UNIVERSITY OF TARTU
PRESS
1632

Papers on Anthropology

XXI

UNIVERSITY OF TARTU
CENTRE FOR PHYSICAL ANTHROPOLOGY

2012

PAPERS ON ANTHROPOLOGY
XXI

UNIVERSITY OF TARTU
CENTRE FOR PHYSICAL ANTHROPOLOGY

PAPERS ON ANTHROPOLOGY

XXI

UNIVERSITY OF TARTU
PRESS

The journal is indexed in BIOSIS, SPORTDiscus,
Anthropological Index Online,
EBSCO Publishing, CABI International,
Index Copernicus International,
Thomson Scientific Master Journal List,
GALE / CENGAGE Learning

The journal is available electronically at
ojs.utlib.ee/index.php/PoA

The publication of the journal has been supported by
the Institute of Anatomy, University of Tartu

ISSN 1406–0140

University of Tartu Press
www.tyk.ee
Order No 484

PREFACE

On 15 October 2012 we celebrate the 115th birth anniversary of Prof. Juhan Aul (1897–1994), the founder of the Estonian school of anthropology. We as J. Aul's successors are grateful to him for setting an example with voluminous research papers that have helped us to develop our research. We are also thankful to the European Anthropological Association for their support. Next year we are going to mark the 20th year of activities of the Centre for Physical Anthropology. During those years, three doctoral theses, eight master's theses and two candidates theses have been completed at the Centre. Our collection *Papers on Anthropology* has reached its XXI issue.

We thank our authors and look forward to further cooperation with them.

Helje Kaarma

Prof. Helje Kaarma

CONTENTS

Papers on Anthropology XXI, 2012, pp. 9–26

DO ANTHROPOLOGICAL, ANATOMICAL AND PATHOANATOMICAL EXHIBITS SPEAK?

MAIE TOOMSALU

Institute of Anatomy
Medical Collections of the Faculty of Medicine
University of Tartu, Estonia

INTRODUCTION

The exhibits are spotlighted so that the visitor can see them from several sides. They are provided with explanations in several languages so that everyone interested would understand what they represent. Each exhibit has its own story about how it happened to be included in the exhibition and the story of the person behind it. In rare cases the story of the person is known, but mostly the exhibit and its case history have not moved together. Even if the patient's name is known, it is hidden, and the specimen has become just an object displayed at the exhibition.

"Allegedly it was the Ancient Greek physician Hippocrates who introduced the medical concept of a disease, the idea that diseases have their course which begins with the first symptoms and continues to the climax or turning point and thereafter their happy or fatal end. In medical science, this process is called pathology or the natural course of the disease. The natural course of the disease, however, does not tell us anything about the persons, their experiences of the disease, sufferings and emotions. In present-day case histories, the person is often objectified into the disease that the patient is suffering from, the patient's gender and age" (Sacks 2007). "Patient narratives, pathographies or simply case histories told or written by people on the basis of personal experience show that, when facing medical science, the problem of many patients is that they are not treated as individuals who have their story to tell but as objects carrying the diseases" (Paal 2010: 10–11).

"Different diseases have been predominant at different times, although some diseases have spread for millennia. Traces of cancerous tumours and cardiovascular diseases have been discovered in skeletons found in archaeological excavations and in Egyptian mummies, which means that conditions conducive to the existence and spread of those diseases have also existed in the past" (Paal 2010: 11).

"At present, people's life expectancy has increased; diagnostic technologies enable doctors to discover diseases at their early stages, and diseases are overcome. People can be offered purely preventive treatment, which enhances the quality of life or self-feeling without any obvious symptoms of a disease" (Kinnunen 2012 and Konsa 2012). Paradoxically, from the viewpoint of normative treatment of health, health risks can be substantiated if a value essential for the individual, e.g. pleasant appearance, is created. These procedures also reflect the society and culture. In T. Kinnunen's opinion, people have beauty operations of their own will but motivated by culture (Kinnunen 2010: 289). In other words, cultural discourses have formed people's vision of their bodies. Views on the healthy and the diseased body are changeable.

There also diseases that have a name (diagnosis) but no scientific explanations of their origin and no appropriate cure. If the symptoms of a disease have appeared, the question arises how to become well again. If home cure does not help, a professional is approached. While on a long waiting list, help is sought from various sources. Here an essential role belongs to the economic situation (whether I can afford to be ill) and the health policy of the society (whether the patients get sufficient support and if there are enough finances for treatment and rehabilitation).

The understanding of health and diseases is different in each culture, but nobody denies that health is an asset. Social pressure on biomedicine impels the application of ever better and more efficient medicines. The medicines and treatment methods that used to be considered the best are declared useless or outright harmful. People are in the centre of constant changes; pollution of the environment and the increasing significance of synthetic compounds in people's lives create health problems.

The current study observes why people come to see anthropological, anatomical and pathoanatomical exhibits, what kind of emotions these create in them, and whether certain specimens elicit a dialogue with the viewer and a wish to learn more about them. Are the exhibits and the contexts created by them recorded only in the visitor's short-time memory and forgotten in twenty

seconds, or are connections created between neurons in the visitor's brain, and in addition to the context offered by the curators of the exhibition, a story between the visitor and the exhibit is created, which is recorded in the visitor's long-time memory and can lead to changes in lifestyle?

THEORETICAL VIEWPOINTS OF MUSEUM WORKERS OF THE WORLD

"Responses to and experiences of medical objects on display are historically specific and widely varied. Even the anatomical and medical exhibitions between them today evoke all kinds of different intended and unintended reactions and experiences. ... Medical museums displaying diseases and exhibiting patient histories and experiences can benefit from the debates around the display of disability. One of the core functions of the museum is to hold topics up for discussion, to reflect, and to pave the way for debate, learning and imagination" (te Hennepe 2012:101). "Exhibition can show how the fascination with the damaged body may be turned into a powerful experience and engagement with patient history. Without falling into the trap of stereotyping or discrimination, the display may invite people to stare, so as to reframe those suffering and excluded, and to become involved with the person, to know and let them be known" (te Hennepe 2012:101).

"Museums have a responsibility to keep telling their stories and keep diverse audiences involved with human experiences over time" (te Hennepe 2012: 102).

The Dutch art theorist Hsiang-Ching Chuang finds, "Museum has always been a well-structured elaborating story, in my opinion. Every time when I enter a museum, I always have the feeling that I am walking into an epic. The curated route clearly delivers the core idea of the exhibition through the curator's view. On the way of this fascinating journey, the interwoven story line between the exhibition and the collection and also the various artifacts with perfectly refined elucidations always catch my eyes and bring my thoughts to a magic carpet ride. After the trip, most of the time, with my heart full of amazement, I told myself, "What an exhibition!" (Chuang 2012: 96)

"The strange thing is, I feel satisfied. I am satisfied with the stories of the collection that I have been told in the exhibition, and the concept that the exhibition tries to deliver. At the very same time, I notice that something is missing and the missing part baffles me. Such a feeling, in effect, results from

the fact that my thoughts are trapped in an invisible boundary called "selected information" (Chuang 2012: 96).

"According to my observation, there is always a very strong bond among objects, stories and exhibitions. Depending on the exhibition, selected collections and stories are presented together in a fixed context with their own unique roles. This collective information forms the exhibition, and it gives the core idea and values to the exhibition. In this context, the exhibition builds up a well-structured, narrative and effective presentation. ... this way of presenting is merely a one-way linear communication with the visitors, which limits and scales down the possibility of exploring" (Chuang 2012: 96).

"But then, when we speak of the hidden stories behind (or beyond) the objective impression; they are often referred to as the unknown, the oblivion, the extinction or the uniqueness which are buried inside the object. Unfortunately, these stories and qualities are usually excluded in the range of selected information in exhibition. ... I believe that the unknown, the oblivion, the extinction and the uniqueness are exactly the missing puzzle pieces which lead us forward to discover the true essence of these fascinating collections. Thus, in order to better reveal the hidden story, the current presentation dialogue of the museum needs to bee challenged, and the communication needs to be risen to a higher level" (Chuang 2012: 96).

Chuang also finds that "Medical objects and artifacts are beautiful in their appearances, gestures and pure functionalities. Their rich background can be traced long way back to the history. Yet, due to the differences of time, space, perception and the development of knowledge, the meaning of medical artifacts is hard to be properly translated in the modern era. Even if we try to put those stories and ideas into words, it would just be a limited translation of their breathtaking richness" (Chuang 2012: 97).

"Ruysch always insisted that with the anatomical preparations in his cabinet he wanted to stress even in dead specimens the beauty of life" (Huisman 2012: 111).

Mieneke te Hennepe, conservator of Leiden Boerhaave Museum specifies, "Horrifying images and objects have always attracted audiences in many ways. Between oddities of the freakshow, the curiosities of the nineteenth century anatomical museum and the current day television shows on medical extremities, the common attraction seems a desire to fulfil curiosity. An interest in observing the different, the deformed, the damaged – the other. A peculiar aesthetic pleasure. To reproach this feeling or urge to look, to stare, as a vulgar

human trait is too easy. Behind this interest in the representation and exhibition of damaged bodies lies a complex interplay between the power of the visual, feelings and meaning. Furthermore, it still drives many visitors to our medical collections today, as this extract from a blog on medical museums shows: "The gruesome appeal of medical museums is twofold. While dissected cadavers, preserved parasites, and diseased organs fulfil the sick fascination for human oddity in all of us, the fact that it is a "museum" makes visiting them a commendable act of self-education. A real win-win!" (NileGuide Travel Blog 2010) (te Hennepe 2012: 99).

"...many exhibitions are made to discuss a topical issue, present arguments in favour of an idea, and convince the visitors about something – or maybe just provoke visitors to think deeper about something, to urge them into action" (Jütte 2012: 9).

"These things stay quiet. Certainly they don't speak. They just pose, endowed with their own special aura, staying cool before our curios eyes. Little divas on the catwalk, we might think, walking in, walking out. Leaving us impressed, fascinated, clueless, puzzled".

"These objects do not talk. They cannot talk. But if they could, they would have a lot to say. So if we want to listen to their stories we would have to make them speak" (Schnalke 2012: 74).

HEALTH AND RISK BEHAVIOUR

Nowadays health is considered something that can be restored if necessary, like a wall that can repeatedly be rebuilt. A stage has been reached where some people do not participate in the formation of their health, prevention of diseases and avoidance of risk behaviour but think that responsibility for their health lies with those who have been trained for it. A great number of people at various ages damage their health by various forms of risk behaviour and, by doing so, shorten their lifespan.

However, before we speak about damage to health, we should know what health is.

There are very different concepts of health, from the strictly technical viewpoint directed at diseases to philosophical approaches that stress positive health and well-being, self-actualisation and life quality. There is no correct answer to the question 'what is health?' that could universally be used for different cultures, contexts and lifestyles. Health, just like disease, is

experienced individually, but it is also influenced by numerous factors like living conditions, environment, socio-economic status, ethnic background, culture, age, gender, etc.

Thus, in 1947 the World Health Organisation defined health as "complete physical, mental and social well-being, not merely the lack of disease or infirmity" (WHO 1947, Simovska et al 2006). In 1986, however, the WHO declared, "Health is a resource for everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities" (WHO 1986, Simovska et al. 2006). An Arabian proverb, however, simply says, "He who has health has hope, and he who has hope has everything."

The holistic concept of health treats the body, the spirit and the individual in the society as a whole, thus closely connecting the different aspects of health. Health is a topic that concerns not only individuals but also the society as a whole. Health in its broadest meaning is equally affected by the way of life and living conditions. People's way of life includes their habits, the choices concerning their health, including the choice of food, physical activity, sexual behaviour, smoking, drug use, etc. People are able to change their ways of life.

The positive concept of health presupposes that health is more than the mere absence of disease. Health is not a static concept. Positive health or well-being shows which are the personal and social resources of the individual's life quality. Health is created where people live and love, work and play (Kickbusch 1997), but unfortunately, in the same situations, it can also be destroyed. In this article, such destruction of one's health is called risk behaviour. M. Harro has defined risk behaviour as behaviour that has or, under certain circumstances, can have an unfavourable effect on the health of the person who practises this kind of behaviour or on the fellow citizens. The consequences of risk behaviour incur, in addition to expenses on health care, expenses on economy, society, etc. Among the main categories of risk behaviour, she mentions smoking, (excessive) use of alcohol, trying and using of drugs, unprotected sexual intercourse with unreliable partners, violations of the highway code, not using protective means, ignoring safety rules, etc.) (Harro 2005). For example 300 people in the UK daily die of diseases caused by smoking, and diseases caused by smoking cost the country 1.7 billion pounds a year. Half of cancerous tumours could be prevented by lifestyle changes (Medical News Today 2006).

Like elsewhere in the world, risk behaviour is an increasingly common problem in Estonia too. The inhabitants of Estonia drink large quantities of

alcohol and smoke; 14,000 injecting drug addicts visit syringe exchange points (Postimees on-line 2007). According to some expert opinions, smoking is annually the cause behind 3000 disease cases in Estonia and accounts for one fifth of deaths. Numerically, this means approximately ten deaths per day (Paat et al. 2009). More disguised but not less serious problems are overwork, wrong nutrition and insufficient physical activity.

In Estonia, communication warning against risk behaviour has actively been promoted – several social advertising campaigns (Be smoke free; Health strategy: smoking; Health strategy: nutrition; Drug fairy-tales never have a happy end; Remain clean! narko.ee), schooling and prevention programmes have been launched. The central question is how to convey the message about the possible consequences of risk behaviour to the people who are prone to take risks. In the current article, the author attempts to discuss how the exhibition based on the Medical Collections of the Faculty of Medicine of the University of Tartu can contribute to this aim. The goal of the Medical Collections is to use its original specimens to provide information on human health and risk behaviour. By doing so, they attempt to be an institution providing out-of-school health promotional education. The specificity of the medical collection lies in its originality. For example, while social advertising uses a model to pose in a heap of vomit next to a toilet bowl, in the medical collection each specimen represents the story of an unknown real person. Just this real, human measure distinguishes the medical exhibition from social advertising; this is a message from one person to another via a disease specimen. The wish of the organizers of the exhibition is that each exhibit would convey the message: take care of yourselves, do not destroy your life. Nonetheless, the exhibits do not carry the slogan "don't smoke"; the visitors have to form their own opinion about what they have seen.

The visitors can be different. Some walk around with a list of their own and their family's diagnoses and ask to be shown exhibits and given explanations. Others walk quietly and furtively, and when leaving, are absorbed in thoughts or glad that they have fared well until now. There are also visitors who boast of their risk behaviour and want to speak about it. I have been told, "You are showing a smoker's lung here; mine is definitely blacker, as I use more than two packets of cigarettes daily. I know this is harmful but I don't care. In our family everyone has always smoked." After a few minutes' talk, it becomes evident that such people do not know anything about their risks, and the other heavy smokers in the family have already passed away long ago.

HOW TO ADDRESS RISKERS?

Although smoking has been related to at least 25 diseases and causes the greatest harm in Estonia in the form of tumours, many people continue taking high risks. Conveying the health promotion message to riskers has become a separate theme of research, as for several reasons, the message does not reach them or reaches them too late.

Definitely, one of the causes of risk behaviour is ignorance. During the 2006 campaign *Smoke is poison*, British researchers questioned 1600 people, including 500 smokers, at different places of England, and 61% of smokers did not know which chemical compounds a cigarette contained; only nicotine could be mentioned. Many were shocked when hearing that 67 substances out of 4700 were known to cause cancer (Medical News Today 2006). A visitor study at the Medical Collections of the University of Tartu showed that health awareness was much lower in riskers (smokers and/or habitual users of alcohol) than in non-riskers – every third risker claimed that smoking was not harmful for health (Toomsalu 2009).

Herzlich (1973) interviewed 80 people asking them about the causes of good and bad health. The study revealed that health was perceived as internal (something that naturally exists within a person), but the causes of diseases were seen as located outside the organism (the disease comes form outside; it is not caused by the person) (Harro 2002). Therefore, many people with risk behaviour do not realise that they harm their own health but attribute their diseases to some other reasons.

Weinstein (1983, 1984) has tried to explain why people continue practising unhealthy behaviour. He asked his subjects to assess to what extent different health disorders might affect them compared to other persons of the same age and gender (more, equally or less). The study revealed that most subjects believed that health disorders would affect them less often than their peers. Weinstein called this phenomenon unrealistic optimism, as it is impossible that everyone is less threatened by health disorders than the others are. The author mentions four cognitive factors conducive to such unrealistic optimism: (1) lack of personal experience related to the corresponding health disorder; (2) the belief that the health disorder can be prevented or balanced by some other way of behaviour; (3) the belief that if this disorder has not occurred up to now, it will not happen in the future either (thus – it will not affect me) and (4) the belief that this health disorder occurs seldom (therefore – it will not affect me). These factors indicate that the cognition of one's own risk is not

purely a rational process. The study reveals that people perceive their own and other people's behaviour differently.

Studies and theories of human behaviour indicate the following ways of changing risk behaviour. According to the Health Belief Model, people are most likely to change their risk behaviour if they believe that they are endangered by a certain disease, that getting this disease would lead to severe consequences, and healthy behaviour would diminish the risk. Thus, they are convinced that the benefits of the new (preventive) behaviour will outweigh the disadvantages and expenses (Goldberg et al 1997). To form such a conviction, the person has to be reasonably well informed, self-critical and imaginative. Still, in many cases the change in behaviour does not happen, as some of the conditions described above do not function. An essential component is self-efficacy – the belief that one is able to behave in the desired way (Höglund 2008).

Studies of smokers' personal characteristics reveal connections with extroversion (sociality and impulsivity and the use of risky behaviour to achieve the desired level of excitement), neuroticism (emotional instability) and aggressiveness (recklessness and a trend towards ignoring social norms) (von Knorring and Oreland 1985, Eysenck 1990, Flay et al 1998, Adalbjarnardottir and Rafnsson 2002, Costa, McCrae 1985). A study of Estonian teenagers shows that smoking is related to high extroversion and lower firmness of mind, which can be the strongest factor in revolting behaviour, which also includes smoking (Liiv 2003, Gullone and Moore 2000).

The Theory of Reasoned Action (Goldberg et al 1997) states that the realisation of individuals' behaviour depends primarily on their intention to behave in the corresponding way. This, in its turn, depends on how the individuals imagine the good and bad consequences of the new way of behaviour (for example, giving up smoking), how they imagine other people's attitudes to the changed behaviour (e.g. whether friends will mind if one gives up smoking). Studies conducted in Estonia also demonstrate that, in order to change one's behaviour, personal conviction is needed that one's friends and family support the attempt to change the behaviour and other members of the society change their behaviour as well (Höglund 2008). Thus, when alcohol advertising is shown on television, or teachers and doctors smoke, this gives people a signal that part of the society has a favourable attitude towards this; therefore, there is no need to change one's behaviour.

The Theory of Social Cognition proposes that people can be influenced to behave in the desirable way if they are presented with a model they can identify with – either negatively (the potential negative consequences are shown) or positively (by showing the benefits of correct behaviour) (Goldberg et al. 1997).

The exhibits of the Medical Collections are negative models that are direct embodiments of the adverse effects of risk behaviour. Definitely, they do not have the same impact on everyone. A feedback study of visitors of the Medical Collections of the University of Tartu showed that visitors who practised risk behaviour (smokers and frequent users of alcohol) considered the exhibition less novel and exciting and more often gave the answer "I know it anyhow." However, namely in riskers, the exhibition produced a more unpleasant feeling – they mentioned more often that they felt sick. This may be a repulsive reaction – one tries to diminish the significance of the unpleasant message – I already know this/this is one more sermon – and does not pay attention to the medical aspects (Toomsalu 2009). The question *Did the exhibition or lecture make you think about your health?* was answered negatively by each fourth young visitor who practised risk behaviour, and only 16% responded that they would like to correct their behaviour (Toomsalu 2009). Obviously, the communicative impact of medical exhibits as negative models can be increased. To get a more precise overview about the impact of the exhibits to different types of visitors, I conducted interviews with young viewers of the exhibition.

THE PALETTE OF VISITORS

Qualitative research was based on 11 unstructured in-depth interviews conducted in the rooms of the Medical Collections on different dates from February 2007 to April 2008 after unguided individual visits of the medical exhibition. The subjects were students at different ages, as young people are an age group whose value judgements and thought patterns can be very different, but the representatives of this age group are creative and eager to make proposals, thus giving us interesting material.

In the preparatory stage, the following research questions were posed:

- Why do young people visit such an exhibition?
- What new information did they get during their visit, and did this make them think?

- What are the young people's own and their friends' attitudes to their health?

The results of the interviews were analysed from the health promotional viewpoint. From the respondents' attitudes, estimations, mental images and visions, we expected to understand the role of the medical exhibition in shaping their ideas about health.

The strategy for selecting the sample was the principle of homogeneity. In the case of a homogeneous sample, one or two characteristics of the sample are deliberately similar. The similar characteristics of this homogeneous sample were:

1) all the subjects were students;
2) all the subjects visited the medical exhibition without a guide.

A great part of the subjects of this study were students of different faculties of the University of Tartu, although there were also some vocational school students, Estonian secondary school students, an Austrian secondary school student and an Austrian university student. Two of the eleven interviewees were men and nine were women.

Two interviewees were medical students – one of them from Estonia, the other from Austria; the others studied non-medical subjects – economics, semiotics, communication, English language and literature, or were secondary school and vocational school students. Five respondents had been born and lived in Tartu; two descended from Tallinn but studied in Tartu; one was an inhabitant of Pärnu and also studied there; two were Austrians studying in Vienna. The medical student, the student of English and one vocational school student had visited the exhibition earlier; the others visited it for the first time.

In the analysis of interviews was based on qualitative content analysis. The analysis consists of a descriptive text, direct quotes from the interviews and their interpretation. Risk behaviour is understood in this study as smoking, abuse of alcohol and use of drugs.

Before the in-depth analysis of interviews, we studied the respondents' health behaviour and classified them into four groups: knowledgeable non-riskers, ignorant non-riskers, knowledgeable riskers, ignorant riskers.

Knowledgeable non-riskers (KNR) state firmly that they take care of their health and do not take risks. They do not smoke, do not use alcohol in excessive quantities and do not use drugs. KNR1: *I think about my health anyhow.* KNR5: *Don't use; my parents don't use. ... I have behaved in the right way*

and should continue doing so. KNR2: *Healthy lifestyle, healthy nutrition, sport and so on. At least I follow this.*

Ignorant non-riskers (INR) do not practise risk behaviour themselves, but they have friends who take risks, and they are unable to talk to them about health hazards (e.g. passive smoking). INR1: *I have never smoked, haven't tried drugs either; I use alcohol sometimes. I have really fared well in this respect that very few in my circle of friends smoke, but I am unable to say much about this topic.*

Knowledgeable riskers (KR) know that what they do is bad; they have intended to give up their behaviour. KR1: *I really abuse alcohol and cigarettes. I'm not proud of it. But I have really planned to quit smoking.* KR2: *I've been smoking for years; I know this is unhealthy; I've tried to quit but have failed.*

Ignorant riskers (IR) do not know how harmful their risk behaviour is. They need additional guidance. IR1: *Alcohol ... I think you can drink, at least on Friday nights. To drink with your friends sometimes – I don't think this can be very bad. I don't know quite well how harmful it is and what it does to me. Well, I don't smoke very regularly and...*

The exhibition is the same for everyone, but starts to live its own life for each visitor. Each visitor actually creates his/her own exhibition. The exhibits can be interpreted in several ways, and they develop differently in different contexts. The visitors can learn from them, more or less, whatever they like. In the case of a medical exhibition, a lot depends on the visitor's previous knowledge. When looking at the visitors' responses about their health behaviour and reception of the exhibition, we can see that a knowledgeable non-risker (KNR3) already takes preventive actions: *Healthy nutrition, taking care of myself and my body.* The exhibition elicits emotions: *Interesting, exciting and made me wish to learn more and to know more,* but it also increased awareness about potential diseases and their connection with the body: *you see what these diseases are like in reality and what happens to your own body.*

A knowledgeable non-risker (KNR4) finds that health is, in addition to preventive actions, a mental and emotional state: *Sport, healthy nutrition, and joy, joy.* The exhibition made the visitor aware of different diseases: *It was somewhat repulsive at a few moments; it made me shiver with cold.* The exhibition activates the existing fear of cancer: *I, personally, am afraid of cancer as a lot of my relatives have it,* and makes the visitor take action in this respect: *I should have a medical check-up more often.*

A knowledgeable non-risker (KNR5) finds that health is both mental and physical harmony; the exhibition, however, gives her self-confidence. *It makes*

me think that it's good that I don't use any pleasure substances, that I still have behaved the right way.

Although the ignorant non-risker is aware of preventive actions: *Today, it is first of all sport, and to a certain extent choice of food,* for her the health promotional message of the exhibition is hampered by the age barrier: *The exhibition did not directly make me think about my own health; this is perhaps a theme for higher age; at present health is not so topical.*

A knowledgeable risker (KR1) feels guilty about his health behaviour, *At my age, I already start feeling pangs of conscience about health-related topics. Particularly, if you know that you should behave more wisely towards your body. You tend to think that you're a fool when you do things one or another way, and then you mentally scold yourself for being so lazy and weak.* The exhibition, however, made him elaborate on this thought: *I didn't expect that many things can make a relatively cynical and cold-hearted person like me think about my health. I have lived my life in the wrong way.* Simultaneously, the exhibition elicits a strong positive emotion: ... *I've been awfully lucky to have been born healthy and managed to avoid severe diseases during my life up to now,* and leads to the conclusion, *in some sense, it* [the exhibition] *makes you evaluate more highly what you've got.* Although the exhibition does not teach the risker anything new, as he knows that he treats himself badly, he finds confirmation to his doubts, *the exhibition seems to have confirmed some of my doubts.*

For another knowledgeable risker (TR2), health means primarily *the prevention of health risks.* The exhibition invites her to come back: *Obviously, everything here should be viewed once again as it creates such interest and excitement. I think I would need hours, and more than once,* but the exhibition also makes her aware of her own health problems: *Most probably, I would like to have a closer look at various things about the heart, as I have problems with the heart myself; how serious this could be and how it might finish.*

An ignorant risker (IR1) finds: *Either you have good health or you haven't,* and sees only one aspect – sensation – in the exhibition: *got a good emotion as I could see something again and told the others about it or shared something with the others,* but she feels left aside, *you see those obscenities as if from aside; it does not influence me so much that I would start thinking about myself.*

Another ignorant risker (IR2) views health in a very narrow way: *being well, not being ill,* and she views the exhibition as a natural picture book *it is seriously interesting; it is one thing to look at pictures in a book, but if you see things in reality, it is quite a different matter.* She does not relate the exhibition to her own health

behaviour – she has used drugs, and like the knowledgeable risker, feels some relief, *Thank God that everything is all right with me.*

According to their health behaviour, we classified the informants into four groups, but based on the manner of reception we can speak about five groups:

I. Those who feel guilty about their risk behaviour but are relieved as everything is all right: *I eat regrettably unhealthy things ... I abuse alcohol and cigarettes and I'm not proud of it ... I've been awfully lucky as I've had no severe illnesses in my life up to now.*
II. Seeing diseases makes them aware of their own ailments: ... *I would like to see more closely various things about the heart, as I have problems with the heart myself.*
III. For those who practise prevention activities, the exhibition confirms their own convictions: ... *I have behaved in the right way and should continue doing so.*
IV. For some, the exhibition is not exciting, as the theme of health is not topical for them: *I'm still relatively young ... At present the theme of health is not so topical.*
V. Some take the exhibition as a curiosity: *It was quite awesome. And this one with children and embryos that we saw – this was also quite awesome.*

When the exhibition is visited without a guide, the communication is asymmetrical and one-sided. Although the participants in communication are not forced to be passive, they do not receive guidance about the content and form of the exhibits and cannot enter into a discussion with the representatives of the source of information. It seems to researchers that the visit to an exhibition influences the visitor afterwards through two-step-flow or three-step-flow of communication. This means that what has been seen at the exhibition becomes essential if it is discussed with reliable people once or for several times.

When viewing Gunther von Hagens' exhibition *Body Worlds I* in Edmonton (http:www.hsaa.ca/news_and_media/new_releases/gunther_von_hagens_body_works_i_quit_campaign), smokers immediately left their half-finished packets of cigarettes near the exhibit of a smoker's lungs. The results of our analysis also confirm the rightness of the theory. The exhibits are perceived as confirmation to what is already known; for that moment, they form a new background, a new context for the existing knowledge, which can become associated with the viewer. Seeing states of disease makes the viewers aware of

their healthy organisms and draws attention to harmful behaviour – smoking and excessive consumption of alcohol. Thus, viewing the medical exhibition makes the viewers appreciate their health, to see its great benefits – he who has health, has hope; he who has hope has everything. After the research results had become known, the layout of exhibits in the Medical Collections was changed, and a wall of risk behaviour was created, where, after explanations, the visitors are left on their own. People look at the exhibits carefully and sometimes speak to themselves. By the next series of interviews, we attempt to find whether they talk about themselves or the exhibit tells its sad story that has been known for generations. In conclusion, we can say that a health promotional lecture in its usual form, with a slide programme and original specimens, followed by a guided tour of exhibition, addresses mostly the non-riskers who get confirmation to their right behaviour. In the case of those, however, who have already practised harmful behaviour, communication depends on their openness and readiness to acquire new knowledge, draw conclusions from their experience or to change their behaviour. However, when a riskers, having listened to the lecture and looked at the exhibition, lock themselves up for communication, the conveyed message does not reach them and they continue their risk behaviour. Thus, in the case of riskers, their greater involvement is needed, and they should be given opportunities to excel at non-risk behaviour.

In the case of individual visitors, we can see that the impact of the exhibition is based on earlier knowledge to which the exhibition creates a new background or a new context. Against the background of diseases, people start to see the value of the healthy organism. For knowledgeable riskers, this can amplify their earlier knowledge about their harmful behaviour and make them appreciate the lack of diseases as a benefit that they would receive from changing of their behaviour. If, however, the reception of the message is blocked, either by communicating with only one part of the exhibition or by the age barrier, the message does not reach the visitor. Thus, for those visitor types the display of exhibits and explanations should be arranged in such a way that it would create a context addressing them and drawing their attention to general themes of health in order to raise their health awareness. This would particularly apply to the visitors who saw the exhibition as a curiosity, as there were several themes about which, in their opinion, there was too little information and they risked their health out of ignorance: *I think that more*

could be spoken ... about smoking and the bad influence of alcohol ... where the ... abuse of alcohol begins.

ACKNOWLEDGEMENT

The study was supported by the ETF project 8006.

REFERENCES

1. Adalbjarnardottir S., Rafnsson F. D. (2002). Adolescent antisocial behavior and substance use: longitudinal analyses. Addictive Behaviors, 27, 227–240.
2. Costa P. T., McCrae R. R. (1985). The NEO Personality Inventory manual. Odessa, FL: Psychological Assessment Resources.
3. Chuang H. C. (2012). Storytelling and Methaphorical Language. Abstract Book. Hidden Stories. What do medical objects tell and how can we make them speak? 16th Biennial EAMHMS Conference, 13–15 September 2012, Berlin Museum of Medical History at the Charité.
4. Eysenck H. (1990). Biological dimensions of personality. In: Pervin L. A., Editor, Handbook of personality: theory and research. Guilford, New York.
5. Flay B. R., Hu F. B., Richardson, J. (1998). Psychological predictors of different stages of cigarette smoking high school students. Preventive Medicine, 27, A9–A18.
6. Goldberg M. E., Fischbein M., Middlestadt S. E. (1997). Social Marketing: Theoretical and Practical Perspectives. N.J.: Lawrence Erlbaum Associates.
7. Gullone E., Moore S. (2000). Adolescent risk-taking and the five-factor model of personality. Journal of Adolescence, 23, 393–407.
8. Habermas J. (1981). Theorie des kommunikativen Handels. Band I. Handlungsrationalität und gesellschaftliche Rationalisierung. Suhrkamp.
9. Harro M. (2002). Sissejuhatus tervise edendamisel kasutatavatesse teoreetilistesse mudelitesse. Based on D. Nutbeam and E. Harris' book *Theory in Nutshell. A Guide to Health Promotion Theory.* Translated and supplemented by M. Harro.
10. Harro M. (2005). Riskikäitumine Eesti noorte hulgas; olukord, ennetamine: teooria ja praktika. Presentation at the final conference of the international drug prevention project *This is Your Choice.* Tartu, 17 May 2005.
11. Health Sciences Association of Alberta www.hsaa.ca/news_and_media/new_releases/gunher_von_hagens_body_works_i_quit_campaign)
12. te Hennepe M. (2012). Scary things: horrifying objects between disgust and desire. Abstract Book. Hidden Stories. What do medical objects tell and how can

we make them speak? 16th Biennal EAMHMS Conference, 13–15 September 2012, Berlin Museum of Medical History at the Charité.
13. Herzlich C. (1973). Health and Illness. London: Academic Press.
14. Hover S., Gaffney L. (1998). Factors associated with smoking behavior in adolescent girls. Addictive Behaviors, 13, 139–145.
15. Huisman T. (2012). Bidloo's Anatomia Humani Corporis, a 17th Century Form of Augmented Reality? Abstract Book. Hidden Stories. What do medical objects tell and how can we make them speak? 16th Biennal EAMHMS Conference, 13–15 September 2012, Berlin Museum of Medical History at the Charité.
16. Höglund I. (2008). Hoiatavate reklaamide vastuvõtt noorte seas. Bachelor's thesis. The University of Tartu, Faculty of Social Sciences, Institute of Journalism and Communication.
17. Jütte R. (2012). Exhibiting Some Reflections on the Visual Display of a Culturally Purposeful Object. Abstract Book. Hidden Stories. What do medical objects tell and how can we make them speak? 16th Biennal EAMHMS Conference, 13–15 September 2012, Berlin Museum of Medical History at the Charité.
18. Kickbusch I. (1997). Health-promoting environments: the next steps. Australian and New Zealand Journal of Public Health, 21, 4, 431–434.
19. Kinnunen T. (2010). Arsti juurde sootsiumi survel – ilukirurgia eetilised väljakutsed. Inimene, tervis ja haigused. Terviseteemaline artiklikogumik "MEDICA" (Toim. P. Paal) Tänapäeva folkloorist 9, 287–307.
20. Knorring K., von Oreland L., (1985). Personality traits and platelet MAO in tobacco smokers. Psychological Medicine, 15, 327–334.
21. Konsa K. (2010). Kuidas me tahaksime elada: haiguste ja vananemise transhumanistlik käsitlus. Inimene, tervis ja haigused. Terviseteemaline artiklikogumik "MEDICA" (Toim. P. Paal) Tänapäeva folkloorist 9, 308–326.
22. Lifeline. Medizin im Internet www.lifeline.de/rauchen_actuell/content-120595.html
23. Liiv K. (2003). Suitsetamise seotus isiksuseomadustega teismeliseeas. Master's thesis on public health The University of Tartu, Institute of Public Health
24. Paal P. (2010). Sissejuhatus. Inimene, tervis ja haigused kultuurilises perspektiivis. Inimene, tervis ja haigused. Terviseteemaline artiklikogumik "MEDICA" (Toim. P. Paal) Tänapäeva folkloorist 9.
25. Paat G., Aaviksoo A. (2009). Suitsetamisest loobumise nõustamisteenuse hindamine. Final report. 27 March 2009. Poliitikauuringute Keskus PRAXIS.
26. Prävention für Kinder und Jugendliche. www.nichtraucher-in-5-stunden.de/html/praevention/fuer_kinder_und_jugendliche
27. Public Ignorant About Poisons Found In Cigarette Smoke Medical News Today, 29. Dec. 2006. Http://www.medicalnewstoday.com/articles/59233.php.

28. Puuronen A. (2010). Tänapäevane toiduaskees tervisliku eluviisi alusena. Inimene, tervis ja haigused. Terviseteemaline artiklikogumik "MEDICA" (Toim. P. Paal). Tänapäeva folkloorist 9.
29. Reinap A. (2007). Online-intervjuu: Vastas narkomaaniaga võitleja Aleksander Laanemann. Postimees online, 18.04.2007.
http://www.postimees.ee/210907/esileht/arvamus/255710.php
30. Sacks O. (2007). The Man Who Mistook His Wife for a Hat: and Other Clinical Tales. Great Britain: Piscador
31. Schnalke T. (2012). Divas on the Catwalk. Some thoughts on how to perform research with objects in medical history. Abstract Book. Hidden Stories. What do medical objects tell and how can we make them speak? 16th Biennal EAMHMS Conference, 13–15 September 2012, Berlin Museum of Medical History at the Charité.
32. Simovska V., Jensen B. B., Carlsson M., Albeck C. (2006). Laste ja noorukite tervise ja tasakaalustatud arengu suunas. Lapsed ja täiskasvanud tegutsevad koos ühise eesmärgi nimel. Methodological handbook. National Institute of Health Development.
33. Toomsalu M. (2009). Meditsiiniekspositsioon terviseteadlikkuse kommunikeerijana. Master's thesis University of Tartu, Faculty of Social Sciences, Institute of Journalism and Communication.
34. Weinstein N. (1983). Reducing unrealistic optimism about illness susceptibility. Health Psychology, 2,11–20.
35. Weinstein N. (1984). Why it won't happen to me: perceptions of risk factors and susceptibility. Health Psychology, 3, 431–457.

Address for correspondence:
Maie Toomsalu
Institute of Anatomy
Medical Collections of the Faculty of Medicine of the University of Tartu
Ravila 19, 51014 Tartu, Estonia
E-mail: maie.toomsalu@ut.ee

Papers on Anthropology XXI, 2012, pp. 27–49

THE CONTENT OF CHEMICAL ELEMENTS IN ARCHAEOLOGICAL HUMAN BONES AS A SOURCE OF NUTRITION RESEARCH

RAILI ALLMÄE[1], JANA LIMBO-SIMOVART[1],
LEIU HEAPOST[1], EVELIN VERŠ[2]

[1] *Institute of History, Tallinn University, Estonia*
[2] *Institute of Geology, Tallinn University of Technology, Estonia*

ABSTRACT

The aim of the present research was to determine chemical elements using the inductive plasma mass spectrometer (ICP-MS) in Estonian archaeological human bones to establish the possible content of the menu in different communities.

Among the studied material clear differentiation can be made between the Pärnu cemetery of St John's church (the cemetery of the Pärnu garrison) from the 16–18th cc. and the Tääksi village cemetery from the 14–18th century. The material from the 12–13th cc. Pada cemetery remains between the two above-mentioned cemeteries concerning the content of the observed elements.

The initial data show only the differences of the general trends of the content of chemical elements between the inland and the coastal areas, the village and the town, the higher and the lower social status communities. The contents of chemical elements in the Estonian archaeological bones were similar to the respective contents in Latvia.

Key words: *palaeodiet, trace elements, Estonia, the Late Iron Age, the Middle Ages, the Modern Times*

INTRODUCTION

The information about the diet of historical populatons can be obtained from very different sources like the historical documents, finds, which are connected with the production or processing of food, archaeobotanical and zoological materials and archaeological human remains.

The nutrition of people in the past can be studied with the help of chemical analyses of human bones. The first attempts to reconstruct the diet of the people in the past on the basis of the content of chemical elements in the bones were made in the second half of the 20th century, Brown (1973) [12] and Gilbert (1975) [23] being the pioneers. The research trend was especially intensive in the 1980s. The contents of different chemical elements and their relationships allow the researcher to study, which the people's food was in different historical periods and areas.

Calcium (Ca) is one of the main parts of the mineral component in the bones. The bone's mineral part consists of a most stable mineral hydroxyapatite in which the calcium content is quite stable (about 38%). The measurement of the calcium content in microanalyses is mainly made with the purpose of assessing the quality of the material. In the case of the fully preserved collagen, the Ca content varies to the degree of 26%–38% [14] in archaeological bones.

The contents of **vanadium (V), copper (Cu)** and **zinc (Zn)** in bones are considered to be the indicators of meat food [13]. For example, the organism, which uses more animal food (incl. fish, crustaceans, molluscs), always contains more **zinc (Zn)**. It is confirmed by the comparative studies of the zinc content in the bones of carnivores and herbivores. Here the only exception is nuts, containing also noteworthy amounts of zinc, in the plant food. Also, the people, in whose diet marine food has had a big role, may have a higher content of Zn in their bones than the people consuming the mainland food [24, 31]. The Zn content in the bones of a human being as an omnivore (including both animal and vegetable tissue in the diet) varies in the degree 50–826 ppm-i [7]. In principle, on the higher level of the trophic pyramid the organism is, the bigger is its Zn content in its bones and the smaller is the Sr content. The comparative analysis of the Zn content in the bones of omnivores should consequently reflect the relative proportion of the consumed meat food in the menu. When low Zn contents are equal to the higher Sr contents, it may be supposed that the community consumed a smaller amount of meat [19].

The main foodstuffs containing **copper (Cu)** are liver, red meat, fish meat, beans, peas, products of full cereals, nuts. In the organisms of carnivores there is always more copper than in herbivores [24]. Also, crustaceans and molluscs contain much copper [35]. The major products containing **vanadium** (V) are liver, plant and animal lipids. For example, high contents of vanadium are in the fresh vegetables like parsley, dill, radish, lettuce, in the berries like strawberries and in fatty fish and the fish liver [51]. When the established indicators of Zn and Cu in bones are high, then, as a rule, together with them the content of V is high because animal fat contains V [13].

The indicators of plant food in bones are considered to be the contents of **manganese (Mn), barium (Ba), and strontium (Sr)** [49].

The best sources of **manganese (Mn)** are plant foodstuffs. The content of manganese in them depends on the soil they have grown on [26]. Manganese cannot almost be found in meat, chicken, fish, milk and milk products but it is in big quantities in legumes, green vegetables, cereals, especially in wheat sprouts, whole-meal bread, nuts. The manganese content in bones is considered to be a good indicator in assessing the proportions of plant food [49] but contrary conclusions have also been made [33].

The strontium (Sr) content in bones is considered to be the indicator of plant food. Plants get strontium from the soil, this is how strontium enters substance chain. The plants, having grown on carbonate soils, are especially rich in strontium [34]. There is relatively much strontium in spices, in green vegetables, root crops, cereals, beans, peas, lentils and also marine food. 99% of the strontium in the organisms of vertebrates is in the inorganic content of bones [8]. By its structure strontium is similar to calcium and can replace calcium in the inorganic part of bones – in hydroxyapatite. As it is known, in the human organism strontium does not have a definite physiological role and the organism processes it similar to calcium. In the bones of omnivores, including human beings, the smaller the relative content of Sr, the bigger is the proportion of meat in their food. The situation becomes more complicated in the marine environment because the concentrations of Sr are bigger in the sea water and the marine food [34]. In the research of the paleodiet Sr contents are also used for distinguishing marine and inland nutrition [18].

In nature **barium (Ba)** can be found in cereals, potato, milk and to a certain degree in algae and fish. In the organisms of vertebrates 90% of Ba is in the bones. As it is known, Ba in the organism does not have a clear biological function [45]. Similar to strontium also Ba may replace Cu in the mineral part

of the bone. Ba is a thankworthy indicator of plant food in comparison with strontium because of two reasons. Firstly, it is less dependent on diagenesis. Secondly, if the high content of strontium in bones may be caused by the menu containing basically plant food and also the menu of marine food, then differently from strontium there is very litte barium in the sea water [41]. Higher contents of barium in bones are directly connected with plant food [49].

Relations between Ba and Sr. When the Sr contents are high in marine organisms, the Ba contents are low at the same time. Consequently, in the bones of the individuals, having mainly marine food, the Ba/Sr relation is very low in spite of the fact whether Ba is from a plant or an animal source [42]. When the foodstuffs from the inland are added, the Ba/Sr relation grows quickly because Ba contents in the food grown inland are always bigger. Burton and Price (1990) [15] recommended for distinguishing the marine nutrition (coastal agriculture and marine protein) and the inland nutrition (inland agriculture and terrestrial protein) to use the Ba and Sr logarithmic relation (log Ba/Sr). The values of log Ba/Sr which are smaller than –1.40 refer to the fact that the community's diet is mainly based on marine food. The values of log Ba/Sr which are equal or higher than –0.40 show that the community mainly consumed foodstuffs from the inland.

Lead (Pb) does not have an important role in nutrition, it is rather harmful for the human organism. The content of lead in the bones refers to the influence of the surrounding environment. Lead gets into the organism either through the digestive tract or lungs and most of the lead getting into the organism is stored in the bones [11]. When the person gets older, the content of Pb in bones accumulates if the organism is exposed to the source of pollution. Biologically Pb behaves in the organism similar to Sr and Ba replacing calcium in the mineral part of the bone [14].

The people who lived in towns in the Middle Ages and the Early Modern Times have usually more lead in their bones than the people who lived in the rural areas. The appearance of lead in the organism is explained by the use of domestic vessels, which had the glazing containing lead, or the drinking water, which came from the pipelines containing lead [17, 49].

In interpreting the chemical composition of the archaeological bones there are also certain possibilities for making mistakes. It is well known that the chemical composition of the bones, which were in the soil for a long time, may have changed, the joint effect of the temporal factor and the environmental

conditions playing a decisive role [10, 21, 45, 52]. The cumulative effect of the physical, chemical and biological processes on the bones changing their chemical and physical composition is called diagenesis [54]. This is why in the recent years, in the nutrition research of archaeological population tooth dentine [16] has been used more often because thanks to the layer of enamel covering the tooth crown it is better protected from the other influence of the environment together with the geological, climatological and ground water characteristic features of the burial environment [52]. There are numerous studies of the diagenesis of bones in which the authors have tried to find a common scale for the assessment of the processes of diagenesis [21, 28, 45 etc]. With time the conclusion has been made that the diagenesis of each bone and skeleton is very specifically different, even within the same burial area, while the important role is played by early taphonomic factors or how human remains were treated before burial and the pH level of the soil is taken into consideration [40, 48].

The researcher must be careful in taking bone samples because different bones and also their parts may differ in the concentration of chemical elements [49, 43]. It is also known that the compact substance of bones is modelled more slowly and it is more inert to the effects of the other environment because of its compact structure [25, 20] and this is why in taking samples the diaphysis of long bones should be preferred instead of taking ribs and flat bones because in them the sponge matter, being sensitive to pollution, is less protected. The chemical elements which are most often detected in the archaeological bones with the purpose of reconstructing the diet of the people in the past and the environmental effects are Ca, P, Ba, As, Mg, Sr, Al, Zn, Mn, Cu, V, Cd, Cr and Pb and also their interrelations are studied.

The aim of the present research is to study the contents of macro- and microelements in the archaeological bones with the inductive plasma mass spectrometer (ICP-MS) to assess the nutrition of ancient and historical populations from different areas in Estonia. Partially the results of the analysis have been interpreted already earlier [5]. Also, the results have been interpreted on the background of the studies, dealing with different food resources, relying as well as on the archaeological analysis and the research results based on historical sources [6]. We express our gratitude to a group of Latvian scientists whose research of the nutrition of the people in the past inspired us to carry out similar research in Estonia. In the present paper the contents of

chemical elements of the Latvian archaeological bones have been used as a material for comparison [46].

MATERIAL AND METHODS

From the archaeo-osteological materials of Estonia three series were chosen for determing the content of chemical elements: 12th–13th cc. skeletons from the underground cemetery at the Pada ancient stronghold [53], 14th–18th cc. skeletons from the village cemetery at Tääksi [50] and 16th–18th cc. skeletons from the cemetery of St. John's church in Pärnu (the archaeologist Jaak Mäll, AGU-EMS 1998). In the choice of the material the researchers proceeded from the geographical, temporal and also possible life-style differences (Figure 1).

Figure 1. Estonian and comparative Latvian samples [46].

Most probably the local community was burying their dead in the Pada and the Tääksi cemeteries. The history of the cemetery of St. John's church in Pärnu is more complicated because it was closely connected with Swedish and Russian garrisons. Initially the Lutheran congregation used the cemetery of the St. John's church in Pärnu which was founded at the turn of the 16th–17th century.

From the year 1617 Pärnu was under the rule of the Swedish power [32] and then the soldiers of the Pärnu garrison and the members of their families were buried in the cemetery. In the year 1710 the Pärnu garrison surrended to Russia, the membership in the Russian Empire brought the Russian garrison and the Russian Orthodox religion to Pärnu. In the year 1714 the St. John's church together with the cemetery was handed over to the Russian garrison [29]. The Orthodox crosses in big number were found during the archaeological study of the cemetery of St. John's church in Pärnu (Villu Kadakas, oral information to the authors).

In the chemical composition of the bone material from Tääksi, Pada and Pärnu there could appear differences which characterize the nutrition of the communities from three different areas and with a different social status. All the series of skeletons have been studied with different methods of physical anthropology in the recent [1, 27, 3, 2, 36, 37, 4] and this is why the age and the gender of the buried are known. For the comparison of the situation in Estonia, the analysis of the Latvian 13^{th}–17^{th} cc. bone materials were used. The Latvian material consists of three series: the 13^{th}–17^{th} cc. St. Peter's churchyard in Riga, the 14^{th}–18^{th} cemetery in the Cesis district and the 16^{th}–17^{th} cc. Jurkalne cemetery in the Liepaja district [46].

From the skeleton series of Tääksi 28 adult skeletons (14 women and 14 men), from the Pada series 30 (15 men ja 15 women) and from the Pärnu series 31 (18 men ja 13 women) were chosen for chemical analyses. The bone samples were taken as a rule by drilling the right tibia's proximal part (min 5 mg). The surface bone layer was drilled off before collecting the material for the analysis. Samples were not taken from the bones which had evident traces of bronze objects. Further, the material was made into powder and 300 mg of the test material was taken. The test material was weighed and put into the microwave oven's test vessel where concentrated ultrapurified acids were added (Fluka Analytical, Sigma-Aldrich Chemie GmbH, Germany): 4 ml of 69–70% HNO_3 (with the purification level TraceSELECT®) and 2 ml of 30% H_2O_2 (with the purification level TraceSELECT® Ultra).

All the tests were processed with the microwave oven MW3000 (Anton Paar, Germany), using the rotor 16HF100 which is meant for the tests of hardly soluble materials (geological tests, metals, alloys, glass, quartz, polluted soil) to solve them because the rotor allows to use somewhat higher pressure (max 240°C) in comparison with other analogical rotors. All the processing was made using the similar parameters of power and time, heating the tests for

40 minutes at the temperature ca 120°C and the pressure 35–40 bar. After processing the reaction tubes were released from too much pressure (the pressure openings of corks were turned open) and some time was given for cooling. The tests were poured into the centrifuge cups and were diluted with ultraclean MilliQ water to the quantity of 50 ml.

