) electronic platform scale in kg (precision to 0.05 kg). Body height was measured to the nearest 0.1 cm with the Martin metal anthropometer. The Martin calipers (small and big) were used for the measurements of the breadths and depths. Circumference measurements were performed using the anthropometric tapes of 3 meters and 7 mm wide. Measuring of skinfolds thicknesses followed the methodology provided in Knussmann's Handbook, 1988 [5]. Body fat (%) and total body fat (kg) were measured by the hand-to-hand electrodes OMRON® BF 300 body fat monitor (OMRON Matsusaka Co., Japan). The height and weight- based equation (body mass index, BMI) was calculated as kg/m^2.

Also the body density (Wilmore and Behnke 1970), body surface area, mass and relative mass of subcutaneous adipose tissue and relative mass of fat by Siri were calculated. Anthropometric measurements were performed by a trained anthropometrist.

Food intake

The 3-day menu was analyzed personally by the first author of the article.

The mean values of the consumption of food energy and the main nutrients were determined on the basis of the 3-day menu. The Micro-Nutrica program was used [7, 11]. The menus were collected simultaneously with anthropometrical measurements. Dietary modifications must be individualized, appropriate to the stage of chronic kidney disease and customized with the the socioeconomic status renal transplant patients [4].

Statistical analysis

The data were processed using the Statistical Package System (SAS). First, the mean values and standard deviations of all the anthropometric variables were calculated for two groups of patients (males, females). Anthropometrical basic statistics was given for means, standard deviations (SD), minimum (min) and maximum (max) for the initial observation period calculated.

Nutrient intake was determined using the Micro-Nutrica software and the food composition database [7]. The collected data were used to calculate the most essential energy and nutrient contents of individual the 3-day menus: food energy (kcal), proteins (g), fats (g) and carbohydrates (g). Also were calculated main nutrients in the menu: cholesterol (mg), sodium (mg), potassium (mg), calcium (mg), magnesium (mg), phosphorus (mg) and water (mg).

Linear correlation coefficients were used to determine the relationship between mean values of anthropometric measurements ad mean values of food.

Data processing and statistical analysis was performed by Säde Koskel, M.SC., from the University of Tartu.

Ethics

The study has been approved by the Ethics Committee on Human Research of the University of Tartu, Estonia (protocol no 103/1; 2004) and carried out at the Tartu University Hospital.

RESULTS

In the present paper we demonstrate the correlation between the mean anthropometrical indicators and the mean nutritional indicators of studied patients.

Table 1 of 12 male patients the age of 42.8±16.1 (min 18, max 70) years. The table presents the correlation coefficients of all the 36 anthropometric variables with 10 indexes and consumed energy with 10 food nutrients. In Table 1 of male patients the consumed energy and the amount of basic nutrients and micronutrients are not significantly connected with single features (breadts and depths, circumferences, skinfolds, indexes). Only certain features deserve attention: the connections between cholesterol and the breadth of chest (r= 0.581) and waist (r= 0.592); the circumference of neck (r= 0.615), upper leg (r= 0.907), lower leg (r= 0.597) and wrist (r= 0.818); index of body surface area (r= 0.634) are statistically significant. While the food water indicators are negative correlation the breadth of ankle (r= –0.601) and the circumference of wrist (r= -0.581) are statistically significant.

The daily average energy intake in the male group was 2,690±468 (min 2,030, max 3,676) kcal. The daily average protein intake in the male group was 106.7±22.4 (min 74.9, max 153.1)g.

Table 2 of 16 female patients the age of 47.0±14.9 (min 21, max 71) years. The table presents the correlation coefficients of all the 36 anthropometric variables with 10 indexes and consumed energy with 10 food nutrients. In Table 2 of female patients the consumed energy and the amount of basic nutrients and micronutrients are not significantly connected with single features (breadths and depths, circumferences, skinfolds, indexes). Only certain features deserve attention: the connections between cholesterol and the skinfold of chest (r= 0.531) and body fat indexes by OMRON (r= 0.537, r= 0.501). While the food calcium are statistically significant negative correlation the body height (r= –0.508).

The daily average energy intake in the female group was 2,028±466 (min 1,128; max 2,974) kcal. The daily average protein intake in the female group was 74.6±19.7 (min 49.2, max 123.2)g.

Table 1. Correlations between anthropometric variables and the consumption of energy and the main nutrients in kidney transplant males (n= 12)

Variables	Anthropometrical data after kidney transplantation				Mean values of 3- days menus energy and nutrients data										
					Energy (kcal)	Protein (g)	Fat (g)	Carbo-hydrate (g)	Chole-sterol (mg)	So-dium (mg)	Potas-sium (mg)	Calcium (mg)	Mag-nesium (mg)	Phosphorus (mg)	Water (mL)
	Min	Max	Mean	SD	Correlation coefficients (r)										
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Weight (kg)	57.10	134.10	75.13	20.70	0.210	0.423	0.005	0,192	0.501	0.211	0.412	-0.153	0.355	0.323	-0.405
Heights (cm)	166.50	190.00	174.82	7.37	0.057	-0.065	0.536	-0.243	0.392	0.099	0.293	-0.346	-0.177	-0.135	0.091
Breadths and depths (cm)															
Biacromial breadth	37.50	49.50	40.76	3.41	0.152	0.309	0.162	0.033	0.472	0.289	0.439	-0.299	0.231	0.219	-0.423
Chest breadth	26.80	37.00	30.56	2.99	0.193	0.384	0.297	-0.013	0.581*	0.371	0.314	-0.281	0.081	0.180	-0.509
Waist breadth	25.80	37.00	30.03	3.20	0.201	0.379	0.077	0.147	0.592*	0.350	0.333	-0.167	0.264	0.263	-0.462
Pelvis breadth	27.50	39.00	31.62	3.44	0.316	0.509	0.154	0.236	0.520	0.578*	0.165	-0.028	0.161	0.418	-0.671
Chest depth	19.50	33.00	23.45	3.63	0.074	0.196	-0.351	0.281	0.097	0.185	0.044	-0.095	0.211	0.164	-0.305
Abdomen depth	19.50	36.00	24.75	4.63	-0.006	0.110	-0.261	0.123	0.065	0.031	-0.089	-0.257	-0.010	-0.058	-0.253
Humerus breadth	6.20	8.50	7.30	0.62	0.089	-0.085	0.062	0.122	0.301	0.034	-0.107	0.098	0.073	-0.015	0.406
Wrist breadth	5.10	6.80	5.87	0.51	0.262	0.019	-0.047	0.435	0.176	0.018	0.182	0.368	0.409	0.231	0.511
Femur breadth	9.10	11.00	10.14	0.55	0.284	0.429	0.248	0.148	0.520	0.235	0.036	-0.145	-0.064	0.190	-0.347
Ankle breadth	6.00	8.50	7.35	0.87	-0.201	-0.362	-0.125	-0.117	0.133	-0.405	0.404	-0.083	0.257	-0.166	-0.601*
Circumferences (cm)															
Head	55.00	60.30	58.00	1.47	0.341	0.501	0.100	0.326	0.447	0.047	0.273	0.413	0.165	0.550	-0.080
Neck	37.00	46.30	40.37	2.71	0.121	0.190	-0.046	0.158	0.615*	-0.151	0.416	-0.140	0.444	0.111	0.221
Chest	88.20	122.00	102.56	8.44	0.193	0.342	0.039	0.171	0.493	0.370	0.272	-0.156	0.199	0.238	-0.431
Waist	77.60	124.00	89.47	12.98	0.135	0.325	-0.234	0.265	0.414	0.094	0.362	-0.075	0.413	0.274	-0.244
Hip	86.70	138.00	99.19	12.95	0.216	0.430	-0.113	0.276	0.368	0.157	0.394	-0.048	0.449	0.390	-0.388

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Proximal thigh	51.10	71.00	56.26	5.63	0.047	0.261	-0.080	0.035	0.340	0.243	0.364	-0.292	0.387	0.188	-0.540
Middle thigh	45.00	60.00	49.07	4.09	0.248	0.328	-0.234	0.433	0.064	0.018	0.255	0.113	0.498	0.341	-0.121
Upper leg	32.10	38.00	34.26	1.80	0.043	0.234	0.365	-0.240	0.907*	0.230	0.447	-0.302	0.277	0.108	-0.275
Lower leg	20.20	27.00	23.10	1.93	0.242	0.485	0.156	0.125	0.597*	0.443	0.147	-0.051	0.169	0.379	-0.500
Arm, relaxed	24.90	47.50	30.96	5.83	0.138	0.333	-0.199	0.240	0.393	0.105	0.464	-0.119	0.551	0.310	-0.285
Arm, flexed and tensed	25.80	46.00	32.81	5.05	0.080	0.273	-0.184	0.159	0.492	0.154	0.558	-0.184	0.583*	0.292	-0.309
Forearm	26.00	31.70	28.09	1.94	0.324	0.414	-0.108	0.441	0.446	0.276	0.121	0.096	0.493	0.366	-0.168
Wrist	16.30	23.80	18.78	2.25	0.405	0.568	0.369	0.217	0.818*	0.658*	0.281	0.017	0.304	0.469	-0.581*
Skinfolds (mm)															
Chin	2.50	22.00	7.88	5.27	-0.143	0.018	-0.485	0.085	0.013	-0.081	0.209	-0.198	0.341	0.013	-0.088
Chest	5.00	26.00	11.17	5.76	-0.180	0.081	-0.467	0.002	-0.035	-0.156	-0.006	-0.139	0.015	-0.020	-0.230
Side	5.50	28.00	14.13	7.45	-0.255	-0.058	-0.447	-0.089	-0.040	-0.225	0.107	-0.182	0.195	-0.116	-0.034
Waist	5.00	26.00	13.83	6.45	-0.232	-0.054	-0.408	-0.077	-0.227	-0.190	0.010	-0.055	0.021	-0.050	-0.019
Suprailical	4.00	23.00	9.41	5.59	0.075	0.239	-0.203	0.171	0.131	-0.049	0.141	-0.023	0.290	0.179	-0.063
Umbilical	7.00	42.00	18.23	11.44	-0.106	0.065	-0.417	0.087	0.046	-0.175	0.115	-0.062	0.219	0.100	0.037
Subscapular	4.50	33.00	10.17	7.96	-0.056	0.212	-0.376	0.094	0.227	-0.086	0.321	-0.152	0.352	0.153	-0.253
Biceps	1.50	12.00	4.93	3.13	-0.057	0.199	-0.221	-0.010	0.352	-0.135	0.350	-0.245	0.430	0.078	-0.204
Triceps	3.30	24.20	10.67	6.29	-0.162	0.041	-0.353	-0.038	0.089	-0.256	0.409	-0.256	0.485	0.017	-0.157
Thigh	6.80	40.00	16.46	9.07	-0.144	0.013	-0.518	0.105	-0.213	-0.100	0.161	-0.077	0.364	0.081	-0.172
Calf	2.00	24.00	8.88	6.29	-0.427	-0.154	-0.647*	-0.196	-0.190	-0.154	0.005	-0.291	0.046	-0.115	-0.309
Indexes															
Body fat (%) by OMRON	7.80	39.40	18.19	8.68	-0.047	0.193	-0.378	0.119	0.071	0.126	-0.149	-0.019	-0.022	0.086	-0.430
Body fat (kg) by OMRON	5.30	52.80	14.92	12.75	0.073	0.306	-0.224	0.165	0.208	0.205	0.076	-0.118	0.138	0.185	-0.483
Body mass index (kg/m^2)	19.40	46.10	24.66	7.19	0.190	0.427	-0.159	0.268	0.363	0.166	0.314	-0.048	0.396	0.351	-0.406

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Waist to Hip ratio	0.81	1.00	0.91	0.07	-0.205	-0.142	-0.370	-0.030	-0.233	0.005	-0.561	0.024	-0.421	-0.222	-0.094
Body surface area (m^2)	1.66	2.39	1.89	0.21	0.232	0.395	0.194	0.112	0.634*	0.240	0.486	-0.235	0.291	0.278	-0.348
Mean skinfolds (mm)	6.00	27.29	11.43	6.04	-0.175	0.054	-0.478	0.022	-0.005	-0.167	0.177	-0.159	0.277	0.023	-0.139
Body density (g/cm^3)	1.03	1.06	1.05	0.01	0.136	-0.051	0.476	-0.080	0.001	0.102	-0.230	0.177	-0.385	-0.049	0.143
Relative mass of fat by Siri (%)	18.13	29.33	21.02	3.03	-0.133	0.054	-0.473	0.081	0.001	-0.100	0.231	-0.176	0.384	0.051	-0.146
Mass of subcutaneous adipose tissue (kg)	5.16	29.36	9.98	6.69	-0.075	0.153	-0.384	0.086	0.100	-0.084	0.237	-0.162	0.304	0.102	-0.210
Relative mass of subcutaneus adipose tissue (%)	6.25	21.26	11.57	4.79	-0.307	-0.073	-0.575	-0.080	-0.082	-0.330	0.178	-0.137	0.271	-0.059	-0.009

Statistically significant difference ($P \leq 0.05$)

Table 2. Correlations between anthropometric variables and the consumption of energy and the main nutrients in kidney transplant females (n= 16)

Variables	Anthropometrical data				Mean values of 3-days menus energy and nutrients data										
	after kidney transplantation				Energy (kcal)	Pro-tein (g)	Fat (g)	Carbo-hydrate (g)	Chole-sterol (mg)	Sodium (mg)	Potas-sium (mg)	Cal-cium (mg)	Mag-nesium (mg)	Phos-phorus (mg)	Water (mL)
	Min	Max	Mean	SD	Correlation coefficients (r)										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Weight (kg)	40.00	126.50	74.35	22.33	0.140	0.032	0.132	0.116	0.422	0.134	-0.262	-0.258	-0.246	-0.132	-0.242
Heights (cm)	150.00	171.50	164.88	6.51	0.048	-0.157	-0.086	0.207	0.078	0.139	-0.085	-0.508*	0.022	-0.323	0.005
Breadths and depths (cm)															
Biacromial breadth	32.00	42.80	35.89	2.91	0.246	0.095	0.218	0.210	0.173	0.051	-0.245	-0.381	-0.208	-0.186	-0.181
Chest breadth	23.00	34.50	27.73	3.43	0.213	0.180	0.138	0.213	0.269	0.060	-0.172	-0.361	-0.106	-0.077	-0.239
Waist breadth	23.00	39.00	28.46	4.71	0.067	0.051	0.154	-0.043	0.132	0.232	-0.155	-0.118	-0.187	-0.072	-0.058
Pelvis breadth	26.00	35.50	31.58	2.63	0.111	-0.096	0.181	0.059	0.483	0.139	0.001	-0.338	0.049	-0.143	-0.182
Chest depth	17.00	28.00	21.54	3.19	0.045	-0.214	0.068	0.022	0.280	-0.180	-0.353	-0.420	-0.424	-0.353	-0.325
Abdomen depth	16.50	40.00	24.68	6.68	0.176	0.224	0.207	0.076	0.261	0.049	-0.165	0.053	-0.164	0.135	-0.213
Humerus breadth	5.70	8.40	6.56	0.73	0.296	0.367	0.270	0.193	0.310	0.376	-0.154	-0.054	-0.087	0.102	-0.195
Wrist breadth	4.70	6.20	5.28	0.38	0.247	0.329	0.151	0.223	0.006	0.164	-0.147	-0.130	-0.011	0.075	-0.203
Femur breadth	8.20	11.70	9.53	0.96	0.003	-0.001	-0.047	0.001	0.135	0.251	-0.303	-0.220	-0.278	-0.152	-0.308
Ankle breadth	4.20	7.60	6.33	0.98	0.013	0.064	-0.061	0.056	-0.271	0.079	-0.170	-0.243	-0.155	-0.159	0.134
Circumferences (cm)															
Head	53.00	59.50	55.59	1.93	0.098	-0.168	0.029	0.167	0.221	0.018	-0.267	-0.349	-0.196	-0.260	-0.314
Neck	29.50	42.50	35.86	3.90	0.364	0.321	0.285	0.336	0.321	0.061	-0.055	0.078	-0.058	0.207	-0.252
Chest	76.80	114.20	95.06	10.54	0.288	0.210	0.251	0.231	0.366	0.002	-0.196	-0.142	-0.216	0.014	-0.296
Waist	62.00	124.00	88.55	15.75	0.214	0.118	0.219	0.157	0.270	0.022	-0.180	-0.085	-0.209	0.015	-0.192

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Hip	86.00	140.00	107.75	15.36	0.161	0.075	0.195	0.086	0.447	0.196	-0.169	-0.172	-0.195	-0.057	-0.189
Proximal thigh	45.80	73.00	59.19	9.43	0.089	-0.031	0.085	0.081	0.398	0.209	-0.221	-0.255	-0.214	-0.169	-0.166
Middle thigh	38.00	65.10	51.74	8.44	0.019	-0.055	-0.001	0.017	0.306	0.185	-0.304	-0.365	-0.276	-0.255	-0.239
Calf	29.70	53.80	37.28	6.85	0.168	0.309	0.149	0.109	0.317	0.362	-0.092	0.381	-0.100	0.280	-0.087
Ankle	17.80	32.50	23.58	4.04	0.220	0.144	0.118	0.267	0.112	0.238	-0.019	0.213	-0.010	0.186	-0.162
Arm, relaxed	22.00	39.00	31.74	5.23	0.404	0.318	0.332	0.381	0.453	0.295	-0.010	0.161	-0.032	0.205	-0.126
Arm, flexed and tensed	23.50	40.10	32.61	5.78	0.338	0.242	0.282	0.311	0.443	0.237	-0.107	0.057	-0.114	0.130	-0.190
Forearm	20.50	32.50	25.28	3.69	0.265	0.146	0.149	0.289	0.283	0.110	-0.264	-0.183	-0.263	-0.068	-0.258
Wrist	14.00	21.00	16.49	1.92	0.269	0.180	0.145	0.303	0.252	0.050	-0.275	-0.365	-0.198	-0.128	-0.262
Skinfolds (mm)															
Chin	1.80	18.00	9.31	4.46	0.072	0.051	0.080	0.018	0.317	0.086	-0.174	-0.068	-0.200	0.019	-0.283
Chest	3.00	20.00	12.16	5.04	0.492	0.246	0.445	0.464	0.531*	0.263	0.223	0.105	0.126	0.255	-0.023
Side	2.80	30.00	12.77	6.96	0.231	0.055	0.306	0.128	0.264	0.215	-0.005	-0.077	-0.073	0.035	0.011
Waist	4.50	36.00	14.75	9.96	0.141	0.020	0.256	0.006	0.191	0.255	-0.138	-0.190	-0.193	-0.098	0.081
Suprailical	3.00	35.00	14.55	9.56	0.205	0.260	0.232	0.096	0.244	0.219	-0.169	0.007	-0.103	0.142	-0.185
Umbilical	2.50	42.00	18.38	11.17	0.272	0.172	0.325	0.162	0.473	0.291	0.019	-0.166	-0.012	0.026	-0.031
Subscapular	4.10	28.00	14.56	6.43	0.165	0.106	0.130	0.131	0.356	-0.075	-0.357	-0.316	-0.312	-0.126	-0.352
Biceps	2.20	17.50	8.68	4.14	0.163	0.041	0.197	0.086	0.445	0.166	-0.225	-0.145	-0.237	-0.055	-0.240
Triceps	6.00	28.00	18.59	6.95	0.334	0.144	0.407	0.256	0.393	0.475	0.210	0.212	0.118	0.209	0.253
Thigh	7.00	36.00	21.59	9.68	0.145	0.065	0.226	0.062	0.334	0.374	0.034	-0.171	-0.005	-0.053	0.189
Calf	5.50	31.00	15.91	8.34	0.017	-0.110	0.090	-0.024	0.439	0.282	-0.151	-0.201	-0.158	-0.163	-0.069
Indexes															
Body fat (%) by OMRON	9.90	44.80	33.06	10.80	0.386	0.259	0.403	0.305	0.537*	0.123	0.077	0.198	-0.002	0.252	-0.151
Body fat (kg) by OMRON	4.20	46.50	25.74	12.57	0.311	0.237	0.310	0.237	0.501*	0.157	-0.135	-0.108	-0.115	0.063	-0.217

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Body mass index (kg/m^2)	14.90	43.80	27.26	7.48	0.145	0.090	0.170	0.076	0.433	0.114	-0.249	-0.125	-0.260	-0.044	-0.246
Waist to hip ratio	0.69	0.93	0.80	0.07	0.013	-0.036	0.047	-0.032	-0.121	-0.322	-0.185	0.222	-0.267	0.092	-0.256
Body surface area (m^2)	1.39	1.06	1.80	0.25	0.169	0.007	0.126	0.186	0.422	0.146	-0.228	-0.307	-0.206	-0.166	-0.212
Mean skinfolds (mm)	5.28	28.59	14.66	6.59	0.226	0.111	0.283	0.131	0.403	0.284	-0.071	-0.117	-0.101	0.011	-0.039
Body density (g/cm^3)	1.04	1.06	1.05	0.01	-0.128	-0.058	-0.171	-0.053	-0.384	-0.221	0.125	0.132	0.155	0.024	0.122
Relative mass of fat by Siri (%)	18.41	28.25	22.69	2.93	0.126	0.057	0.169	0.050	0.382	0.221	-0.127	-0.134	-0.156	-0.027	-0.122
Mass of subcutaneous adipose tissue (kg)	3.58	29.94	12.51	7.18	0.163	0.059	0.209	0.086	0.382	0.244	-0.155	-0.206	-0.160	-0.066	-0.107
Relative mass of subcutaneus adipose tissue (%)	7.25	23.97	15.21	5.09	0.200	0.038	0.276	0.108	0.358	0.325	0.034	-0.017	-0.055	0.044	0.049

*Statistically significant difference ($P \leq 0.05$)

CONCLUSION

On the basis of the table of male patients it can concluded that the features of body build are not significant by connected with the nutritional content and the consumption of food energy. Significant connection were only with cholesterol, the breadths of chest and waist. The female patients had statistically significant correlations between calcium received by food and body height. In comparing the results of male and female patients there were no statistically significant connections. The results of our work indicated that the amount of consumed food was generally little connected with the anthropometrical variables of the studied renal transplant patients. Therefore, there is no clinical significance of these correlations.

The present data constitute the initial stage of investigation. The second correlation analysis of body build and menus which was made 1.5 years later together with the patients` dietological conselling will be published separately.

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ANTHROPOMETRICAL AND SPORT-CONSTITUTIONAL COMPARISON OF MALE AND FEMALE TENNIS PLAYERS AT DIFFERENT PERFORMANCE LEVELS

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ABSTRACT

The purpose of this study was to compare male and female tennis players with respect to their body construction and to identify possible anthropometrical differences. In addition, the study carried out a comparison between different performance levels for both genders, in order to be able to contribute to an explanation of differences between those performance levels. For this reason 40 male and female players who played in the third and fourth divisions of German tennis, and another 35 male and female tennis players who played in the lowest divisions – which are the ninth and tenth tiers – were anthropometrically examined.

The result supplies evidence for a simple gender specific difference on the examined subjects. Male tennis players with an average body height of 181.7 cm and average body weight of 79.4 kg are both significantly taller and heavier than the female tennis players, whose average body height is 167.3 cm and average body weight is 57.9 kg. In addition, the investigation reveals some performance level specific differences for male-players. The male subjects who played at the higher level show a lower body fat percentage – with an average of 13.7% after skinfold-based body fat estimation – than the male subjects who played at the lower level and displayed an average body fat percentage of 18.3% after skinfold-based body fat estimation.

Finally, the male tennis players at the higher level are on average 182.4 cm tall and have a body weight of 76.7 kg. In comparison, the male tennis players at the lower levels are on average 180.9 cm tall and have an average body weight of 82.4 kg.

For the female gender, no body-construction-specific disparities relating to the different performance levels were identified.

It may be the case that the observed performance-level based difference for the male tennis players indicates a more pronounced athleticism in men's tennis than in ladies′ tennis.

INTRODUCTION

The varying body constitution of athletes in different sports attracts the attention of a layman as well the sport scientist or coach. For example, there are the tall basketball players besides whom everybody else with an average heights looks like a dwarf. Or the male and female shot-putters and hammer throwers who typically also fairly tall, but appear especially bulky and heavy [11]. But which body frame characteristics are most noticeable when it comes to a tennis player? Which shape comes to mind if you think about a tennis player? On the face of it, it seems more difficult to characterize the body constitution of a tennis player than is the case in the above mentioned sports. Perhaps the highly complex set of abilities required in the sport of tennis is partly responsible for this difficulty.

An initial view of world-class male and female tennis players of the past and present is sufficient to conclude that no obvious tendency of the body constitution of players is recognizable. This finding holds from the top of the world to the bottom in tennis sports, because in the lower leagues too there appears to be a very wide range of constitution types.

Yet in the past there were efforts to undertake such a constitutional and anthropometrical classification as the following characterisation of the body constitution displays: "slim and wiry, relative narrow shoulders, relative wide pelvis, slim arms, visible lateral difference to the benefit of the dominant arm" [9]

To what extent a description and characterisation of the body constitution of male and female tennis players is possible, and whether this description after Maas is correct should be observed and evaluated within the scope of this study.

It is not only the body composition of male and female tennis players that is the focus of interest, but also a body-compositional difference between the genders and the different performance levels. A possible difference in the body composition between the performance levels could be of interest, for example, for the talent scouting of kids and youth and also for the optimisation of talent scouting and talent promotion. In accordance with Knussmann [7] the determining questions of body constitution research and, in this particular case, of the sport anthropology are to what extent the constitution of a human being has an effect on the general and specific sport skills and also, in return, to what extent the practised sport has an influence on the constitution of a human being. This study tries to illuminate those two questions by focusing on the sport of tennis and attempts to answer the questions at least in part.

For this reason the relative body fat was measured as well as the constitution typologies according to Parnell, Heath and Carter, Conrad and Knussmann.

MATERIAL AND METHODS

Against this background, 75 male and female tennis players were examined in this study. Each player participated voluntarily and provided the data anonymously. Twenty male and 20 female players from the third and fourth divisions and a further 18 female and 17 male tennis players of the ninth and tenth divisions were anthropometrically measured. Their ages ranged from 14 years for the youngest female participants and 16 years for the youngest male participants to 38 years for the oldest male participants and 31 years for the oldest female participants.

During the anthropometrical examination the heights and lengths were measured with an anthropometer of the brand GPM Anthropological Instruments, the breadths and widths were measured with a pelvimeter, the circumferences were measured with a measuring tape, the skinfolds were measured with a caliper of the brand Ti Xing and the body weight and the body fat percentage were measured with a BIA-scale of the brand Fit Scan. The measurements took place under standardized conditions and were completed by the author of this study. The results were statistically checked. Besides those anthropometrical facts, the age, the dexterity as well as some parameters of training science, like frequency of training and the duration of a training session, were recorded for each player.

The exact defined landmarks after Knussmann [8] conduced as foundation of the examined and calculated measures. It should be pointed out that, for the sake of consistency, the measured data were taken from the dominant side of each player (i.e. the left side for left-handed players and the right side for right-handed players).

RESULTS

The observations summarised in Table 1 show a clear difference between the male and female subjects. The male tennis players were taller and heavier than the female players. Most of the additional parameters, such as widths, circumferences, body fat percentages and the results of the single determinations of the constitution typologies also support this gender-specific difference. With respect to the different performance levels, the variations are less clear. Nevertheless, especially in relation to the male players, there are noticeable performance-level specific differences such as a greater body height at a lower body weight amongst the higher performance level players in comparison to the lower performance level players. The body fat percentage results shows similar results. Male players in the third and fourth divisions display a lower body fat percentage following the skinfold method than the male players in the ninth and tenth divisions. Such variations in the body constitution between the different performance levels could not be verified for female players.

Another mentionable aspect in this study supplies a view on the results of the epiphysis width of the humerus. The width of the left humerus of all female tennis players and also the male tennis players at the higher performance level is a few millimetres narrower than the width of the right humerus. Only the male players at the lower performance level show identical widths on both humerus epiphyses.

As with the results of the widths of the humerus epiphysis, the results of the circumferences of the upper extremity show certain features. Both the maximum and minimum circumferences of the upper arm and the maximum and minimum circumferences of the forearm display greater results for the right upper limb.

Table 1. Averages, standard degression and significance levels of selected parameters for both genders and performance levels

Parameter	Males	Females	p	3rd / 4th Division ♀	♂	9th / 10th Division ♀	♂	p
Age (in years)	22.6 ± 5.5	18.9 ± 4.3	≤ 0.01	19.2 ± 5.1	21.8 ± 5.1	18.5 ± 3.5	23.6 ± 5.9	n. s.
Frequency of training (units / week)	2.2 ± 1.8	2.6 ± 2.6	n. s.	4.3 ± 2.5	3.2 ± 1.8	0.7 ± 0.7	1.1 ± 0.9	≤ 0.001
Duration of training session (hours / session)	1.3 ± 0.7	1.3 ± 0.8	n. s.	1.8 ± 0.4	1.7 ± 0.6	0.7 ± 0.6	0.9 ± 0.7	≤ 0.001
Body height (in cm)	181.7 ± 6.4	167.3 ± 5.3	≤ 0.001	167.5 ± 5.8	182.4 ± 6.3	167.1 ± 4.9	180.9 ± 6.7	n. s.
Body weight (in kg)	79.4 ± 13.8	57.9 ± 8.0	≤ 0.001	58.3 ± 8.7	76.7 ± 7.4	57.4 ± 7.4	82.4 ± 18.6	n. s.
Body fat (in %) after skinfold method	15.8 ± 6.0	21.1 ± 3.2	≤ 0.001	20.8 ± 3.9	13.7 ± 3.8	21.3 ± 2.3	18.3 ± 7.3	≤ 0.05
Body fat (in %) after BIA	15.4 ± 6.0	22.6 ± 5.3	≤ 0.001	22.5 ± 5.9	13.7 ± 4.0	22.8 ± 4.7	17.4 ± 7.4	n. s.
Epiphysis width right Humerus (in cm)	7.4 ± 0.4	6.4 ± 0.4	≤ 0.001	6.4 ± 0.4	7.4 ± 0.4	6.4 ± 0.4	7.5 ± 0.4	n. s.
Epiphysis width left Humerus (in cm)	7.4 ± 0.5	6.2 ± 0.3	≤ 0.001	6.2 ± 0.3	7.2 ± 0.5	6.2 ± 0.4	7.5 ± 0.4	n. s.
Upper arm circumference maximum right (in cm)	33.6 ± 3.6	27.0 ± 2.5	≤ 0.001	27.1 ± 2.8	32.9 ± 2.4	26.9 ± 2.1	34.5 ± 4.5	n. s.
Upper arm circumference maximum left (in cm)	32.9 ± 3.5	26.2 ± 2.2	≤ 0.001	26.3 ± 2.5	32.0 ± 2.4	26.2 ± 1.7	33.8 ± 4.3	n. s.
Upper arm circumference minimum right (in cm)	30.8 ± 3.4	25.3 ± 2.5	≤ 0.001	25.4 ± 2.9	30.1 ± 2.4	25.2 ± 2.1	31.6 ± 4.2	n. s.
Upper arm circumference minimum left (in cm)	30.7 ± 3.5	25.0 ± 2.3	≤ 0.001	25.2 ± 2.6	30.0 ± 2.6	24.9 ± 2.0	31.5 ± 4.2	n. s.
Forearm maximum right (in cm)	28.4 ± 2.2	23.6 ± 1.3	≤ 0.001	23.8 ± 1.3	28.2 ± 1.8	23.5 ± 1.4	28.7 ± 2.6	n. s.
Forearm maximum left (in cm)	27.5 ± 2.0	22.7 ± 1.1	≤ 0.001	22.8 ± 1.0	27.1 ± 1.4	22.7 ± 1.2	28.1 ± 2.5	n. s.
Forearm minimum right (in cm)	17.7 ± 1.1	15.5 ± 0.8	≤ 0.001	15.6 ± 0.9	17.7 ± 0.8	15.4 ± 0.7	17.7 ± 1.3	n. s.
Forearm minimum left (in cm)	17.3 ± 1.1	15.0 ± 0.8	≤ 0.001	15.0 ± 0.8	17.2 ± 0.9	15.0 ± 0.7	17.4 ± 1.4	n. s.

Table 2. Averages, standard degression and significance levels of the parameters of the determination of the constitution typologies for both genders and performance levels

Parameter	Males	Females	p	3rd / 4th Division ♀	3rd / 4th Division ♂	9th / 10th Division ♀	9th / 10th Division ♂	p
Endomorphy (after Parnell)	4.6 ± 0.9	4.9 ± 0.8	n. s.	4.8 ± 1.0	4.4 ± 0.7	5.1 ± 0.5	4.9 ± 1.1	n. s.
Mesomorphy (after Parnell)	3.9 ± 1.0	2.8 ± 0.9	≤ 0.001	2.9 ± 0.9	3.8 ± 0.9	2.6 ± 1.0	4.0 ± 1.1	n. s.
Ectomorphy (after Parnell)	3.4 ± 1.1	3.8 ± 1.2	n. s.	3.9 ± 1.3	3.6 ± 1.1	3.8 ± 1.2	3.2 ± 1.2	n. s.
Endomorphy (after Heath & Carter)	4.0 ± 1.5	4.3 ± 1.2	n. s.	4.1 ± 1.4	3.5 ± 1.1	4.5 ± 1.0	4.5 ± 1.8	≤ 0.05
Mesomorphy (after Heath & Carter)	5.0 ± 1.3	3.4 ± 1.1	≤ 0.001	3.4 ± 1.1	4.7 ± 0.9	3.3 ± 1.1	5.4 ± 1.6	n. s.
Ectomorphy (after Heath & Carter)	2.6 ± 1.2	3.2 ± 1.2	≤ 0.05	3.2 ± 1.3	2.9 ± 1.1	3.2 ± 1.2	2.3 ± 1.3	n. s.
Metrik-Index (after Conrad)	–0.7 ± 0.7	–1.4 ± 0.4	≤ 0.001	–1.3 ± 0.5	–0.8 ± 0.5	–1.4 ± 0.2	–0.6 ± 0.9	n. s.
Plastik-Index (after Conrad)	88.1 ± 5.1	75.5 ± 2.9	≤ 0.001	75.7 ± 2.4	87.3 ± 3.8	75.2 ± 3.5	87.3 ± 3.8	n. s.
Pyknomorphy (after Knussmann)	–2.2 ± 2.5	–2.7 ± 1.3	n. s.	–2.8 ± 1.3	–2.8 ± 1.9	–2.6 ± 1.2	–1.6 ± 2.9	n. s.
Macrosomia (after Knussmann)	0.2 ± 1.7	–0.2 ± 1.3	n. s.	0.1 ± 1.2	0.1 ± 1.5	–0.5 ± 1.3	0.4 ± 1.8	n. s.