The contents of micro- and macroelements in the test, received in the solution, were measured with the inductive plasma mass spectrometer (ThermoScientific X-Series 2 quadropool-ICP-MS) which was connected to the automatic input of tests Cetac AutoSampler ASX-520. As a measurement standard the International standard NIST-SRM 1486 (animal bone flour) and the multielement liquid standard Multi Element Solution 2 (SPEX CertiPrep, Inc.) in 5% HNO_3 matrix, to which the liquid mercury standard in 10% HNO_3 matrix (SPEX CertiPrep, Inc.) was added, were used. As the inner standard, the liquid standard of 10ppb rhenium was used. Every test was measured three times and the statististically average result was taken into consideration. The calibration of the results of tests was made according to the fully quantative analysis in which the linear correlation, measured with stand, was taken as the starting point through the measured "blank". Ultraclean 2% of HNO_3 was used as a blank. In the taken bone samples the contents of the following chemical elements were detected: Ca, V, Cr, Mn, Fe, Cu, Zn, Sr, Ba, Hg and Pb. All the detected elements will not be treated below. For the assessent of the quality of the bone material or possible diagenesis the correlation of the contents of iron and strontium were used. If the correlation between Fe and Sr is missing, the material is not polluted – the exchange of ions between the soil and the bone tissue has not taken place [13]. In the whole studied material the correlation between Fe and Sr was very weak but statistically significant (r=0,303; P=0,04). If to view the relation between Fe and Sr in the studied series, the correlation between Fe and Sr was fully missing in the Tääksi and the Pärnu series (in Tääksi r= –0.337, P= 0.079; in Pärnu r=0,034, P=0.857), but it was significant in the Pada series (r=0.538; P=0.002).

The Pada cemetery, as well as the Tääksi cemetery, is located in the area of the leached soil which was formed on the carbonate lower stratum and is consequently of neutral reaction [39, 47]. In the neutral environment ions are moving very little and this is why it may be supposed that the exchange of ions between the bone and the soil has been of little importance. Unfortunately, we do not have the data concerning the soil pH of the Pärnu cemetery.

In addition to the level of the substrate's pH level, differences in the preservation of the bone material may be caused by the co-effects of the taphonomic process having taken place in the local microlevel together with the temporal factor. In its turn, the processes depend on the burial rituals. It is very hard to assess the microlevel diagenesis after it had taken place but it deserves mentioning that Pada is the earliest and with the richest grave goods among the studied series. It would explain the weak and significant correlation of Fe and Sr and the abnormal contents of some elements in the Pada bones. In the present paper 3 individuals from the Pada series have been left out because in their bones the content of Cu was over the physiological limit. Abnormal contents of Cu could have been caused by bronze adornments in the burial.

Statistically significant differences, in the contents of microelements in the bones of men and women and the differences between different series were obtained using the t-test. The sizes of the sample were too small for the analysis of gender differences in the series of the basis of correlations. For the mutual comparison of the studied series the cluster analysis (average linkage method between the groups) was used. For the analysis the contents of Ba, Cu, Pb, Sr, Zn and Mn in different groups were used. The data were processed with the software program SPSS 17.0.

RESULTS AND DISCUSSION

The contents of chemical elements determined in the bones are presented in Table 1 and Table 2. The measurement of the content of calcium (**Ca**) was carried out with the purpose of assessing the quality of the material under study. In the case of the fully preserved collagen, the content of Ca in the archaeological bones fluctuates 26%–38% [14]. In the whole archaeological material, studied by us, on average there was 24.95% of calcium (16.2–34.9%), the smallest was in Tääksi women (Table 1). In all the groups variation was bigger in women. On the one hand, it may be caused by a bigger diagenesis [44]. On the other hand, the calcium content in the women's bones varies much depending on the physiological satus of the woman's organism. It is known that during the periods of pregnancy, breast feeding and in the end of the fertile age the proportion of Ca in the bone tissue may decrease. Gender differences in the average contents of Ca in bones were not statistically significant.

Table 1. Average chemical element contents (ppm) and differences between samples

Seeria Sample	Element	Ca%	V	Mn	Cu	Zn	Sr	Ba	Pb	Log Ba/Sr
Pada (n=30)	**X̄**	**27.59**	**4.99**	**267.7**	**5.29**	**120.3**	**126.6**	**17.42**	**1.52**	**–0.88**
	Min	20.7	1.1	53.5	1.3	62.9	82.5	7.1	0.3	
	Max	34.9	11.9	625.7	18.4	448.4	202.7	36.9	3.2	
	STD	3.41	3.20	157.2	3.75	68.96	35.72	7.41	0.81	0.14
	Median	27.4	3.8	225.1	3.9	102.2	102.2	16.2	1.3	
Tääksi (n=28)	**X̄**	**22.69**	**1.36**	**57.55**	**0.89**	**81.29**	**73.61**	**22.84**	**1.34**	**–0.57**
	Min	16.2	0.4	6.4	–1.05	51.9	51.7	4.8	0.1	
	Max	27.5	4.3	257.4	3.93	169.3	94.5	51.9	3.5	
	STD	2.62	0.91	65.03	1.31	27.48	11.18	12.84	0.82	0.26
	Median	22.8	0.9	33.98	0.85	75.7	73.6	18.0	1.2	
Pärnu	**X̄**	**24.6**	**11.5**	**185.5**	**14.1**	**141.8**	**133.7**	**15.8**	**10.7**	**–0.96**
(n=31)	**Min**	16.8	2.1	4.2	2.7	96.8	89.7	5.8	0.7	
	Max	29.5	39.9	722.6	55.8	265.0	212.9	51.7	49.5	
	STD	3.4	7.9	204.5	12.6	50.4	27.2	8.3	12.7	0.20
	Median	25.9	8.9	93.7	9.4	127.2	132.9	15.4	6.1	
Tääksi & Pada t-test		**	**	**	**	*	**			**
Pärnu & Tääksi t-test		*	**	*	**	**	**	*	**	**
Pada & Pärnu t-test		*	**	*	*				**	

t-test ** *– p≤ 0.001;* * *– p≤ 0.05*

Table 2. Sexual differences in average concentrations (ppm) of analysed chemical elements and log Ba/Sr

Sample	Element	Ca%	V	Mn	Cu	Zn	Sr	Ba	Pb	Log Ba/Sr
Pada ♂ (n=15)	X̄	27.4	3.62	226.8	4.1 (n=14)	108.8	115.6	14.81	1.1	–0.90
	Min	22.7	1.07	53.5	1.3	88.5	88.5	7.074	0.3	–1.09
	Max	32.2	9.22	487.1	9.4	194.4	194.4	20.96	2.4	–0.79
	STD	2.7	2.15	140.6	2.2	29.9	27.2	4.02	0.6	0.09
	Median	26.8	3.50	177.3	3.5	99.2	107.5	15.07	0.9	–0.86
Pada ♀ (n=15)	X̄	27.7	6.35	308.6	6.9 (n=10)	131.8	137.5	20.02	2.0	–0.86
	Min	20.7	1.38	59.6	2.9	62.9	82.5	7.427	0.7	–1.15
	Max	34.9	11.95	625.7	18.4	448.4	202.7	36.9	3.2	–0.62
	STD	4.1	3.54	166.9	4.9	91.1	40.6	9.10	0.7	0.17
	Median	27.95	6.76	359.7	5.6	105.6	129.1	21.13	2.1	–0.86
Pada ♂ ♀ t-test			*						*	
Tääksi ♂ (n=14)	X̄	23.5	1.09	29.92	0.19	71.17	72.35	14.48	1.27	–0.73
	Min	19.4	0.36	6.367	–1.0	51.9	51.7	4.8	0.1	–1.18
	Max	27.5	2.19	54.860	1.6	91.2	94.5	32.9	2.7	–0.31
	STD	2.5	0.61	17.53	0.92	9.29	12.92	6.34	0.77	0.21
	Median	23.6	0.89	24.4	0.2	72.6	76.5	13.7	1.1	–0.70

Table 2. Continuation

Sample	Element	Ca%	V	Mn	Cu	Zn	Sr	Ba	Pb	Log Ba/Sr
Tääksi ♀ (n=14)	X̄	21.5	1.70	86.9	1.64	91.47	73.40	31.12	1.46	–0.40
	Min	16.2	0.62	11.1	–0.9	56.1	55.1	11.2	0.3	–0.78
	Max	24.8	4.35	257.4	3.9	169.3	91.5	51.9	3.5	–0.02
	STD	2.41	1.08	81.48	1.2	35.40	10.7	12.32	0.88	0.22
	Median	22.2	1.45	42.2	1.5	80.7	72.5	31.7	1.2	–0.38
Tääksi ♂ ♀ t-test		*		*	**	*		**		**
Pärnu ♂ (n=18)	X̄	25.01	10.75	133.61 (n=17)	14.38	150.56	139.42	17.81	9.26	–0.94
	Min	20.3	2.1	4.2	4.4	81.9	101.4	6.6	1.1	–1.33
	Max	29.3	22.1	481.6	42.5	344.6	182.2	51.7	43.3	–0.45
	STD	3.19	5.70	144.29	11.94	75.55	23.01	10.07	11.92	0.19
	Median	25.9	9.3	93.6	9.6	125.9	141.2	17.1	4.6	–0.95
Pärnu ♀ (n=13)	X̄	24.01	12.56	211.99	13.73	142.39	125.88	13.09	12.62	–0.99
	Min	16.8	3.3	4.5	2.7	61.4	89.6	5.8	0.7	–1.57
	Max	29.5	39.9	545.0	55.8	265.0	212.9	18.5	49.5	–0.74
	STD	3.71	10.34	219.57	13.84	60.77	31.33	3.65	13.99	0.21
	Median	23.1	8.3	68.9	9.43	118.0	118.6	14.4	7.6	–0.95
Pärnu ♂ ♀ t-test										

t-test **– $p \leq 0.001$; * – $p \leq 0.05$

The contents of **Mn, Ba and Sr** are considered to be the indicators of plant food. The higher the indication, the bigger the plant component in the community's nutrition has been. The manganese (**Mn**) content varies in a noteworthy way in the Estonian archaeological bones: in the Tääksi material it was between 6–257 ppm, in the Pada material 59.6–625.7 and the Pärnu material 4–723 ppm (Table 1). On the one hand, it gives an idea that possibly the higher values of Mn in some single individuals are connected with later post-mortem chemical processes having taken place. The pollution of bones with Mn ions has also been noticed earlier [52]. On the other hand, it is known that plant foodstuffs are the main sources of Mn while the content of Mn in the plant is directly caused by the content of Mn in the soil.

In the Tääksi bones the average content of manganese was the smallest in the studied Estonian series (Tables 1, 2; Figure 2). In the Pada and Pärnu bones it was significantly bigger. Here it can be concluded that more plant food was consumed at Pada and in Pärnu but the content of microelements (V, Cu, Zn) describing meat food, was also bigger at Pada and in Pärnu [6]. In principle, these results are in harmony between themselves because manganese cannot be well assimilated from only the food consisting of plants but its consumption together with animal protein increases the assimilation of manganese significantly [30].

In all the Estonian series there was more manganese in women's bones (Table 2), this difference was statistically significant in the Tääksi series. Similar gender difference has also been found by Latvian researchers [46]. The first hypothesis is that most probably the women consumed more plant food than men. The second hypothesis to explain the higher content of Mn in the women's bones in comparison with men is caused by the women's physiology. Namely, it is known that if the organism suffers from the lack of iron, it assimilates manganese in bigger quantities [22]. The lack of iron in the organism appear more often in women caused by their physiological specificity. The gender differences of the content of Mn in all the compared series (Table 2) speak of the possibility of both hypotheses.

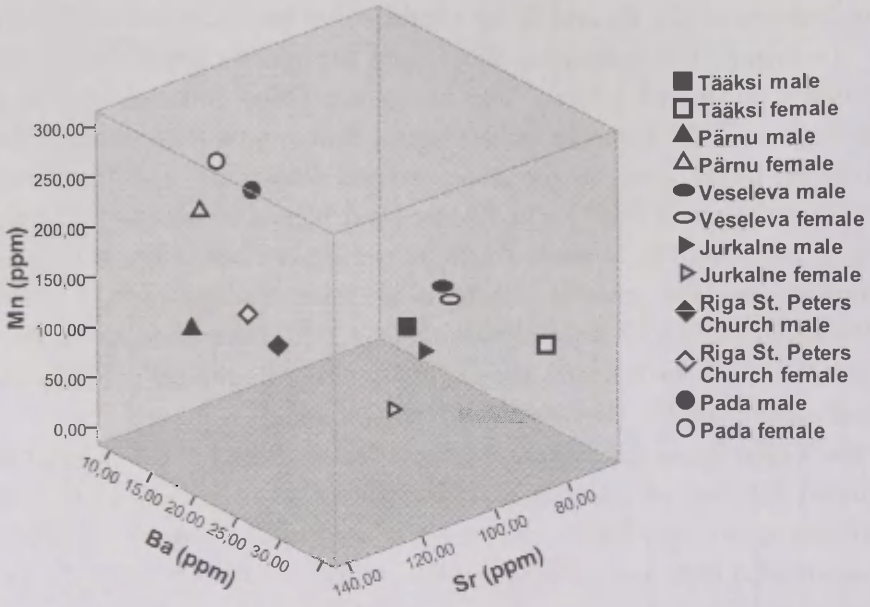


Figure 2. Average concentrations of Mn, Ba and Sr in studied Estonian and comparative Latvian samples (Veseleva, Jurkalne, Riia St. Peters: Rudovica et al 2009).

The contents of barium (**Ba**) in the Estonian series are relatively similar (Table 1), being in the Pärnu and Pada bones respectively 15.8 and 17.42 ppm and in Tääksi bones 22.84 ppm. The gender differences of the content of Ba are statistically significant both at Pada and at Tääksi which can show the bigger proportion of plant food in the menu of their women. Also, in comparison with Latvia, significant differences between series do not appear (Table 2, Figure 2). Tääksi deserves special mentioning. At Tääksi the contents of Ba in men and women differ almost 2 times.

The content of strontiumi (**Sr**) in bones is considered to be the indicator of plant food. The situation becomes more complicated in the marine environment because the concentrations of Sr are bigger in the sea water and the marine food [34].

The content of Sr in the Tääksi bones was on average 73.6 ppm, in the Pada bones 126.58 ppm, in the Pärnu bones 133.7 ppm (Table 1). The higher content of strontium in the Pärnu and the Pada bones in comparison with Tääksi may be caused by a higher amount of sea products in their nutrition. The importance of carbonate soils in different areas cannot also be excluded. Both the marine food and the specific features of the soil may cause higher values of Sr in bone. In the Pada and Tääksi bones the content of Sr was higher in

women, in Pärnu it was slightly higher in men and the statistically significant gender differences were missing (Table 2, Figure 2).

In the paleodiet research the contents of Sr are used for distinguishing the marine and the inland nutrition [18]. The studied Estonian series also show that the concentration of strontium in the bones is bigger in the bones of the populations which lived closer to the sea (Table 1). Our reserach shows that **Sr** is rather connected with the marine origin of food. The contents of Sr are bigger in the bones from Pärnu and Pada as well as from Riga and Jurkalne in Latvia. The contents of Sr are smaller in the bones from the burial places more to the inland (Table 2, Figure 2).

Log Ba/Sr as the indicator of the origin of food

In the marine organisms the contents of Sr are higher while the contents of Ba are low.

The log Ba/Sr of the population of the village of Tääksi is almost two times higher (–0.57) than in the population of the town Pärnu (–0.96), a rather similar value of log Ba/Sr (–0.88) also characterizes the population of Pada (Table 1). The values of log Ba/Sr refer to the so-called mixed menue of the people of the town of Pärnu and the stronghold of Pada which contained both the inland and the marine food, but in comparison with the village of Tääksi, relatively more marine food was consumed. Gender differences were statistically significant at Tääksi but missing in the groups of Pärnu and Pada. The variability of the log Ba/Sr of the bones of Pada women was notably high as also in the case of the contents of other elements. It may show the different origin of the Pada women (the distance of the place of living from the sea) and the differences in the composition of their food and eating habits. The highest log Ba/Sr (–0.40) value characterizes the women of Tääksi (Table 2, Figure 3) who most probably consumed more inland food. Also, the values of log Ba/Sr are high (–54 to –60) characterizing the village communities Jurkalne and Veseleva. A lower log Ba/Sr characterizes the communites buried to the cemeteries of the Pärnu garrison and St. Peter's church in Riga, which refers to the bigger proportion of marine food in their choice of food (Table 2).

V, Cu and Zn are the indicators of meat food or the animal protein in food [13]. Vanadium **(V)** is plentiful in fish fat but green vegetables are also rich in vanadium [51]. Consequently, vanadium can be rather called an indicator of diversified menu [6]. The V concentration in the bones of Tääksi is on average 1.36 ppm, in the bones of Pärnu there is about 10 times more vanadium – on

average 11.5 ppm, the bones of Pada remain in between these two with the content of V being 4.99 ppm (Table 1). In the Latvian material V content was not measured [46].

It has been observed that if the determined Zn and Cu indicators are high, then as a rule, together with them the V indicator is high because animal fat contains V [13].

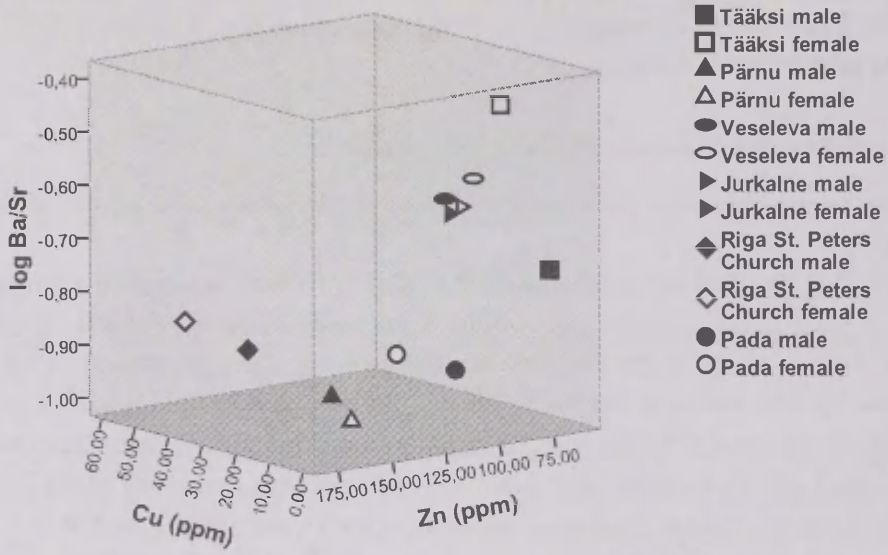


Figure 3. Average concentrations of Cu, Zn and average log Ba/Sr in studied Estonian and comparative Latvian samples (Veseleva, Jurkalne, Riia St. Peters: Rudovica et al 2009).

The average content of copper (**Cu**) in the Pärnu series was significantly higher (14.1 ppm) than in the Pada (5.29 ppm) and the Tääksi (0.89 ppm) series. The higher content of copper in the Pärnu bones can be connected with the bigger importance of meat and fish in the diet. Considering the eating habits in those times, we may suppose that the proportions of crustaceans in the menu were relatively small. In the women's bones the content of copper was bigger at Pada and Tääksi, in Tääksi gender difference was statistically significant (Tables 1, 2; Figure 3).

In the studied Estonian series the content of zink (**Zn**) was the lowest at Tääksi (81.29 ppm). The content of zink in the bones of Pada and Pärnu was higher – 120.35 and 141.80 ppm – respectively, which refers to the bigger

proportions of meat and marine food in the nutrition of the Pada and the Pärnu communities (Table 1).

At the same time one should be careful in interpreting the content of zink because the Zn content in women's bones grows with age, in men's bones it decreases [38, 9]. In the bones of the older women of Tääksi in some individuals there were suprisingly high contents of zink which raised the average content of zink in Tääksi women – in women 91.5 ppm, in men 71.1 (Table 2). Also, it should be remembered that a bigger part of zink in the bones is connected rather to the organic part of the bone tissue than the inorganic part. In the case of archaeological bones, the loss of the organic part is possible, which may make the interpretation of zink more difficult [42].

In comparison with Latvian trace element analyses [46] Zn and Cu values are higher in the archaeological bones of the towns of Riga and Pärnu (Table 2, Figure 3). On the one hand, the people buried in the cemetery of the Pärnu garrison and St. Peter's church in Riga represent the town populations at the sea. On the other hand, it is known that mainly the middle class of German origin was buried in the St. Peter's church [46] and the cemetery of St. John's church in Pärnu was mainly used by the Russian garrison. The menu of these communities with relatively higher social status most probably contained more meat and marine food. Tääksi, Veseleva and Jurkalne, represent village communities in the Middle Ages and the Early Modern Times. In their bones the contents of Cu and Zn are lower which probably refers to the smaller proportion of meat and marine food in their menu (Table 2, Figure 3). The group is characterized by the inland food and it is most probably of major plant composition. In the case of the studied indicators (Zn and Cu) the community buried to the Pada cemetery is different from the seaside towns and inland village communities. It may be caused by the heterogenity of the community (different geographical origin of individuals, social status) and the connected differences in nutrition. It should be born in mind that the Pada community is the earliest in time, originating from the final period of ancient times when the climatic conditions and the social order were different.

In the bones of the people who lived in town in the Middle Ages and the Early Modern Times **lead (Pb)** is usually in a bigger quantity than in the bones of the rural people. Appearance of lead in the organism is explained by the facts that the kitchen vessels were covered with the glazing containing lead and the drinking water coming from the pipelines containing lead [49, 17]. In the Pärnu bones there was significantly more lead than in the bones of Pada and

Tääksi and the differences were statistically significant (Table 1). It may be connected with the style of life in a town of the Early Modern Times but at the same time we cannot exclude the post-mortem pollution of bones of Pärnu with Pb ions which has also been found even earlier in the case of archaeological materials [52].

The comparative research of nutrition in the rural and town popultions in Estonia in the 12th–18th cc. showed that the higher contents of Pb, Sr, Zn and Cu in the bones were characteristic of the town population. In the bone material from the town of Pärnu the levels of Pb, Sr, Zn and Cu are higher than in the material of Tääksi or Pada [6]. The same trend (Table 2, Figure 3) is also demonstrated by the analysis of the Latvian 13th–17th cc. material [46].

The Estonian and the Latvian series were compared with the method of cluster analysis (average linkage, Euclidean distance) using the contents of the following chemical elements in bones: Mn, Ba, Sr, Zn, Cu and Pb. According to the content of chemical elements, the studied groups can in general be divided into two clusters, which join between themselves at a rather high level (Table 3, Figure 4). The first, the biggest cluster unites the most similar groups – medieval and early modern Estonian and Latvian rural populations (Tääksi, Veseleva and Jurkalne). On the other side the town populations of the same time join them (the town of Riga and men from Pärnu). The second cluster unites from the compared series the ancient Pada and the group of women from the town of Pärnu having relatively similar indicators. Clusters are different mainly because of the contents of strontium, manganese and barium. The groups united in the first cluster are characterized by a smaller content of Sr and Mn and a bigger content of Ba (Table 3).

Table 3. K-means cluster analysis final cluster centres

Cluster Centers		
	Cluster	
	1	2
Zn	120.47	127.70
Sr	96.46	126.36
Mn	84.50	249.17
Ba	21.04	15.98
Cu	11.71	8.26
Pb	6.70	5.23

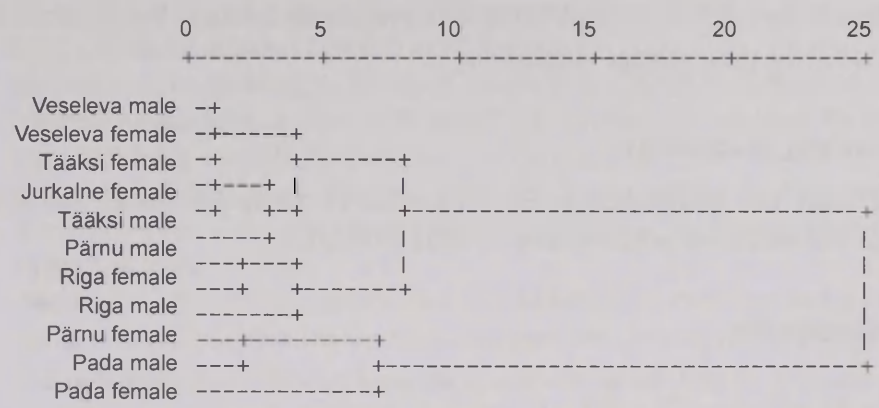


Figure 4. Hierarhical cluster analysis (Average Linkage Cluster Analysis with squared Euclidean distances) dendrogram based on Ba, Cu, Pb, Sr, Zn, Mn contents.

CONCLUSIONS

The communities buried to the cemeteries of the Pärnu garrison and St. Peter's church in Riga have certain similar nutrition indicators, log Ba/Sr is relatively low referring to the bigger proportion of marine food in comparison with Latvian and Estonian village communities. Also, the values of Zn and Cu in the archaeological bones of the towns of Riga and Pärnu are higher which are the indicators of the proportions of both meat and seafood in nutrition. On the one hand, the communities buried to the cemetery of the Pärnu garrison and into St. Peter's church in Riga were of a higher social status but on the other hand, both are the town populations at the sea.

Tääksi, Veseleva and Jurkalne represent medieval and early modern village communities and from a separate group on the basis of nutriton indicators. The group is characterized by the food from the inland and most probably the smaller proportions of meat in the menu. Concerning the studied indicators, the community buried to the Pada cemetery is different from the communities of the seaside towns and inland villages. It may be caused by the heterogenity of the community (the different geographical origin of individuals, their social status) and in this connection their nutrition is different. We should bear in mind that the Pada comunity is the oldest in time, originating from the final period of ancient times when climatic conditions and the social order were different. It should be mentioned that in the contents of copper and zink there were certain differences between the Latvian and the Estonian series. As a rule, the content of these elements is bigger in men but in the Tääksi and the Pada

series it is the other way round. What such irregularity is caused by is difficult to explain at the present stage of research.

ACKNOWLEDGEMENT

The study was undertaken in the framework of the target funded research project of the Estonian Government (SF0130012s08).

REFERENCES

1. Allmäe R. (1998). Tääksi 14.–18. sajandi populatsiooni demograafiline analüüs ja kehapikkuse rekonstrueerimine. Muinasaja Teadus 5, Loodus, inimene ja tehnoloogia: interdistsiplinaarseid uurimusi arheoloogias, 163–187.
2. Allmäe R. (2009). Composition of urban population of Pärnu in the 16th–18th centuries. Papers on Anthropology, XVIII, 38–48.
3. Allmäe R., Limbo J. (2008). 16.–18. sajandi Pärnu garnisoni kalmistule maetute antropoloogiast. Pärnumaa 1. köide. Loodus. Aeg. Inimene. Eesti Entsüklopeediakirjastus, Tallinn, 369–387.
4. Allmäe R., Limbo J. (2010). Skeletal stress-markers in the Early Modern town of Pärnu, Estonia. Papers on Anthropology, XIX, 29–48.
5. Allmäe R., Verš E. (2011). Pilguheit esivanemate toidulauale – kas liha-, kala- või taimesööjad? In: Verš E., Preeden U., Lang L. (eds.) Maa ressursid. Schola Geologica, Tartu. Eesti Looduseuurijate Selts, 44–55.
6. Allmäe R., Limbo-Simovart J., Heapost L., Verš E. (2012). Arheoloogilised inimluud toitumisuuringute allikana. Muinasaja Teadus 23, Loodus, inimene ja tehnoloogia: interdistsiplinaarseid uurimusi arheoloogias. In print.
7. Armelagos G. J., Alcom M., Martin D., Vangreven D. P. (1989). Factors affecting elemental and isotopic variation in prehistoric human skeletons. In: Price T.D. (ed.) The Chemistry of Prehistoric Human bone. Cambridge: Cambridge University Press, 230–244.
8. Avioli L. V. (1988). Calcium and Phosphorus. In: Shils M. E., Young V. R. (eds.) Modern Nutrition in Health and Disease, 7th ed. Lea and Febiger, Philadelphia, 142–158.
9. Benfer R. (1995). Age of Pregnancies and Age of Weaning from Prehistoric Bone: Are Sr and Zn Indicators? Am. J. Physic. Anthrop, Supplement 20, 89–90.
10. Bentley R. A. (2006). Strontium isotopes from the earth to the archaeological skeleton: a review. Journal of Archaeological Method and Theory, 13, 135–187.
11. Bronner F. (2008). Metals in bone: Aluminium, Boron, Cadmium, Cromium, Lanhanum, Lead, Silicon, and Strontium. In: Bilezikian J. P., Lawrence G. R., Martin T. J. (eds.) Principles of Bone Biology. Third edition. Volume 1. Elsevier, USA, 515–532.

12. Brown A. (1973). Bone strontium as dietary indicator in human skeletal populations. PhD dissertation. University of Michigan.
13. Buikstra J. E., Frankenberg S., Lambert J. P., Xue L. A. (1989). Multiple elements: Multiple expectations. In: Price T. D. (ed.) The Chemistry of Prehistoric Human bone. Cambridge: Cambridge University Press, 155–210.
14. Burton J. H. (2008). Bone chemistry and trace element analysis. In: Katzenberg M. A., Saunders, S. R. (eds.) Biological Anthropology of the Human Skeleton. Wiley-Liss, USA, 443–460.
15. Burton J. H., Price T. D. (1990). The ratio of barium to strontium as a paleodietary indicator of consumption of marine resources. Journal of Archaeological Science, 17: 5, 547–557.
16. Burton J. H., Price T. D., Cahue L., Wright L. E. (2003). The use of barium and strontium abundances in human skeletal tissues to determine their geographic origins. International Journal of Osteoarchaeology, Special Issue: Bone Chemistry. 13: 1–2, 88–95.
17. Celminš A. (1998). Zemē apslēptā pilsēta. Dizaina un drukas apgāds, Riga.
18. Connor M., Slaughter D. (1984). Diachronic study of Inuit diets utilising trace element analysis. Arctic Anthropology 21, 123–134.
19. Edward J., Benfer R. A. (1993). The Effects of Diagenesis on the Paloma Skeletal Material. In: Sanford M. K. (ed.) Investigations of Ancient Human Tissue: Chemical Analyses in Anthropology. Philadelphia: Gordon and Breach, 183–268.
20. Ezzo J. A. (1994). Putting the "chemistry" back into archaeological bone chemistry analysis: modeling potential paleodietary indicators. J. Anthropol. Archaeol. 13, 1–34.
21. Fabig A., Herrmann B. (2002). Trace elements in buried human bones: intrapopulation variability of Sr/Ca and Ba/Ca ratios – diet or diagenesis? Naturwissenschaften, 89, 115–119.
22. Finley J. W., Johnson P. E., Johnson L. K. (1994). Sex affects manganese absorption and retention by humans from a diet adequate in manganese. American Journal of Clinical Nutrition, 60:6, 949–955.
23. Gilbert R. I. (1975). Trace elements analyses of three skeletal Amerindian populations at Dicson mounds. PhD dissertaion, University of Massachusetts, Amherst.
24. Gilbert R. I. (1985). Stress, paleonutritiona nd trace elements. In: Gilbert R. I., Milke J. H. (eds.) The analysis of prehistoric diets. Academic Press, 339–357.
25. Grupe G. (1988). Impact of the choice of bone samples on trace element data in excavated human skeletons. Journal of Archaeological Science, 15: 2, 123–129.
26. Hasan H. (2008). Manganese. Understanding the Elements of the Periodic Table. The Rosen Publishing Group, Inc. New York.

27. Heapost L. (2002). Pada 12.–13. sajandi kalme osteomeetria ja rekonstrueeritud somatomeetria. Eesti Antropomeetriaregistri Aastraamat 2002. Tartu Ülikooli Kirjastus, 39–46.
28. Hedges R. E. M., Millard A. R., Pike, A. W. G. (1995). Measurements and relationships of diagenetic alteration of bone from three archaeological sites. Journal of Archaeological Science, 22, 201–9.
29. Jürjo, I. (2010). Pärnu ja Pärnumaa 18. sajandil. In: Vunk, A. (ed.) Pärnumaa. Loodus. Aeg. Inimene. Eesti Entsüklopeediakirjastus, 114–123.
30. Kies C., Aldrich K. D., Johnson M. J., Creps C., Kowalsi C., Wang, R. H. (1987). Manganese availability for humans, effect of selected dietary factors. In: Kies C. (ed.) Nutritional Bioavailability of Manganese. American Chemical Society, Washington, DC.
31. Klepinger L. L. (1993). Culture, health and chemistry: a technological approach to discovery. In: Sandford M. K. (ed.) Investigations of ancient human tissue. Gordon and Breach Science Publisher, 167–80.
32. Küng E. (2010). Rootsi aeg 1600–1609 ja 1617–1710. In: Vunk A. (ed.). Pärnumaa. Loodus. Aeg. Inimene. Eesti Entsüklopeediakirjastus, 95–109.
33. Lambert J. B., Szpunar C. B., Buikstra, J. E. (1979). Chemical analysis of excavated human bone from Middle and Late Woodland sites. Archaeometry, 21,115–129.
34. Leach F., Quinn C. J., Morrison J., Lyon G. (2003). The use of multiple isotope signatures in reconstructing prehistoric human diet from archaeological bone from the Pacific and New Zealand. New Zealand Journal of Archaeology, 23, 31–98.
35. Lidén K. (1995). Prehistoric Diet Transitions. An Archaological perspective. PhD Dissertation. Stockholm University.
36. Limbo J. (2004). Pada kalmistu indiviidide esinevad hambapatoloogiad (XII–XIII saj.). Eesti Arholoogiaajakiri, 8:1, 49–75.
37. Limbo J. (2009). Dental pathologies and linear enamel hypoplasia in Pärnu St. John's church cemetery (16^{th}–18^{th}) skeletons. Papers on Anthropology, XVIII, 234–249.
38. Magee B. J., Sheridan S. G., Van Gerven D. P., Greene, D. L. (1994). Elemental analysis of Mesolithic bone from Wadi Halfa: A diagenetic and dietary investigation of permineralized human remains. Denver CO, March 30-April 2. Amer. Journal of Physical Anthropology, 18:134.
39. Maps of the Estonian Land Board (2012). http://geoportaal.maaamet.ee/est/Kaardiserver-p2.html
40. Nielsen-Marsh C. M., Smith C. I., Jans M. M. E., Nord A., Kars H., Collins M. J. (2007). Bone diagenesis in the European Holocene II: taphonomic and, environmental considerations. Journal of Archaeological Science 34, 1523–1531.
41. Pate D. F. (1994). Bone chemistry and paleodiet. Journal of Archaeological Method and Theory 1, 161–209.

42. Pearsall D. M. (1989). Paleoethnobotany: A Handbook of Procedures. Academic Press.
43. Pollard M., Batt C., Stern B., Young S. M. M. (2007). Analytical chemistry in archaeology. Cambridge University Press, New York.
44. Price T. D. (1989). Multi-element studies of diagenesis. In: Price T. D. (ed.) The Chemistry of Prehistoric Human bone. Cambridge: Cambridge University Press, 126–154.
45. Price T. D., Blitz J., Burton J., Ezzo J. A. (1992). Diagenesis in prehistoric bone: Problems and solutions. Journal of Archaeological Science, 19:5, 513–529.
46. Rudovica V., Viksna A., Katkevich J., Zarina, G. (2009). Some aspects of diet of the 13th–17th century population of Latvia. Papers on Anthropology, XVIII, 328–338.
47. Reintam L. (2012) Eesti mullad. http://www.botany.ut.ee/mullaveeb/sisu/yldine.html 15.05.2012
48. Smith C. I., Nielsen-Marsh C. M. Jans M. M. E., Collins M. J. (2007). Bone diagenesis in the European Holocene I: patterns and mechanisms. Journal of Archaeological Science, 34, 1485–1493.
49. Smrčka V. (2005). Trace elements in bone tissue. The Karolinum Press, Prague.
50. Sokolovski 1990 = Соколовский В. (1990). Средневековое деревенское кладбище в Тяэкси. Eesti TA Toimetised, Ühiskonnateadused, 4, 412–422.
51. Söremark R. (1967). Vanadium in Some Biological Specimens. Journal of Nutrition, 92:2, 183–90.
52. Zapata J., Pérez-Sirvent C., Martínez-Sánchez M. J., Tovar, P. (2006). Diagenesis, not biogenesis: Two late Roman skeletal examples. Science of the Total Environment, 369, 357–368.
53. Tamla T. (2010). Aruanded Pada maa-aluse kalmistu kaevamistest Rakvere rajoonis Viru-Nigula kolhoosis (Viru-Nigula Kihelkond. Pada asundus; tänapäeval Viru-Nigula vald, Pada küla) aastatel 1987–1989. Käsikirjad 1–103, nr 49–51, in TLÜ AI Fund.
54. Wilson L., Pollard M. (2002). Here today, gone tomorrow? Integrated experimentation and geochemical modeling in studies of archaeological diagenetic change. Acc. Chem. Res., 35, 644–51.

Address for correspondence:
Raili Allmäe
Department of Archeobiology and Ancient Technology
Institute of History
Tallinn University
Rüütli 6, Tallinn 10130, Estonia
E-mail: raili.allmae@ai.ee

Papers on Anthropology XXI, 2012, pp. 50–55

GLUCOSE TRANSPORTERS IN THE BLOOD-BRAIN BARRIER

PIRET HUSSAR[1], INDREK BENNO[2], ÜLO HUSSAR[1†]

[1] *Institute of Anatomy, Faculty of Medicine, University of Tartu, Estonia*
[2] *Surgery Clinic, Tartu University Hospital, Estonia*

ABSTRACT

The central nervous system and peripheral nerves are guarded against free access from the outside by the blood-brain, blood-cerebrospinal fluid and blood-nerve barriers. The glucose transporter GLUT1 mediates the specific transfer of glucose across these barriers while GLUT3 is a high-affinity isoform of Type I glucose transporter expressed mostly in neurons where it is believed to be the main glucose transporter isoform. As for a long time it was an open question whether, GLUT1 and GLUT3 are present in the olfactory system, the aim of the present study was to give answers to these questions. In the study mucous membranes of the olfactory region of 20 male Wistar rats were studied by double immunofluorescence labeling. As the result of the study, the immunolocalization of glucose transporters GLUT1 in the endothelial cells of the olfactory mucosa and GLUT3 expression in olfactory receptor neurons were detected.

Key words: *glucose transport, GLUT1, GLUT3, blood-brain barrier*

INTRODUCTION

Glucose transporters are the membrane proteins that serve in the transfer of sugars across the cellular membranes [1, 2, 11, 12]. Two types of glucose transporters have been identified: the SGLT family and the GLUT family. SGLT glucose transporters are sodium-dependent active transporters serving in the concentrative transport of sugars in the small intestine and the kidney. GLUT glucose transporters are the passive facilitated-diffusion transporters that trans-

port sugars according to their concentration gradient. Previously it has been shown that GLUT1, an isoform of the GLUT family, is abundant in the cells of blood – tissue barriers [10, 13]. The importance of GLUT1 was made evident by a mutation of GLUT1 that was shown to be responsible for seizures due to the decrease of the glucose level in the cerebrospinal fluid caused by defective glucose transport across the blood – brain barrier [9].

The olfactory system is a unique extension of the central nervous system as the sensory cells of the olfactory system, olfactory receptor neurons are embedded in the olfactory epithelium of the nasal mucosa, and protrude their dendrites to the lumen (3–5). Protein gene product 9.5 (PGP 9.5) is a useful marker for various types of neurons [14]. To clarify the olfactory mucosa antisera to tubulin and PGP 9.5 were used.

MATERIAL AND METHODS

In the experiment mucous membranes of the olfactory region of 20 four weeks old male Wistar rats were studied by double immunofluorescence labeling. Specimens were fixed with 1–3% paraformaldehyde in phosphate-buffered saline (PBS) at 4°C for 3–24 h; thereafter washed with PBS, infused with 20% sucrose in 0,1 M sodium phosphate buffer, frozen in liquid nitrogen, and stored at –80°C until use. Cryostat sections, 4–8 μm thick, were cut and mounted on the glass slides coated with poly-L-lysine. Double-immunofluorescence labeling was carried out as described previously (Takata et al. 1990). Rabbit anti-GLUT1, guinea pig anti-GLUT1 (raised by K. Takata, Gunma University, Japan), rabbit anti-chicken tubulin (from S. J. Singer, University of California at San Diego), rabbit anti-GLUT3 and mouse anti-PGP 9.5 served as primary antibodies. Fluorescein isothiocyanate-labeled donkey antiguinea pig immunoglobulin G (IgG), dichlorotriazinyl amino fluorescein-labeled and rhodamine red X-labeled donkey anti-rabbit IgG, and Cy3-labeled donkey anti-mouse IgG were used as secondary antibodies (Jackson Immunoresearch, West Grove, PA). Nuclei of the cells were counterstained with 4',6-diamidino-2-phenylindole (DAPI). Specimens were sequentially incubated with a mixture of the primary antibodies raised in different animal species, then with a mixture of fluorescence-labeled species-specific secondary antibodies. Immunolabeled samples were examined with AX-70 epifluorescence microscope (Olympus, Tokyo, Japan).

RESULTS

The studies indicated the abundant presence of GLUT1 in the endothelial cells of olfactory mucosa while the cells of the olfactory epithelium were positive for PGP 9.5 (Figure 1). The upper cells of olfactory epithelium (*cellulae neurosensoriae olfactoriae*) stained srongly positive for GLUT3 (Figure 2). Anti-tubulin antibody strongly stained the apices of the olfactory epithelial cells as well as nerve fiber bundles emanating from the epithelium (Figures 3–4).

DISCUSSION AND CONCLUSIONS

The glucose transporter GLUT1 mediates the specific transfer of glucose across blood-brain, blood-cerebrospinal fluid and blood-nerve barrier barriers [11, 12].

The delivery of glucose from the blood to the brain involves its passage across the endothelial cells of the blood-brain barrier, which is mediated by the facilitative glucose transporter protein 1 and then across the neural cell membranes, which is mediated by GLUT 3 [6]. By Mantych et al. [8] it has been proved that the prominent localization of GLUT3 to mature neuronal processes suggests an essential role for this transporter in regulating fuel requirements for dendritic and axonal traffic, thereby mediating neurotransmission. However the question whether GLUT1 and GLUT3 are present in the olfactory system as well has been under discussion. GLUT1 and occludin may serve as a part of the machinery for the specific transfer of glucose in the olfactory system while preventing the non-specific entry of substances [7].

Our investigations showed the immunolocalization of glucose transporters GLUT1 in the endothelial cells of olfactory mucosa and GLUT3 expressing primarily in olfactory receptor neurons indicating to the pathway of glucose to cross the blood-brain barrier and enter neurons. The results also tshowed that tubulin acts as a marker for the nerve fibers in the olfactory mucosa and PGP9.5 serves as a marker both for the olfactory epithelium and nerve fibers.

Figure 1. Immunofluorescence localization of GLUT1 and PGP9.5 in the olfactory mucosa. GLUT1 is abundant in the endothelial cells of the blood vessels and PGP 9.5 in the olfactory receptor neurons of the olfactory epithelium.

Figure 2. Immunofluorescence localization of GLUT3 and PGP9.5 in the olfactory mucosa. Note the upper cells of olfactory epithelium *(cellulae neurosensoriae olfactoriae)* stained positive for GLUT3.

Figure 3. Immunofluorescence localization of tubulin and GLUT1 in the olfactory mucosa. The apices of the olfactory epithelial cells are strongly stained positive for tubulin.

Figure 4. Immunofluorescence localization of tubulin and GLUT1 in the olfactory mucosa. The nerve fiber bundles emanating from the epithelium stained positive for tubulin while GLUT1 is localizing in the nerve fiber sheets and in the endothelial cells of the surrounding blood vessels.

ACKNOWLEDGEMENTS

This work was supported in part by Grants-in-Aids for Scientific Research from the Ministry of Education, Science, Sports, and Culture of Japan. P.H. was the recipient of a Japanese Government (Monbusho) scholarship.

REFERENCES

1. Baldwin S. A. (1993). Mammalian passive glucose transporters: members of an ubiquitous family of active and passive transport proteins. Biochim Biophys Acta, 1154, 17–49.
2. Bell G. I., Burant C. F., Takeda J., Gould G. W. (1993). Structure and function of mammalian facilitative sugar transporters. J Biol Chem, 268, 19161–19164.
3. Doucette R (1990). Glial influences on axonal growth in the primary olfactory system. Glia, 3, 433–449.
4. Farbman A. I. (1992). Cell Biology of Olfaction. Cambridge University Press, Cambridge.
5. Graiziadei P. P. C. (1973). The ultrastructure of vertebrate olfactory mucosa. In: Friedmann I. (ed.). The Ultrastructure of Sensory Organs. North-Holland, Amsterdam. 269–305.
6. Hou W. K., Xian Y. X., Zhang L., Lai H., Hou X. G., Xu Y. X., Yu T., Xu F. Y., Song J., Fu C. L., Zhang W. W., Chen L. Chin (2007). Influence of blood glucose on the expression of glucose trans-porter proteins 1 and 3 in the brain of diabetic rats. Chinese Medical Journal, 5, 120, 19, 1704–1709.
7. Hussar P., Tserentsoodol N., Koyama H., Yokoo-Sugawara M., Matsuzaki T., Takami S., Takata K. (2002). The glucose transporter GLUT1 and the tight junction protein occludin in nasal olfactory mucosa. Chem Senses, 27, 1, 7–11.
8. Mantych G. J., James D. E., Chung H. D., Devaskar S. U. (1992). Cellular localization and characterization of Glut 3 glucose transporter isoform in human brain. Endocrinology, 131, 3, 1270–1278.
9. Seidner G., Alvarez M. G., Yeh J., O'Driscoll K. R., Klepper J., Stump T. S., Wang D., Spinner N. B., Birnbaum M. J., De Vivo D. C. (1998). GLUT-1 deficiency syndrome caused by haploinsufficiency of the blood-brain barrier hexose carrier. Nature Genet, 18, 188–191.
10. Takata K., Kasahara T., Kasahara M., Ezaki O., Hirano H. (1990). Erythrocyte/HepG2-type glucose transporter is concentrated in cells of blood – tissue barriers. Bioche. Biophys Res Commun, 173, 67–73.
11. Takata K., Kasahara M., Oka Y., Hirano, H. (1993). Mammalian sugar transporters: their localization and link to cellular functions. Acta Histochem Cytochem, 26, 165–178.
12. Takata K. (1996). Glucose transporters in the transepithelial transport of glucose. J Electron Microsc, 45, 275–284.

13. Takata K., Hirano H., Kasahara M. (1997). Transport of glucose across the blood-tissue barriers. Int Rev Cytol, 172, 1–53.
14. Thompson R. F., Doran J. F., Jackson P., Phillon A. P., Rode, J. (1983). PGP9.5-a marker for vertebrate neurons and neuroendocrine cells. Brain Res, 278, 224–228.

Address for correspondence:
Piret Hussar, M.D., D.M.Sc
Institute of Anatomy
Faculty of Medicine
University of Tartu
Ravila 19, 50411 Tartu, Estonia
E-mail: piret.hussar@ut.ee

Papers on Anthropology XXI, 2012, pp. 56–71

ANTHROPOMETRIC MEASUREMENTS OF THE BODY COMPOSITION OF CANCER PATIENTS DETERMINE THE PRECISE ROLE OF THE BODY SURFACE AREA AND THE CALCULATION OF THE DOSE OF CHEMOTHERAPY

AIJA GERINA-BERZINA[1], ULDIS VIKMANIS[1],
ULDIS TEIBE[2], SILVIJA UMBRASHKO[2]

[1] *Faculty of Medicine, University of Latvia*
[2] *Department of Anatomy and Anthropology, Riga Stradiņš University, Latvia*

ABSTRACT

The calculation of an accurate dose of chemotherapy for oncological patients reduces the possible medication errors and the toxicity of the body and so it improves the outcome of the treatment (survival). In oncological practice for the calculation of the dose of chemotherapy the human body surface area (BSA) is used. The human body surface area is determined by derived formulas, but it is not directly linked to the pharmacokinetics of the drugs. Pharmacokinetic studies have demonstrated that for the calculation of the chemotherapy dose the actual body weight should be taken into account rather than the ideal one. In the therapeutic dose determination the body fat mass has essential significance.

202 patients aged from 19 to 83 years with various tumor localizations underwent anthropometric measurements (height, weight, circumferences, fat-fold thickness, the distance between the hills above the joint), the body mass index (BMI) and the BSA (according to the Mosteller formula).

The average weight of 99 men was 78.5 ± 16.4 kg and the mean body weight of 103 women was 70.1 ± 14.6 kg, statistically non-significantly different ($F = 0.358$, $p = 0.551$), but the independent-sample t-test arithmetical mean differed statistically significantly ($t = 3.839$, $p < 0.001$). The oncological patients

in the absolute and relative distribution of groups according to the body mass index in relation to the patients gender differed statistically significantly ($\chi 2$ = 11.510, df = 4, p = 0.021). Half of the men had ideal weight (body mass), but only about 1/3 of women were with the ideal body weight. The men's average body mass index was 25.41 ± 4.73 kg/m^2 and the women's average body mass index was 26.20 ± 5.90 kg/m^2. After arithmetic calculation of the body surface area using a variety of formulas, men's BSA differs less than 1% compared to the calculated area of Mosteller formula. For women the differences are more than 1%. Distribution of patients in groups body fat content (%) of the patient's shows that male and female patients were primarily from the group with excessive fat in the body, the body fat for men is 25% or more of the total body weight, but for the women it is over 32% of the total body weight. Correlation analysis showed that the body fat for men correlates with the body surface area, calculated using the Mosteller formula (r = 0.663, p <0.001) and the fat content for women correlates with the body surface area, calculated using the Mosteller formula (r = 0.760, p <0.001). The male body volume of the mean value was 75, 0 ± 17.1 dm^3, the female body volume of the mean value was 68, 6 ± 15.6 dm^3. After the independent samples t-test between men and women in body volume arithmetical means differed statistically significantly (t = 2.437, p = 0.016).

Anthropometric measurements are suitable for the calculation of the doses of chemotherapy, but taking into account the correlation, it cannot be excluded that they reflect the same body surface area. The BMI does not feature the percentage of the fat mass of the whole body. Consequently, it is possible that the patient's body density is a more physiological parameter, which could be determined for comparison by using abdominal computer tomography. The body volume index(BVI) could be one of the most recent parameters for the more accurate calculation of chemotherapy for cancer patients. The Body Volume Index (BVI) is a new measurement for human **obesity** that has been proposed as an alternative to the **Body Mass Index** (BMI).

Key words: *body surface area (BSA), chemotherapy, body mass index (BMI), body volume index(BVI)*

INTRODUCTION

Individuals' response to receiving chemotherapy can be very different, with significant clinical implications. A successful chemotherapy program develops a consistent therapeutic effect minimizing normal tissue toxicity. A fixed-dose chemotherapy reduces the calculation of potential medication errors [6].