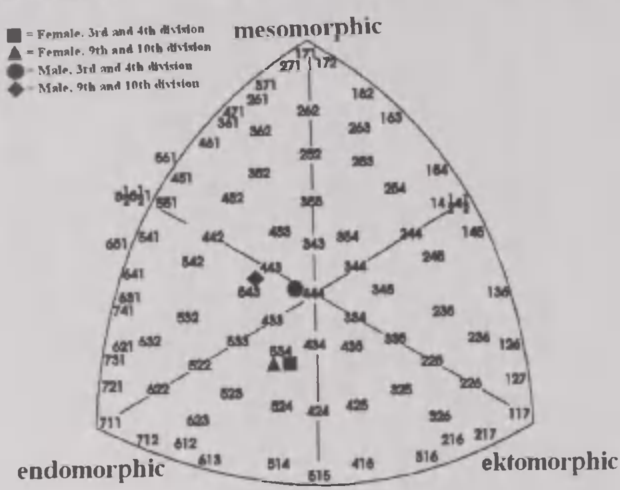

Figure 1. Somatochart after Parnell with the averages of both genders and performance levels

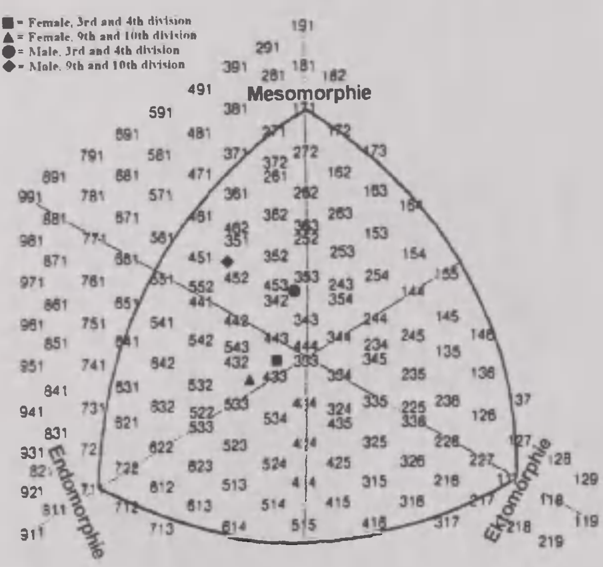

Figure 2. Somatochart after Heath and Carter with the averages of both genders and performance levels

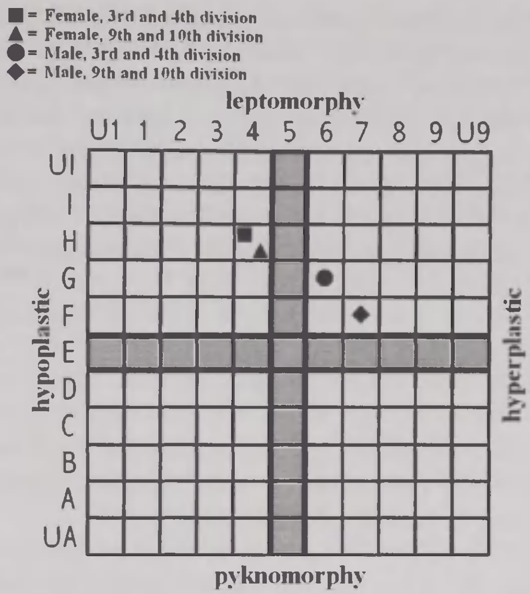

Figure 3. Chessboard pattern graphic after Conrad with the averages of both genders and performance levels

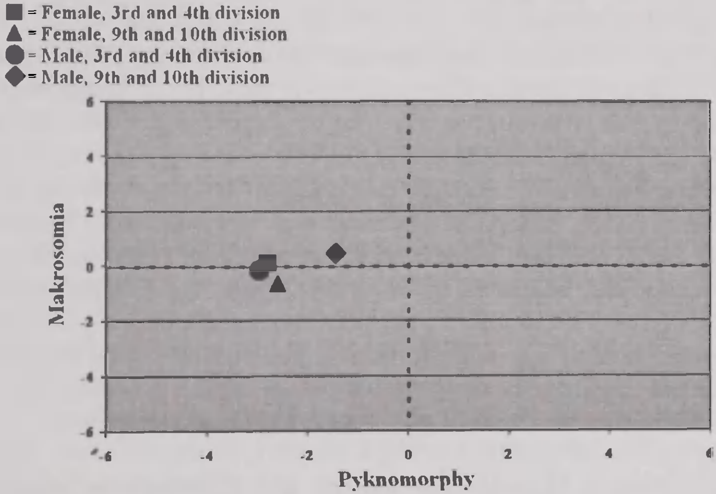

Figure 4. System of the constitution types after Knussmann with the averages of both genders and performance levels

The results of the German determination of the constitution types reveal for all the players a picture which seems to lean more towards leptomorphy compared with the Anglo-American determination of constitution types. In particular, the averages of the female tennis players according to Conrad and Knussmann imply a rather willowy body constitution. Among the male tennis players in this study, the averages of the players at the lower performance levels show a higher degree of musculature compared against the players at the higher performance levels.

DISCUSSION

The present study supports the conclusion of a clear gender-specific difference, and also especially in mens' tennis a performance-level specific difference in the body constitution.

The male tennis players who play in the third and fourth divisions are, on average, 182.4 cm tall whereas the female players of the same divisions display an average height of only 167.5 cm. The male players of the ninth and tenth divisions display an average size of 180.9 cm and the female players of the ninth and tenth division are on an average 167.1 cm tall. According to the Federal Office of Statistics the average size for 18 to 40 year old women in the Federal Republic of Germany lies at 167 cm and for men the same age at 180 cm [4]. The female tennis players of both performance levels thereby lie almost exactly at the nationwide average, the male tennis players, especially the players on the higher performance levels lie with a few centimetres above the nationwide average. This could be an indication that above-average tall men are preferentially prone to the sport of tennis or that a certain body height facilitates the achievement of a higher performance level. Concerning this matter Sánchez-Munoz, Sanz and Zabala determined with a study on the world's best male and female junior tennis players under 16 years of age that the twelve best female junior players were significantly taller than the girls who were ranked below those twelve. With respect to male junior players no significant differences in body height were observed [12].

According to the study by Johnson and Mc Hugh the serve is the most important shot in tennis for the simple reason that it is the most frequent shot in the game [6]. Especially when taking into account the fact that the optimal hitting point of the ball during a tennis serve is at the highest point reachable with a tennis racket it seems advantageous to be tall and have a long reach. This hypothesis could be neither proven nor disproven with the current data.

The findings for body weight reflect the expectation that men, with an average body weight of 79.4 kg, are significantly heavier compared to women, with an average weight of 57.9 kg. The average weight of the studied male players is slightly lower than the declared nationwide average body weight for 18 to 40 year old men [4]. The findings of the average body weight at different performance levels for men , however, shows a clear difference. Players at the lower performance levels, with an average body weight of 82.4 kg, are approximately two kilograms above the nationwide average weight for this age class. The tennis players at the higher performance levels by contrast are, with an average body weight of 76.7 kg, four kilograms below the nationwide average. Unlike male players, the observed difference of 0.9 kg against nationwide average body weights for female players is fairly small.

This gives rise to the hypothesis that players at higher performance levels, and especially men, are perhaps more athletically trained than players at lower performance levels, or maybe have a disposition towards leptomorphy.

The findings in relation to body fat percentages, which were ascertained through skinfold method, display a significant difference in the averages by performance level. This seems to support the abovementioned hypothesis.

This performance-level specific difference amongst men may well point to a higher performance density and correspondingly to a more pronounced athleticism in mens' tennis than in ladies tennis. But due to the fact that this was not the object of the study it could not be proven.

This suggests the need for further investigation into the constitution of male and female tennis players and their actual training conditions.

A possible explanation for the lateral difference of the epiphysis width of the humerus of all players at the higher performance levels, and also the female players at the lower levels, could be the higher strain on the right arm. Almost all measured players stated that they are right handed and consequently play tennis with the right hand. A Finnish study carried out in 1998 examined the effect of unilateral activity on the bone density of young female tennis players. Within the scope of this study young female players were examined who played tennis many times per week over several years. The result is a significantly higher bone density in the region of the upper- and forearm on the dominant side in comparison to the non-dominant side of the female tennis players [5]. Transferred to the players who were examined in the present study this could be an explanation for the differences in the widths of the humerus epiphysis. Perhaps the male tennis players at the higher performance levels show a wider width of the humerus epiphysis than the male players at the lower performance levels because they practice and exercise longer and more often and therefore the right arm is exposed to higher levels of strain compared to the left arm. The diameter of a long bone thickens through high mechanical strain and also in the region of the insertion spot of tendons to bones it comes to a condensation of the tissue which appears in form of larger protuberances in the region of the enthesis [2]. Certainly this should lead to a wider humerus epiphysis of the female players on the higher performance levels compared to the female players on the lower performance levels. But this could not be proven in the present study. A possible attempt to solve this problem would be a study about the stroke hardness for male and female tennis players because, in theory, the higher speed of the ball in mens' tennis could lead to a greater compression of the arm in the moment of the hitting point of the ball whereupon the body reacts with an increase of the bone density and bone width.

The present study is not able to clarify if the differences of the width measures which were observed definitely arise from an intensified width growth through the exerted sportive activity. It can be assumed that constant sporting activity, in which form however, has an influence on the width growth especially for juveniles and young adults [10].

It might be that the results of the represented circumference measures show some conspicuities like the widths of the humerus epiphysis do as well because of the laterality. The case that both the maximum and minimum circumferences of the upper arm and the circumferences of the forearm of the right upper limb show greater results compared to the left upper limb appears reasonable based on the fact that only seven out of 75 subjects were left handed. According to de Marées, high mechanical strain results in an increased muscle cross section and muscle strength [2]. Because the majority of the examined players in this study play tennis with the right hand, a higher mechanical strain is experienced in the whole right arm which could lead to a hypertrophy musculature of this preferred arm. After Daly, Saxon, Turner, Robling and Bass a comparison between the dominant and the non-dominant arm of young female tennis players shows that the musculature as well as the bones of the dominant arm were six to 13 percent bigger than in the non-dominant arm [1]. Further support for this thesis comes from an American study which proves that in 32 young elite female tennis players the strength of the dominant under arm in relation to flexion, extension and pronation of the hand is significantly stronger than the strength of the non-dominant arm [3].

The high significant more frequently and longer physical strain of the probands who play on the higher performance levels in comparison to the players on the lower performance levels could be a reason for the, a few millimetres notably, right-left-differences regarding to the maximum circumference of the upper arm and also the maximum and minimum circumference of the forearm for the players on the higher performance levels.

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NOTES ON HOW ANTHROPOLOGY BECAME AN INDEPENDENT BRANCH OF SCIENCE

Linda Kongo

The aim of the article is not to discuss the entire history of anthropology but to dwell on some initiatives and connections.

Anthropology became an independent science in the second half of the 19^{th} century, although its roots extend into the distant past. The term 'anthropology' was first used by Magnus **Hundt** (1449–1519), a German philosopher, physician and theologian, Rector of Leipzig University, in his paper published in Latin in 1501 *Anthropologicum de hominis dignitate, natura et prprietatibus*. Almost a century later the German philosopher Otto **Casmann** (1562–1602), in his paper *Psychologia anthropologica seve animae humanae doctrina*, published in 1594, approved of the use of the term 'anthropology' in the sense used by Magnus Hundt.

In the second half of the 18^{th} century the term was applied by Immanuel **Kant** (1724–1804), the founder of German classical philosophy. Kant began his work at Königsberg University in 1755 as a *privatdozent*; from 1770 he was Professor of Logic and Metaphysics, in 1786 and 1788 also Rector. He was interested in natural science and natural philosophy. Among other subjects, he lectured on anthropology at Königsberg University for more than 30 years. During the winter holidays, he lectured on anthropology as a science on humans and anything concerning them, in summer – on physical geography as the whole environment that surrounds people, including astronomy, geology, geography and other sciences, in short – cosmology (Бензенгре, 1877). He lectured on those subjects for non-specialists as part of their general education

In 1777 the post of Professor of Medicine at Königsberg University was taken up by Johann Daniel **Metzger** (1739–1805). He lectured on anatomy, psychology, pathology, surgery and anthropology. In 1790 Metzger published a textbook of medical philosophical anthropology for physicians and non-physicians (Metzger, 1790). Metzger's teachings on medicine as well as anthropology formed the foundations for the views of Daniel Georg **Balk** (1764–1826), a graduate of Königsberg University.

Balk studied at the Faculty of Medicine at Königsberg University from 1780–1787. In 1802 he became Professor of Pathology, Physiology and Semiotics at the University of Tartu. For his lectures of anthropology at the University of Tartu, he used the textbook of Metzger.

In the early 19^{th} century, the leading trend in philosophy at the University of Tartu was Kant's teaching, which was also the peak of European philosophy (TÜ ajalugu, 1982). In 1802, Kant's student Gottlieb Benjamin **Jäsche** (1762–1842) was employed as Professor of Philosophy at the University of Tartu. He promoted Kant's papers on philosophy and published in print Kant's lectures on logic (Jäsche, 1800). Jäsche's views were also manifest in the works of his students. Jäsche's anthropological paper published in Moscow was referred to by Alexey Nikolayevich Maklakov (Маклаков, 1875).

In 1802 Heinrich Friedrich **Isenflamm** was invited to the post of Ordinary Professor of Anatomy, Physiology and Forensic Medicine at the University of Tartu. He drew students' attention to ethnic differences in bones and emphasized the need for collecting skeletons (Toomsalu, 2001). He worked at the University of Tartu until 1810. Two years later he published a paper on anthropology (Isenflamm, 1812).

From 1810–1814 one of Balk's students at the University of Tartu was Karl Ernst von **Baer** (1792–1876), who graduated in 1814 with a doctoral thesis on Estonians' endemic diseases (Baer, 1814). This is considered to belong to the area of both pathology and anthropology (Бензенгре, 1877). Another of Baer's teachers at the University of Tartu was Karl Friedrich **Burdach** (1776–1847). Burdach worked at the University of Tartu from 1811–1814 as Professor of Anatomy, Physiology and Forensic Medicine. He was the first to use the term "biology". In 1814 he took up a post at Königsberg University. There he lectured on anthropology and in 1837 published the text of his lectures, the revised edition of which was republished in 1849 by his son (Burdach, 1837). In 1817 Burdach invited Baer to work under him as a prosector at Königsberg University. While working there, Baer delved into the works of Kant, Metzger, Balk and Burdach who had worked as professors in Königsberg before. This also influenced Baer's undertakings in anthropology. Having been elected Professor of Zoology at Königsberg University in 1819 and Professor of Anatomy in 1826, he established an anatomy room, for which he received means from Burdach. From 1817–1830 he lectured, along with zoology, on human anatomy and anthropology. In 1824 Baer published the first volume of his lectures on anatomy for self-study (Baer, 1824). In the textual part of the book he dealt thoroughly with human organs and anatomy (in his sense, anthropology). In an appendix, published as a separate volume, he included drawings of all human organs (Baer, 1824a). According to his definition, "anthropology is everything we know about humans" (Raikov, 1968, p. 260). In Baer's point of view, anthropology comprised such sciences as anatomy, physiology, human psychology as well as the physical description of human races, ethnography, and partly, archaeology. Two years later, in 1826, Baer was appointed Director of the Institute of Anatomy at Königsberg University. That year he made his most important discovery – the ovum of mammals, including humans. The paper was published next year (Baer, 1827). Other significant papers followed.

In 1834 Baer was employed by St Petersburg Academy of Sciences where he delivered public lectures for physicians and natural scientists mainly on anthropology and development history. In 1841 Baer was appointed Ordinary Professor of Comparative Anatomy and Physiology at the Academy of Medicine and Surgery. Baer's work in anthropology continued in 1845 when he was transferred to the Department of Comparative Anatomy and Physiology and had to take over the management of the Museum of Anatomy at St Petersburg Academy of Sciences. As the collections of the museum were enriched by materials gathered during expeditions, Baer became interested in craniology. In 1858 he studied craniological materials in Basel museum. Baer proposed that measuring of skulls should be based on the system of the Swedish craniologist and anthropologist Anders **Retzius** (1796–1860), to which Baer made an essential improvement (Tammiksaar, 1999). In the same year, 1824, when Baer published his lectures on anthropology, the German anthropologist Johann Friedrich **Blumenbach** (1752–1840), Professor of Medicine at Göttingen University, published the third edition of his handbook *Handbuch der vergleichenden Anatomie und Physiologie* (Blumenbach, 1824). Even before the publication of the first edition of this handbook (1804), Blumenbach had published several papers on anthropology where he related systematic zoology to comparative anatomy. Another handbook written by him, *Handbuch der Naturgeschichte*, which came out in eight editions from 1799–1807, was used by Gottfried Albrecht **Germann**, the first Professor of Botany at the re-opened University of Tartu, for compiling his lectures on mineralogy, where he also dealt with fossils.

In 1838 Alexander von **Hueck** (1802–1842), Professor of Anatomy at the University of Tartu, published a paper on craniology (Hueck, 1838), which was the first to describe the skulls of Estonians.

In 1843, at Baer's recommendation, his former student Adolf Eduard **Grube** (1812–1880) was invited from Königsberg to the University of Tartu to work there as Professor of Zoology. He was also the head of the zoology room and Director of the Museum of Zoology. Primarily, Grube took care of replenishing the zoological collections.

Georg Carl Maria **Seidlitz** (1840–1917), a graduate of the University of Tartu, continued his education in Dresden on anatomy and anthropology. Delivering a course on Darwinism at the University of Tartu, he ran into a conflict with the predominant views at the University and had to leave for Königsberg in 1877.

In 1845 Georg Schultz (1808–1875), conservator at St Petersburg Museum of Anatomy, published a paper where he made the first attempt at comparative measuring of individuals of different ethnicities, including four Estonians (Schultz, 1845; see Table).

In 1863, at the initiative of Anatoli Petrovich **Bogdanov**, Nikolai Petrovich **Danilov**, August Yulyevich **Davidov**, Mikhail Afanasyevich **Malinovski** and other professors of the Faculty of Physics and Mathematics at the University of Moscow the Society of Friends of Natural Sciences, Anthropology and Ethnography was founded at the University. The Society initiated systematic anthropological research in Russia. The society published its research papers in the series *Известия*... The Society had 20 foreign members, including Anders **Retzius** (1796–1860) from Stockholm, Paul **Topinard** (1830–1911) from Paris, Rudolf Ludwig **Virchow** (1821–1902) from Berlin. Karl Ernst von Baer and Ludwig **Stieda** (1837–1918) were elected honorary members of the Society. Well-known French anthropologists Paul **Broca** (1824–1880) (Брока, 1865, 1879) and Paul Topinard (Топинар, 1886) and the German anthropologist Rudolf Virchow (Virchow, 1892) published their papers in the publications of the Society. The latter two made presentations at an international conference of archaeology and prehistoric anthropology in Moscow in 1892. All the presentations made at the conference were published in print with the support of the Society. In 1931 the society joined the Moscow Society of Naturalists.

In 1885 Professor of Anatomy Christian Hermann Ludwig Stieda left the University of Tartu to become Professor of Anatomy and Director of the Institute of Anatomy at Königsberg University. He is known as the biographer of Baer; after Baer's death he systematized Baer's legacy and published the first monograph on Baer (Stieda, 1878). Stieda participated in several international anthropological congresses and published a number of papers on anthropology (Kongo, 2002). One of Stieda's students at the University of Tartu was Oskar **Grube** who, under Stieda's supervision, defended a doctoral dissertation on anthropological research of Estonians (Grube, 1878). Several other students of Stieda at the University of Tartu also obtained degrees of Doctor of Medicine in anthropology under his supervision.

The founders of scientific anthropology are considered J. F. Blumenbach, as he started the measuring of skulls, A. I. Bogdanov, P. Broca, A. Retzius and R. Virchow. A. I. Bogdanov was the founder of anthropology in Russia. In 1879 he arranged an anthropological exhibition in Moscow, by which he laid the foundation to the museum of anthropology there. In the same year he published the results of this journey to Finland and Estonia (Богданов, 1878). He was one of the founders of the Society of Friends of Natural Sciences, Anthropology and Ethnography at the University of Moscow in 1863.

P. Broca merit was the introduction of new anthropometric and craniometric methods for studying various aspects of the human body and human organisms, including races, appearance, stature, etc. He devised the formula for calculating body mass. In Paris he founded the first anthropological society, journal and school in the world.

A. Retzius introduced the system of craniological measurements, which was improved by Baer.

R. Virchow was one of the founders of cell theory. He published groundbreaking works in anthropology and is also called the father of pathology. He published a six-volume handbook of pathology. In 1869 he founded the Berlin Society for Anthropology, Ethnology and Primeval History.

In conclusion, it should be stated that the names of Baer and of his teachers as well of his students appear repeatedly in the treatment of development of anthropology in the 19th century, and those. All of them are mentioned in relation to teaching or studies at the universities of Tartu and Königsberg (now Kaliningrad). The University of Königsberg was founded in 1544. At the reopening of the University of Tartu in 1802 and later, several professors left Königsberg for Tartu. Afterwards, Baer and several others left Tartu to work in Königsberg. The speciality that linked them was anthropology.

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DENTAL PATHOLOGIES AND LINEAR ENAMEL HYPOPLASIA IN PÄRNU ST. JOHN CHURCH CEMETERY (16TH–18TH CC.) SKELETONS

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ABSTRACT

A study of dental pathologies is important in investigating the health and the diets of past populations. Dental pathologies show not only nutritional and hygienic habits but also cultural and socio-economic factors which may influence the teeth and their supporting structures in a given population. If dental pathologies of adult people's show nutritional and hygienic habits in adulthood, then childhood metabolic stresses can be observed in the occurrence of linear enamel hypoplasia (LEH). In the current study dental hard tissue pathologies (caries, *pre mortem* tooth loss, abscesses, calculus, the reduction of the alveolar bone in the molar region) and LEH were observed in the individuals over 15 years from the Hanseatic town Pärnu (17th–18th cc. Northeast Estonia) buried in St. John Church Cemetery. The individuals who were buried in the cemetery were mostly soldiers of the Pärnu Garrison and their family members. The aim of the study was to describe the occurrences of dental pathologies among the individuals of the Military Garrison at the end of the Middle Ages in Western Estonia and trace sexual differences in the diet and subsistence patterns through an analysis of dental pathology.

Key words: linear enamel hypoplasia, dental pathologies, the Hanseatic League

Teeth are among the most frequently recovered skeletal elements being particularly resistant to decay because of their strong structure. In addition, teeth provide a wealth of information about, for example, the diet, the oral hygiene, the stress, and the subsistence economy [24]. Because of the fact that teeth directly interact with the environment, they are susceptible to damage from physical and biological influences not operating on other skeletal elements [26]. Most of the dental diseases observed in archaeological skeletons arise as a result of the exposure of the teeth to foodstuffs and the associated material taken into mouth [19]. The mouth functions primarily as a food processor; the food type determines the micro-organisms present in the mouth, and the condition of the person's teeth reflects the composition of the food that has come into contact with those teeth [24]. Much work on the dental disease in ancient skeletons has focused on the investigation of ancient diets using the diseases, which originate from the attacks on the teeth from substances in the oral environment. On the other hand, dental health is an important parameter contributing to the knowledge about the people's general health. Good teeth are a prerequisite for the individual's physical and psychological well-being. Good dental health means that the individual can consume all types of food, while poor health (e.g. caries or loose teeth) can result in a monotonous, unbalanced diet, which in its turn can lead to an impaired general state of health [4]. There are differences between the populations depending on the type of food and the ways of its preparation. At the same time there may occur intra-population differences that depend on the sex or the status. However, it is not necessarily true that poor dental health reflects poor living conditions or vice versa. Anyway, dental pathologies – caries, *pre mortem* tooth loss, abscesses, dental calculus, and the reduction of the alveolar bone allow describing the diet and subsistence patterns. For example: more carbohydrates in food cause more caries but fats, oils and meats (including the fish) are noncariogenic [8, 9, 19, 24]. Tooth loss is associated with caries, alveolar reduction, and severe attrition [4, 5]. The abscesses may form, in association with general periodontal infection, considerable tooth wear or caries [6, 9]. The dental plaque, which can become mineralised into dental calculus, accumulates faster when there is sucrose in the diet [24]. The main cause of reduction in the marginal alveolar bone is the periodontal disease [5], which may become chronic and at the end the resorption of alveolar bone and the exposure of tooth roots may develop [24].

The above stated dental pathologies enable the description of the dietary habits and the lifestyle of adult individuals starting at about the

15th year of age. But the episodes of childhood metabolic stresses of the same individuals may be described using the developmental defects of enamel – dental enamel hypoplasia.

Dental hypoplasia is any disturbance in tooth formation associated with macroscopic defects in the surface of enamel [22]. Furrow-type defects are most common and are often referred to as linear enamel hypoplasia (LEH) [10]. LEH is defined as horizontal lines of decreased enamel thickness on the external surface of the tooth crown. They are due to the disturbance of enamel formation during tooth crown formation in childhood. Such disturbances are caused by the factors that affect the activity of ameloblasts so that the formation of dental enamel stops. After the child survives the stress, the normal formation of dental enamel is continuing leaving the thinner line of enamel to the surface of the tooth. Mainly such disturbances are resulting from the systemic metabolic stresses caused by malnutrition or infection diseases [7, 8]. Since the chronological development of hypoteeth is well understood, it is possible to determine the developmental age at which the hypoplasias occurred during the life of an individual [7, 8, 25].

In Estonia more detailed studies of dental pathologies have been made earlier only in the population of Pada (12th–13th cc), Tääksi (14th – 18th) and Jõuga (12th –16th) [1, 15, 16]. No town population has been studied before. In all three earlier studied Estonian skeletal series the frequencies of dental pathologies were very high and there were no sexual differences in the occurrences of pathologies.

As the Military Garrison of Pärnu supposedly used the Pärnu St. John's Church Cemetery, then also the studies of dental pathologies of skeletal samples of military origin were used for comparison. Most of such studies comprise the data from young men from a later period – the 19th century [20].

The aim of the current study was to examine the occurrence of caries, *pre mortem* tooth loss, abscesses, dental calculus, the reduction of alveolar bone, the degree of attrition of molars and the occurrence of LEH in St. John Church Cemetery (17th –18th cc.) skeletons from Pärnu, Estonia and to find out if there were subsistence role differences between sexes. The differences in the pathologic cases of men/women might suggest the variation of nutrition of the men compared to the women, the differences of hypoplasia frequencies may hint that males and females had different living conditions in their childhood.

MATERIAL AND METHODS

The current study was performed as a small part of a bigger research project the aim of which was to study the inhabitants of the Hanseatic town Pärnu osteologically. The examined skeletons were from St. John's Church Cemetery that was used in the 17th –18th centuries. Pärnu is situated in Western Estonia on the coast of the Baltic Sea and near the river creek of Pärnu. From historical records it is known that mainly the military garrison used the studied cemetery. Most of the buried people were soldiers and their family members from the Swedish and later from the Russian army. The individuals of the Pärnu Cemetery had round-headed skulls with a high cranial vault and with a broad and high face skull [3]. This craniological type is not spread in Western Estonia. Skeletons had the northern gracile odontological type that is also not spread in Western Estonia. Maybe most of these individuals who were buried in the cemetery were not local. The children of the Pärnu Garrison were relatively tall [2]. The statue of adult men and women of Pärnu was smaller than in other urban peoples at the same time in Estonia but sexual dimorphism in stature was bigger [2].

Statistically reliable sex determination can be made only in adult individuals and that is why the observations were made on the individuals over 15 years of age. There were 52 observable skulls (25 females and 27 males). Totally 627 teeth (252 in females and 375 in males) were studied. All the individuals included were divided into five age groups:

Juvenilis, *adultus*, *maturus*, *senilis*. The age distribution of males and females was quite similar (Table 1).

Table 1. The age and sex distribution of the Pärnu St. John's Cemetery skeletons.

	Men		Women		Total	
	N	%	N	%	N	%
Juvenilis (15–19 years)	3	11.1	2	8	5	9.6
Adultus (20–34 years)	8	29.6	9	36	17	32.7
Maturus (35–55 years)	15	55	13	52	28	53.9
Senilis (56+ years)	1	3.7	1	4	2	3.8
Total	27	51.9	25	48.1	52	100

From dental hard tissue pathologies the occurrences of caries, *pre mortem* tooth loss, abscesses, dental calculus, the reduction of the alveolar bone and the occurrence of LEH were registered separately in females and males.

Dental caries. The occurrence of caries was registered in all the observable teeth. Only those cavities that could be seen with a naked eye without the use of microscope or radiology have been included [5]. The discoloration of tooth enamel (initial caries) on the surface was also included. The frequency of caries affected individuals was calculated, but also the frequency of affected teeth was calculated. The location of primary caries was also recorded.

Ante mortem tooth loss (AMTL) was registered, then alveolus for tooth was partly or entirely closed. The frequency of affected individuals, but also the percentage of missing teeth from all the observed alveoli (closed or not) was found.

Dental abscesses on the tips of the roots. Only those abscesses that could be seen with the naked eye have been included.

Dental calculus. The presence of calculus was registered in all the teeth and the frequency of affected individuals was found. Also, the severity of calculus was recorded according to Brothwell 1972.

Reduction of the alveolar bone in the region of molars was registered according to Brothwell [6]. An individual was considered to have a reduction of the alveolar bone if the reduction degree was medium or considerable.

LEH was registered macroscopically on all the permanent teeth. The frequency of affected individuals was found. Only those individuals who had at least one upper central incisor and one lower canine (which are most hypoplastic teeth) were included. In all the observed teeth the age at LEH formation was recorded. The age at LEH formation was determined according to Massler et al. [22]. The severity of defects was registered according to Brothwell 1972.

Statistically significant differences between men and women were found using the t-test. The statistical package SPSS was used for data processing.

RESULTS

It is known that in archaeological skeleton series the occurrence of several dental diseases increases with age [4, 5, 14]. As the age distribution of males and females in the Pärnu series was quite similar, then dividing individuals into age classes was not used. The frequencies of the observed dental pathologies and the differences between men and women are given in Table 2.

Table 2. Occurrences of dental pathologies in males and females.

	Total			Males			Females			Differences between males and females t-test; value of p
	N	n	%	N	N	%	N	n	%	
Caries	45	28	62.2	24	15	62.5	21	13	61.9	0.968
AMTL	51	26	53.1	26	11	45.8	25	15	60.0	0.267
Abscesses	46	18	39.1	25	11	44.0	21	7	33.3	0.325
Calculus	42	38	90.5	22	21	95.5	20	17	80.0	0.07
Reduction of alveolar bone	44	29	65.9	23	15	65.2	21	14	66.6	0.922

Dental caries. Totally 62.2% of individuals (♂ 62.2%; ♀ 61.9%) had caries. From all the observed teeth (605) had caries 13.7% (♂–10.4%; ♀–18.8% of teeth); from all the observed molars (263) were carious 22.8% (♂–19.7%; ♀–27.0% of molars). So the number of the caries affected individuals was similar among men and women but women had more teeth affected.

Both men and women had most of the caries lesions located in the neck area (Table 3) but women had less neck caries and more crown caries than men. Crown caries was mostly located on the occlusal surface (♂ 75%, ♀ 62.5% of crown caries).

Table 3. Occurrence and location of caries in the teeth of men and women.

	Teeth with caries	Caries primary on neck		Caries primary on crown		Caries primary on root		Strong caries primary location unknown	
	N	n	%	N	%	n	%	N	%
Men	38	21	55.2	4	10.5	1	2.6	12	36.8
Women	45	17	37.8	9	20	2	4.4	19	42.2
Total	**83**	**34**	**40.9**	**13**	**15.6**	3	3.6	33	39.7

AMTL. Men had tooth loss more often than women but this difference was statistically insignificant (Table 2). Totally 7.4% of teeth were missing *pre mortem* per observed alveoli (♂– 8.7%; ♀– 5.8%).

Reduction of the alveolar bone in the molar region had 65.9% of individuals over 15 years, the reduction of the alveolar bone and occurrence was similar in men and women (♂ – 65.2%; ♀ – 66.6%).

Abscesses on the tips of roots occurred in 26% of individuals (♂ – 21.7%; ♀ – 33.33%). Women had abscesses more often than men but this difference was statistically insignificant (Table 2).

Tooth calculus was observed in 88.1% of individuals. Men had calculus more often and its occurrence was more severe than in women (♂ –95.5%; ♀ – 80%).

LEH occurred in 87,2% (♂ – 85.7%; ♀ – 88.2%). The difference between men and women was statistically insignificant (t=–0.3; p=0.766). Strong defects were seen very seldom: only 7.5% of the defects had severity degree 2, the mean severity of defects was 1.12 (♂ – 1.11; ♀ – 1.13). Most often the age of LEH formation in women was 4.5–5 years, in the case of men 4–4.5 years (Figure 1).

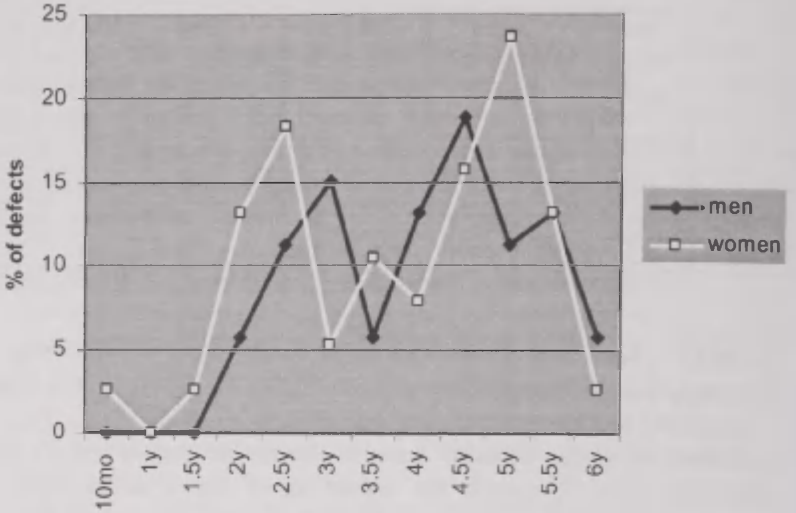

Figure 1. The percentage of LEH defects formed in certain years of life of men and women.

DISCUSSION

The skeletons of the Pärnu series had a lot of teeth missing *post mortem* and the occurrences of the observed pathologies may be therefore underestimated. Especially in the case of caries, as with high probability there may have been caries infected teeth among the missing ones. Both men and women showed a high frequency rate of all the dental pathologies.

From the historical data it is known that the Pärnu Military Garrison also used St. John's Church cemetery. At the time of the Swedish Army almost half of the soldiers in the Pärnu garrison were married and many of them had their wives and children in the garrison [13]. The army also kept a count of the soldier's children and also took care of them.

It is also known that the living conditions of ordinary soldiers in the Livonian garrisons were quite bad [13]. But the occurrence of dental pathologies and the stress markers (LEH) of adults in the Pärnu individuals do not show the difference from other populations from same time in Northern and Central Europe.

Dental caries. Dental caries is perhaps the most common of the dental diseases. Caries is caused by a number factors, and it is not possible to identify an individual factor as the most important. The composition of the food and the individual's eating habits are the factors today considered most important [4].

Although the occurrence of caries in the Pärnu group is high, it is similar to other European skeleton series from same time (Figure 2). At the same time the occurrence of caries is much more lower than in the modern so-called civilized human populations where more than 90% of population might be infected [23]. Generally, the percentage of caries has increased step-by –step with the time [6, 28, 29]; however, the caries rate in the Pärnu individuals is lower than in the Estonian skeleton series from the end of the Iron Age. The occurrence of caries is very similar to the Tääksi village population from the same time in Estonia [1].

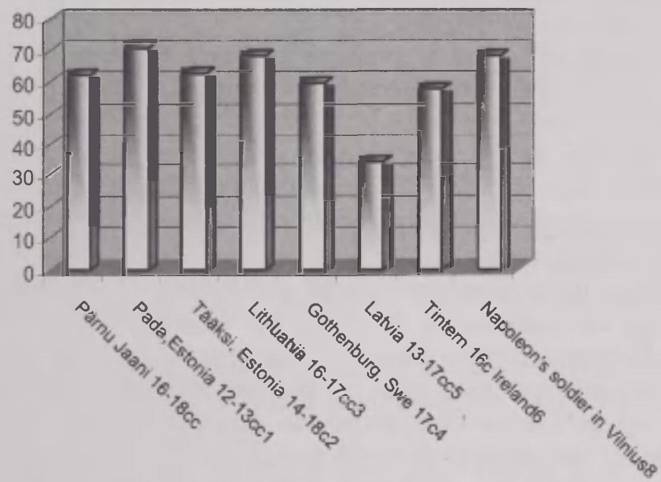

Figure 2. Caries affected adults in different populations 1–Limbo 2004, 2–Allmäe 1999, 3–Balčiūnienė 1987, 4–Lingström, Borrman 1999, 5–Derums 1978, 6–Power 1985, 7–Palubeckaitė et al. 2006

The occurrence of caries was similar in men and women. Supposedly the men and the women had very similar dietary habits, eating mainly the food rich in starches. At that time a portion of the salary in the Garrisons was received as grain as there were also mill and baking ovens inside the Garrison. We may guess that food was made mainly from grinded grain (flour) [13].

It is probable that they ate comparatively little meat and fish. An important factor of the prevalence of caries is oral hygiene, which was probably very bad in both men and women.

In both men and women caries was mostly found in the tooth neck. Caries can develop on the tooth neck only if the latter has been exposed due to the alveolar bone reduction, which in its turn is caused by infectious processes in the gums and the dental attrition. Both of these pathologies increase with the age of people. There were no differences between the caries distribution on the teeth between the men and the women, so one may deduct that the composition and the processing methods (abrasiveness, and the percentage of starches) of food were similar for both men and women.

AMTL. It is not possible to detect a distinct cause of tooth loss. However, it is certain that these have been the cases of dental pathologies. The two main reasons of lost teeth are far developed caries and the reduction of the alveolar bone (caused by weak attrition or periodontal disease) [4, 5, 24]. The occurrence of the loss of teeth before death was quite high and similar in men and women. More than half of the grown individuals had either removed teeth or the teeth that had fallen out due to far developed dental pathologies. There were more women with the antemortem lost teeth but men had more teeth per socket missing pre mortem. Usually if the man had antemortem tooth loss, then several teeth were missing. We cannot say whether the main reason of lost teeth in the Pärnu group was caries or the reduction of the alveolar bone. The occurrence of both pathologies was quite high.

Antemortem tooth loss in Pärnu is similar or even little higher than in Europe at same time but it is still lower than in later populations (Figure. 3). Similarly high occurrences of antemortem tooth loss were observed in the early populations in Estonia and in Sweden (Lund) and no sexual differences were observed [4, 14].