Chemotherapy dose calculation is using the human body surface area(BSA). For the BSA calculation different derived formulas are used. The means of the measurement of patients of different ages, shapes and sizes a formula for calculating the surface area using weight and height was first derived in 1916(DuBois and DuBois) [4]. The surface area has been defined by a concept, that it is variable with difficult reproductive assessments. Currently, several institutions are using the Du Bois formula. There are several arguments for and against the Du Bois formula used to calculate body surface area. The fact that the nine subjects who were assessed had different body shapes is in favor of the Du Bois formula. However, many researchers have questioned the accuracy of the formula. In the results of the study, Jones and his colleagues [10] have shown that this equation is not the most accurate, because the Du Bois and Du Bois formula estimate only one leg and arm assuming that the body is symmetrical. But this assumption cannot be applied to people with disabilities [2], as well as the formula greatly overestimates the surface area of the people who are overweight (obese). The above-described results were supported by Wand and his colleagues in 1992. Since the Du Bois formula was derived from a small number of individual measurements, where some of them had skeletal deformities and only one child was included, the question of the reasonableness and accuracy of the formula for babies, people with excess body (pregnancy, obesity, high height) was raised. The Du Bois formula accuracy was evaluated using the predictive mean squared error (RMSE interpreters. Vkk) method. RMSE is the degree of correlation between the measured and the expected data because the Du Bois formula systematically underestimates the BSA (body surface area) by almost 5%. After the RMSE methods there are about 15 different formulas to predict the BSA, 8 is the RMSE of less than 8%. The Du Bois formula ranks fifth on the lowest RMSE. Nevertheless, the Du Bois formula continues to be used, probably more than a tradition of precision and for most drug manufacturers still provide its customers with nomograms, which is taken as the basis for this formula. Nomograms are printed in the standard text, which does not always accurately reproduce the original, which increases the risk to underestimate the surface area. A change in the BSA from 1.87 to 1.60 m^2 is equivalent to the weight loss of 22 kg for a woman with the weight of 80.5 kg and the height 158 cm. This means that it changes the dose of doxorubicin (50 mg/m^2) from 93.5 mg to 80 mg.

Drugs pharmacokinetics (PK) does not largely explain the variability of the BSA. Patients' metabolism and the elimination of drugs vary. The same

chemotherapy dose among patients can give different effects. The body surface area does not take into account the pharmacokinetic processes caused by cytotoxic drugs. The given mathematical analysis of the weight is proportional to (correlate) the volume. This assumption is a valid argument for investigation.

METHODS

The study involved 202 patients, including 164 (81.2%) oncologic patients and 38 (18.8%) control group patients. In the oncologic patient group there were 93 (93.9%) men and 71 (68.9%) women. The control group consisted of 6 (6.1%) men and 32 (31.1%) women. After the Pearson's chi-square test of men and women groups statistically differed significantly ($\chi 2 = 20.670$, $p < 0.001$). Also, the Fisher's exact test shows that the null hypothesis probability is less than 0.001.

Anthropometry: Body anthropometric parameters in cancer patients were used as scales, measuring tapes, antropometers (gauge height) and calliper. The body volume was determined from the formulas using anthropometric measurement data.

Adipose tissue (passive) mass of the formula:

$D = 1{,}3 \times \frac{100 + W + (H - 160}{100} \times \frac{(d_1 + d_2 + d_3 + d_4 + d_5 + d_6)}{12}$, where D – fat mass (kg), W – body weight (kg), H – height (cm), d – fat fold thickness (mm) on the upper arm, forearm, thigh, lower leg, pass the ribs and abdomen.

Active muscle mass of the formula:

$M = 6{,}5 \times H \times \left(\frac{E_{4apk}}{25{,}12} - \frac{E_{Staukaudukrokas}}{100} \right)^2 \times 10^{-3}$, where M – muscle mass (kg) E4 lower arm + forearm + Upper + Lower the amount of girth (cm) E5 fat fold- 5 fold the amount of fat (2 × arm + forearm + Upper + Lower) (mm), H – height (cm)

Bone mass of: $O = 1{,}2 \times H \times \left(\frac{E_{4epi}}{4} \right)^2 \times 10^{-3}$, where O – bone mass (kg), H – height (cm) E4epi – the distance between epicondil amount (arm epicondil + forearm + Upper + Lower) (cm). Adipose tissue, muscle, bone mass determination in relative terms (%) was carried out according to the formulas:

$$\text{Adipose tissue mass}(\%)=\frac{D\times 100}{W}$$

$$\text{Muscle mass}(\%)=\frac{M\times 100}{W}$$

$$\text{Bone mass}(\%)=\frac{O\times 100}{W}, \text{ where W – body weight (kg)}$$

Mediumbuild body tissue composition in relative terms (%):

Gender	Adipose tissue mass	Muscle mass	Bone mass
Male	12.63–16.29	32.91–35.18	10.77–12.88
Female	19.60–24.21	23.69–25.64	8.64–9.61

Different cultures and different times have different body compositions, and a body composition is also associated with health and sports performances. The body fat is epidemiologically sensitive to gender and age. [18] There are different recommendations for the ideal body fat percentage. It is designed by the American Council (not an official government agency) recommendations. (Table 1)

Table 1. Aproximate relative amount of fat in the body of an adult.

Description	Female	Male
Essential fat	8–12%	3–5%
Athletes	14–20%	6–13%
Fitness	21–24%	14–17%
"Average"	25–32%	18–24%
Excess fat	32%+	25%+

Five formulas were used for calculating the BSA, ranked according to the RMSE Method of Prediction by Wang et al. (Table 2)

Table 2.

Autors	BSA (KVL) formula
Boyd[1]	$BSA\ (m^2) = Wt(kg)^{0.4838} * Ht(cm)^{0.3} * 0.017827$
Gehan and George	$BSA\ (m^2) = Wt(kg)^{0.51456} * Ht(cm)^{0.42246} * 0.02350$
Mosteller	$BSA\ (m^2) = [\ Ht(cm) * Wt(kg) / 3600\ ]^{½}$ vai $BSA\ (m^2) = [\ Ht(in) * Wt(lbs) / 3131\ ]^{½}$
Haycock	$BSA\ (m^2) = Wt(kg)^{0.5378} * Ht(cm)^{0.3964} * 0.024265$
Du Bois and Du Bois	$BSA\ (m^2) = Wt(kg)^{0.425} * Ht(cm)^{0.725} * 0.007184$

The **Body volume** was determined from the formulas using anthropometric measurement data.

Statistical analysis: The study of statistical data analysis uses mathematical statistical methods to evaluate the measurements (length, thickness, circumference and weight), the reliability and the relevance of the theoretical probability distributions, as well as to check the set of statistical hypotheses. So the work has very widely used common (popular) methods of descriptive statistics, which are described in many books, such as the books on statistics of biology and medicine [1, 15, 16]. The variables are measured on a relative scale and were normally distributed (Gaussian obeyed the law), were analyzed using parametric statistical methods. In other cases, the use of parametric statistical methods was done. Hypotheses on the data with a normal probability of distribution is mainly tested in the Kolmogorov-Smirnovs test. Two-sample equal the arithmetical mean, using t-test. Three or more teams equal the arithmetical mean, for testing the analysis of variance (ANOVA) was used. ANOVA – English – Analysis of variance. A number of cases was used to compare the chi-square test and the Fisher's exact test. Relationship among different variables for the analysis and the prediction of events were calculated by using correlation and linear regression methods. Statistical data processing of a database to MS Excel, then conversion of the data to the professional study of statistical data processing (analysis) program SPSS (Statistical Package for Social Sciences) version 16.0 for Windows followed. All the hypothesis tests used the duplex (2-tailed) of statistical hypotheses and the null hypothesis was rejected if the probability (of relevance, significance level) was less than 5% or $p < 0.05$.

RESULTS

Body Weight: In the study it was important to determine the sample descriptive statistic indicators. The average weight of 99 men was 78.5 ± 16.4 kg and the mean body weight of 103 women was 70.1 ± 14.6 kg. After the Lieven test sample distribution was statistically significantly different ($F = 0.358$, $p = 0.551$), but the independent-sample t-test arithmetical means differed statistically significantly ($t = 3.839$, $p < 0.001$). The men's average body weight was 59.9 passive ± 7.9 kg and the women's average body mass was passive 46.6 ± 4.7 kg. After the Lieven test sample distribution statistically

differed significantly ($F = 18.003$, $p < 0.001$) and independent samples t-test arithmetical means statistically differed significantly ($t = 14.512$, $p < 0.001$). The men's ideal average body weight was 70.9 ± 6.3 kg and the women's average body mass of the passive was 55.9 ± 5.9 kg. After the Lieven test sample distribution was statistically significantly different ($F = 1.123$, $p = 0.290$), but the independent-sample t-test arithmetical means differed statistically significantly ($t = 17.434$, $p < 0.001$).

Patient's height: Patient's height (body length standing) ranged from 148.6 to 192.5 cm, the average height – 169.6 ± 8.9 cm. Patient's distribution according to height histograms and normal (Gaussian) distribution curve, where the average male's height was 175.5 ± 6.9 cm and the females average height was 163.9 ± 6.6 cm (Figure 1). After the Lieven test sample distribution was statistically significantly different ($F = 1.123$, $p = 0.290$), but the independent-sample t-test arithmetic means differed statistically significantly ($t = 12.203$, $p < 0.001$).

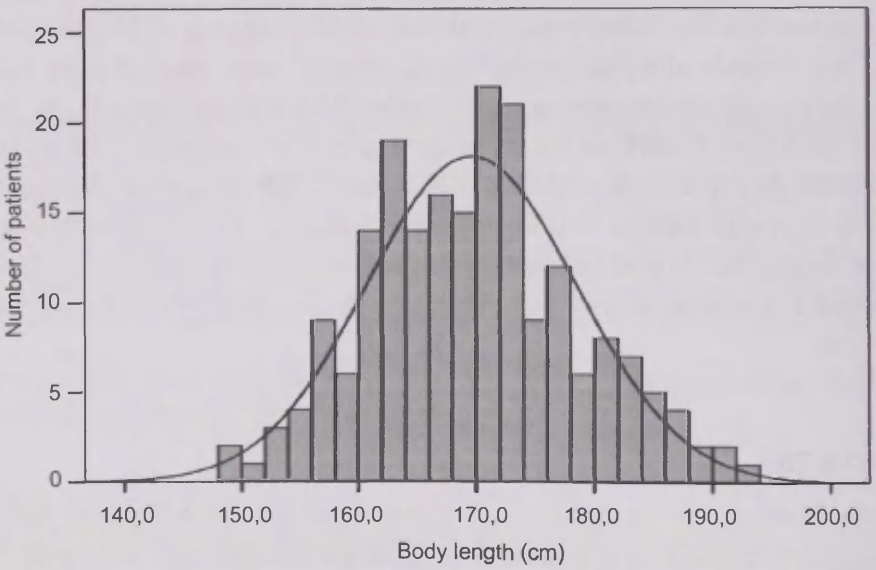


Figure 1. Patients with the absolute height distribution of the histogram and the normal (Gaussian) distribution curve.

Body Mass Index: The men's average body mass index was 25.41 ± 4.73 kg/m^2 and the women's average body mass index was 26.20 ± 5.90 kg/m^2. After the Lieven test sample distribution was statistically significantly different

($F = 3.075$, $p = 0.081$), and also by independent samples t-test arithmetical means was statistically significantly different ($t = 1.043$, $p = 0.298$).

Table 3. Oncologic patients in the absolute and relative distribution of groups according to body mass index.

BMI group	Number	%	Accrued %
Light	23	11.4	11.4
Ideal weight	98	48.5	59.9
A little too heavy	17	8.4	68.3
Heavier	33	16.3	84.7
Obesity	31	15.3	100.0
Together	202	100.0	

Oncologic patients in the absolute and relative distribution of groups according to the body mass index in relation to the patient's gender (Table 4). After the Pearson's chi-square test of oncological patients in the absolute and relative distribution of groups according to body mass index in relation to the patient' gender differed statistically significantly ($\chi 2 = 11.510$, $df = 4$, $p = 0.021$). We can see that about half of men have the ideal weight (body mass), but only about 1/3 of women are with the ideal body weight.

Table 4. Oncologic patients in the absolute and relative distribution of groups according to the body mass index in relation to the patient's gender.

BMI group	Gender				Together	
	Male		Female			
	Number	%	Number	%	Number	%
Light	15	16.10	4	5.60	19	11.60
Ideal weight	44	47.30	25	35.20	69	42.10
A little too heavy	5	5.40	10	14.10	15	9.10
Heavier	17	18.30	15	21.10	32	19.50
Obesity	12	12.90	17	23.90	29	17.70
Together	93	100.00	71	100.00	164	100.00

Body surface area (BSA): The body surface area was used to calculate the methods described in five most popular formulas. The body surface area in the descriptive statistics is summarized (Table 5). The body surface area of the arithmetical mean and the standard deviations schedule of different methods of calculating the area are shown in Figure 2.

Table 5. Descriptive statistics of the body surface area calculation formula.

BSA m^2	M	N	SD	m
Mosteller	1.88	164	0.22	0.01760
Du Bois & Du Bois	1.86	164	0.21	0.01618
Gehan and George	1. 90	164	0.23	0.01787
Boyd	1.91	164	0.24	0.01839
Haycock	1.90	164	0.24	0.01848

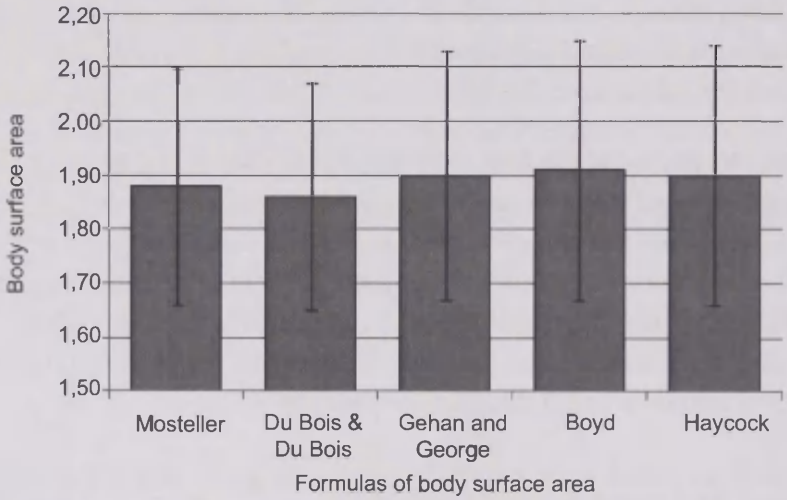


Figure 2. Body surface area of the arithmetical mean and the standard deviations schedule of different methods of the calculating area.

The relative comparison of different calculation methods for the body surface are given in relation to the patient's gender (Table 6). After using a variety of arithmetic formulas in the calculation of the BSA men's differs less than 1% compared to the calculated area of the Mosteller formula. For women the difference is more than 1%.

Among the body surface areas, calculated using different formulas there is a positive, strong and statistically significant ($p < 0.001$) correlation. Calculated after Mosteller and Boyd formulas the body surface area of inter-relationships between the points in the chart with gender (Figure 3).

Table 6. Body surface area, relative comparison of different calculation methods in relation to the patient's gender.

BSA of against Mostseller (%)	Gender	N	M	SD	m
Gerhan George	Male	99	100.631	0.3305	9.0332
	Female	103	101.008	0.4394	0.0433
Du Bois & Du Bois	Male	99	99.533	1.3932	0.1400
	Female	103	98.875	1.7374	0.1712
Boyd	Male	99	100.693	0.9121	0.0917
	Female	103	101.576	1.2625	0.1244
Haycock	Male	99	100.464	0.7220	0.0726
	Female	103	100.716	0.8755	0.0863

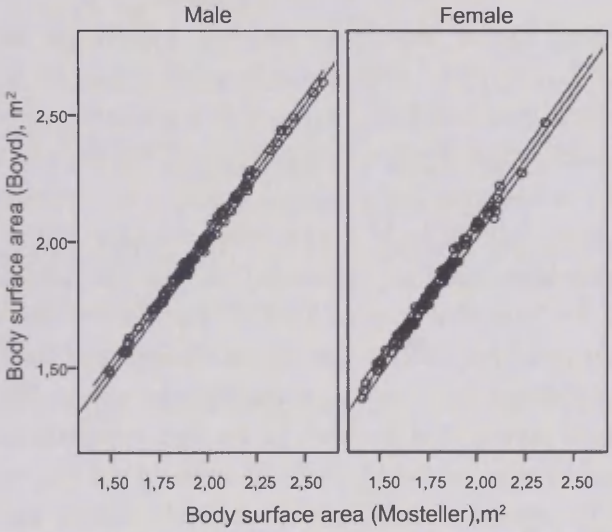


Figure 3. Calculated after Mosteller and Boyd formulas the body surface area of the interrelationships between points graphs, the linear regression lines and their 95% confidencial interval limits in relation to the patient's gender.

Among the various calculated body surface areas there is a linear relationship (coefficient of determination $r^2 = 0.991$). Since the analysis of variance (ANOVA) significance level areas interconnecting the $p < 0.001$, then these fields are obtained using a linear combination. When the linear regression analysis was used, the equations, obtained by linear regression are:

Male:

$$\mathbf{BSA\ (Boyd),\ m^2 = -0{,}078 + 1{,}047 \times BSA\ (Mosteller),\ m^2;}$$

Female:

$$\mathbf{BSA\ (Boyd),\ m^2 = -0{,}130 + 1{,}090 \times BSA\ (Mosteller),\ m^2.}$$

Body fat: The body fat calculation, using the body mass index, being put into practice by Deurenberg [3]. Correlations between densitometric body fat percentage (BF%) and BMI considering age and gender. Children and adults, body fat percentage calculated from different formulas:

Body fat (for children)

$$\% = (\mathbf{1.51 \times BMI}) - (\mathbf{0.70 \times age}) - (\mathbf{3.6 \times Gender}) + \mathbf{1.4};$$

Body fat (for adults)

$$\% = (\mathbf{1.20 \times BMI}) + (\mathbf{0.23 \times age}) - (\mathbf{10.8 \times Gender}) - \mathbf{5.4},$$

* Gender = 1 (for Male)

Gender = 0 (for Female)

The average body fat of oncologic patient's percentage for men was 27.3 ± 7.2% and 31.1 ± 9.7%. After the independent samples the t-test two sample arithmetical means differed statistically significantly ($t = 8.105$ and $p<0.001$). The distribution of patients in groups[18], the body fat content (%) of the patient shows that male and the female patients were primarily from the group with excessive fat in the body, the body fat for men is 25% or more of the total body weight, but that of women is over 32% of the total body weight. Calculated after the Mosteller formula the body surface area and the body fat interrelationships point graphically, the regression lines and their 95% confidencial interval limits in relation to the patients' gender appear (Figure 4). The correlation analysis showed that the body fat for men correlates with the body surface area, calculated using the Mosteller formula ($r = 0.663$, $p<0.001$) and the fat content for women correlates with the body surface area, calculated using the Mosteller formula ($r = 0.760$, $p <0.001$). We can see that outside the 95% confidencial interval limits for men are 5 cases, but for women there are only 2 cases.

The body volume: The body volume study enrolled the patients ranged from 37.3 to 124.6 dm^3 (liters). The oncologic patients body volume ranged from 40.3 to 124.6 dm^3 (liters). The body volume mean value was 72.2 ± 16.7 dm^3. For all the men involved in the study the body volume the mean value was 74.7 ± 16.7 dm^3, the mean value of the female body volume was 66.2 ± 14.9 dm^3. After the independent samples t-test between men and women in the body volume, the arithmetical means differed statistically significantly ($t = 3.839$, $p <0.001$). For the male body volume the mean value was 75.0 ±

17.1 dm^3, for the female body volume the mean value was 68.6 ± 15.6 dm^3. After the independent samples t-test between men and women in the body volume, the arithmetical means differed statistically significantly (t = 2.437, p = 0.016) (Figure 5).

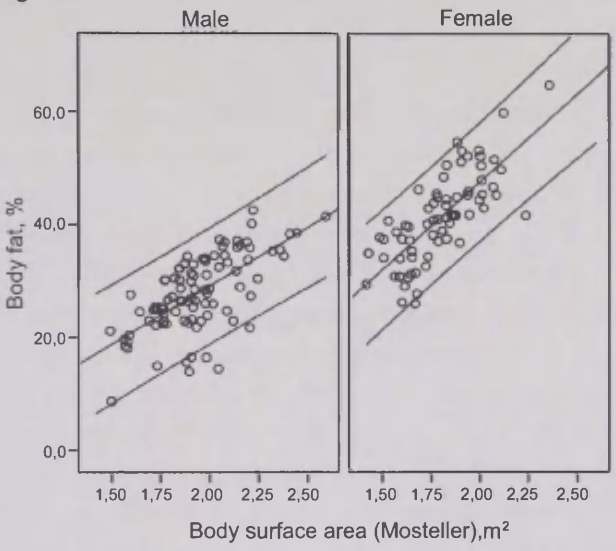


Figure 4. Calculated after the Mosteller formula the body surface area and the body fat interrelationships point graphs, the regression lines and their 95% confidencial interval limits in relation to the patients' gender.

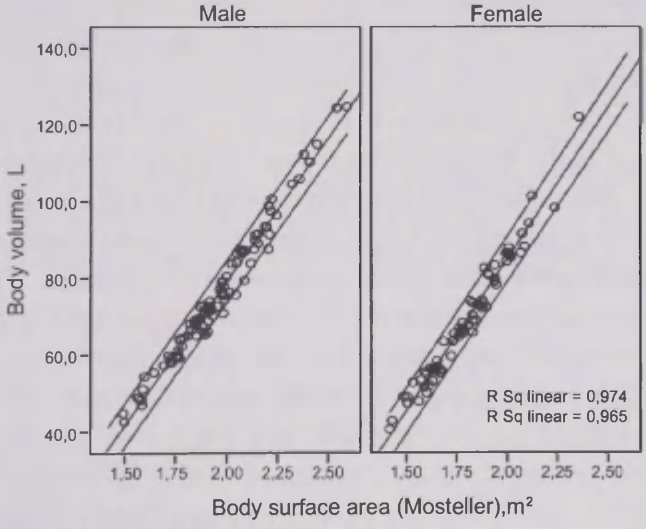


Figure 5. Calculated after the Mostsellera formula the body surface area and the body volume (in liters) and between points graphs, the linear regression lines and their 95% confidencial interval limits in relation to the patients' gender.

DISCUSSION

Anthropometric measurements are suitable for the calculation of the doses of chemotherapy, but taking into account the correlation it cannot be excluded that they reflect the same body surface area. The BMI does not feature the percentage of the fat mass of the whole body. Consequently, it is possible that the patient's body density is a more physiological parameter, which could be determined for comparison by using abdominal computer tomography. The body volume index (BVI) could be one of the most recent parameters for the more accurate calculation of chemotherapy for cancer patients. The **Body Volume Index** (BVI) is a new measurement for human ***obesity*** that has been proposed as an alternative to the ***Body Mass Index*** (BMI). The BMI is based on a measurement of the total mass, irrespective of the location of the mass, but the BVI looks at the relationship between mass and volume distribution (i.e. where the body mass is located on the body). Recent studies have highlighted the limitations of the BMI as an indicator of the individual health risk [19,20]. The Body Volume Index (BVI) was originally devised in February 2000 as a new modern day measurement for measuring ***obesity***; an alternative to the ***Body Mass Index*** (BMI) which was originally conceived between 1830 and 1850. The BMI is based on height and weight only, but the new BVI system automatically measures the ***BMI***, ***waist*** circumference and ***waist-hip ratio*** in addition to the highly sophisticated volumetric and body composition analysis. It is projected that scientific and technical development of the BVI may take a similar period to the BMI, so the year 2020 is the current projected date for adoption and delivery on the scale required. By 2012 there were 6 scientific and 7 academic institutions involved in the evaluation and validation of the BVI as a potential new health risk measurement and indicator, which has been ongoing since March 2007. The BVI is an application [21] that can be used on a 3D Full Body Scanner to determine the individual health risk, whether the scanning hardware uses visible light optical information or otherwise. The BVI allows the differentiation between the people who are assigned the same BMI rating, but who have a different body shape and weight distribution, so that their individual BMI rating may not accurately reflect their own risk. The BVI has undergone clinical trials in the U.S. and Europe as part of a three year collaborative project, the Body Benchmark Study, the results of which were presented in October 2010 at a publicaly funded launch in Birmingham, the UK and scientific research and evaluation continuied in 2011 [22,23]. Whereas the BMI of a person is measured manually by total weight and height, the BVI

is calculated by using 3D full body data to determine volume or weight distribution. The BVI measures where the weight and the fat are distributed on a person's body, rather than the total weight or the total fat content. There has been an acceptance in recent years that abdominal fat and weight around the abdomen constitute a greater health risk[24], commonly known as ***central obesity***. A full body surface scanner determines the three-dimensional outline of a person's exterior surface, so that computation can be used to calculate the part volumes and the part body composition of that person. The BVI makes an inference as to the body's distribution of weight and the distribution of muscle and fat, using complex and detailed ***Body Composition*** data[25]. Most 3D scanners suitable for the BVI require that the subject is scanned for a series of images under varying lighting conditions (various projected patterns), to determine the body shape and weight distribution data for the individual patient and the statistical analysis and the BVI is currently under evaluation by government agencies in the UK as a possible long-term replacement for the BMI. The BVI was conceived as a potential replacement for the BMI at the turn of the millennium and after preliminary development, initial validation was undertaken by the Heartlands Hospital, a ***NHS*** Obesity Centre in the UK. This was followed by clinical testing in the US by the ***Mayo Clinic*** in Rochester, Minnesota[26]. An initial pilot study highlighted the potential of the BVI as a motivational tool for the weight loss in patients and as part of the Body Benchmark Study, a recent further study aimed to assess the validity and reproductibility of the BVI scanner in measuring the anthropometric markers of obesity[22,27]. Comparative validation of the reliability of automatic measurement as opposed to manual measurement concluded that the scanner is a reliable, valid and reproducible method to measure waist and hip circumferences[27]. Ongoing developments in 2012 include initial benchmarking of the BVI values for children aged 4–17 and the collation of 3D data in the US and Europe for use as normative data for the BVI in male and female adults.

REFERENCES

1. Altman D. G. (1999). Practical Statistics for Medical Research. London, Chapman & Hall, 1999, pp. 611.
2. Banerjee S., Sen R. (1955). Determination of the surface area of the body of Indians. J Appl Physiol, 7, 585–588.

3. Deurenberg P., Weststrate J. A., Seidell J. C. (2007). Body mass index as a measure of body fatness: Age- and sex-specific prediction formulas. British Journal of Nutrition, 65, 2, 105–14.
4. Du Bois D., Du Bois E. F. (1916) A formula to estimate the approximate surface area if height and weight be known. Archives of Internal Medicine. 17, 863–871.
5. Fahey T., Insel P., Roth W. (2010). Body Composition. Fit & Well, Core Concepts and Labs in Physical Fitness and Wellness, McGraw-Hill.
6. Favier M., de Cazanove F., Saint-Martin F., Bressolle F. (1994). Preventing medication erros in antineoplastic therapy. American Journal of Hospital Pharmacy 51, 832–833.
7. Gehan E. A., George S. L. (1970). Estimation of human body surface area from height and weight. Cancer Chemother Rep 54, 225–235.
8. Gurney H. (2006). Developing a New Framework for Dose Calculation. Journal of Clinical Oncology, 24, 10, 1489–1490.
9. Jackson A. S., Stanforth P. R., Gagnon J., Rankinen T., Leon A. S., Rao D. C., Skinner J. S., Bouchard C. et al. (2002). True. International Journal of Obesity, 26, 6, 789–96.
10. Jones P. R. M., Wilkinson S., Davies P. S. W. (1985). A revision of body surface area estimations. European Journal of Applied Physiology, 53, 376–379.
11. Mathematical Sciences Education Board. High School Mathematics at Work: Essay and Examples for the Education of All Students, 145–146, 1998.
12. Mosteller R. D. (1987). Simplified calculation of body-surface area. New England Journal of Medicine, 317, 1098.
13. Polovich M., White J. M., Kelleher L. (2005). Chemotherapy and biotherapy guidelines and recommendations for practice (2nd ed.). Pittsburgh, PA: Oncology Nursing Society
14. Rogers J. A., Blake-James M., Green S. (2002). Investigation into the relationship between body surface area and Kopā body potassium using Monte Carlo and measurement. Physics in Medicine and Biology, 47, 5, 789–800.
15. Teibe U. (2007). Bioloģiskā statistika. Rīga, LU Akadēmiskais apgāds, 156 lpp.
16. Teibe U., Berķis U. (2001). Varbūtību teorijas un matemātiskās statistikas elementi medicīnas studentiem. Rīga, AML/RSU, 88 lpp.
17. Anjana M., Sandeep S., Mphil R., Vimaleswaran K. S., Farooq S., Mohan V. (2004). Visceral and Central Abdominal Fat and Anthropometry in Relation to Diabetes in Asian Indians. Diabetes care, 27, 12, 2948–2953.
18. Carey D. G. P. (1998). Abdominal Obesity. Current Opinion in Lipidology. 9, 1. Retrieved on April 9, 2012, 35–40.
19. Romero-Corral A., Somers V. K., Sierra-Johnson J., Thomas R. J., Collazo-Clavell M. L., Korinek J., Allison T. G., Batsis J. A., Sert-Kuniyoshi F. H., Lopez-Jimenez F. (2008). Accuracy of body mass index in diagnosing obesity in the adult general population. International Journal of Obesity 32 (6), 959–956.

20. Association of bodyweight with total mortality and with cardiovascular events in coronary artery disease: a systematic review of cohort studies. Lancet (2006-08-19) 368(9536): 666–78. (Retrieved on 2008-09-08).
21. Bespoke software used in the Body Volume Index (BVI) 3D Body Scanner [1] [a] [b] [2]
22. Barnes R., Rahim A. (2009). The Body Volume Index: New Imaging Technology for Body measurement. Hospital Imaging & Radiology Europe Autumn 2009, 4, (Retrieved on 2010-29-02).
23. Craver R. (2008). Location, not volume, of fat found to be key www.journalnow.com. Retrieved on 2008-10-09.
24. Abd T., Boelaert K., Barnes R., Palin S., Field A., Redmayne H., Aytok L., Rahim A. (2008). Body volume index: time to replace body mass index?. Endocrine Abstracts (Society for Endocrinology, British Endocrine Societies) 15, 104. http://www.endocrine-abstracts.org/ea/0015/ea0015pl104.htm. Retrieved 2008-09-07.
25. Romero-Corral A., Somers V., Lopez-Jimenez F., Korenfeld Y., Palin S., Boelaert K., Boarin S., Sierra-Johnson J., Rahim A. (2008). 3-D Body Scanner, Body Volume Index: A Novel, Reproducible and Automated Anthropometric Tool Associated with Cardiometabolic Biomarkers Obesity A Research Journal 16 (1), 266-P.
26. Boelaert K., Palin S., Field A., Rahim A., Barnes R. http://www.endocrine-abstracts.org/ea/0015/ea0015p125.htm.
27. Korenfeld Y., Ngwa T., Friedman L., Romero-Corral A., Somers V., Xu L. Albuquerque F., Sert-Kuniyoshi F., Ockay A., Lopez-Jimenez F. Validation of a Novel 3D Body Scanner for Obesity Anthropometric Measurements AHA.

Address for correspondence:
Aija Gerina-Berzina
Paul Stradiņs University Hospital
Clinic of Oncology
Pilsonu Street 13, LV-1002, Riga, Latvia
E-mail: a.gerina@inbox.lv

Papers on Anthropology XXI, 2012, pp. 72–83

STRESS AND MUSCLE DAMAGE MONITORING IN HIGH-LEVEL BASKETBALL PLAYERS

AUDRIUS GOCENTAS[1], ANATOLI LANDÕR[2]

[1] *Lithuanian University of Educational Sciences, Lithuania*
[2] *Faculty of Medicine, University of Tartu, Estonia*

ABSTRACT

Close complex monitoring during the entire training period is essential for professional athletes to assess the effect of the training programme and to determine the quality of recovery. Follow-up of biochemical and hormonal variables throughout the season can help realize the abovementioned goals.

Objectives: To determine baseline blood creatine kinase (CK) and cortisol (C) levels in professional basketball players before the beginning of regular training and to follow up the subsequent levels of blood C and CK over an entire season with analysis of dynamic changes in relation to individual coefficients of variation.

Methods: Six professional basketball players were monitored from the first pre-season day to the end of a regular season. Blood samples were collected at six time points: before the pre-season, after the pre-season and four times during the in-season to determine blood C and CK concentrations.

Results: Individual trends of the investigated variables were established and analysed with respect to the calculated intra- and inter-individual coefficients of variation for C and CK. Dynamic changes in C and CK levels coincided with changes in the content of the training process.

Conclusion: In summary, the findings in the present study suggest that long-term intensive exercise in basketball has a significant influence on the blood cortisol profile. Muscle damage was associated with bodily collisions between the players but not with stress response in the current study.

Key words: *stress, cortisol, monitoring, basketball*

INTRODUCTION

The goal of athletic training is to prepare the body for an intensive stimulus, to increase the capacity of the various systems to carry strenuous workloads, and hence to enhance performance. Because of the increased training loads and the growing number of matches accompanying modern team game sports, it is important to find simple, rigorous, and regular monitoring tools to prevent injury, to stimulate recovery, and to optimally train athletes. Various biochemical, hormonal and immune markers, were selected to evaluate the athletes' physical status and to recognize overreaching and overtraining during a training programme with different degrees of success. However, the lack of specific and/or universal markers has still complicated detection of fatigue [4, 8, 9, 14, 21].

Physical stress as a consequence of the training loads triggers a number of physiological changes such as activation of the sympathetic nervous system and the hypothalamic – pituitary – adrenal axis [5, 24]. The testosterone to cortisol (T/C) ratio has been suggested as simplified marker for assessing the balance between anabolic and catabolic processes [17]. In our previous study we showed that changes in the T/C ratio mostly depended on the value of cortisol in professional basketball players [11]. Cortisol is considered an important stress hormone which acts to mediate catabolic activity, decreasing protein synthesis and increasing protein degradation in the muscle tissue [5, 17, 24]. Blood CK level is considered an indirect measure of skeletal-muscle damage in response to the physical load [2, 6, 18, 19, 23]. Higher intensity and total volume as well as short rest intervals are associated with the magnitude of stress and muscle damage [2, 9, 19, 23]. Numerous laboratory and field studies address changes in blood cortisol as response to different loads in different environments among athletes [1, 3, 4, 6, 8, 10, 16, 18, 21, 23]. Recently Cunniffe and al. [6] described in detail "pericompetitional" fluctuations in the blood level of cortisol and creatine kinase in response to high-level rugby match. Despite the informative content, frequent interventions have met limited practical application in competitive sport because of possible alteration in the regular course of the training cycle. Standardised repeated single interventions as longitudinal measures of hormonal, immunological and biochemical variables have been described in different sports, including team-game sports, as an expression of the impact of training [3, 13, 15, 16, 18–20, 23]. Analysis of longitudinal measurements can be carried out in comparison with an accepted reference interval but such an approach is not always productive in the case of athletes because of biological, procedural and environmental influences [12].

An alternative way to test the difference between longitudinal measures is evaluation of individual dynamic changes in relation to an intra-individual coefficient of variation. Such analysis can be used in the case of absence of a normative reference interval. This method could also be applied when changes in serial testing do not exceed normal limits for the reference population [22].

Data about dynamic changes in hormonal and biochemical variables in relation to the training process in basketball are still scarce. Martinez et al. [20] described the course of biochemical and hormonal variables through the main time points of a basketball macro cycle starting from the pre-season. However, inclusion of more time points throughout the season in analysis would give more reliable results. We aimed to determine baseline blood C and CK levels in professional basketball players before the beginning of regular training and to follow the subsequent levels of blood C and CK over an entire season with analysis of dynamic changes in relation to individual coefficients of variation.

MATERIAL AND METHODS

Subjects

The athletes of the Lithuanian Basketball League, i.e. representatives of the same club, were recruited in this study. Some players of this team were excluded because of delayed joining the team practices or because of transfers. Finally, the study was conducted on six male international-level basketball players throughout the pre-season and the whole regular season. All subjects were informed about the purpose of the study and written informed consent was obtained according to the Declaration of Helsinki. The participants were aware that all the individual study results would remain confidential. Prior to the study, the players underwent a physical examination by a medical staff, and were cleared of any medication or diseases that might confound or limit their ability to fully participate in the investigation. The physical characteristics of the participants were the following: age (years) 24.3±3.22, body mass (kg) 98.7±13.79, height (cm) 200.2±4.62, and peak oxygen consumption (ml/kg/ min) 50.8±6.06 as mean (±SD). Experimental procedures

All involved athletes were observed from the first day after the summer vacation (mid-August) until the end of a regular season (mid-April). They had been recruited for Euroleague matches as well for Lithuanian and Baltic championships matches.

The period of observation comprised 228 practices, 71 matches and 38 rest days. The C and CK concentrations in rest conditions were measured at six time points. The first blood sample (M1) was taken before the first practice after the off-season and represented the rest reference value. The second sampling (M2) took place during pre-season preparation (September). All other consecutive samplings took place throughout the in-season (October=M3, December=M4, February=M5 and April=M6). The last sampling took place after the end of the regular season and 5-day tapering before play-offs. To avoid any confounding effects of variations in circadian rhythm and food intake on hormonal secretion, the athletes provided blood samples at same time (09.00–09.30) after overnight fasting. All samplings, except for the first one, took place 14 h after the last physical load. The analysed parameters were determined by standard clinical laboratory techniques. All venous blood samples were drawn via antecubital venipuncture in a semirecumbent position. Blood was collected in Vacutainer tubes. Blood C concentrations were assayed using an Immulite 2000 analyser and an immunoassay (Siemens Healthcare Diagnostics Products Ltd., Llanberis, Gwynnedd, UK) according to the manufacturers' instructions. The CK activity was assessed with an Advia 1650 analyser (Siemens Healthcare Diagnostics, Deerfield, IL, USA) using the IFCC method and according to the manufacturer's instructions. All samples were tested in the same series to avoid inter-assay variations.

Statistics

The data were analysed using SPSS for Windows (version 13.0; SPSS Inc., Chicago, IL) and expressed as a mean ± standard deviation. The coefficient of variation (CV) was calculated as the ratio of mean to standard deviation. The difference in level of cortisol between two consecutive measurements was expressed as proportion $(C_{current} - C_{previous})/C_{current}$. The Pearson correlation coefficient was used to assess possible relationships between C and CK. A critical value of $p < 0.05$ was considered significant.

RESULTS

The individual values of C and CK as well as the coefficients of variation are presented in Tables 1 and 2, respectively.

The number of episodes of hypercortisolaemia varied between 2 and 4 for individual athletes. There were no cases of hypercortisolaemia among

measurements 1 and 6. Only one player had normal cortisol level during pre-season preparation (M2). The highest variability of C was detected in the first sample, which represents the off-season stress status. As is evident from Table 1, the intra-individual coefficients of variation for cortisol fit a relatively narrow range.

Table 1. The matrix of cortisol values and coefficients of variation

	M1	M2	M3	M4	M5	M6	$CV_{intra\text{-}individual}$
A1	245	**761**	**795**	**784**	**731**	477	0.302
A2	221	**841**	687	**726**	681	615	0.281
A3	235	**825**	582	**739**	579	464	0.282
A4	563	**1126**	**723**	**800**	679	560	0.365
A5	356	640	**844**	**806**	**739**	538	0.339
A6	350	**786**	**784**	571	**698**	439	0.353
$CV_{inter\text{-}individual}$	0.393	0.194	0.127	0.119	0.083	0.129	

Cortisol concentrations presented in nmol/l. A1...A6 – athletes from first to sixth. M1...M6 – measurements from first to sixth. The values in bold exceed the upper limit (690 nmol/l) of the reference interval. CV – coefficient of variation.

Table 2. The matrix of creatine kinase values and coefficients of variation

	M1	M2	M3	M4	M5	M6	$CV_{intra\text{-}individual}$
A1	276	**576**	**720**	416	**635**	273	0.392
A2	84	541	**777**	421	**1334**	**591**	0.667
A3	158	167	264	132	364	136	0.453
A4	70	225	184	64	381	182	0.632
A5	172	178	500	127	367	184	0.573
A6	64	192	272	126	265	195	0.432
$CV_{inter\text{-}individual}$	0.597	0.611	0.558	0.747	0.717	0.645	

CK concentrations presented in U/l. A1...A6 – athletes from first to sixth. M1...M6 – measurements from first to sixth. The values in bold exceed triple upper limit (190 U/l) of the normal reference interval. CV – coefficient of variation.

Altogether 21 episodes of elevated CK concentration were detected among 36 measurements. Episodes with the markedly increased amount of CK, exceeding the triple upper limit of the reference interval, were detected only in two athletes (see Table 2).

Altogether 21 episodes of elevated CK concentration were detected among 36 measurements. Episodes with the markedly increased amount of CK,

exceeding the triple upper limit of the reference interval, were detected only in two athletes (see Table 2).

There was found no direct correlation between individual C and CK values with only a slight tendency for one athlete (r=0.794, p=0.059).

Figures 1 and 2 represent the individual dynamics of the analysed variables. As shown in Figure 1, all individual trends follow a similar pattern consistent with the training volume and intensity. An immediate increase in blood C is evident after the beginning of regular training. Another general trend is the decrease of the stress marker under the influence of tapering.

As shown in Figure 2, intense training throughout the pre-season was associated with muscle damage, but not in all players. The highest CK values were associated with certain bodily collisions.

The number of episodes with a proportional change in the concentration of C exceeding personal coefficients of variation was different for individual athletes.

As seen from Figure 3, the direction and magnitude of C response were highly similar in individual athletes after the beginning of regular training. Further on, the uniformity of changes in C response disappeared. Also the effect of tapering had a unidirectional effect on C levels but the magnitude of changes exceeded the individual coefficients of variation, but not in all players.

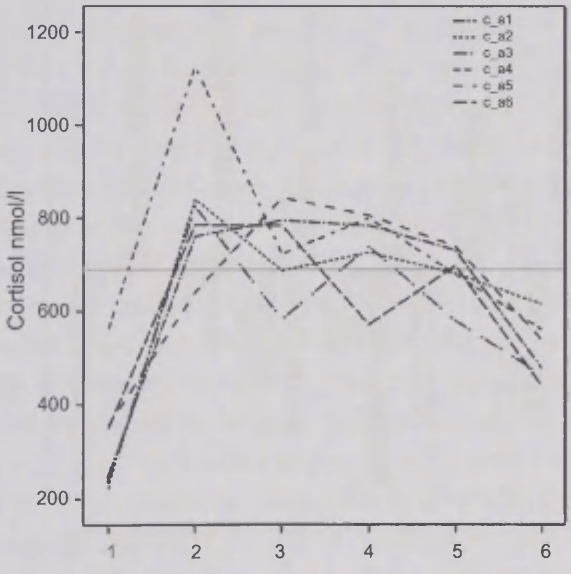


Figure 1. Individual trends of stress response in the basketball players. Upper limit of the normal reference interval (690 nmol/l) is highlighted as a fine grey line. C – cortisol, a1...a6 – athletes from first to sixth.

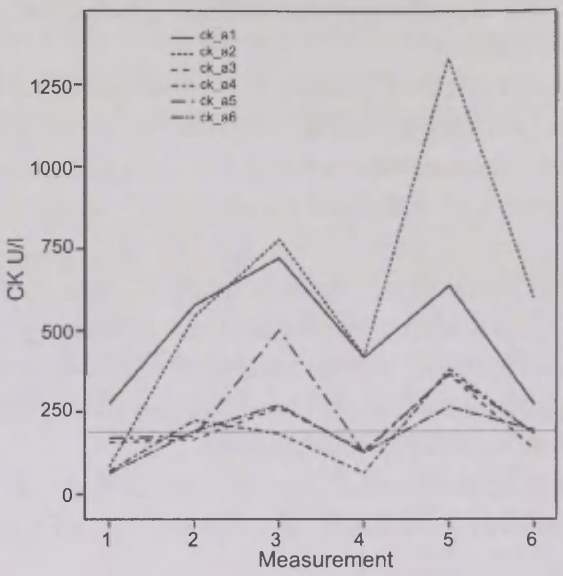


Figure 2. Individual trends of muscle damage in the basketball players. Upper limit of the normal reference interval (190 nmol/l) is highlighted as a fine grey line. CK – creatine kinase, a1…a6 – athletes from first to sixth.

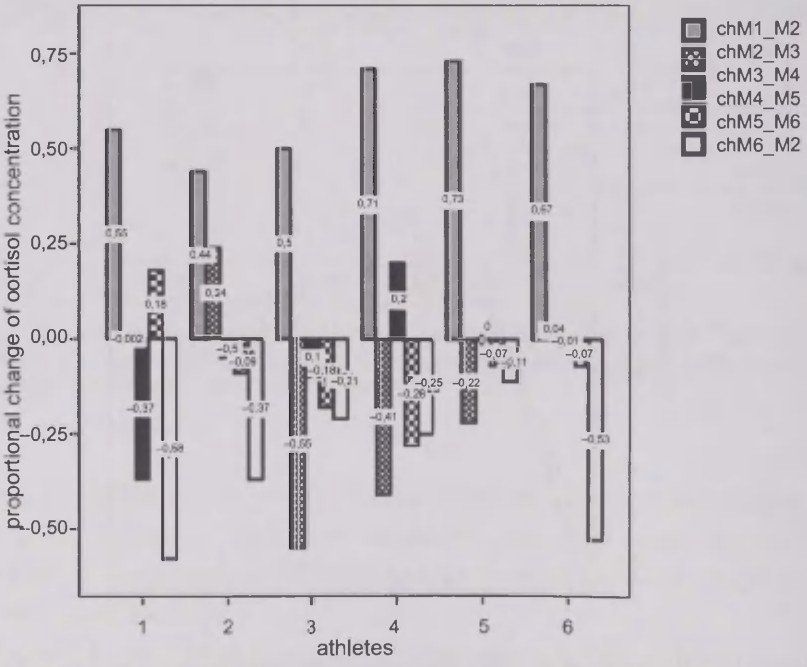


Figure 3. Proportional expression of changes in the level of cortisol throughout the period of observation.

DISCUSSION

This study confirms that professional basketball has a temporary effect on body metabolism, resulting in muscle damage and alteration of circulating hormonal levels. The key finding of the study is the observation of repeated episodes of hypercortisolaemia throughout the basketball season, which was clearly associated with the training content. The highest C levels in the pre-season coincide with the highest training volume in that period. The disappearance of hypercortisolaemia after exercise training requires 2–4 hours [7, 18]. Our results suggest a longer period for normalisation of C level. Blood sampling as extra stress for the investigated athletes cannot be the possible cause of hypercortisolaemia. This postulate is based on the results of the first sampling when no cases of hypercortisolaemia were detected. Our findings are inconsistent with the data of Cunniffe et al. according to which normal levels of C were detected 14 h after rugby competition [6]. This inconsistemcy could be explained by differences in the training schedules. Martinez et al. [20] found no hypercortisolaemia in high-level basketball players, either. Different timing regimens for performing blood sampling could be one reason for such a discrepancy between the reported findings about C levels. Kraemer et al. [16] described the predominance of catabolic processes throughout the competitive season in soccer players based on the findings of elevated cortisol level at rest, which is consistent with our findings. An important observation is that the majority of studies dealing with periodical monitoring in athletes are not indicating real base values for pre-season. If the base value is taken from the measurements taken at the preparation period, the results may be impacted not only by the last exercise session, but also by the effects of the whole training micro cycle. Recently it was shown that chronic exposure to intense loads is associated with deprivation of circadian rhythms of cortisol in young athletes [10], which can also explain the revealed discrepancies.

The possible consequences of repeated episodes of hypercortisolaemia 14 hours after the last physical load are not clear. Prolonged hypercortisolaemia is associated with adverse events such as bone demineralization, muscle catabolism, impaired antimicrobial defence, and emotional disturbances. Absence of typical clinical symptoms in the case of above disturbances and concurrent elevated cortisol levels could be explained by limited availability of circulating cortisol described in athletes [1, 7]. The obtained normal values of C after 5-day tapering suggest normal reaction of the hypothalamic – pituitary – adrenal axis of the involved players.

Direct comparison of stress as perceived by individual basketball players is possible by the way of calculating the proportional value of C change between two consecutive measurements.

The analysis of individual proportional changes in C levels revealed mainly two types of response (Fig. 3) to training-induced stress. Some players were able to minimize the high stress response to pre-season preparation during the early in-season. In these players the effect of tapering was less expressed. The favourable effect of tapering on C level was typical of athletes who were not able to diminish stress response immediately after pre-season preparation. However, more detailed individual analysis requires data about executed physical loads, which was not within the scope of the current study and is also a limitation of the study.

The obtained inter- and intra-individual coefficients of variation support the findings of other similar studies.

Mild persistent increase of CK is often revealed in regularly exercising persons. The most probable cause of elevated CK level could be occurrence of repeated episodes of eccentric muscle action [2]. Thorpe et al. [23] described clear relationship between number of episodes of highest intensity and muscle damage in soccer. As expected, higher intensity could provoke higher stress and, consequently, higher C response. Absence of direct correlation between C and CK can suggest predominance of a low number of responders to CK [2] among involved athletes or a relatively small amount of eccentric activities in basketball. This could be proved using time motion analysis, however such investigation remained beyond the interest of the current study. Our findings regarding elevated CK levels in professional basketball coincide with data from other team ball games [15, 19, 23]. We found no cases of clinically important CK elevation (>5000 U/L). Body collisions between the basketballs players during a match, which contribute to muscle breakdown, were responsible for the observed episodes of the highest elevation of CK in the current study. The established ranges of intra-individual coefficients of variation of CK were high, which is consistent with results from other studies [22].

It seems that isolated measures of CK in basketball have a limited practical benefit because of high CV and the multifactorial background. Expected muscle damage after basketball matches or practices will hopefully stimulate wider use of various methods and modalities to accelerate the recovery of athletes.

Another limitation of this study was that hormonal and biochemical measurements were restricted to a single morning sample and did not cover the

entire 24 h cycle, which can be a source of artefacts. Such an intervention design was predicted by the circumstances of the training process as well as by the intention to minimize the possible influence of interventions on the training regimen.

In summary, the findings in the present study confirm that long-term intensive exercise in basketball has a significant influence on the blood cortisol profile. However, stress response and muscle damage were not directly related in the investigated players.

Longitudinal evaluation of fluctuations in blood C requires a new, individualised approach in assessment of stress and muscle damage, taking account of perceived loads throughout practices and competitions.