Abscesses. An abscess may be defined as a collection of pus, surrounded by a denser tissue, and within a cavity of the body. In skeletons it is possible to detect abscess cavities within the alveolus at the root apex. Abscesses develop in response to other severe dental pathologies, mainly caries and periodonthosis [6, 9].

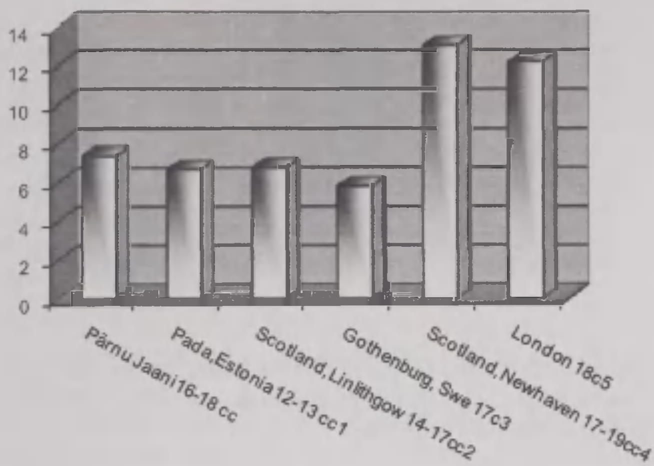

Figure 3. Antemortem tooth loss in different populations per observed tooth sockets. 1– Limbo 2004, 2 – Kerr et al. 1990, 3–Lingström, Borrman 1999, 4– Lunt 1973, 5–Whittakker & Molleson 1996

The abscesses also may form in association with considerable tooth wear or cracking of the tooth, which allow bacteria to enter the pulp [9]. Abscess frequencies vary considerably in different populations (Figure 4).

In the Pärnu group the occurrence of abscesses was higher than in the early periods in Estonia and it is very similar to other populations in Europe at the same period.

Women had less abscesses than men, maybe they had less far developed pathologies. **Dental calculus.** The presence of dental calculus indicates long-standing plaque accumulations in the mouth. Dental plaque consists of microorganisms embedded in the matrix partly composed by the organisms themselves and partly derived from proteins in saliva [24]. Plaque can become mineralised into dental calculus.

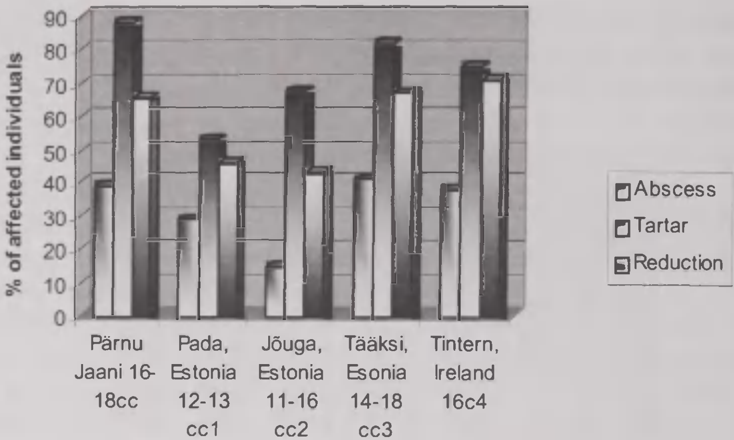

Figure 4. Occurrence of abscesses, dental calculus (tartar) and reduction of alveolar bone in adults in different populations. 1–Limbo 2004, 2– Limbo 2009, 3– Allmäe 1999, 4– Power 1985

The accumulation and mineralization of plaque is related to several factors. Different individuals show a wide variation in the extent of calculus deposits, but the mixture of inherited, dietary and other factors responsible is not well understood [9]. Plaque accumulates faster if there are more carbohydrates in the diet and calculus develops most commonly on the teeth nearest the salivary glands [9, 24].

Dental calculus was very common among Pärnu individuals. Men had tartar deposits more often and several individuals had severe amounts of tartar. As the general percentage of occurrence of caries and its distribution on various locations of teeth did not vary for men and women, one can say that the chemical and physical characteristics of the food were the same for the men as for the women. Differences in the occurrence of tartar may show that the preparation of food or hygienic habits in men and women differed a little. On the other hand, the variance of calculus may be considered incidental, the cause of it being a too small sample size. Among the same period skeletal series (the Tääksi village burial ground from the 14th – 18th cc), calculus occurs also frequently, and more often with men than with women [1]. In earlier periods in Estonia calculus was less frequent (Figure 4).

Reduction of alveolar bone. The main cause of reduction in the marginal alveolar bone is the periodontal disease [5]. The periodontal disease is an infection not only of the alveolar bone, but also of the soft tissues of the mouth. It starts as an inflammation of the gingivae, which may become chronic and finally the periodontitis (the inflammation of the bone) may occur [9]. The resorption of the bone and the exposure of the tooth roots develop [24]. A current suggestion is that a part of the cases of the alveolar reduction only reflects the body's compensatory mechanism for extreme attrition [24].

The reduction of the alveolar bone in the Pärnu group is similar to other contemporary populations in Europe (Figure 4). Earlier populations in Estonia have less reduction of the alveolar bone; also in earlier populations women have less reduction than men. In the Pärnu group men and women had similar occurrences of alveolar reduction. The same was also seen in thethe Tääksi village burial ground from 14^{th}–18^{th} cc.

LEH. In modern populations the incidences of hypoplasia usually remain under 20 per cent [12], but in historical skeleton series LEH occurs more often. In the early modern samples in Europe the frequencies of hypoplasia rise up to 100% [21].

Among the Pärnu skeleton series the LEH percentage was almost the same as at the beginning of Medieval Estonia and it is a little lower than in the beginning of modern the times in Europe [15,16,21].

Men and women had enamel defects similarly frequently. Also, the severity of LEH defects was low in both. However, there were clear differences between men and women in the age of the formation of LEH defects. Both groups had two peak ages of the LEH formation, women at the age of 2–2.5 years and of 5–5.5 years; men at the age of 2.5–3 years and 4.5–5 years (Figure 1). Maybe such differences occur not because the boys and girls in the Pärnu group were treated differently but adult men and women had a different origin and hence had different life conditions in their childhood. We know that the Military Garrison of Pärnu was using the observed cemetery and soldiers in the garrison had several nations [13].

CONCLUSIONS

In the Pärnu group, both men and women showed a high frequency rate of all dental pathologies. But all pathologies showed the same frequencies as in Northern and Central European populations from the same period. The contributing factors to the high rate of dental illnesses were probably poor dental hygiene, the food consisting extensively of carbohydrates (e.g., cereals), micro-organisms present in the oral cavity causing pathologies and perhaps also the individual inclination for infections. Almost the same frequencies of all the observed pathologies characterized the inhabitants of the Tääksi (Estonia) village burial ground from the 14^{th} – 18^{th} cc. It seems that in Estonia at the beginning of modern times people in villages had the same nutritional habits as people in towns.

According to the frequency of dental pathologies in men versus women, the dietary habits of adult individuals (the composition, preparation and consumption of food) can be deducted similar for men and women.

The hypoplasia speaking of childhood metabolic stress occurred in most of the adults of the Pärnu group. Its frequency was higher than at the beginning of Medieval Estonia. But disturbances were not severe and the occurrence of LEH was a little lower than in other towns in Europe.

The LEH occurrence was similar among the Pärnu men and women. However, the peak ages of LEH formation were little different in men and women. Such differences could be explained with a different origin of adult individuals rather than different life conditions of boys and girls in the Pärnu group.

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APPLICATION OF CORRELATION ANALYSIS IN ESTONIAN ANTHROPOLOGY

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ABSTRACT

The present article is dedicated to the 50th anniversary of the Computing Centre at the University of Tartu and to the 45th anniversary of the first dissertation on the anthropology of Estonian students, which also applied anthropometric data analysis by help of the computer. At this time the computer was Ural-1. Today is the new era – from the beginning of the 1990s personal computers are used for data analysis.

The goal of the present study was to investigate the correlations between the height, weight and BMI and other anthropometric measurements. The subjects of the present investigation were 17-year-old conscripts of the town of Tartu and Tartu County.

In all of them height, weight, 33 anthropometric variables and 12 skinfolds were measured. The measurements were made after the recommendations of Martin (Knussmann, 1988).

There were significant correlations between height and other anthropometric variables and between weight and other anthropometric variables. There were also correlations between BMI and circumferences, breadths and depths variables and skinfolds. Differently from weight, there were no significant correlations between height and BMI.

Key words: physical anthropology, correlation analysis, computer application in physical anthropology, conscripts, height, weight, BMI

INTRODUCTION

In 2009 the Computing Centre at the University of Tartu celebrates its 50^{th} anniversary. The hardware of the Computing Centre in 1959 was the computer Ural-1 [10].

Very good cooperation between the mathematicians of the University of Tartu and scientists from the other faculties of the university raised the scientific level of research and opened up the possibility for statistical calculations which were not performed using the memory in one's head or the mechanical crank mechanism named Felix.

In 1960–1963 Heino Tiik was taking a postgraduate course at the Department of Hygiene of the Faculty of Medicine under the guidance of Professor M. Kask. For his academic dissertation Heino Tiik had selected the theme *Physical development and health state of the students of the Estonian SSR* [7, 9]. In this study Heino Tiik measured many anthropometrical variables of men and women students as well as many functional variables of human strength. In the course of statistical analysis of the data, correlation analysis was also applied. The scientific consulting advisors of data analysis were Head of the Electrophysiological Laboratory at the University of Tartu, Candidate of Physical and Mathematical Sciences Associate Professor Leo Võhandu and a researcher at the same laboratory, Sven Veldre. The statistical calculations were made at the Computing Centre of the University of Tartu.

One of the results of the study was confirmed hypothesis that correlations exist between height and other anthropometrical variables and weight and other anthropometrical variables in men and women students' materials. These results were of recent origin in Estonian anthropology. Heino Tiik [9] wrote in his dissertation, "Calculating of correlations by usual methods (by hand) is very time-consuming. Using the old methods of calculation, the four tables of correlations submitted in this dissertation would have needed one person working eight hours a day for 8–10 years."

Heino Tiik's dissertation was completed in 1964 and he defended it on 26 May 1965 [9]. In 1966 Heino Tiik left the University of Tartu, settled down in Tallinn and began to work as Senior Lecturer at the Pedagogical Institute of Tallinn. His activities in the field of physical anthropology stopped [7].

In the 1970s, Candidate of Medical Sciences Helje Kaarma, Assistant at the Department of the Obstetrics and Gynecology and a fellow student of Heino Tiik, became interested in physical anthropology. She contacted Heino Tiik, received from him the first instructions for measuring anthropometrical variables and resumed anthropological studies at the Faculty of Medicine. Candidate of the Physical and Mathematical Sciences Associate Professor Ene-Margit Tiit (later Professor and Head of the Department of Mathematical Statistics at the University of Tartu) helped Helje Kaarma as an advisor in mathematical statistics. Säde Koskel MSc did the calculations at the Computing Centre.

Kaarma [4, 5] applied more anthropometrical variables that represented many other parts of the body and she complemented the series of anthropometrical variables with new variables – the skinfolds. It was a very thorough multidimensional study. There are only few studies available for us that are more complicated [1, 2]. The skinfolds were measured with a standardized skinfold caliper. The hypotheses that there are the correlations between height and other anthropometrical variables and between weight and other anthropometrical variables were also proven by Kaarma [4, 5]. In this situation Kaarma made an essential novel corollary and named height and weight the leading variables among all the investigated anthropometrical variables.

The goal of the present study was to investigate the validity of the principle: whether there are correlations between height and other anthropometrical variables, and correlations between weight and other anthropometrical variables in the anthropometrical material the conscripts from the town of Tartu and Tartu County.

The second goal was to investigate whether there are correlations between body mass index (BMI) and other anthropometrical variables.

MATERIAL JA METHODS

The subjects of the present investigation were 739 seventeen-year-old conscripts from the town of Tartu and Tartu County. Measurements were taken of each subject in all 47 anthropometric variables. The total body weight was measured with Soehnle digital scales with the precision of 0.05 kg. During the anthropometric investigation the rules of Martin (Knussmann 1988) [6] were followed. The numbers for each anthropometric variable were as suggested by Knussmann (1988) [6]. Height measurements included 8 variables: height (1.4), suprasternale height (4), processus xipoideus height (4[1]), umbilical height (5), symphyseal height (6), acromiale height (8), dactylion height (11) and height of anterior superior iliac spine (13).

Breadth and depth measurements were as follows: biacromial breadth (35[1.10]), chest breadth (36) and depth (37), waist breadth (39), bicristal diameter (40), elbow breadth (52 [3] [11]), wrist breadth(52[4][11]), femur breadth (59d[12]) and bimalleolar breadth (59e). Abdomen depth was measured between umbilicus and processus spinosus columnae vertebralis lumbalis on the horizontal plane. Circumferences (n=16) were measured as follows: chest (61), maximum inspirational circumference (61a) and maximum expiration chest circumference (61b), waist (62), neck (63), hip (64 [1]), arm relaxed (65), arm flexed and tensed (65 [1]), forearm (66), wrist (67a), upper thigh (68), calf (69) and minimum ankle circumference (70). Pelvis circumference was measured laterally at the level of the iliac crests. The midthigh was measured in the middle of the distance between spina iliaca anterior superior and upper crest of patella. Head circumference was measured superior to the eyebrow line and encompassing the occipital protuberance. Skinfolds were measured as follows: chin (72b), chest (72c), midaxillary (72e), suprailiac (72g), supraspinale (the fold was picked up three-four centimeters above the anterior superior iliac spine on a diagonal line going downwards and inwards), subscapular (72d), abdominal (72f), biceps and triceps (72a), femoral (72i), calf (72j) and on the dorsal surface of the right hand. In measuring of skinfolds the recommendations of Lohman et al. [8] and Heyward and Stolarzcyk [3]were also followed. Skinfolds were measured twice and the values were averaged.

All the anthropometrical variables were measured on the right side.

Sternal length was calculated as suprasternale height (4) minus processus xiphoideus height (4[1]).

Abdominal length was derived as processus xiphoideus height (4) minus symphyseal height (6).

Trunk length was calculated as suprasternale height (4) minus symphyseal height (6). Upper limb length was calculated as acromiale height (8) minus dactylion height (11).

Lower limb length was calculated as sum of the heights of anterior superior iliac spine (13) and symphyseal height (6) divided by two.

Body mass index (BMI) was calculated as weight kg / (height m)^2.

The data were processed by the SAS for Windows version 6.12 software. The level of significance was set at $p < 0.05$.

RESULTS

It is interesting to note that in our material the correlations between height and other variables are statistically significant. However, the strongest are the correlations between height and three length variables – lower and upper limb and trunk length (r=0.86-0.61 p<0.001). The correlation between height and weight is by strong rank in the fifth place (r=0.45 p<0.001). The weakest are the correlations between height and skinfolds (r=0.14–0.03 p<0.001–p>0.05).

All the correlations between weight and other anthropometrical variables are also statistically significant. The strongest are the correlations between weight and proximal thigh, hip, chest pelvis, waist and arm circumferences (r=0.92–0.88 p<0.001). It should be noted that the correlation between weight and height are by strength on the 35th place (r=0.45 p<0.001) and all other length variables – trunk, upper and lower limb, sternum and abdomen length show the weakest correlations (r=0.41–0.16 p<0.001).

The correlation between BMI and weight were the strongest (r=0.91 p 0.001). It is essential to remark that the correlations between BMI and height, abdomen, lower limb length are not significant (r=0.05–0.02 p>0.05).

DISCUSSION

The present study demonstrated that in the material of conscripts of the town of Tartu and Tartu County the correlations between height and other measured anthropometrical variables really exist, and the same is the situation with weight – the correlations between weight and other measured variables are statistically significant.

Consequently, the results of the present study are in good concordance with the earlier studies of Tiik [9] about men and women students of Estonia and of Kaarma [4, 5] about women students at the University of Tartu.

Thus, our study confirms the hypothesis that height and weight are the leading variables in the system of the anthropometric variables of the body. It should be mentioned that the correlations between height and other anthropometrical variables are weaker as compared to the correlations between weight and other anthropometrical variables.

If to rank by strength the correlations between height and other anthropometric variables was the weight on the sixth place. If to rank the correlations between weight and other variables the height was on the 35th place.

As far as BMI is concerned, the correlations between BMI and other anthropometrical variables are nearly as strong as those with weight, but the correlations between BMI and height are not significant.

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THE TYPE OF *MENARCHE* AGE VARIATION AT GIRLS IN BELARUS

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ABSTRACT

With the purpose of studying variability of *menarche* age dependence terms in urban girls of the Minsk District, and also for carrying out the comparative analyses of time and territorial variability of this puberty attribute, during the complex anthropological research conducted by us, corresponding data on schoolgirls in Minsk (404 persons) and in Slutsk (425 person) were collected. The comparisons of occurrence frequencies in menstruating adolescent girls, depending on their age (12–15 years), have shown that, at the age of 12 years, the parameters of Minsk and Slutsk schoolgirls almost do not differ; in 13-year-old girls the corresponding territorial differences are maximal. By the age of 14 years, reductions in these differences were noted, and, at the age of 15 years, the attribute presence frequencies are again becoming closer. The share parameters of menstruating girls in Minsk and in Slutsk are higher than the data for other regions provided in the corresponding scientific sources. In comparison with 1967–1968, the age frequency maximum of menarche schoolgirls has moved from 12 to 13 years due to the percentage reduction in schoolgirls who first started menstruating at 11 years, and due to the increase in the portion of girls who started menstruating at the age of 13.

Key words: the period of puberty, the processes of acceleration.

INTRODUCTION

To find out the rules and define the tendencies of growth and development of children and teen-agers is one of the main branches of anthropological research in Belarus. The way, how exogenous factors impact on the physical development of the child, differs [1, 3]. Depending on the individual characteristics of the organism they may occur stimulating or having inhibitory influence on the growth and development of the child. The processes of the physical development in girls are closely connected. Nowadays, the researchers note the growth of the negative tendencies, among which is the decrease of inter-connection between sex maturation and the morphological state of the growing organism [6, 7]. Being an important stage in human onto-genesis, the puberty period is characterized by the changes in the hormonal status and significant morphological and functional trans-formations. The time, which that period takes and the velocity in growing the concentrations of sex hormones are characterized by huge variability. Professionals in pedagogic, medical, and sport profiles have to consider the degree of maturation of children's organisms.

The stage of bones, teeth, and reproductive system development are taken to be the criteria of the physiological maturation. *Menarche* (the time of the first menstruation) is a very informative sign in the girl's maturation in the teen-age period. The beginning of menstruations marks the transformation from prepuberty to the puberty period, with related changes in the organism.

MATERIALS AND METHODS

The data of the anthropological research of the teen-agers, living in Minsk (2003–2004 school year) and in Slutsk (2004–2005 school year), collected by our department, allowed us to analyze the tendencies of variations in the age of menarche in 12–15-year-old urban Belarusian girls. 829 schoolgirls were examined in total (404 in Minsk, 425 in Slutsk). The comparative analysis in the variations of the age of the first menstruation was done in the time aspect (from the end of the 1960s till 2005), as well as admitting the territorial variability of that sign in the girls of Minsk and Slutsk in comparison with the town of Miori

(Vitebskaia oblast) and Tartu (Estonia). The age groups were formed by the Martin method well known in anthropology. The information on the age of the first menstruation (*Me*) is obtained by the questionnaire.

RESULTS AND DISCUSSION

In each age group the quantity of girls, which already had the first menstruation was defined. The growth of the frequency of menstruating schoolgirls beginning from 12 till 15 year-olds is shown in Table 1. In the group of 12-year-old girls (until 12 years 6 months and 29 days) 21.0% of girls living Minsk and 21.6% girls living in Slutsk had *Me*, so the part of girls with early maturation, having *Me* at this age is practically the same.

Table 1. The age distribution of menstruating girls – teenagers in different regions in the end of the 1990s – beginning of the 2000s (in %)

Age, years	Minsk, Belarus *2003–2004 (T.V. Skrigan)*	Slutsk, Minsk district, *2004–2005 (T.V. Skrigan)*	Miori, Vitebsk district, *2002–2003 (L.I. Tegako, O.V. Marfina, T.L. Hurbo, 2004)*	Tartu, Estonia *the end of the 1990s (G. Veldre, 2003)*
12	21.0	21.6	3.7	12.1
13	55.0	49.0	25.4	27.3
14	82.1	80.0	60.4	69.6
15	94.4	95.1	92.7	87.6

The differences in the quantity of Me presented in Minsk and Slutsk teen-agers were more significant in the groups of 13 (until 13 years 5 months 29 days) and 14 years old (until 14 years 5 months 29 days), reached the maximum level in 13 y. o., when 55.0% of respondents in Minsk and 49% in Slutsk had *Me*. Among the 14-year-old schoolgirls that sign of puberty is fixed in 82.1% and 80.0% of the examined accordingly. The minimum increase in the part of menstruating girls is common for the period from 14 to 15 years, so at the age of 15 (up to 15 years 5 months and 29 days) the part of girls with *Me*, is 94.4% in Minsk and 95.1% in Slutsk (fig. 1).

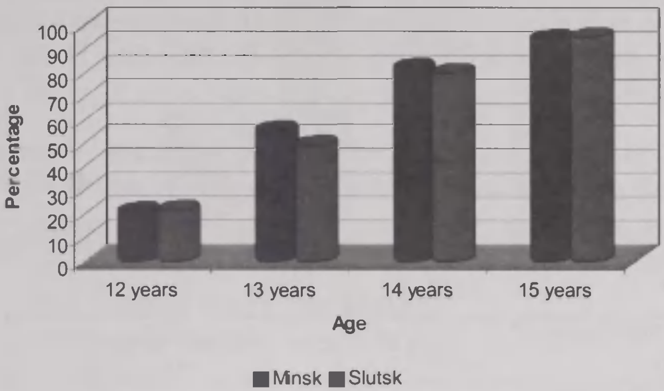

Figure 1. Percentage distribution of the menarche age in girls, living in Minsk and Slutsk in 2003–2005

The obtained results on the age distribution of menstruating girls are compared with the similar data on the girls from Miori, Vitebsk region, Belarus by L.I. Tegako [4], and girls from Tarty, Estonia by G. Veldre [8]. In each of the examined age periods (beginning from 12-year-old) the part of girls having *Me* in Minsk and Slutsk is higher than in Miori and Tarty (table 1), the maximum difference (6%) is seen at the age of 13. Among 14-year-old girls there is less difference in parts of girls with Me, and at the age of 15 it is minimum and the part of menstruating girls in Minsk and Slutsk are closer to that index in Miori. In the interval from 12 to 15 years total increase of the part of girls with *Me* in Minsk (73.4%) and Slutsk (73.5%) is quite closer to that index in Estonian schoolgirls (75.5%) and lower, than in Vitebsk region (89.0%).

The comparison of *menarche* age in the examined Minsk schoolgirls with the data related to 1967–1968, given in the works of Timanovich [5] allowed to trace the time variability of the sign (Table 2). The cases of the first menstruations to begin at 10 or 15 years in the modern schoolgirls and in the girls who lived at the end of the 1960s is not numerous, and these indices changed little in time. Reducing the part of girls with *menarche* through the period of 35 years in the 11-year-old age – from 10 years 6 months till 11 years 5 months 29 days – is more evident (5.3%), than in 12-year-old (1.4%). The part of modern girls, which began to menstruate at 13, had maximum increase (11.1%) relating to their teen-agers in the 1960s, and the maximum frequency of *menarche* transferred from 12 to 13 years. The difference in this index at 14 is less (4.6%).

Table 2. The age distribution in the frequency of the first menstruation in Belarussian girls at the end of the 1960s – beginning of the 2000s (in %)

The place and years of research	Age					
	10 years	11 years	12 years	13 years	14 years	15 years
Minsk, 2003–2004 (T.V. Skrigan)	1.5	9.7	30.9	42.0	14.1	1.9
Slutsk, 2004–2005 (T.V. Skrigan)	0.4	7.4	35.5	39.3	15.7	1.7
Minsk, 1967–1968 (N.K. Timanovich, 1971)	1.0	15.0	32.3	30.9	18.7	2.2

The average age of the first menstruation was defined on the data of our research. In modern girls from Minsk it is 12 years 7.5 months, and a little bit higher in Slutsk – 12 years 8 months. The frequencies of girls, who began menstruating at 10 and at 15 years are low, in Minsk those are 1.5% and 1.9% accordingly. Among the schoolgirls of Slutsk were only 0.4%, or one case when the first menstruation began at the age of 10, and 1.7% – at the age of 15 years. At the age of 11 years, *menarche* appeared in 9.7% of girls from Minsk and in 7.4% of girls from Slutsk. After this index grows to 30.9% and 35.7% accordingly at the age of 12, and reaches its maximum at the age of 13 years: 42.0% and 39.3%. Beginning of *menarche* at 14 years was much more rare – only in 14.1% of Minsk and 15.7% of Slutsk schoolgirls.

The regional samples of menstruating girls were distributed by the age and the according percentage of *menarche* (fig. 2).

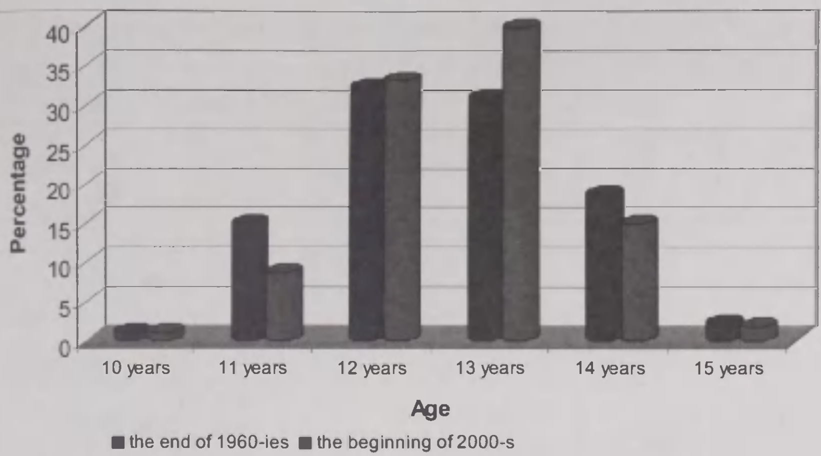

Figure 2. The age dynamics of the first menstruation in Belarussian girls at the end of the 1960s – beginning of the 2000s

The comparison with the similar data on Minsk schoolgirls of the 1990s, published in the works of I.I. Salivon [2], and the data by N.K. Timanovich of the 1960s showed, that in modern girls of Minsk, examined by us the average age of the first menstruation is nearer to those, fixed in the 1960s (12 years 7 months), and three months less, then in schoolgirls of the 1990s (12 years 10,5 months). So, the age of *menarche* which became slightly higher in the 1990s, changed by more early beginning of menstruations in the 2000s, thus appears closer to the meanings of the 1960s.

One year interval distribution of age frequencies of the *menarche* beginning in the examined girls of Minsk and Slutsk showed the acceleration of the first menstruation starting terms in younger age groups comparing with older (Table 3). The marked tendency is significant in Minsk schoolgirls in the intervals of 11, 12 and 13 years, and in Slutsk – in 12 and 13 years.

Table. 3. The age frequency in terms of *menarche* beginning in 12–15-year-old schoolgirls of Minsk and Slutsk (in %)

City	Age, years	One year intervals					
		10 лет years	11 лет years	12 лет years	13 лет years	14 лет years	15 лет years
Minsk	12	1.0	8.0	12.0*	–	–	–
	13	0	5.5	26.4	22.7*	–	–
	14	0.9	6.6	21.7	43.4	9.4*	–
	15	0.9	5.6	17.8	39.3	26.2	4.7*
Slutsk	12	0	4.0	17.0*	–	–	–
	13	0	4.0	25.3	19.2*	–	–
	14	0	6.1	25.3	42.4	6.1*	–
	15	1.0	4.1	19.2	34.3	32.3	4.1*

** The growing of frequency is possible in the age group until all the girls reach the next age*

SUMMARY

Thus, during the examination of *menarche* terms in Belarusian teen-age girls showed that the percentage of 12 and 15 year old Minsk and Slutsk schoolgirls, having *menarche,* practically do not differ. The differences are more evident in 13-year-old teen-agers (until 13 years 5 months 29 days) and in 14 years (until 14 years 5 months and 29 days), reaching the maximum level in 13-year-old girls.

Thus, girls in Minsk and Slutsk become woman-grown earlier than girls from Miori and Tartu. The value of the average increase (from 12 to 15 years) of the part of menstruating girls in the Minsk region is lower than in Vitebsk, and is near to the index, registered in Estonian schoolgirls.

The highest frequency of *menarche* is noted at the age of 12 and in 13-year-olds (from 11 years 6 months, until 13 years 5 months 29 days). The maximum of the first menstruation in modern Buelorussian girls, transferred from the age of 12 to 13 years in comparison with the data of the 1960s.

The average age of *menarche* is three months earlier in the modern girls of Minsk in comparison with the schoolgirls of the 1990s, and is more similar by that sign with the teenagers of the 1960s.

Taking into account, that the age of *menarche* at one point shows the dynamics of the acceleration processes, and at the other point is influenced by the ecological factors, it is necessary to monitor the variations in the terms of the first menstruations, as well as the time, age and territorial variability of this index.

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OBSERVATIONS ON THE UNKNOWN QUETELET INDEX W^2/H^5

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Abstract

In his famous work "Sur l'homme et le développement des ses facultés" published in 1835 Adolphe Quetelet has mentioned a relation between the square of body weight (W) and the fifth power of body height (H), which he supposed to be valid during the phase of bodily development [1]. This index has obviously been neglected in scientific publications so far. Data for W and H from Quetelet's original publication covering males and females from birth to the age of 80 years were used, but confined to ages from 3 to 18. These data served to estimate index W^2/H^5. Its relation with age was markedly nonlinear; it showed a steady decrease during early childhood up to the age of approximately 10 years, followed by an increase till adulthood. This relation was best expressed by a quadratic or cubic regression equation, the cubic one being slightly better with respect to the sum of squares of the residuals. The minima were found at the ages of about 10 to 11 years. This may well match with the adiposity rebound [2]. The Quetelet's assumption, however, could not in the least be confirmed.

Key words: Weight-height index, Quetelet, history

The famous Belgian scientist Lambert Adolphe Jaques Quetelet (1796 – 1874) is best known for having discovered and first described the relation between body weight (W) and the square of body height (H) in the mid nineteenth century, which is now also being called "body mass index" or the Quetelet index. Quetelet has also used the simple quotient between body weight and height W/H in his studies, which is occasionally called the Quetelet index, as well. Interestingly, he has mentioned still another relation between the square of body weight and the fifth power of body height. He supposed that this relation W^2/H^5 would be valid during different stages of bodily development ("*... pendant le developpement, les carrés des poids aux différentes ages sont comme les cinquièmes puissances des tailles*"). However, neither did he present examples nor have later researchers obviously tried to verify or disprove his conjecture.

The aim of this study was to show whether Quetelet's hypothesis would be substantiated.

MATERIAL AND METHODS

Data for W and H were taken from Quetelet's original publication, which covers male and female individuals from birth to their eighties. The data of children between 4 and 12 years had been taken in Brussels on schoolchildren and on the children from an orphanage, those of adolescents at the university and a medical school. Quetelet has noted already that there was a possible bias caused by the fact that all weights were taken on fully dressed individuals, and also because the young people more often came from upper social classes. He corrected the weights by subtracting the known constant figures for the weight of clothing, and also by using age specific W/H-index figures, which were based on a large sample of persons from different social classes. In this study only the corrected data for the children and adolescents between 3 and 18 years of age were used (Table 1).

Table 1. Height H (m) and weight W (kg) of children and adolescents aged 3 to 18 years published by Quetelet (original and corrected)

	male				female			
age	H orig	H corr	W orig	W corr	H orig	H corr	W orig	W corr
3	0.860	0.846	13.21	12.47	0.850	0.852	12.45	11.79
4	0.932	0.928	15.07	14.23	0.910	0.915	14.18	13.00
5	0.990	0.988	16.70	15.77	0.974	0.974	15.50	14.36
6	1.046	1.047	18.04	17.24	1.032	1.031	16.74	16.00
7	1.112	1.105	20.16	19.10	1.096	1.086	18.45	17.54
8	1.170	1.162	22.26	20.76	1.139	1.141	19.82	19.08
9	1.227	1.219	24.09	22.64	1.200	1.195	22.44	21.36
10	1.282	1.275	26.12	24.52	1.248	1.248	24.24	23.52
11	1.327	1.330	27.85	27.10	1.275	1.299	26.25	25.65
12	1.359	1.385	31.00	29.82	1.327	1.353	30.54	29.82
13	1.403	1.439	35.32	34.38	1.386	1.403	34.65	32.94
14	1.487	1.493	40.50	38.76	1.448	1.453	38.10	36.70
15	1.559	1.546	46.41	43.62	1.475	1.499	41.30	40.37
16	1.610	1.594	53.39	49.67	1.500	1.535	44.44	43.57
17	1.670	1.634	57.40	52.85	1.544	1.555	49.08	47.31
18	1.700	1.658	61.26	57.85	1.562	1.564	53.10	51.03

Table 2. Results for quadratic and cubic regression models for index W^2/H^5 vs age for boys and girls 3 to 18 years old

model		R^2	SS(res)	const	age	age^2	age^3
quadratic	male	0.982	528	445.0	–46.77	2.07	
	female	0.960	844	397.6	–40.05	1.85	
cubic	male	0.985	438	468.8	–55.97	3.06	–0.032
	female	0.976	506	443.9	–57.93	3.78	–0.061

RESULTS

The index means are 226.2 and 220.9 for boys and girls, respectively, with a wide range (148 and 132). The distribution is not normal (Kolgomorov-Smirnov 0.136 and 0.167, each $p>0.05$). There is no statistically significant difference between the index means of boys and girls ($p>0.05$) and no linear correlation with age (Pearson $r = -0.359$ and -0.143 for boys and girls, respectively; each $p>0.05$). Figure 1 shows that the relation between the index and the age is markedly nonlinear for boys and girls likewise.

From all the curve estimation models tested the cubic model had the best correlation (and the lowest sum of squares of the residuals SS(res)), but the quadratic one was only somewhat inferior (Table 2).

Figures 3 and 4 show the fitted lines for the cubic correlation between the age and index W^2/H^5, together with 95% confidence limits, for boys and girls. The estimated minima for the quadratic model are 11.3 and 10.8 years for boys and girls, respectively, as well as 11.0 and 10.2 years, respectively, for the cubic model. In both models the depression in the curves for girls became apparent at an earlier age than for boys.

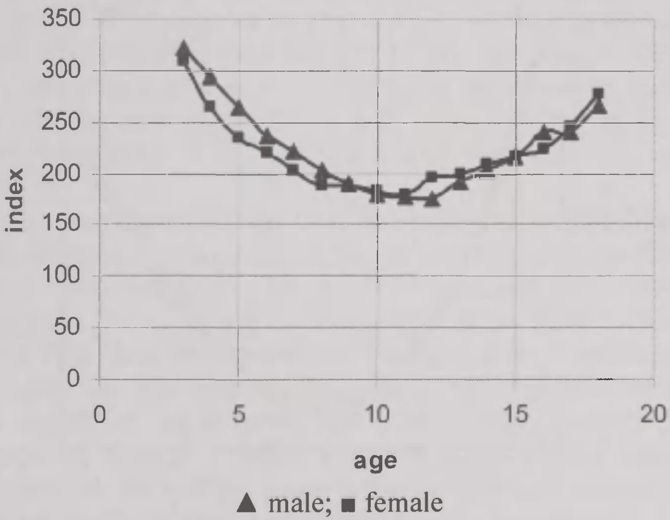

Figure 1. Age vs index W^2/H^5 for boys and girls aged 3 to 18

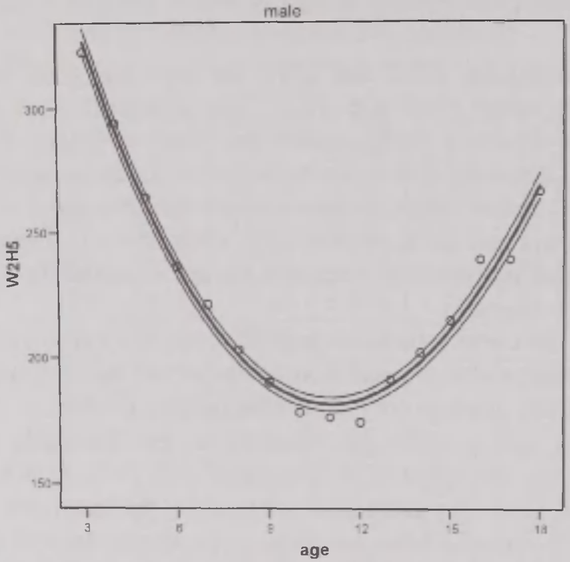

Figure 2. Cubic correlation with 95% confidence intervals between index W^2/H^5 and age for boys 3 to 18 years

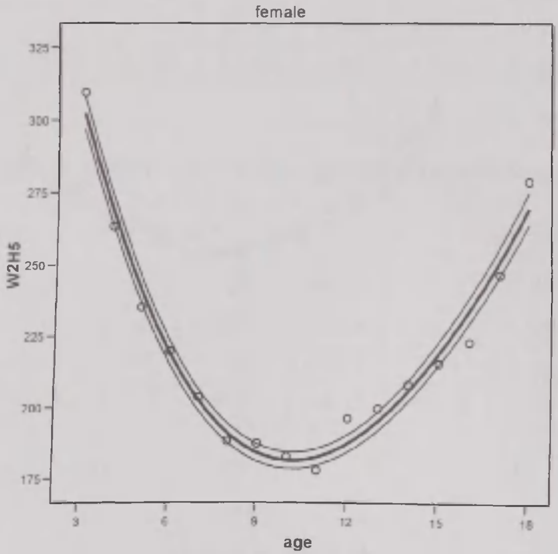

Figure 3. Cubic correlation with 95% confidence intervals between index W^2/H^5 and age for girls 3 to 18 years

DISCUSSION

During his most industrious scientific life Adolphe Quetelet has been a master of calculus. In his treatise on the faculty of man he devoted a special chapter to "The relation between weight and height", where he also mentions that during development the squared body weight is related to the fifth power of body height. Whether he has studied this relation in detail, is not known, at least he did not offer a single example for his assumption. It seems that Quetelet himself was not fairly confident of the validity and the robustness of the proposed index, because he modified his statement by saying that "one would, in general, not be far from truth" with this assumption ("... *En general, on s'écarte peu de la vérité, en posant que*...).