REFERENCES

1. Bonifazi M., Mencarelli M., Fedele V., et al. (2009). Glucocorticoid receptor mRNA expression in peripheral blood mononuclear cells in high trained compared to low trained athletes and untrained subjects. J Endocrinol Invest, 32(10), 816–20.
2. Brancaccio P., Maffulli N., Limongelli F. M. (2007). Creatine kinase monitoring in sport medicine. Br Med Bull, 81–82, 209–30.
3. Córdova A., Sureda A., Tur J. A., Pons A. (2010). Immune response to exercise in elite sportsmen during the competitive season. J Physiol Biochem, 66(1), 1–6.
4. Coutts A. J., Reaburn P., Piva T. J., Rowsell G. J. (2007) Monitoring for overreaching in rugby league players. Eur J Appl Physiol, 99(3), 313–24.
5. Crewther B. T., Cook C., Cardinale M., et al. (2011). Two emerging concepts for elite athletes: the short-term effects of testosterone and cortisol on the neuromuscular system and the dose-response training role of these endogenous hormones. Sports Med, 41(2), 103–23.
6. Cunniffe B., Hore A. J., Whitcombe D. M., et al. (2010). Time course of changes in immuneoendocrine markers following an international rugby game. Eur J Appl Physiol, 108(1), 113–22.
7. Duclos M., Guinot M., Le Bouc Y. (2007). Cortisol and GH: odd and controversial ideas. Appl Physiol Nutr Metab, 32(5), 895–903.
8. Eliakim A., Portal S., Zadik Z., et al. (2009). The effect of a volleyball practice on anabolic hormones and inflammatory markers in elite male and female adolescent players. J Strength Cond Res, 23(5), 1553–9.
9. Fragala M. S., Kraemer W. J., Denegar C. R., et al. (2011). Neuroendocrine-immune interactions and responses to exercise. Sports Med, 41(8), 621–39.
10. Georgopoulos N. A., Rottstein L., Tsekouras A., et al. (2011). Abolished circadian rhythm of salivary cortisol in elite artistic gymnasts. Steroids, 76(4), 353–7.

11. Gocentas A. (2011). Longitudinal changes of anabolic/catabolic balance in high-level male basketball. In: 7th EFSMA – European Congress of Sports Medicine, 3rd Central European Congress of Physical Medicine and Rehabilitation. Salzburg, 26.–29.10.2011. Düsseldorf: German Medical Science GMS Publishing House. Doc11esm089.
12. Hackney A. C., Viru A. (2008). Research methodology: endocrinologic measurements in exercise science and sports medicine. J Athl Train, 43(6), 631–9.
13. Handziski Z., Maleska V., Petrovska S., et al. (2006). The changes of ACTH, cortisol, testosterone and testosterone/cortisol ratio in professional soccer players during a competition half-season. Bratisl Lek Listy, 107(6–7), 259–63.
14. Hartwig T. B., Naughton G., Searl J. (2009). Load, stress, and recovery in adolescent rugby union players during a competitive season. J Sports Sci, 27(10), 1087–94.
15. Ispirlidis I., Fatouros I. G., Jamurtas A. Z., et al. (2008). Time-course of changes in inflammatory and performance responses following a soccer game. Clin J Sport Med, 18(5), 423–31.
16. Kraemer W. J., French D. N., Paxton N. J., et al. (2004). Changes in exercise performance and hormonal concentrations over a big ten soccer season in starters and nonstarters. J Strength Cond Res, 18(1), 121–8.
17. Kraemer W. J., Ratamess N. A. (2005). Hormonal responses and adaptations to resistance exercise and training. Sports Med, 35(4), 339–61.
18. Kraemer W. J., Spiering B. A., Volek J. S., et al. (2009). Recovery from a national collegiate athletic association division I football game: muscle damage and hormonal status. J Strength Cond Res, 23(1), 2–10.
19. Lazarim F. L., Antunes-Neto J. M., da Silva F. O., et al. (2009). The upper values of plasma creatine kinase of professional soccer players during the Brazilian National Championship. J Sci Med Sport, 12(1), 85–90.
20. Martínez A. C., Seco Calvo J., Tur Marí J. A., et al. (2010). Testosterone and cortisol changes in professional basketball players through a season competition. J Strength Cond Res, 24(4), 1102–8.
21. Meeusen R., Nederhof E., Buyse L., et al. (2010). Diagnosing overtraining in athletes using the two-bout exercise protocol. Br J Sports Med, 44(9), 642–8.
22. Nunes L. A., Brenzikofer R., de Macedo D. V. (2010). Reference change values of blood analytes from physically active subjects. Eur J Appl Physiol, 110(1), 191–8.
23. Thorpe R., Sunderland C. (2011). Muscle damage, endocrine and immune marker response to a soccer match. J Strength Cond Res, Nov 23. In press.
24. Viru A. (1992). Plasma hormones and physical exercise. Int J Sports Med, 13, 201–209.

Address for correspondence:
Anatoli Landōr
University of Tartu
Faculty of Medicine
Ravila 19, Tartu, 50406, Estonia
E-mail: anatolilandor@gmail.com

Papers on Anthropology XXI, 2012, pp. 84–109

THEORETICAL AND PRACTICAL ISSUES IN THE IMPLEMENTATION OF CASE-BASED NETWORKING IN THE FIELD OF SPECIAL EDUCATIONAL NEEDS

TIINA KALLAVUS, VALLO REIMAA

Tartu Herbert Masing School, Estonia

ABSTRACT

Numerous research results show that today's society is characterized by deep and unresolved issues which have also found their way into the school life and influence the pupils' well-being and how well they cope in the school environment (Käst 2010: 3). In searching for a solution, what is usually lacking is a systematic and holistic approach. Estonian scientists find that the starting point for the changes that have taken place in the Estonian education system over the last decades has not been the comprehensive development of the education policy and the changes that have occurred have not been systematic and consistent enough in their assessment (Rinne et. al. 2008: 15).

Under the pressure of the politics of new liberalism that dominated concessions were granted in the education policy that were more characteristic of a free market economy and which were guided by the ideas of competition, the free choice of the client, and sponsorship. In parallel with the triumph of liberal ideology in the 1990s, what also began was the forceful moving of postmodernist discourse next to and in place of modernist discourse. The research results of K. Aava, however, show that in educational texts, liberal discourse is weakening whereas conservative discourse is gaining in strength (Aava 2010).

Yet, studying only discourse that can be found in educational texts might not give enough relevant material for analysis because, for example, research done by K. Lukk reveals that there exists a significant chasm between theory and practice in Estonian educational reality. What is more, the values of parents

and teachers do not coincide which makes it difficult to set common goals in a child's development (Lukk 2008: 4–5). It is no secret that an effective cooperation between the school and the home is first and foremost based on good relations (Sutton 2006; Vincent 1996). Good relations in turn are rooted in trust. Building this, however, is a long and complicated process and it is dominated by two main aspects: shared values and communication. K. Lukk points out in the conclusion of her research that it is necessary to **create a new way of thinking – instead of being strictly connected to specific forms and methods, the school and home should work together to find a form of cooperation for each individual child and his/her family** (Lukk 2008: 4–5). The field of education as a whole urgently needs a new way of thinking and what mostly hinders this is getting stuck into established patterns of thinking and attitudes.

RESEARCH PROBLEM

In the practical everyday work of the authors it clearly becomes evident that the absence of sufficient cooperation between the education and social fields (and between the respective services) in the development of special-needs children has created a favourable opportunity for the arising of difficulties in coping and hinders the all-round preparation of these children in the best way possible for the independent life as an adult (Kallavus 2010).

As a result of the aforesaid, the authors have formulated a hypothesis that there exists a contradiction in Estonia between:

- the needs of society (from being subject-centred to being pupil-centred, individual approach, etc.) and the kind of school culture that dominates in practice;
- the needs of today and those that are expected (the challenges facing education) and the ability of Estonian education to respond to them (by developing the necessary services).

The following goals were set: 1. to present the conceptual starting points of the thought culture necessary for building the education service of special-needs pupils as a case-based networking; 2. to formulate the framework proposals for building an education system in Estonia that is based on case-based networking.

The following is an overview of the initial research results which were based first and foremost on such philosophical-methodological approaches as **critical**

theory, pragmatism and (social) constructivism/social constructionism and the following recurring principles were focused on: holism, systematic approach, contextuality, networking.

POSTMODERNISM AND EDUCATION

What connects the oftentimes quite contradictory approaches of the researchers of postmodernism is the opinion that postmodernism is characterized by the loss of originality and historical truth, as well as by the loss of artistic values and standards, fragmentariness, indeterminacy, pluralism. What dominate in the respective cultural manifestations are irony, fragmentation, discontinuity, playfulness, parody, hyperreality, and simulation (Kraavi 2005; Malpas 2005: 5; Viires 2008: 11). For example, Fuller argues that it is precisely postmodernism that has enabled universities to be divided into countless encapsulated scientific fields which is characterized by an ever-growing lack of interest towards one another (Fuller 1999: 586). The same can be observed in the general education despite all of the attempts to change the course. To understand this, it is enough to compare today's basic school with Käis or Taba's one-time statements and with memoirs on the topic.

Defining postmodernism can be done above all by forming a contrast with modernism. Enlightenment philosophers formulated the positions of modernism already in the 18th century and according to J. Habermas modernism means the cultivation of objectifying sciences, the universalistic general principles of morals and justice. Modernism is characterized by the belief that it is possible to reach the truth through thinking. This kind of optimism is based on science and education. As a result of the aforesaid, in the modernist world, phenomena are evaluated according to the criteria of rationality and intellectuality. What take centre stage are the individual and the individual's intellectual freedom. At the same time, modernism also brought along breaking with a tradition, the replacement of a religious worldview with a secular one, and an appreciation for progress and change (Viires 2008: 12–13).

The modernist paradigm ruled as an autocratic dominant until the end of the 19th century and thereafter existed side by side with postmodernism until the latter rose to become the dominant in the second half of the 20th century (according to different assessments since the 1950s or 1960s or even later decades). At the same time, several theorists of postmodernism have simply seen postmodernism as an extreme expansion of some of the features of

modernism (Viires 2008: 10, 13). Today's society is described as already proceeding into a period following postmodernism that has not yet been precisely defined. Postmodernism brought along a so-called "new education sociology" which offered the ideal of intellectual freedom through education. Regardless of the social background, everyone gained the right to criticize the positions of scientists, philosophers, and others individuals regarded as experts and to develop their own theories. At the same time, by disregarding the objective truth as the goal, the new education sociology robbed itself of the means to justify and implement their own programme. In the worst case, the new education sociology created a theoretical basis for the arbitrary criticizing of any kind of authority by any interest group (Young & Muller 2007: 181–182). Thanks to postmodernism, schools lost their former "monopoly on truth" and the material a teacher discussed in class became merely his/her own personal opinion which is unfortunately also more boring and difficult to grasp than what the media, Internet, or friends offer.

The courage of a great figure in the new education sociology M. Young to re-evaluate today his own previously held views deserves recognition. Differently from the past, he now underlines that the social origin of knowledge is not a reason to doubt in truth and objectivity but, vice versa, the main reason to strive towards objectivity (Young & Muller 2007: 183).

The second neopositivist school, social constructionism, is based on the assumption that reality is socially constructed as a result of the interaction between people (Burr 1995; Gubrium et al. 1994). Berger and Lucmann, the authors of the work *The Social Construction of Reality* (1966), are convinced that only people together create and then preserve a social phenomenon through social practice. Moreover, people themselves are also socially constructed. Burr (1995: 3–5) has formulated the main principles of social constructionism as follows:

- *Social constructionism is critical toward our taken-for-granted ways of understanding the world. Relying on the knowledge that social reality is constructed during interaction between people, nothing can be defined as a predetermined character. Except that a social phenomenon is constructed in a process between people.*
- *Knowledge and reality are dependent on one another in the process of construction. The knowledge acquired influences the process of construction: every new interpretation is based on the existent knowledge and the production of new experience and understandings creates new knowledge.*

THE QUESTION OF THE TRUENESS OF SOCIAL FACTS

The central factor in the social theory of the founder of structural functionalism, the French sociologist E. Durkheim (1858–1917), is considered to be the collective notion, or *the social fact* (Durkheim 1895/1982) and the most problematic part of this is the scientific verifiability of the social fact. In order to avoid this dead end, the authors of the present article find that one of the solutions is to rely on pragmatic philosophy and its experience of the theory of truth which was founded by the American philosopher C.S. Peirce (1839–1914). From the perspective of pragmatism, the primary source of truth is experience and actually doing something. In the words of another American pragmatic philosopher and psychologist W. James (1842–1910), the truth of an idea is not its natural and fixed quality, events *make* it true instead. Trueness actually *is* an event, a process: namely verifying it, the process of *verification* itself. Truth *is made* during experience. Truths emerge out of facts but, at the same time, they also submerge back into facts and bring addition to them; those facts in turn create or manifest a new truth (the word is not important) and so on, indefinitely. In the meantime, however, "facts" themselves are not *true*. They just are. Truth is the function of beliefs. It resembles to the growing of a snowball that occurs on the hand thanks to the distribution of the snow and on the other hand thanks to the boys' pushes following one another and, at the same time, these factors constantly codetermine one another (James 1997: 8).

The pedagogical teachings of the third great pragmatist J. Dewey have directly been built upon his extensive psychological and logical, ethical and socio-psychological experience, relying among other things on the practical experience of a test school at the University of Chicago. Dewey's pragmatism, which he himself calls instrumentalism, underlines the social importance of truth. It is thanks to Dewey that most American pragmatists have begun to talk about ideas as instruments of the interpretation and organization of experience, about the instrumental character of thinking, about the growth and usefulness of truth, etc. (Koort 1935: 4).

A comparison can be drawn with the school of cognitive psychology that also remains between extreme determinism and freedom. Their point of departure is that our cognition is not a one-to-one copy of the world but a biased process instead that takes place within a certain framework. A figure is more easily associated with an emotion than a word or a concept. At the same time,

figurative images always feed us a certain way of looking at things and thereby reduce our free will (Kolga 2009: 4).

The area of contact and point of convergence of different subjects and action systems is filled by practical training (Noorväli 2009: 4), as a result of which several theoretical treatments in the field of educational sciences have drawn a link between practical training and learning (see for example Bourdieu 1977; Griffiths et al. 2000; Pohjonen 2001; Lasonen 2001)[1]. Relying on the historico-cultural action theory of L. Võgotski and his disciples, the famous Swedish educational scientist Y. Engeström founded a school respected in the world about the development of action systems, learning, and the transfer of knowledge from one action system to another (Noorväli 2009: 12). His connective model is based on reflective learning and action theories and strives to connect learning at school and work, vertical learning at school, which means moving towards more and more abstract and complex knowledge that is more highly valued by experts, and also horizontal learning at work where the knowledge grows more in width than in depth and the development of the learner moves toward the practicality of the knowledge and the expansion of the horizons rather than some kind of a "higher" knowledge. The model of Engeström had a lot in common with Dewey's theoretical views on education (Noorväli 2009: 13–14).

PRINCIPLE OF SYSTEMATICITY

The German sociologist and theorist of society N. Luhmann (1927–1998) asks that how can closeness directed at itself create openness (Luhmann 2009: 27). One of the central methodological issues arising from the objective of the present research is precisely related to the fact that every theory seeking universality unavoidably also acts as an object of itself, otherwise it would have to relinquish its objectivity (see Luhmann 10–11). It is precisely the practical implementations of such theories that over time become restrained by the tendency to lean towards voluntary closeness, the solutions become rigid and lose their ability to adjust and be creative. Focusing on the unique solution to the actual case becomes replaced by imitating a solution that is supported by

[1] In Estonia, what is still understood under practical training is practical work with specific learning objectives done within the framework of a study programme in a working environment and under the guidance of a supervisor (Vocational Education Standard § 8; Vocational Educational Institutions Act § 17).

various strategies of justifying oneself. In the end, the situation is basically back in the starting point, search for the culprits begins, a rephrased and re-encoded (but essentially the same) universal theory is rediscovered and everything begins all over again.

In the opinion of the authors of the present article, what offers the best opportunity to mitigate the effects of this essential contradiction is the implementation of the achievements of the *general system theory* that rapidly evolved in the second half of the 20th century and that hopefully is becoming an instrument for overcoming the prolonged crisis of the modernist society (which is usually referred to as postmodernism).

N. Luhmann particularly underlined the importance of including the system theory in the development of the science of sociology and what he had in mind was precisely the *general system theory* that he regarded as a pragmatic change in comparison with the Newtonist modern system theory. The distinction between the *whole* and the *part* that had persisted since the antiquity was now replaced with the distinction between the *system* and the *environment* (Luhmann 2009: 16–24).

The starting point of the general system theory were first formulated by L. von Bertalanffy who began to draw a distinction between *open and closed systems* that are located in a certain *environment* and, furthermore, both of them are made up of parts *connected* to one another and are more than just a sum of their parts. Open systems are characterized by a constant contact with their environment. N. Luhmann also emphasizes that systems do not consist only of connections between the elements because the relationship between the elements is also regulated (Luhmann 2009: 46). His central thesis says that the social system consists mainly of communication (and not of subjects, individuals and other things like that) and functions in *autopoiesis* through which the system produces and reproduces itself.

Von Bertalanffy formulated the concept of the system as follows – system is a structure that is defined by its *parts, the processes between them*, and the *input* and *output*. One and the same phenomenon can be described through different system. A system consists of its *elements, attributes* (features than can be perceived and measured) and *connections* that form between the elements and attributes. A system is hierarchically divided into subsystems and these in turn into subsystems and a system on one level can be a subsystem on another level. Thus a *child* can be viewed as part of the system of *family* and, at the same time, family can be viewed as part of the system of the child. What regulates these

connections is the principle of *conditioning* which means that a certain connection between the elements is realized only on the condition that something else either exists or does not exist. Every time one speaks of "conditions" or "conditions of possibility" (also in the epistemological sense) what they have in mind is this concept. From the principle of the unity of structure and function comes the *principle of the dual treatment of systems*. Any real system can only be comprehensive and hierarchical. Of these two features, comprehensiveness is primary and it acts as a factor triggering hierarchicality (Luhmann 2009: 46; Meriste 194–195).

In addition, all systems are characterized by the *principle of contextuality* or, in other words, by the existence of background systems(s) and there exists a *border* between the system and the context (the environment). The environment/context can be defined as a place where the system acts as objects that influence the behaviour of the environment. It is precisely the principle of contextuality that is related to von Bertalauff's idea of open and closed systems. For example, in the case of the development of schools, what can be observed is how they have moved from a relatively closed system towards a more open system. What is meant under openness here is the ability to change with the environment while at the same time retaining a constant *balance*. Being balanced is part of the main criteria of describing a system together with openness and closeness.

The concept of the balance of a system can be illustrated very well with a school that should accomplish externally determined academic goals while, at the same time, also bearing in mind the pupils' individual capabilities and needs. Schools are always fighting for an inner balance. Under certain conditions, this can also take the form of resisting change.

A family is system-theoretically conceptulizable through its inner relations and the individual as a subsystem of the family, through the relations between the family system and the external environment. Every individual member of the family is organized as a system living simultaneously in different places and that has biological, psychological, and social characteristics.

The same theoretical framework can be used to examine the relations between a child and school. Similarly to a family, a school also consists of the action patterns of individuals that are directed towards certain goals, it has its own subsystems and borders and consequently the framework of a system is suitable for examining a school. The challenge of a school is to integrate the individual experiences of its members into a meaningful whole. The starting

point of this integration is the recognition that all the school's processes, procedures and actions form a whole and every component influences it and its other components while at the same time also being influenced by them in return. A common recipe for the successful functioning of the systems of school and family is clearly defined borders, communication, and coherence between the subsystems (Rendall & Stuart 2005).

PRINCIPLE OF CONTEXTUALITY

One of the direct predecessors of the general system theory was the Estonian-born J. J. Baron von Uexküll (1864–1944) and founder of biosemiotics who brought into biology the term *Umwelt*, developed significantly further ecology[2] and was an intellectual role model for cybernetics as well as radical constructivism (including for the founder of the theory of *autopoiesis* H. Maturana, in philosophy for E. Cassireril, O. y Gasset, M. Heidegger, G. Deleuze and others).

By looking at the ecosystem as a whole, the relations between its parts and their functioning, ecology focuses on the examination of circulations, relations between organisms, and on the environment[3] that is related to them. At the same time, a school can also be viewed as a comprehensive ecosystem and the classes as its subsystems. The principal research object of ecology is the circulation and the flow of energy in the ecosystem – in a school, respectively, the synergy mechanisms of the institution as a whole and its subsystems under the conditions of the prevailing general context.

In ecology, the concept of "balance" plays an important role and it can mean at least three different things: 1) the ability of an association to resist change; 2) stability or the ability to stay in a certain size; 3) recovery or the ability of an association to regain its previous level following some kind of damage. The more balanced an association is, the more quickly it will recover. What should be avoided are such unrecoverable changes an association cannot recover from

---

[2] The concept of ecology was first used by the German biologist, naturalist and philosopher E. Haeckel in 1866. The term "ecosystem" was fisrst formed by the English florist A. R. Clapham in the early 1930s but it became more widely used through the works of the plant ecologist Arthur Tansley (since the year 1935).

[3] The environment or milieu (in German *Umgebung, Umwelt*) is the system of things, conditions, and relations that can encompass the whole world in its diversity but can also, for example, be natural (ecological, biological), economic, social, cultural, technological, etc.

on its own. What can be viewed as a change of this kind is, for example, the constant changing of the student body in a class which actually takes place all the time throughout the whole school year in a special-needs school. When speaking of the balance of a class (and a school), it is most useful to concentrate on the study of the limit conditions of recoverability.

What evolved on the direct influence of Von Uexküll's works as a branch of the general system theory was **system biology** and the latter term was first used in 1928 by von Bertalanffy himself. What grew out of the general system theory was the so-called **Living systems theory** that was founded by J. G. Miller (1916–2002) whose main work *Living Systems* was published in 1978, almost at the same time was also born Bronfenbrenner's (1917–2005) so-called **Ecological Systems Theory**, sometimes also referred to as Development in Context or Human Ecology. What is related to the latter is the so-called **Context theory**, one of the founders of which Wilden emphasizes in his research *System and Structure* the importance of the ecosystem as a self-organizing system and of the ecological approach (Widen 1972).

The **organizational theory** of the American psychologist K. Lewin (1890–1947) is based on the **field theory** formulated by him and the concept of *life space*. Lewin, however, was originally involved with the behavioural psychology of schools before entering the field of science and gestaltpsychology. Lewin treated the social environment as a dynamic field that is interacting with a person's senses. A person's psychological condition is therefore influenced by the social field or milieu and he focused on the subjective components of the environment and their meaning in a person's life. His students Barker and Wright were interested in those parts of the society where a person's behaviour can be observed, analogically to the ecological environment. Those parts of the society can be viewed as the context of the behaviour that depended on the following factors: place, time, physical characteristics, activeness, participants, roles. Those kinds of contexts are, for example, a parents' house together with the family living there, a classroom together with the class and teacher belonging there, etc. In those contexts, the individual is in direct contact with social partners. An individual's development cannot be viewed separately from those contexts or, in other words, developmental environments. Changing the context can mean a change in the behavioural patterns – thus development cannot simply be viewed as acquiring new ways of behaving but as adjusting to new environments and to the requirements they set.

System theory has had a great impact on social work. What is taken as the basis is the principle that a satisfiable life depends on the systems of a person's closest social environment. Social work and among that child protection work deals exactly with these system (Payne 1995: 26). Pincus and Minahan (1973) present a direction of social work that directly implements the ideas of system theory. According to their classification, people can be helped by two kinds of systems: 1) informal or natural systems (family, friends or colleagues) and 2) formal systems – community groups or associations, societies and systems of the society (hospitals, schools, day centres or rehabilitation institutions) (Payne 1995: 112)

THE PRINCIPLE OF BEING CASE-BASED

As a result of their analysis concluding their longstanding material of experience, the authors find that the central questions of the principle of being case-based are as follows:

1. What is the truth, the criteria for assessing development, for the given case?
2. What is the context of the given case?
3. How do the case and its context build up as a mutual synergy network?
4. What is the suitable intervention strategy for the given case and the resulting tactical steps?
5. What is the cooperation organization like governing the planned actions (the case management solution) and the communication system keeping it functioning?
6. On the basis of what kind of criteria and how to recognize that a given case has to be closed and transferred to the case management of the next subsystem in the holistic health system?

The best answer to the first of these questions is given by the pragmatist conception of truth described above. Namely, in the opinion of Dewey, the method cannot be separated from the material and changes individually. This idea can also be extended to the organisation of studies. Dewey's whole pedagogics derives from the conviction that learning is only possible through action (learning by doing). At the same time, a school cannot become a vocational school, even though it is based on different forms of practical activity (occupations). In order to realize these goals, he farsightedly advises to break away from the standardized educational path that has only been made

suitable for the preparation of academically educated people, at the same time also referring to statistical data in quite a modern way which show that many pupils leave school already at the basic school level because studies are too theoretical for them and they do not see any point in continuing with their school work (Koort 1935: 4–5).

The principle of being case-based derives from the principle that **everything that happens is real** and we can plan activities that guarantee the building of sustainable balanced social systems only by relying on the specific and unique reality. A different issue is the question about what kind of methodology better enables to take into account this changing and unique reality that is always slipping away? There can only be one answer here as well – this methodology also has to be case-based, unique, and as flexible and continuously changing.

The applied version of the principle of being case-based is called case management and nowadays this is very common in social work, but unfortunately not in the field of education. What is common is the treatment of case management on the one hand as a process of problem solution and on the other hand as a system that functions thanks to administrative support, systematic management, as well as the inclusion of formal and informal community resources (O'Connor 1988, cited in Wood, Tully 2006: 169).

Based mainly on the experience of the social field, literature distinguishes between the following generalizations of the actual practice of case management:

1. The role-based or generalist model of social work where the case manager himself/herself does a lot of client work and is in different roles as the need arises, such as the mediator, counsellor, coordinator, etc.
2. The organization-based or case-management working group model which has been created to offer a service package as wide-ranged as possible primarily for clients with issues related to mental and physical special needs. Every member of the interactive group has a function with a clear purpose in providing the services (social work, physiotherapy, speech therapy, etc.).
3. The duty-based case management or supportive care that is based on the client's natural environment and takes place in the client's close network. The tasks of the case manager are here performed by a family member, a member of the network, or a volunteer who have been prepared for this, or by the client himself/herself.

Case management involves two kinds of networks and working within/with them: the network of specialists/service providers and the close network of the client/family (Wood, Tully 2006: 170). International literature draws a clear line between the case management dealing with formal networks and the work with a client's close network done within the framework of a specific service.

In applying the principle of being case-based in the education practice, it has to be borne in mind that, for example, the critical analysis of the Australian researcher and theorist of social work J. Fook shows that **applying case management by order makes it not function**. Fook suggests that in a situation where the management and administrative checks of the apprentices and clients become more and more frequent, case management becomes a way of working that concentrates on the system rather than on the client, serves the interests of the administration rather than vocational interests or those of the client, is technocratic and simplifying rather than multifaceted, holistic and directed towards the long period and, as a result, cares less about personalized, individual needs, being driven mainly by economic-rationalistic principles. This can cause the shift of attention from addressing the clients' needs to the fact whether the clients are guided and coordinated properly, and what develops is a competition inside the system to become the most legitimate case manager in the given context (Fook & Gardner 2007)..

Every case lives in its specific environment and one can distinguish between the impact of different contexts (family, community, school, and peers) on a child's development. A framework for this is offered by Bronfenbrenner´s ecological system theory. Analogically to biological ecosystems, Bronfenbrenner attempted to describe the development of a human being in the ecological system where the change of one element in the system (as, for example, the birth of a new child into a family) changes the whole system. Wishing to understand and change the pupils' behaviour, we therefore have to examine and take under consideration the environment (the context) in which the behaviour takes place (Nordahl 2002). However, the link between problem behaviour and school context is not always clearly identifiable as the problems referred to always have several contributing factors. In addition, pupils act as subjects capable of choosing their own actions (Bø et al. 2003).

Unfortunately teaching/educating can only be viewed to a certain extent as an instrumental undertaking in which we unanimously and objectively discover and decide what kind of methods, principles, goals and content of the organization ensure the best learning results. This is a multilateral active

process where nowhere near everything can be planned in detail. What are crucial for the planned intervention activities are the relations between the participants and their quality.

SUSTAINABILITY, COHERENCE, TRANSITIONING

What are increasingly seen as problems are weak integration between the educational stages, an emphasis on academic results, and little attention on the attaining of study skills and educational goals (Bracken & Fischel 2007, Huffman et al. 2000, Lõoke & Saarits 2004, Leino 2005, McIntyre et al. 2007: 67; Penjam 2004; Petriwskyj et al. 2005: 58–59; Pianta & Kraft-Sayre 2003; Sarv 2006: 22–24; Webster-Stratton et al. 2008: 471–473).

In the context of the present article, it is important that a child's personal coping at every new educational stage is connected with such social skill as adaptability. A learner who transitions from one educational stage to the next one has to adapt to new kinds of circumstances and use different strategies in order to cope with the external and internal requirements. For example, German and Gitterman's "life model" of social work that has grown out of the ecological system theory treats people as constantly adapting in interaction to the many different aspects of their environment (Payne 1995: 114).

In assessing the sustainability of education, one has to consider a child's coping in the transition process from one educational stage to the next, bearing particularly in mind the realization of the general goals of the study programme. In reality, however, this is only measured by extremely formalized marks on the leaving certificate which generally are very weakly linked with the study programme's general competencies (see for example Kukk 2010: 9).

In the Social Welfare Act (1995) coping has been defined as a person's or family's physical or psycho-social ability to cope in their everyday life. This definition is individual-centred, disregarding the environment. According to Lazarus (1980), a person needs two main skills to cope – solving problems and overcoming negative emotions. For both of these, a person needs his/her own as well as the environment's resources (Viiralt 1999). The coping of a disabled child can be supported by a method of social work – empowerment which relies primarily on the child's strong qualities, thus improving his/her ability to act and cope. What plays an important role here is the environment, particularly its social parameters (relationships, roles), the competence of the rehabilitators also matters (Viiralt 1999).

Coping is directly linked to adaptability, in connection with which what are treated as basic skills are the skills related to learning to study and attaining the general educational goals which have been grouped into the following categories: a positive self-concept, study motivation, academic skills and co-operation skills. The category mentioned last relies on the existence of social skills (Kukk 2010: 19). In practice, the greatest problem is evaluating actual coping in transitioning from one educational stage to the next.

The most important component of adaptability, however, is socializing which means the acquisition of experiences and value orientations in order for a person to fulfill his/her social roles. Socializing is a constant process during which the formation of the personality takes place that ensures the consistency and preservation of the individual and the social group (Aimre 2001: 160–162).

A person's social life includes stages and cycles of different social quality.

During socialization different social experiences are stored in every period of the life-span. Values and value orientations develop and change and different resocialization also takes place. What is important about socialization is that in every stage, some new socialization agents start to program it: school comes next to the family, schoolmates and participants in hobby schools come next to the playmates, etc. (Aimre 2001:166).

According to the principles of sustainable education and child-centred pedagogics, a child's adaptability and coping depend to a large extent on the environment where he / she grows up (Kukk 2010: 10). In the assessment of L. Võgotski, the environment where one grows up has its own specific physical, psychological, social, cognitive, and emotional factors during preschool as well as school which have to be taken under consideration when creating a learning environment that supports a child's all-round and sustainable development. When transitioning, for example, from one education institution to another, the influences of the two different systems integrate. A child's wish to learn has to receive new stimulations that also consider his/her previous experience and level of development (Kukk 2010: 11). Similar kinds or even more serious adapting issues arise due to familial changes.

In the transition process from one system / environment to another, what becomes important is a child's readiness for the transition. In the education system this complex concept designates a child's physical, social, and psychical level of development for systematic and intentional studying (Broström 2003; Tulva 1987; Veisson, Veispak 2005) that begins in the preschool period and

continues without interruption during the first school years in the school context (Broström 2003; Hytönen 1999).

Bronfenbrenner describes a child's transition from one microsystem to another as an ecological transition. The process of transition depends on whether the rules that apply in the new microsystem are in contradiction with the ones that applied before, whether the new rules are explained, whether someone from the old microsystem accompanies during the transition (Bronfenbrenner 1992).

The more aware a teacher and parent are of a child's transition issues and peculiarities, the more smooth the transition from one educational stage to another and the more sustainable a child's development, which requires from the teacher a very good understanding of the education reality, readiness for discussions, and the ability to analyse one's own development (Krull 1998). What is important in the teacher's action is focusing on the primary coherence between the educational stages and acknowledging the importance of the transition period and sustainable learning. The teachers of both educational stages have to perceive as their goals in the transition period the attainment of the objectives of the study programme in cooperation (Biggs & Tang 2008; Broström 2003; Hains et al. 1989; Hargreaves & Fink 2006; Kukk 2010: 32).

Engeström came to the conclusion that the development takes place by way of the interaction between the action systems and represents the developmental transitioning of knowledge (Engeström 2001; Tuomi-Gröhn & Engeström 2003: 27) that starts with questioning the existent practice that is followed by its analysis, the modelling of the (future) practice desired, then by the testing, implementation, and assessment of the model. In the course of this takes place the construction of the so-called limit object and the transition of knowledge between different action systems, the construction of new practices, concepts, and theories (Engeström 2004: 60–61). In Engeström's treatment expansive learning also includes most of the known learning models – experiential, reflexive, situational, social, and transformative learning (Noorväli 2009: 16).

In the end, the question is not so much about the decontextualization of the previously acquired theoretical knowledge, but about their recodification and implementation in the service of a specific practice and its improvement (Noorväli 2009: 18).

SOCIAL NETWORK

In analyzing the relations between people, G. Simmel (1908) was the first to start to use the term social network which in his treatment means a "chain" of those people who are connected to each other (neighbours, relatives, self-help groups). Sometimes the terms social support network and social support system are also used as synonyms (Korp 2002). The social network can be viewed as a system of intertwined relations. The classical definition of social network comes from J. C. Mitchels: "Social network is a model of contacts /relations/typical of a group the characteristics of which help to explain the behaviour of the individuals belonging to the group" (Kiik 2001).

The social network therefore means all the relationship networks of an individual. When social support is received from certain people belonging to the network, then this forms the support network which is smaller than the whole network. The whole system, however, includes networks of close as well as formal relations (Korp 2002; Tulva 1996).

In the practice of social work, the most wide-spread approach that emphasizes networks is related to the ecological metaphor, systems theory, and ecosocial approach (Bronfenbrenner 1979; Healy 2005; Collins et al. 2007, etc.) that in the understanding and building of networks relies on the individual that is linked to and receives feedback from the context with which it forms a common ecological synergy system.

The ecological system theory has been integrated with the constructionist theory (Kilpatrick, Holland 2003; Iversen et al. 2005). The ecosystematic approach helps to comprehend the action field and the constructionist/narrative experiences/meanings in it. This kind of integrating helps to partly deflect the criticism the ecosystematic approach has received. For example, Healy (2005: 147–148) claims that the "fundamental truth" according to which a change in one part of the system triggers a change in the other parts and the whole system involves knowledge that is to a large extent intuitive and untested. It is, of course, the truth because the general system theory assumes an inevitable need to every time independently identify the influences of the system and the context. There do not arise any fundamental truths from the general system theory that are automatically carried over besides the principles of the structure of the system itself. In general, this trivial fact is not regarded as guiding the phenomena falling under social systems, whether it be the school, the kindergarten, or the education network as a whole, at least not in Estonia.

A network, including a social network, is characterized by: wholeness (*holism*), coherence (*communicativity*), hierarchicality, and the constant changing and intertwining of the roles of the subject and object, as well as those of a member and the environment.

In the discourse of the social field, "network" and "networking" are used as metaphors as well as terms. The word "framework" is also used, but considerably less. As any other system, a network also consists of members and the relations and communication between them (Korp 2002). Networking, however, means active and intentional intervention activities into the working mechanisms of a specific network.

Even though the importance of a child's close network is often emphasized, in practical work, the main attention is usually on the networks of officials and specialists. Unfortunately, the participants in the networking also perceive it as being restricted in this way. In addition, the interpretation of the central subject of the network is also inconsistent: sometimes it is the child, other times "the child's problem," then the family or even the child protection official (Selg 2007).

THE MAIN ELEMENTS OF THE EDUCATION NETWORK

Differently from the widespread opinion that the main elements of the education network are the pupil and the school, they should still be considered to be **the pupil** and **the learning situation**. The latter usually takes place in a classroom (less frequently in an individual study room), but they can also be the learning environment at home and all kinds of learning situations outside the classroom and the home.

The main elements of the learning situation in addition to the pupil (who is again in the central place) are also the teacher (or some other person fulfilling the same function), the spatial environment, aids (including teaching materials), and regulation mechanisms (for example, legislation, regulations concerning organization of study, informal regulations, oral agreements). From the subsystems what belong here as the main ones (depending on the learning situation) are the family, friends, members of the class, all of them are described by Bronfenbrenner by the term microsystem. The subsystems referred to at the same time also belong among the systems of the next level, the most institutionalized among which is, of course, the school (also the kindergarten, hobby school, etc.), in other words Bronfenbrenner's mesosystem. Contrary to

Bronfenbrenner's ideas, a class is only initially part of the mesosystem (when entering the first grade, when changing schools), thereafter slowly becoming the microsystem of the adaptation process. The same thing occurs from the child's perspective also with the circle of friends and its changing, as well as with the family in case of a divorce or the emergence of a stepparent.

The primary system, however, is the pupil himself/herself. The level of his/her individual development, however, depends most of all on the primary microsystem in which the child spends his/her time – on the family (including the background of the parents, their childhood experiences, the surrounding growing environment, the state of health, the gene pool, etc.). Significant influences are also the attitudes, values, and ideological dispositions of the parents (Klefbeck & Ogden 2001; Tulva & Viiralt 2001; Leppiman 2002). According to Bronfenbrenner, the last one falls under the macrosystem, whereas the size and structure of the family, interpersonal relationships, and health belong to the microstructure (Leppiman 2002).

In the case of the exosystem and macrosystem, the child does not anymore have a direct physical interaction, even though the processes related to them influence the environment where he/she lives and through which the child's world expands (Kiik 2001; Leppiman 2002). Bronfenbrenner's system levels existing together at a given point in time are essentially simply different kinds of relations and the social memory stored through them, and incidentally, the exosystem and macrosystem become realized mainly through the microsystem and mesosystem, but also through the space environment that remains between them – the public space (together with the institutions and enterprises that belong to it), including the street, transport vehicles, natural environment, etc., and the private space (the apartments and households of the circle of acquaintances).

Because the synergy network can only be built upon real subjects, what can come under consideration in networking are only the child (together with self-reflection) and his/her microsystem and mesosystem. From the perspective of the child, the main task of the synergy network is to ensure that he/she copes better and to unite the education system, the social system, and the medical system together as the subsystems of one comprehensive system. Consistent and thorough documenting of the child's development, however, is nothing other than the chronosystem of the ecological system theory in its materialized form. It also forms the central axis of the communication system that unites the networking connected with the child.

Because a functional comprehensive system is only possible through sustainable connections and transitions, it has to be borne in mind that: 1. transition is a process that has to be supported by legislation and political measures; 2. the young person has to part of the transition process and his/her choices have to be respected; 3. transition is part of a long and complex process that prepares the young person for entering the adult and working life.

Every system needs regulation to function and this has to be based on the same holistic principles and sustainable transitioning between the subsystems as the network theory described above. All the more so because in the assessment of R. Maruste, the right to education entails the positive obligation of the state to regulate the respective field (Maruste 2004: 506). What follows from the obligation to study in turn is the need for minimum standards concerning the organization of study (see about this the Commented Edition of the Constitution of the Republic of Estonia 2002: 644; Alexy 2001: 29, 78; Veermäe 2004: 714; Annus 2006: 370). The fact that as a general rule, the pupils' opportunity to choose increases as they reach higher levels on the education ladder (Comparative administrative politics: 29) presupposes the establishment of minimum standards according to the stages of study, whence we move on to the minimum standards regarding different types of schools and classes (including the quality requirements for the classrooms, the technical aids, the support personnel, the safety of the school environment, the structure of a school day, etc.) (Reimaa 2008). In the end, however, all these different standards have to be brought together into a united whole and the transitions between them have to be described and composed through. Otherwise we would largely be dealing merely with labelling.

CONCLUSION

An ideal situation is where the medical system, the social system, the education system, as well as the child and the family act in a coordinated way, with a clear division of responsibility and tasks for the purpose of achieving the child's maximum developmental, intellectual, and health potential and good coping.

Medical care assesses the need for medical aid (determining the cause of the health disorder, treatment with medicines, surgical treatment, rehabilitation, health check, etc.) and guarantees the availability of the necessary aid.

The social sphere assesses the person's need for external help and support services in order for him/her to cope and guarantees the necessary social assistance.

The education system determines the child's special educational needs and arranges the availability of the relevant pedagogical assistance (appropriate form of study, study programme, etc.).

The education system that is based on this kind of cooperation has to be sufficiently flexible and able to change in order to constantly adjust and develop creatively further the learning system in which the child spends his/her time.

Most importantly, in the legislation framing this kind of an education system have to be described also the sustainability mechanisms or, in other words, the supported transitions from one educational stage to another, from one subsystem of the education network to another, from one subsystem of the support network to another, and, in the end, from the education system to the working world.

REFERENCES

1. Aava K. (2010). Eesti haridusdiskursuse analüüs. Doktoritöö analüütiline ülevaade. Tallinna Ülikool. Sotsiaalteaduste dissertatsioonid. Tallinn.
2. Alexy R. (2001). Põhiõigused Eesti põhiseaduses. Juridica erinumber.
3. Annus T. (2006). Riigiõigus. Tallinn.
4. Berger P. L., Luckmann T. (1991). The Social Construction of Reality. Penguin:
5. Harmondsworth B., Roberta M. (1985). Child, Family, Community. CBS College Publishing. Holt, Rinehart and Winston.
6. Biggs J., Tang C. (2008). Õppimist väärtustav õpetamine ülikoolis. Tartu: Tartu Ülikooli Kirjastus.
7. Bourdieu P. (1977). Reproduction in Education, Society and Culture. London: Sage Publications.
8. Bracken S. S., Fischel J. (2007). Relationships Between Social Skills, Behavioral Problems, and Readiness for Head Start Children. – NHSA Dialog: A Research to Practice Journal for the Early Intervention Field, Vol. 10, Issue 2, 109–126. http://www.informaworld.com/smpp/content~db=all~content=a788046967. (29.07.2011)
9. Bronfenbrenner U. (1979). The Ecology of Human Development. Harvard University.

10. Bronfenbrenner U. (1992). Ecological systems theory. In Vasta R. (ed.) Six theories of child development: Revised formulations and current issues (pp. 187–249). London: Jessica Kingsley.
11. Broström S. (2003). Communication & Continuity in the Transition from Kindergarten to School in Denmark. http://extranet.edfac.unimelb.edu.au/ LED/ tec/pdf/brostrom.pdf (30.07.2011)
12. Burr V. (1995). An Introduction to Social Constructionism. London and New York: Routledge.
13. Burr V. (2003). Social constructionism. Second edition. London. Routledge. New York.
14. Collins D., Jordan C., Coleman H. (2007). An Introduction to Family Social Work. Second edition. Thomson. Brooks/Cole.
15. Durkheim E. (1895/1982). The Rules of Sociological Method. New York: Free Press.
16. Eesti Vabariigi Põhiseadus. Kommenteeritud väljaanne. (2002). Tallinn.
17. Engström Y. (2001). Expansive Learning at Work: toward an activity theoretical reconceptualization. Journal of Education and Work. 14 (1), 133–156.
18. Engeström Y. (2004). Ekspansiivinen oppiminen ja yhteiskehittely työssä. Tampere.
19. Fook J., Gardner F. (2007). Practising critical reflection: a resource handbook. Maidenhead: McGraw Hill/Open University Press.
20. Fuller S. (1999). Making the University Fit for Critical Intellectuals: recovering rom the ravages of postmodern condition. British Educational Research Journal, 25 (5), 583–595.
21. Goldberg W. G., Tully C. T. (2006). The Structural Approach to Direct Practice in Social Work: A Social Constructionist Perspective. 3rd rev. ed. Columbia University Press.
22. Griffiths T., Madsen T., Wallentin C., McKenna P., Colm Ó'Maolmhuire, Marhuenda F., Cros M. J., Gimenez E., Herlau H., Rasmussen L. B., Christensen L., Krarup G., Benke M., Gorgenyi I. (2000). Work experience as an education and training strategy: new approaches for the 21st century (WEX21C) FINAL REPORT.
23. Gubrium J. F., Holstein J. A. (eds.) (2002). Handbook of interview research. Context & method. SAGE Publications.
24. Hains A. H., Fowler S. A., Schwartz I. S., Kottwitz E., Rosenkotter S. (1989). A comparison of pre-school and kindergarten teacher expectations for school readiness. Early Childhood Research Quarterly, 4, 75–88.
25. Hargreaves A., Fink D. (2006). Sustainable leadership. San Francisco: Jossey-Bass.
26. Hartman A., Laird J. (1983) Family-centered Social Work Practice. New York, Free Press.

27. Healy K. (2005). Social Work Theories in Context: Creating Frameworks for Practice. Palgrave Macmillan.
28. Huffman L. C., Mehlinger S. L., Kerivan A. S. (2000). Risk Faktors For Academic and Behavioral Problems at the Beginning of School. http://www.nimh.nih.gov/childhp/huffman.pdf. (14.01.2009)
29. Hytönen J. (1999). Lapsekeskne kasvatus. Tallinn: Tallinna Pedagoogikaülikool; Sihtasutus Omanäolise Kooli Arenduskeskus.
30. Kallavus T. (2010). Helping children with special educational needs as a coopetation between the fields of education, social work, and medidicine. Papers on Anthropology. XIX. Tartu, 130–144.
31. Kiik R. (2001). Laps ja võrgustikutöö, SA Omanäolise Kooli Arenduskeskus.
32. Kilpatrick A., Holland T. P. (2003). Working with families: an integrative model by level of need. Boston: Allyn and Bacon.
33. Klefbeck J., Ogden T. (2001). Laps ja võrgustikutöö: lapse arengu ökoloogiline perspektiiv ja võrgustikuteraapia meetodid töös lastega. Omanäolise Kooli Arenduskeskus.
34. Kolga V. (2009). Haridus teeb vabaks. Haridus, 1–2, 3–4.
35. Koort A. (1935). John Dewey pedagoogika aluseid. II osa Eesti Koolist nr. 6.
36. Korp, E. (2002). Võrgustikutöö võimalused lapse aitamisel; Laps elu, probleemid ja lahendused, Tallinn
37. Kraav J. (2005). Postmodernismi teooria ja postmodernistlik kultuur. Ülevaade 20. sajandi teise poole kultuuri ja mõtlemise arengust. Viljandi Kultuuriakadeemia.
38. Krull E. (1998). Õpetamise tõhususe hindamine. Tartu: Tartu Ülikool 1998.
39. Kukk A. (2010). Õppekava eesmärkide saavutamine üleminekult lasteasutusest kooli ning I kooliastmes õpetajate hinnangul. Analüütiline ülevaade. Tallinna Ülikooli sotsiaalteaduste dissertatsioonid. Tallinn.
40. Käst J. (2010). Õpetajate ja koolide tugispetsialistide võrgustikutöö tõlgendused ja koolitusvajadused ning soovitused õpilaste heaolu paremaks tagamiseks koolikeskkonnas. Magistritöö. Tartu Ülikool Sotsiaal- ja Haridusteaduskond. Tartu.
41. Lasonen J. (2001). Työpaikat oppimisympäristöinä. Työpaikkajohtajien, opiskelijoiden, työpaikkaohjaajien ja opettajien arviot Silta-hankkeen (2+1 –kokeilun) kokemuksista. National Board of Education. Helsinki: Hakapaino.
42. Leino M. (2005). Töötu abirahast lapsesõbraliku koolini. Õpetajate Leht, nr. 23, http://www.opleht.ee/Arhiiv/2005/10.06.05/dialoog/1.shtml. (300.07.2011)
43. Leppiman A. (2002) Sotsiaalse sugupoole kujunemisest, "laps elu, probleemid ja lahendused", Tallinn
44. Luhmann N. (2009). Sotsiaalsed süsteemid. Tõlge eesti keelde: kirjastus "Ilmamaa". Tartu.
45. Lukk K. (2008). Structural, Functional and Social Aspects of Home-School Cooperation. Abstract DOCTORAL THESIS. Tallinn.

46. Lõoke E., Saarits Ü. (2004). Koolivalmidus – mida ootavad lasteaialt lapsevanem ja algklassiõpetaja? – ÕpetajateLeht. http://www.opleht.ee/Arhiiv/2004/05.03.04/aine/3.shtml. (30.07.2011)
47. Malpas S. (2005). The postmodern. London; New York: Routledge.
48. Maruste R. (2004). Konstitutsionalism ning põhiõiguste- ja vabaduste kaitse. Tallinn.
49. McIntyre L. L., Eckert T. L., Fiese B. H., DiGennaro F. D., Wildenger L. K. (2007). Transition to Kindergarten: Family Experiences and Involvement. Early Childhood Education Journal, Vol. 35, No. 1. (Online). http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=5&hid=8&sid=92422183-be60-4704-b716-f824243b0c8f%40sessionmgr10. (29.07.2011)
50. Noorväli H. (2009). Praktika arendamine kutsehariduses. Analüütiline ülevaade. Tallinn: Tallinna Ülikooli Kirjastus. Tallinna Ülikool. Sotsiaalteaduste dissertatsioonid, 38. ISSN 1736-3675. ISBN 978-9985-58-665-5.
51. Payne M. (2005). Modern Social Work Theory. (3rd ed.). Palgrave Macmillan.
52. Penjam T. (2004). Võrdsusest on asi kaugel. Õpetajate Leht. http://www.opleht.ee/Arhiiv/2004/16.04.04/koik.shtml. (29.07.2011)
53. Petriwskyj A., Thorpe K., Tayler C. (2005). Trends in construction of transition to school in three western regions, 1990–2004. International Journal of Early Years Education, Vol. 13, No.1, 55–69. http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=4&hid=8&sid=92422183-be60-4704-b716-f824243b0c8f%40sessionmgr10.(30.07.2011)
54. Pianta R. C., Kraft-Sayre M. E. (2003). Successful kindergarten transition. Baltimore: Paul H. Brookes Publishing Co.
55. Pincus A., Minahan A. (1973). Social Work Practice: Model and method. Itasca: F. E. Peacock.
56. Pohjonene P. (2001). Työssäoppiminen tarkasteltuna ammatillisen aikuiskoulutuksen ja työelämän näkökulmasta. [Academic dissertation.] Tampere University. Juvenes Print.
57. Reimaa V. (2008). Haridus kui põhiõiguslik kohus ja miinimumstandardid. Põhikool annab põhja. 11. ja 12. jaanuar 2008 Väimela. Ettekannete ja artiklite kogumik. Koost. Olav Aarna. Tallinn 2008.
58. Rendall S., Stuart M. (2005). Excluded From School. Systemic Practice for Mental Health and Education Professionals. London, New Yprk: Routledge
59. Rinne R., Jõgi L., Klemelä K., Korpas M., Leppänen R. (2008). Soome ja Eesti ühisprojekti Suviko (Suomalainen ja virolainen koulutus aj EU:n uusi koulutuspolitiikka") lähtekohad. Jõgi L., Jääger T., Leppänene R., Rinne R. (koost). Eesti ja Soome haridus ning muutused ELi hariduspoliitikas 1990–2000. Tallinn: TLÜ Kirjastus, 11–16.
60. Sarv E. S. (2006). Õpetaja ja kool uuringute peeglis. R. Vürmer (toim). Elukestev kutseõpe – tõkked ja sillad. Tallinn: Eesti Haridusfoorum, 85–112.