Looking at the change in the index values over several ages (from 3 to 18 years) revealed an unexpected behaviour of the W^2/H^5 index with age: there was a steady drop in the younger child, which suddenly changed into a noticeable increase at the very beginning of adolescence. This is unquestionably related to what has now become known as "adiposity rebound" [2], the time, where during the development of a child the body mass index begins to increase. The close relation between the estimated adiposity rebound age and the minimum age estimated from index W^2/H^5 should not be a big surprise, because in the former the rebound age is estimated from index W/H^2 and this must be expected to produce the same results as $W/H^{2.5}$, which is the square root of W^2/H^5. Indeed, rebound ages obtained from W/H^2 were the same as the minima obtained from index W^2/H^5 (11.3 and 10.8 years for boys and girls, respectively).

One can only speculate why Quetelet did not notice the phenomenon of a decreasing/increasing index with age. But in his data he has always only seen increasing figures for weight, height, and W/H with age. In the proposed index, however, there were high figures throughout, perhaps a little bit higher for the very young than for the older ones and again higher for adolescents. This might have looked to him like a normal variability of a mean that was constant over the whole developmental phase of a child. In essence he has rightly observed the non-linearity of the relation index versus age, but he was mistaken in considering the flat minimum of a parabola to be a constant.

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SECULAR TRENDS IN ANTHROPOMETRICAL MEASUREMENTS OF INFANTS IN LATVIA

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ABSTRACT

The aim of the presented study was to find secular trends for newborns' height and weight at birth dynamics over the century in Latvia. Over the last 79 years six research papers about newborns in Riga – the capital of Latvia – have been published. The results of those different researches conducted in different periods of time were compared. The comparison of data was more difficult as the overall differentiation ratios used in other respective researches were not specified (the standard deviation, the standard error or something else). To make a comparison of the nutritional status the possible Rohrer index within each research was calculated.

The research studies conducted in the first third of the last century had large research samples – a great number of new-borns was surveyed. That is the reason for small overall differentiation ratios. In the latest studies the number of the surveyed new-borns was considerably smaller, which causes the appearance of a greater standard deviation. However, no tendency to increase or decrease for the new-borns' body mass arithmetic mean was observed during the considered research studies. In addition, we found out that new-born boys in Latvia get burlier over time.

The question: which dominants in causing changes in anthropometric measurements over time – the environment or hereditary – are still open.

Key words: newborns, height, weight, the Rohrer index

INTRODUCTION

In Latvia, the demographic situation has shown the downward tendency since year 1920. As in most Central and Eastern European countries, political changes in the early 1990s have contributed to the deteriorating birth rates and the natural increase in the last decade (Figure 1). According to the data from the Health Statistics Department, the birth rate has decreased from 21.87 in 1920, to 9.7 in 2006 [6, 9, 17]. During the last years the demographic situation has been improving slowly; however, still it has not reached the zero level.

Numerous studies have been conducted regarding the secular trends of the anthropometrical measurements of infants in the world. The most important anthropometrical measurements of newborns are body weight, body length, head and chest circumference. Researchers have pointed to the increasing out-of-date standard curves of the newborns' anthropometric measurements and it is suggested to conduct the control of the most important parameters every 10 to 15 years [16].

Over the last 79 years, six scientific research papers have been published regarding the anthropometrical measurements of newborns in Riga – the capital of Latvia.

The aim of the presented study was to assess the secular trends for the newborns' height and weight at birth dynamics over the century in Latvia by collecting and comparing the published data of the anthropometrical measurements of the newborns in Latvia from 1928 to 2006.

MATERIAL AND METHODS

The longitudinal study was carried out in the Riga Maternity Hospital from December 2004 until January 2006. The study included anthropometric measurements of 503 (256 girls and 247 boys) healthy newborns of gestation 36–41 weeks. Most of the infants were from singleton pregnancies, there were only 2 pairs of twins, 63.3% of the infants were born in the 1st delivery, 29.9% in the 2nd delivery, 4.9% in the 3rd delivery, 1.7% in the 4th and 0.2% (1 infant) in the 5th delivery of the mother.

The following anthropometric data were collected: body weight in grams and body length in centimetres. The measurements were taken within 24–48 hours after delivery. The results were documented in an inquiry form. Body length was measured using a Martin metal anthropometer in cm (±0.1) and body weight was measured with medical electronic scales (±0.05) kg), which are yearly re-calibrated by metrological authorities.

Secular changes in the body dimensions of newborns from different research studies conducted on different periods of time were gathered. The data about the weight and the length of newborns have been acquired from the following publications by: Āboliņš (1928–1938) [2]; Eikens (1929–1936) [5]; Segleniece (1970) [12]; Andrejeva, Gololobova (1973) [1]; Krūmiņa (1996–1997) [8]. (Table 1).

For the comparison of the data the statistically-descriptive method has been used. The Rohrer index of a newborn was calculated according to the formula: The Rohrer index = weight / length^3 * 100.

The data were processed by the means of SPSS / PCT software.

The study was approved by the Ethical Committee of Riga Stradins University.

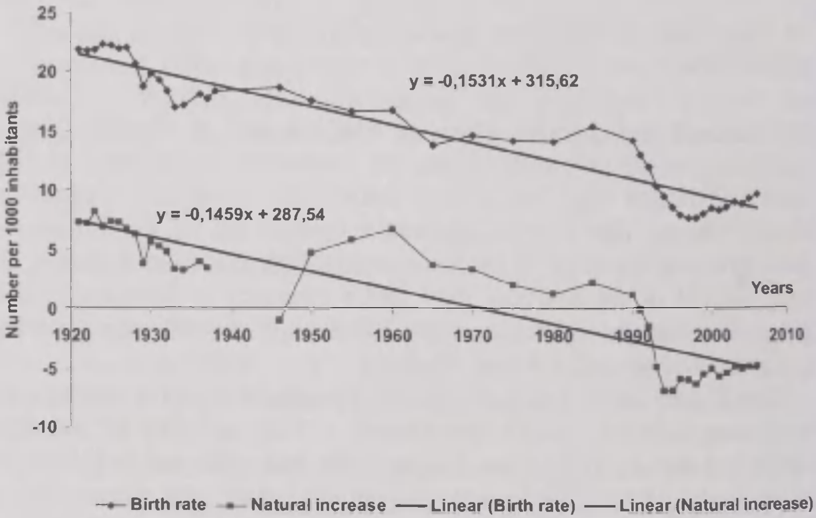
RESULTS

The research results are shown in Table 1 and in Figures 2 to 7. According to the obtained results, the newborns' mean value of body mass and length does not have a statistically significant tendency to change into any direction (to increase or to decrease, i.e. the direction of the regression equation is close to zero) (Figure 6). For instance, the body weight of the newborn girls had a tendency to decrease by 0.43 grams in a year from 1928 to 2006. For boys this tendency is even less explicit – 0.13 grams in a year (Figure 5).

The Rohrer index has had a positive tendency over the last century, increasing from 2.65 / 2.64 (girls/ boys) in 1928 to 2.69 / 2.73 in 2006 (Figures 4 and 7). The lowest Rohrer index was observed in 1970 when it dropped to 2.42 / 2.47 (girls / boys). The study did not reveal any specific reasons for such a decrease.

Table 1. Descriptive Statistics of the Weight (g) and Length (cm) of Newborns in the Study of Various Authors

Author	Number of newborns	Period of study	Body weight (g)		Body length (cm)		Rohrer index	
			Girls	Boys	Girls	Boys	Girls	Boys
Āboliņš	10.100	(1928–1938)	3,521 ± 11	3,659 ± 11	—	—	—	—
Eikens	5,043	(1929–1936)	3,428 ±8	3,562 ±9	50.6 ±0.04	51.3 ±0.4	2.65	2.64
Segleniece	746	(1970)	3,386 ±10	3,580 ±10	51.9 ±0.15	52.53 ±0.13	2.42	2.47
Andrejeva, Gololobova	200	(1973)	3,432 ±155	3,431 ±131	50.9 ±1.4	51.0 ±1.5	2.60	2.59
Krūmiņa	368	(1996–1997)	3,430 ±50	3,570 ±30	50.4 ±1.4	51.1 ±1.5	2.68	2.68
Oginska	503	(2004–2006)	3,467 ±53	3,659 ±32	50.5 ±1.7	51.2 ±1.3	2.69	2.73
Average			3,455 ±55	3,576 ±43	50.6 ±1.5	51.1 ±1.4	2.67	2.68



** from 1939–1946 no data available*

Fig. 1. Birth Rate and Natural Birth Increase by Years in Latvia

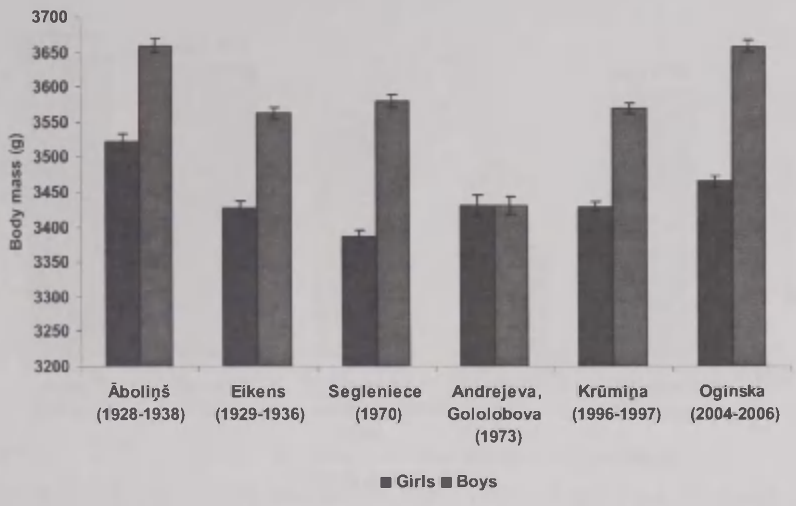


Fig. 2. The Mean Value of the Weight of Newborns in the Study of Various Authors

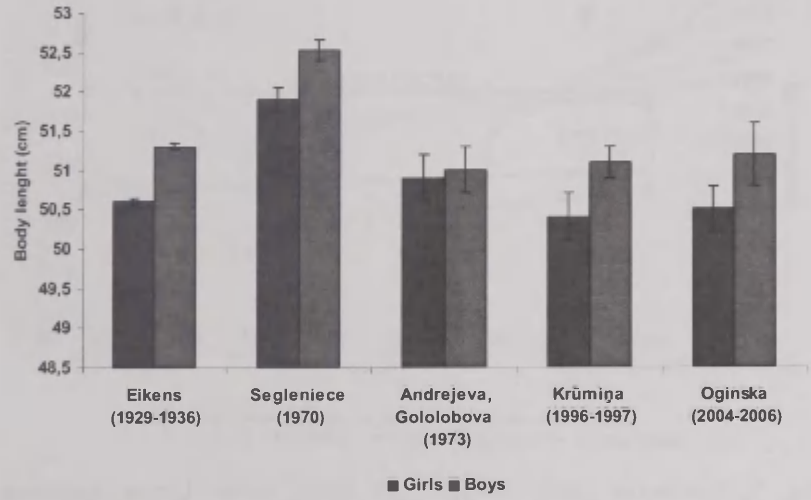


Fig. 3. The Mean Value of the Length (cm) of Newborns in the Study of Various Authors

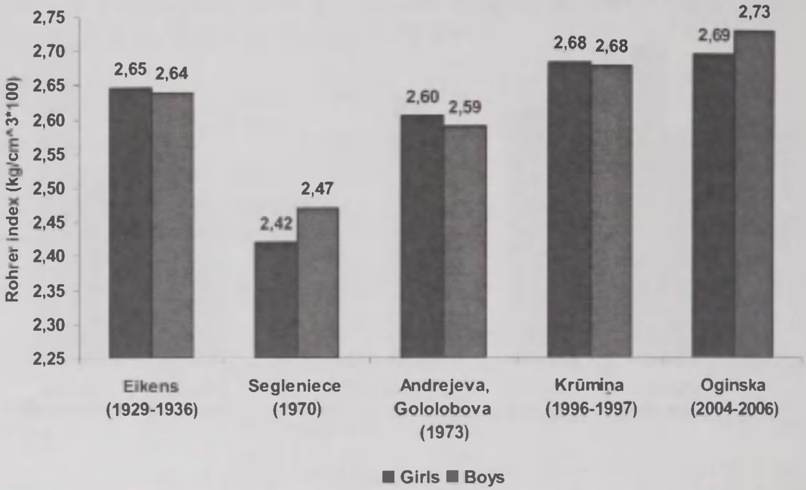


Fig. 4. Mean value of the Rohrer's Index (kg/cm^3*100) for Newborns in the Research of Various Authors

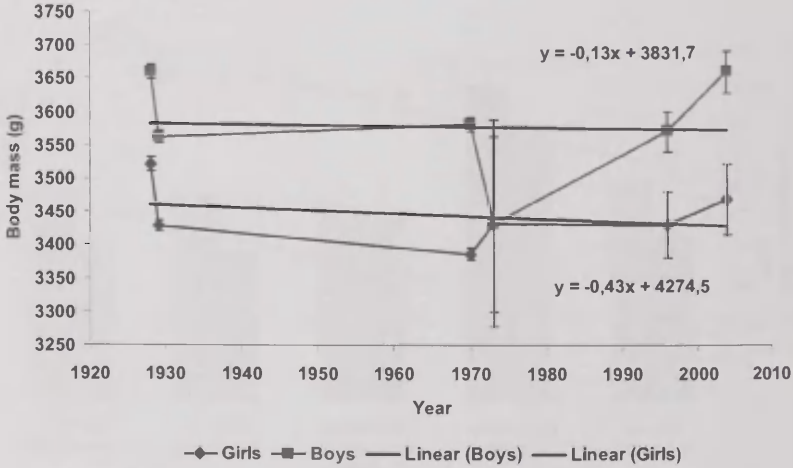


Fig. 5. Newborns' Body Weight (g) Mean Value Linear Regression Analyses and Equations in Relation to the Gender

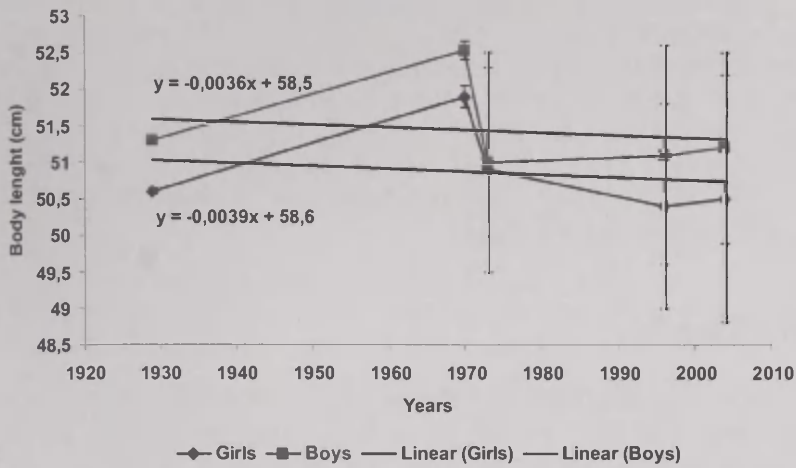


Fig. 6. Newborns' length (cm) Mean Value Linear Regression Analyses and Equations in Relation to the Gender

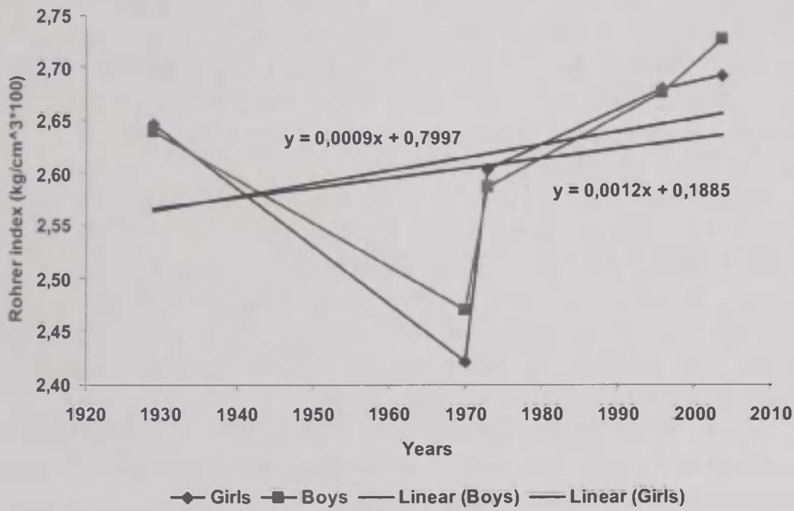


Fig. 7. Mean Value of Rohrer's Index ($kg/cm^3 \times 100$) Linear Regression Analyses and Equations in Relation to the Gender

In the research of the first third of the last century a comparatively large number of newborns was surveyed (746–10,100) and therefore the data differentiation ratios are small. In the latest studies (starting from 1973) the number of surveyed newborns was considerably smaller (200–503), which caused the appearance of a greater standard deviation. The comparison of data is difficult because it is not known what value the authors show as data dispersion ratio (the standard deviation, the standard error or anything else).

DISCUSSION

Studies of secular trends in anthropometrical measurements changes of newborns have been carried out in many countries covering different periods, methods and sample sizes. The specifics of our study were to assess the secular trend over almost a century in comparison to most of the studies which cover periods up to 30 years.

In comparison, the Japanese research of secular trends between 1962 and 1988 of 6,563 newborns showed that the boys consistently exceeded the girls in all four variables – weight, height, head and chest circumference. Newborns' weight and height increased significantly from the 1960s to the 1970s, but did not differ between the 1970s and the 1980s in both boys and girls. Also, these findings suggest that changes in newborns' sizes are influenced by environmental changes such as socio-economic improvements [10].

Researchers from Croatia were studying the trends in birth weights of 959,591 newborns in the period between 1991 and 1995. The authors divided the period of study in the pre-war, the war and the post-war sub-periods. The study revealed positive secular changes in the pre-war and post-war period in contrast to the negative changes during the war period. The findings indicate a relation between war suffering and the changes in birth weights of newborns [3].

Secular trends of fetal growth from 1981 to 1997 were described and analyzed in Canada. The authors of the study concluded that the infants born at the term are getting bigger [15].

Changes in birth weight, crown-heel length and head circumference of 10,032 Chinese newborns were analyzed between 1982 and 2000.

The study revealed a significant secular trend to increased birth weight, for crown-heel length and head circumference [7].

The study from the neighbouring country Lithuania analyzed the body size of 3,281 (1,705 boys and 1,576 girls) infants born in the period from 1974 to 2004. The study showed the trend that newborns became longer, but not relatively heavier. The mean body length was 52.8 / 52.19 cm (boys / girls), the body weight – 3,589 / 3,454 g [14].

A secular study was also carried out in Russia, where anthropometrical measurements were analyzed in total of 1,174 infants born between 1987 and 2002. The sample was divided into three geographical localities – two big cities and one town. The research revealed that the body length and weight for the period under investigation increased in the big cities, while in the town there was a significant decrease of the body length for boys and the downward trend of body weight for both girls and boys. The authors assumed that the changes in the anthropometrical measurements have been influenced by socio-economic changes [13].

The secular study conducted in Denmark covering the period from 1973 to 2003 revealed similar results as our study, indicating that newborns have become bigger with a larger relative increase in body weight than body length. These changes may have been caused by increased maternal mean weight, which could further promote the obesity [11].

The study carried out of 32,062 Israeli neonates in the period from 1986 to 2004 revealed that newborns are getting bigger and taller. The authors were focusing on analysing secular trends in fetal growth. The study showed that the term newborns have significant increase in the mean crown-heel length and head circumference [4].

The studies conducted over shorter periods of time as discussed above showed the increasing trend of body weight and body length. However, our study covering 79 years of data revealed an overall downward tendency in the body size dimensions of newborns.

CONCLUSIONS

In spite of different factors such as economic growth, rise in living standards, environmental pollution, and other factors, the secular trends for the arithmetical mean height and weight of newborns basically have not changed during the period from 1928 to 2006. According to the Rorher's Index nowadays newborns have become comparatively burlier.

ACKNOWLEDGEMENTS

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GROWTH FACTORS, NEUROPEPTIDE-CONTAINING INNERVATION, CELL ADHESION MOLECULES AND APOPTOSIS IN HUMAN FIBROUS ADHESIONS OF DIFFERENT LOCALIZATION

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ABSTRACT

Introduction. Adhesions occur in more than three fourths of patients after laparotomy following by numerous serious complications. Thus pathogenesis of adhesions still is the research field and the aim of our work was to reveal the growth factors, neuropeptide-containing innervations, cell adhesion molecules, and apoptosis in human intact and fibrous peritoneal tissues of different adhesion sites.

Materials and methods. Fibrous adhesions were obtained from eight 10–14 years old patients. Tissues were proceeded for bFGF, FGFR, NGF, NGFR, TGFβ, PGP 9.5, VEGF, VIP, SP, ICAM-1, VCAM-1 immunohistochemically. TUNEL was used for the detection of apoptosis.

Results. All the tested areas showed a high expression of FGFR and NGFR, but bFGF and NGF were low or negative. TGFβ-containing structures were richly distributed in the connective tissue of adhesions (except the small intestine area) and in intact peritoneum. Numerous to abundant PGP 9.5-containing nerves were detected only into the adhesions. Occasional SP positive nerves were observed only in all the adhesions, while VIP fibres here were slightly increased. VEGF was richly expressed by endothelial cells in appendix adhesions, notable in small intestine adhesions, but almost negative in large bowel adhesions and intact peritoneum. Numerous to abundant ICAM-1 and VCAM-1 expression was observed regionally in all the materials. Apoptosis affected regionally connective tissue cells, changed in shape mesothelial cells in adhesions and some cells in intact peritoneum.

Conclusions. The inhomogeneous appearance of TGFβ and VEGF suggests about the individual variations in expression of these growth factors in adhesions. The abundant expression of ICAM-1 and VCAM-1 in endothelium and mesothelium proves the involvement of these adhesion molecules in functioning of blood vessels and simple squamous epithelium of adhesions. Increased occurrence of neuropeptide-containing nerves and NFGR also indicates the increased role of innervation in adhesions. However, PGP 9.5-containing innervation does not cover the appearance of VIP- and SP-nerves and also seems to include other neuropeptides in the pathogenesis of adhesions. Regional apoptosis is speculated to depend on the local expression of growth factors, inflammatory mediators and tissue degradating enzymes. The distribution of growth factors, neuropeptide-containing innervation and apoptosis do not depend on the adhesion site.

Key words: *growth factors, innervation, cell adhesion, apoptosis, adhesions, children*

INTRODUCTION

The similar European, US and Latvian statistics demonstrated that adhesions occur in more than three fourths of patients following laparotomy. There are more than 90% of the patients following major abdominal surgery and in 55–100% of the women undergoing pelvic surgery [16]. Commonly, postoperative adhesions are found in 10% of patients after only one laparatomy, but multiple laparatomies are following by intra-abdominal adhesions in 93% of persons [18]. Peritoneal adhesions are the leading cause of pelvic pains and dysfunctioning of pelvic organs [19] and are the reason of serious complications like intestinal obstruction [30] and infertility [28]. Additionally, adhesioleson used for the surgical treatment of adhesions, often remains problematic [6]. The effects of adhesions are unpredictable but are wide ranging, causing a significant health care burden [20].

The mechanisms, underlying the predisposition to form adhesions, are completely unknown. However, studies in recent years have improved the understanding of the pathogenesis of adhesions and led to the molecular level of the biologically active molecules regulating inflammatory, immune processes, angiogenesis and tissue remodelling events with the participation of growth factors, cytokines, chemokines, proteases and extracellular matrix [5]. Also, cell growth, differentiation and cell death, apoptosis are mentioned to play an important role in adhesioformation. Some authors have tried to detect the phenotype of this pathology and described reduced plasminogen activator activity, increased angiogenesis and cytokine production, extracellular matrix deposition, but reduced apoptosis [11, 22]. Controversial are the data about the role of innervation in the affected places. So, the increased growth of nerves seen in human and animal adhesions [10, 24] is opposite to the data of Tulandi et al. [1998), who did not find any correlation between the nerves and this pathology [29].

Although understanding of the pathogenesis of adhesions has improved recently, there are many unclear questions in the molecular level to be solved. So, it is not still clear whether molecular pathogenetical mechanisms are equally strong in all the sites of abdominal adhesions and whether intact peritoneum is really such morphologically. The correlations between the distribution of biologically active substances in the different places of adhesions of one and the same patient and such correlations between the patients are not clear. Thus the aim of our research was to investigate tissue growth factors, neuropeptide-containing innervation, cell adhesion molecules and apoptosis in human fibrous adhesions in different sites and to correlate the obtained data.

MATERIALS AND METHODS

Fibrous adhesions from small intestine, appendix, large intestine and intact peritoneum areas were obtained from eight 10–14-years old patients during a surgical procedure. Tissues were fixed in Stefanini's solution, embedded in paraffin, and sectioned into 5 μm thick slides. For each adhesion site routine staining with haematoxylin and eosin was performed.

For adhesions innervation evaluation, immunohistochemistry (IMH) [9, 13] with antibodies against nerve growth factor receptor p75 (NGFR, Mouse/ M3507/262, working dilution 1:150, DakoCytomation, Glostrup, Denmark), nerve growth factor (NGF, Rabbit/ab6199, 1:500, abcam, UK), protein gene product 9.5 (PGP 9.5, Rabbit/Z5116, 1:150, DakoCytomation, Glostrup, Denmark), vasoactive intestinal peptide (VIP, Rabbit/ab22736, 1:400, abcam, UK), substance P (SP, Mouse/ab14184, 1:1000, abcam, UK) was performed. From growth factors and their receptors antibodies for basic fibroblast growth factor (bFGF, Rabbit/ab16828, 1: 200, abcam, UK), fibroblast growth factor receptor one (FGFR1, Rabbit/ab10646, 1:100, abcam, UK), transforming growth factor beta (TGFβ, Mouse/b1279, 1:1000, abcam, UK), vascular endothelial growth factor (VEGF, Mouse/M7273, 1:50, DakoCytomation, Glostrup, Denmark) were used, but for cell adhesion molecules intracellular adhesion molecule (ICAM-1, goat, (CD54)AQX02, 1:300, RD systems, UK), Vascular Cell Adhesion Molecule-1 (VCAM-1, goat, (CD106)/AQY01, 1:1000, RD systems, UK) were performed. The following semiquantitative evaluation for IMH was used: 0 – no positive structures found in the visual field, 0/+ – occasional positive structures seen in the visual field, + – few positive structures seen in the visual field, ++ – moderate number of positive structures seen in the visual field, +++ – numerous positive structures seen in visual field, ++++ – abundance of positive structures seen in the visual field.

For apoptosis detection, terminal deoxynucleotidyl transferase-mediated deoxyuridinetriphosphate nick end-labelling (TUNEL) using *in situ* cell death detection kit (Roche Applied Science, Penzberg, Germany) was performed [8].

RESULTS

The abundance of blood vessels and chaotically orientated connective tissue bundles were seen in the adhesion regions (Fig.1). Neo-angiogenesis was observed almost in all the adhesion affected tissue. Some blood vessels demonstrated sclerotic changes with the increase of smooth muscle cells into the wall. Mesothelial cells of different form starting from very flat to a round one were observed within one and the same adhesion area including intact peritoneum (Fig. 2). Inflammatory cells were seen mainly in the lumen of blood vessels. However, some neutrophils and lymphocytes were observed in the perivascular area, but macrophages – in the same adhesion regions beneath the mesothelium.

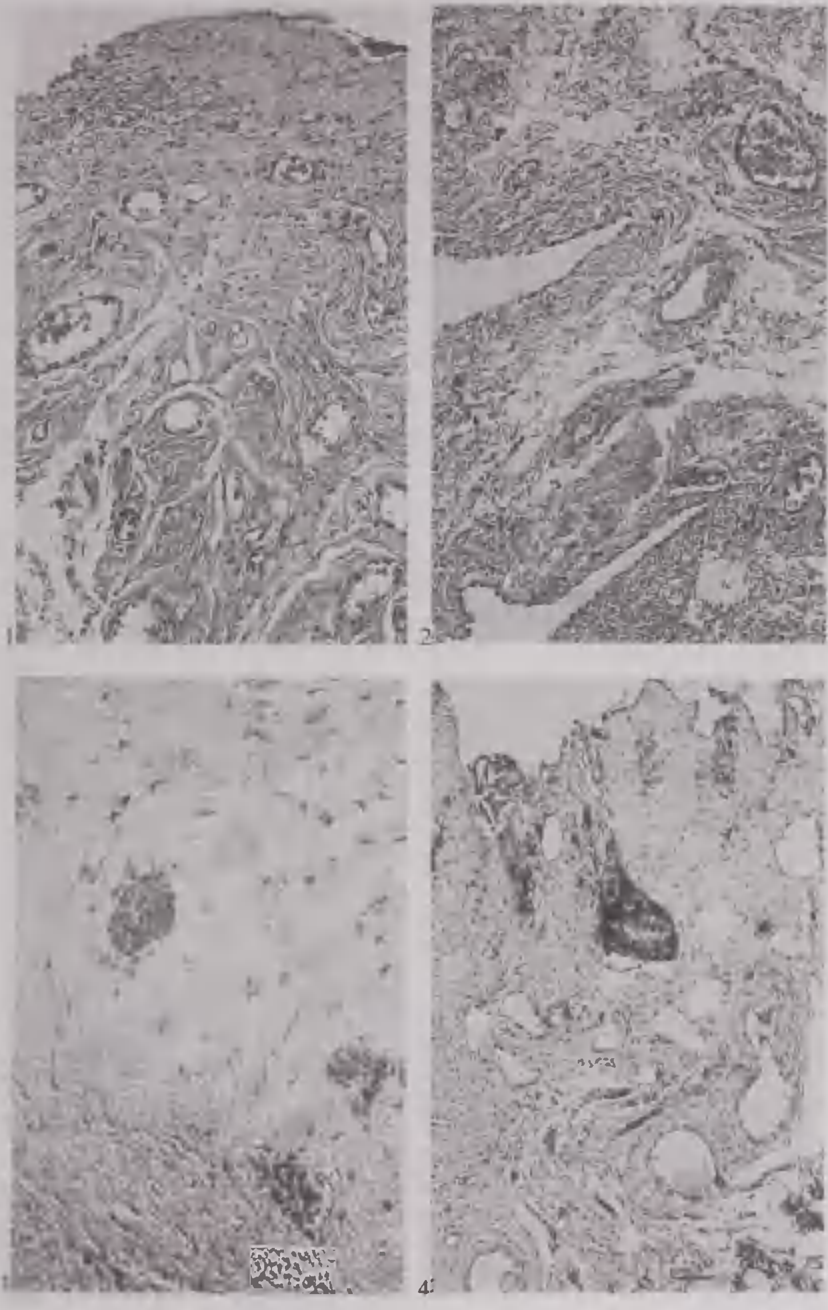
The generally abundant expression of FGFR1 seen on connective tissue cells and fibers with occasional or few positive for the same factor connective tissue cells in the adhesions of all the tested areas did not differ from such a distribution in the intact peritoneum. A similar situation was detected for the appearance of NGFR and NGF when generally receptors were much more expressed than the same NGF. However, the distribution of the NGFR was observed to be more abundant in adhesions while the intact peritoneum showed only a numerous number of receptors (Table 1).

Interestingly, the TGFβ marked abundance of structures – connective tissue cells, fibers, endothelial cells, mesothelial cells, smooth muscle cells in adhesions of large intestine, appendix vermiformis and also in intact peritoneum area, but was almost absent in the adhesions of small intestine. Only endothelial cells and smooth muscle cells of occasional sclerotic blood vessels demonstrated TGFβ-immunoreactivity (Fig. 3).

Also, the distribution of VEGF was not homogenous in all the tested tissue. So, intensive staining for this growth factor was found in the blood vessels of appendix vermiformis and small intestine adhesions, especially in the tissue infiltrated by inflammatory cells (Fig. 4). Only occasional cells in the wall of large blood vessels were positive for VEGF in intact peritoneum and the adhesions of large intestine (Fig. 5).

The abundance of PGP 9.5-containing nerve fibers in all the fibrous tissues of peritoneum was observed and it was slightly dominating in number here to compare with intact peritoneum (Fig 6). Notable increase in the number of SP-containing nerve fibers was detected in all the adhesions with persistence in inflammatory regions again (Fig. 7). VIP positive nerves also increased in number in adhesions in comparison with intact peritoneum. Neuropeptide immunoreactive fibres innervated blood vessels, fibrous adhesion tissue and were also seen to develop prominent nerve bundles.

Numerous to abundant endothelial cells of blood vessels and mesotheliocytes expressed ICAM-1 and VCAM-1 in intact peritoneum and adhesions (Figs. 8–9).