61. Selg M. (2008). Lapsekesksuse tõlgendusi Eesti lastekaitse käsiraamatute võrgustikutöö juhistes. A. Rämmar (Toim), Vaateid teelahkmelt. Sotsioloogia, sotsiaaltöö ja sotsiaalpoliitika aktuaalseid probleeme Eestis (lk 167–188). Tartu Ülikooli Kirjastus.
62. Shepard J., Carlson J. S. (2003). An Empirical Evaluation of School-Based Prevention Programs That Involve Parents. Psychology in the School, 40 (6), 641–656.
63. Sutton C. (2006). Helping Families with Troubled Children: A Preventive Approach. Hoboken, NJ: John Wiley.
64. Teich A. C. (1995). Võrdlev halduspoliitika. Sotsiaalse valiku poliitika Ameerikas, Euroopas ja Jaapanis. Tallinn
65. Tulva T. (1996). Sotsio-ökoloogiline teooria lastekaitsetöö lähtekohana. Teadusartiklite Kogumik. K. Suislepp (koost.)., Lastekaitse muutuvas ühiskonnas (5–18). Tallinn: TPÜ.
66. Tulva T., Viiralt I. (2001.) Võrgustikutöö võimalusi laste- ja pereprobleemide lahendamisel. Laps ja pere tänases Eestis, teadusartiklite kogumik, Tallinn.
67. Tuomi-Gröhn T., Engström Y. (2003). Conceptualizing Transfer: From Standard Notions to Developmental Perspectives. Between School and Work. T. Tuomi-Gröhn, Y. Engeström (eds.). New perspectives on Transfer and Boundary-crossing. Pergamon, 19–38.
68. Veermäe K. (2004). Hariduskorralduse põhiprintsiipide rakendamisest Eestis. Juridica X, 712–721.
69. Viiralt I. (1999). Sensoorse integratsiooni häiretega koolieelne laps: toimetuleku toetamise võimalusi. Magistritöö referaat. TPÜ. Tallinn.
70. Viires P. (2008). Eesti kirjandus ja postmodernism. Tartu Ülikooli Kirjastus.
71. Vincent C. (1996). Parent Empowerment? Collective Action and Inaction in Education. The Annual Meeting of the American Educational Research Assosiation. USA: New York.
72. Vygotski L. (1981). Thought and language. Cambridge, MA: MIT Press.
73. Webster-Stratton C., Reid M. J. Stoolmiller M. (2008). Preventing conduct problems and improving school readiness: evaluation of the Incredible Years Teacher and Child Training Programs in high-risk schools. Journal of Child Psychology and Psychiatry 49:5, 471–488.
http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=7&hid=8&sid=92422183-be60-4704-b716-f824243b0c8f%40sessionmgr10. (28.07.2011)
74. Young M. F. D., Muller J. (2007) Truth and truthfulness in the sociology of educational knowledge. Theory and Research in Education 5 (2), 173–201.

Address for correspondence:
Tiina Kallavus
Tartu Herbert Masing School
Vanemuise 33, Tartu 51014
E-mail: tiinakallavus@masing.tartu.ee

Papers on Anthropology XXI, 2012, pp. 110–122

FINGER AND PALMAR DERMATOGLYPHICS IN MUZEINA BEDOUIN FROM SOUTH SINAI: A QUANTITATIVE STUDY

BIBHA KARMAKAR[1], EUGENE KOBYLIANSKY[2]

[1] *Biological Anthropology Unit, Indian Statistical Institute, India*
[2] *Human Population Biology Unit, Department of Anatomy and Anthropology, Sackler Faculty of Medicine, Tel Aviv University, Israel*

ABSTRACT

Quantitative finger and palmar dermatoglyphics of 218 individuals (170 males and 48 females) belonging to the Muzeina Bedouins from South Sinai Peninsula. They are characterized with a high degree of consanguinity, a small isolate nomadic tribe. 22 quantitative dermatoglyphic traits (12 finger and 10 palms) were considered in the present study. Except PII (non-significant sex difference), the results of significant sex-differences of finger ridge counts (TFRC), MLI are similar with the earlier studies in various populations. However, the results of palmar traits reveal homogeneity which also presents a common picture obtained in the earlier studies perhaps, due to the possible role of environmental (prenatal) factors in the realization of dermatoglyphics between finger and palm. The development of palmar dermatoglyphics has a relatively longer growth period compared with fingers (Cummins 1929). Thus, the palmar dermatoglyphic pattern of affinities corresponds better than fingers to the ethno- historic background of the populations (Reddy et al. 1988, Karmakar et al. 1989, 2002, 2008, 2010).

Key words: *Dermatoglyphics, pattern types, Bedouins*

INTRODUCTION

Several studies had demonstrated that dermatoglyphics are phylogenetically more stable than other biological traits (Rothhammer et al. 1977, Froehlich and Giles 1981). The fact that dermatoglyphic traits appear to be evolutionarily conservative renders them more reliable for studies of the historical relationships of population components. Dermatoglyphic character has also been suggested by Singh 1978 as the result of a biogenetic expression, rather than physical environment, because dermatoglyphic features are formed before the 19th week of gestation (Penrose and Ohara 1973) and thereafter are not amenable to change due to age and/or environmental factors. Dermatoglyphic characteristics thus permanently preserve an earlier stage of fetal development, whereas most other biological characteristics are examined through postnatal development. Thus, due to these important characteristics, fingerprint patterns first attracted the interest of workers (see among others, Chakraborty et al. 1982; Karev 1991; Singh 1985; Devi 2000; Sengupta and Karmakar 2004; Karmakar et al. 2005, 2008, 2011). It was also found long ago that the application of proper statistical techniques, the genetics of quantitative aspect of dermatoglyphics could be better demonstrated than the qualitative traits (see among others, Bonnevie 1924; Newman 1930; Geipel 1941; Holt 1968; Matsuda 1973; Singh 1979, Dittmar 1994). Furthermore in general, the relative contribution of genetic and environmental factors to the phenotypic variation of dermatoglyphics differs from population to population (Cummins and Midlo 1961, Holt 1968, Kobyliansky et al. 1986, Kobyliansky and Livshits 1986, Arrieta et al. 1987, Karmakar et al 1989, Kobyliansky 1990, Crawford and Daggirala 1992, Jantz et al. 1993, Demarchi et al. 1997).

In view of the well-known ethnic diversity of the populations from different geographic areas, the main objective of the present article is (a) to provide information of quantitative finger and palmar patterns in a small isolate with a high degree of consanguinity, the nomadic tribe Muzeina Bedouins from South Sinai Peninsula and (b) to compare the present result with our previous studies on Indian populations (Karmakar et al 2002a, b), the Chuvashian population of Russia (Karmakar et al 2007, 2008) and Turkmenian populations (Karmakar and Kobyliansky 2010).

MATERIALS AND METHODS

Sample and the analyses of prints

For centuries the Muzeina tribe inhabited the Sinai desert, which was especially occupied by the Bedouins and they originated mainly from the Saudi Arabian Peninsula (Hershkovitz 1985). The Muzeina tribe is characterized by strong biological isolation, rarely the intermix and shows preference for first-cousin marriages. The frequency of such marriages is 15% and the inbreeding coefficient is 0.09. The sample contains data of 218 individuals (170 men and 48 women).

Finger and palmar prints were collected using the ink and roller method of Cummins & Midlo (1961). The prints were mostly evaluated following Cummins & Midlo (1961) and Holt 1968. Dermatoglyphic traits include the total of 22 quantitative traits- 12 finger and 10 palms were considered in the present study. Three types of finger patterns (UL, RL, and W) for finger ridge counts RC) on 10 fingers with total, absolute ridge counts and the pattern intensity index (PII); and on palm a-b ridge count, a-b distance, the main line index (MLI) and the mainline (A and D) terminations (MLT) were analyzed. All the types of true whorls like concentric, single spiral, double spiral, accidental, etc. and also all the types of composite whorls like twin loops, central pocket loops, lateral pocket loops, crested and knot-crested loops are grouped under the broad category of 'whorls'. On the other hand, radial and ulnar loops (RL and UL) were classified separately. The dermatoglyphic features were evaluated and presented for each sex and each hand separately in order to investigate both the sex and the bilateral differences.

The data were processed at the Tel Aviv University computer center, using the computer programs described by Nie et al., (1975). The phenotypic correlations between the studied finger ridge count variables were determined in males and females separately. One way analysis of variance was used to assess the statistical significance of the dermatoglyphic sex differences.

RESULTS AND DISCUSSION

Finger Dermatoglyphics

The pattern intensity index (PII) is little higher (Table 1) in females (15.03) than in males (14.72) with very small bilateral differences. PII values in our previous study (Karmakar et al. 2002a, b) in five Indian populations (ranging from 12.98 to 13.99 in males and 12.42 to 13.74 in females) differ significantly

between males and females. This result is corroborated with earlier studies in diverse Jewish populations; they ranged from 14.07 to 14.50 in males and 12.93 to 13.42 in females (Cummins and Midlo 1927, Sachs and Bat Miriam 1957, Bat Miriam Katznelson and Ashbel 1973, Pereira et al. 1977), in the Chuvashian population (Karmakar et al. 2008). However, the present results of sex difference in PII are contradicted with all the above-mentioned earlier studies of diverse Jewish groups, Chuvashians as well as Indian populations. This difference may be due to a high degree of consanguinity of the nomadic tribe Muzeina Bedouins.

Table1. Pattern intensity index (PII) by hand and sex in Muzeina Bedouins

	Mean	S.D.	C.V.	Mean	S.D.	C.V.
Hand		Males			Females	
Left	7.31	1.82	24.83	7.55	1.63	21.56
Right	7.43	1.77	23.86	7.41	1.45	19.63
Both	14.72	3.42	23.24	15.03	2.80	18.62

Regarding *the ridge count of pattern types* in both sexes (Table2), the pattern type with the highest mean ridge count is whorl (18.62 in males, 17.53 in females), followed by the ulnar loop (14.12 in males, 14.07 in females), and the radial loop (8.88 in males, 12.32 in females), Similarly, the CV of pattern types increases from whorl to the ulnar loop and to the radial loop. *The mean ridge count* of a pattern of a given type is greater in males than in females (Table 3) for each finger with negligible differences. These results are similar to the above mentioned studies. *The ridge counts of individual fingers are* presented in Table 4. The mean ridge count of the first finger (21.75 in males, 20.01 in females) is invariably the highest among all the fingers, followed by the fourth finger (15.87 in males, 15.06 in females), which is in agreement with Karmakar et al. (2002a, b, 2008; Karmakar and Kobyliansky 2010). The lowest values belong to fingers II, III, and V. In all the fingers, the mean ridge count is greater in males than in females with very minimal differences in finger II. The CV of ridge counts is lower in fingers IV, V, and I and higher in fingers II and III, respectively and supports the above earlier findings. *The total finger ridge count (TRC)* is presented in Table 5. TRC is greater in males (160.81) than in females (155.96) for both hands, while C.V. is higher in females (24.02) than in males (22.56), may be due to a greater variability of pattern types in females, which corroborates the results of Kobyliansky and Micle (1988, 1989;

Karmakar et al. 2008, Karmakar and Kobyliansky 2010). Therefore, we have the same interpretation as suggested in earlier studies (Kobyliansky and Micle 1983, 1986) that the variability of TRC is conditioned by the frequencies of the same genes that are responsible for the presence of different finger pattern types.

Table 2. Ridge counts of finger pattern types by hand and sex in Muzeina Bedouins

Hand	Left	Right	Both	Left	Right	Both
	Males			Females		
Ulnar loop						
Mean RC	14.09	14.15	14.12	13.42	14.62	14.07
S.D.	5.29	5.68	5.48	5.64	5.89	5.80
C.V.	37.57	40.16	38.85	41.99	40.28	41.20
Number	487	475	962	161	189	350
Radial loop						
Mean RC	6.96	10.26	8.88	10.93	15.29	12.32
S.D.	3.97	5.38	5.08	5.12	4.35	5.21
C.V.	57.09	52.47	57.18	46.82	28.44	42.32
Number	25	35	60	15	7	22
Whorl (max-count)						
Mean RC	19.01	18.22	18.62	17.72	17.34	17.53
S.D.	4.70	4.91	4.82	4.52	4.46	4.49
C.V.	24.72	26.92	25.88	25.51	25.73	25.60
Number	503	505	1008	195	183	378
Arch (RC = 0)						
Number	22	14	36	7	6	13

RC= Mean ridge count

Table 3. Mean ridge counts of pattern types depended on pattern location on individual fingers by hand and sex in Muzeina Bedouins

Finger Pattern types	I		II		III		IV		V	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Males										
UL	19.21	4.50	12.05	4.97	13.79	4.49	12.00	4.85	13.22	4.64
Left RL	–	–	5.79	3.15	7.50	3.54	12.25	4.03	–	–
W	23.21	4.22	16.65	4.29	17.88	3.87	18.25	4.02	17.59	3.89
UL	20.35	5.30	12.39	5.06	13.48	4.42	12.15	4.73	11.83	4.44
Right RL	–	–	9.62	5.74	9.00	4.24	13.20	4.21	12.50	2.12
W	23.26	4.15	16.14	3.92	17.74	3.98	17.40	4.16	15.84	3.87
Females										
UL	17.53	3.79	11.95	6.13	13.30	5.35	9.86	4.90	13.00	5.35
Left RL	–	–	10.89	6.23	11.00	5.00	11.50	2.12	10.00	–
W	20.72	4.28	16.52	4.11	17.50	5.39	17.30	3.73	15.63	3.80
UL	20.08	4.88	13.02	4.76	14.50	5.05	10.00	5.37	12.25	5.78
Right RL	20.00	–	17.00	–	–	–	15.25	4.03	9.00	–
W	21.06	4.00	18.11	4.43	16.75	3.84	16.76	4.00	14.84	3.63

Table 4. Ridge counts of individual fingers by hand and sex in Muzeina Beduins

Finger	Left hand			Right hand			Both hands		
	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.
Males									
I	21.50	4.77	22.17	21.96	4.91	22.35	21.75	4.41	20.27
II	13.17	5.61	42.58	12.82	5.96	46.51	13.10	5.15	39.34
III	14.86	5.04	33.90	14.56	4.82	33.12	14.66	4.47	30.47
IV	16.14	5.37	33.27	15.78	5.11	32.38	15.87	4.81	30.32
V	15.40	4.80	31.16	13.97	4.57	32.74	14.62	4.45	30.43
Females									
I	19.48	4.36	22.39	20.54	4.45	21.66	20.01	4.11	20.55
II	13.51	5.89	43.61	14.08	6.26	44.49	13.66	5.49	40.21
III	14.59	5.68	38.94	14.77	5.14	34.82	14.71	5.00	34.01
IV	15.29	5.50	35.94	15.36	5.01	32.63	15.06	4.94	32.79
V	14.41	4.70	32.61	13.78	4.71	34.20	14.05	4.33	30.83

Table 5. Ridge counts of left, right and both hands by hand and sex in Muzeina Beduins

Sex	Left hand			Right hand			Both hands (TRC)		
	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.
Males	82.24	19.31	23.48	78.44	18.84	24.01	160.81	36.27	22.56
Females	76.95	20.80	27.03	79.57	19.97	25.09	155.96	37.46	24.02

Correlation coefficients between finger ridge counts are presented in Table 6. The correlation ranged from 0.230 to 783 in males and from 0.241 to 0.826 in females. However, these coefficients of correlation are not similarly high (0.722 to 0.817 in males and 0.744 to 0.846 in females) as those obtained in other Jewish populations (Kobyliansky and Micle 1988, 1989) as well as in other populations (Holt 1959, 1968; Mavalwala 1962, Singh et al. 1977). The correlation ranged from 0.286 to 0.783 in males and from 0.292 to 0.776 in females in the Turkmenian population (Karmakar et al. 2010) are also similar with the present results. But the correlation ranged from 0.067 to 0.574 in males and from 0.119 to 0.592, in females in the Chuvashian population (Karmakar et al. 2008) figures are lower than the above findings, it may be due to major ethnic differences.

Table 6. Correlation coefficients of finger ridge counts by sex and hand in Muzeina Bedouins

Finger	Left hand					Right hand				
	V	IV	III	II	I	V	IV	III	II	I
I	0.374	0.248	0.261	0.230	0.681	0.340	0.271	0.301	0.290	–
II	0.505	0.517	0.546	0.646	0.420	0.501	0.462	0.619	–	0.477
III	0.537	0.633	0.649	0.569	0.367	0.570	0.650	–	0.677	0.407
IV	0.618	0.717	0.643	0.473	0.340	0.640	–	0.703	0.674	0.366
V	0.783	0.654	0.505	0.513	0.369	–	0.588	0.520	0.573	0.241
I	0.432	0.328	0.433	0.390	–	0.404	0.517	0.552	0.524	0.705
II	0.506	0.578	0.578	–	0.523	0.679	0.645	0.626	0.782	0.391
III	0.499	0.611	–	0.647	0.552	0.608	0.751	0.719	0.691	0.451
IV	0.636	–	0.826	0.580	0.493	0.572	0.794	0.696	0.651	0.387
V	–	0.552	0.531	0.705	0.496	0.787	0.480	0.527	0.615	0.315

Males: Above and left of the diagonal.
Females: Below and right of the diagonal.

Palmar dermatoglyphics

The main line index (MLI), angle 'atd' and a-b inter-digital ridge count are all presented in Table 7. The mean value of MLI for both hands in males (8.42, 9.12) is higher than in females (8.24, 8.57). There are slightly greater MLI values in the right hand than in the left one in both sexes, which reflects the transversality of the palmar main lines, and sex- differences are not significantly different. However, the angle 'atd' (88.89 in males, 91.43 in females) and a-b inter-digital ridge count (79.60 in males, 81.33 in females) shows slightly higher values in females than in males, which does not differ significantly. These results are corroborated to those of Jewish populations (Kobyliansky and Micle 1988), the Chuvashian population (Karmakar et al. 2008), the Turkmenian population (Karmakar et al. 2010) and Indian populations (Karmakar et al. 2002a, b).

Table 7. Means and standard deviations of palmar dermatoglyphic traits by hand and sex in Muzeina Beduins

Trait	Hand	Males		Females	
		Mean	S.D.	Mean	S.D.
Main line index	Left	8.42	1.92	8.24	1.72
	Right	9.12	1.89	8.57	2.00
	Both	8.79	1.76	8.39	1.69
atd angle (degrees)	Left	45.03	10.12	46.03	8.08
	Right	44.10	8.46	45.39	7.95
	Both	88.89	16.09	91.43	14.15
a-b ridge count	Left	40.53	6.74	41.81	6.33
	Right	39.06	7.18	39.59	6.59
	Both	79.60	12.71	81.33	11.71
a-b distance (mm)	Left	21.36	4.19	20.28	3.66
	Right	20.94	3.99	19.84	3.94
	Both	42.30	7.73	40.08	7.22
Ridge breadth	Left	0.529	0.089	0.490	0.066
	Right	0.519	0.087	0.475	0.062

Sex Comparison

Table 8 presents the sex differences of 22 dermatoglyphic variables by the ANOVA test. The ridge counts on individual fingers regarding sex differences are mostly uniform between the right and left sides. Finger I shows a markedly significant difference (4.86 on right, 10.55 on left). Significant sex differences (4.03) appear for total (TFRC) finger ridge counts, the main line A and D terminations, but there are no significant differences on the palmar a-b ridge count. Thus, compared to the finger ridge count, the results of palmar traits

Table 8. Comparison of 22 quantitative dermatoglyphic traits and indices in males and females by ANOVA method in Muzeina Beduins

Tralt	Males		Females		Sex differences	
	Mean	S.D.	Mean	S.D.	F ratio	Sign.*(P)
Finger RC, I-r	21.96	4.91	20.54	4.45	4.86	**0.03**
Finger RC, II-r	12.82	5.96	14.08	6.26	2.43	0.12
Finger RC, III-r	14.56	4.82	14.77	5.14	0.10	0.75
Finger RC, IV-r	15.78	5.11	15.36	5.01	0.37	0.54
Finger RC, V-r	13.97	4.57	13.78	4.71	0.09	0.77
Finger RC, I-l	21.50	4.77	19.48	4.36	10.55	**0.00**
Finger RC, II-l	13.17	5.61	13.51	5.89	0.18	0.67
Finger RC, III-l	14.86	5.04	14.59	5.68	0.14	0.70
Finger RC, IV-l	16.14	5.37	15.29	5.50	1.35	0.25
Finger RC, V-l	15.40	4.80	14.41	4.70	2.24	0.14
Total RC	154.36	38.02	144.20	41.37	4.03	**0.05**
Absolute RC	215.93	79.58	201.04	76.30	2.12	0.15
PII, lh	7.31	1.82	7.55	1.63	1.00	0.32
PII, rh	7.43	1.77	7.41	1.45	0.01	0.93
PII, both h	14.72	3.42	15.03	2.80	0.47	0.50
a-b RC, rh	39.06	7.18	39.59	6.59	0.39	0.53
a-b RC, lh	40.53	6.74	41.81	6.33	2.60	0.11
A-line exit l	4.11	0.87	4.33	0.79	4.36	**0.04**
A-line exit r	4.11	0.96	4.03	0.93	0.43	0.51
D-line exit l	4.30	1.42	3.87	1.43	6.11	**0.01**
D-line exit r	5.00	1.30	4.64	1.48	4.99	**0.03**
Main line index	8.79	1.76	8.39	1.69	3.01	0.08

* The differences are statistically significant when $P < 0.05$

reveal homogeneous character in nature. These results are similar to earlier studies in various populations (see among others, Reddy & Malhotra 1985, 1987, Arrieta et al. 1990, Demarchi et al. 1997, Gomez & Martin 1992, Karmakar et al. 2002, 2006, 2007, 2010). This difference between palm and finger may be due to the possible role of the environmental (prenatal) factors in the realization of the dermatoglyphic sex difference. The development of palmar dermatoglyphics has a relatively longer growth period compared with fingers (Cummins 1929). Thus, the palmar dermatoglyphic pattern of affinities corresponds better than fingers to the ethno- historic background of the populations (Reddy et al. 1988, Karmakar et al. 1989, 2002).

REFERENCES

1. Arrieta M. I., Ibrarrondo M. A., Lostao C. M. (1987). Digital dermatoglyphics in the Basque population: Univariate and multivariate comparison with other Spanish populations. Am J Phys Anthrop 73, 89–98.
2. Arrieta M. I., Martinez B., Simson A., Salazar L., Criado B., Lostao C. M. (1990). Quantitative and qualitative finger dermatoglyphics in the Basque valley of Urola, Spain. Anthrop Anz 48, 65–84.
3. Bat-Miriam Katznelson M., Ashbel S. (1973). Dermatoglyphics of Jews. 1. Normal Ashkenazi population Z Morph Anthrop 65, 14–28.
4. Bonnevie K. (1924). Studies on papillary pattern human finger. J Genet 15: 1–12.
5. Chakraborty R., Mathew S., Satyanarayana M., Majumder P. P. (1982). Inheritance of digital arches in humans: is major gene fully penetrant? Am J Anthrop 58, 431–71.
6. Cummins H., Midlo C. (1927). Dermatoglyphics in Jews. Am J Phys Anthrop 10, 91–113.
7. Cummins H. (1929). The topographic history of the volar pads (walking pads, tast ballen) in the human embryo. Embryol 20, 103–126.
8. Cummins H., Midlo C. (1961). Finger prints, palms and soles. Dover Publ. New York.
9. Crawford M. H., Duggirala R. (1992). Digital dermatoglyphic patterns of Eskimo and American populations: Relationships between geographic, dermatoglyphic, genetic and linguistic distances. Hum Biol 64, 683–704.
10. Demarchi D. A., Giordano A. R., Marcellino A. (1997). Dermatoglyphics in Araucanian Indians from Patagonia and multivariate comparisons with other Argentinian aboriginal populations. Hum Biol 69, 227–239.
11. Devi S. (2000). Mode of inheritance of finger and palmar dermatoglyphic patterns in an endogamous population of Orissa. Ph.D. Thesis, Utkal University, India.

12. Dittmar M. (1994). Qualitative and quantitative analysis of digital and palmar dermatoglyphics in Chilean Aymara Indians. Anthropologia Biologica 2, 39–58.
13. Froehlich, J. W., Giles E. (1981). A multivariate approach to finger prints variation in Papua New Guinea: Perspectives on the evolutionary stability of dermatoglyphic markers. Am J Phys Anthropol 54, 93–106.
14. Geipel G. (1941). Die Gesantalage der finger leisten als neuea Merimal Zur Zwillings diagnose. Ibid 39, 414–419.
15. Gomez P., Martin J. (1992). Dermatoglyphic analysis of La Liebana (Cantabria-Spain). 1- Fingertip patterns and pattern intensity index. Coll Antropol 16, 395–403.
16. Herskovitz I. (1985). The effect of mating type on growth and development of children in South Sinai Bedouin Isolates. Ph.D. Thesis. Tel Aviv University, Israel.
17. Holt S. B. (1959). The correlations between ridge count on different fingers estimated from a population sample. Ann Hum Genet 23, 459–460.
18. Holt S. B. (1968). The genetics of dermal ridges. CC. Thomas, Springfield (III).
19. Jantz R. L., Eriksson A. W., Brehme H. (1993). Population relationships of Lapps as reflected by quantitative dermatoglyphics. Hum Biol 65, 711–730.
20. Karev G. B. (1991). Hypothener radial arch in man: Observations on its distribution, morphology, symmetry and inheritance. Am J Phy Anthrop 84, 479–487.
21. Karmakar B., Malhotra K. C., Narain P. (1989). Palmar dermatoglyphic distance analysis among 20 Dhangar castes of Maharashtra, India. Anthropologie 27, 13–28.
22. Karmakar B., Yakovenko K., Kobyliansky E. (2002) Sexual dimorphism: 22 dermatoglyphic traits in five endogamous populations of West Bengal, India. In: Papers on Anthropology. Tartu University, Estonia. XI, 93–112.
23. Karmakar B., Yakovenko K., Kobyliansky E. (2005). Complex segregation analysis of quantitative dermatoglyphic traits in five Indian populations. Ann Hum Biol 32, 445–468.
24. Karmakar B., Yakovenko K., Kobyliansky E. (2006). Mode of inheritance of dermatoglyphic pattern intensity index on fingers in five Indian populations: A comparative study between individual trait and its factor. Am J Hum Biol 18, 377–386.
25. Karmakar B., Yakovenko K., Kobyliansky E. (2007). Qualitative finger and palmar dermatoglyphics: Sexual dimorphism in the Chuvashian population of Russia. Anthrop Anz 65, 383–390.
26. Karmakar B., Yakovenko K., Kobyliansky E. (2008). Quantitative digital and palmar dermatoglyphics: Sexual dimorphism in Chuvashian population of Russia. Homo 59, 317–328.
27. Karmakar B., Kobyliansky E. (2010). Qualitative and quantitative finger and palmar dermatoglyphics: Sexual dimorphism in the Turkmenian population. In: Research in Physical Anthropology: Essays in honor of Professor L. S. Penrose, S.

Datta Banik (edit), unas Letras industria editorial Publ, Merida, Yucatan, Mexico, page 115–145, Chapter 6.

28. Karmakar B., Malkin I., Kobyliansky E. (2011). Inheritance of 18 quantitative dermatoglyphic traits based on Factors in MZ and DZ twins. Anthrop Anz 68, 185–193.
29. Kobyliansky E., Livshits G. (1986). Anthropometric multivariate structure and dermatoglyphic pecuiliarities in biochemically and morphologically different heterozygous groups. Am J Phys Anthrop 70, 251–263.
30. Kobyliansky E. (1990). Gene pool as evidence of environmental adaptation of human populations: Based on biochemical, dermatoglyphic, morphological likeness and differences of the Jewish populations of the world. Hum Ecol 9, 37–62.
31. Kobyliansky E., Micle S. (1986). Finger patterns characteristics as determinants of total ridge count variability. Int J Anthropol. 1, 49–58.
32. Kobyliansky E., Micle S. (1987). Dermatoglyphic sexual dimorphism in Middle Eastern Jews. Bull. et Mem de la soc d'Anthrop. De Paris t 4, ser. XIV, no. 4, 271–290.
33. Kobyliansky E., Micle S. (1988). Dermatoglyphic sexual dimorphism in North African Jews. Int J Anthropol. 3, 77–91.
34. Kobyliansky E., Micle S. (1989). Dermatoglyphic sexual dimorphism in East European Jews. Bull. et Mem de la soc d'Anthrop. de Paris t 1, no. 1–2, 13–36.
35. Matsuda F. (1973). Genetic studies on total finger ridge count among Japanese. Jap J Hum Genet 17, 293–318.
36. Mavalwala J. (1962). Correlations between ridge counts on all digits of the Parsis of India. Ann Hum Genet 26, 137–138.
37. Newman H. H. (1930). Palmar dermatoglyphics of twins. Am J Phys Anthrop.14, 331–378.
38. Penrose L. S., Ohara P. T. (1973). The development of epidermal ridges. J Med Genet 10, 201–208.
39. Pereira. M., Petit-Maire N., Jagolnitzer E. R. (1977). Dermatoglyphes digitaux et palmaries d'lsraelines. Bull. Et Mem. De la Soc. D'Anthrop. De Paris, a) 4, 2, 149–164, b) 4, 3, 245–263.
40. Reddy B. M., Malhotra K. C. (1985). Genetic significance of the relationship between total finger ridge count and its variability: Indian data. Homo 36,11–26.
41. Reddy B. M., Malhotra K. C. (1987). Genetic significance of the relationship between absolute total finger ridge count and its variability. Int J Anthropol 2, 141–149.
42. Reddy B. M., Chopra V. P., Karmakar B., Malhotra K. C. (1988). Quantitative palmar dermatoglyphics and the assessment of population affinities: Data from marine fishermen of Puri, India. Anthropol Anz 46, 235–244.
43. Rothhammer F., Chakraborty R., Liop E. (1977). A collation of gene and dermatoglyphic diversity at various levels of population differentiation. Am J Phys Anthrop 46, 51–59.

44. Sachs, Bat-Miriam M. (1957) The genetics of Jews populations.1. Fingerprint pattern in Jewish populations in Israel. Am J Hum Genet 9, 117–126.
45. Sengupta M., Karmakar B. (2004). Mode of inheritance of finger Dermatoglyphic traits among Vaidyas of West Bengal, India. Ann Hum Biol 31, 526–540.
46. Singh S., Attkin M. A., Westwood N. H. (1977). Structural analysis of the ridge count data of Australian Europeans using multivariate analysis. Acta Genet Med Gemell 26,167–171.
47. Singh R. D. (1985). Digital ridge count variation in some castes of India. In: Progress in Dermatoglyphic Research. Barsocas CS (Ed). New York, 303–315.

Address for correspondence:
Dr. Bibha Karmakar
Biological Anthropology Unit
Indian Statistical Institute
203 B.T. Road, Kolkata 700 108, India
E-mail: bibha@isical.ac.in

Papers on Anthropology XXI, 2012, pp. 123–136

ON PROF. DANIEL GEORG BALK (1764–1826), SUPERVISOR OF KARL ERNST VON BAER'S DOCTORAL THESIS ON ESTONIANS' ENDEMIC DISEASES

(for K. E. von Baer's 220th birth anniversary)

JAAN KASMEL, TIIU KASMEL

Centre for Physical Anthropology, University of Tartu, Estonia

Karl Ernst von Baer (1792–1876), a graduate of the University of Tartu, which will celebrate its 380th anniversary in October this year, can be considered one of the most renowned natural scientists of the 19th century. His 220th birth anniversary was at the end of February this year.

His work and activities have influenced the development of embryology, zoology, geography, geocryology, ichthyology, geomorphology, archaeology, ornithology, botany and climatology.

K. E. von Baer may also be called an ethnographer, anthropologist, medical scientist, historian, bibliographer, philosopher, populariser of science, reformer of education and science in Russia, researcher of local history and manor economy manager (1834–1866 he was the owner of Piibe and Selli manors) [1].

A few years ago, Aadu Must, Professor of Archival Studies at the University of Tartu, public figure and politician, relying on sources found in Russian archives, discovered the surprising fact that K. E. von Baer was also one of the founders of the Russian analytical intelligence service and its main ideologist [2].

Archive dossiers may still hide many unknown materials and facts about K. E. von Baer.

The first step in his long and fertile career as a scientist was the doctoral dissertation *On Estonians' Endemic Diseases,* which was defended it in front of the Council of the Faculty of Medicine of the Imperial University of Dorpat (the present University of Tartu) on 29 August 1814.

The documents on the defence of his doctoral thesis and the preceding exams are preserved in the Estonian Historical Archives as a separate storage item. Along with documents in German and Latin on 17 pages, the file also includes the doctoral diploma given to Baer, his doctoral thesis in Latin (88 pp.) and the diploma given to Baer by the Medical Faculty of the University on the 50th anniversary of the defence of his doctoral thesis [3].

Forty years ago, at a conference to mark Baer's 180th birth anniversary, Associate Professor of Tartu State University (now the University of Tartu) Tullio Ilomets made a presentation *On the defence of Karl Ernst von Baer's doctoral dissertation.* An extended version of the presentation was published in the collection *Folia Baeriana I* (Tallinn: Valgus 1975, 184 pp., 1000 copies), which shows that, in addition to the above-mentioned archive file, the author has used 13 other publications.

With this collection, the publication of Baer's original papers in Estonian began. The first to be published in Estonian was the translation of his Latin thesis, on pages 141–181 of the collection [4].

In the following year, 1976, the Estonian translation of Baer's dissertation appeared in Issue 33 of *Loomingu Raamatukogu* series in 25,000 copies [5].

The doctoral dissertation and the Latin materials of the archive file were translated into Estonian by Ülo Torpats, a lecturer of Tartu State University [3].

Thus, it has been possible for everyone who knows Estonian to read Baer's doctoral thesis for more than 35 years. Estonians have found quite interesting facts in it, as it deals with the life and health of Estonian serf peasants in the early 19th century, being a valuable source on the history of sanitation and hygiene in Estonia.

The printed version of Baer's doctoral dissertation in Latin, like its reprint in 1938, have become bibliographical rarities.

Relatively little has been written about the content of his doctoral thesis as a medical-geographical study. The papers describing it have been limited to summaries of the chapters and do not contain any analyses of problems. The main reasons seem to be the local character of the theme, treatment of a geographically limited area and the fact that the thesis was written in Latin [3].

Baer's choice of the theme for his doctoral thesis *On Estonians' Endemic Diseases* was influenced by Daniel Georg Balk (1764–1826), Ordinary Professor of Pathology, Semiotics, Therapy and Clinic [6].

In his autobiography Baer notes that he felt well prepared for the theme, as in his boyhood he had accompanied his private teacher when the latter visited peasant families to treat illnesses. Command of the Estonian language enabled him to communicate directly with the country people; when collecting specimens for his herbarium in Estonia and Livonia, he had learned to recognise many medicinal plants.

In his thesis Baer relies on observations made at the clinics of the University of Tartu, Riga military hospital and on expeditions, also on literary sources that describe Estonians' way of life and health status [7].

The thesis consists of a preface and five chapters. The second chapter of Baer's doctoral thesis (*On Estonians' customs*) is of particular interest from the anthropological point of view, as it provides an overview of the Estonian people in general, their dwellings, clothing, food and drink. It also describes Estonians' physical development and temperament, taking care of one's body and lifestyle during different seasons [4].

The short description of Estonians' habitus (body build) compiled by him is a telling example of the anthropological thinking of the period.

Baer's doctoral thesis can be considered the first paper that thoroughly dealt with Estonians' anthropology. It marks the beginning of Estonians' anthropological research [8].

Because of the description of Estonians' body build and appearance, the thesis can also be considered an anthropological-medical-geographical paper.

Prof. D. G. Balk, the scientific supervisor of K. E. Baer's doctoral thesis, has found little or no attention in publications about K. E. von Baer's doctoral thesis, its writing and defence.

Therefore, we are going to discuss Prof. Balk's activities as Ordinary Professor of Pathology, Semiotics, Therapy and Clinic and a developer of anthropology at the Imperial University of Dorpat from 1802–1817.

In addition, we are trying to establish by whom, when and under what conditions the teaching of anthropology – the academic study of humans – began at the Medical Faculty of the University of Tartu, and what the University Statutes that were in effect then said about the teaching of that subject.

During its 380 years of existence, the University of Tartu has gone through a complex and discontinuous route of development. The university has

sometimes even changed its location, but throughout its history it has included the Faculty of Medicine. Among the numerous disciplines taught at the faculty, one of the oldest and most essential ones is anatomy. Its teaching began as soon as the enlightened Swedish king Gustavus II Adolphus gave permission to open a university with four faculties in Dorpat (Tartu) in war-ravaged Livonia from 15 (25) October 1632 [9].

Although the roots of anthropology (the Greek for 'the study of humans') go back to the distant past, and even the term dates from Aristotle (384–322 BC), it became established as a separate branch of science as late as in the 19th century. This had been facilitated by expeditions of discovery and the development of natural sciences, particularly of anatomy [10]. It is not always easy to tell when anthropology began to be taught at one or another university as detailed research into the matter is lacking.

To get a comprehensive answer to our last question, we should look back at the history of the Faculty of Medicine at the University of Tartu, starting from the first two periods of the university under the Swedish rule when tuition was in Latin. By the statutes of Academia Gustaviana Dorpatensis (1632–1665) and Academia Gustavo-Carolina (1690–1710), which were modelled on the statutes of Uppsala University, the Faculty of Medicine was to have two professors. One of them was supposed to lecture on anatomy, botany and physics, and the other had to teach illnesses and their treatment. Annually a dissection was to be arranged. However, due to the small number of students, often only one professor's post was filled, and sometimes even that was vacant. All the professors of medicine who worked in Dorpat (Tartu) were at the level of their time as they had studied at the best universities of Europe [11].

As elsewhere, professors began to pay increasing attention to the issues of human body and spirit, which corresponded to the dualist treatment typical of that time's anthropology.

Despite many difficulties, during both periods teaching and research at the university was more or less met the academic standards of the time. Unfortunately, the activity of the only Livonian university was interrupted by the epidemic of plague that broke out in the summer of 1710 during the Northern War. Opportunities to continue it came as late as at the end of the century [9].

Hoping to prevent the inflow of the ideas of the French Revolution to Russia, Paul I in his ukase of 9 April 1798 forbade Russian subjects to study at Western European universities. They were ordered to return home in a few following months. Simultaneously with the ban, the Baltic knighthoods were

allowed to quickly open a local Protestant university for the whole Russian Empire, and particularly for the knighthoods of Estonia, Livonia and Courland. Its location was to be chosen by an agreement between the knighthoods. From the beginning, it was supposed to bear the name of "imperial university", although its had to be financed by the knighthoods. The representatives of the latter prepared a plan for founding the university but failed to reach an agreement about its location. Finally the Senate was offered two towns to choose from: Mitau (Jelgava) and Dorpat (Tartu). The Senate favoured the latter as the seat of the university because of its central location in the Baltic provinces, favourable climate and cheapness of foodstuffs, which was supposed to offer better opportunities for less well-off parents to send their children to the university [12].

On 4 May 1799 Paul I confirmed the resolution of the Senate and the plan for instituting the university, which in its essence became the provisional statutes of the University. The plan provided for a total of 22 professors in the faculties of theology, law, medicine and philosophy, and teachers of several subjects, mostly of languages. Thus it covered nearly all the principal research areas of that time. The system of teaching was to follow the model of Western European universities and the Russian university in Moscow. The Faculty of Medicine was to have six full professors. The subjects taught at the Faculty of Medicine were divided between them as follows: 1) physiology and pathology; 2) therapy and clinic; 3) anatomy and *medicina forensis* (forensic medicine); 4) surgery and obstetrics; 5) botany and *materia medica* (pharmacology); 6) chemistry and pharmacy.

The same plan envisaged the foundation of several ancillary institutions at the faculties. The university as a whole was to have a library, a manege, a dance hall and a bathing establishment. The plan also included the annual budget of the university, which covered the expenses for the staff and ancillary institutions [13].

Preparations followed for finding lecturers and putting the university into operation, as the opening of the university had been planned for 15 January 1801.

The first members of the Faculty of Medicine who were appointed to their posts on 14 December 1800 were full professor of anatomy and forensic medicine Martin Ernst Styx and full professor of chemistry and pharmacy Philipp Erdmann Heinrich Gottlob Arzt [14].

While the preparations for opening not only the Medical Faculty but the whole university were in progress, Paul I unexpectedly changed his mind and

on 25 December 1800 still appointed Mitau (Jelgava) as the location of the university instead of Dorpat (Tartu) as the knighthoods of Courland and Pilten had submitted a respective application. However, the emperor's sudden death on 12 March 1801 prevented the execution of this order. The new emperor Alexander I, on 12 April 1801, appointed Dorpat (Tartu) again as the seat of the university, substantiating it with its central location, congenial surroundings and several other reasons, including the fact that there had been a university in Dorpat (Tartu) before. The situation had changed in favour of Dorpat (Tartu) again, this time conclusively. Now it would be more appropriate to speak about the re-opening the university in Dorpat (Tartu), not its opening, as years ago, in the early 18th century it had wound up its activities there. (It would be even more exact to speak about its second re-opening as for the first time the university had been re-opened in 1690).

In such a complicated situation the curators of the university found it necessary to introduce several changes and additions to the plan of opening the university in order to strengthen their influence over the university council that consisted of professors [12].

The university statutes confirmed by the ukase of Alexander I of 5 January 1802 provided only 19 professors for all the four faculties. While the foundation plan of the university envisaged six full professors for the Medical Faculty, then the statutes confirmed two years and eight months later had reduced the number of positions to four. As hygienic disciplines had been added, the number of disciplines to be taught by the faculty had increased. The subjects were divided between the professors as follows: 1) anatomy, physiology, surgery and obstetrics; 2) pathology, semiotics, therapy and clinic; 3) dietetics, public and popular medicine and *materia medica*; 4) chemistry and pharmacy. The professor of public medicine also had to lecture on the main hygienic disciplines and forensic medicine.

The statutes did not introduce any changes into the number ancillary institutions affiliated to the Faculty of Medicine and supervision of their work [15].

In addition to the two professors who had already been appointed, the third was employed on 27 February 1802, before the re-opening of the university according to the new statutes – Daniel Georg Balk, full professor of pathology, semiotics, therapy and clinic [14].

The preparations for re-opening the university were brought to a conclusion in April 1802 when, in addition to the first professors, the first students were enrolled from 5 April. On 21–22 April 1802 the University of

Dorpat (now Tartu) was festively re-opened after a long interval of 91 years and 8 months.

On 1 May work began in the four faculties of the only German-language university of the Russian Empire with 9 professors and 19 students. The Faculty of Medicine started with three full professors instead of four; all of them were engaged in teaching during the first semester, which lasted for two months. The post of the professor of anatomy, physiology, surgery and obstetrics remained vacant. The number of students at the faculty was a modest six.

In the first years after the re-opening the university suffered not only from a shortage of lecturers who would have met the requirements but also from lack of suitable rooms. Classes were held in private houses and flats rented for that purpose. Therefore, the construction of new, up-to-date buildings became topical, as the number of students was growing fast.

At the time there were no stable obligatory curricula at the university. The duration of studies had not been fixed, although at the Medical Faculty it was initially two years. Checking of knowledge acquired by the students was superficial and unsystematic. Along with obligatory lectures professors gave students individual tuition and rarely supervised some practical work. Thus, a number of problems concerning the organisation of studies had to be solved [12].

To improve the university structure and management, new statutes were approved on 15 September 1803. These provided four full and two extraordinary professors for the Medical Faculty. The disciplines were divided between the full professors as follows: 1) anatomy, physiology and forensic medicine; 2) pathology, semiotics, therapy and clinic; 3) dietetics, *materia medica*, history of medicine and medical literature; 4) surgery and obstetrics. In addition to these, there was to be a post for a professor extraordinary in veterinary medicine. Under the statutes of 1803 the prosector of the anatomical theatre also got for the first time the rights and obligations of a professor extraordinary [16].

The university staff as envisaged in these statutes was quite numerous for its time – a total of 29 professors and 12 lecturers. Compared to the 1804 statutes of Moscow University, which provided for 28 professorships, the University of Tartu could be very satisfied; theology even got more professorships here (four) than in Moscow (two) [12]. The new statutes introduced several changes concerning the ancillary institutions of the Faculty of Medicine. As the teaching of chemistry was transferred to the Faculty of Philosophy, the

chemistry laboratory was also included among the ancillary institutions of that faculty. The list of ancillary institutions of the Medical Faculty, however, had been supplemented with the collection of anatomical specimens and the pathology study room. The former was to be supervised by the professor of anatomy and the latter by the professor of pathology. The collection of anatomic specimens was to be located at the anatomical theatre; the location of the pathology study room was not specified. The clinical institute that was envisaged for the Medical Faculty in the plan of foundation of the university, was renamed by the 1803 statutes the medical clinical institute and the surgical hospital the surgical clinical institute. No changes were made in the administration of the renamed ancillary institutions and the maternity hospital [16].

The question we were interested in – what the university statutes said about teaching of anthropology at the Faculty of Medicine – could be answered, after a cursory examination: neither the statute of the Swedish university nor the foundation plan of the university (approved in 1799) and the first statutes (1802, 1803) provided for teaching of anthropology at this faculty.

However, looking through the lecture programmes of the university revealed that in the autumn semester of 1802 (from 1 August to the end of December) the list of lectures by the full professor of pathology, semiotics, therapy and clinic D. G. Balk started with lectures of medico-philosophical anthropology for the students of the Medical Faculty, four hours a week, one hour each time [17].

His lectures were based on the textbook *Medizinisch-Philosophische Anthropologie für Aerzte und Nichtaerzte* (*Medico-philosophical anthropology for doctors and non-doctors*) by Johann Daniel Metzger (1739–1805), physician in ordinary to the Prussian king, privy councillor, and professor of Königsberg University. This publication served as the recommended textbook for giving academic lectures. The book consisted of an introduction and six chapters. For its time, the first chapter gave a thorough overview of the descent of man. The following chapters dealt with medical psychology, physiology, dietetics, pathology and therapy [18].

Prof. Balk's lectures on medico-philosophical anthropology were followed by lectures on general pathology. In addition, he lectured on the influence of galvanic electricity on living and dead animals by applying an experimental method. He may have been the first lecturer in the Russian Empire to illustrate his lectures with experiments.

As the professor of anatomy had not arrived as yet, he also taught osteology, which was accompanied by a demonstration of bone specimens.

During the autumn semesters of the next two years Professor D. G. Balk taught physico-philosophical anthropology as a preparatory course for purely philosophical anthropology. Then, during the autumn semester of 1805, he taught natural historico-philosophical anthropology as a prerequisite for purely philosophical anthropology.

During the spring semesters of 1807 and 1808 Prof. Balk taught physiologico-philosophical anthropology as an introduction to philosophical anthropology.

In total, he lectured on anthropology during four autumn and two spring semesters. In his lectures he presented an assemblage of knowledge on the human being that fully met the requirements for teaching anthropology at that time.

All the above-mentioned courses were taught within the same number of hours and according to the textbook by J. D. Metzger.

As visual aids for the lectures, Prof. Balk used specimens from his anatomico-pathological collection (which he himself called a museum). Thus he laid the foundation to the specimens collection of both normal and pathological anatomy at the University of Dorpat (Tartu) and, indirectly, also to the anthropological collection. Because Prof. Balk had started the anatomico-pathological collection, the university statutes of 1803 included the collection of anatomical specimens and the pathology study room in the list of the ancillary institutions of the Medical Faculty.

The list of Prof. D. G. Balk's lectures is not short. He taught introduction to pathology, general ja special pathology, semiotics, health science and, to law students, medico-philosophical jurisprudence according to his own study aid. He is known to have claimed as early as in 1795 that each judge should have knowledge of forensic medicine, medical police and anthropology, and should pass examinations in these subjects before taking office. Moreover, he used to teach general therapy, casuistic medicine, gynecological diseases, special pathology and therapy of children's and fever diseases, general medical science, suspended animation, diseases that may result in sudden death, the art of writing prescriptions, venereal diseases, forensic medicine, treatment of chronic skin diseases, pathology and treatment of mental diseases, introduction to surgery, surgery, medical encyclopaedia and methodology. During a number of semesters he also supervised clinical practice [19].

Next we present an overview of Prof. D. G. Balk's life and work before taking office at the university and during his service here, as in the autumn semester of 1802 he was the first to start teaching anthropology to the students of the Medical Faculty of the University of Tartu (Dorpat).

Daniel Georg Balk was born in Königsberg in the family of an amber polisher on 23 June 1764. He got his first education at home and at school from 1775 [14]. From 1780–1787 he studied at the Medical Faculties of Königsberg and Berlin Universities [20]. In 1787 he earned his doctorate of medicine at Königsberg University. His dissertation studied irritants of skin and the mucous membrane.

Thereafter he practised medicine in Courland and Lithuania. In 1796 he was appointed district physician of Jakobstadt (Jekabpils). On 28 June 1799 Balk became the doctor of Baldone health resort, which is located 33 km from Riga. The numerous medical books he wrote during this period point to the drawbacks in health service and emphasise the need to protect one's health and the social significance of health. In his opinion, training of physicians at local universities would give better results than studying abroad.

Balk's proposals concerning the health service had a reformative character and were progressive for his time. In addition, Balk revealed a literary genius and took a deep interest in the theatre. His fame grew after he took measures against the cattle plague that ravaged the entire Courland at the turn of the century. This was the reason why he was invited to become the first professor of pathology, semiotics, therapy, and clinic at the University of Dorpat (Tartu) in 1802.

As a professor, D. G. Balk became actively involved in the development of the university. In a number of his speeches he drew attention to the human being, educational problems, and the physical and intellectual development of the human being.

As the second Rector of the University of Dorpat (Tartu) (from 1 August 1803 to 1 August 1804) and four-time Dean of the Faculty of Medicine (1804–1805, 1808–1809, 1811–1812, 1815–1816), Prof. Balk made an important contribution to the development of the university and the Medical Faculty [21]. He was involved in the construction of the so-called Old Anatomical Theatre, which began on 8 June 1803. In addition, he was involved in the construction of the clinics in 1806–1808 [22].

In the first half of 1804 Professor D. G. Balk introduced clinical practicums to the curriculum. On 1 May of the same year he opened the first polyclinic in the Russian Empire, which applied rudiments of serving the population

according to the territorial principle. In 1808 he set up an emergency medical aid station, which can be considered the first in Russia.

He also set up a hydropathic establishment that was affiliated to the clinic and a school for teaching of female nurses. Prof. Balk contributed a lot to the treatment of sick and wounded soldiers in the wars of 1807 and 1812–1813 [21].

Prof. D. G. Balk also participated actively in the administration of research.

Professor of anatomy, physiology and forensic medicine Karl Friedrich Burdach has stated that most dissertations written at the Medical Faculty of the University of Dorpat (Tartu) during its first 15 years reflected Balk's views [1].