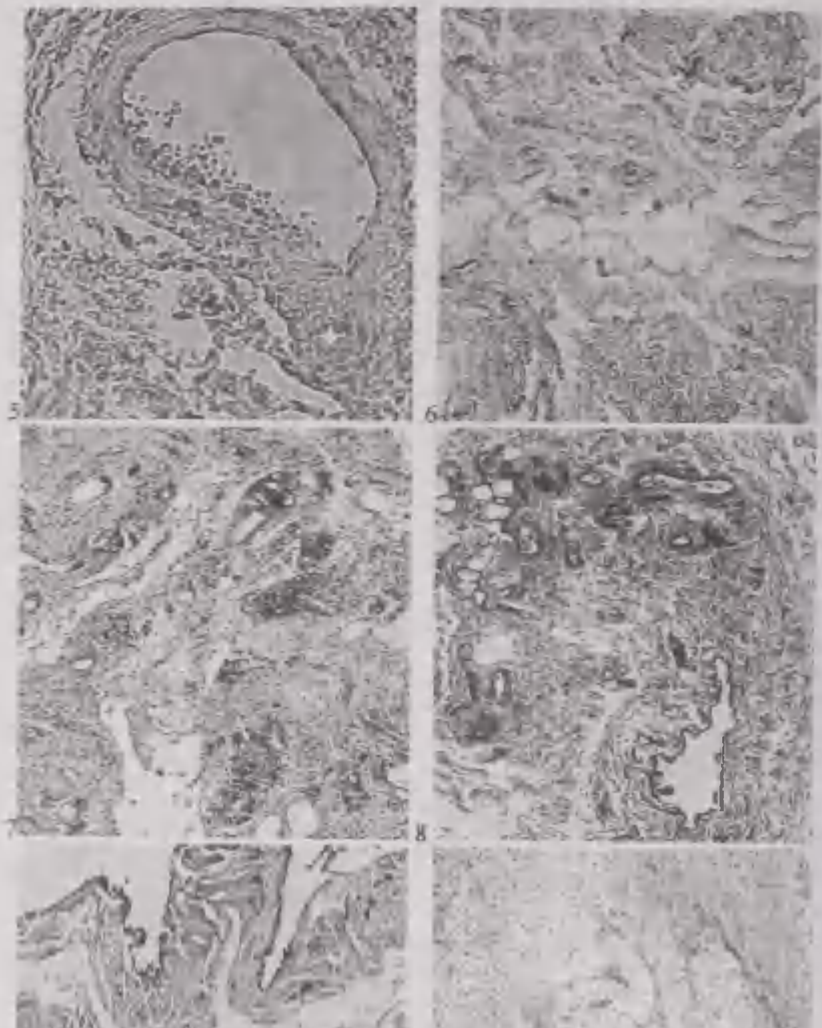

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Fig. 1. Fibrous adhesions of the large bowel demonstrating numerous blood vessels and chaotically located bundles of connective tissue fibers. Haematoxylin and eosin, X 250.
Fig. 2. Note the oval and spherical shape of mesothelial cells (arrows) in the adhesions of appendix vermiformis. Haematoxylin and eosin, X 250.
Fig. 3. Intensively stained for TGFβ immunoreactivity endothelial cells and smooth muscle cells in sclerotic blood vessels in the adhesions of small the intestine. TGFβ IMH, X 250.
Fig. 4. Moderate numbers of blood vessels are stained for VEGF in the inflamed adhesions of the small intestine (arrows). VEGF IMH, X 160.
Fig. 5. Note the large blood vessel wall with weak occasional cells-containing VEGF (star) in the intact peritoneum. VEGF IMH, X 250.
Fig. 6. Abundance of fine PGP 9.5-containing nerve fibers and small nerve trunks in the adhesions of the small intestine (arrows). PGP 9.5 IMH, X 250.
Fig. 7. Note numerous SP-containing nerve fibers and nerve bundles in the inflamed adhesions of small intestine (arrows). SP IMH, X 160.
Fig. 8. Endothelium of blood vessels and capillaries intensively expressing VCAM-1 in small intestine adhesions (arrows). VCAM-1 IMH, X 160.
Fig. 9. Endothelium of blood vessels and mesothelial cells (arrows) intensively expressing ICAM-1 in the adhesions of large intestine. ICAM-1 IMH, X 160.
Fig. 10. Almost total apoptosis in connective tissue cells in the adhesions of appendix vermiformis. TUNEL, X 160.

Table 1. Relative occurrence of growth factors, their receptors, neuropeptide-containing nerves and adhesion molecules in intact peritoneum and adhesion areas

Factors/ /Place	TGFβ	bFGF	FGFR1	NGF	NGFR	VEGF	PGP 9.5	VIP	SP	ICAM–1	VCAM-1
Intact peritoneum	++++	0/+–+	++++	0/+–+	+++	0–0/+	+++	++	0/+–+	+++/++++	+++/++++
Adhesions of small intestine	0–0/+	0/+	++++	0/+–+	++++	++/+++	++++	++/+++	+++	++++	++++
Adhesions of large intestine	++++	+	++++	0/+	++++	0–0/+	++++	++/+++	+++	++++	++++
Adhesions of appendix vermiformis	++++	0/+	++++	+	++++	+++	++++	++/+++	+++	++++	++++

Abreviations: 0 – no positive structures found in the visual field, 0/+ – occasional immunoreactive structures seen in the visual field, + – few immunoreactive structures seen in visual field, ++ – moderate number of immunoreactive structures seen in the visual field, +++ – numerous immunoreactive structures seen in the visual field, and ++++ – abundance of immunoreactive structures seen in the visual field. TGFβ – transforming growth factor beta; bFGF – basic fibroblast growth factor; FGFR1 – fibroblast growth factor receptor 1; NGF – nerve growth factor; NGFR – nerve growth factor receptor p75; VEGF – vascular endothelial growth factor; PGP 9.5 – protein gene product 9.5; VIP – vasoactive intestinal peptide; SP – substance P; ICAM–1 – intracellular adhesion molecule one; VCAM-1 – vascular cell adhesion molecule one.

DISCUSSION

Commonly our data did not show correlations in the distribution of adhesion molecules, growth factors, their receptors, and neuropeptides between different adhesion sites. The appearance and the relative number of positive for bFGF-, FGFR1- and NGF-containing structures was also not changed in adhesions in comparison with the intact peritoneum, while TGFβ was decreased in small intestine adhesions, but VEGF expression varied from similar to such in the intact peritoneum up to the strongly increased number of positive structures in all the sites of adhesions. Interestingly, that expression of both above mentioned factors are described to depend on the hypoxia, a condition that promotes the development of adhesions and alters the expression of cytokines, chemokins and eicosanoids, including VEGF and TGFβ with following tissue fibrosis [12]. Additionally, peritoneal damage rise also release of FGFs that along with VEGF possess the angiogenic effect. Changes (decline) in growth factor expression and/or altered endothelium response may result in delayed angiogenesis and healing [26] possibly taking place in the large intestine of our patients, as here VEGF expression was notably decreased, and in adhesions of small intestine, where only occasional of TGFβ-immunoreactive structures were seen. However, the last case might be explained by the lack of latent TGFβ activation due to the unknown reasons [3, 23] and/or dysbalance in the regulation of angiogenesis as the above mentioned factor belongs to the angiogenic suppressors [27]. TGFβ is described to modulate extracellular matrix by inducing of protein synthesis, decreasing matrix degradation and regulating mesothelial cells fibrinolitic activity [7]. Mesothelial cells and fibroblasts are described to be major TGFβ expressing sites, and the elevated level of this factor is described to characterize the adhesion tissue and patient blood [17, 21]. In our patients we observed the abundance of other cells beside the mesotheliocytes and fibroblasts to express TGFβ, thus, we generally are agree with Rougier et al. (1998) that the tissue with a higher expression of this factor are more predisposed to develop adhesions compared to others [21].

The adhesions of our patients have shown a high expression of adhesion molecules in the endothelial cells of the blood vessel wall and mesothelial cells. As irregular inflammatory cells were detected in the perivascular area, we suggest the role of these adhesion molecules to stimulate inflammatory cells adhesion and transmigration. Moreover, our data are also supported by the findings of Cannistra et al. (1994) who proved the expression of VCAM-1 from the activated cultured mesothelial cells stimulating the leukocyte trafficking to the abdominal cavity [4]. On the other side, the direct influence of the inflammatory mediators like TNF alfa and interleukins on the mesothelium is described to associate also with the high expression of ICAM-1 from the mesotheliocytes with following tumor cell adhesion to the peritoneum [1, 31] that seemingly is not only the one tissue condition for abundant molecule expression from the mesothelial cells. The other interesting point is the phenotype of adhesion molecules expressed by mesothelial and endothelial cells. Jonic et al. (1992) suggested about the different phenotype of VCAM1 and ICAM1 from the cultured human mesothelial cells and endothelial cells after the influence of chemotactic cytokines [14]. We slightly disagree with this view as in the adhesions of our patients the antibodies marked one and the same type of adhesion molecules in both – mesothelium and endothelium. Probably the change of phenotype differ *in vitro* and *in vivo* conditions and, additionally, might be influenced not only by chemotactic cytokines, but also by other tissue factors (the complex of inflammatory cell influence, the stage of inflammation, growth factors, matrix metalloproteinases, and anti-microbial peptides).

Neuropeptide-containing innervation was notably increased in all the adhesion affected tissue of our patients. VIP- and SP-containing nerve fibres were detected practically in all the fibrous tissue, in the wall of blood vessels and close to the mesothelium, but not always marked in one and the same nerve fibres in serial sections which were positive for the diffuse neuroendocrine system marker PGP 9.5. Thus, we suggest the important role of these neuropeptides not only in vasodilatation (VIP) and vasoconstriction (SP), but probably also in the modulation of immune response, simultaneously to the other, not detected yet, neuropeptides expressed in the adhesions. Commonly, we would not focuse only on the role of SP in the conduction of pain impulses, suggested by [25], as the main part of our patients did not complain about pains at all. Also, Kligman et al. (1993) showed not more prevalent nerve fibres in the adhesions of patients with pelvic pains from those without pains [15]. The explanation for the development of prominent nerve bundles in adhesions might be the stimulatory influence of inflammatory mediators on the nerves described as a phenomenon in the other tissue [2] and the increased expression of NGFR observed in our patients.

The distribution of apoptotic cells was similar in adhesions and in intact peritoneum of our patients and only regionally observed. Regional apoptosis affected the same mesothelium, mainly of changed cellular shape. These data are similar to the findings of [22] about the insignificant programmed cell death in adhesions. As the blockage of apoptosis is suggested to raise the exacerbation of the disease [11] in rodent adhesion disease model, it is difficult for us to speculate the real significance of apoptosis in our patients. Seemingly, there are many other tissue molecular events developing the formation of adhesions and the complex understanding of them still needs a future research *in vivo* and in human.

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ASSESSMENT OF FUNCTIONAL PARAMETERS OF HEALTH OF THE MILITARY PERSONNEL

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ABSTRACT

The health capacity and physical endurance is an important advantage for the military personnel in their daily work. Military service needs the personnel with professional skills and knowledge, with a high level of physical endurance, the health standards and the functional characteristics of health condition should correspond to the military environment demands. The target of our Project was to improve the clinical diagnostic analysis system for the evaluation of the health functional condition of the military personnel that allows us to reveal the health problem in the early stage, to elaborate recommendations for the healthy behaviour to improve the health quality of the military personnel on the scientific basis. We examined 120 military officers, soldiers and cadets. The subjects were divided into subgroups according to their age. We provided clinical and laboratory tests on the basis of P.Stradiņa University hospital. Clinical examinations of randomised persons revealed adequate, a good level general health statement in the cadets` group. The improving of physical preparedness and endurance, the prevention of cardiovascular disease risk factors require the physical load planning with the gradually increasing physical load level and the duration that correspond to the individual physical fitness level. The health assessments of the military personnel from the unit in age above 40 years revealed the symptoms of metabolic disorders and the initial digression of lipid metabolism, obesity with hypertension problems. It was necessary to develop a specific physical activity planning program for the person with health problems in the age above 40. A simple physical load could be used for monitoring cardiovascular problems and planning wider and deeper clinical investigation for preventing health disorders.

Key words: *health functional parameters, anthropometric parametres, military personnel health capacity*

INTRODUCTION

Latvia is a member of the North Atlantic Treaty Organization. The military personnel of the Latvian Armed Forces participate in the international cooperation and the international operations of NATO. The new tasks put forwards new higher demands for the military personnel as in the military professional skill and knowledge area health standards of the military personnel are important. The military personnel should keep to a high level of physical preparedness and endurance, a high level of health capacity for the successful performance of military task. The evaluation of the health standards of the military personnel is carried out according military regulations. The target of our project was to provide the evaluation and analyses of clinical and diagnostic data, make health assessments, elaborate recommendations for the military personnel health evaluation system to reveal health problems and to provide preventive measures, and put forward proposals for supporting the well-being and health of the military personnel. The Project was realized on the basis of the modern P.Stradina University hospital with the fundamental clinical basis and the highly qualified medical personnel.

MATERIAL AND METHODS

Clinical analyses were carried out for 120 randomized persons in both genders. We divided all the participants into two groups: the 1st group included – 60 cadets, the 2nd included 60 military persons from units. In each examined group subjects were divided according to their age into two subgroups. The participants of the 1st group (cadets) formed two subgroups till 25 years (the 1^{st} subgroup) and above 25 years (the 2^{nd} subgroup). The participants of the second group (the military personnel from units) were subdivided into two subgroups till 40 years (the 3^{rd} subgroup) and above 40 years (the 4^{th} subgroup). Participants were subjected to anthropometric, clinical and biochemical assessments, pulmonary functional diagnostic analyses and tests, tests on a cycle ergo meter, etc.

The results of clinical tests and analyses allowed us to make the assessment of the heath statement and the endurance level. We have carried out the analyses of cardiovascular risk factors.

RESULTS AND CONCLUSION

On the basis of the assessments of the clinical results we have fixed significant hypertension for 15% of participants (18 from 120, $p<0.001$) Fig 1. The level of the baseline blood pressure was over 130 mm Hg for systolic Blood pressure and over 85 mm Hg for diastolic Blood Pressure. After physical load (15 exercises), the load hypertension was fixed for 43% participants (52 from 120, $p<0.0001$).Increasing the blood pressure considered to the systolic blood pressure >140 mmHg as well for diastolic blood pressure >90 mmHg) was determined for 22% of the examined persons (26 no 120, $p<0.001$) Fig. 2. It was noticed that the physical preparedness of persons with the load hypertension is inadequate to the physical load.

Blood pressure level characteristics in the group of military personnel from the unit were worse then in the cadets` group, the baseline level of blood pressure (systolic >130 mmHg and diastolic >85 mmHg), was higher for 3% of cadets and for 43% of the military personnel ($p<0.001$). The blood pressure level after physical load (15 exercises): hypertension was fixed for 41% of cadets and 45% of the military personnel. The data of biochemical analyses for the person in the group of the military personnel in the age above 40 years have revealed cardiovascular disease (CVD)risk factors. The level of high dense lipid cholesterol (HDLC) ($p<0.001$), triglyceride (TG) ($p<0.001$), the body mass index (BMI) ($p<0.0001$), the waist circumference values ($p<0.0001$) were significantly higher. During the study 19% of subjects (the 23 persons from120) received the negative clinical conclusion that was connected to the determined cardiovascular disease risk factors such as the digression of lipid metabolism, hypertension, obesity, ect.

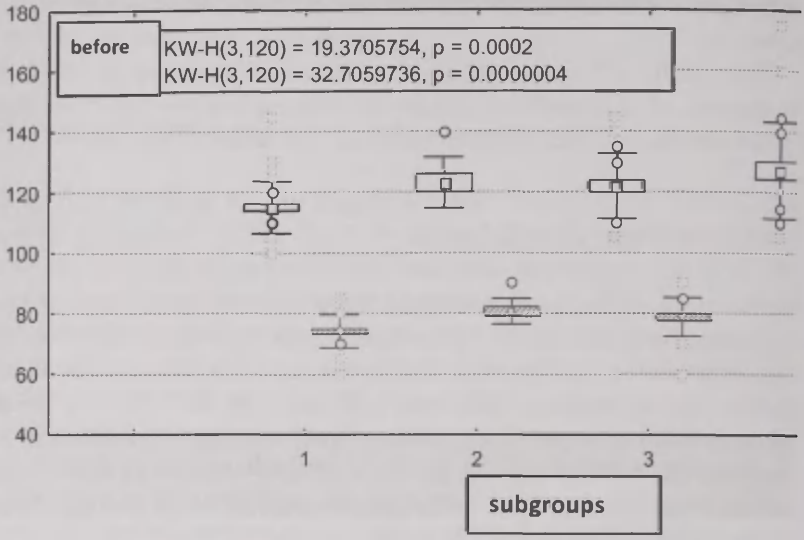


Fig. 1. Baseline Systolic and diastolic blood pressure (-S; before-D) in age-specific groups: cadets till 25 years (1), cadets above 25years (2) and military personnel till 40 years (3) and military personnel over 40years (4).

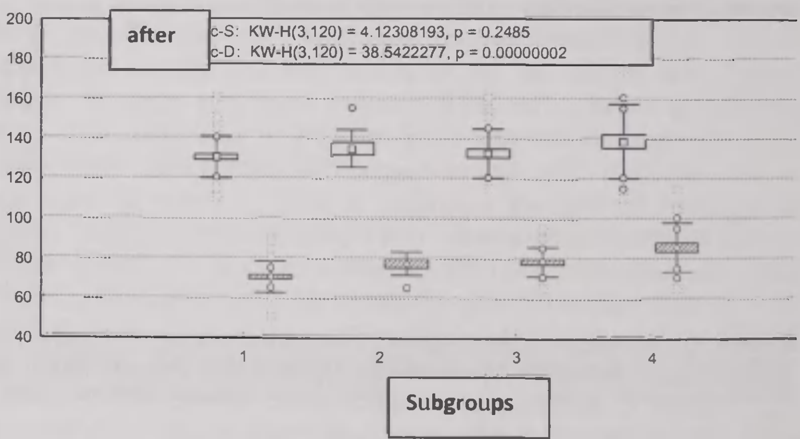


Fig. 2. Systolic and diastolic blood pressure after Physical load (15 exercise) in age specific groups (after-S; after-D) : cadets till 25years (1), cadets above 25years (2) and military personnel till 40years (3) and military personnel above 40years (4).

These subjects received the conclusion about the low physical preparedness and endurance, all these persons were from the group of the military personnel over 40 years ($p<0.005$).

The results of the study have revealed mutual influence (correlation factors) of the blood pressure level on some anthropometric characteristics that correspond to the findings of other authors [1, 2, 3, 4, 5, and 6]. The Body Mass Index has a significant impact on the level of systolic and diastolic blood pressure ($p<0.0001$), waist circumference values ($p<0.0001$), low dense lipid cholesterol ($p<0.03$), Triglyceride ($p<0.0001$), insulin resistance or HOMA-IR ($p<0.02$).

We found significant mutual interference of the values of the Body Mass Index, waist circumference and blood pressure (systolic, diastolic). Multiple regression analyses revealed the correlation of the Body Mass Index and waist circumference values to systolic blood pressure ($r=0.51$, $p<0.001$) (Fig. 3).

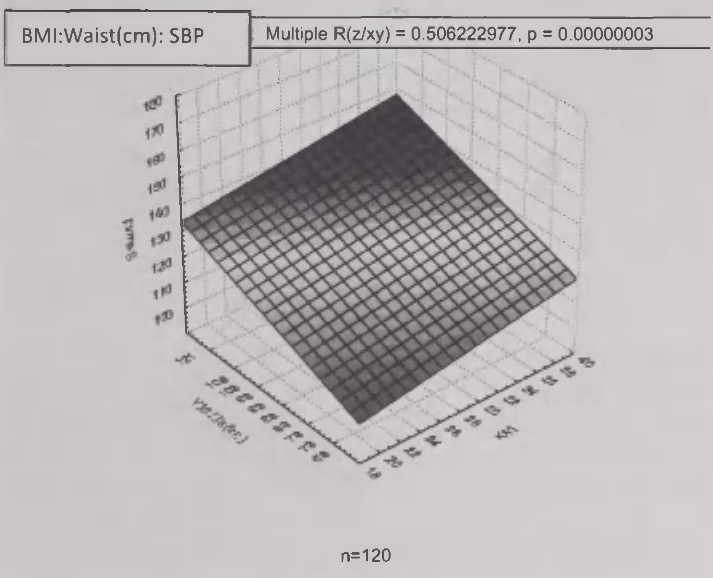
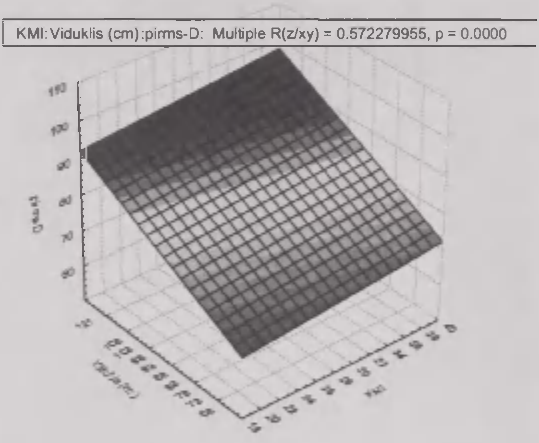


Fig. 3. Body mass index (BMI) and waist circumference interaction to systolic blood pressure (SBP) ($r=0.51$, $p<0.0001$)

Correlations have been found between the Body Mass Index, waist circumference and diastolic blood pressure values(r=0.57, p<0001); as well between anthropometric index (body mass and height index), the body mass relative index and systolic blood pressure values(r=0.44, p<0001). There was mutual interference between the body mass and the height index, the body mass Relative index to diastolic blood pressure values(r=0.34, p<0001) Fig.4.

All the subjects passed through the test on a cycle ergometer. The optimal conclusion of tests was received from 80% of the examined persons, the rest of the persons – 20% (24 from 120: 8 cadets and 16 military personnel) (p<0.001), had a positive conclusion where were the fixed tolerance to physical load was moderate or diminished without ischemic disorders on ECG. During the study we revealed the influence of biochemical parameters on the results of the tests on a cycle ergo meter such as triglyceride and insulin resistance (HOMA-IR) to baseline heart rate and restoring Heart rate after a physical load (r=0.25, p<0.03); the influence of the Body Mass Index and waist circumference on the baseline Heart rate and restoring heart rate level (r=0.33, p<0.01), Fig. 5. The maximal load in tests on a cycle ergo meter (100W) shows 6% (p=0.68); 150W – 23%(p<0.0001); 200W – 44%; and 250W – 27%



n=120

Fig. 4. Body mass index (BMI) and waist circumference interaction to diastolic blood pressure (DBP) (r=0.57, p<0.0001)

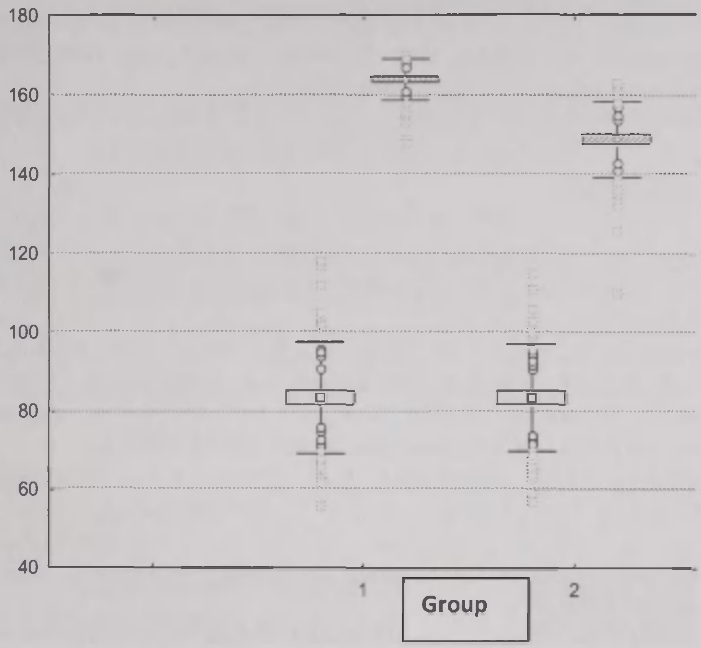


Fig. 5. Baseline heart rate and restoring heart rate in cadets (1) and military personnel (2) group (HR baseline)

CONCLUSION

Clinical examinations of 120 randomised persons have revealed an adequate, good level general health statement in the cadets` group. The improving of physical preparedness and endurance, the prevention of cardiovascular disease factors require the physical load planning with the gradually increasing physical load level and the duration that correspond to the individual physical fitness level.

The health statement for the military personnel from the unit in the age above 40 years reveals the symptoms of metabolic disorders and the initial digression of lipid metabolism, obesity with hypertension problems. It was necessary to develop a specific physical activity planning program for the person with health problems in the age above 40 years.

The simple physical load (15 exercises) could be used for monitoring cardiovascular problems and planning wider and deeper clinical investigation for preventing health disorders.

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THE CONTRIBUTION OF ALEŠ HRDLIČKA TO AUSTRALIAN ANTHROPOLOGY

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Dr. Aleš Hrdlička visited Australia in 1925 during a seven-month journey from the United States via France to India, Ceylon, Java, Australia, South Africa and via Great Britain back to Washington. He was aged 56 years and had completed 20 years of successful activity at the Smithsonian Institution, Washington. A few years later he was to complete his book *The Skeletal Remains of Early Man* [4]. The purpose of the journey was to visit the sites of important discoveries of early man, specifically the valley of the River Solo in Java where E. Dubois found skeletal remains of *Pithecanthropus* in 1981 and Taungs, South Africa, where Professor R. Dart had discovered a young fossil primate which he called *Australopithecus Africanus*.

Hrdlička travelled by boat from Java along the north-western and western coasts of Australia stopping at every small port between Derby and Perth. He met Australian Aboriginals and was deeply impressed by their dancing rituals and beautiful spearheads made from the glass of broken bottles, which he saw in Derby. He noticed fair-haired Aboriginals for the first time in Windham, although he saw many others later near Ooldea during his journey on the Transaustralian Railway. He visited South Australian Aboriginals at the lower reaches of the River Murray.

The skull collections in the museums of Perth, Adelaide, Melbourne, Sydney and Brisbane were of particular interest to Hrdlička who expressed surprise at the wealth and variety of the ethnographical, archaeological and anthropological collections representing Australia, Tasmania and Melanesia. He had the opportunity to study additional material from some private collections, such as those of Basedow and Pullein in Adelaide as well as collections in anatomical institutes. The most extensive series of skulls, about 600 at the time, was studied at the South Australian Museum where he was received by Professor F. Wood Jones and assisted by N. B. Tindale, then a young museum assistant. In Sydney he was the guest of Professor A. N. Burkitt of the University Institute of Anatomy who made it possible for Hrdlička to examine the Talgai skull which in 1925 was considered the oldest Australian skeletal finding. In Melbourne he met the anatomist Professor R. J. A. Berry.

Hrdlička spent five weeks working with the skull collections and examined over 900 specimens. According to published data, measurements were tabulated for 935 skulls, including 37 from Tasmania [3]. This extensive catalogue included, besides the Australian observations, numerous series from other parts of the world which Hrdlička measured personally and which form part of the collections he founded. He supplemented the Australian data later by measuring Tasmanian skulls from collections in the museum of the Royal College of Surgeons, London.

The measuring technique described in his book *Anthropometry* [2] was applied to all skulls published in the *Catalogue* [3], provided the state of preservation permitted. Descriptions of the skulls were based on 26 variables including linear distances, angles and indices, but in the *Catalogue* Hrdlička provided only mean values for these characteristics and not variation statistics. Each skull was listed according to the locality where it was found; in South Australia alone 354 skulls are represented from numerous localities, the major sites being the Swanport-Murray Bridge region (approximately 63 males and 47 females), Adelaide and environs (33 males and 34 females) and the Coorong region (37 males and 25 females).

Many eminent anthropologists studies and reported on the cranial collection from the South Australian Museum and several early attempts were made to catalogue the specimens. Dr. N. B. Tindale, in a personal communication [8], summarized the history of this collection. One of the first to assign catalogue numbers to the collection was Sir Edward Stirling who later described the burial series from Swanport, near Murray Bridge [7]. Herman Klaatsch and Rudolf Pöch were also among the early workers in Adelaide and the latter placed a second number series on the specimens. Thomas D. Campbell had also commenced a further numbering system at one stage, but the current cataloguing method, which assigns a routine A.... number to each anthropological specimen, was commenced by Edgar Waite about 1915 and completed later by N. B. Tindale. Tindale also labelled all specimens in English and completed a cross-reference index, this work being completed in the 1930s.

Ramsay Smith worked on the collection between 1903 and 1920 and Edward Stirling continued his interest after Tindale's appointment as Museum Assistant in 1918 spending most afternoons in the osteological room. The anatomist F. Wood Jones took an immediate interest in the cranial collection on his appointment to the Chair in Anatomy at the University of Adelaide in 1920. Tindale, who assisted Hrdlička in 1925 commented that the vistor adopted his own sexing rather than the labelled ones with subsequent conflict in some instances. This led Wood Jones to apply Hrdlička's technique in an attempt to sex the specimens independently, but his results were never published.

Among other researchers who completed significant studies of the collection from the 1930s to the present were Frank J. Fenner, Paul S. Hossfeld, J. Wunderly, Joseph B. Birdsell, N. B. Tindale, Andrew A. Abbie, Thomas Murphy, Ruggles Gates, William H. Howells and Murray J. Barret, and his dental colleagues from the University of Adelaide. This latter group were influenced by T. D. Campbell who began his dental studies in the 1920s under the guidance of F. Wood Jones and continued his interest until his death in the 1960s. Campbell's major contribution was his monograph on the dentition and palate [1].

The present authors were interested in the morphology of South Australian skulls to provide a comparative basis for the study of other cranial material, for example the series from Roonka flat in the lower valley of the River Murray [5, 6]. Accordingly, we recalculated the descriptive statistics for 198 male and 156 female skulls from South Australia using the original measurements published in Hrdlička's *Catalogue*. These standards are presented in the form of means and standard deviations (Table 2) which can be used to quantify differences between the standards and other series of skulls or individual specimens.

Table 1. Origin of Australian crania measured by A. Hrdlička in 1925

Region	Males	Females	Total
South Australia	198	156	354
Victoria	74	49	123
New South Wales	59	44	103
Queensland	49	51	100
Northern Territory	103	80	183
Western Australia	10	7	17
N.-W. Australia	7	3	10
Central Australia	6	2	8
Tasmania	22	15	37
Total	**528**	**407**	**935**

It is interesting to note that sexual dimorphism in the South Australian skulls was most marked in the linear dimensions; all mean values of distances except the orbital mean height were significantly greater in the males. The dimorphism, calculated as the sex difference in means expressed as a percentage of the female mean, averaged 4.2% for the cranial vault and orbits, 7.1% for facial dimensions and 6.3% overall. However, no significant differences between male and female average values were noted for five angular and proportionate measurements of shape – facial angle, alveolar angle, mean height index, facial index total and the nasal index.

REGIONAL COMPARISON OF AUSTRALIAN SKULLS

Hrdlička's standards for South Australia may be used to compare morphological differences between the other series of Australian crania reported in the *Catalogue*. This comparison is shown for male specimens from five states in Table 3. The basis for the comparisons is departure from the South Australian means expressed in the form of z-scores of standard deviation units, that is *(population mean – South Australian mean / South Australian SD*. Table 3 indicate the extent and direction of deviation from the South Australian mean values shown by the other five groups of skulls. Compared with the South

Table 2. Descriptive statistics for 26 variables measured on South Australian crania by Aleš Hrdlička. Linear dimensions in mm.

Variable	Males (n=198)			Females (n=156)		
	N	Mean	SD	N	Mean	SD
1. Max Length	198	190.9	5.7	156	181.6	5.0**
2. Max. Breadth	198	133.1	4.6	156	128.4	4.7**
3. Basion – Bregma Ht.	187	130.8	5.3	143	125.0	4.8**
4. Cranial Index	198	69.8	2.6	156	70.8	2.7**
5. Mean Ht. Index	187	80.8	3.4	143	80.7	3.1
6. Cranial Module	187	151.6	3.6	142	144.9	3.5**
7. Menton – Nasion Ht.	101	114.5	6.5	76	104.9	5.4**
8. Alveolar Pt. – Nasion Ht.	169	69.6	4.5	121	65.2	3.4**
9. Max Facial Breadth	161	135.6	5.0	110	125	4.8**
10. Facial Index Total	97	84.4	5.6	72	83.8	4.5
11. Facial Index Upper	157	51.3	3.9	107	52.2	3.4*
12. Basion – Alveolar Pt.	156	107.1	5.1	117	102.0	4.4**
13. Basion – Nasion	182	102.7	3.8	140	97.3	3.6**
14. Basion – Subnasal Pt.	166	94.3	4.5	124	89.5	3.7**
15. Facial Angle	152	67.3	3.5	115	66.9	2.8
16. Alveolar Angle	150	50.0	5.7	115	49.1	5.0
17. Ht. of Symphysis	92	34.4	3.0	73	30.8	2.7**
18. Orbital Mean Height	176	33.5	1.9	126	33.3	1.7
19. Orbital Mean Breadth	176	38.7	1.6	126	37.4	1.3**
20. Orbital Mean Index	176	86.7	5.2	126	89.0	4.5**
21. Nasal Height	176	48.6	2.8	127	45.6	2.5**
22. Nasal Breadth	176	26.7	2.0	127	25.3	1.9**
23. Nasal Index	176	55.1	4.5	127	55.6	5.0
24. Palate Ext. Length	157	62.5	3.3	111	59.1	2.8**
25. Palate Ext. Breadth	157	68.3	3.4	111	63.4	3.0**
26. Palatal Index	157	109.4	6.2	111	107.1	5.8**

* Mean values for males and females differ at $p<.05$

** Mean values for males and females differ at $p<.01$

Table 3. Regional comparison of male Australian crania measured by A. Hrdlička showing departures from South Australian mean values in standard deviation units.

Variable	Victoria	N.S.W.	Queensland	N.T.	Tasmania
1. Max Length	–0.018	–0.158	–0.737	–0.947	–0.281
2. Max Breadth	0.283	–0.087	–0.391	–0.891	1.370
3. Basion – Bregma Ht.	1.132	0.717	1.019	0.830	0.604
4. Cranial Index	0.231	0.038	0.192	–0.077	1.654
5. Mean Ht. Index	0.971	0.765	1.441	1.529	0.235
6. Cranial Module	0.667	0.250	–0.056	–0.472	0.694
7. Menton – Nasion Ht.	–0.200	0.031	–0.200	–0.308	–0.369
8. Alveolar Pt. – Nasion Ht.	0.333	0.022	–0.267	–0.133	–0.422
9. Max. Facial Breadth	0.640	–0.220	–0.200	–0.080	0.080
10. Facial Index Total	–0.375	0.143	0.071	–0.214	–0.232
11. Facial Index Upper	–0.026	0.026	–0.103	–0.077	–0.385
12. Basion – Alveolar Pt.	0.217	–0.255	–0.588	–0.137	–0.098
13. Basion – Nasion	0.474	0.053	–0.158	0.211	–0.289
14. Basion – Subnasal Pt.	0.356	–0.267	–0.511	0.044	0.244
15. Facial Angle	0.057	0.200	0.486	0.343	0.200
16. Alveolar Angle	0.439	0.000	0.000	0.175	0.439
17. Ht. of Symphysis	0.400	0.300	–0.267	–0.333	–1.000
18. Orbital Mean Height	–0.158	–0.158	0.000	–0.158	–1.421
19. Orbital Mean Breadth	0.313	0.188	0.000	0.188	–0.250
20. Orbital Mean Index	–0.385	–0.308	–0.019	–0.308	–1.231
21. Nasal Height	0.071	0.107	0.000	0.143	–0.250
22. Nasal Breadth	0.600	0.600	0.400	0.350	0.200
23. Nasal Index	0.467	0.444	0.333	0.178	0.356
24. Palate Ext. Length	–0.030	–0.061	–0.758	–0.303	–0.091
25. Palate Ext. Breadth	0.235	0.265	–0.147	–0.324	0.294
26. Palatal Index	0.226	0.274	0.581	–0.016	0.323

Australians all groups displayed greater mean values for basion-bregma height, mean height index, facial angle, nasal breadth and nasal index but smaller means for cranial length, orbital mean index and external length of the palate. For the other variables, the South Australian means fell within the range of the other group means. The major sources of variation, as indicated by z-scores outside the range of ±0.5 standard deviation units, are summarized below for the five regions represented in Hrdlička's *Catalogue*.

Northern Territory

Skulls from this region differed from the South Australians in the cranial vault and they can be characterized on average as being shorter, narrower and higher (z-scores being: length −0.95, breadth −0.83, mean height index 1.53). All other variables were within ±0.5 units from the South Australian means. Variables relating to dimensions of the orbit, nose and palate were similar in the Northern Territory and Queensland groups but with a tendency for the Northern Territory palates to be slightly longer and narrower.

Queensland

On average, the Queensland skulls were shorter, higher, less prognathic and had shorter palates than the South Australians. Standard scores were: length −0.74, height 1.02, mean height index 1.44, basion-alveolar pt. −0.59, facial angle 0.49 and palate length −0.76.

Victoria

In comparison with the South Australian standards, the Victorian skulls were higher and displayed a broader face and nose (z-scores were: height 1.13, height index 0.97, facial breadth 0.64, nasal breadth 0.60). Variables relating to the orbit, nose and palate were similar to those derived for the New South Wales series.

New South Wales

The mean values were close to the South Australian standards, with deviations exceeding 0.5 units for height (z=0.72), mean height index (z=0.77), and nasal breadth (z=0.60) only.

Tasmania

The Tasmanian skulls, compared with the standards, displayed greater cranial breadth and height (breadth z=1.37, height z=0.60, cranial index z=1.65), but smaller symphysis height (z=−1.00), mean orbital height (z=−1.42) and orbital mean index (z=−1.23). All other variables fell within ±0.5 units from the South Australian means.

SUMMARY

Aleš Hrdlička's visit to Australia in 1925, although of short duration, provided a wealth of valuable observations which may be applied in the description and evaluation of more recent skeletal discoveries in the continent. This paper has tabulated a descriptive statistical analysis of Hrdlička's data relating to Australian material examined in 1925 and it provides a short history of the of the South Australian craniological collection.

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CONNECTION OF RAUBER'S ANATOMICAL MUSEUM WITH THE PRESENT

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ABSTRACT

Health and diseases are an issue concerning every person. The medical museum can, with its activities, help to raise people's health awareness. Not only lectures and interactive activities can serve as communication tools, but centuries-old objects can also be informative and attractive and make the visitor ponder and encourage further discussion. The article deals with a question of museum communication, trying to find out what connection the museum and its exhibits should have with people's daily life. Objects from the hundred-year-old collection of Professor Rauber have been presented as practical examples.

Similarly with other museums, the medical museum proceeds in its communication work from the general theoretical principles of museum communication, which is not only a science of communication but an interdisciplinary blend of museology, pedagogy and, ever increasingly, economics. Communication of the museum with the public as well as its public relations have been treated in different papers within the framework of culture marketing.

Change in the function of the museum has been caused by a change in general social conditions under which the museum – an elite temple of art – has become a visitor-oriented recreational environment, rich in experience.

Communication and public relations are a relatively new sphere of activities in the museum. With a view to integrating the sphere of communication effectively into the museum's daily life and thus better reaching the visitors, one of the questions studied was – what kind of a relation an exhibit should have with the visitor's daily life.

To that end, museums' communication specialists were interviewed. The results are based on the analysis of the interviews.

It appeared that the more the visitors feel the relevance of the theme for themselves, the closer are the ties they have with the museum and the objects exhibited there.

Search for the connection of an exhibit with everyday life and giving it a practical meaning is a part of the museum's communication work. Although the museum can have different meanings for the visitor's daily life, it still has a significant role as social media.

Key words: communication of museum, social media, medical museum, anatomy

THEORETICAL BACKGROUND

The activities of the museum are based on specific treatment of objects selected from an enormous number of objects as worthy of preservation – they are presented, stored and their significance is mediated to the public. The exposition consists, to a great extent, of items that have lost their original function. However, by becoming museum pieces, those objects do not entirely lose their function; with a change in their function, they become bearers of cultural significance [2].

When discussing the function of the museum in the contemporary society within a more comprehensive study, the authors dealt with the ties of the museum and its exhibits with people's daily life.

The needs and demands of visitors with regard to the museum have changed due to the emergence of new cultural forms and institutions in the late 1960s and the 1970s. Due to a change in the general environment, the attitude of the public to cultural offers has changed too. Mandel [4] has remarked that that owing to that circumstance the traditional permanent public of many cultural institutions has vanished. Options to pick from among different offers made people's decision-making more and more spontaneous. Culture consumption has become self-evident, and the share of permanent visitors has decreased. Nowadays a great deal of the public increasingly prefers to consume culture as entertainment. Even though a cultural institution pursues other purposes, it cannot ignore the prevailing demand in case it wants to increase the number of its visitors.

Museum pedagogy is being replaced by museum communication, i.e. through exhibits visitors are being led to join the process of thinking and to express their opinion. Through presentations objects become part of life, which bring on discussion.

FROM THE PAST TO THE PRESENT

Medicine in a museum is a theme that can be presented to visitors in quite different ways – informatively, didactically as well as offering sheer viewing pleasure or a shocking experience.

Collections of medical objects have, as a rule, a long and interesting history. Until the 17th century objects collected by universities had a scientific purpose – malformed organs and anomalies were collected. In the 18th century interest arose in making of macroscopic specimens. The first museum in principle open to the public was the British Museum in London, established in 1753. A few of the first public museums in Estonia were the *Naturalienkabinet* at the University of Tartu and the University of Tartu Art Museum (1803). In 1890 Professor of Anatomy August Rauber established an anatomical museum at the Department of Anatomy of the University of Tartu. He considered it important that the study hall of anatomy should be accessible not only to medical students but to all the interested persons. He considered his aim achieved when the study hall, "which completely lacks the frightening aspect, is also suitable for students of the other faculties in order to help mediate to them knowledge of their body to them through visual study. If such a study hall exerts a favourable influence beyond the Medical Faculty and encourages non-medical students to study anatomy, then, to my firm conviction, the study hall has achieved its purpose" [7].

RESULTS OF THE INTERVIEWS

The then standpoint by Rauber is also topical today. The study of the function of the museum attempted to find out what connection the museum and the objects exhibited there should have with people's daily life. Since in Estonia such a study could not be based on medical museums only, nine other state and municipal museums were selected for the purpose (including the Museum of Tartu University History and the Science Centre AHHAA). The method used was non-standardized thorough interviews, and the empirical analysis was based on the transcriptions of interviews.

The results showed that the museum's relationship with a person's daily life could vary greatly. The following two standpoints prevailed. The more individual the approach to the visitor, the closer is his/her relationship with the museum exhibit; the visitor has to feel the relevance of the theme for him/herself and at the same time get an emotional experience, "*...there is an attempt to make the communication very personal; the museum should approach the visitor relevantly, so to speak – the thing in question must be my personal problem; it must have got very close to my heart and touched me emotionally /.../ this relevance or "hearts on" is exactly this daily life and not the ivory tower, which has been described all the time, meaning that scholars potter in some high tower and that nobody can get up there, and they have a beautiful and broad view but others, down at the base of the tower can by no means get up there* [5]. A close connection may also emerge when the museum can be used as a place of recreation or as an information bank.

The other standpoint expressed the museum's potential and commitment to interfere in the topical issues and discourses of the society and help to bring about a change of attitude. According to Habsburg-Lothringen [1], presentations have to have a relation to actual reality, which reflects contemporary cultural theoretical, philosophical and other standpoints. An approach that surpasses the borderlines of one's branch of knowledge enables one to specify phenomena and developments in their cultural connections and bring the connections with the nature and other branches of knowledge into sight. When dealing with topical problems at a social level, the importance of the individual diminishes; here, however, the interviewees emphasized the importance of cooperation between the communication manager and the researcher in the communication of problems, so that the visitor would feel the topicality of the theme for him–/herself personally. They regarded it important to find an angle through which to make the problem topical for people *"... it is the aim of the communication manager and of that institution. When an exhibition is being put together, the PR specialist should help to realize it, as the researchers often have their own firm vision. The communication manager should help to reflect the needs of the society. It is exactly this cooperation that can produce the result, which is socially topical for some groups – it can never be topical for everyone. The museum reflects what is topical in the society. ...the museum is up-to-date; the museum communicates actively with the society, this can sometimes remain out of sight"* [5].

The interviewees also brought forth the socio-pedagogical and educational aspects expressed in the opportunities offered to pupils to advance the knowledge acquired at school. Mention was made of another aspect springing from the obviousness of the existence of the museum. Although people do not associate the latter aspect with their daily life, they are subconsciously aware that they can always go to the museum if they wish. An opinion was also expressed that *"the museum should not be very closely connected with everyday life, but it should be continually aware of the processes and trends in the society and have the opportunity, by using its means of expression, also to react to them and have its say in the matter."* Fig. 1, Fig. 2

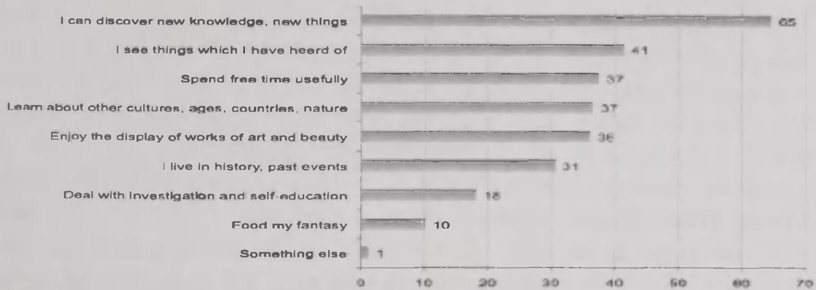

Fig. 1. Why I like visiting museums? N=1570, 2008 [3]

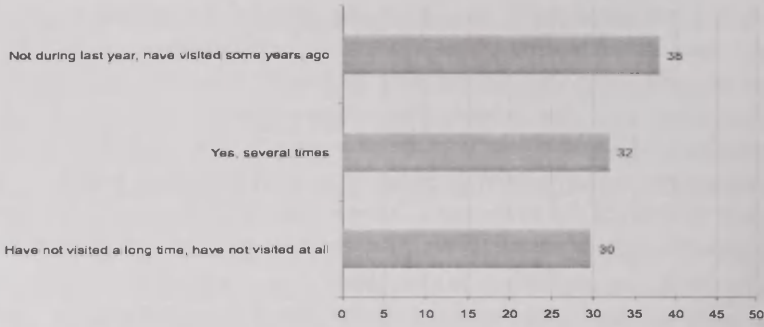

Fig. 2. Have you visited a museum during the last year? N=1570, 2008 [3]

CONNECTION OF THE 100-YEAR-OLD COLLECTION WITH THE PRESENT

Director of the Federal Pathologic-Anatomical Museum in Vienna [6] has made the following observation about the tasks of the medical museum in present-day society: the medical museum has both an educational and entertaining function. At the same time, she mentions a new development – when a couple of years ago the educational mission, namely that the museum should inform and teach, was emphasized, today people come just to look at, for example, specimens of malformed organs, which are also a part of our daily life. This also brings about an exchange of opinions. It is important that topics that may arouse horror should not acquire an event-character. People are interested in discussing essential medical issues – diseases and their prevention. Visitors come to get information on a particular issue, but they also come out of sheer curiosity. The mission of the medical museum is to meet the visitors' expectations as well as to direct them, so that at the end of their visit they experience the so-called aha-effect, which means that their expectations have come true in quite a different sense.

In the case of visits to the anatomy collection, we have noticed people's keen interest in skull specimens. Those specimens originate from the 100-year-old collection of Professor of Anatomy A. Rauber. In order to illustrate the above-treated subject, we have below, in the case of anatomical specimens, tried to bring forth, alongside their scientific aspect, the daily, practical meaning of museum objects.

SPECIMENS OF NORMAL ANATOMY

Figure 3. Skulls of 4-, 6- and 8-month-old embryos. Today we can see the embryo on the computer-screen, but the natural specimens give us the real picture of the development in the first months. Dry specimens (photo by T. Kripson).

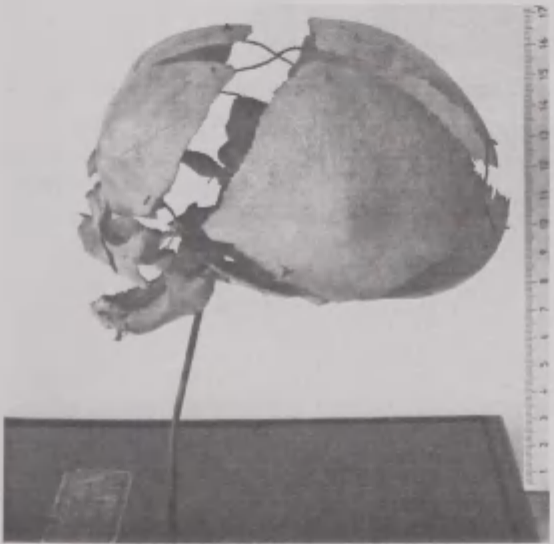

Figure 4. The skull of a newborn, *cranium neonati*. The bones of the newborn are separated from each other to demonstrate the sutures between them. The lines and the ossification centres in these bones are clearly differentiated. Number of museum object 125/C.171, (Gesprengter Schaedel eines Neugeborenen), dry specimen (photo by T. Kripson).

Figure 5. The frontal and parietal bones are separated for the demonstration of the type of sutures as – *sutura serrata* between them. Number of museum object 194; 201/675, dry specimen (photo by T. Kripson).

Figure 6. The structure of the bones of the calvaria. The diploe and diploic veins in the vault bones. The specimen of the flat bones of vault has been prepared to show the structure of the bone. The *lamina externa* has been removed – *diploe* and *vv. diploicae* (a) have become visible. Number of museum object 152, dry specimen (photo by T. Kripson).

Figure 7. The structure of the bones of calvaria. *Dura mater cranii.* The specimen of parietal bone has been prepared for the demonstration of the relationship of different layers of the bone. Number of museum object 122/2568, dry specimen (photo by T. Kripson).

Additional bones can be found in the sutures, but also inside the bones, derived from additional ossification centres

Figure 8. The vault of cranium. Additional bone has been derived between parietal and frontal bones – in the site of anterior fonticle. Number of museum object 138, dry specimen (photo by T. Kripson).

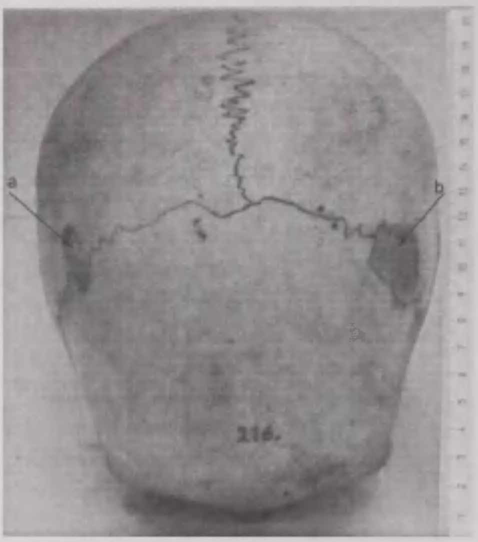

Figure 9. The paired additional bones (a,b) have been derived in coronal suture from two additional ossification centres. Number of museum object 216, dry specimen (photo by T. Kripson).

MALFORMATIONS OF BONES AND SUTURES OF CRANIUM

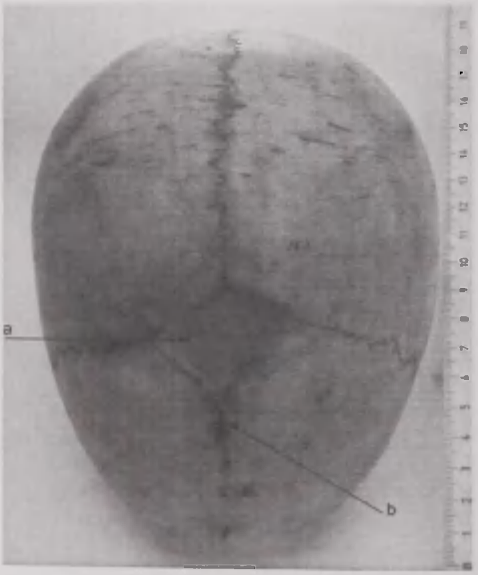

Figure 10. Malformation of the bones and sutures of the cranium. The skull deformation, unclosed anterior fontanelle (a) in adults. Normally the *fonticulus anterior* remains open until two years of age; has remained *sutura metopica* (b) between frontal bones; the bones of cranial vault do not complete their growth during fetal life. The soft, fibrous structures that join them permit the skull vault to deform passes through the birth canal and allow continual growing of brain throughout childhood. Number of museum object 153/ 176, dry specimen (photo by T. Kripson).

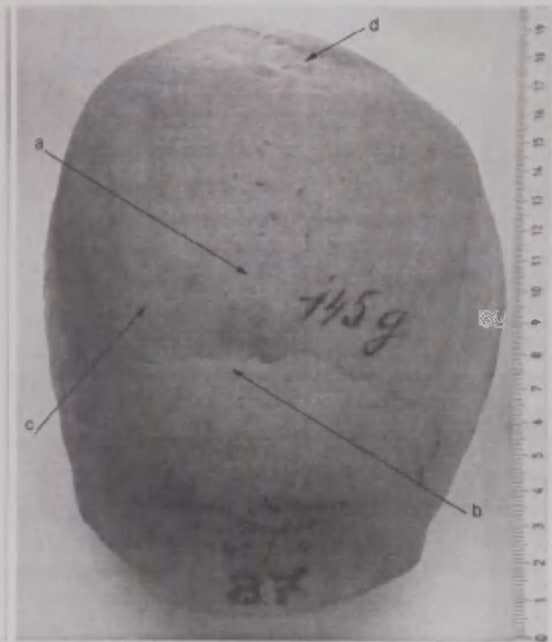

Figure 11. Malformation of the ossification process of the vault of cranium – *plagiocephalus*. The deformed asymmetric skull is the result of premature ossification – closure of sagital (a), coronary sutures (b), temporoparietal (c) and lambdoid sutures (d) – ossification centres and process can be clearly seen. Number of museum object 44/87, note on the skull: *Nikolai Neumann aus Dorpat, 42 Jahre, 145* g, dry specimen (photo by T. Kripson).
Os frontale

Figure 12. Frontal bone, *os frontale* (normal). The line of the *sutura metopica* can hardly be seen. Number of museum object 101, dry specimen (photo by T. Kripson).

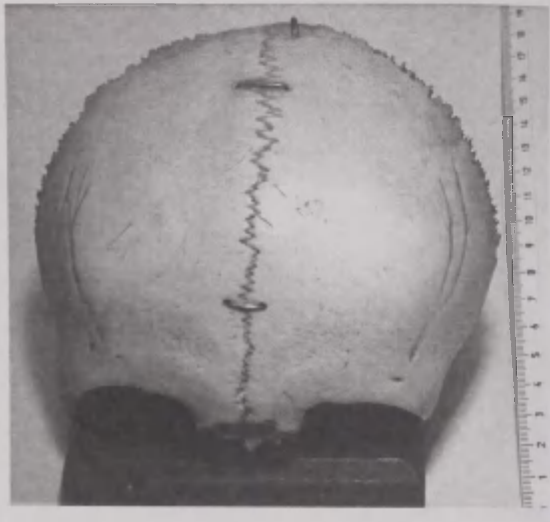

Figure 13. The malformation process of ossification between sutura of the frontal bone. *Sutura metopica* (infused suture between frontal bones). The ossification process of sutura, between the frontal bones normally takes place in the early childhood. At birth the flat bones of the skull are separated from each other by narrow seams. The suture between frontal bone in the normal skull has to be closed at birth. Dry specimen (photo by T. Kripson).

In conclusion, we can say that finding a point of contact between the past and the topical issues of today can be integrated into the museum's strategy and used as a starting point for the museum's communication work.

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SOME ASPECTS OF DIET OF THE 13TH –17TH CENTURY POPULATION OF LATVIA

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ABSTRACT

The paper demonstrates some properties of the palaeodiet in the 13th–17th century Latvia, obtained in a chemical study of archeological bones of the Riga city urban population (13th –17th), the Veselava (14th–17th) and the Jurkalne (16th–17th) rural populations. The determination of seven trace elements (Zn, Sr, Cu, Mn, Ba, Cd, Pb) in bone samples from the proximal end of the tibia was done using ICP-MS. The obtained data show significant differences between the rural and the urban population diets. The highest content of Zn, Sr, Cu and Pb levels were found in the urban population. In all the analyzed population groups Sr, Ba and Mn content was slightly higher in female than male bones, but significant variation among gender was not found. It seems that provisions of the middle class Riga inhabitants were noticeably richer in protein and vegetables than in rural regions. The high level of lead (3 – 10 times more then for rural population), found in the Riga population bones, probably was the result of the usage of lead pipes in the water supply system and the use of pottery made with lead–based glaze for cooking, eating and storing food.

Key words: Latvia, Middle Ages, palaeodiet, urban and rural populations, trace elements in bone tissue

INTRODUCTION

Changes in the diet have played an important role in the biological evolution of humans, and the knowledge of the type of the diet provides useful information about survival mechanisms, economic and social organization and the state of health in the past. In a palaeonutritional investigation only the chemical elements which are assimilated by the organism through food consumption are useful. These elements are fixed in the bone structure in proportion to the consumed amount and are related to specific food categories. The higher levels of Mg, Sr, Ba, Mn, V and Ni content suggest a vegetal diet; higher level of Zn, Cu, Se, and Mo indicate the presence of animal products in the diet [12,13 20]. According to Arrenius (1990, 1994) [1, 2] Zn, Cu and Cd can be used as indicators also for the fish and mollusk diet. Some physiological processes influence the accumulation of trace elements. For example, the higher amount of Sr accumulates in woman bones during pregnancy and the lactation period [3]. Bone sampling location is also important to get valid information for diet studies. Some elements, especially Zn, have a tendency to accumulate in the most intense bone growth places [7]. Some contaminant elements occurring in food are useful for analysis. Lead is one of them, especially in the palaeodiet studies of bone samples from medieval times.

Almost every bone in the human body has been used for drawing dietary inferences: skull, teeth, jaw, vertebra, rib, ilium, femur, tibia, and even undefined bone fragments. It was the explicit assumption of many scientists that dietary conclusions would not depend on the choice of bone, so long as all the samples were of the same type [18].

The multielement analysis of bone samples is most perspective, but various single element analytical techniques are still used. Flame or graphite atomic absorption spectrometry, anodic stripping voltammetry, X-ray fluorescence, spark source mass spectrometry, isotope dilution mass spectrometry, and inductively coupled plasma emission spectrometry are among most useful analytical techniques [16, 19]. The nature of samples can cause analytical difficulties in the application of ICP-MS. The improvement of analytical methods in the last decades has made it possible to employ the trace elements found in bone remains for the reconstruction of the diet. However, there are some problems associated with the analysis of calcified tissues – the low concentration of the accumulated trace elements; interferences from the large amounts of hydroxyapatite present in the matrix and a lack of suitable reference materials for the measurement quality assurance [16].

At the turn of the 13th century, Latvia came under German control, with an orientation in all the spheres of life towards the German-populated areas of Central Europe. In the 14th–18th century, the territory of present-day Latvia was several times divided anew among major neighbouring powers. Most important in terms of consequences were the divisions after the Livonian War (1558–1583) and after the Peace of Altmark (1629). The Latgale region came under the rule of Catholic Poland, the Vidzeme region (Veselava is located in the central part of it) was conquered by Protestant Sweden, while in the regions of Kurzeme, Zemgale and Augšzeme the Duchy of Courland and Semigallia was established, under strong Polish and German influence [5]. Fragmentation brought about significant economic differences between the different regions in the area of present-day Latvia. The economic development of the medieval Riga was determined by its advantageous geographical situation – located at the crossroads of international traffic routes, the city came to be an important centre for transit trade, in 1282 it joined the Hanseatic League [4]. According to these medieval historical events, eating habits and cooking methods varied among the rural and the urban population.

The present study is an attempt to evaluate the properties of the diet of the medieval population in Latvia using the chemical analysis of the archeological bone samples taken from different regions.

MATERIALS AND METHODS

The skeletal material excavated from the three cemeteries – St. Peter's churchyard in Riga (13th–17th century), Veselava in the Cēsis district (14th–17th century) and the Jūrkalne in the Liepāja district (16th–17th century) – have been subjected to trace element analysis. St. Peter's churchyard in Riga contained burials of middle class Riga inhabitants (mainly of German origin), peasants of the manors were buried in Veselava and Jūrkalne cemeteries which contained burials of the serfs of the local manors (see Fig. 1.).

Fig. 1. The geographical location of the Medieval cemeteries

In total, bones of 87 individuals were analyzed. Age and sex were determined using conventional morphological methods. The samples were taken from the proximal end of the tibia using a drill. Samples were then ground in a griding mill using a Retsch ball miles MM301, then dried in an oven at 105 °C till the constant weight. The amount of 0.3000 g of the dried bone sample was placed in the PTFE pressure vessel and the mixture of 4 mL HNO_3 (65%, Merck, suprapur) and 2 mL H_2O_2 (33%, Merck, suprapur) was added. The vessels were capped, placed in the microwave digestion system (Anton Paar, Austria) and heated for 40 min (maximum temperature: T = 125°C, maximum pressure: 35–40 bar). After digestion, solutions were transferred to 25.0 mL volumetric flask and the volume was made up with deionized water (Mili–Q system). Having in mind the very high Ca and P concentrations, the obtained solutions were diluted 10 and 50 times with deionized water before the analysis by ICP-MS.

Seven trace elements (Mn, Cu, Zn, Sr, Cd, Ba, and Pb) were determined by ICP-MS (Elan DRCII-e, Perkin-Elmer, USA). The external calibration method was used in these analyses. Analytical multi-element standard solutions were prepared by diluting multi-element 10 μg mL^{-1} stock solution (Perkin Elmer) for ICP-MS.

Quality control and method validation were performed by the analysis of NIST-SRM 1486 (animal meal) standard reference material.

RESULTS AND DISCUSSION

The sample preparation method and the analysis method by ICP-MS was validated applying standard reference material NIST-SRM-1486 (animal bone). The acid digestion procedure of reference material was successful, digested samples were clear and colorless after dilution with deionized water. The obtained results were in good agreement with the certified values. The recovery of reference material certified value was from 95% to 105%.

As shown in Table 1, the results of elemental analysis demonstrate significant variation among the population groups. According to our data, the highest content of Zn, Sr, Cu and Pb levels was found in the bones of urban population. In all the analyzed population groups Sr, Ba and Mn content was slightly higher in the female than the male bones, but significant variation among gender was not found.

Table 1. Zn, Sr, Cu, Mn, Ba, Cd, Pb average concentrations (μg g^{-1}) in the bone samples from St. Peter's Church, Veselava and Jūrkalne cemeteries

Element	Veselava n=36		Jūrkalne n=12		St. Peters Church n=39	
	Female n = 14	Male n = 22	Female n = 4	Male n = 8	Female n = 20	Male n = 19
Zn	104±26	117±22	109±2	114±11	157±40	170±37
Sr	83±19	78±12	108±21	83±18	122±13	109±17
Cu	1.8±0.5	2.0±1.0	2.1±1.0	2.3±0.9	54±28	27±23
Mn	114±70	107±45	56±29	49±18	121±60	63±29
Ba	24±8	21±10	28±12	21±8	17±6	15±4
Cd	0.10±0.05	0.10±0.04	0.12±0.04	0.08±0.04	0.08±0.06	0.06±0.02
Pb	2.2±2.0	2.2±2.0	2.6±0.9	3.3±1.6	19±12	19±14

In other authors' opinion, Zn is a good diagnostic element in respect of the animal protein content in the diet [10, 12, 13, 18, 20]. The data showed that the determined Zn content was higher in the male than the female bones (Table 1).

Strontium, an element which is not indispensable to effective functioning of the organism, is characterized by a similar chemical structure as calcium; about 99% of ingested strontium is present in the bone at the level of the crystals which form the inorganic component of the skeleton, and it remains there quite stably even after the individuals' death and while the skeleton lies buried [6]. Strontium is particularly concentrated in vegetables, which absorb it from the soil through their fine roots, and is much more present in wide–leafed than in graminaceous plants. In this way strontium enters the food chain and tends to be found in high concentrations of herbivores, and in lower proportions in those of omnivores and carnivores [12, 14, 20, 21].

Figure 2 showed that the determined Zn and Sr content in bone samples among individuals from Veselava and Jūrkalne cemeteries forms a data group with lower Zn and Sr contents than in the individuals from St. Peter's Church cemetery, which formed another group (paired *t*-tests, $p<0.05$). The calculated ratio of Sr/Zn content in the analyzed bone samples ranged from 0.7–0.8, it seems, that the ionic exchange of these elements between the soil solution and the bone proceeded in a similar way in all the analyzed burial sites.

There is more Cu in the bones of carnivores than in those of herbivores [12, 13, 20]. The analysis of Cu content showed an increased level in the analyzed male bone samples. Copper mass concentration ranges from 1 to 6 $\mu g\ g^{-1}$ in the inhabitants of Veselava and Jūrkalne and from 10 to 86 $\mu g\ g^{-1}$ in the inhabitants of Riga. Figure 3 shows that the found Zn and Cu content in bone samples in individuals from Veselava and Jūrkalnes cemeteries formed a data group with lower Zn and Cu contents than in the individuals from St. Peter's Church cemetery, which formed another group (paired *t*-tests, $p<0.05$).

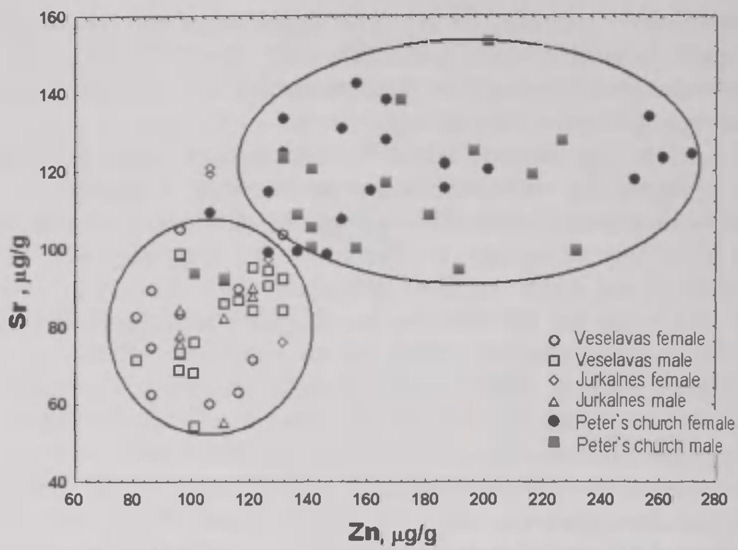

Fig. 2. Relationship between the strontium and zinc content in bone samples in the inhabitants of investigated cemeteries

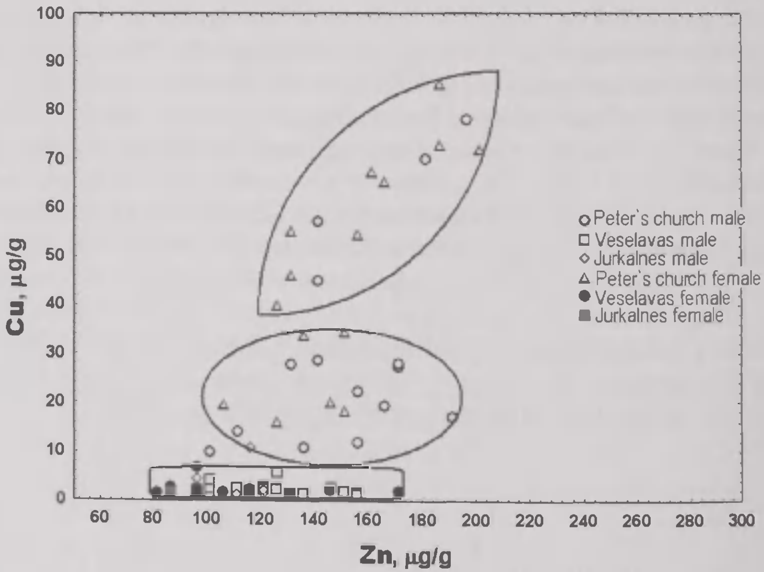

Fig. 3. Relationship between Zn and Cu mass concentrations found in the investigated cemeteries in human bone remains

Barium and manganese are also sensitive diet indicators, which characterize the used quantity of plant food [20]. The obtained data show that the Ba and Mn contents were slightly higher in the female than the male bones, but significant variation was not found (Table 1).

The cadmium content in the bone samples was similar at all the analyzed sites and ranged from 0.06 to 0.12 μg g^{-1}. These data variations were not significant enough to assume the important role of fish and mollusk diet in these populations. It can be stated that Cd was not a significant anthropogenic element at that period.

Lead gives information about anthropogenic activities and environmental pollution. The variation among individuals in Pb bone content is demonstrated in Figure 4.

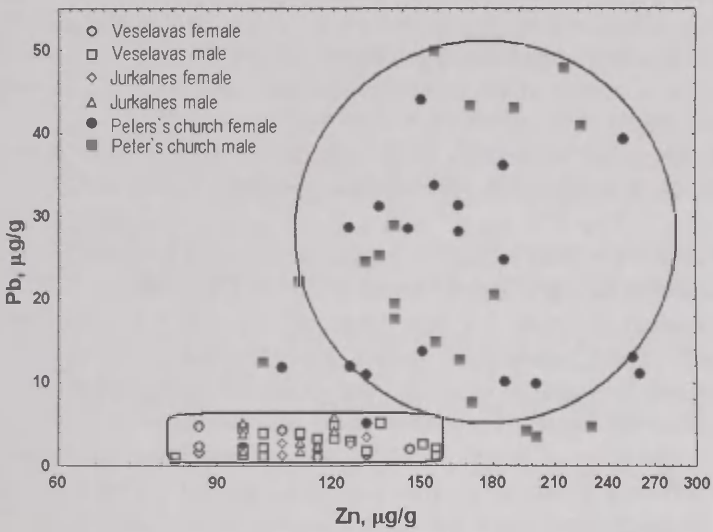

Fig. 4. Relationship between lead and zinc content in the bone samples in the individuals from the investigated cemeteries (Zn contents in the logarithmic scale)

The results of statistical tests demonstrated a significant difference ($p=0.05$) in the contents of Pb between the rural and urban groups of inhabitants. In the city of Riga lead content was 3 – 10 times higher then in the rural populations. Lead mass concentrations range from 0.5 to

5.0 μg g^{-1} among the individuals of Veselava and Jūrkalne (one data group) and from 1.6 to 47 μg g^{-1} for the individuals of the city of Riga (other data group).

Potential contamination may have originated from anthropogenic sources, such as drinking water from lead pipes. The use of lead for the water mains and the poor quality of the water from the River Daugava were of course both detrimental to the health of the consumers. The pipes were made of pine logs of 25 to 30 cm diameter, with a water channel bored through the centre. Special links consisting of lead pipes of various lengths (4 to 8 cm in diameter) were utilized for joining the wooden sections and attaching branching pipes. The lead–glazed 13^{th} and 14^{th} century redware found in Riga was manufactured mainly in Southern Scandinavia. Pottery with lead–based glaze was used for cooking, eating and storing foods and beverages [4]. Lead may leach out of such glazing, especially if in contact with acid food or drink. Glazed pottery as a source of Pb contamination has been common in Medieval Europe [20].

The mean Sr, Zn and Pb levels reported in the studies of the Middle Age in Poland, Bulgaria and England generally lay in the range 109–250 μg g^{-1}; 150–173 μg g^{-1} and 1.1–2.8 μg g^{-1} respectively, showing large variations from region to region and among individuals [17, 20]. Our obtained data are slightly lower in Sr and Zn occasion.

Historical sources indicate, that in the 13^{th}–18^{th} centuries the structure of the Latvia rural population provisions was determined by the limited availability of even most primitive components. The most common constituents of a peasant meal were cereals – groats and flour, used in the form of bread, boiled gruel and porridge. Agriculture and cattle breeding productivity was low. Poor harvest and animal diseases were frequent phenomena and then followed locust years. A significant part of crop was to be surrendered to landlords. Meat was available only on occasions, mainly in the salted form or as fat. Milk was available only seasonally and generally was preserved as butter. Sweets typically consisted of some forest berries and honey [9].

The landlord doctor J. B. Fischer illustrated that inimical conditions for sowing, ripping, reaping was due to frequent raining in summers. People died after a bad crop in 1695–1696 in Vidzeme [11]. There are also a lot of literature sources about the years of the famine in the 18^{th} century, when cold cereals, livestock and peasant's basic food was chaff bread. Mushrooms, moss, couch-grass roots, creeping thistles, nettles, oak acorns, tree barks were important supplements to this diet. In the 19th century potato cultivation helped to eliminate hunger [8].

The situation in the middle class population of the city of Riga was quite different. The consumption of meat, fats, milk products had a significant part in the daily diet [9].

The results of this study are in good accordance with the historical data on the diet structure of Latvian Medieval population.

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BODY BUILD AND PERFORMANCE OF ADOLESCENT MALE VOLLEYBALLERS (AGED 13–15 YEARS)

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ABSTRACT

The article analyzes concisely young male volleyballers' age, body build and performance in Estonian championships for Class C (up to 16-year-olds) in the last three tournaments –Tartu 2005, Viljandi 2006 and Rakvere 2008. In all these years, the participants were the eight best teams of Estonia at the moment. A total of 197 boys were studied; 13 body measurements were taken. Proficiency in the game was assessed for both teams in parallel with two computers provided with the program *Game*.

The basis for creating a classification for adolescent boys with different age and body build was the mean height and weight of the whole sample and their standard deviations. A 5 SD classification of height and weight was used, with the following classes: small, medium, big, pycnomorphs, leptomorphs. The boys' anthropometric variables formed a system according to classes.

Twenty-eight indicators of proficiency in the game were placed into the same classes. Differences in performance could be clearly seen between the first three classes with the results improving gradually towards the big class. No significant differences were revealed between the classes of pycnomorphs and leptomorphs. A characteristic indicator was the total number of points scored, which was six times higher in the big class than in the small class.

In conclusion, the 5 SD classification of height and weight can be recommended for simultaneous assessment of age, body build and proficiency in the game.

Key words: young male volleyballers, height-weight classification, recording system *Game*

INTRODUCTION

Adolescent male and female volleyballers' technical skills are developed at practice sessions and competitions. During the last decade, regular championships have been held in Estonia for 13–15-year-old players – for boys and girls in alternate years – with the participation of the eight best teams. During all these competitions, the players' performance is recorded by the computer program *Game*, and the players are measured anthropometrically [5, 6, 7, 8, 9, 10, 11].

The current paper analyzes concisely young male volleyballers' age, body build and performance in Estonian championships for Class C (up to 16-year-olds) in the three last tournaments – Tartu 2005, Viljandi 2006 and Rakvere 2008. Traditionally the Estonian Volleyball Coaches Association had selected the eight best teams of Estonia for participation. Detailed results are presented below.