To stimulate students' interest in independent research, the university statutes of 1803 provided that prize essays should be written. Prof. D. G. Balk also participated in supervising students' research activities. The first prizes for essays were awarded in 1805. The essay by *stud. med.* Otto Girgenson *On the Relations between Medicine and Philosophy*, which received the gold medal, was supervised by Prof. Balk [12].

Unfortunately, we do not have any photographs of Prof. D. G. Balk. Johann Wilhelm Krause (1757–1828), professor of agriculture, technology and architecture, described him as a man of noble appearance with fine features and slender build. He is said to have been characterised by wisdom, wit, sense of humour, and skill at work [23].

For his diligent work Professor Balk was awarded three valuable diamonds rings.

Because of his uncompromising character he had a number of arguments with Prof. Georg Friedrich Parrot (1767–1852), Rector of the university for several terms, and some professors of the Medical Faculty. In his later years at the university he began to spend more time in the *Musse*, drinking and gambling there. All this, including his participation in theatrical performances, served as a reason for accusing Prof. Balk of immorality. On 5 June 1817, at the age of 53, Balk was forced to leave the university, whereby he lost the privileges for himself and his children, which were provided for in the foundation plan of the university. Balk left for Tula where he died early in 1826 [21].

The lectures on medico-philosophical anthropology by full professor of pathology, semiotics, therapy and clinical medicine D. G. Balk in the autumn semester of 1802 and this course of lectures as a whole were the first at the University of Dorpat (Tartu) in the field of anthropology.

Anthropology can be regarded as one of the first academic subjects introduced by Prof. D. G. Balk at the Faculty of Medicine of the University of Tartu 210 years ago.

In addition to Prof. Balk's lectures on anthropology that started in 1802, Prof. H. Fr. Isenflamm started to lecture on anthropology in the autumn semester of 1803, and in the spring of 1805 Professors M. E. Styx and L. E. Cichorius followed.

After that the number of faculty members who taught anthropology declined constantly, and, eventually, after 13 years these lectures were discontinued [19].

Here it would be proper to ask when teaching of anthropology started in the other older universities of Czarist Russia. At Moscow University (the oldest university of Czarist Russia), Ivan Fyodorovich Vensovich (1769–1811), Professor of Anatomy, Physiology and Forensic Medicine, reported for the first time about the need to teach anthropology at Moscow University in 1805 in his festive speech at the celebrations of the 50th anniversary of the university [24]. By then anthropology had been taught in Dorpat (Tartu) for three years already. The year 1805 could still be considered as the peak of teaching anthropology at the University of Dorpat (Tartu) throughout its history. At that time four professors at the Faculty of Medicine were dealing with it – D. G. Balk, H. F. Isenflamm, M. E. Styx and L. E. Cichorius. It is known that they were teaching five different courses on anthropology or courses that included elements of anthropology. The other older universities of Czarist Russia were established or restored after the reopening of the University of Dorpat (Tartu) in 1802 [12]. Therefore, Prof. D. G. Balk's lectures on medico-philosophical anthropology delivered during the autumn semester of 1802, and this lecture course as a whole, can be regarded as the first of its kind at any university of the Russian Empire.

Several authors have written that Prof. D. G. Balk has made an important contribution to popularisation of hygiene in the Baltics, the development of clinical medicine in Tartu, and the development of polyclinical medicine in Russia [21].

He can be regarded as an outstanding physician in the Baltics at the end of the 18th and the beginning of the 19th century who was also influential in the development of anthropology at the University of Dorpat (Tartu) and in Tsarist Russia.

REFERENCES

1. Kaavere V. (1992). Baer. Tartu.
2. Ajaloolane: Karl Ernst von Baer oli Venemaa luure asutaja (2010). Postimees, 10.01.
3. Ilomets T. (1975). Karl Ernst v. Baeri doktoritöö kaitsmisest. In: *Folia Baeriana I.* Tallinn: Valgus, 113–115.
4. Baer K. E. (1814). Eestlaste endeemilistest haigustest. In: *Folia Baeriana I.* Tallinn: Valgus, 141–181.
5. Baer K. E. (1814). Eestlaste endeemilistest haigustest. In: "Loomingu" Raamatukogu, 33. Tallinn: Perioodika, 7–56.
6. Kalnin V. (1967). C. E. Baeri doktoriväitekirjast. Nõukogude Eesti Tervishoid, 3: 228–229.
7. Kalnin V. (1976). Ääremärkusi ja selgitusi K. E. v. Baeri doktoriväitekirja juurde. In: "Loomingu" Raamatukogu, 33. Tallinn: Perioodika, 59–62.
8. Ауль Ю. (1964). Антропология эстонцев. Тарту.
9. Tartu Ülikooli ajalugu I. 1632–1798. Koost. H. Piirimäe. Tallinn: Valgus, 1982.
10. Тегако Л. И., Саливон И. И. (1989) Основы современной антропологии. Минск.
11. Mikelsaar R.-H. (1998). 300 aastat sektsioonikursust ja patoanatoomiat Tartu Ülikoolis. Eesti Arst, 6: 544–548.
12. Tartu Ülikooli ajalugu II. 1798–1918. Koost. K. Siilivask. Tallinn: Eesti Raamat, 1982.
13. Plan der errichtenden Universität. [Riga, 1799].
14. Левицкий Г. В. (1902, 1903). Биографический словарь профессоров и преподавателей Императорского Юрьевского университета за сто лет его существования. Т. I, Юрьев; Т. II, Юрьев.
15. Statuten der Kayserlichen Universität zu Dorpat. Dorpat, 1802.
16. Statuten der Kaiserlichen Universität zu Dorpat. Dorpat, [1803].
17. Verzeichnis der Vorlesungen auf der Kaiserlichen Universität in Dorpat vom 1. August bis Ende Dezember des Jahres 1802. Dorpat, 1802.
18. Metzger J. D. (1790). Medizinisch-Philosophische Anthropologie für Aerzte und Nichtaerzte. Leipzig.
19. Verzeichnis der haltenden Vorlesungen auf die Kaiserlichen Universität zu Dorpat, 1803–1817. Dorpat, 1803–1817.
20. Album rectorum Universitatis Tartuensis 1632–1997. Tartu, 1997.
21. Kalnin V. (1996). Daniel Georg Balk. In: Eesti arstiteaduse ajaloost. Ed. V. Kalnin. Tartu: 25–29.
22. Normann H. (1925). Katkend Tartu Ülikooli arstiteaduskonna algetest. Eesti Arst, 11: 323–332.
23. Krause J. W. Kunagise Tartu ülikooli esimene aastakümme. In: Mälestusi Tartu ülikoolist (17.–19. sajand). Ed. S. Issakov. Tallinn, 1986.

24. Залкинд Н. Г. (1974). Московская школа антропологов в развитии отечественной науки о человеке. Москва.

Address for correspondence:
Jaan Kasmel
Centre for Physical Anthropology
University of Tartu
Lossi 38, Tartu 51003
E-mail: jaanjkasmel@hot.ee

Papers on Anthropology XXI, 2012, pp. 137–146

COMPARATIVE ANALYSIS OF THE CENTRAL BODY FAT DISTRIBUTION OF WOMEN IN THE URBAN POPULATION IN LATVIA

DZINTRA KAŽOKA, JĀNIS VĒTRA

Institute of Anatomy and Anthropology, Riga Stradiņš University, Latvia

ABSTRACT

The aims of this study were to determine and compare the differences between the regional adiposity and some indexes of central body fat distribution of women according to age group categories in the urban population in Latvia. For this purpose 373 women were anthropometrically examined during the period 2001–2005. The body height, body weight, three circumferences (chest, waist, hip) and four skinfolds (biceps, triceps, subscapular, suprailiac) were measured. The four indexes were calculated and studied: the subscapular/triceps (STSR) skinfold ratio and the centripetal fat (CPFR) ratio, the waist-hip ratio (WHR) and the body mass index (BMI). In general, the age values showed an increasing of the central body fat distribution for women in the urban population. The associations of age with all the central body fat distribution indexes were significant. This study provided evidence that there is a significant positive trend of increased central body fat distribution with the increasing age of the women in the urban population in Latvia. Future studies should also investigate whether the same phenomenon exists for women in rural population in Latvia.

Key words: *anthropometric measurements, urban population, age, fat distribution*

INTRODUCTION

Changes in the body weight, the body composition, fat distribution, the relationships between anthropometric and laboratory characteristics have been studied very intensively [14]. The distribution of body fat are the complex traits, which are determined by a combination of genetic and environmental factors. A number of factors have been linked to the changes in the body weight, including age, gender and the socioeconomic status. Today it is estimated that some changes are more prevalent among the urban populations in comparison to the rural ones [9, 16].

The increase of the body fat content seems to be the most important steps to aging, and it is associated with the transition from the rural to the urban lifestyle. The urban lifestyle has been linked with intensive changes leading to the increased consumption of the high energy dense foods and decrease in physical activity. The trends of fat accumulation in the central region of the body with age could have serious health problems [6, 18].

The aims of the present study were: to determine and compare the differences between the regional adiposity and some indexes of the central body fat distribution of women according to the age group categories in the urban population in Latvia.

MATERIAL AND METHODS

This population study was conducted during the period 2001–2005. The sample of subjects consisted of 373 women aged 18–35 years. All the women were born in urban areas (seven largest cities) in Latvia. Each woman participated voluntarily and the data were used anonymously. In this study women were examined anthropometrically. All the anthropometric measurements were made by trained investigators according to the methodical recommendations by R. Martin and K. Saller [12], using the Swiss company's "Siber-Hegner and Co" anthropometric instruments. The body height, body weight, three circumferences (chest, waist, hip) and four skinfolds were measured. The body height and the body weight were measured to the nearest 0.1 cm and 0.5 kg, respectively, using Martin's anthropometer and the standard weight scale, respectively. The circumferences were measured to the nearest 0.1 cm using a tape measure. Four skinfolds namely, biceps (BSF), triceps (TSF), subscapular (SSF) and suprailiac (SISF) were measured to the nearest 0.2 mm using a skinfold calliper.

Paralelly four indexes were derived to study the central body fat distribution. The indexes were computed using the following formulas [2]:

Waist-hip ratio (WHR) = Waist circumference in cm / hip circumference in cm;

Subscapular-triceps skinfold ratio (STSR) = Subscapular skinfold in mm / triceps skinfold in mm; Centripetal fat ratio (CPFR) = Subscapular skinfold / (subscapular + triceps skinfold) x 100.

The body mass index (BMI) was computed using the following standard equation: BMI (kg/m^2) = weight (kg) / height (m^2) [21]. The women were classified as underweight (≤18.49), normal weight (18.5–24.99), overweight (25.0–29.99) and obese (≥30.0) according to the classification system recomended by the World Health Organization [22].

All the individuals have been categorized into three age group categories, i.e., Groups I, II and III. The individuals belonging to Group I, Group II and Group III were in the age categories of 18–20 years, 21–25 years and 26–35 years, respectively.

Data were entered on spreadsheets and performed using the SPSS for Windows, version 17.0. The distributions of the anthropometric variables and indexes were described by their minimum, maximum, means and standard deviations. To test any significant differences between age group categories, the analyses of variance were undertaken. Regression analyses were used to test significant associations between age and all the three central fat distribution indexes.

RESULTS

The means and standard deviations of age, anthropometric and indexes variables of all the women of the urban population are shown in Table 1. The mean age of women was 23.8 ± 1.5 years. The characteristics of the values (minimum and maximum) of the urban population by age group categories are presented in Table 2. The differences between the values for all the variables indicated great ranges for the measurements and indexes.

Table 1. Characteristics of the sample (n = 373)

Variables		m	SD
age, years		23.8	1.5
body height (cm)		165.6	6.4
body weight (kg)		59.9	9.7
BMI (kg/m^2)		21.8	3.1
circum-ferences (cm)	chest	83.4	18.7
	waist	68.2	7.2
	hip	93.4	7.6
skinfolds (mm)	biceps	6.9	2.5
	triceps	12.2	3.6
	subscapular	12.8	4.2
	suprailiac	13.5	4.7
central body fat distribution indexes	STSR	1.09	0.35
	CPFR	50.90	7.50
	WHR	0.73	0.05

n – number of women; m – mean; SD – standard deviation; STSR – subscapular/triceps skinfold ratio; CPFR – centripetal fat ratio; WHR – waist-hip ratio

Table 2. Minimum and maximum values for anthropometric variables of women according to age group categories in the urban population

		Group 1 (18–20) (n = 220)		Group 2 (21–25) (n = 111)		Group 3 (26–35) (n = 42)	
		min	max	min	max	min	max
body height (cm)		150.9	182.3	151.9	180.6	150.0	179.3
body weight (kg)		41.0	120.1	40.3	79.2	48.0	98.5
BMI (kg/m^2)		16.6	44.4	15.6	31.4	18.3	34.7
circum-ferences (cm)	chest	57.0	117.2	73.8	98.0	60.0	100.8
	waist	53.5	101.0	52.5	87.0	58.2	90.0
	hip	79.8	133.2	57.0	108.0	80.5	126.4
skinfolds (mm)	biceps	2.8	14.2	2.0	14.2	2.6	14.6
	triceps	4.2	25.6	5.2	22.0	6.0	26.0
	subs-capular	7.0	32.0	6.6	27.2	6.8	30.8
	suprailiac	6.0	36.0	5.8	30.0	6.6	27.8
central body fat distribution indexes	STSR	0.50	2.53	0.52	2.37	0.61	1.98
	CPFR	33.33	71.65	34.00	70.29	37.72	66.45
	WHR	0.63	0.84	0.64	1.14	0.63	0.89

n – number of women; min – minimum; max – maximum; STSR – subscapular/triceps skinfold ratio; CPFR – centripetal fat ratio; WHR – waist-hip ratio

The means, standard deviations and the results of the analysis of the variance of the anthropometric variables and indexes are given in Table 3. It is evident from this table that for all the three central body fat distribution indexes (STSR, CPFR, WHR) existed a significant increasing trend from Group I to Group III. As can be seen from the table, between the age group categories significant differences were observed in the mean values for: body height ($p<0.001$), body weight ($p<0.001$), all the three circumferences ($p<0.001$). Significant differences between age groups were found for all the four skinfolds ($p<0.001$) and for all the three indexes: STSR ($p<0.001$), CPFR ($p<0.001$) and WHR ($p<0.001$).

Table 3. Oneway analysis of variance of anthropometric characteristics of women by age group categories in the urban population

		Group 1 (18–20) (n = 220)		Group 2 (21–25) (n = 111)		Group 3 (26–35) (n = 42)		F value
		m	SD	m	SD	m	SD	
body height (cm)		166.6	6.6	165.5	6.0	164.6	6.6	8.557**
body weight (kg)		60.2	9.4	57.6	7.9	62.0	11.7	27.375**
BMI (kg/m^2)		21.6	3.0	21.0	2.6	22.8	3.7	51.241**
circum-ferences (cm)	chest	83.1	5.9	82.4	5.0	84.8	7.8	38.099**
	waist	67.0	6.6	66.2	6.5	71.4	8.6	62.201**
	hip	93.4	6.6	92.1	6.8	94.8	9.5	30.348**
skinfolds (mm)	biceps	6.8	2.3	6.7	2.2	7.1	2.9	9.986**
	triceps	12.5	3.8	11.5	3.0	12.7	3.9	10.308**
	subscapular	12.5	3.9	11.9	3.7	14.0	4.9	32.787**
	suprailiac	13.6	4.6	12.7	4.5	14.2	5.0	25.328**
central body fat distribution indexes	STSR	1.06	0.36	1.07	0.34	1.14	0.35	6.380**
	CPFR	50.07	7.87	50.55	7.39	52.07	7.25	6.207**
	WHR	0.72	0.04	0.72	0.06	0.75	0.06	36.389**

** $p<0.001$
m – mean; SD – standard deviation; STSR – subscapular/triceps skinfold ratio; CPFR – centripetal fat ratio; WHR – waist-hip ratio

The regression analyses of age with STSR, CPFR and WHR showed that age had significant associations with all the three indixes of the central body fat distribution (STSR, $p<0.001$; CPFR, $p<0.001$; WHR, $p<0.001$) (Table 4).

In this study population the mean BMI was 21.8 ± 3.1 kg/m^2. Women in Groups 1 and 2 had a lower BMI than the individuals in Group 3 (Table 3).

78.3% (n = 292) of the subjects were found to be of normal body weight and 9.7% (n = 36) of women were overweight, but the prevalence of underweight for all the women was 10.2% (n = 38), and the prevalence of obesity was only 1.8% (n = 7) (results not presented). Overall percentages of underweight, normal weight, overweight and obesity according to age groups categories are shown in Table 5.

Table 4. Regression analysis of age and central body fat distribution indexes of women in the urban population

Dependent variable	B	SEB	Beta	t	R^2
STSR	0.058	0.012	0.214	4.721**	0.046
CPFR	1.215	0.264	0.209	4.611**	0.044
WHR	0.020	0.002	0.473	11.577**	0.224

** $p<0.001$
STSR – subscapular/triceps skinfold ratio; CPFR – centripetal fat ratio; WHR – waist-hip ratio

Table 5. Prevalence of underweight, normal weight, overweight and obesity of women according to age group categories in the urban population

	Group 1 (18–20) (n = 220)		Group 2 (21–25) (n = 111)		Group 3 (26–35) (n = 42)	
	n	%	n	%	n	%
underweight (≤18.49)	19	8.7	16	14.5	3	7.1
normal weight (18.5–24.99)	177	80.8	85	77.3	30	71.4
overweight (25.0–29.99)	21	9.6	8	7.3	7	16.7
obesity (≥30.0)	3	0.9	2	0.9	2	4.8

n – number of women

Next, there were significant age group differences in the BMI and weight (results not presented).

Table 6 shows correlation coefficients of STSR, CPFR and WHR with the BMI and age. WHR showed the strongest significant ($p<0.01$) correlation with the BMI and age. CPFR and STSR were also found to be significantly correlated with the BMI ($r = 0.343$; $p<0.01$ and $r = 0.342$; $p<0.01$) and age ($r = 0.227$; $p<0.01$ and $r = 0.230$; $p<0.01$).

Table 6. Correlation coefficients of central body fat distribution indexes with the BMI and age

Variables	BMI	age
STSR	0.342*	0.230*
CPFR	0.343*	0.227*
WHR	0.505*	0.502*

* $p<0.01$
STSR – subscapular/triceps skinfold ratio; CPFR – centripetal fat ratio; WHR – waist-hip ratio

DISCUSSION

The use of anthropometric measures is one of the most common ways of assessing body composition. Of the methods used to measure body fat and its distributions, anthropometric measurements play an important role in clinical practice [11]. Many aspects of the theory and practice of human life need the anthropometric characteristics of the human body. This necessity determines the interest of the scientists of the 20th century and nowadays in the form and variations. During aging changes occur in the body proportion and structure. A numeric difference in many of the parameters can be found between the subsamples, as well as great intragroup differences, which determine the variability of the groups in terms of the evaluated characteristics [3].

Several factors, such as changes in lifestyle, feeding and stress increase, associated to the technological, economic and social advance over the last periods, led to an increase in body weight worldwide, representing public health problems [13]. Recent studies show the trend of obesity and abdominal obesity to be increasing, in both developed and developing countries [10].

The nature of excess body weight may be changing to one of greater central adiposity. Explanations for the upward trend in abdominal obesity in comparison with fewer changes in obesity may be related to the changes in health over time. Cardiovascular diseases and other diseases of civilisation have increased dramatically due to the changes in the lifestyle, and several studies have shown lifestyle factors to be associated with the body fat distribution [4, 15].

The present study investigated age-related trends of the central body fat distribution of 373 women aged 18–35 years in the urban population in Latvia. By analyzing the data for the anthropometric characteristics and indexes of the women, we can conclude that the great ranges of the differences between the minimum and maximum values for all the variables can be the result of the influence of outside factors, but also of great intra-group differences.

Significant differences were found in the mean values for all the anthropometric variables between the age group categories. In our sample fat distribution was determined thoroughly by four skinfolds, and the differences between the results increased with age.

Anthropometric indexes, such as the body mass index (BMI) and the waist-hip ratio (WHR), remain the most commonly used tools for assessing the body composition because of their simplicity and low cost. The body mass index (BMI) is a measure of overall adiposity, whereas, waist circumference (WC) and waist-hip ratio (WHR) are reliable proxy measures of abdominal fat [1, 2, 7]. In Latvia this was the first study of women in the urban population, to describe central body fat distribution including two new indexes, namely the subscapular/triceps skinfold ratio (STSR) and the centripetal fat ratio (CPFR). In general, the analysis of our data further demonstrated that age had significant positive association with all the three determined indexes of the central body fat distribution (STSR, CPFR and WHR). The correlation between the BMI and body weight was strong for women of all age groups. We found that WHR had a better correlation with the BMI as well as with age.

The changes related to gains in visceral or subcutaneous fat associated with aging may be affected by both the initial amount of fat and by the increases in body weight [8, 17]. These transformations occur differently in men and women, and genetic characteristics are the predisposition factors for fat centralization. Some authors in an analysis of fat distribution in women from different age groups by computerized tomography, showed that aging leads to the redistribution and internalization of abdominal fat [19].

There is a significant positive trend of increased central adiposity and fat distribution with increasing age in women in the urban population in Latvia. Our results support earlier studies showing that considerable differences are observed in the total and the regional body composition with age in women [5, 20].

The correct understanding of the trends of fat accumulation in the central regions of the body of women can limit serious health problems in different age groups in Latvia. In conclusion we propose that further studies are therefore needed to explain whether similar age-related trends of increasing the central body fat distribution are observed among women who were born in the rural areas in Latvia.

ACKNOWLEDGEMENTS

This study was undertaken as a part of investigation "Appreciation of biological status of women in Latvia". It was funded by the European Union Structural Funds for Scientific Research. In addition, acknowledgements are given to the following institutions: Riga Stradiņš University, the Institute of Anatomy and Anthropology, the Department of Anthropology and Physics Department. The authors wish to thank medical nurses of the anthropology unit for helping during anthropometric measurements of women.

REFERENCES

1. Bedogni G., Pietrobelli A., Heymsfield S. B., et al. (2001). Is body mass index a measure of adiposity in elderly women? Obes Res, 9 (1), 17–20.
2. Bose K. (2002). Age trends in adiposity and central fat distribution among adult white men resident in Peterborough, East Anglia, England. Coll Anthropol, 26, 179–186.
3. Bose K. (2001). The interaction of waist-hip ratio and Conicity index with subcutaneous adiposity in two ethnic groups: native British and migrant Pakistani men. Anthrop Anz, 59, 275–282.
4. Canoy D. (2008). Distribution of body fat and risk of coronary heart disease in men and women. Curr Opin Cardiol, 23, 591–598.
5. Davy K. P., Evans S. L., Stevenson E. T., et al. (1996). Adiposity and regional body fat distribution in physically active young and middle-aged women. Int J Obes, 20, 777–783.
6. Despress J. P. (2006). Intra-abdominal obesity: an untreated risk factor for type 2 diabetes and cardiovascular disease. J Endocrinol Invest, 29, 77–82.
7. Gill T., Chittlebourough C., Taylor A., et al. (2003). Body mass index, waist-hip ratio and waist circumference: which measure to classify obesity? Soz Preventive med, 48, 191–200.
8. Grabowski D. C., Ellis J. E. (2001). High body mass index does not predict mortality in older people: analysis of the longitudinal study of aging. J Am Geriatr Soc, 49, 968–979.
9. Janssen I., Shields M., Craig C. L., et al. (2011). Prevalence and secular changes in abdominal obesity in Canadian adolescents and adults, 1981 to 2007–2009. Obes Rev, 12, 397–405.
10. Kusuma Y. S., Babu B. V., Naidu J. M. (2008). Chronic energy deficiency in some low socio-economic populations from South India: relationship between body mass index, waist-hip ratio and Conicity index. Homo, 59, 67–79.
11. Lukaski H. C. (1987). Methods for the assessment of human body composition: Traditional and new. Am J Clin Nutr, 46, 537–556.

12. Martin R., Saller K. (1957). Lehrbuch der Anthropologie. Stuttgart, Fischer, Bd. I.
13. National Institutes of Health, National Heart, Lung and Blood Institute, North American Association for the Study of Obesity. (2000) The practical guide: identification, evaluation and treatment of overweight and obesity in adults. Bethesda, MD, NIH (NIH Publication no. 00–4084.)
14. Neovious M., Linne Y., Rossner S. (2005). BMI, waist circumference and waist-hip ratio as diagnostic tests for fatness in adolescents. Int J Obes, 29, 163–169.
15. Nicklas B. J., Penninx B. W., Cesari M., et al. (2004). Association of visceral adipose tissue with incident myocardial infarction in older men and women: the health, aging and body composition study. Am J Epidemiol, 160 (8), 741–749.
16. Olds T. S. (2009). One million skinfolds: secular trends in the fatness of young people 1951–2004. Eur J Clin Nutr, 63, 934–946.
17. Shimokata H., Tobin J. D., Muller D. C., et al. (1989). Studies in the distribution of body fat: I. Effects of age, sex and obesity. J Gerontol, 44, 66–73.
18. Vazquez G., Duval S., Jacobs D. R., et al. (2007). Comparison of body mass index, waist circumference, and waist/hip ratio in predicting incident diabetes: a meta-analysis. Epidemiol Rev, 29, 115–128.
19. Venkataramana P., Reddy P. C. (2002). Association of overall and abdominal adiposity with coronary heart disease factors: comparison between urban and rural men. Asia Pac J Clin Nutr, 11, 68–71.
20. Zamboni M., Armellini F., Harris T., et al. (1997). Effects of age on body fat distribution and cardiovascular risk factors in women. Am J Clin Nutr, 66 (1), 111–115.
21. World Health Organization (2000). Obesity: preventing and managing the global epidemic. Report on a WHO Consultation on Obesity, Geneva, World Health Organization.
22. World Health Organization (1995). Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee, Geneva, World Health Organization.

Address for correspondence:
Dzintra Kažoka
Institute of Anatomy and Anthropology
Riga Stradiņš University
Kronvalda blv. 9, Riga, LV-1010, Latvia
E-mail: Dzintra.Kazoka@rsu.lv

Papers on Anthropology XXI, 2012, pp. 147–154

FEMALE PELVIC TYPES AND AGE DIFFERENCES IN THEIR DISTRIBUTION

OKSANA KOLESOVA, JĀNIS VĒTRA

Institute of Anatomy and Anthropology, Riga Stradiņš University, Latvia

ABSTRACT

The aim of this study was a statistics-based exploration of a typology of the female pelvis. The research sample included 172 females aged from 18 to 69. For measurements, the three dimensional CT images of pelvis were used. A cluster analysis was performed on anteroposterion and transverse diameters of the pelvic inlet and the midplane. The results revealed three clusters representing gynecoid, "narrow", and intermediate types of female pelvis. The distribution of pelvic types in age groups indicates a tendency for the "narrow" pelvis to be presented more frequently in the group of younger females.

Variability and typology of the female pelvis is a traditional topic in anthropological studies [3, 4, 13, 17]. The best known classification of the female pelvis was suggested by Caldwell and Moloy in 1933 [3] and it was based on the pelvic inlet shape. In the frame of this classification, four main pelvic types were suggested: gynecoid, android, anthropoid, and platypelloid. The development of this classification resulted in the identification of the mixed types and subtypes based on the width of the pelvic outlet [3]. As a result, more than twenty subtypes were suggested that complicated their analytical implication. In addition, the critics of this classification addressed the subjective impression in the judgments of pelvic shapes without a well established statistical base [19].

A tendency of increase in cesarean section is observed in the last decades [2, 5, 9, 15]. In Latvia, the number of cesarean section delivery is growing from 3.9% in 1980 to 23.7% in 2010 [18]. A narrow pelvis is one of the factors increasing the risk for cesarean section [12]. On the one hand, there is a solution for the narrow pelvis problem from the obstetric perspective. On the other hand, a more detailed analysis is needed from the anthropological perspective because of possible evolutionary trends in the human body in general

and in the pelvic shape in particular. The aim of this study was a statistics-based exploration of a typology of the female pelvis.

A well recognized anthropological tendency of the last century is the secular trend in growth. Previous studies demonstrate an increase in the mean height about 1–2 cm per decade in different European countries [6, 8]. An investigation of external body parameters of Latvian women also demonstrated significant changes in the period of 70 years. The women's height increased for 6 cm, shoulder breadth increased for 0.6 cm, and the hip breadth increased for 2.9 cm [8]. Based on the relationship between the lesser pelvic parameters and height observed in previous studies [7, 11, 13], it is possible to expect that parameters of the lesser pelvis also changed during the last 6–7 decades.

It should be noted that the female pelvic cavity has a cylindrical shape with the narrowest place in the midplane between two ischial spines (the bispinous diameter). The obstetric importance of the pelvic inlet and the midplane was emphasized in anthropological studies [3, 4, 16, 17]. In a typical female pelvis, a longer diameter of the inlet (the transverse diameter) and a longer diameter of the midplane (the anteroposterior diameter) are placed perpendicularly. Therefore, a fetal head rotates from a transverse position in the pelvic inlet to a sagittal position in the midplane. A narrowing of the pelvic cavity in the midplane causes this rotation. Stalberg at al. [12] demonstrated that a narrow pelvic midplane is an important reason for the emergency cesarean section. In addition, an inadequate proportion of the pelvic inlet also causes cesarean section [1].

Therefore, both the pelvic inlet and the midplane are highly important from the anthropological perspective and need to be included in a statistics-based exploration of the female pelvic typology. Changing body parameters allow to expect age differences in a distribution of pelvic types between younger and older females. As a result, two research questions were posed for the present study:

1. What female pelvic types could be detected on the basis of the measures of the inlet and the midplane of the lesser pelvis?
2. How does the distribution of female pelvic types among age groups differ?

Key words: *pelvic typology, narrow pelvis, pelvimetry*

MATERIAL AND METHODS

The study was based on the archive data of the Department of Radiology, "Gailezers" Hospital, Latvia, in the period from October of 2009 to November of 2010. Archive data were available according to legal requirements. The

research sample included 172 females aged from 18 to 69 (the mean age=42.9, SD=14.7 years). For measurements, three dimensional CT images of pelves (performed on 1.25 mm slices) were used. Exclusion criteria were bones' fractures, osteoporosis, scoliosis, transitional vertebras, and polytraumas.

For each pelvis anteroposterion and the transverse diameters of the inlet and the midplane were measured:

(1) The anteroposterior diameter of the inlet – the distance between the posterosuperior border of the pubic simphysis and the promontory of the sacrum;
(2) The transverse diameter of the inlet – the widest distance between iliopectineal lines;
(3) The anteroposterior diameter of the midplane – the distance between the lower border of the pubic simphysis and the anterior point between the fourth and the fifth sacral vertebrae;
(4) The transverse diameter of the midplane (the bispinous diameter) – narrowest distance between two ischial spines.

RESULTS

In order to answer the first research question, a cluster analysis was performed on the pelvic measures of 172 females. Taking into account the exploratory nature of the study, the number of clusters was not specified before the analysis. The identification of clusters was based on TwoStep Cluster procedure in the IBM SPSS 19.0 program. Three clusters were suggested as the cluster solution. The average silhouette coefficient of cohesion and separation was 0.4 that indicates the acceptable level of cluster quality. Table 1 demonstrates the descriptive statistics of selected clusters.

Post-hoc pair comparisons (Tukey HSD) revealed significant differences between clusters. The anteroposterior diameter of the midplane and the transverse diameter of the inlet demonstrated significant differences among all the pairs of clusters. There were no differences on the bispinous diameter in Cluster 2 and Cluster 3. The anteroposterior diameter of the inlet was similar in Cluster 1 and Cluster 2.

Table 1. Descriptive statistics of three clusters based on the measures of the lesser female pelvis (n=172)

	Cluster 1 (n=51)	Cluster 2 (n=62)	Cluster 3 (n=59)
Measures (Importance)	Mean (SD), cm	Mean (SD), cm	Mean (SD), cm
Anteroposterior diameter of midplane (1,0)	12.0[a] (0.6)	13.1[b] (0.6)	11.7[c] (0.5)
Transverse diameter of inlet (0,88)	12.6[a] (0.5)	14.0[b] (0.7)	13.7[c] (0.6)
Bispinous diameter (0,79)	10.3[a] (0.6)	11.7[b] (0.9)	11.6[b] (0.5)
Anteroposterior diameter of inlet (0,21)	12.8[a] (0.9)	13.0[a] (0.8)	12.1[b] (1.0)

[a, b, c] Different letters indicate significant differences between clusters.

Cluster 1 has the lowest means of the pelvic midplane. For this cluster, both diameters of the inlet are near equal, the longer diameter of the midplane is the anteroposterior diameter, and the bispinous diameter is the smallest among three groups. Therefore, this cluster represents a "narrow" female pelvis with the inlet shape close to round. Cluster 2 has the highest means of the midplane and of the inlet. The longer diameter of the inlet is the transverse diameter, but the longer diameter of the midplane is the anteroposterior diameter. Having the anteroposterior diameter of the inlet similar to Cluster 1, Cluster 2 has a significantly "wider" inlet. The parameters of Cluster 3 are between of t Cluster 1 and Cluster 2. The longer diameter of the inlet was the transverse diameter, and both diameters of the midplane are near to be equal. Therefore, this cluster represents the female pelvis with the midplane shape close to round.

To answer the second research question, the observed occurrence of each pelvic type was detected in three age groups (18–25, 26–49, and 50–69). Table 2 represents the absolute and relative frequencies of clusters observed in each age group. The Chi-square test confirmed a tendency for pelvic types to be distributed differently in three groups, $\chi^2(4, N=172)=13.12$, $p<.05$.

Table 2. Distribution of female pelvic types within age groups

Age group	Cluster 1	Cluster 2	Cluster 3
18–25 (n=34)	17 (50%)	8 (24%)	9 (26%)
26–49 (n=74)	22 (30%)	31 (42%)	21 (28%)
50–69 (n=64)	12 (19%)	23 (36%)	29 (45%)

Further exploration of this tendency revealed a significant variation of Cluster 1 among age groups, $\chi^2(2, N=172)=10.39$, $p<.01$. The distributions of Cluster 2 and Cluster 3 were without significant differences, $\chi^2(2, N=172)=3.41$, $p=.18$ and $\chi^2(2, N=172)=5.52$, $p=.06$, respectively.

DISCUSSION

In general, the results of this study demonstrate a relatively simple classification of female pelvic types using parameters of the pelvic inlet and midplane. Three pelvic types were detected as statistically significant clusters, and their distribution among three age groups was tested. The most significant difference among age groups addresses the distribution of the "narrow" pelvis. As Caldwell and Moloy [3, 4] demonstrated, the pelvic type effects the biomechanics of labor and obstetric complications. Therefore, the observed differences should be discussed in greater details.

As it is observed, there is no agreement between the number of pelvic types in the present study and in the typology suggested by Caldwell and Moloy [3]. This finding is in accordance with the early critics of pelvic classification [19].

Cluster 1 represents a "narrow" female pelvis with the inlet diameters near to equal. According to Yong and Ince [19], these proportions of the inlet are similar to the pelvic inlet in males. Parameters of this cluster are similar to the pelvic diameters of the females who had the emergency cesarean section due to dystocia [12, 10]. Therefore, this cluster is potentially problematic from an obstetrical perspective.

Cluster 2 has the highest means of the midplane and of the inlet and has the wider transverse the oval inlet. It is presented in the 36% of the research sample (the most frequent pelvic type). According to Caldwell and Moloy, the female pelvis with a wide transverse oval inlet is a typical – gynecoid – female pelvis (about 40% of females). Females with this pelvic type usually do not have difficulties in labor [3, 4]. Therefore, Cluster 2 is near to the gynecoid type in the most known classification.

The inlet of Cluster 3 is similar to the gynecoid type, but equal parameters of the midplane indicate that the pelvis may have a narrow posterior segment of the midplane. This feature can negatively effect fetal passing through the pelvic midcavity and fetal rotation in the midplane.

It should be noted that the android pelvic type ("heart-shaped" inlet), the anthropoid type (longitudinal oval inlet with a longer anteroposterior dia-

meter), and the platypelloid type (the flattened pelvis) were not identified as independent types. A possible reason for this change is the inclusion of the pelvic midplane in the analysis. As the results demonstrated, the most important measure in the classification is the anteroposterior diameter of the midplane.

Testing of differences among age groups leads to a conclusion that the distribution of the "narrow" pelvis significantly differs in these groups. The "narrow" pelvis is observed more frequently in the younger age group (18–25), but less frequently in the older age group (50–69). Three points seem important for the explanation of observed differences.

First, according to the secular trend in growth confirmed in an earlier study in Latvia [8] and on a positive correlation between the anteroposterior diameter of the inlet and the stature [7], it is possible to expect that pelvic sizes in the younger group are larger, but in the older group, pelvic sizes might be smaller. However, the results of this study support the opposite view. Younger females have a narrow pelvis more often than older females. These results concur with a Tague's discussion on pelvic sizes of "big females" [13]. Tague concludes that a degree of correlation between the female's height and the pelvic size is low, and more important predictors of the pelvic size are clavicular length and the femoral head diameter.

Second, pelvic midplane parameters were added to the inlet parameters in the cluster analysis. The relationship between the pelvic midplane and the stature differs from the relationship between the pelvic inlet and the stature. The measures of the midplane area have significant negative partial correlation with femoral length [13]. In addition, the bispinous diameter has no correlation with height [11, 16]. Therefore, the females with a shorter stature can have a wider pelvic midplane and on the contrary.

Third, pelvic parameters are changing with age. The parameters of the pelvic inlet increase till 25 years [14]. Therefore, the parameters of the pelvic inlet can be larger in females over 25. This tendency of growth is in question for a further research focused on the pelvic type distribution and individual parameters' trajectories trough the age of 18–25.

An important limitation for this study concerns the research sample. The number of younger females in the age group under 26 is relatively small. It should be noted that the sample represents proportionally age distribution of the female population in Latvia. However, indications for the pelvic computer tomogrpahy are not applicable to the whole population. Therefore, a further study can be focused on a wider group of young females. Non-pelvic body

parameters can be included in the analysis. An additional dose of radiation needs to be taken into account during the CT investigation.

In summary, this study suggests a relatively easy pelvic typology based on the important measures of the lesser female pelvis. Three clusters represent gynecoid, "narrow", and intermediate types of female pelvis. The distribution of the identified pelvic types in age groups indicates a tendency for the "narrow" pelvis to be presented more frequently in the group of younger females.

REFERENCES

1. Adadevoh S. W. K., Hobbs C., Elkins T. E. (1989). The relation of the true conjugate to maternal height and obstetric performance in Ghanaians. Int J Gynecol Obstet, 28, 243–251.
2. Bregar A. T., Cerar V. M., Slavec Z. Z., Verdenik I. (2008). Indication for caesarean delivery between 1955 and 2005. Wien Klin Wochenschr, 120, 23–24, 761–765.
3. Caldwell W. E., Moloy H. C. (1933). Anatomical variation in the female pelvis and their effect in labor with a suggested classification. 58th Annual Meeting of the American Gynecological Society, 479–504.
4. Caldwell W. E., Moloy H. C. (1938). Anatomical variations in female pelvis: their classification and obstetrical significance. Proceeding of the royal society of medicine, 32, 1, 1–30.
5. Eskew P. N. J., Saywell R. M. J., Zollinger T. W., Erner B. K., Oser T. L. (1994). Trend in the frequency of cesarean delivery. A 21-year experience, 1970–1990. J Reprod Med, 39, 10, 809–817.
6. Gohlke B., Woelfle J. (2009). Growth and puberty in German children. Deutsches Ärzteblatt International, 106, 23, 377–382.
7. Holland E. L., Cran G. W., Elwood J. H., Pinnkerton J. H. M., Thompson W. (1982). Associations between pelvic anatomy, height and year of birth of men and women in Belfast. Annals of human biology, 9, 2, 113–120.
8. Kažoka D., Vētra J. (2008). Secular trends in basic body transversal parameters in adult Latvian women between 1929–1930 and 2001–2005. Papers on Anthropology, 17, 158–168.
9. Krychowska A., Kosinska K., Karwan-Plonska A. (2004). Comparison of indication for cesarean section in 1985–86 and 2000–01. Analysis of changes. Ginekol Pol, 75, 12, 926–931.
10. Lenhard M. S., Johnson T. R. C., Weckback S., Friese K., Hasbargen U. (2010). Pelvimetry revisited: Analyzing cephalopelvic disproportion. Europien Journal of Radiology, 74, 107–111.

11. Ridgeway B., Arias B. E., Barber M. D. (2011). The relationship between anthropometric measurements and the bony pelvis in African American and European American women. Int Urogunecol J, 22, 1019–1024.
12. Stalberg K., Bodestedt A., Lyrenas S., Axelsson O. (2006). A narrow pelvic outlet increases the risk for emergency cesarean section. Acta Obstetrica et Gynecologyca, 85, 821–824.
13. Tague R. G. (2000). Do big females have big pelves? American Journal of physical anthropology, 112, 377–393.
14. Tague R. G. (2011). Fusion of coccyx to sacrum in humans: prevalence, correlates, and effect on pelvic size, with obstetrical and evolutionary implications. American Journal of Physical Anthropology, 145, 426–437.
15. Tampakoudis P., Assimakopoulos E., Grimbizis G., Zafrakas M., Tampakoudis G., Mantalenakis S., Bontis J. (2004). Cesarean section rates and indications in Greece: data from a 24-year period in a teaching hospital. Clin Exp Obstet Gynecol. 31, 4, 289–292.
16. Walrath D. E., Glantz M. M. (1996). Sexual dimorphism in the pelvic midplane and its relationship to Neandertal reproductive patterns. American Journal of Physical Anthropology, 100, 89–100.
17. Walrath D. (2003). Rethinking pelvic typologies and the human birth mechanism. Current Anthropology, 44, 1, 5–30.
18. WHO/Europe, European HFA Database. Caesarean section per 1000 live births in Latvia (Line chart), June 2012// http://data.euro.who.int/hfadb/linecharts/linechart.php?w=1024&h=600
19. Young M., Ince J. G. H. (1940). A radiographic comparison of the male and female pelvis. Journal of Anatomy, 74, 3, 374–385.

Address for correspondence:
Oksana Kolesova
Institute of Anatomy and Anthropology
Riga Stradiņš University
16 Dzirciema Street, LV-1007, Riga, Latvia
Postal address: Lacplesa iela, 43/45-10, Riga, LV-1011, Latvia
E-mail: oksana-kolesova@inbox.lv

Papers on Anthropology XXI, 2012, pp. 155–162

SPORTS ANTHROPOLOGICAL COMPARISON BETWEEN MALE MARTIAL ARTS FIGHTERS AND THE STUDENTS MAJORING IN PHYSICAL EDUCATION

CHRISTOPH KRICK, CHRISTOPH RASCHKA

Institute of Sports Science, Julius-Maximilians-University Würzburg, Germany

ABSTRACT

The goal of the present study is to present the differences in the body composition of male Muay Thai fighters and the students majoring in physical education. The students majoring in physical education served as a control group.

The two groups (Muay Thai fighters and the students majoring in physical education) were divided into four groups: Experienced Muay Thai fighters and less experienced Muay Thai fighters as well as experienced students majoring in physical education and less experienced students majoring in physical education. The definition for "experienced" has been used when someone was engaged in sports longer than 10 hours a week.

All the measurements of this study have been taken under the standardized measurement procedure by the author of this study. The results have been statistically analyzed with the program SPSS.

The study shows that the experienced Muay Thai fighters are significantly smaller (the average body height of 177. 2 cm) than the experienced students majoring in physical education (the average body height 184.1).

Other data in the study which used the methods developed by Conrad, Knussmann, Parnell and Heath and Carter show that, while the experienced Muay Thai fighters are significantly smaller than the other participants, they are nonetheless better trained (more muscle tissue) than their counterparts.

Key words: *Sports anthropology, Muay Thai, Martial Arts, Body Composition, Somatotype.*

INTRODUCTION

Muay Thai is a martial arts discipline that has existed for more than 2000 years. This form of martial arts has its origins in southern China. It was practiced by the Ao Lei tribes. In fact, the Ao Lei tribes brought this type of martial arts to Siam (Thailand).

Until the year 1920 Muay Thai was a part of the school curricula in Thailand. Even though it is not an integral part anymore, Muay Thai remains the nation's traditional and most practiced type of martial arts. During the last decade Muay Thai has become popular among Westerners. In the USA and Europe there is much interest shown in this sport.

Muay Thai is a martial arts sport which requires great physical condition. Muay Thai allows punches and kicks. Therefore one can assume that the trained muscle tissue is of essence in order to be able to win a tournament.

This study is aimed at analyzing whether the body composition of the experienced Muay Thai fighters shows any specifics that could lead to the assessment that their body composition makes them more successful in tournaments.

The participants in the study

In this study 70 people participated. All the participants were males and at least 16 years of age. The average age of the participants is 24 years.

30 male participants in this study go in for Muay Thai. 40 male participants are the students majoring in physical education. These two groups were divided into two sub-groups; that means into experienced and less experienced sportsmen. The definition of experienced in this study is based on the number of hours a participant actively trained during the week. All the participants who trained less than ten hours a week were defined as less experienced. Those who trained more than ten hours a week were defined as experienced.

All the participants in this study lived in the Rhine-Main area in Germany where the measurements took place.

Anthropometric measurements

The Body Mass Index of the participants in this study shows that the experienced Muay Thai fighters had the highest values. The result is seen in Table 1.

Table 1. Body Mass Index (in kg/m²)

participants	experience	mean	n	Standard Deviation	Standard Error
students	unexperienced	24.64	15	2.25	0.58
	experienced	24.39	25	2.15	0.43
	all	24.48	40	2.16	0.34
Muay Thai fighters	unexperienced	24.04	15	2.10	0.54
	experienced	26.34	15	2.81	0.72
	all	25.19	30	2.70	0.49
all	unexperienced	24.34	30	2.16	0.39
	experienced	25.12	40	2.57	0.40
	all	24.79	70	2.42	0.28

Other results concerning the somatotype of the different participants are based on the methods created by Conrad, Knussmann, Parnell and Heath and Carter.

Parnell

The results of the somatochart based on the method of Parnell show that the experienced as well as the less experienced Muay Thai fighters are found mainly around the 4-4-4. However, the experienced Muay Thai fighters tend to have a more meso-ectomorphic body composition than the less experienced ones. (Figure 2)

The somatotypes of the students majoring in physical education (Figure 1) tend to be found more in the endomorph- ectomorph region.

Conrad

The majority of the experienced Muay Thai fighters show a trend to pycnomorphy in Figure 6 whereas the rest of the participants (students and less experienced Muay Thai fighters (shown in Figures 3–5) show a balance between pycnomorphy and leptomorphy. All the participants are dominant in the hyperplastic region.

Tittel and wutscherk

The AKS- Index was used in the present study in order to determine the lean body substance of the different athletes. The results shown in Table 2 show that the Muay Thai fighters had a slightly higher AKS- Index than the students.

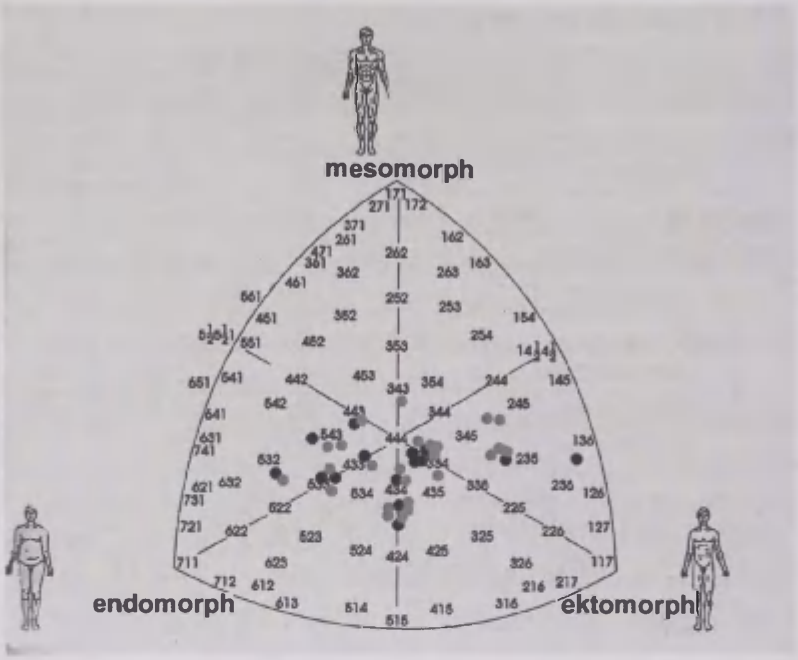


Figure 1. Somatochart according to the Parnell's method. The black dots represent the inexperienced students, the grey dots represent the experienced ones.

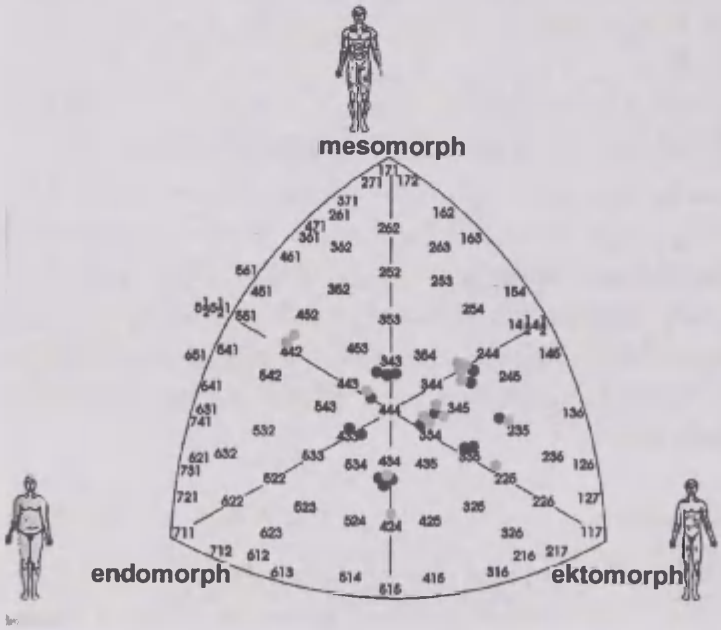


Figure 2. Somatochart according to the Parnell's method. The black dots represent the inexperienced Muay Thai fighters, the grey dots represent the experienced ones.