MATERIAL AND METHODS

The sample consisted of 197 boys aged 13–15 years from the eight most successful volleyball teams of Class C (up to 16-year-olds) who participated in Estonian championships in Tartu in 2005, in Viljandi in 2006 and in Rakvere in 2008.

Variables and measurement procedures

Anthropometric research

During the intervals between the matches all 197 boys were measured anthropometrically using the method of Martin [2]. Anthropometric measurements were taken by a trained anthropometrist (Mart Lintsi MSc) who had previously shown a test-retest reliability of $r>0.90$.

Thirteen body measurements were taken that in the present authors' earlier studies [10, 11] had shown significant correlation with proficiency in the game. These measurements were weight, height, suprasternal height, xiphoidal height, wrist breadth, chest circumference, waist circumference, hip circumference, upper thigh circumference, lower leg circumference, arm circumference , flexed and tensed arm circumference, and wrist circumference.

Assessment of players' proficiency

To record the games, an original computer program was used, which was first presented by R. Nõlvak (Stamm) [3] in 1995 and has been introduced in a specialist journal in the USA [5, 6].

In this study, two computers equipped with the program *Game* were used for simultaneous recording of the performance of two opposing teams. Parallel recordings were made by volleyball experts – the authors of the present paper, M. Stamm and R. Stamm. All the participating teams played with one another once.

The assessment of players' proficiency proceeded as follows: during the match, the expert registered each case when a player performed a technical element (serve, reception, block or spike). This was done by pressing three keys on the computer keyboard, thereby registering (1) the element performed, (2) the grade for its performance on a five-point scale (1 – excellent ... 5 – failed) and (3) the number of the player who performed the element. For all the elements, the program calculated each player's index of proficiency according to the following formula:

$$\text{Index of proficiency} = \frac{\text{number of performances} \times \text{maximum grade} - \text{sum of grades}}{(\text{maximum grade} - 1) \times \text{number of performances}}$$

Proficiency can range from 0 to 1, where 1 means that in all cases the element was performed excellently and 0 a failure in all the cases.

In addition to the index of proficiency the program calculates the following data for each set and for the whole match:

1) number of performances of technical elements of the game (serve, reception, block, spike) for each player and for the whole team;
2) average indices of proficiency of each element for each player and for the whole team;
3) points scored by performing the elements by each player and by the whole team.

For all the technical elements (serve, reception, block, spike) the total number of their performance for all games was calculated as well as the average number of their performance in one game. A separate count was kept on the total number of successfully performed elements and their average number per game. The number of errors while performing each element and the average number of errors per game were also calculated.

Thereafter, the anthropometric measuring data and the data obtained from the computer program *Game* were further analyzed with the SAS program by one of the authors of the article – Säde Koskel MSc. Relations between the boys' body build and proficiency in the game were calculated using the 5SD classification of height and weight (see Fig. 1).

<table>
<tr><td colspan="5">Weight classes</td></tr>
<tr><td rowspan="4">Height classes</td><td></td><td>Light</td><td>Medium</td><td>Heavy</td></tr>
<tr><td>Short</td><td>Small</td><td></td><td rowspan="2">Pycno-
morphic</td></tr>
<tr><td>Medium</td><td rowspan="2">Lepto-
morphic</td><td>Medium</td></tr>
<tr><td>Tall</td><td></td><td>Large</td></tr>
</table>

Fig. 1. Body build classes

Statistical analysis

The data were analyzed using the SAS system. Means and standard deviations of anthropometric measurements for the whole sample (3 tournaments) and separately for each age group (13–15) were calculated and the variables' relations with age were found (Table 1).

Table 1. Mean values of anthropometric variables of 13-15-year-old adolescent male volleyballers in Estonian championships in 2005, 2006 and 2008 (n=197)

No	Variable	13 years n=23		14 years n=49		15 years n=125		Statistical signi-ficance
		x̄	SD	x̄	SD	x̄	SD	
1.	Height (cm)	161.70	8.432	173.3	8.105	177.79	7.122	+
2.	Weight (kg)	50.46	9.613	59.1	7.965	64.65	8.556	+
3.	Suprasternal height (cm)	131.17	7.404	141.40	7.21	145.57	6.081	+
4.	Xiphoidal height (cm)	115.14	6.557	123.72	6.66	127.38	5.621	+
5.	Chest circum-ference (cm)	76.45	7.551	78.6	10.583	82.17	8.048	13+15, 14+15
6.	Waist circun-ference (cm)	72,58	10.176	77.0	8.503	81.30	10.793	13+15, 14+15
7.	Hip circun-ference (cm)	70.69	25.194	70.5	31.115	67.82	31.851	–
8.	Arm circum-ference (cm)	25.09	2.934	26.3	2.19	27.81	2.754	13+15, 14+15
9.	Arm circum-ference flexed and tensed (cm)	24.13	4.453	24.8	5.798	24.71	5.832	–
10.	Wrist circum-ference (cm)	16.23	0.960	17.1	0.956	17.26	0.963	13+14, 13+15
11.	Upper thigh circumferenc e (cm)	50.72	4.907	52.8	5.011	54.40	5.358	13+15
12.	Lower leg circum-ference (cm)	22.89	1.697	23.4	1.639	23.98	1.422	13+15, 14+15
13.	Wrist breadth (cm)	5.59	0.308	5.9	0.334	6.03	0.336	+

The basis for creating the classification of adolescent boys with different age and body build was the mean height and weight of the whole sample and their standard deviations. To create a 5 SD classification, first a classification consisting of 3×3=9 SD classes (small, medium and big height and weight) was formed. From these nine classes, a classification of five SD classes was created in the following way: first, three classes of concordant height and weight were taken (small height – small weight; medium height – medium weight; big height – big weight). Then the remaining six classes were united into two classes of disconcordant height and weight (big weight and small height – pycnomorphs; small weight and big height – leptomorphs; see Fig. 1). Thus, the five height-weight SD classes were created according to the following rules:

Class 1 (small):

$$\text{weight} < \bar{x}_w - 0.5\ SD_w \text{ and height} < \bar{x} - 0.5\ SD_h$$

Class 2 (medium):

$$\bar{x}_w - 0.5\ SD_w \leq \text{weight} < \bar{x} + 0.5\ SD_w \text{ and } \bar{x}_h - 0.5\ SD_h \leq \text{height} < 0.5\ SD_h$$

Class 3 (large):

$$\text{weight} \geq \bar{x}_w + 0.5\ SD_w \text{ and height} \geq \bar{x}_h + 0.5\ SD_h$$

Class 4 (pycnomorphs):

$$\text{weight} \geq \bar{x}_w - 0.5\ SD \text{ and height} < \bar{x}_h - 0.5\ SD_h \text{ or}$$
$$\text{weight} \geq \bar{x}_w + 0.5\ SD \text{ and height} < \bar{x} + 0.5\ SD_h$$

Class 5 (leptomorphs):

$$\text{weight} < \bar{x}_w - 0.5\ SD \text{ and height} \geq \bar{x}_h - 0.5\ SD_h \text{ or}$$
$$\text{weight} < \bar{x}_w + 0.5\ SD \text{ and height} \geq \bar{x}_h + 0.5\ SD_h \text{ (see Fig. 1).}$$

In order to assess players' body build and age simultaneously, boys of different ages (13–15 years) were placed into the classes of the height-weight classification according to their individual heights and weights. Thereafter, for each of the five classes, average ages were calculated. Then the results were assessed statistically.

Then, the mean values of all anthropometric variables were calculated for all five classes, and the results were compared statistically between classes 1, 2, 3 and classes 4 and 5 by Scheffé test. The significance level α=0.05 (Table 3).

The boys' (n=197) performance in the games during all the tournaments (in 2005, 2006 and 2008) was assessed in the same height-weight classes that had been used for systematization of their anthropometric measurements.

Table 2. Linear models for predicting all anthropometric variables of adolescent male volleyballers (n= 197) by height, weight and age.

		Explanatory variables and coefficients				
No	Predicted variable	Intercept	Age	Height	Weight	R^2
1.	Suprasternal height	–5.3597		0.8344	0.0381	0.9691
2.	Xiphoidal height	–7.1799		0.7564		0.9223
3.	Upper chest circumference	58.9792	1.0579	0.6818	–0.1787	0.8534
4.	Waist circumference	81.2786		–0.2759	0.6460	0.8286
5.	Hip circumference	69.7194		–0.1234	0.6938	0.9047
6.	Arm circumference	31.6526		–0.1403	0.3126	0.8443
7.	Arm circumference flexed and tensed	26.0856		–0.0877	0.2891	0.8119
8.	Wrist circumference	12.3401			0.0784	0.5928
9.	Upper thigh circumference	66.7718		–0.3001	0.6374	0.7596
10.	Lower leg circumference	22.5410		–0.0457	0.1483	0.5936
11.	Wrist breadth	1.009		0.0282		0.5070

For each body build class, the total number of serves, receptions, blocks and spikes, their mean values per player and per game were calculated. In addition to the total number of elements performed, separate count was kept on serves, blocks and spikes that were performed successfully and scored a point.

Additionally, the average (per game) and total number of errors made in performance of all the elements of the game (serve, reception, block, spike) were calculated.

Mean values of the index of proficiency were calculated for performances of serve, reception, spike and block for all the tournaments (2005, 2006 and 2008) and for each class per player.

Finally, the average per game per class and total number of points scored during all the tournaments (2005, 2006, 2008) were calculated.

The data of performance in the game were compared statistically between classes 1, 2, 3 and between classes 4 and 5 (Table 4).

Table 3. Means and standard deviations of anthropometric measurements in a 5SD height-weight classification of adolescent male volleyballers (aged 13-15 years) in Estonian championships in 2005, 2006 and 2008 (n=197)

No	Variable	Body build classes												
		1. Small n=36		2. Medium n=41		3. Large n=36		Statis-tics 1–3	4. Pycnomorphs n=30		5. Leptomorphs n=54		Statis-tics 4–5
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD		$\bar{x}$	SD	$\bar{x}$	SD	
1.	Age	13.861	0.833	14.707	0.461	14.886	0.323	1+2 1+3	14.400	0.814	14.630	0.560	+
2.	Height	161.528	6.373	175.112	2.523	185.483	4.907	+	171.300	6.070	178.500	4.822	+
3.	Weight	48.478	5.733	61.773	2.943	73.450	4.792	+	68.723	7.221	58.661	5.685	+
4.	Suprasternal height	131.197	5.916	143.234	2.660	152.164	4.211	+	140.127	5.230	145.863	4.276	+
5.	Xiphoidal height	115.061	5.177	125.093	2.854	133.161	4.563	+	122.177	4.562	128.022	4.069	+
6.	Upper chest circumference	77.472	4.383	85.168	2.648	90.867	3.870	+	91.320	5.024	82.902	4.623	+
7.	Waist circumference	67.453	3.615	72.861	2.507	77.253	3.666	+	78.967	5.142	70.231	2.679	+
8.	Hip circumference	83.136	5.356	91.066	2.209	97.233	3.728	+	96.397	4.446	88.802	4.052	+
9.	Arm circumference	24.078	1.966	26.398	1.489	28.286	1.664	+	29.300	1.971	25.061	1.664	+
10.	Arm circumference flexed and tensed	25.832	1.842	28.693	1.644	30.778	1.547	+	31.137	1.861	27.430	1.839	+
11.	Wrist circumference	16.064	0.733	17.385	0.599	18.117	0.787	+	17.677	0.799	16.859	0.756	+
12.	Upper thigh circumference	48.800	5.743	53.463	2.394	57.889	3.480	+	59.330	3.917	50.872	3.179	+
13.	Lower leg circumference	22.367	1.546	24.024	0.918	25.047	1.209	+	24.653	0.984	22.894	1.180	+
14.	Wrist breadth	5.561	0.275	6.022	0.276	6.283	0.323	+	5.820	0.318	5.993	0.246	+

Table 4. Adolescent male volleyballers' (aged 13-15, n=197) proficiency in Estonian championships in 2005, 2006 and 2008

No	Variable	Body build classes											
		1. Small n=36		2. Medium n=41		3. Large n=36		Statistics 1–3	4.Pycno-morphs n=30		5. Lepto-Morphs n=54		Statis-tics 4–5
		x̄	SD	x̄	SD	x̄	SD		x̄	SD	x̄	SD	
1.	Serves-total	33.52	17.67	47.40	14.54	41.78	19.38	1+2	34.74	24.71	32.13	21.08	–
2.	Serves-average per game	6.39	2.08	7.66	1.87	6.72	2.43	–	5.99	3.30	6.81	2.47	–
3	Successful serves-total	2.55	2.13	5.47	4.22	5.78	5.55	1+2, 1+3	5.17	4.91	3.49	3.48	–
4.	Successful serves-average per game	0.43	0.34	0.84	0.66	0.97	0.80	1+2, 1+3	0.83	0.75	0.66	0.65	–
5.	Serve errors-total	2.68	2.6	5.42	3.12	5.81	4.86	1+2, 1+3	3.61	3.91	3.36	3.35	–
6.	Serve errors-average per game	0.45	0.41	0.86	0.47	0.97	0.64	1+2, 1+3	0.62	0.54	0.63	0.65	–
7.	Index of proficiency at serve	0.39	0.06	0.41	0.07	0.42	0.08	–	0.40	0.1	0.42	0.13	–
8.	Receptions - total	19.27	23.52	43.68	31.91	39.17	30.44	1+2, 1+3	28.77	26.58	31.81	31.22	–
9.	Receptions-average per game	1.71	2.16	2.31	3.13	4.00	3.10	1+3	3.17	4.57	4.97	4.17	–
10.	Reception errors-total	3.04	3.53	6.15	4.42	4.64	3.68	1+2	3.86	3.53	4.08	4.30	–
11.	Reception errors-average per game	2.10	3.80	2.93	3.55	1.44	1.89	–	1.71	2.46	1.91	3.21	–
12.	Index of proficiency at receptions	0.46	0.17	0.55	0.13	0.55	0.14	1+2, 1+3	0.52	0.12	0.53	0.17	–
13.	Spikes-total	19.36	25.99	60.97	49.51	71.44	65.50	1+2, 1+3	33.68	42.95	40.13	38.89	–
14.	Spikes–average per game	3.74	5.25	9.51	7.43	11.96	9.24	1+3	5.99	6.33	9.13	7.23	–
15.	Successful spikes - total	5.32	8.74	23.11	20.72	31.89	32.65	1+2, 1+3	13.44	17.97	13.80	15.40	–

No	Variable	Body build classes												
		1. Small n=36		2. Medium n=41		3. Large n=36		Statistics 1–3	4.Pycno-morphs n=30		5. Lepto-Morphs n=54		Statis-tics 4–5
		x̄	SD	x̄	SD	x̄	SD		x̄	SD	x̄	SD	
16.	Successful spikes-average per game	0.93	1.67	3.53	2.97	5.06	4.56	1+2, 1+3	2.20	2.50	2.51	2.61	–
17.	Spike errors – total	4.19	5.74	11.18	9.44	11.86	10.47	1+2, 1+3	5.28	7.85	7.52	7.08	–
18.	Spike errors-average per game	0.71	0.98	1.74	1.37	1.92	1.50	1+2, 1+3	0.95	1.12	1.42	1.38	–
19.	Index of proficiency at spike	0.49	0.19	0.58	0.10	0.59	0.15	1+2, 1+3	0.53	0.27	0.55	0.14	–
20.	Blocks-total	4.0	6.06	16.92	12.96	24.51	17.29	1+2, 1+3	12.81	12.91	12.6	12.42	–
21.	Blocks-average per game	0.69	0.41	2.67	1.80	4.16	2.19	+	1.99	1.57	2.82	1.96	–
22.	Successful block-total	0.56	1.47	3.84	3.41	7.66	5.97	+	3.62	4.56	3.6	4.48	–
23.	Successful blocks-average per game	0.09	0.23	0.60	0.49	1.30	1.03	+	0.58	0.63	0.61	0.67	–
24.	Block errors-total	1.56	2.34	5.53	4.53	7.17	5.03	1+2, 1+3	4.43	3.85	3.51	3.46	–
25.	Block errors-average per game	0.27	0.37	0.83	0.63	1.28	0.81	+	0.76	0.51	0.62	0.54	–
26.	Index of proficiency at block	0.28	0.26	0.49	0.20	0.46	0.18	1+2, 1+3	0.41	0.24	0.44	0.26	–
27.	Points won-total	7.43	9.86	31.51	24.89	45.37	42.52	1+2, 1+3	17.67	23.18	19.98	21.12	–
28.	Points won-average per game	1.27	1.81	4.87	3.48	7.26	5.87	+	2.85	3.27	3.63	3.43	–

RESULTS

The results of volleyballers' anthropometric measuring during all the three tournaments of Estonian championships (Tartu 2005, Viljandi 2006, Rakvere 2008) showed the statistically significant mutual correlation between all the variables and the variables' correlation with age (Table 1).

The values of individual variables were in correlation not only with age but even more with height and weight, which represent the body as a whole. In Table 2 we present comparative linear models for predicting all the anthropometric variables of volleyballers (n=197) from age, height and weight.

By predicting the variability of all measurements from height, weight and age, we could demonstrate that together they determine the variability of other measurements with a description rate (in the sense of R^2) in 50–96%. Along with height and weight, the impact of age in regression models was essential in only one case (upper chest circumference).

Consequently, in order to assess simultaneously the peculiarities of body build and age, we placed all the boys into a unified classification of mean height and weight. Boys of different ages (13–15 years) were placed into five classes according to their individual heights and weights.

As Table 3 shows, the systemic character is revealed here as well. There was a significant gradual increase in all body measurements between classes 1, 2 and 3 and essential differences between classes 4 and 5.

Thereafter, the means of performance in the game (28 variables) of the 197 boys participating in all the three tournaments were placed into the same classes that were used to systematize the anthropometric variables (see Table 4). Proficiency in the game was registered by the computer program Game (see *Material and Methods*).

As Table 4 shows, there are clearly noticeable differences in performance between the first three classes. Serves – total, successful serves – total, successful serves – average per game were significantly lower in the small class and increased gradually towards the big class. There were no significant differences in the average number of serves per game and proficiency at serve.

As for reception, the situation was similar. All the variables were the smallest in the small class and increased towards the big class, except the average number of reception errors per game.

All the elements of attack and block also increased gradually and statistically significantly from small to medium to big class.

The results are best illustrated by the number of points scored. While in the small class it was 7.43 and in the medium class 31.51, then in the large class it was 45.37, which is six times more than in the small class.

In the classes of pycnomorphs and leptomorphs, leptomorphs showed better results in some variables, but the difference between these classes was not statistically significant.

DISCUSSION

As can be seen from the aforementioned, body build is very significantly related to proficiency in the game and should therefore always be taken into consideration when studying the performance of adolescent boys.

Considering the peculiarity of the anthropometric structure of the body as a whole, where the leading characteristics are height and weight and the variability of other characteristics is determined by height and weight within 50% [1], the appropriate method for classifying the bodily characteristics is a 5 SD classification of height and weight [8, 9,]. In this classification, all the other bodily characteristics also form a system between classes 1–3 and 4–5. As the classification was based on the mean height and weight of the whole sample, then it was possible to place all the children into the respective classes.

The mean indicators of proficiency of all the boys participating in the games were also placed into classes according to their height and weight. As a result, it was revealed that the height-weight classification showed systematic differences between the classes here too. Thus, it can be concluded that such a classification is justified in practice for adolescent male volleyballers.

The authors have obtained analogous results in assessment of proficiency of young female volleyballers (aged 13–16) in competitions [7, 8]; therefore, our classification can be recommended for simultaneous assessment of body build and proficiency in the game. Application of the computer program *Game* also proved very suitable for recording the matches.

We have not found analogous results in international literature. However, our classification has been acknowledged by C. Raschka [4] as an innovative achievement – an Estonian classification of sport and constitutional typology.

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THE MATURATION OF HUNGARIAN GIRLS DURING THE PAST 60 YEARS

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ABSTRACT

The aim of the present study was to analyse directions and velocities of secular changes in maturation at Hungarian girls from 1947 to 2008. This paper focuses on the changes in the ages at menarche. For the first time, in the middle of the last century, positive secular changes have been observed in Hungary and several parts of Hungary but at end of the 20th century and after that, positive secular trend seems to be slowed down.

Key words: Secular changes; Maturation; Age at menarche, Hungary.

INTRODUCTION

Society, education policy and public health care are all responsible for the children's bodily-physical and mental state. To be able to make efficient decisions, decrees and occasionally laws, information on the biological development of children is indispensable. The secular trend is one of the most important signals of the children's development.

The expression of secular trend means the direction of continuous changes taking place for a long time, for centuries. It became one of the most determinate human biological phenomena during the past one hundred years. According to Eiben's (1988) definition [7], the secular trend is a world-wide famous phenomenon, which manifests itself in the long-term systematic changes of the wide variation of anthropometric traits on consecutive generations living in a given geographical region.

Besides the secular change in body dimensions, the changing rate of development can also be studied by the following menarcheal age in girls. In the beginning, the data on the age at menarche were collected with the help of the retrospective method, thus they are not as reliable as those gathered by the status-quo method. The first estimation of this, which is valid according to the methodology applied today, comes from Véli's research from 1947 [24]. Usually the data have been available since the sixties of the past century.

In Hungary, there are only a few growth studies that provide repeated data on the maturation of girls living in different regions of the country over a longer period to allow a quantitative estimation of secular change in this respect. One of these important studies refers to Kaposvár [27, 4, 19, 21, 22], and the other survey is the Körmend Growth Study [7, 8, 9, 10, 11, 13, 25, 26]. Besides these studies there are some examinations repeated in the same locality several times as well, but they show a shorter period of secular changes (Érd, Székesfehérvár, Makó, Jászság).

The aim of the study was: to analyse the directions and the velocities of secular changes in maturation at Hungarian girls from 1947 to 2008.

MATERIAL AND METHODS

Two nation-wide representative growth studies were carried out in Hungary. The first one was organised in 1982–1985 [12] and the second one in 2003–2006 [5].

In the former period menarcheal data were published from time to time in Kaposvár [27, 4, 19, 21, 22], in Körmend [7, 8, 9, 10, 11, 13, 25, 23], in Érd [17, 18, 16], in Székesfehérvár [2, 3], in Makó [15] and in Jászság [20].

In all the studies the ages at menarche were collected with the status quo method and elaborated with the probit analysis. A regression curve, a trend line was put on to the point lines which were going to be analysed for studying the tendency. With this method the speed of the rhythm of the change was indicated besides the direction of the change.

Statistical analyses were made by the SPSS programme-pocket.

RESULTS AND DISCUSSIONS

In Hungary the first information on menarche was collected by Semmelweis, from the1860s (recall method). At that time the occurrence of the first menstruation was between 15–19 years. After that, almost one hundred years later, in the middle of the last century Frigyesi calculated 15.5 years (the recall method) [7]. It is more years less than the former result! One part-phenomena of the positive secular trend is that the maturation has started earlier, so the age at menarche decreased. As it is well known, all these happen under the influence of genetic and environmental factors, too. About ten years later, in 1959–1961, some data of menarcheal were collected from the local studies and the national survey was made from these results. On the basis of this study the age at menarche was: 13.23 years [6]. But the first nation-wide representative growth study was the Hungarian National Growth Study (HNGS). It was carried out between 1982 and 1985, covering 1.5% of all the children aged 3 to 18 years [12]. The study program consisted of the investigation of anthropometric measurements and fitness data, in addition, a questionnaire on the children's socio-demographic background was used. The growth standards from 3- to 18-year-old children, based on these results, were published. The authors already used the statusquo method for calculating the menarcheal age. The median was: M=12.89 years. At the same time Farkas (1986) [14] collected the data of menarche as well, with great numbers of his sample but not covering the whole country. He got M=12.79 years. Between the previous and the next studies the difference is nearly half a year. Decreased at a rate of 2.6 months per decade by linear regression. When the settlement size was included as a grouping factor in the linear regression estimate, it was found that the decrease of the maturation age was fastest in the case of girls living in the settlements with 10,000 and 20,000 inhabitants (about 4 mo/decade), the same rate in the communities with more than 100,000 inhabitants was about 2.5 mo/decade. In the capital of more than 1 million inhabitants the age at the onset of menstruation decreased also 2.5 mo/decade between 1959 and 1979 [1]. Twenty years later the second nation-wide representative growth study was carried out at the beginning of the 21th century. The "National representative survey, 2003–2006, of the biological and health status of children aged 3–18" was organised by Bodzsár [5]. The median age at menarche remained practically the same – M= 12,79 years (95%: 12,78–12,81) (Bodzsár and Zsákai, unpublished data). Thus the secular trend appears to have levelled off for the age at menarche in Hungary according to the last results.

What can be explained on menarcheal changes in several parts of Hungary? The first series of importance refers to Kaposvár (Table 1, Figure 1).

Table 1. Menarcheal age (years) medians in Kaposvár

Author	Year of study	Age of menarche (median, year)
Véli	1947-48	13,90
Véli	1962	12,98
Bodzsár and Véli	1975	12,72
Környei et. al.	1981	12,69
Suskovics	1997	12,61

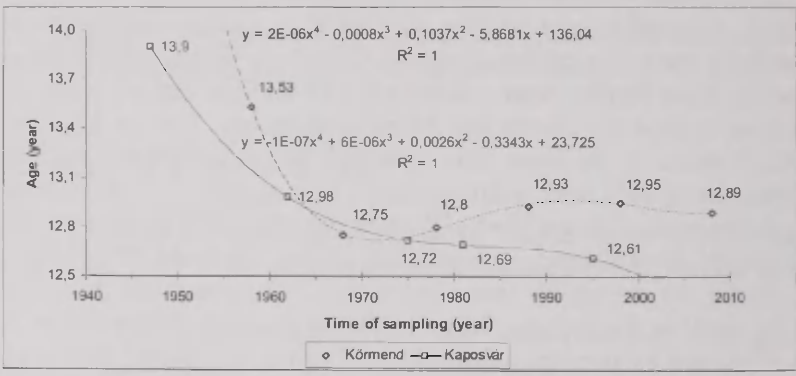

Figure 1. Regression equations and trend lines for age at menarche in Kaposvár and Körmend

In this town growth studies have been conducted since the nineteen-twenties. The first auxological researches were carried out by Véli. Besides the issue of growth, Véli had also interest in the maturation of girls, the change of age at menarche. The first survey of Véli concerning menarche dates back to 1947. Employing the probit analysis, he re-evaluated his data in 1968 so also these data could be compared to later observations. Thus in 1947–48, Véli [27] found a median M=13.9 years as the appearance of the first menstruation in Kaposvár girls. The median age at menarche in 1962 was calculated nearly a year earlier – M=12.98 years – than in the previous study [27]. His data from Kaposvár concerning this were used for the first national menarche study as well [6]. In the relationship of maturation and growth, he stated that menarche appears in the year following the largest growth of the body, the puberty growth impulse peak [27]. More than ten years later, in 1975, Bodzsár and Véli [4] calculated M=12.72 years. Following this, in 1981, another study was carried out. Környei et al. [19] defined the median age at menarche as M= 12.69 years. At the end of the last century (1997) sample resulted M=12.61 years (conf. intervall: 11.86–13.36) [21, 22]. Figure 1 shows the secular change in maturation in the past 50 years. Secular changes in Kaposvár kept a positive trend all throughout the 20th century. Based on the latest research results, this trend is slowing down due to significant economic and social changes in the background.

The Körmend Growth Studay (KGS) is another survey of repeated cross-sectional growth studies. The KGS was started in 1958 by Ottó Eiben, and thereafter he repeated his investigations every ten years – K-58, K-68, K-78, K-88 [7, 8]. In 1998 the study was carried out by Eiben and Tóth– K-98 [9, 10, 11, 13, 25] and after Eiben's death KGS – K-008 was organised by Tóth. The ages at menarche are presented in Table 2 and Figure 1.

Table 2. Menarcheal age (years) medians in Körmend

Author	Year of study	Age of menarche (median, year)
Eiben	1958	13,53
Eiben	1968	12,75
Eiben	1978	12,80
Eiben	1988	12,93
Eiben and Tóth	1998	12,95
Tóth and Suskovics	2008	12,89

These have changed over the previous decades. The age at menarche at the first study was M=13.53 years. This median was the highest value among others, which was carried out at that time and therefore it was higher than the result of the national-wide sample in 1959–61 [6]. The median of K-58 had been decreasing during the first period of the study and it became the earliest ages at menarche until that time in Hungary (M=12.75 years) [9]. This was followed by stagnation, then by a reversal of the trend. In addition to referring to the important changes in the socio-economic conditions of the town, population had undergone certain change affecting also its relative genetic balance owing to the migration observed in 1970–1980 [9].

A shorter period was studied in Érd, in Székesfehérvár, in Makó and in the Jászság region. In Érd M=12.85 years was estimated for the menarche median in 1979 [17]. The next investigation was in 1989, with M=12.60 years [18]. The last study, in 1999, resulted M=12.56 years, so the menarcheal values did not change in the last decade [16]. The decrease of age at menarche had stopped by 1999.

The median age at menarche in the Székesfehérvár sample was 12.61 years in 1972. After ten years, in 1982, M=12.65 years was evaluated, then, in 1991, the median decreased to 12.54 years [2, 3]. The results do not show a significant change in the maturation at girls during the investigated period.

In Makó, the earlier study was carried out in 1983 and the last one was organised in 2002 [15]. The median age at menarche was M=12.66 years in the case of the first investigation, and M=12.72 years was calculated in 2002. The results did not indicate any change at sexual maturity in the girls in this region.

The Jászság growth studies were carried out in 1983 and 1984 [20]. The menarche median remained unchanged during the past twenty years (M=12.75 years in 1983, M=12.68 years in 2004).

In comparison of the ages at menarche the investigation reveals first of all that there is a positive secular trend up to the end of the 20th century, though it shows decreasing intensity during the last decades. According to the changes of the median values of ages at menarche the previously faster decrease, between 1947 and 1960s, became considerably slower since the 1960s.

This corresponds to the experience at the end of the 20th century, which shows a stop of the earlier occurrence of menarche, what is more, sometimes its later occurrence. At the end of the 20th century the positive secular trend seems to be slowed down in Hungary. This trend can be followed mostly at the samples of Kaposvár and Körmend (Figure 1). The reason can be explained by the decreasing standard of living after the change of the regime because the secular trends are strongly influenced by the different environmental factors.

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FEATURES OF LIVER APOPTOSIS IN CHRONIC HEPATITIS C VIRUS INFECTION

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ABSTRACT

Hepatocyte cell death by apoptosis is emerging as a fundamental component of all acute and chronic liver diseases. The aim of our study was to quantify hepatocyte apoptosis in hepatitis C virus (HCV) infection and to attempt to relate it to the clinical and morphological severity of the disease. The diagnosis of hepatitis C was based on clinical, biochemical, morphological analysis and the detection of HCV RNA in serum. Hepatocyte apoptosis was assessed in 11 patients with HCV and 6 controls without liver disease using the TUNEL method. Disposition and the number of TUNEL positive cells was found out. The Knodell Histology Activity Index was used to grade histopathological lesions. The ISHAK and the METAVIR scoring systems were used for detecting the stage of fibrosis.

The investigations showed that the apoptotic index strongly varies in liver of patients with chronic HCV infection – the difference between minimal and maximal significances runs up to 60 times. It can be supposed that there is a probable interrelation between the number of apoptosis and the intensity of necro-inflammatory lesions and severity of fibrosis.

Key words: apopotosis, chronic hepatitis C virus infection, TUNEL, Ishak scoring system

INTRODUCTION

In spite of a large number of publications about chronic hepatitis C virus (HCV) the pathogenesis of the disease remains the object of discussion. In recent years the interest in HCV has increased the number of studies of regulated cell death – apoptosis, via which the elimination of hepatocytes infected by viruses accomplishes. The process of apoptosis proceeds very rapidly; presumably therefore the identification of apoptotic hepatocytes under physiological conditions is very difficult: only 2–4 hepatocytes from 10 thousand can be defined as apoptotic [22].

Information about apoptosis in liver is limited. Until the 1990s clinicians-hepatologists paid almost no attention to the hepatocyte's apoptosis, and systematic studies on this problem were not conducted [4]. Nowadays it is widely acknowledged that apoptosis plays a significant role in the pathogenesis of many liver diseases, including hepatitis, hepatocellular carcinoma, cholestatic diseases of liver [7, 15, 28], etc. Different aspects of connections between apoptosis and pathology of the liver have been examined in numerous studies [3, 16, 20, 21].

The aim of our investigation was to study the distribution and the quantity of apoptotic hepatocytes and find out the correlations between morphological and clinical features – apoptotic index, histolpathological lesions and stage of fibrosis – in the patients affected with HCV.

MATERIAL AND METHODS

Patients

In the study 11 HCV patients with weak, moderate and expressed degree of fibrosis according to the classifications by Ishak and METAVIR participated [5, 9]. The biopsies from 6 patients with B hepatitis served as negative controls.

The diagnosis of chronic HCV was established after careful examination of patients: the anamneses of diseases and life, laboratory analyses, virological and morphological studies. During the formulation of the diagnosis the classification of chronic liver diseases, accepted by the International Congress of Gastroenterologists (Los Angeles, 1994), was used. To refine the diagnosis as well as for the detection of the activity of pathologic processes in the liver, aspiration biopsy according to G. Menghini was taken from all the patients [12, 13].

Immunohistochemistry

For a better determination of apoptotically changed cells the terminal deoxynucleotidyl transferase (TdT) mediated dUTP nick-end-labelling (TUNEL) was carried out. For TUNEL assay a standard *In Situ* Cell Death Detection Kit-POD (Roche, U.S.A.) was used according to the manufacture guidelines as described previously [6, 17, 25, 26]. In short: paraffin slices with a thickness of 5 μm were cut followed by deparaffination and rehydration, incubation in the working solution of proteinase (Proteinase K), washing in the phosphate-buffered saline (PBS); thereafter the first standard medium (Converter- POD), the second standard medium (PDD-substrates), incubation, washing in PBS, staining by Harris hematoxylin and mounting (Permount) were carried out. The solution without TdT served as a negative control. Slices were observed by microscope Olympus-BX-50 (Japan).

The hepatocyte *apoptotic index* was determined by counting the number of apoptotic cells divided by the total number of hepatocytes, i.e. expressed in percentage.

Stereometric analysis

The stereometric analysis is based on the determination method of the specific volumes of different structures [2]. The calculation was carried out using the standard graticule (400 squares) by microscope objective 400-times. In each field of sight a quantity of non-parenchymal liver structures – portal tracts, with nearby necroses, vessels, interlobular necroses (infiltrations) – were calculated. Other liver structures were studied together with parenchyma (hepatic cords and sinusoids). The relationship between parenchymal and non-parenchymal elements was calculated in percentage.

Semiquantitative methods

To evaluate the activity and the stage of fibrosis, the semi-quantitative methods of rank calculations were used. The index of histological activity (IGA) was determined by Knodell [11], the stage of fibrosis (F) – by two methods: by Ishak and METAVIR [5, 9].

RESULTS

Localization of TUNEL- positive hepatocytes

The nuclei of TUNEL-positive hepatocytes stained in yellow-brownish colours. The arrangement of TUNEL- positive hepatocytes proved to be different. Partly these cells revealed in the form of single cells or small groups (3–5 cells), which lay in the hepatic cords (Figure 1). These hepatocytes were not associated with lymphocytes or with other cells probably because these hepatocytes are eliminated from the cords later. This arrangement of TUNEL- positive cells was characteristic, mainly, for the patients with a comparatively low level of apoptotic index. We assume that in this patient group apoptosis developed as a result of the direct action of the hepatotropic virus. But the course of the possibility of initiation of apoptosis as a result of oxidative stress due to the disturbance of the processes of interlobular microcirculation can not be excluded.

In the patient group with a higher level of apoptosis TUNEL-positive cells revealed more frequently in the zone of small interlobular infiltrations. In this case the hepatocytes were totally surrounded by lymphocytes and Kupffer cells (Figure 2).

Besides that, TUNEL- positive cells were also discovered in the deep zones of severe necroses, connected with portal tracts. Interestingly in the peripheral zones of necroses, on the boundary with intact parenchyma, the TUNEL- positive hepatocytes were not revealed, although these hepatocytes, as a rule, were associated with lymphocytes. It has been assumed that the prevailing form of the hepatocytes damage associated with the necroses is apoptosis, not lytic necrosis [19]. We assume that localizing the TUNEL- positive hepatocytes, closely associated with the lymphocytes, gives us information about the development of apoptosis in hepatocytes.