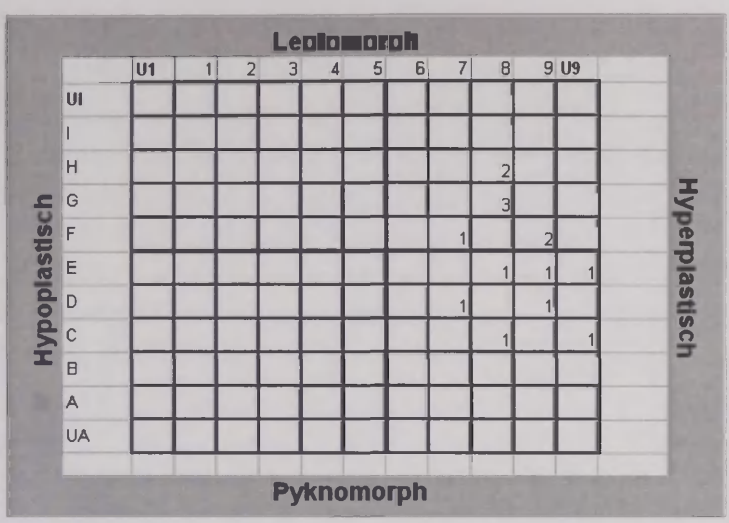


Figure 3. Conrad's chessboard sample: Inexperienced students

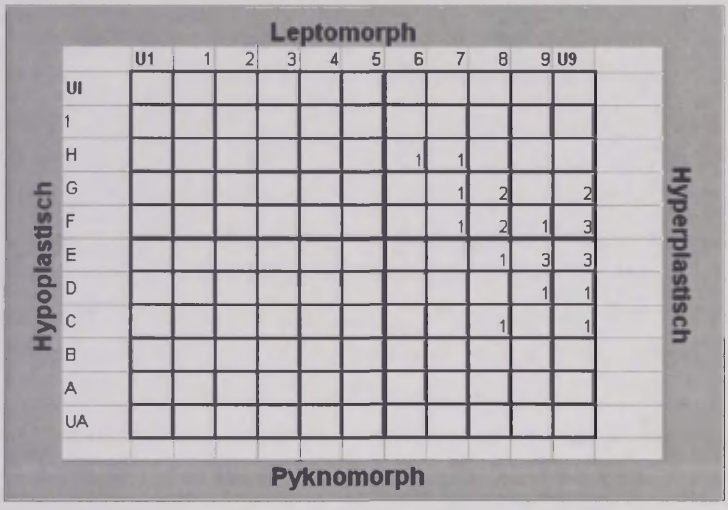


Figure 4. Conrad's chessboard sample: Experienced students

Figure 5. Conrad's chessboard sample: Inexperienced Muay Thai fighters

Figure 6. Conrad's chessboard sample: Experienced Muay Thai fighters

Table 2. AKS- Index according to Tittel and Wutscherk

AKS Index	
students	
unexperienced	**1.04**
experienced	**1.05**
Muay Thai fighters	
unexperienced	**1.09**
experienced	**1.16**

DISCUSSION

The results of the present study show that significant differences between the participants are given. While the majority of the students showed a great body height, the Muay Thai fighters were smaller. While the experienced students of physical education showed the highest value in body height with 184.1 cm, the experienced Muay Thai fighters showed the lowest value in the height with the average of 177.2 cm. It is interesting to note that comparing the body height of the participants of this study with the body height of fighters of the Superleague (2010), the fighters of the Superleague had the average body height of 190.2 cm. This is significantly higher.

Although the experienced Muay Thai fighters were the smallest among the participants, their chest girth was the biggest with the average of 97.8 cm compared to the chest girth of the experienced students which had the average chest girth of 94.4 cm.

The results achieved by the help of CONRAD'S method also show that the students' body composition tends to be between pycnomorphy and leptomorphy. Almost all the participants, however, demonstrated an hyperplastic tendency. The experienced Muay Thai fighters, however, show a greater tendency towards pycnomorphy.

Concerning the body weight, it is interesting to point out that the experienced students as well as the experienced Muay Thai fighters had the same average body weight. When regarding that the students in general were bigger than the Muay Thai fighters one could easily assume that the Muay Thai fighters have more body fat. This, however, was not the case. As the AKS-Index shows and the results by the Parnell's method: the Muay Thai fighers, especially the experienced ones had more muscle tissue while being significantly smaller. Comparing the AKS- Index with experienced Karate fighters shows that the experienced Muay Thai fighters had the same AKS- Index number of 1.16. The inexperienced Muay Thai fighters, as well as less experienced Karate fighters, show similar results of 1.09 versus 1.05.

CONCLUSION

The results show clearly significant differences in the body composition between the experienced students of physical education and experienced Muay Thai fighters. For a martial art fighter the smaller size can be of advantage due to being able to move more quickly, being able to avoid punches and kicks. However being smaller, results in smaller extremities such as arms and legs,

which makes it more difficult to reach the opponent. In this study the experienced Muay Thai fighters showed to have more muscle tissue than the students and were in general better trained. This fact can to a certain point be of advantage since punches and kicks can be made faster and harder.

REFERENCES

1. Bös K., Hänsel F., Schott N. (2004). Empirische Untersuchungen in der Sportwissenschaft. Hamburg, Czwalina.
2. Conrad K. (1963). Der Konstitutionstypus. Berlin, Göttingen, Heidelberg, Springer Verlag.
3. Fritsche J. (2006). Sportanthropometrische Untersuchungen zu Konstitutionstypologie von Kampfkünstlern der Sportart Karate. Frankfurt: Goethe Universität.
4. Martin R., Saller K. (1957). Lehrbuch der Anthropologie, 3. Auflage. Stuttgart: Gustav Fischer.
5. Moore K. (2008). Muay Thai. The Essential Guide to the Art of Thai Boxing. Johannesburg, Hirt und Carter.
6. Parizkova J., Buzkova P. (1971). Realtionship between skinfold thickness measured by Harpenden Caliper and densitometric analysis of total body fat in men. A methodical contribution to the international Biological Program. Human Biology, 43, 16–21.
7. Parnell R. W. (1958). Behaviour and physique. London, Arnold.
8. Raschka C. (2006). Sportanthropologie. Köln, Sportverlag Strauß.
9. Statistisches Bundesamt (2003). Mikrozensus 2003. Körperhöhe der Bevölkerung. Wiesbaden.
10. Statistisches Bundesamt (2009). Mikrozensus 2009. Körperhöhe der Bevölkerung. Wiesbaden.
11. Tittel K., Wutscherk H. (1972). Sportanthropometrie: Aufgaben, Bedeutung, Methodik und Ergebnisse biotypologischer Erhebungen. Barth.

Address for correspondence:
Priv.-Doz. Dr.med. Dr.rer.nat. Dr. Sportwiss. Cristoph Raschka
Institute of Sports Sciences
Julius-Maximilians-University Würzburg
Judenbühlweg 11. D-97082 Würzburg, Germany
E-mail: christoph.raschca@uni-wuerzburg.de

Papers on Anthropology XXI, 2012, pp. 163–175

DIETARY BEHAVIOUR OF STUDENTS FROM POZNAN UNIVERSITIES

IDA LAUDANSKA-KRZEMINSKA

Department of Health Education,
University School of Physical Education, Poland

ABSTRACT

The problem raised in the study relates to the eating habits of students and their relations with the body mass index (BMI). The effect of selected socio-demographic variables (sex, place of residence, material status, field of study) on eating habits of the respondents was also analysed. The structure of the Dietary Behaviour Index (DBI) was proposed and its relations to the BMI were established.

Material and methods. The study covered 508 students of state and private universities in Poznań (Poland) of whom 73% were female and 27% male. The study used an anonymous questionnaire poll on the basic dietary habits developed on the basis of the Food Pyramid guidelines as well as the Golden Charter of Correct Nutrition. The BMI was calculated on the students' self-reported weight and height.

Results. 15% of the participating students are overweight or obese. The distribution of the BMI differs between men and women ($p<.000$). Particularly unfavourable behaviour was noted in terms of the consumption of legumes (72% of respondents), fish (53%), dairy products (36%), vegetables (29%) and fruit (27%). Beneficial trends relate to the everyday consumption of breakfast (63%), the number of meals per day (59%), limiting the consumption of red meat (59%), including vegetable fats in the daily diet (56%). The differences in the way of eating described by the DBI is related to the field of study ($p<.001$) as physical education students had the best indicators.

Conclusions. In the studied group of students overweight and obesity are not as frequent as in other countries of Western Europe or America. We noted a number of dietary mistakes made by the respondents, which can lead to adverse health consequences in the future. During the university studies, not

only in the fields related to health, information promoting pro-health lifestyle should appear more often.

Key words: *dietary behaviour, eating patterns, students, Poland, BMI*

INTRODUCTION

Dietary behaviour is one of the most significant risk factors of civilisation-related diseases [12]. The health effects of dietary mistakes such as cancers, type 2 diabetes, hypertension or obesity do not appear immediately, thus it is particularly important to monitor the dietary behaviour of young people [3, 5, 10]. A person, also a young person, faces the need to reconcile health recommendations of specialists on the one hand, and his or her own culinary preferences on the other hand. Unfortunately, often it is not easy and a careful search for a compromise is needed. A correct diet involves following many various recommendations and their relations to health and disease are the subjects of numerous scientific reports [7, 18, 19].

From the point of view of public health it is important to formulate relatively easy dietary tips and recommendations, which are also simple to communicate. The best known and popular dietary guidelines for healthy adults are presented in the so-called food pyramids [2, 21]. In Poland we also refer to the document called the Golden Charter of Correct Nutrition signed by several dozens of medical organisations involved in the promotion of appropriate nutrition of sick people, people at a risk of diseases and healthy people [23]. As we know, dietary recommendations evolved in the last few decades, therefore many people oppose the new, better guidelines from specialists, in order to justify their own bad eating habits. At the same time, it is not often that we encounter a person who follows a completely healthy diet. Therefore, attempts are made to indicate the recommendations which are most important for health and to categorise the behaviour of respondents indicating whether the presented diet is beneficial for health or not. The current study joins this discussion.

The study raises the problem of dietary habits of students of Poznan universities and the relation of these habits to the Body Mass Index (BMI). An attempt was also made to categorise the diets of students on the basis of the analysed dietary behaviour. The following questions were asked in this report: Do students in the city of Poznan follow the healthy dietary style and to what extent? Is it related to socio-demographic variables which characterise the

respondents? What are the most common dietary mistakes? What is the least difficult in terms of the diet of the respondents? Is healthy eating related to a better body mass index of the respondents?

MATERIAL AND METHODS

The study used the method of a diagnostic survey and the technique of anonymous questionnaire poll. The results are a part of a wider study of health-related behaviour of the student population of the Wielkopolska Province in Poland. The study was carried out in April and May 2011. The study included 508 students from Poznan state universities (University School of Physical Education, Adam Mickiewicz University, Poznan University of Technology, Medical University) and private universities (the Academy of Hotel Management and Catering Industry, Wielkopolska Higher School of Tourism and Management, Poznan Trade and Commerce College). The stratification of the respondents was presented in Table 1.

Table 1. Socio-demographic status of the studied group of respondents

	Number (n)	Percentage (%)
Women	372	73
Men	136	24
Full-Time Students	396	78
Extramural Students	112	22
Living With Parents	240	47
Living With Their Own Family	36	7
Living On Their Own	232	46
Material Status: Low	16	3
Material Status: Average	170	34
Material Status: Good	271	53
Material Status: Very Good	51	10

The questionnaire used in the study contained 12 questions about strategic habits making up the pattern of dietary behaviour. The questions related to: the frequency of meals, eating breakfast daily and the frequency of eating selected foods, important for health (wholegrain products, vegetables, fruit, milk and dairy products, legumes, red meat, poultry, fish, vegetable fats, water and natural juices). The responses were classified into three groups according to

the guidelines of the Food Pyramid and the Golden Charter of Correct Nutrition: positive (3 points), moderate (2 points), negative (1 point). Then the classification of the diet pattern of the participating students was made depending on the number of the points scored (the minimal number of points 12 – all the habits negative, and the maximum number 36 – all the habits positive). The reference point was the arithmetic mean of 12 questions. If it was less then a 2 points, such a diet model was considered negative, from 2 to 2.5 – it was moderate, and 2.5 or more – positive.

The study also used the body mass index (BMI) calculated on the students' self-reported weight and height. The classification used was based on the WHO recommendations [14].

The statistical analyses were carried out with Statistica (Version 9) software using non-parametric Mann-Whitney and Kruskal-Wallis tests; also the Spearman's rank correlation and the tau Kendalla correlation were calculated and percentages were calculated.

RESULTS

In the studied group of respondents the problem of obesity and overweight applies to approx. 15% of the people. Table 2 presents the frequency of occurrence of individual BMI categories in the studied group of students. Women are significantly more often underweight ($p<.000$) than men (13% of female respondents compared to 0% of men). Out of the analyzed socio-demographic variables, describing the respondents, only the current place of residence differentiates the status of nutrition of the subjects ($p<.01$). Problems with obesity or overweight are more frequent in the students who have started their own families. Living with one's parents or on one's own resources in a rented room or in the students' dormitory has a kind of protective property in this respect. The material status of respondents, parents' education and the field of study were not related to the differences in terms of incorrect values of the BMI in the subjects.

Table 2. The BMI and the sex of the respondents

	BMI categories							
	Underweight (<18.5)		Normal (18.5–24,9)		Overweight (25–29.9)		obese (≥30)	
	n	%	n	%	n	%	n	%
Women	48	14	264	75	29	8	13	4
Men	–	–	101	75	26	20	7	5
All	48	10	365	75	55	11	20	4

In the present study 12 dietary habits were analyzed. The respondents were asked to indicate the number of meals they have per day, as well as provide information on how often they eat breakfast and the frequency of eating the foods important for the health: wholegrain products, vegetables, fruit, milk and dairy products, red meat, poultry, fish, vegetable fats, legumes, water and natural juices. Figure 1 shows how often the students eat breakfast depending on the sex and the BMI of the respondents.

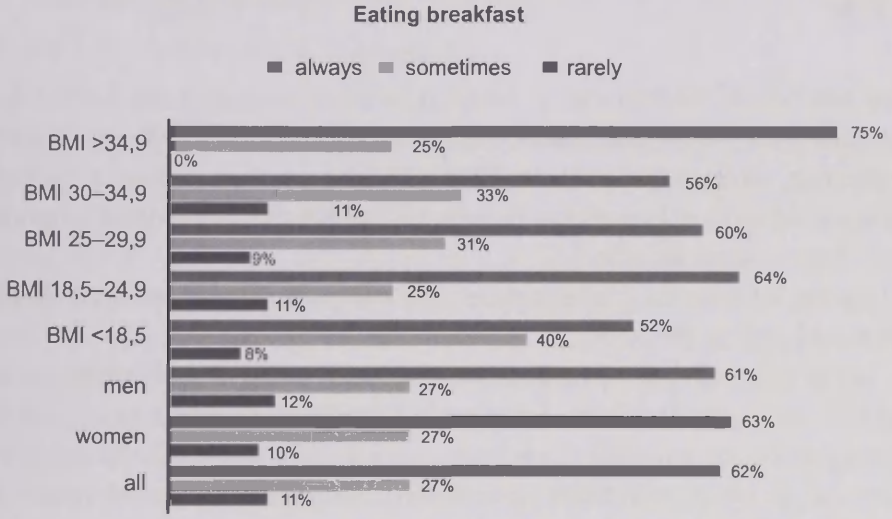


Figure 1. The frequency of eating breakfast by respondents depending on their sex and the BMI (%)

The majority of the students usually eat breakfast and no statistically significant differences were noted between men and women. The BMI also is not differentiated by this selected habit.

Figure 2 presents the number of meals consumed by the respondents depending on the sex and the BMI.

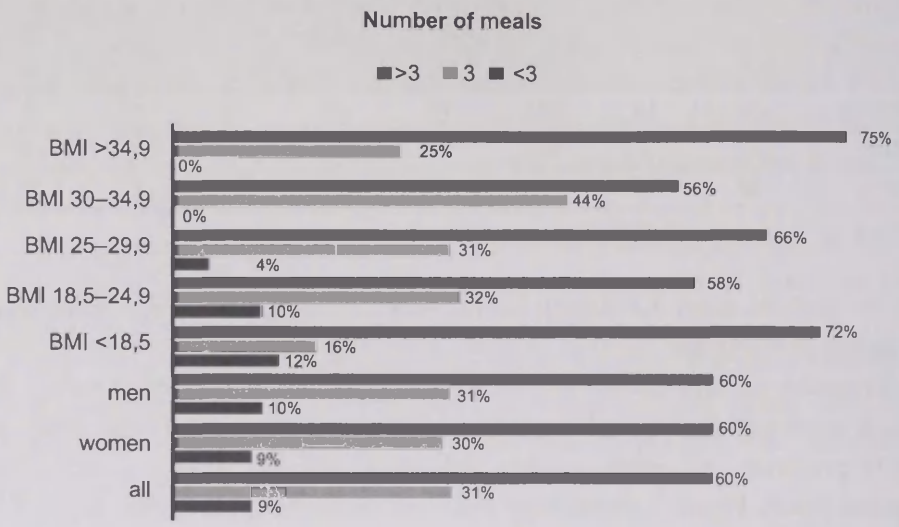


Figure 2. Number of meals consumed by students per day depending on the sex and the BMI (%)

The majority of students eat, as recommended, more than three meals a day. No difference was noted between men and women in this respect. What is interesting, underweight students (BMI<18.5) most often represent the most beneficial behaviour (more than three meals) and the least beneficial behaviour (less than three meals a day).

Figure 3 shows the percentages of the respondents who consume certain foods with certain frequency.

Let us follow the consumption of individual foods and their relations with the BMI and individual socio-demographic variables (Table 3). Less than half of the participants eat daily wholegrain products such as bread, rolls and pasta. They still do not constitute the basis of the students' diets, in spite of generally available knowledge and many advertising campaigns about it. Everyday consumption of fruit and vegetables (including frozen fruit and vegetables) looks even worse. Approximately 30% of respondents eat them every day, and only some (1–3%) a few times a day. Women eat fruit slightly more often ($p<.05$). As it turns out, the current place of residence has a great impact on the amount of fruit consumed by young people ($p<.01$), the most being eaten by

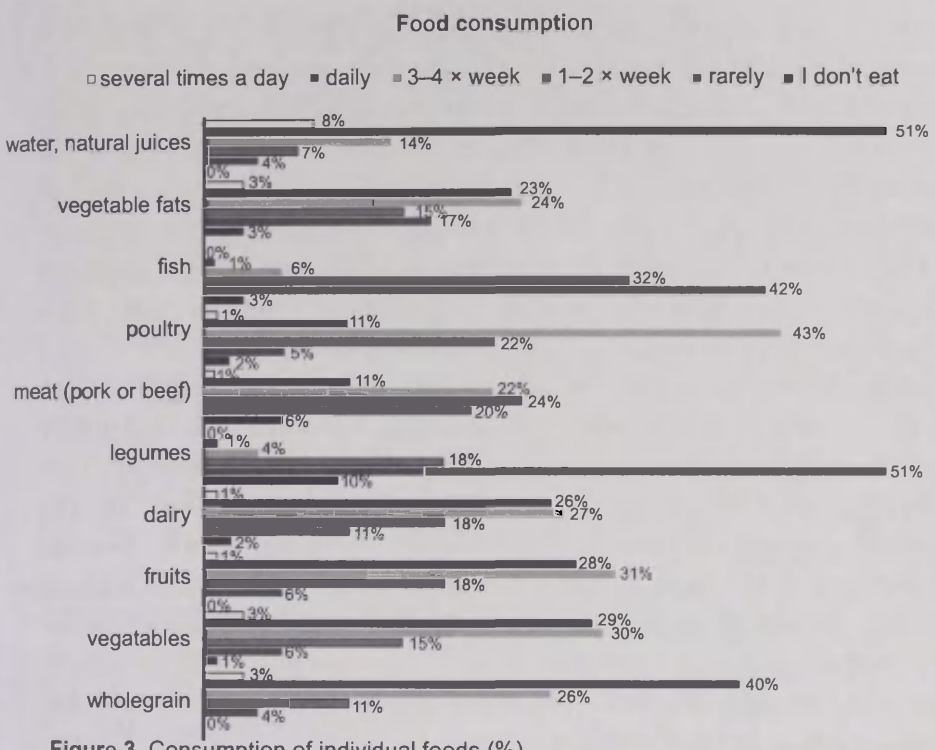


Figure 3. Consumption of individual foods (%)

those living with their own family, much less by those living with their parents, and the least by those living on their own in a students' dormitory or in a rented room – as it seems they would be most independent of their families. The consumption of fruit is also related to the field of study of the participants ($p<.01$). Physical education students eat most fruit, followed by medical students. The cosmetology students eat fruit least often. The majority of the respondents do not follow the dietary recommendations which probably will have a great impact on the health of future elites. The consumption of dairy products (milk, cheese, yoghurt) is similar. Less than 30% of the subjects follow the recommendations to eat them every day. The majority of subjects, as it seems, already at their young age contribute to many health consequences resulting from an insufficient supply of calcium and other important nutrients contained in dairy products (e.g. protein in the form of low-calorie dairy products). We also notice the effect of the field of study on the rationalisation of students' diets in this respect ($p<.001$). Again, it is physical education students who most often follow the recommendations, followed by social science students. Medicine students eat dairy products least often. The questioned students also avoid eating vegetable sources of proteins such as

legumes (e.g. soy, beans, peas). Most of them eat them seldom or never, and men eat them slightly more often ($p<.05$). Similarly, students of various fields of study differ in their preferences in this respect ($p<.001$). Social science and medical students eat legumes least often. As we know, legumes should be eaten as a substitute of animal sources of protein, in particular fat rich meats, once or twice a week. The data indicate that this is not a general practice among students.

Fish consumption is slightly better. Approximately 40% of respondents eat fish once or twice a week or more often. This is still an insufficient percentage, in particular taking into account many advertising campaigns in Poland and a tradition of many generations, which involves having meat-free meals, often fish meals, every Friday. Students of tourism and recreation and cosmetology students eat fish least often ($p<.01$). In terms of meat consumption we noted that poultry is on the menu more often than red mead (pork, beef). This is a beneficial and welcome direction of changes. We noted a more frequent consumption of red meat by male students as compared to female students ($p<.001$). Water and natural juices are in the daily diet of the majority of the subjects, but significantly more often in men's diets ($p<.001$) and least often in diets of the students of social sciences ($p<.01$). Unfortunately, vegetable fats are not a popular addition to everyday diet.

In the current study 12 dietary habits were analyzed. The study described also correlations (the Spearman's rank correlation or the Kendall's tau) of the DBI with certain dietary habits which it is made up of (Table 3). The correlations ranged from 0.07 to 0.61. The correlation of red meat and poultry consumption with the indicator was the lowest.

In the next stage of analysis an attempt was made to classify the diets of students taking into account the 12 habits above. This was done on the basis of the value of the arithmetic mean. Three categories of dietary behaviour patterns were obtained: negative, moderate, positive. Taking into account the number of statistically significant relations between individual habits making up the DBI and the BMI and socio-demographic variables (Table 3), it was expected that only statistically significant differences for the DBI in respect of the field of study of the respondents will be obtained. Such a relation was obtained ($p<.001$). According to the DBI – 22% of respondents present negative eating habits, 55% – moderate and 23% of them – positive habits.

Table 3. Significance of the relations of the studied dietary habits with sex, the BMI and the socio-demographic situation (the Mann-Whitney test or the Kruskal-Wallis test)

	p-value				r
	Sex	BMI	Place of residence	Field of study	DBI
Number of meals	,94	,541	,061	**,001**	,29***
Frequency of eating breakfast	,860	,882	,195	**,016**	,38***
Wholegrain products	,661	,441	,904	,72	,39***
Vegetables	,383	,061	,411	,156	,61***
Fruit	**,027**	,482	**,022**	**,003**	,52***
Dairy products	,252	,115	,818	**,001**	,42***
Legumes	**,012**	,705	,78	**,001**	,45***
Red meat	**,000**	,212	,261	,098	,12**
Poultry	.023	**,020**	,587	,528	,08 (,07*)
Fish	,461	,077	,458	**,012**	,41***
Vegetable fats	,164	,869	,628	,337	,28***
Water and natural juices	**,001**	,505	**,039**	**,001**	,36***

p – value – bold p<.05;
r – Spearman rank correlation or Kendall's tau correlation
* – p<.05; ** – p<.001; ***p<.001

DISCUSSION

Dietary habits of the questioned students were analysed both from the point of view of the frequency of consumption of individual products and in terms of generalisation in the form of the DBI. The assessment of basic dietary habits of students showed both positive trends and a number of mistakes. The assessment of the nutrition using the Body Mass Index showed a large percentage of people with incorrect weight – 15% above the normal weight and 10% below the normal weight. These indicators are lower than those noted for American students, where approx. 35% of respondents are overweight or obese [17] or students from Croatia – 23% [4].

The majority of respondents follow the recommendations relating to an optimum number of meals per day. Similarly, in an all-Poland survey carried out by the CBOS (Public Opinion Research Centre) positive habits of Poles in this respect have been noted for more than 10 years [13, 22]. Similarly, the majority of students of a medical university and a physical education university in the study of Duda, consume three or more meals a day [6]. Eighty percent of people declared eating breakfast every day in an all-Poland survey. In the

studied group of students this important element is present in the daily routine of 62% of respondents. Students often have an irregular cycle of work (study) and rest, which does not favour the regularity of eating meals and may also affect such differences in comparison to the population in general.

One of the more important dietary mistakes made by the studied students is infrequent eating of fruit and vegetables. Only 37% of adult Poles eat vegetables every day and in the studied group only 32% of respondents do it. Everyday consumption of fruit is even lower (less than 30% of the studied students). As the surveys of CBOS show, the falling trend in the consumption of fruit and vegetables has been seen in Poland for 10 years [22]. This may probably be caused by the fact that fruit and vegetables are the most expensive foods. In the case of our respondents, who are beginning their career, and who often have to pay for their studies, it is an important obstacle on the way to their consumption. The problem of low consumption of fruit and vegetables is noted in the group of students in various countries [1, 11]. Attempts are made to indicate various ways to increase the interest of young people in these products, and the most important are better prices, more availability, increase in varieties, ready-to-eat packs [20]. Similar reasons may be obstacles for an increase in the consumption of complex carbohydrates. They definitely appear too seldom in the diets of students and less than half of students eat them often enough.

An even smaller number of respondents regularly eat dairy products. This is even more worrying as the percentages noted in the current study are lower than in the population of adult Poles, of whom 44% do not eat products of this type every day [22]. The dietary recommendations for healthy adults recognise the advantages of consumption of fermented milk and its products. Taking into account the fact that 5–40% of inhabitants of Poland display intolerance of cow's milk protein [8, 16], this element of diet should be promoted and implemented in diets. In the studied group 27% follow this recommendation daily.

Information about health advantages of eating fish is generally available in the media and popular magazines. Sea fish are indicated as an extremely good source of unsaturated fatty acids (omega 3). Even though we see a growing trend in the consumption of fish in Poland [9, 15], fish is still not chosen by the Poles often enough – only 23% people declare eating fish a few times a week and 56% a few times a month [22]. In the declarations of the studied group of people we noted that almost half of them eat fish at least once a week, yet an equally large number of people do not eat enough fish. Even a higher percentage of fish consumption among students was noted by Duda in her study [6], where only 11% of students eat fish less often than a few times a

week. This type of tendencies can be an effect of widespread information campaigns and better availability of the product in the market. This conclusion is also confirmed by other observations. The consumption of meat products, in particular the so-called red meat and animal fats in the studied group of people is not too high compared to the trends noted in the population of adult Poles. Only 12% of subjects consume products of this type every day, and more than 20% do so a few times a week, which is a highly expected behaviour. Similar, good trends are noted in other studies [6] which reveal the changes in students' preferences towards more frequent eating of poultry and the limitation of red meat consumption.

The study proposed to construct the Dietary Behaviour Index on the basis of 12 studied habits. Taking into account its correlations with individual behaviour, it can be stated that it allows for distinguishing people with a more or less healthy diet. In the analysis of the individual elements of food consumption structure, the percentage of people who follow the desirable model of dietary behaviour in the studied group of students is moderate and comparable to the percentage of people showing an unfavourable model of dietary behaviour (that is approx. 22%).

CONCLUSIONS

The majority of the students, participating in the study, present a moderately beneficial model of dietary behaviour and almost one in four students follows the healthy eating style. Probably as a consequence the percentage of overweight and obese people is lower than in many countries of Western Europe or America.

Particularly worrying dietary mistakes, made by the students, are a low consumption of fruit and vegetables, fish and low-fat dairy products. Good trends were noted in terms of regularity of meals and the limited consumption of red meat.

The proposed Dietary Behaviour Index was the way to estimate the diets of the young people. The majority of participants follow a moderately beneficial model of behaviour.

Socio-demographic variables, which characterise the subjects, differentiated their dietary behaviour to some extent and the most important one is the field of study. Thus our suggestion is that the time of university studies may and should be used more intensively to promote a healthy lifestyle, in particular for students whose field of study is not related to health.

REFERENCES

1. Anding J. D., Suminski R. R., Boss L. (2001). Dietary intake, body mass index, exercise, and alcohol: Are college women following the Dietary Guidelines for Americans? J Am Coll Heath, 49, 167–171.
2. Całyniuk B., Grochowska-Niedworok E., Białek A., Czech N., Kukielczak A. (2011). Piramida żywienia – wczoraj i dziś. Probl Hig Epidemiol, 92, 1, 20–24.
3. Capita R., Alonso-Calleja C. (2003). Intake of nutrients associates with an increased risk of cardiovascular disease in a Spanish population. International Journal of Food Sciences and Nutrition, 54, 57–75.
4. Colić Barić I., Satalić Z., Lukesić Z. (2003). Nutritive value of meals, dietary habits and nutritive status in Croatian university students according to gender. International Journal of Food Sciences and Nutrition, 54, 6, 473–484.
5. Ding E. L., Mozaffarian D. (2006). Optimal dietary habits for the prevention of stroke. Semin Neurol, 26, 1, 11–23.
6. Duda B. (2006). Nutrition and body mass assessment of extra mural students from the Medical Academy and the Academy of Physical Education and Sport in Gdańsk. Acta Medica Lituanica, 13, 1, 34–37.
7. Gawęcki J., Hryniewecki L. (2000). Żywienie człowieka. Podstawy nauki o żywieniu. PWN, Warszawa.
8. Heyman M. B. (2006). From The American Academy of Pediatrics: Lactose Intolerance in Infants, Children, and Adolescents. Pediatrics, 118, 3, 1279–1286
9. Honkonen P., Brunsø K. (2005). On the average European fish consumption is below recommended levels. The SEAFOOD plus project 2.1. printed from www.SEAFOODplus.org. Accessed on 15.04.2011
10. Hung H. C., Joshipura K. J., Jiang R., Hu F. B., Hunter D., Smith-Warner S. A., Colditz G. A., Rosner B., Spiegelman D., Wiolett W. C. (2004). Fruit and vegetable intake and risk of major chronic disease. J Natl Cancer Inst, 96, 21, 1577–1584.
11. Lowry R., Lee S. M., Mckenna M. L., Galuska D. A., Kann L. K. (2008). Weight Management and Fruit and Vegetable Intake Among US High School Students. J Sch Health, 78, 8, 417–24.
12. Manson J. E., Skerrett P. J., Greenland P., VanItallie T. B. (2004). The escalating pandemics of obesity and sedentary lifestyle. A call to action for clinicians. Archives of Internal Medicine, 164, 3, 249–258.
13. Nawyki żywieniowe i upodobania kulinarne Polaków. (2000) Komunikat z badań. CBOS, Warszawa.
14. Obesity: preventing and managing the global epidemic. (2000). Report of a WHO Consultation. WHO Technical Report Series 894. Geneva: World Health Organization
15. Seremak-Bulge J. (2010). Rynek i spożycie ryb w latach 2009–2010.: www.sprl.pl/doc/konf2010/rynek.pdf. Accessed on 15.04.2011

16. Socha J., Książyk J., Flatz G., Flatz S. D. (1984). Prevalence of primary adult lactose malabsorption in Poland. Ann Hum Biol, 11, 311–316.
17. Taylor J. P., Mccarthy M. J., Herbert R. J., Smith P. B. (2009). A Comprehensive Profile Of Health Risk Behaviors Among Students At A Small Canadian University. College Student Journal, 43, 2, 255–267
18. US Department of Agriculture (2011). USDA's MyPlate. http://www.choosemyplate.gov/Accessed on 04.07.2012
19. US Department of Health and Human Services. US Department of Agriculture (2010). Dietary Guidelines for Americans. (7th ed.) US Government Printing Office, Washington, DC, http://www.cnpp.usda.gov/Publications/DietaryGuidelines/2010/PolicyDoc/PolicyDoc.pdf Accessed on 04.07.2012
20. Walker B. M., Schroeter C., Wolf M. M. (2009). An Examination of College Students' Produce Consumption and Purchasing Behavior: A Case Study in California. Journal of food distribution research, 40, 1, 180–186
21. Willett W. C, Stampfer M. J. (2003). Rebuilding the Food Pyramid. Scientific American, 288, 1, 64–71.
22. Zachowania i nawyki żywieniowe Polaków. (2010). Komunikat z badań. CBOS, Warszawa.
23. Złota Karta Prawidłowego Żywienia. (1997). Czynniki Ryzyka, 3–4.

Correspondent author:
Ida Laudanska-Krzeminska
Department of Health Education
University School of Physical Education
ul. Krolowej Jadwigi 27/39
61–871 Poznań, Poland
E-mail: idalk@poczta.fm

Papers on Anthropology XXI, 2012, pp. 176–186

MATRIX METALLOPROTEINASE 9 (MMP-9) IS DIFFERENTLY EXPRESSED IN CUTANEOUS LICHEN PLANUS AND LICHEN SCLEROSUS

ILZE LEGUSA[1], VALERIE GROMA[2]

[1] *Clinical Centre for Skin and Sexually Transmitted Diseases, Riga, Latvia*
[2] *Laboratory of Electron Microscopy, Institute of Anatomy and Anthropology, Riga Stradiņš University, Riga, Latvia*

ABSTRACT

Lichen planus is a mucocutaneous inflammatory disease of unknown etiology. Hyperkeratosis, focal hypergranulosis, damage to the basal cell layer, and band-like infiltrate are hallmarks of LP skin. Lichen sclerosus is a lymphocyte-mediated dermatosis that has a predilection for the genital skin in both sexes. Both pathologies are sharing a number of common characteristics. Previous studies have reported on involvement of matrix metalloproteinases and their capability of digesting extracellular matrix and basement membrane components. We report on the clinical examination of 11 lichen planus patients and 5 lichen sclerosus patients and the morphological evaluation of their skin biopsy samples. Clinical and routine light microscopy findings correlate with the literature data. By contrast, the expression of MMP-9 was greatly varying among clinical types of cutaneous lichen ruber planus. There was similarity in the MMP-9 expression observed between lichen planus pemphigoides and lichen sclerosus.

Key words: *lichen planus, lichen sclerosus, matrix metalloproteinase 9 (MMP-9).*

INTRODUCTON

Lichen planus (LP) is a mucocutaneous inflammatory disease of unknown etiology [1]. LP shares common chracteristics with the lupus erythematosus, benign lichenoid keratosis, keratosis lichenoides chronica, lichen notidus, and

lichen sclerosus (LS) lesions. These pathologies are characterized by the damage of epidermis appearing mostly in the basal cell layer, and dermal infiltration. Lichen sclerosus is a lymphocyte-mediated dermatosis that has a predilection for the genital skin in both sexes. LP and LS are usually diagnosed clinically [2]. LP is characterized by flat-topped, pink to violaceous, shiny, pruritic polygonal papules that may coalesce into plaques. The typical clinical picture of LS is characterized by whitish, ivory or porcelain-white, sharply demarcated, pruritic, individual papules that may become confluent and form plaques [3]. The aetiology of both diseases is uncertain [4]. The histologic examination of skin or mucosal biopsy is helpful in the cases where there is some clinical doubt about the diagnosis and in the documentation of atypical features. The classical histological features of LS include a thinned epidermis with hyperkeratosis, a wide band of homogenized collagen below the dermo-epidermal junction and a lymphocytic infiltrate beneath the homogenized area [5]. Histologically, LP is characterized by basal layer vacuolization, acanthosis, hypergranulosis, and a lymphocytic infiltrate mostly localized at the dermal-epidermal interface [6]. The lesions usually involve skin, the oral mucous membranes, and genitalia. Direct immunofluorescence studies may be helpful in the disease differentiation for the cases with no specific clinical or histologic characteristics, or with ambiguous features of other diseases [7]. The matrix metalloproteinases (MMPs) are a large family of zinc-dependent endopeptidases, which are capable of digesting extracellular matrix and basement membrane components. These enzymes can be produced by several types of cells in skin such as fibroblasts, keratinocytes, macrophages, lymphocytes, endothelial cells, mast cells, and eosinophils [8]. The MMPs are involved in many processes including cell proliferation, differentiation, migration, apoptosis, and angiogenesis. Previous studies [9] have shown that dermal inflammatory cells are strongly expressing MMP-9. The elucidation of the role of MMPs in pathogenesis of chronic dermatosis, in general, and LP, in particular, is far from definitive. The comparative evaluation of the clinical and pathomorphological features of LP and LS including the peculiarities related to the expression of MMP-9 in LS and various types of LP appears under the scope of this paper.

MATERIALS AND METHODS

Our target patients were at least 18 years old, suffering from LP or LS for at least 4 weeks, having visible characteristic LP or LS eruptions in typical localization sites. We selected 11 patients (7 female and 4 male patients) with the

histologically confirmed diagnosis of LP and 5 patients (all the patients were females) with the histologically confirmed diagnosis of LS. All the patients were admitted and treated at the Clinical Centre for Skin and Sexually Transmitted Diseases, Riga, Latvia between February 2010 and February 2012. Punch biopsy tissues archived at the above mentioned Centre were examined using light microscopy. At the time of biopsy all the patients were off any topical or systemic LP or LS medication. Study procedures were conducted in accordance with the rules of the Ethical Committee.

Histological sections of 4–5 μm were cut from formalin-fixed, paraffin-embedded punch biopsy tissues and mounted on slides. Consecutive sections were used as negative controls of the immunohistochemical reactions and for hematoxylin and eosin (H&E) staining to confirm the diagnosis. For immunochemistry paraffin sections were dewaxed and transferred to a methanol/0.3% hydrogen peroxide solution in order to abolish endogenous peroxidase activity. After quenching of endogenous peroxidase activity sections were washed three times in double distilled water. Heat-induced antigen retrieval was accomplished with the sections placed in 10mM citrate buffer for 30 minutes in a vapor lock. After antigen retrieval, specimens were allowed to cool for 20 minutes. Nonspecific binding was blocked with 1% bovine serum albumin/5% normal goat serum in phosphate buffered saline. Thereafter, sections were incubated at 4°C overnight with the primary antibody(anti-MMP-9) at a dilution 1:50, and next day, with secondary biotinylated antibody (1:500 dilution) for 30 min and streptavidin-biotin-peroxidase preformed complex (1:250 dilution) for 30 min. The immunological reaction was developed with 3, 3'-diaminobenzidine tetrahydrochloride (50 mg in 100 ml of PBS with 0.03% v/v hydrogen peroxide). Sections were counterstained with Harrys haematoxylin and mounted in Kaiser's glycerol gelatin. The intensity of immunostaining was graded semiquantitatively using the following scale: (0) – negative expression, (+) – a weak expression of MMP-9, (++) – a moderate expression of MMP-9 and (+++) – an intense MMP-9 expression.

RESULTS

Small, flat-topped, shiny, polygonal, violaceous papules were limited to the flexor surfaces of the forearms, the legs, the back of the trunk and submammary folds. Histologically, the hypertrophic variant of LP, LP pemphigoides and follicular form of lichen planus were confirmed. Hypertrophic (three cases) appeared to be a common variant which consisted of thickened plaques and

showed hyperkeratosis, focal hypergranulosis, basal cell layer degeneration, and a band-like subepidermal infiltration (Figure 1). LP pemphigoides (five cases) showed bullae arising from papules and normal appearing skin. There were a focus of epidermal thickening with liquefaction degeneration of the basal layer, a lichenoid inflammatory infiltrate, and, sometimes, fibrin deposition (Figure 2). Lichen follicularis (three cases) revealed dilated hair follicles containing keratotic plugs (Figure 3). There were rather dense chronic inflammatory infiltrates in the close vicinity to the hair follicles, and band-like infiltrates beneath the epidermis. In LS were observed hyperkeratosis with follicular plugging, the atrophy of the stratum malpighii with the hydropic degeneration of basal cells, lymphedema and the homogenization of the collagen in the upper dermis, an inflammatory infiltrate in the mid-dermis, and the homogenization and swelling of the collagen bundles in the lower dermis (Figure 4).

MMP-9 expression was observed to be greatly varying among the cases enrolled in this study (Table 1). In a hypertrophic variant moderate to intense expression of metalloproteinase was revealed within the basal and suprabasal location of the stratum spinosum (Figure 5). A diffuse and strong MMP-9 immunostaining throughout all epidermal layers was noticed in the follicular variant of LP (Figure 6). The first two types of LP demonstrated diffuse and intense MMP-9 immunostaining in dermal lymphohistiocytic infiltrate, hair follicle and dermal sweat glands. By contrast, LP pemphigoides (Figure 7) demonstrated a weak expression of MMP-9 to the basal layer of epidermis whereas intense expression in dermal lymphohistiocytic infiltrate. LS demonstrated mild epidermal anti-MMP-9 decoration, which became moderate in dermal lymphohistiocytic infiltrate, and intense in sweat glands (Figure 8). In LS inflammatory infiltrates occupied mid-dermis region comparing with subepidermal characteristic for LP. Moreover, LS showed anti-MMP-9 decoration related to collagen location.

Figure 1. Hypertrophic LP with hyperkeratosis, hypergranulosis, saw-tooth profile of rete ridges, the degeneration of the basal cell layer, and compact band-like infiltrate below the epithelium. H&E, original magnification × 100.

Figure 2. LP pemphigoides showing the separation of the epidermis from the dermis. A subepidermal bulla overlying a perivascular infiltrate, characteristic of LP pemphigoides. The liquefaction degeneration of the basement membrane. H&E, original magnification × 100.

Figure 3. Follicular LP with the basal cell degeneration and subepidermal infiltrate. H&E, original magnification × 100.

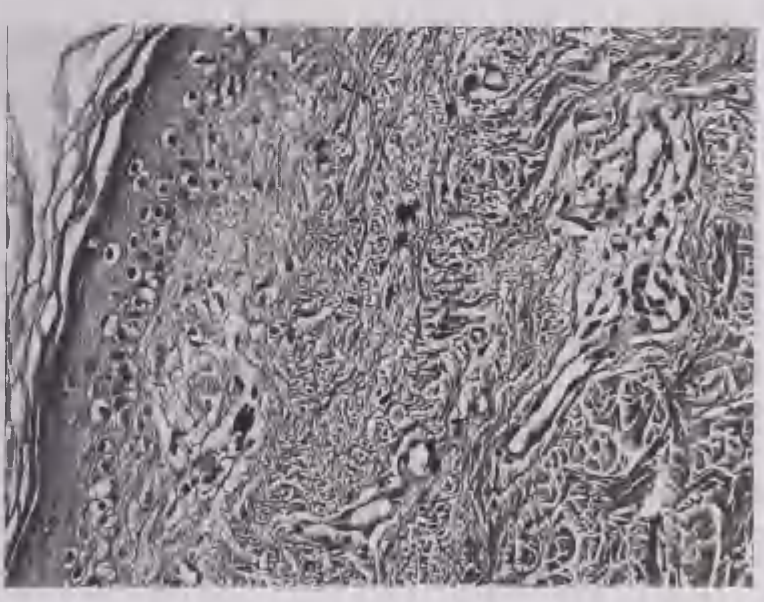


Figure 4. LS revealing hyperkeratosis and hypergranulosis, the atrophy of the stratum malpighii with the hydropic degeneration of basal cells, lymphedema and the homogenization of the collagen in the upper dermis, as well as a certain number of pigment cells. H&E, original magnification × 200.

Table 1. Expression of MMP-9 in various clinical types of cutaneous LP and LS.

Disease \ Skin structure		Horny layer	Granular layer	Spinous layer	Basal layer	Infiltrate	Hair follicle	Sebaceous gland	Blood capillaries	Sweat gland
Lichen planus	Hypertrophic lichen planus	0/+	0	++/+++	++/+++	+++	+++	0	++	+++
	Follicular lichen planus	0	0	++/+++	++/+++	+++	+++	0	+	+++
	Lichen planus pemphigoides	0	0	0/+	+	+++	++	0	0/+	+/++
Lichen sclerosus		0	0	0/+	+/++	+++	0/+	0	0/+	+++

Figure 5. Expression of MMP-9 in hypertrophic LP appearing through the malpighii layer, dermal infiltrates, vascular beds, and sweat glands; original magnification × 100.

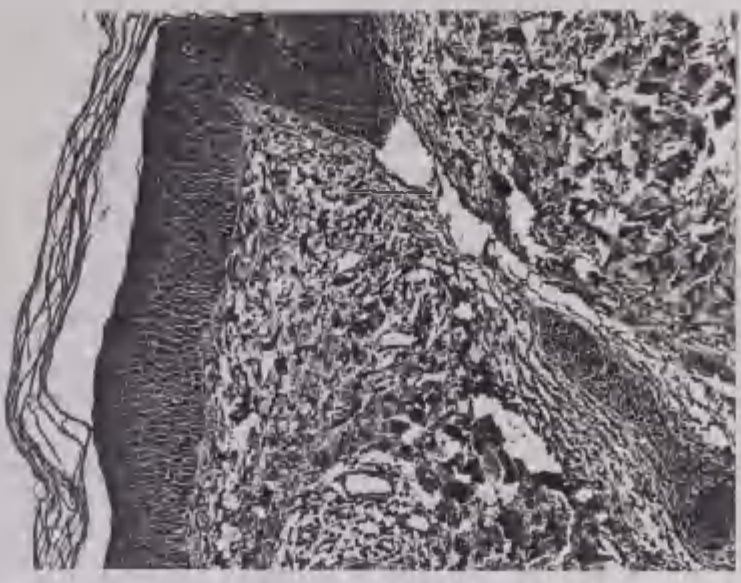


Figure 6. Epidermis and hair follicles appearing to be heavily decorated with the anti-MMP-9 antibody in the follicular variant of LP, original magnification × 100.

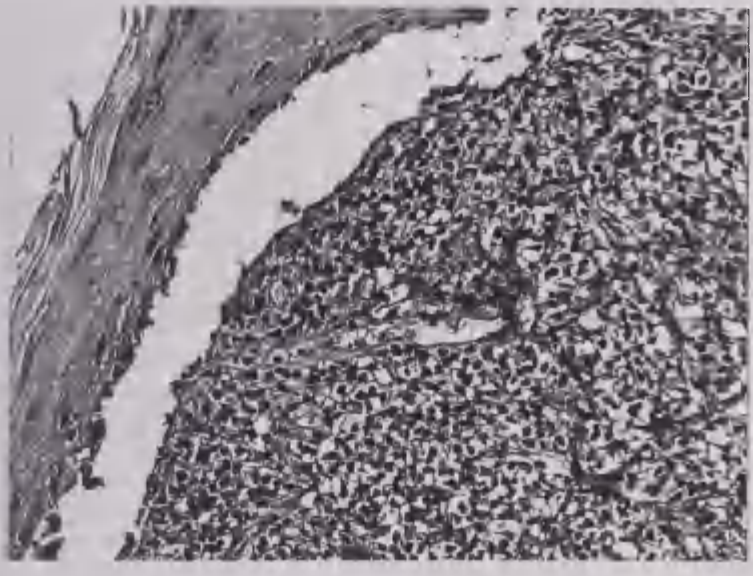


Figure 7. Mild epidermal and strong expression of MMP-9 in the inflammatory infiltrate demonstrated in LP, original magnification × 200.

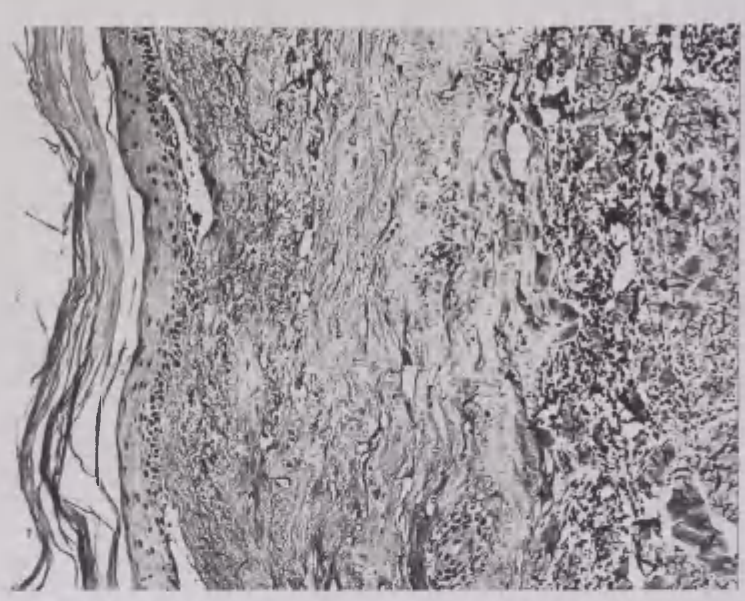


Figure 8. Mild epidermal and strong expression of MMP-9 in the inflammatory infiltrate localized in the mid-dermisin case of LS, original magnification × 100.

DISCUSSION

We performed a complex clinical and pathomorphological study on the skin punch biopsy tissue with the confirmed LP diagnosis, and compared them with LS biopsy tissue samples. We found that an addition of immunohistochemistry data was more relevant and instructive as compared with solely used methods and examinations.

Our evidence regarding the contribution of MMPs to the events underlying these cutaneous pathologies is important for further understanding of intimate pathways of pathogenesis of LP.

We demonstrated the moderate and unregulated epidermal expression of MMP-9 in the hypertrophic and follicular variants of LP. Our findings suggest that the action of MMP-9 is directed toward epidermal/dermal interface, and the cells of inflammatory infiltrates localized subepidermally keep a strong action potential regarding remodeling of the extracellular matrix and basement membrane components. Differences in MMP-9 expression related to collagenous structures clearly appeared in the cases of LS that are characterized by other events underlying the pathogenesis of this dermatosis. The results of the present study suggest that immunologic mechanisms may play a crutial role in the pathogenesis of LP. Our results are in accordance with the data reported by Gunduz [9]. It seems that inflammatory cells are constant producers of

MMP-9 in LP. Moreover, the application of immunohistochemical technique allowed us to suggest that inflammatory cells are placed in the close vicinity to the vascular beds, which, in turn, are somehow involved in cell migration, and, probably, the further induction of the transformation of the perivascular extracellular matrix. Semiquantitative scoring of MMP-9 expression was helpful in estimation of greatly varying patterns of immunostaining revealed among the cases used in this study. The same approach has been reported in a few the cases published previously [9]. Lowering of MMP-9 expression in the case of LP pemphigoides can be explained by the severe damage of the keratinocytes within the stratum malpighii due to bulla formation, still the inflammatory infiltrate appeared to be heavily stained. Sweat glands constantly showed rather strong MMP-9 expression. In this case explanation can be based on developmental peculiarities when glands and surface epithelium are sharing common characteristics. Still, other explanations may appear from further studies. The analysis of the literature available shows that the enzymatic remodeling caused by MMP-9 has been studied exploring the role of MMPs in the cancerization of oral lichen planus [10]. It has been proved that the risk of cutaneous LP [11] or LS malignizations is very small compared with mucosal involvement [12]. More studies are needed to elucidate the role of MMP-9 in malignancy.