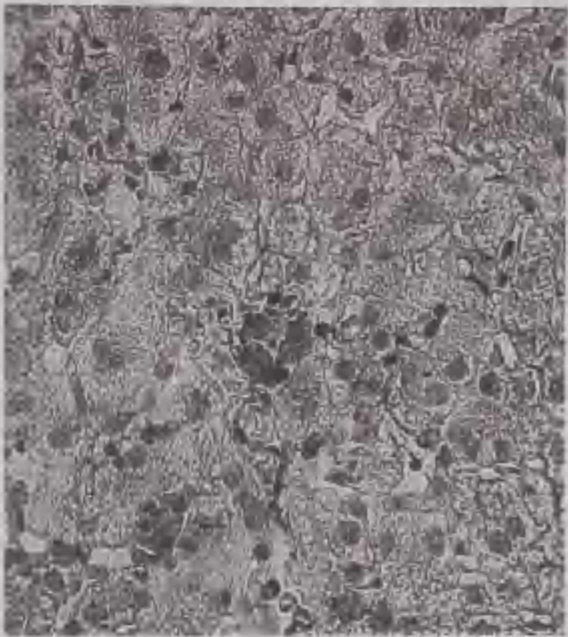

Figure 1. TUNEL assessment of HCV-induced apoptosis in human liver: TUNEL-positive cells (dark cells) in hepatic cords. Obj. 40x.

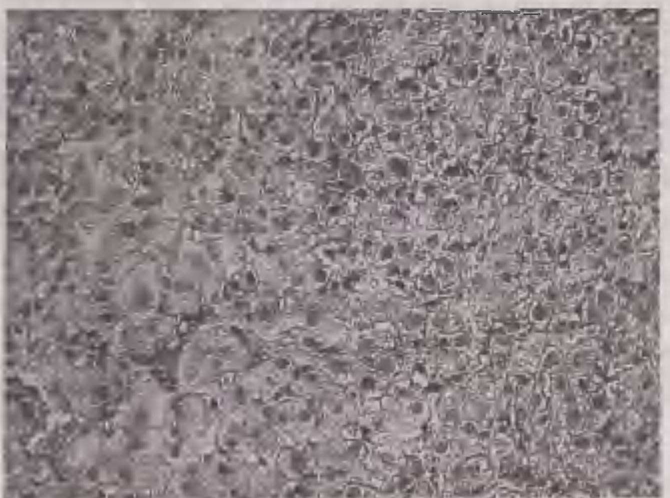

Figure 2. Darkly stained apoptotic cells in interlobular infiltrations. Note the hepatocytes surrounded by lymphocytes. Obj. 40x.

Quantity of TUNEL- positive hepatocytes

Our studies showed that during HCV the number of TUNEL- marked hepatocytes increased in the liver of all the patients. The apoptotic index varied greatly- from 0.02% to 1.2%. As the TUNEL-method reveals the internuclear fragments of DNA, which are formed in the nucleus during apoptosis as a result of activating the endonucleases [6] enabling to fix only a part of the apoptotic cells at the moment of DNA fragmentation, it is possible to suggest that the number of apoptotic cells really increases in HCV virally affected patients. Our investigations indicated to the correlation between the level of apoptotic loss of hepatocytes and the degree of liver damage (Table 1).

For the comparison of liver biopsies the index of histological activity by Knodell [11] and the stage of fibrosis by different methods were determined [5, 9]. Table 1 includes also our data about the morphometric estimation of the specific portion of non-parenchymal elements and interlobular focus infiltrations. For a better understanding of the comparison of the apoptotic index is in the table in the way of its sequential increase. Our analyses cleared up that there are no direct correlations between the number of apoptosis and the degree of liver damage. In the group of patients with a comparatively low level of apoptosis (from 0.02% to 0.10%) the stage of fibrosis varied from F0 to F4 (by METAVIR), the percentage of non-parenchymal elements varied from 4.30% to 21.53%, the portion of focus infiltrations respectively was from 0.13% to 1.76%. In the group of patients with the high level of apoptosis (from 0.33% to 1.21%) all these indices proved to be more uniformed. The index of histological activity varied from 7 to 12 by Knodell, the stage of fibrosis corresponded F2 and F3 (by METAVIR), the specific share of non-parenchymal elements was from 5.18% to 11.76% and the portion of focus infiltrations varied from 0.84% to 2.61%.

Our studies, based on the localization of apoptotic hepatocytes and quantitative analysis, proved that there is a tendency towards an increase in the number of apoptotic hepatocytes in the patients with HCV.

Table 1. Comparative characteristics of the apoptotic index, grading of histopathological lesions (HAI) and stage of fibrosis (semiquantitative and morphometrical estimation) in liver of patients with HCV

No.of patients	Apoptotic index (%)	HAI by Knodell	Stage of fibrosis		Stereological morphometry	
			Ishak (1995)	METAVIR (1994)	non-parenchymal elements (%)	intralobular infiltrates (%)
1	0.02	2	F_0	F_0	4.30	0.13
2	0.02	8	F_2	F_3	9,68	1.17
3	0.03	2	F_1	F_1	4.63	0.30
4	0.09	13	F_3	F_4	21.53	1.64
5	0.10	10	F_2	F_3	9.46	1.76
6	0.11	5	F_1	F_1	4.70	0.02
7	0.12	7	F_3	F_4	10.89	1.27
8	0.33	12	F_2	F_3	5.18	0.84
9	0.48	8	F_1	F_2	6.64	2.02
10	0.65	10	F_2	F_3	10.56	2.61
11	1.21	7	F_2	F_3	11.76	1.56

DISCUSSION

The studies about HCV have been increased recently. Calabrese with co-authors studied hepatocyte apoptosis by TUNEL in 61 of patients with chronic HCV [1] showing the correlation between the apoptotic index, the index of histological activity and the quantity of CD8-positive lymphocytes was established. At the same time no revealed correlation with transaminase level or with genotype HCV was noted. The obtained results confirmed the role of the immunemediated apoptosis in the pathogenesis of HCV.

The increase of apoptosis is usually connected with the involvement of different signal systems, such as Fas, TNF-alpha, the members of family Bcl-2 [3, 14]. Thus, in the liver of HCV patients the expression of Fas and the core antigen of virus hepatitis has been studied [8]. The probable mechanisms of viral action on hepatocytes have been presented by Rust and Gores [21].

Apoptosis during the virus hepatitis can be a result of the direct action of the virus or as the defined immune reaction. Since in the dead cell the replication of the virus becomes impossible, the "interest" of virus is to stop apoptosis and to preserve hepatic cells alive. It has been shown that some virus proteins are coded to possess anti-apoptotic activity, suppressing the functions of the protein p53 and enhancing the expression of Bcl-2 [15, 16].

Our data about the quantity of TUNEL- positive hepatocytes are very close to the results of the studies by Calabrese and co-authors [1]. According to their data the apoptotic index in HCV patients varied from 0.01% to 0.5%. To compare, in our study the apoptotic index varied from 0.02% to 1.2%.

It has been shown that the absorption of the apoptotic corpuscles, formed during hepatocyte's apoptosis, might be caused by perisinusoidal stellate cells [27] which activate the synthesis of collagen thus serving in the development of fibrosis during liver damage. Our material revealed the tendency towards an increase in the number of apoptotic hepatocytes simultanously with the histolopathological changes including fibrosis, during HCV.

Some researchers suggest that in HCV two processes occur – the induction of intra-hepatic apoptosis and the induction of anti-apoptotical signals [10]. The HCV proteins induce strong intrahepatic signals, which cause the expression of factor kappa B (NFkB), the activator of apoptosis and IL-8. The surplus of expression of NFkB can cause either an increase in the sensitivity or the stability of apoptosis, which, in turn, leads either to the elimination or to replication of the virus inside the liver [23]. At present special attention is paid to the possibilities of using the knowledge of suppression or the activation of apoptosis for the therapeutic purposes of HCV.

CONCLUSION

Apoptosis is an essential feature contributing to liver injury in a wide range of acute and chronic liver diseases [21]. In the present study we have demonstrated that the hepatocyte apoptosis significantly increases in patients with chronic HCV infection. The apoptotic index strongly varies in the liver of patients with chronic HCV infection. The difference between minimal and maximal significances runs up to 60 times, that may be caused by the individual properties of an organism.

The number of apoptotic cells appears to increase coincidently with the severity of histopathological lesions and especially with the severity of fibrosis. The hepatocyte apoptosis results in the generation of apoptotic bodies. As apoptotic bodies are cleared from tissues by phagocytosis [18, 27] it can be assumed that the phagocytosis of apoptotic bodies by stellate cells in the space of Disse may be the potential mechanisms linking liver injury to fibrosis.

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AUGUST RAUBER'S TARTU PERIOD AND CREATION OF THE PROFESSORSHIP OF ANTHROPOLOGY AT THE UNIVERSITY OF TARTU

Maie Toomsalu

Medical Collections of the University of Tartu

In 1885, after Professor of Anatomy Ludwig Stieda had left the University of Tartu (in German Dorpat) for Königsberg University, the post of the professor of anatomy in Tartu remained vacant. On 18 November 1885 Eduard Raehlmann, then Professor of Ophthalmology, invited August Rauber to work in Tartu, and Rauber accepted the offer. Wilhelm His[1] had, despite disruption of cooperation with Rauber, given the Faculty of Medicine at the University of Tartu an entirely laudatory opinion about Rauber. What became decisive, however, was

[1] Swiss anatomist and embryologist (1831–1904), the discoverer of histogenesis, taught in Basel (1857–1872) and Leipzig (1872–1904). He discovered neuroblasts and that each nerve fibre is connected to a certain nerve cell (1883). In 1872 His invited Rauber to Basel and when he moved on to Leipzig, he asked Rauber to come along. In Leipzig, however, discords arose between Rauber and the Leipzig school, including His, on questions of principal importance, and in 1875 Rauber left His' department.

the praise by Carl Wilhelm von Kupffer, a former professor of anatomy at the University of Tartu, who was then working at the University of Munich [13, 7]. By that time the University of Tartu had employed such renowned scientists as Professor of Physiology Alexander Schmidt (nicknamed Blut-Schmidt), Professor of Pathological Anatomy Richard Thoma, gynaecologist Heinrich Max Runge and psychiatrist Emil Kraepelin. The University of Tartu enjoyed a good reputation, and it had happened earlier too that a German scholar chose Tartu instead of a minor university in Germany. For Rauber Tartu was the only opportunity. Although the danger of Russification loomed on the horizon, Tartu was still a university with a German teaching staff, a German mentality and numerous German-speaking students. Rauber was already receiving congratulations in Leipzig, but the Russian government was slower than expected at giving its approval, which made Rauber somewhat impatient. On 10 December 1885 Rauber sent a letter to the Dean of the Faculty of Medicine at the University of Tartu where he announced in his modest but determined way,

"So darf ich Ihnen denn gestehen ... dass ich mich ... in die neuen Verhältnisse bereits so gut eingelebt habe, als aus der Ferne möglich. Trotz vielfach abziehender Beschäftigung verweile ich doch im Geiste sehr viel bei Ihnen und habe mir auch meine Vorlesungen und Kurse alle schon zurecht gelegt, die Pläne schon gehörig durchgedacht, nach welchen ich nützlich zu wirken bestrebt sein werde, und die Ziele in Erwägung gezogen, welche mir vorschweben sollen, wenn ich das Lehramt angetreten haben werde. ... Mancher gute Bekannte betont, ... die Schwierigkeiten der politischen Lage der Ostseeprovinzen. Es ist wahr, diese Lage ist ernst. Aber meine Aufgaben liegen einmal nicht nach dieser Richtung hin; andererseits bin ich begierig, auch diese Zustände durch eigene Erfahrung kennen zu lernen; dadurch werden meine Kenntnisse nur gewinnen können." (Thus, I can confirm to you ... that I have already adapted myself to the new conditions as much as it is possible from the distance. Despite various distractions, I am very often with you in my mind and have already prepared my lectures and courses, thought over the plans according to which I am going to act and set myself the goals I should follow when I have taken up the professor's post. ... A good acquaintance emphasizes ... the difficulties in the political situation of the Baltic Sea provinces. It is true that the situation is severe. My tasks, however, are not along these lines, but on

the other hand, I am eager to experience these conditions personally, as this would only enrich my knowledge.) [7]

Obituaries to Rauber claim that Rauber arrived in Tartu on 21 February 1886, but the articles “Furchung und Achsenbildung bei Wirbeltieren” and “Über die Mitosen des Medullarrohres”, which were published in the journal *Zoologischer Anzeiger*, have already been dated in Tartu and arrived in Leipzig on 9 and 11 January 1886 [7]. As we can see, the resettlement problems did not stop the scientist’s research activities. After L. Stieda’s departure, the tasks of Director of the Institute of Anatomy had been assigned to B. Körber (1837–1915), Ordinary Professor of the Institute of State Medicine. It was he who handed over to August Rauber the possessions of the Institute of Anatomy, including the large collection of anatomical specimens – 882 types of specimens, a total of 1170 exhibits [2]. The staff of the Institute of Anatomy included, apart from the director, a prosector and a supernumerary assistant to the prosector. After Stieda’s departure, anatomy had been taught by Prosector Adam Bruno Wikszemski, who had occupied the prosector’s post from 1876 already [15]. Although Wikszemski was in poor health, he worked under Rauber as prosector until 1889 when he went to Berlin for an operation and did not return to Tartu. His successor from 1891 was Hermann Ernst Adolphi. The assistants who worked under Rauber during his Tartu period were A. Kolossow (1891–1894), R. Weinberg (1895–1905) and E. Landau (from 1905).

By that time, the Institute of Anatomy had already been divided into the departments of normal anatomy and embryology, histology and comparative anatomy. The head of the latter was Emil Rosenberg. On 27 February 1886, Rauber took his oath of office. He also delivered an introductory lecture “On the significance of scientific anatomy” in which he defined the trends and tasks of anatomy. He emphasized the significance of the phylogenetic and ontogenetic trends in anatomy, underlining the interdependence of function and morphology. Along with the practical significance of anatomy, he emphasized its importance for general education. A. Rauber set the task to create optimal living conditions for the human organism with its complicated composition from its initial stages of development, in order to decrease morbidity and prolong life expectancy.

The list of possessions Rauber took along from Germany [4] shows that he arrived in Tartu with four boxes of books, a box of anatomical instruments, three boxes of wet specimens, a box of anatomical specimens and plaster casts, and a box with models of prehistoric tools and other teaching materials. Rauber started to rule the institute with a firm hand; he did not undertake any great changes but followed the beaten track. He paid great attention to demonstrating original specimens as well as models, thus creating a solid foundation for the students to start using the museum of anatomy created in 1890. Until 1890, Rauber taught, along with anatomy, also a course on microscopic anatomy and until 1898 topographical anatomy.

What changes happened shortly after August Rauber had taken up a professor's post at what he expected to be a reputable German-language university? The Universities Statutes of 1884 put an end to the autonomy of universities, which was limited anyway, and subjugated them fully to the minister of education and the curator of the educational district. The reform of the University of Tartu in 1889–1895 consisted mostly in partial application of the 1884 Universities Statutes meant for the whole of Russia, adoption of several limiting regulations and transition from German to Russian as the language of tuition. Transition to Russian was encouraged by raising the salaries of the staff members who worked in Russian. Their salaries were equalized to the salaries in other Russian universities, i.e. 3000 roubles a year for an ordinary professor, 2000 for an extraordinary professor and 1200 roubles for an associate professor. According to the Statutes of 1865, ordinary professors of the University of Tartu received 2400, extraordinary professors 1700 and associate professors 900 roubles annually [12].

The regulation of 20 November 1889 abolished the elections of the rector, the vice-rector, deans and professors – they were appointed to their posts. This meant an end to more than 80 years of autonomy of the University of Tartu. Minister of Education Delyanov said in justification that "the extraordinary situation in Tartu curbs the authority of the minister..." [12].

These changes still did not mean full abolishment of the1865 Statutes of the University of Tartu – they were valid with amendments until 1918. Transition to the Russian language of tuition was mostly achieved by employing lecturers of Russian ethnicity. From 1892 clerical work and official correspondence were carried out in Russian. In 1893 an order followed that exams should be taken and public lectures delivered in Russian. In 1895 most lectures in four faculties were given in Russian. An exception was the Faculty of Theology, which continued working in German until 1916 [12]. As the name of the town of Tartu was changed from the German Dorpat to the Russian Yuryev, the university was also officially named the Imperial University of Yuryev (*Universitas Jurjevensis*), and the former Tartu educational district was changed into the Riga educational district.

From 1889–1918, the university had seven rectors. The last German rector and the first who was appointed according to the new rules was O. Meykow (1890–1892), a graduate of the University of Tartu and Professor of Roman Law. He was followed by the first Russian rector A. Budilovich (1892–1901); from 1901–1903 the rector was Professor of Constitutional Law A. Filippov, from 1903–1905 Professor of Anatomy G. Levitski. In 1905 election of rectors by the University Council was restored, and the first rector elected thereafter was Y. Passek, Professor of Roman Law (1905–1908). After that the rector's post was held by Professor of Mathematics V. Alekseyev (1909–1914) and Professor of Criminal Law P. Pustoroslev (1915–1917).

The annual budget as envisaged by the 1865 Statutes of the University had become insufficient for constantly increasing teaching and research expenses. Applications by the University of Tartu for one-off allocations to cover the budget deficit and debts became quite usual. Neither was the existing material basis satisfactory for the needs of developing science. In 1902 Minister of Education G. E. Zenger drew the attention of Minister of Finance S. J. Witte to the fact that all the auxiliary institutions of the University of Tartu were outdated; there were few lecture-rooms and they were cramped; the study rooms and laboratories could not accommodate the equipment and collections [12]. A representative of the Ministry of Education who accredited the University in 1908 reported that lecture-rooms in the main building, physics laboratories and rooms of the Institute of Pharmacy could not accommodate all the students; due to shortage of budgetary funding the clinics of the Faculty of Medicine were mostly maintained by patients, and the Anatomical Theatre lacked "anatomical material" [12].

Renowned professors were still allowed to continue lecturing in German until retirement. These were Professor of Anatomy Rauber, Professor of Geography and Ethnography R. Mucke, Professor of

Zoology J. von Kennel and Professor of Surgery W. Koch [12]. From 1890–1896 the number of students declined by 732 people as many German students left. To improve the situation, the government regulation of 13 July 1897 allowed the University of Tartu to admit graduates of theological seminaries of the first category to all its faculties except the Faculty of Theology; they were required to pass additional exams according to the secondary school curriculum. No obstacles were made to applicants from other educational districts who wanted to enter the University of Tartu [12]. The number of Russian students grew to such extent that Rauber was unable to supervise all the work in the preparation hall himself. He left the preparation hall to his assistants and restricted himself to checking the finished specimens. He continued his successful lectures in German until 1910 [7, 13].

In 1909 the university had 2950 students, approximately 40–45% of them at the Faculty of Medicine. In the years of World War I, 70% of students studied at the Faculty of Medicine [12]. The university had become multiethnic. From 1905 the University of Tartu began to admit women, initially as auditor students. The number of ethnic Estonian students was also on the increase. According to historian of science Viktor Kalnin, August Rauber was an active reformer of the University of Tartu. He answered to the circular of 19 February 1900, which required an increase in the proportion of practical seminars, that at the Institute of Anatomy students did so much practical work already that it was impossible to increase its share. Practical classes at the Institute of Anatomy lasted from 9 a.m. to 1 p.m. and from 3 p.m. to 6 p.m. daily during both semesters. Rauber proposed that preparation of specimens and making models by students should also be considered practical work. The museum of anatomy, founded by Rauber, had found general recognition and praise for its collection of specimens and excellent organization of work [5]. At approximately the same time, Rauber submitted to the Faculty of Medicine the draft budget and staff list of the Institute of Anatomy for 1901. Differently from other institutes, it envisaged two posts of prosector's assistants. The staff list included a professor with an annual salary of 6000 roubles, a prosector with a salary of 2000 roubles, two prosector's assistants with 1000 roubles both; 1200 roubles were assigned for the auxiliary staff, 1500 roubles for supervision of students' practical work, 500 roubles for research and 1200 roubles for various other expenses [5].

Rauber was of the opinion that the university reform of 1901 hindered students' harmonious development, and he proposed to add three areas, which were research, fine arts and physical education. To develop research, Rauber recommended the establishment of departments of anthropology, otolaryngology, dermatology, syphilology and bacteriology. The courses in these subjects were to include lectures as well as practical work. The Faculty of Medicine still did not establish a department of anthropology, for which Rauber had specially trained his student R. Weinberg [14].

To educate students in fine arts, Rauber suggested that museums should be founded in Tartu. Museums would be centres where students could see collections of paintings and new trends in art and where discussions on cultural policy could be held. Rauber also said that new permanent theatres should be opened and the best drama and musical productions staged there. Thirdly, Rauber thought that artists and promoters of art should be encouraged to settle in Tartu and a school of fine arts be established. Rauber also found that the university should have its own music teacher to supervise students' music practice. To ensure students' physical development, Rauber considered it necessary that gymnasiums be built. He recommended that the university should have a riding school as well as a boating and a cycling club and supported the idea of a university swimming pool [14].

Rauber also supported women's struggle for their rights; he believed that women should be given the right to acquire higher education in medicine [10, 11].

At the beginning of the 20th century, the building of the Old Anatomical Theatre was in bad repair; its walls were cracked, and money was badly needed for its renovation, or to be more exact, for reconstruction. The Institute of Anatomy received 3000 roubles annually, out of which 1200 roubles was needed for finding new rooms and repairing the dilapidated building [5]. On 5 March 1902, Rauber applied for financial help for acquisition of new apparatus, models and other technical equipment. His wish list included a projector for showing anatomical slides, a camera for photographing anatomically interesting objects, a set of anatomical slides (70 roubles), new anatomical models from Frans Joseph Steger in Leipzig (800 roubles), a middle ear model from Alexander (nearly 90 roubles), a zinced copper box for storing anatomical specimens, a device made according to

Rüdinger for removing fat from bones, a lymph vessels injection device (according to Dalla Rosa), a model of the sympathetic nervous system from Vasseur in Paris. He proposed that vaulted chambers with cement constructions should be built in Riga where corpses could be stored until their transportation to Tartu. Rauber also wanted the building of the Old Anatomical Theatre to get a new coat of paint for the university jubilee [5].

Early in 1909 David Lavrov, Dean of the Faculty of Medicine and Professor of Pharmacology, forwarded a circular to the heads of institutes where he, on behalf of the rector, asked for detailed information about the construction plans of each institute. The information was needed to apply for money from the budget of the Ministry of Education [6]. Rauber presented immediately, on 21 February 1909, a plan of reconstruction of the Institute of Anatomy. This was a revised and extended version of the plan presented by Rauber on 17 February 1909. The main principles had remained the same, but there were alternatives about the buildings planned. According to the new plan, the Institutes of Histology and Pharmacology should have moved out of the building of the Old Anatomical Theatre, which should have been left only for the professorship of anatomy and the recently founded professorship of anthropology. Rauber suggested that annexes be built to the Anatomical Theatre on both sides; one of them would have been meant for operative surgery and forensic medicine; the other annexe would have accommodated the Institute of Pathological Anatomy on its ground floor and the Institute of Histology upstairs [6]. The Faculty of Medicine decided that the Institutes of Physiology and Hygiene should move to the so-called New Anatomical Theatre [6]. On 15 March 1909 Rauber sent a letter to Dean Lavrov where, referring to his poor health and the short deadline for submitting the project, he asked for an extension so that he could present the plans related to teaching to the curator later. Rauber thought that if the Institute of Histology moved out of the building of the Anatomical Theatre, the western wing could be given to the Institute of Anthropology. The Institutes of Operative Surgery and Forensic Medicine were to get rooms in the new building (50,000 roubles). Further, he described the alternative variants for reconstruction of the Old Anatomical Theatre. Rauber was convinced that vaulted chambers were needed. The wings of the building needed reinforcement. After adding two new rows of seats, the lecture theatre would accommodate 350 students, which would be sufficient. Rauber mentioned that he had spoken to the rector and vice-rector about the idea. In his letter he asked the dean to support him, as this seemed to be an opportunity to create an Institute of Anthropology at the University of Tartu [6], which would have been the first of its kind in the Russian Empire. Rauber had trained his student A. E. Landau for working at that institute. A. E. Landau worked as *Privatdozent* of Anatomy [3]. As no finances were received, the plan was not realized. Only smaller additions were built to the wings and other minor repairs were made [6].

In 1914 a new committee was set up at the Faculty of Medicine to find out the urgent needs of the faculty. This committee already included Rauber's successor H. Adolphi who also asked for more spacious rooms as shortage of rooms hindered the development of research [6]. The committee decided that the first to be moved out of the Old Anatomical Theatre would be the Institutes of Histology and Pharmacology. For that, the building of the New Anatomical Theatre was to be built in the area of Väike-Toome (Kassitoome) to house the Institutes of Histology, Hygiene and Pharmacology. The building was to be designed by architect P. Nikitin. Another building, meant for the Institutes of Physiology, Physiological Chemistry, and General and Experimental Pathology, was to be built near the Eye Clinic. The Eye Clinic would have moved into the new building in Maarjamõisa [6]. As World War I broke out, all the plans shattered.

One of Rauber's aims that cropped up repeatedly during his Tartu period was creation of an Institute of Anthropology. In 1901, to improve the teaching anthropology, he achieved the establishment of a professorship of anthropology. Rauber himself did not lecture on anthropology during his Tartu period, but two of his students did – R. Weinberg and E. Landau [15]. R. Weinberg received quite at the beginning of his path as a scientist the K. E. von Baer Award from St. Petersburg Academy of Sciences for his published research papers, three of which dealt with anthropology.

The University of Tartu has no Institute of Anthropology even today, but Rauber's work in this area is carried on by the Centre of Physical Anthropology, which is affiliated to the Institute of Anatomy.

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THE ACTIVITIES OF THE ESTONIAN NATURALISTS' SOCIETY IN 2008

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Estonian Naturalists' Society

ABSTRACT

The activities of the Estonian Naturalists' Society in 2008 are described.

Key words: naturalists, society

INTRODUCTION

The Estonian Naturalists' Society was founded already in 1853 and we were able to retain our activities through all these long and turbulent years. The ENS started to function as *Die Dorpater Naturforscher-Gesellschaft* at *Der Livländischen gemeinnützigen und ökonomischen Societät*. Now we are associated with the Estonian Academy of Sciences which means that the state finances our activities through the academy. It is true, though, that we earn a substantial part of our expenditures by carrying out different projects at diverse organisations among which the most important is surely the Centre of Environmental Investments, but the list of our partners is rather long.

We have 21 subunits which are relatively autonomous and present only their reports at the end of a year.

In 2008 we heard 8 scientific reports during our general assemblies which took place on the last Thursdays of each month. These reports dealt with broad topics, beginning with the dating of buildings using the method of growth rings in trees up to the activities of our sister society – the Estonian Society of Nature Conservation. We celebrated the annual Baer Day together with the Centre for Science Studies of the Estonian

University of Life Sciences. We did not forget that 200 years had passed since the birth of our first president Karl Eduard von Liphart!

Though officially we are the society for nature studies we do not turn our back on the nature conservation and during the last year we argued vehemently about the future of the Estonian forestry and nature conservation. Together with the Commission of Nature Conservation of the Estonian Academy of Sciences and the Estonian Council of Environmental NGOs we discussed the reorganisation of the Estonian forestry and principal problems of the new Environmental Board to be created by the Ministry of Environment. Regrettably the Ministry parried all our proposals. Time will show whether our warnings were justified.

Our President of Honour Academician Hans Trass and the Ex-President Erast Parmasto together with our well-known algologist Erich Kukk celebrated their 80th birthday.

The Society has not forgotten the teachers of life sciences – we continued with the series of lectures "From natural scientists to teachers of life sciences". In addition to that we organised presentation meetings in our subunits, conferences, seminars, conventions, camps, exhibitions, etc.

Seminars and conferences

The XXXI Naturalists' Day "The Planet Earth – Global and Local Problems" was held in the Karula National Park and at Lüllemäe. On the first day of the event, several presentations were heard about the global problems of the planet Earth to the overviews of the Karula National Park, on the second day an excursion was organised in the Karula National Park. The special volume "XXXI Estonian Naturalists' Day. The Planet Earth – Global and Local Problems" was published. The volume dealt with the problems relating to weather and the richness of life of the planet Earth and also gave a specific overview about the surveys of climate and plant canopy of the Karula National Park.

In February the Society helped to organise the opening event of the UNESCO The Planet Earth Year on 18 February in the hall of the University of Tartu. The Planet Earth Year concentrates on basic problems of the planet Earth geology, incl. climate, water and mineral resources, environmental risks, the formation of natural diversity and its protection. The programme of the UNESCO "The International Year of the Planet Earth" was opened festively on 12–13 February in Paris, the activities will take place in 2007–2009, international culmination of it has been planned for 2009 and drawing conclusions for 2010 (http://yearofthe planetearth.org/).

The Commission on plant names and botanical terminology in Estonian worked very actively supported by the Estonian Terminological Union. The library commission, the anthropology section, the Geological Society and forestry section were elected new boards. The activity of several sections has languished or is languishing, due to insufficient monetary means and human force, the general problem of many subunits is the lack of young persons willing to be members of the Society.

Large scale events carried out by subunits of the Society in 2008 were: The Spring School of Theoretical Biology "Laws in Biology" at Haanja on 23–25 May, the Autumn School of Geology "Grand Theories" at Mäetaguse on 10–12 October and the 7th Baltic Teriological Conference in Pärnumaa at Lepanina on 1–5 October. The topics considered were reflected in the volumes issued in connection with the event. The Jakob von Uexküll Centre organised on 25–26 January jointly with the Institute of Philosophy and Semiotics of the University of Tartu an international seminar "What's Wrong with Nature? An Interdisciplinary Seminar Investigating Human Perceptions of Nature and Environmental Change“ and on 8–9 November "Resemblances in Nature and Culture: Theoretical and Semiotic Perspectives". In March the anthropology section organised jointly with the Institute of History of Tallinn University and the NGO Archaeological Centre the Science Day dedicated to Karin Mark's 86th anniversary "Physical Anthropology. The Second Science Day in the Institute of History" and in October the traditional conference commemorating Juhan Aul's anniversary were held jointly with the Centre of Physical Anthropology of the University of Tartu.

The subunits organised scientific meetings traditionally as well. The members of the botany section participated in the conference-expedition of Baltic botanists held in Daugavpils. There was a gathering of Friends of Lichen at Piusa. The Mycological Society organised two mushroom camps, in spring and in autumn, it participated in the organisation of several mushroom expositions, held topical lectures on mushrooms, supervised Study Days and Hikes. Within the framework of the Naturalists' Day there was a meeting of the weather activists.

Projects

The Society participated in fulfilling the projects funded by the Ministry of the Environment, the Centre of Environmental Investments, the State Nature Conservation Centre, the Centre of Forest Conservation and Renewing, the Tallinn Board of Environment, the Financial Mechanism of European Economic Area and the Financial Mechanism of Norway, the Council of Gambling Tax at the Ministry of Education and Research, the Tartu City Government, the Tartu Parish Government, the Cultural Endowment of Tartu, the Estonian University of Life Sciences, the Estonian Union of Terminology, the Union of Setomaa Parishes, the Foundation Tuuru and the NGO Läänemaa Bird Club.

The Society completed the protection organisation plan of lakes Keeri and Karijärv, it is composed of several expert opinions concerning the assessment of environmental impacts and a detailed plan, as well as an expert opinion as to the need or the possibility to improve the state of eight lakes of the Vooremaa landscape protection area by removing the plant cover. The Society carried out the inventory of the forests suitable to flying squirrels and radio-telemetric surveys of flying squirrels. A number of new habitats of flying squirrels were found and a proposal was made to the Ministry of Environment to take under protection 10 areas as species protection sites for the flying squirrel.

The Society continued to develop the databases of observations of nature and its presentation in cooperation with the information network of biological diversity. The public database which can be used by everyone is a good and interesting study aid to schools and nature centres. The Society continued to monitor the diversity of Estonian biota and landscapes, embracing the collection of data on flying squirrels, bats and snails; the national monitoring of water areas, as well as the education and information programme of the UNESCO The International Year of Planet Earth and the filling in the report forms of the European Union Nature Directive. The Society finalised the first stage of the catalogued herbarium of water plants consisting of 3,000 pages which is ready for putting up also in the Internet. In connection with reforming the Environment Department and the Forestry Act, there was an active cooperation with the Nature Protection Commission of the

Academy of Sciences and the Estonian Council of Environmental NGOs.

Library

As of 31 December, 2008 the library of the Estonian Naturalists' Society had 159,794 printed items. The titles were exchanged in the reporting year with 78 institutions and organisations from 24 countries. During the year the library was visited by 202 persons, the number of visits was 902. The library has 435 registered readers, who borrowed 4,066 items, of which borrowing home consisted of 1,236 items and 2,830 items were used in the library.

General meetings of the Society

Here we present the titles of the scientific reports and other items considered at the meetings:

- Alar Läänelaid "Dating of buildings with the help of growth rings", electing of members of Presidium (31 January).
- The Baer Day, speakers Erki Tammiksaar and Ivar Puura (28 February).
- Tõnu Viik "Radioactive radiation around us", discussion of reports for 2007 and approval of working plan for 2008 (27 March).
- Linda Kongo "Karl Eduard von Liphart and the Estonian Naturalists' Society", Juta Keevallik "Karl Eduard von Liphart – attribution specialist and collector" (24 April).
- The joint meeting of the Estonian Naturalists' Society and the Nature Protection Commission of the Academy of Sciences "Science and Law in the Forest" on the topic of the reform of the Forestry Act: Urmas Tartes "Introduction", Ülo Tamm "The Forestry Act in the independent Estonia", Kalev Jõgiste "Sustainable forest use and eco-systemic economy", Enn Pärt "The tree cutting volumes of the past score of years", Kaili Viilma "Protection of the forest nature", Meelis Teder "Overview on the development of timber trade", Lembit Maamets "Practice of forest economy", Rainer Kuuba "Forestry related legislation and practice",

Marku Lamp " Renovations in the Forestry Act" (May 29).

- The joint meeting of the Estonian Naturalists Society and the Nature Protection Commission of the Academy of Sciences: Leelo Kukk ”A couple of years in the activity of the Nature Protection Centre”, Urmas Tartes ”On nature protection in an ideal way”, the discussion on topics of the reorganisation of Nature Protection Centre as suggested by Ministry of the Environment (25 September).
- Erast Parmasto ”Endless self-reorganisation and the postmodernist world”, Erich Kukk ”The ostensibly new may turn out the forgotten old” (30 October).
- Juhan Telgmaa ”The activities of the Estonian Society of Nature Protection” (27 November).
- Reports of subunits of the Society about the activity in 2008 (18 December).

PUBLICATIONS

In 2008, 12 pieces of printed matter and 1 Internet journal were released by the Estonian Naturalists' Society. Released from print were:

- Estonian Naturalists' Society Year Book Vol. 85. Research papers about the history of the Estonian natural sciences. 264 pp.
- Folia Cryptogamica Estonica; 44. 160 pp. (jointly with the University of Tartu).
- Protection of the *Triturus cristatus in* Estonia. 36 pp. (The Handbook of a Nature Observer; 99).
- Keerus, K., Keskpaik, R., Vaher, A. (ed.). Key texts of the environmental ethics. 93 pp. (Uexküll Centre jointly with Ethics Centre of the University of Tartu); the text also available at the address http://www.eetika.ee/orb.aw/class=file/action=preview/id=409486/Environmentaleetika_v6tmetekste.pdf
- Odonata. 64 pp. (Atlas of propagation of Estonian bugs; 3).
- Collection of the XXXI Estonian Naturalists' Day “The Planet Earth – Global and Local Problems”. 116 pp.
- Resemblances in Nature and Culture: Theoretical and Semiotic Perspectives. 31 pp.
- Saar I, Suija A (eds.). XVII Symposium of the Baltic Mycologists and Lichenologists. Estonia, Saaremaa, Mändjala, September 17–21, 2008. Abstr. 40 pp.

- Laws in Biology. 107 pp. (Schola Biotheoretica; 34).
- 7th Baltic Teriological Conference. 110 pp.
- Grand Theories. 84 pp. (Schola Geologica; 4).
- Action plan for organising the protection of bats for 2005–2009. 64 pp. (Estonian game; 10).
- Action plan for the conservation management of bats 2005–2009. 70 pp. (Estonian game; 10a).
- The Siberian Flying Squirrels and its Protection in Estonia. 80 pp. (Estonian game; 11).
- Internet journal "Friend of Lichen", no. 11, 37 pp.

CONCLUSIONS

Looking back at the activity of our society in 2008 we may be sure that it was versatile, covering many branches of natural sciences.

We are aware that our achievements in 2009 may not be that good since the economic crisis did not leave us untouched. Yet we hope that the crisis will soon go by and the Estonian Naturalists' Society will continue persistently its main activity – the research of nature and presenting the results to our people.

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