REFERENCES

1. Pittelkow M. R., Daoud M. S. Lichen planus. In: Wolff GK, Goldsmith L, Katz S, Gilchrest B, Paller A, eds. (2008). Dermatology in general medicine. 7th ed., New York, McGraw-Hill, 244–55.
2. Neill M., Tatnal F. M., Cox N. H. (2002). Guidelines for the management of lichen sclerosus. BJD, 147, 640–649.
3. Wolff K., Johnson R. (2009). Fitzpatrick's Color Atlas and Synopsis of Clinical Dermatology. Sixth Edition, New York, McGraw-Hill Professional, 128–143.
4. Dickie R. J., Horne C. H. W, Sutherland H. W. (1982). Direct evidence of localized immunologic damage in lichen sclerosus et atrophicus. J Clin Pathol, 35, 1395–9.
5. Hewitt J. (1986). Histologic criteria for lichen sclerosus of the vulva. J Reprod Med, 31, 781–7.
6. McKee P. H. (1999). Essential skin pathology. Hong Kong, Mosby International Ltd., 78.

7. Kulthanan K., Jiamton S., Varothai S., Pinkaew S, Sutthipinittharm P. (2007). Direct immunofluorescence study in patients with lichen planus. International Journal of Dermatology, 46, 1237–1241.
8. Kähäri V. M, Saarialho-Kere U. (1997). Matrix metalloproteinases in skin. Experimental Dermatology, 6, 199–213.
9. Gunduz K., Demireli P., Inanir I., Nese N. (2006) Expression of matrix metalloproteinases (MMP-2, MMP-3, and MMP-9) and fibronectin in lichen planus. J Cutan Pathol, 33, 545–550.
10. Chen Y., Zhang W., Geng N., Tian K., Windsor L. J. (2008). MMPs, TIMP-2, and TGF-β1 in the cancerization of oral lichen planus. Head & Neck, DOI 10.1002/hed, 1237–1245.
11. Sigurgeirsson B., Lindelof B. (1991). Lichen planus and malignancy: an epidemiologic study of 2071 patients and a review of the literature. Arch Dermatol, 127, 1684.
12. Barbagli G., Palminteri E., Mirri F., Guazzoni G., Turini D., Lazzeri M. (2006). Penile carcinoma in patients with genital lichen sclerosus: a multicenter survey. J Urol, 175(4), 1359–1363.

Address for correspondence:
Ilze Legusa
Clinical Centre for Skin and Sexually Transmitted Diseases
Maskavas str. 266/9, Riga, LV-1063, Latvia
E-mail: ilze.legusa@inbox.lv

Papers on Anthropology XXI, 2012, pp. 187–193

220 YEARS FROM THE BIRTH OF THE MEDICAL AND NATURAL SCIENTIST KARL ERNST VON BAER

RAIK-HIIO MIKELSAAR

Professor Emeritus of the University of Tartu,
Chairman of the Karl Ernst von Baer Foundation, Estonia

Karl Ernst von Baer, our most eminent natural and medical scientist of all times, was born in Piibe manor, Järva county, Estonian guberniya, on 28 February 1792 (New Style). His sphere of activities was exceptionally broad, ranging from medicine, zoology, embryology, entomology, ornithology and ichthyology to bibliography, botany, climatology, geomorphology, archaeology, ethnology and anthropology.

Having spent his childhood at the manors of Lasila and Piibe and studied for three years (1807–1809) at Tallinn Cathedral School, Karl Ernst acquired higher education at the Faculty of Medicine at the University of Tartu (*Kaiserliche Universität Dorpat*). The theme of his doctoral dissertation was *De morbis inter esthonos endemicis* (*On Estonians' Endemic Diseases*). After graduating from the university, he continued his education at the medical institutions of Berlin, Vienna and Würzburg from 1814–1817, but being disappointed at that time's medical science, he became interested in comparative anatomy. As he had contacts with Ignatius Döllinger and Karl Friedrich Burdach, he managed to get employment in this field of research at the University of Königsberg for a longer time (1817–1834), first as a prosector, later as a professor.

At the University of Königsberg, Karl Ernst von Baer taught mainly anatomy of invertebrates and vertebrates, but in the winter term of 1817/1818 he also lectured on anthropology. In 1819 he received a proposal to establish a zoological museum there. Working at that museum, he discovered the mammalian (more precisely, the dog's) ovum in 1827 and wrote the research paper *De ovi mammalium et hominis genesi* (*On the genesis of the ovum of*

mammals and humans). In 1828 Karl Ernst von Baer published his pioneering monograph about the regularities of embryonic development of animals *Über Entwicklungsgeschichte der Thiere* (*On the Development History of Animals*). This paper shows that Baer was the discoverer of embryonic rudiments of the spinal cord, the brain vesicles, the eye and the internal organs. Studying the development of the fertilized ovum of the frog, he was the first to describe its segmentation (*Theilung*). Baer named the particles formed by segmentation *Elementar-Teilchen – histologische Elemente* (elementary particles – histological elements), and he also described the halving of the nucleus. As the aforementioned particles correspond to cells in their present-day sense, Karl Ernst von Baer, along with Matthias Jakob Schleiden and Theodor Schwann, can be considered one of the founders of the cell theory. Moreover, his embryologic discoveries also served as a basis for developing of Darwin's evolutionary tree and theory.

From 1834–1867 Karl Ernst von Baer lived in St. Petersburg where he worked at the Academy of Sciences as Academician for Zoology and head of the foreign literature department of the Academy's library, thereafter at the Russian Ministry of Public Education where he drafted the new University Act. Within this period he also worked at St. Petersburg Academy of Military Medicine as Professor of Comparative Anatomy and Physiology (1841–1852). Karl Ernst von Baer participated in numerous expeditions to Novaya Zemlya, Lapland, the shores of the White Sea and the Arctic Ocean, the Volga River, the Caspian and Azov Seas and Lake Peipsi. From 1842–1843 he published a groundbreaking research paper on the geological and physical geographical properties of permafrost. In 1845 Baer initiated the foundation of the Russian Geographical Society. Based on ichthyological studies on Estonian water bodies (1851–1852), he developed the ecological approach to ichthyology. In 1856 he discovered the law of the asymmetry of river banks which became widely known. In 1860 he was President of the Russian Entomological Society and in 1861 chairman of an anthropological conference in Göttingen.

During the last years of his life (1867–1876), Karl Ernst von Baer lived in Tartu where, from 1869, he was President of Tartu Naturalists' Society. Baer died on 28 November 1876 (New Style) and was buried in Raadi cemetery in Tartu.

In 1886 a monument in memory of Karl Ernst von Baer was erected on Toome Hill in Tartu. It was made by sculptor Alexander Opekushin from Yaroslavl at the initiative of St. Petersburg Academy of Sciences. In the Republic of Estonia, too, the heritage of the scientist has been increasingly appreciated. In 1960, at the initiative of the Estonian Academy of Sciences, a

memorial stone was laid at the location of his birth house at Piibe. In Karl Ernst von Baer's last residence at 4 Veski Street in Tartu, the so-called Baer House, an exhibition covering his life and work was opened on 29 September 1976, and the Baer Award and Medal were established to honour the best Estonian medical and natural scientists. Now the building accommodates the Centre for Science Studies (director Erki Tammiksaar) of the Estonian University of Life Sciences, which has turned the exhibition into a permanent display that is constantly being developed. On 28 February each year, on the scientist's birthday, the Centre organises the Baer Day which begins at his monument on Toome Hill with a memorial speech and laying of flowers. In spring 2010 the Centre helped to renovate the Baer tower at the school located in the main building of Lasila manor.

On 16 November 2002, twenty people with a sense of mission (mostly scientists) bought the only preserved building of Piibe manor, the former house of the manager of the estate, in order to arrange events in Karl Ernst von Baer's memory and other educational events there. In 2008, 2.5 hectares of the former manor lands were bought, which, together with the building acquired earlier, form the Baer landed property. On 6 June 2009, 28 people established the Karl Ernst von Baer Foundation (abbreviated as KEBF, in Estonian *Karl Ernst von Baeri Fond*, in German *Karl Ernst von Baer Stiftung*). The aims of the Foundation are: (1) to value and develop the heritage of the eminent natural scientist Karl Ernst von Baer by supporting corresponding research and familiarising the public with scientific treatment of the world and its applications; (2) to promote educational and cultural life on the territory of the former Piibe manor and nature tourism. The Board of the Foundation includes Raik-Hiio Mikelsaar (chairman), Ingrid Mesila and Monika Prede; its Council members are Mati Kaal (chairman), Jüri Martin, Toomas Frey, Andres Kollist, Timo Vunder and Jaan Kaplinski. The other people who established the KEBF were Mart Viikmaa, Rein Vihalemm, Lembi Kogerman, Anto Raukas, Lauri Jõesaar, Jaan Jõers, Ene Talpsep, Ülo Tölp, Arvo Haug, Katri Ling, Karl Heinz Gast (Germany), Gudrun Veldre, Ragnar Viir, Sulev Järve, Laine Trapido, Peeter Normak, Heldur Sander, Lembit Dalberg, Tambet Teesalu and Triinu Vill.

From 2011–2012, with the approval of KEBF, 2.7 km long Piibe Baer Timeway (more precisely Cosmo-Geo-Bioway) was built at Raik-Hiio Mikelsaar's initiative and using his own resources. The route consists of a pedestrian and bicycle path and a deepened water canal. The Timeway gives a symbolic overview of the development of the universe from the Big Bang to the formation of the Solar System, and onwards, from the emergence of Life and its

differentiation through different eras until the present. The Timeway was designed by REIB OÜ (Mairolt Kakko) and earthwork was done by Koidusära Metsatööd OÜ (Marko Pohlak).

From 8–10 June 2012, KEBF, Pandivere Development and Incubation Centre (PAIK) and the Ethics Centre of the University of Tartu organised a three-day event dedicated to Karl Ernst von Baer's 220th birth anniversary. The first day (8 June 2012) began with opening remarks by Raik-Hiio Mikelsaar and Aivar Niinemägi (chairmen of KEBF and PAIK) at Baer's monument on Toome Hill. Art historian Enriko Talvistu analysed the uniqueness of the monument, and physicist Viktor Korrovits described the location of a windmill that had existed near Baer's last place of residence. Thereafter, a musical performance about Karl Ernst von Baer's life and work (script by Raik-Hiio Mikelsaar in cooperation with Mare Rand and Mart Viikmaa) was presented by the actors and musicians of the Vanemuine Theatre and the Emajõe Summer Theatre with help of the historian Eva Piirimäe. The performance began at the monument and continued in the building of the University of Tartu History Museum. On the second day (9 June 2012) the participants were taken on bus tours to the area of Baer's childhood home (Piibe, Kiltsi, Lasila, Porkuni, Võivere and Simuna), and a bonfire party was arranged near artist Hando Kuntro's Sunrise Hut on Emumägi Hill. On the third day (10 June 2012) a conference took place at Rakke community centre. The theme of its first session (moderators Raik-Hiio Mikelsaar and Aivar Niinemägi) was *Karl Ernst von Baer, history and popularisation of science*; the presenters were Cecilia Ödman (Sweden), Madis Linnamägi, Rein Einasto, Jaan Kasmel and Ken Kalling. The second session (moderator Kadri Simm) was *Ethics and science*; the presenters were Vilhjalmur Arnason (Iceland), Theda Rehbock (Germany), Kristi Lõuk, Andres Metspalu and Francesco Frassoni (Italy). The third session was a panel session (moderator Margit Sutrop) *Ethics, society and science.*

KEBF, PAIK, the Centre for Science Studies at the Estonian University of Life Sciences, and the University of Tartu History Museum are going to venerate the life of our great scientist Karl Ernst von Baer in the future as well.

Figure 1. Karl Ernst von Baer Memorial Medal

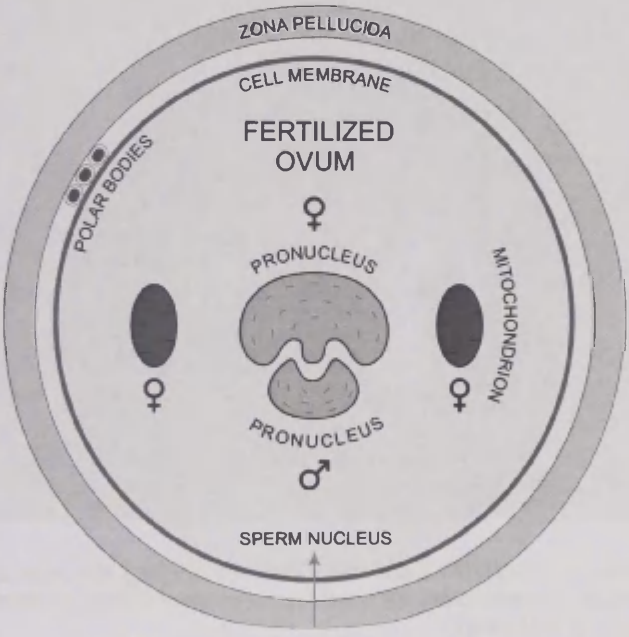


Figure 2. Mammalian fertilized ovum, discovered by Karl Ernst von Baer in Königsberg zoological garden (1827) and demonstrated nowadays as a macroflex-imitation at the end of Piibe Baer Timeway

Figure 3. Baer's descendant Andreas Leo Findeisen washing the head of Baer's monument. The tradition of washing Baer's head was probably initiated by medical students in the 1950s. Photo by Aldo Luud.

Figure 4. Map of Piibe Baer Timeway (Cosmo-Geo-Bioway)

Address for correspondence:
Raik-Hiio Mikelsaar
11–4 Jakobi, Tartu, 51005
E-mail: raik.mikelsaar@ut.ee

Papers on Anthropology XXI, 2012, pp. 194–200

ERECTILE DYSFUNCTION ETIOLOGY AND HORMONAL CHANGES

Minireview

HELEN ORRO, KERSTI KOKK

Institute of Anatomy, University of Tartu, Estonia

INTRODUCTION

Erectile disorder is an inconvenient condition that affects many men and reduces their life quality. It causes problems in private life and may finally lead the patient to deep depression. Hormonal, local biochemical and structural factors of the penis modulate the erectile dysfunction as a neurovascular phenomen. [32]

It is one of the most common forms of male sexual dysfunctions. Approximately 40% of men over 40 years of age and 1 in 3 men over 70 years of age are suffering from the erectile dysfunction. [9] There are many etiologigal factors that play a role in the etiopathogenesis of the erectile dysfunction. The risk factors which may affect erectile mechanisms are age, vascular factors, metabolic diseases, neurologic diseases, HIV/AIDS and some drugs. Such drugs, for example, are: antiandrogenic, anticholinergic, antidepressants, antihypertensive, major tranquilizers, anxiolytics, and certain medicines/metabolites. [6]

Sexual dysfunction is associated with depression and antidepressant therapy. [12] Roughly 70% of patients with depressive disorders (23–50% of men with depression and 33–90% of women) are having problems with sexual function: a decline in libido, the erectile dysfunction, ejaculation disorders in men and orgasm and menstruation in women. [4] Most antidepressants may cause sexual dysfunction as an adverse effect of treatment. [11]

Psychological and hormonal factors are also important as they participate in the erectile function. [2] According to literature sexual dysfunction is a fre-

quent problem in hypertensive patients [18, 21, 23, 5] and also common in the patients with chronic kidney disease. [30] 30% of hypertensive patients have problems with erection. Hypertension and the erectile dysfunction are related diseases the common base of which an endothelial dysfunction. The disorder of endothelium – derived factors may lead to an increase in the vascular smooth muscle contraction. Due to high blood pressure or antihypertensive treatment, hypertension can cause the erectile dysfunction. [21] Vasodilation in response to endothelium – dependent stimuli is inadequate both in the systemic vasculature and the penile arteries. Many antihypertensive drugs may have a drug specific side – effect, which worsens sexual function. [23] Older antihypertensive drugs (diuretics, beta blockers) have harmful effects on the erectile function, but newer drugs (nebivolol, angiotensin receptor blockers) have neutral or even beneficial effects. Phosphodiesterase (PDE) – 5 inhibitors are effective in hypertensive patients and can be safely administered. On has to be careful has to be with alpha blockers and coadministration with nitrates is also contraindicated. [18]

As the erectile dysfunction is mainly a vascular condition, it usually comes before the cardiovascular event by 3–5 years. Due to association with acute coronary syndromes, its early diagnosing gives an opportunity for cardiovascular risk reduction. [9] High LDL, smoking, hypertension and diabetes are risk factors for the coronary heart disease and also for the erectile dysfunction. The erectile dysfunction is a usual problem after the coronary artery disease or myocardial infarction. [5] Obese patients with dyslipidemia, type 2 diabetes mellitus, and/or depression, should be screened for the erectile dysfunction, because of associations between the heart disease, the metabolic disease and the sexual dysfunction. [24] Obesity is confessedly a significant risk factor for the cardiovascular disease, type 2 diabetes, cancer and the erectile dysfunction and low serum sex hormone – binding globulin levels in obesity are associated with the low serum total testosterone. The body mass index and serum total testosterone concentrations are inversely proportional [3] Visceral obesity associates with increased inflammatory responses and thereof predisposes the endothelial dysfunction which together with androgen deficiency are related to the patophysiological mechanisms of the erectile dysfunction. [29]

The increased arterial inflow and the restricted venous outflow, coordinated with corpus cavernosum and penile arterial smooth muscle relaxation, are the hemodynamic processes which are related to the penile erection. [16] The balance of vascular relaxants and constrictors determines the tone of cavernosal smooth muscle cells, which governs the erectile status of the penile tissue.

Vascular relaxants are important in regulating the tone of the cavernosal smooth muscle. Adenosine is a short – lived vasorelaxant, which relaxes the corpus cavernosum and promotes the penile erection. It works via the cyclic nucleotide second messenger signaling to promote smooth muscle relaxation. Impaired adenosine signaling through A(2B) receptor [22] is associated with the erectile dysfunction. [31]

HORMONAL CAUSES OF ERECTILE DYSFUNCTION

When men are ageing a progressive and small decline in several sex hormones takes place. It includes testosterone and dehydroepiandrosterone, and the related increases in the luteinizing hormone, the follicle – stimulating hormone, and the sex hormone – binding globulin. [1]

Changes in the body mass index, osteoporosis, sleep and mood disorders are correlated with hormonal changes in the ageing male. [26]

Testosterone, which is the major circulating androgen in male, shows an age – related decline in the ageing male. [7] The age – related changes in reproductive hormones in men are not precipitous as in women. Such gradual changes appear throughout many years. The decline in the serum testosterone level causes many symptoms of hypogonadism, which include: the loss of energy, the decreased libido, the depressed mood, the erectile dysfunction, the decreased muscle mass and strength, the increased fat mass, frailty, osteopenia, and osteoporosis. This condition is also known as an andropause and diagnosed by clinical symptoms and the laboratory-measured serum testosterone levels. [15] Disorders at the hypothalamic or pituitary level (hypogonadotropic forms) or the testicular dysfunction (hypergonadotropic forms) can cause hypogonadism. [28]

A remarkable percentage of men over 60 years of age are having serum testosterone levels below the lower limits of young male adults. [27]

The classification of hypogonadism includes primary, secondary, and mixed hypogonadism. The disorders of the testes and therefore low testosterone production and impaired fertility cause primary hypogonadism, whereas disorders of the hypothalamus and the pituitary cause secondary hypogonadism which shows low testosterone and low or inappropriately normal LH and FSH levels. Both defects can cause mixed hypogonadism. Older men usually have secondary or mixed hypogonadism. [27]

Hypogonadism is a condition which may be congenital or acquired. Acquired hypogonadotropic hypogonadism includes the postnatal disorders that

change or impair the function of gonadotropin – releasing hormone (GnRH) neurons and/or pituitary gonadotroph cells. The most usual causes of acquired hypogonadotropic hypogonadism are pituitary tumors, particularly prolactinoma, pituitary surgery and head trauma, cranial/pituitary radiation therapy and also sellar tumors or the cyst of the hypothalamus or infundibulum, infiltrative, vascular, the iron overload and other disorders. [25]

The luteinizing hormone receptor and the follicle stimulating hormone receptor are important factors in female and male reproduction. [19] Luteinizing hormone (LH), as follicle – stimulating hormone (FSH) and thyroid – stimulating hormone (TSH), is the member of the pituitary glycoprotein hormone family and stimulated by gonadotrophin – releasing hormone (GnRH). Our study group investigated the LH receptor expression in the mouse penis, to see if its effects are possible in the penis. We used immunocytochemistry, western blotting and quantitative reverse transcriptase polymerase chain (qRT–PCR) reaction to detect LH receptor in the Balb/c mice penis. Positive immunoreaction to LH was found in the mouse penis urethral epithelium, in the endothelial cells of the cavernous spaces both in corpus spongiosum and corpus cavernosum and also in the testis tissue, which were used as positive control and where positive immunoreaction to the LH receptor was detected in the Leydig cells and in the central part of the seminiferous tubules next to the lumen. The LH receptor antigen was also present by using Western blotting and quantitative RT–PCR. As we managed to show, using three methods, that the LH receptor is expressed in the penile tissue of male mice, this finding may suggest, that LH can affect the corpus spongiosum and corpora cavernosa in mice. [13]

Hypogonadism is not the only condition that is connected with the male sexual dysfunction. Other endocrine disorders also associate with it. Severe hyperprolactinemia (>35 ng/mL or 735 mU/L), often related to a pituitary tumor, influences the sexual function negatively and impairs sexual desire, testosterone production and through it the erectile function. [17] Hyper- and hypothyroidism may also influence the male sexual health. Premature ejaculation and maybe also the erectile dysfunction are connected with hyperthyroidism. Sexual desire and the impaired ejaculatory reflex are associated with hypothyroidism. [17, 14, 8] The erectile function and sperm parameters are disadvantageously affected by hypothyroidism, including the sperm count, morphology and motility. Its is recommended to measure thyroid hormones in the patients with the erectile dysfunction and sperm abnormalities. [20]

SUMMARY

The erectile dysfunction is a common disorder around the world and it largely influences largely the quality of life.

The individual general health status, the cardiovascular disease, diabetes mellitus, some genitourinary disease, psychiatric or psychological disorders and overall life conditions are risk factors linked with the sexual dysfunction.

As mentioned above, the hormonal changes which take place in time and some drugs are also associated with erectile disorders.

While many etiological factors may cause the erectile dysfunction, it is important to avoid their development and/or reduce their influence to the minimum. It includes preventing atherosclerosis and avoiding diabetes, neurogenic disorders or mental distress. The healthy lifestyle which contains physical activity together with balanced nutrition, nonsmoking and appropriate alcohol consumption is recommendable. [10]

REFERENCES

1. Araujo A. B., Wittert G. A. (2011). Endocrinology of the aging male. Best Pract Res Clin Endocrinol Metab, Apr; 25(2), 303–19.
2. Breza J. (1995). Diagnosis and treatment of erectile dysfunctions. Bratisl Lek Listy, Dec; 96(12), 642–50.
3. Diaz-Arjonilla M., Schwarcz M., Swerdloff R. S., Wang C. (2008). Obesity, low testosterone levels and erectile dysfunction. Int J Impot Res. 2009, 21(2), 89–98.
4. Gałecki P., Florkowski A., Depko A., Woźniak A., Talarowska M. (2011). Characteristic and treatment of sexual dysfunctions in depression (part I). Pol Merkur Lekarski, 31(183), 193–6.
5. Görge G., Flüchter S., Kirstein M., Kunz T. (2003). Sex, erectile dysfunction, and the heart: a growing problem. Herz. Jun, 28(4), 284–90.
6. Hafez E. S., Hafez S. D. (2005). Erectile dysfunction: anatomical parameters, etiology, diagnosis, and therapy. Arch Androl, 51(1), 15–31.
7. Haring R. (2012). Perspectives for metabolomics in testosterone replacement therapy. J Endocrinol. May 3.
8. Jabaloyas J. M. (2010). Hormonal etiology in erectile dysfunction. Arch Esp Urol, 63(8), 621–7.
9. Jackson G. (2012). Erectile dysfunction and coronary disease: Evaluating the link. Maturitas, 71(1), 20–7.
10. Kaminsky A., Sperling H., Popken G. (2011). Primary and secondary prevention of erectile dysfunction. Urologe A.50(10), 1265–8, 1270.
11. Kennedy S. H., Rizvi S. (2012). Sexual dysfunction, depression, and the impact of antidepressants. J Clin Psychopharmacol, 29(2), 157–64.

12. Kinzl J. F. (2009). Major depressive disorder, antidepressants and sexual dysfunction. Neuropsychiatr, 23(2), 134–8.
13. Kokk K., Kuuslahti M., Keisala T., Purmonen S., Kaipia A., Tammela T., Orro H., Simovart H. E., Pöllänen P. (2011). Expression of luteinizing hormone receptors in the mouse penis. J Androl, 32(1), 49–54.
14. Krassas G. E., Tziomalos K., Papadopoulou F., Pontikides N., Perros P. (2008). Erectile dysfunction in patients with hyper- and hypothyroidism: how common and should we treat? J Clin Endocrinol Metab, 93(5), 1815–9.
15. Krysiak R., Okopień B. (2012). Pathogenesis and clinical presentation of andropause. Pol Merkur Lekarski, 32(187), 70–3.
16. Lamina S., Agbanusi E., Nwacha R. C. (2011). Effects of aerobic exercise in the management of erectile dysfunction: a meta analysis study on randomized controlled trials. Ethiop J Health Sci. 21(3), 195–201.
17. Maggi M., Buvat J., Corona G., Guay A., Torres L. O. (2012). Hormonal Causes of Male Sexual Dysfunctions and Their Management (Hyperprolactinemia, Thyroid Disorders, GH Disorders, and DHEA). J Sex Med Apr 23.
18. Manolis A., Doumas M. (2012). Antihypertensive Treatment and Sexual Dysfunction. Curr Hypertens Rep. May 12.
19. Menon K. M., Menon B. (2012). Structure, function and regulation of gonadotropin receptors – a perspective. Mol Cell Endocrinol. 356(1–2), 88–97.
20. Nikoobakht M. R., Aloosh M., Nikoobakht N., Mehrsay A. R., Biniaz F., Karjalian M. A. (2012). The role of hypothyroidism in male infertility and erectile dysfunction. Urol J. 9(1), 405–9.
21. Nunes K. P., Labazi H., Webb R. C. (2012). New insights into hypertension-associated erectile dysfunction. Curr Opin Nephrol Hypertens, 21(2), 163–70.
22. Phatarpekar P. V., Wen J., Xia Y. (2010). Role of adenosine signaling in penile erection and erectile disorders. J Sex Med. 7(11), 3553–64.
23. Reffelmann T., Kloner R. A. (2006). Sexual function in hypertensive patients receiving treatment. Vasc Health Risk Manag. 2(4):447–55.
24. Ryan J. G., Gajraj J. (2012). Erectile dysfunction and its association with metabolic syndrome and endothelial function among patients with type 2 diabetes mellitus. J Diabetes Complications, 26(2), 141–7.
25. Salenave S., Trabado S., Maione L., Brailly-Tabard S., Young J. (2012). Male acquired hypogonadotropic hypogonadism: Diagnosis and treatment. Ann Endocrinol (Paris), 73(2), 141–6.
26. Schulman C., Lunenfeld B. (2002). The ageing male. World J Urol, 20(1), 4–10.
27. Surampudi P. N., Wang C., Swerdloff R. (2012). Hypogonadism in the aging male diagnosis, potential benefits, and risks of testosterone replacement therapy. Int J Endocrinol. 625434.
28. Zitzmann M., Nieschlag E. (2000). Hormone substitution in male hypogonadism. Mol Cell Endocrinol, 161(1–2), 73–88.

29. Traish A. M., Feeley R. J., Guay A. (2009). Mechanisms of obesity and related pathologies: androgen deficiency and endothelial dysfunction may be the link between obesity and erectile dysfunction. FEBS J., 276(20), 5755–67.
30. Vecchio M., Navaneethan S. D., Johnson D. W., Lucisano G., Graziano G., Saglimbene V., Ruospo M., Querques M., Jannini E. A., Strippoli G. F. (2010). Interventions for treating sexual dysfunction in patients with chronic kidney disease. Cochrane Database Syst Rev.(12), CD007747.
31. Wen J., Xia Y. (2012). Adenosine signaling: good or bad in erectile function? Arterioscler Thromb Vasc Biol, 32(4), 845–50.
32. Williams S. K., Melman A. (2012). Novel therapeutic targets for erectile dysfunction. Maturitas, 71(1), 20–7.

Aadress for correspondence:
Helen Orro
Institute of Anatomy
University of Tartu
Ravila 19, 50411 Tartu
E-mail: helen.orro@ut.ee

Papers on Anthropology XXI, 2012, pp. 201–211

AN ANTHROPOMETRIC MODEL FOR NUTRITION RESEARCH OF ESTONIAN FEMALE STUDENTS[1]

JANA PETERSON, HELJE KAARMA, SÄDE KOSKEL

Centre for Physical Anthropology, University of Tartu, Tartu, Estonia

ABSTRACT

The study is focused on creating an anthropometric model that would enable to associate the body build peculiarities with nutritional variables. Thirty-six body measurements and 12 skinfolds were measured on 131 17–23-year-old female students of the University of Tartu, and 12 body composition characteristics were calculated. The subjects had to submit descriptions of their 24-hour menus. Nutrient intake was determined using the Micro-Nutrica software and the food composition database; the energy (in kcal) and main nutrients (proteins, fats and carbohydrates) content in the subjects' 24-hour menus were calculated. All body measurements were compared with nutritional variables, and 29 anthropometric variables were found that showed statistically significant correlations with at least one nutrient characteristic. The amount of food consumed correlated positively with body density and negatively with weight, circumferences, skinfolds and all indicators of body fat content (r reached 0.32). To associate body size, shape and composition with the amount of food consumed, a 5 SD height and weight classification was used, which consisted of three classes of concordance between height and weight (small, medium, large) and two classes of disconcordance – pyknomorphs and leptomorphs. All the 29 body measurements and nutrient were distributed systematically between the different classes. The pyknomorphous class with its greater body fat content and smaller density contrasted clearly with the class of leptomorphs. Food consumption in total as well as per 1 kg of body weight was smaller in pyknics

[1] Originally published as "Using a height-weight classification for analysis of food energy and main nutrient contents in 24-hour menus of 17–23-year-old Estonian female students" in *Anthropologischer Anzeiger* 2007, 1, 51–59.

than in leptosomes. Protein consumption did not reveal statistically significant differences. One should not overestimate the significance of BMI in nutritional studies. BMI characterises only obesity and cannot replace the characterisation of different body types. In our study, BMI of the small and the leptosomic class was almost equal, although these body types differ greatly from each other.

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

INTRODUCTION

Mutual connection between health variables, anthropometric measurements and nutrition patterns has been reported in many studies [1, 10, 14, 16]. Although the relations between constitutional peculiarities and nutrition are well known, there are no universally recognized anthropometric methods for comparing the amount of food consumed by subjects with the peculiarities of their body build.

The authors of the article set themselves the aim of studying the feasibility of creating such an anthropometric model using the sample of 17–23-year-old female students of the University of Tartu.

MATERIAL AND METHODS

Subjects

The sample consisted of 131 first- and second-year female students of the University of Tartu (aged from 17 to 23 years) who were studied in 1996 and 1997.

Anthropometric research

The methodology of anthropometric study of these students relied on long-term research carried out on many populations at the Department of Obstetrics and Gynecology and the Centre for Physical Anthropology at the University of Tartu [2, 3, 12].

Anthropometric measurements were taken personally by the first author of the article. Students were measured according to the classical method of Martin [7]. Measuring the skinfolds followed the methodology provided in Knußmann's handbook [7: 274].

Thirty-six anthropometric variables and 12 skinfolds were taken. For body composition analysis, body mass index, Rohrer index, body density [17], body surface area, mass and relative mass of subcutaneous adipose tissue, and relative mass of fat by Siri were calculated. In addition, total cross-sectional areas of arm and thigh and the bone-muscle and fat rate of their cross-sectional areas were calculated.

The subjects were also asked to submit descriptions of their 24-hour menus. For filling in their food-diaries, they were instructed to choose a regular working day.

Statistical analysis

Statistical analysis was performed using the SAS-program. First the mean values ($\bar{X}$) and standard deviations of all anthropometric variables were calculated for age groups 17–23. However, as age-related anthropometric differences were mostly insignificant, the students were further analysed as one group.

Nutrient intake was determined using the Micro-Nutrica software and the food composition database [11]. The collected data were used to calculate the most essential energy and nutrient contents of individual 24-hour menus: food energy (kcal), proteins (g), fats (g) and carbohydrates (g).

Thereafter, correlations were found between all the body measurements and food energy and main nutrient content in the menu. Table 1 lists these body measurements (29) that showed statistically significant correlations with at least one nutrient.

To further assess the body measurements that were in statistically significant correlation with nutrition from the viewpoint of the body as a whole, a 5 SD classification of height and weight was used. The application of this classification for assessment of the anthropometric aspect of the body as a whole has justified itself in our earlier studies [5, 9, 12], as it enables systematic comparison of length, breadth and depth measurements, circumferences and body composition characteristics in many populations.

The basis for creating of the classification was the mean height, weight and their standard deviations of all young women. To create the 5 SD classification, initially $3 \times 3 = 9$ SD classes of height and weight were formed. From these nine classes, we took three classes of concordance between height and weight (small height – small weight, medium height – medium weight, big height – big weight). The remaining six classes were joined into two classes of disconcordant height and weight (pyknomorphs with big weight and small height, and leptomorphs with small weight and big height; see Fig. 1).

Table 1. Correlations between anthropometric variables and consumption of energy and main nutrients in female students aged 17–23 years (n = 131).

Variable	Energy (kcal)	Proteins (g)	Fats (g)	Carbohydrates (g)
Weight	–0.21°	–0.12	–0.14	–0.23°
Waist circumference	–0.17	–0.07	–0.10	–0.21°
Pelvis circumference	–0.23°	–0.10	–0.17	–0.25°
Hip circumference	–0.25°	–0.14	–0.18	–0.25°
Waist skinfold	–0.25°	–0.16	–0.18	–0.27°
Suprailiac skinfold	–0.28°	–0.15	–0.22°	–0.28°
Umbilical skinfold	–0.30°	–0.22	–0.22°	–0.30°
Subscapular skinfold	–0.30°	–0.17	–0.21°	–0.32°
Thigh skinfold	–0.27°	–0.15	–0.20°	–0.28°
BMI	–0.26°	–0.15°	–0.23	–0.24°
Rohrer index	–0.23°	–0.16°	–0.17°	–0.23°
Body surface area	–0.17°	–0.09	–0.11	–0.18
Mass of subcutaneous adipose tissue	–0.30°	–0.18°	–0.24°	–0.30°
Relative mass of subcut. adipose tissue (%)	–0.17°	–0.09	–0.11	–0.18
Relat. mass of fat by Siri (%)	–0.31°	–0.18°	–0.23°	–0.32°
Body density (g/cm^3)	0.22°	0.08	0.17°	0.23
Total cross-sectional area of arm (cm^2)	–0.23°	–0.13	–0.21°	–0.21°
Total cross-sectional area of thigh (cm^3)	–0.25°	–0.17°	–0.21°	–0.23°
Bone-muscle rate of the cross-sectional area of arm (cm^2)	–0.18	–0.09	–0.19°	–0.15
Fat rate of the cross-sectional area of arm (cm^2)	–0.22°	–0.13	–0.18°	–0.21°
Fat rate of the cross-sectional area of thigh (cm^2)	–0.27°	–0.16	–0.22°	–0.27°

<table>
<tr><td colspan="4">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>Large</td></tr>
</table>

Figure 1. Body build classes

Thus, the 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 $\geq \bar{x}_w + 0.5\ SD_w$ and height $\geq \bar{x}_h + 0.5\ SD_h$

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

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

The subjects were placed into the classes of this classification according to their individual heights and weights (Table 2). Thereafter, the mean values of all the 29 anthropometric variables were calculated for all classes. Then the mean values of energy, proteins, fats and carbohydrates in the food consumed were added.

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

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

Table 2. Mean values of anthropometric variables and nutrients consumption in height-weight classes in female students aged 17–23 years (n = 131)

Variable	I Small n = 28 x̄/SD	II Medium n = 29 x̄/SD	III Large n = 21 x̄/SD	Statistics 1–3	IV Pycnomorphic n = 25 x̄/SD	V Leptomorphic n = 34 x̄/SD	Statistics 4–5
Height (cm)	160.11/2.90	167.46/1.94	175.53/3.40	+	164.20/4.20	171.29/3.35	+
Height (kg)	50.948/3.804	60.535/2.853	72.230/4.46	+	64.546/8.694	57.706/3.761	+
Upper chest circumference (cm)	80.70/2.57	84.77/2.82	89.68/4.21	+	87.62/5.58	83.19/3.15	+
Waist circumference (cm)	64.96/2.90	69.08/4.86	75.58/4.71	+	73.02/6.71	66.78/2.34	+
Pelvis circumference (cm)	81.42/3.45	86.30/4.29	93.10/4.89	+	90.86/6.90	84.77/3.13	+
Hip circumference (cm)	89.61/3.67	96.14/3.14	102.21/4.90	+	99.76/6.18	94.69/3.36	+
Waist skinfold (cm)	1.11/0.43	1.17/0.39	1.69/0.48	+	1.56/0.53	1.02/0.30	+
Suprailiac skinfold (cm)	1.00/0.37	1.08/0.38	1.42/0.59	+	1.45/0.49	0.90/0.27	+
Umbilical skinfold (cm)	0.99/0.30	1.08/0.33	1.51/0.33	+	1.62/0.36	1.10/0.28	+
Subscapular skinfold (cm)	0.99/0.32	1.18/0.44	1.53/0.51	+	1.76/0.75	0.93/0.23	+
Thigh skinfold (cm)	2.26/0.73	2.87/0.53	3.11/0.60	+	3.18/0.65	2.36/0.68	+
BMI	19.88/1.46	21.59/1.04	23.46/1.79	+	23.90/2.64	19.66/0.94	+
Rohrer index	1.24/0.1	1.29/0.07	1.34/0.12	+	1.46/0.16	1.15/0.05	+
Body surface area (m^2)	1.51/0.06	1.68/0.04	1.88/0.052	+	1.703/0.115	1.68/0.06	–
Mass of subcut. adipose tissue (kg)	7.26/2.202	9.25/2.07	12.64/2.74	+	12.18/3.68	8.03/1.89	+
Relat. mass of subcut. adipose tissue (%)	14.15/3.48	15.23/3.10	17.34/3.32	+	18.63/3.66	13.85/2.84	+

Table 2. Continuation

Variable	I Small n = 28 x/SD	II Medium n = 29 x/SD	III Large n = 21 x/SD	Statistics 1–3	IV Pycnomorphic n = 25 x/SD	V Leptomorphic n = 34 x/SD	Statistics 4–5
Relat. mass of fat by Siri (%)	16.60/0.19	16.74/0.20	16.90/0.24	+	16.98/0.30	16.58/0.15	+
Body density (g/cm^3)	1.061/0.000	1.0606/0.000	1.0602/0.000	+	1.0600/0.000	1.0609/0.000	+
Total cross-sectional area of arm (cm^2)	47.31/6.47	54.93/4.86	61.34/6.23	+	62.17/11.95	49.64/5.65	+
Total cross-sectional area of thigh (cm^2)	231.72/23.86	264.11/25.66	311.71/27.19	+	293.41/44.72	242.48/21.35	+
Bone-muscle rate of the cross-sectional area of the arm (cm^2)	36.63/4.23	41.18/3.20	44.29/4.98	+	43.48/6.19	38.37/4.46	+
Fat rate of the cross/sectional area of the arm (cm^2)	10.68/3.39	13.75/2.67	17.05/4.25	+	18.69/6.62	11.27/3.25	+
Fat rate of the cross-sectional area of thigh (cm^2)	57.13/18.86	76.29/15.56	89.85/18.79	+	88.79/22.50	60.63/17.68	+
Energy (kcal)	1608.60/685.88	1699.58/610.11	1568.38/602.47	–	1423.56/543.88	1766.65/562.65	+
Proteins (g)	49.94/18.67	57.69/23.21	52.56/25.55	–	49.61/19.64	59.05/22.19	–
Fats (g)	55.73/32.95	50.64/21.69	53.24/33.30	–	45.90/27.26	66.94/30.84	+
Carbohydrates (g)	221.45/91.25	247.42/105.56	214.44/77.02	–	198.14/79.86	224.91/67.09	–
Energy/body weight (kcal/kg)	31.83/19.34	29.72/12.31	21.44/8.24	+	23.72/10.03	30.21/12.80	+
Proteins/body weight (g/kg)	0.97/0.34	1.02/0.43	0.71/0.34	–	0.83/0.37	1.00/0.39	–
Fats/body weight (g/kg)	1.09/0.77	0.95/0.49	0.72/0.44	+	0.77/0.48	1.10/0.54	+
Carbohydrates/body weight	4.43/2.68	4.13/1.99	2.97/1.11	+	3.30/1.45	3.97/1.25	+

RESULTS

The study of relations between body build and nutrition started from correlation analysis. Table 1 presents the correlation coefficients of all the 29 anthropometric variables that showed significant correlation with nutrition. It may be surprising that the impact of body composition is clearly revealed in the amount of food consumed. While body fat indicators are in negative correlation with the amount of food consumed, body density was the only indicator that showed positive correlations. The strongest correlations could be found between body measurements and carbohydrates content in food; the strength of these correlations reaches $r = 0.32$. In addition to clearly discernible differences in body composition, the essence of body build as a whole could also be noticed. We are used to thinking that the main indicator is body weight. Correlation analysis, however, shows that thicknesses of individual skinfolds are no less important for representing the body as a whole. Thus, the correlation between body weight and the amount of food energy consumed is $r = -0.21$, but suprailiac skinfold ($r = -0.28$) and umbilical skinfold ($r = -0.30$) demonstrate even stronger correlations. The peculiarities of body composition are similarly represented by BMI, Rohrer index and total cross-sectional areas of the arm and the thigh. Body height alone does not correlate with the amount of food consumed, but it is the most significant component representing body size, shape and density.

Consequently, the anthropometric model for nutrition research might be a classification that would facilitate the systematisation of body size, shape and composition within the population under study. In our research, we applied a 5 SD classification of height and weight.

In Table 2, all the young women ($n = 131$) were placed into classes according to their individual heights and weights. For all the classes, the mean values of the 29 body measurements and body composition characteristics, food energy and the main nutrients consumed were calculated, and the significance of differences was assessed by the t-test.

The table shows that the gradual increase in height and weight in classes small-medium-big brings about a gradual, statistically significant increase in all the circumferences, skinfolds, BMI, Rohrer index, indicators of subcutaneous adipose tissue and total fat content, body density, total cross-sectional areas of the arm and the thigh, fat rates in the arm and the thigh, and bone-muscle rate in the arm.

The same variables also differ clearly in the classes of pyknomorphs and leptomorphs. In the class of pyknomorphs, body fat content is significantly higher and body density significantly lower than in the class of leptomorphs.

As food energy and main nutrients consumption, no statistically significant differences were revealed between the first three classes.

Interesting differences, however, appeared in calculations per 1 kg of body weight. The amount of energy as well as carbohydrates and fats consumed per 1 kg of body weight decreases gradually in the direction from small to medium to large. Protein consumption also shows a similar decreasing trend, but the differences between the classes are not significant.

The consumption of energy and main nutrients in the class of pyknomorphous young women was lower than in the class of leptomorphs in total amount as well as per 1 kg of body weight. The same cannot be statistically proved about the total amount of proteins and carbohydrates consumed and their consumption per 1 kg of body weight, although a corresponding tendency exists.

DISCUSSION

The results of our study indicated that the peculiarities of body build – height, weight, body composition – have significant correlations with the amount of food energy and main nutrients consumed. The problem, however, consists in finding an anthropometric classification that could serve as a basis for statistical analysis of a great number of body build and nutritional data.

Our results suggest that this could be a 5 SD classification of height and weight. Our long-term studies on the whole body anthropometric structure have confirmed that the body as an anthropometric whole consists of individual characteristics that show statistically significant mutual correlations, where the leading characteristics are height and weight. Height and weight correlate most closely with all other characteristics and determine more than 50% of the variability of all the individual characteristics [4, 5].

While creating the classification, we took into consideration that it could be used to characterise different stages of concordance between height and weight (small, medium, large) [6] and simultaneously characterise the classical somatotypes – pyknics and leptosomes [8] as the greatest manifestations of disconcordance between height and weight.

Our detailed comparative studies on the body structure of pyknics, leptosomes and other body build classes have shown that the bodies of pyknics and

leptosomes have no special structure but are also based on relations between height and weight [3].

As body fat content and body density are two very essential factors from the viewpoint of nutrition, the classes of pyknomorphs and leptomorphs in the current classification present a splendid opportunity to compare the nutritional data of persons belonging to these classes [13].

Our experience in studying the body structure of many different populations (schoolchildren, young women, conscripts) has shown that in such a classification many length, breadth and depth measurements, circumferences and body composition characteristics fall into a system according to classes [4, 9, 12, 15]. One of the advantages of this classification is that it consists of SD classes; therefore, the mean anthropometric data of populations of different ages or nationalities, when analysed in an analogous way, are mutually comparable.

It should be noted that the significance of only one indicator – body mass index – in nutrition studies should not be overestimated. Although this index has been formed from height and weight, it characterises only obesity and, therefore, it cannot replace the analysis of different body types. For example, in our study, the BMI of small and leptosomic classes was almost equal, although these body types are greatly different.

REFERENCES

1. Buddeberg-Fischer B., Bernet R., Sieber M., Buddeberg C. (1996). Epidemiology of eating behaviour and weight distribution in 14- to 19-year-old Swiss students. Acta Psychiatr. Scand. 94, 296–304.
2. Kaarma H. (1981). Multivariate statistical analysis of women's anthropometric characteristics system. Tallinn: Valgus.
3. Kaarma H. (1995). Complex statistical characterization of women's body measurements. Anthrop. Anz. 53, 239–244.
4. Kaarma H., Stamm R., Kasmel J., Koskel S. (2005). Body build classification for ordinary schoolgirls (aged 7–18 years) and volleyball girls (aged 13–16 years). Anthrop. Anz. 63, 77–92.
5. Kaarma H., Veldre G., Stamm R., Lintsi M., Kasmel J., Maiste E., Koskel S. (2001). Regularities of body build structure of Estonian girls and youths. Morphology 120, 80–82 (in Russian).
6. Knußmann R. (1961). Makrosomie-Mikrosomie als körperbautypologische Variationsreihe II. Ordnung. – Homo, 12, 1–16.

7. Knußmann R. (1988). Anthropologie. Handbuch der vergleichenden Biologie des Menschen. Band I: Wesen und Methoden der Anthropologie. Gustav-Fischer-Verlag. Stuttgart/New York.
8. Kretschmer E. (1961). Körperbau und Charakter. Berlin/Göttingen/Heidelberg: Springer Verlag. (1. Aufl. 1921).
9. Lintsi M., Kaarma H., Saluste L., Vasar V. (2002). Systemic changes in body structure of 17–18-year-old schoolboys. Homo 53, 157–169.
10. Loolaid K., Loolaid V., Kaarma H., Saluste L. (1999). Dietary intake and body structure of girls from secondary schools of Tartu. Papers on Anthropology VIII, 103–107.
11. Micro-Nutrica, Food and Nutrition (1997). Tallinn Technical University, Department of Food Processing.
12. Peterson J., Saluvere K. (1998). Systematisation of anthropometric data of 18-year-old girls by statistical model. Biol. Sport 15, 105–112.
13. Peterson J., Kaarma H., Koskel S. (2007). Using a height-weight classification for analysis of food energy and main nutrient content in 24-hours menus of 17–23-year-old Estonian female students. Anthrop. Anz. 65, 1, 51–59.
14. Rolland-Cachera M. F., Bellisle F., Deheeger M. (2000). Nutritional status and food intake in adolescents living in Western Europe. Eur. J. Clin. Nutr. 54, 41–46.
15. Saluvere K., Peterson J., Saluste L., Koskel S. (1998). Systematisation of anthropometric data of 17-year-old schoolgirls from Tartu, Estonia. Anthrop. Anz. 56, 267–280.
16. Wardle J., Steptoe A., Bellisle F., Davou B., Reschke K., Lappalainen R., Fredrikson M. (1997). Healthy dietary practices among European students. Health Physiol. 16, 443–450.
17. Wilmore J. H., Behnke A. R. (1970). An anthropometric estimation of body density and lean body weight in young women. Amer. J. Clin. Nutr. 23, 267–274.

Address for correspondence:
Helje Kaarma Dr.Sc., Dr.med.
Centre for Physical Anthropology
Institute of Anatomy
Faculty of Medicine
University of Tartu
E-mail: antrop@ut.ee

Papers on Anthropology XXI, 2012, pp. 212–220

COMPARATIVE ANALISIS OF STUDENTS' PHYSICAL ACTIVITY LEVELS

LIANA PĻAVIŅA

National Defence Academy of Latvia, Latvia

ABSTRACT

The length of the active working life period increases. The interest in the ways of keeping the quality of life, the high working capacities and potentiality of individual creative abilities is high. Many of the habits of the healthy lifestyle and behaviours are developed during the late adolescence and early adulthood. The decline of the individuals' physical activity in that period have an input in the future life quality. The physical working capacities are based on the physical health, the physical development level, physical activity and the healthy lifestyle. The target of the paper is to evaluate the principle anthropometric characteristics and provide the analysis of the students' physical activity levels. Regular physical activity is protective against numerous chronic disease and gives an important contribution for the healthy lifestyle. The main benefits of physical activity are disease preventions, stress management, to have a fun cycling, the improved body beauty. Recent research suggests that a significant percentage of students did not get adequate physical activity. The information concerning eating habits, sports habits, life styles are very important. We have provided a questionnaire for the students from different higher schools concerning physical activities. Respondents were aged from 19 years to 33 years. The questionnaire includes the positions that allow us to collect information about sports and physical activity during the time of the working day and after it. The questionnaire embraced all the spectrums of the week's physical activities. The data of the questionnaire were evaluated according to the scale (in points) and calculated. Those data allow us to divide respondents into subgroups according to the levels of physical activity (low, moderate, and good, high). The determination of the degree of physical activity is essential for answering questions on health sciences for the identification of the target groups for health-related intervention.

Key words: *Anthropometric characteristics of students, physical activity of students, physical development of students*

INTRODUCTION

Nowadays the length of the active working life period increases. The interest in the ways of keeping the quality of life, the high working capacities and the potentiality of individual creative abilities is high[1, 2, 3, 4]. The physical working capacities are based on the physical health, the physical development level, physical activity and the healthy lifestyle. Physical activity is considered a fundamental link by the World Health Organization for the control of non-communicable diseases. Overweight is an established risk factor for cardio metabolic disorders. Therefore in the developed countries interest in the influence of physical activity as a preventive intervention has been promoted [8]. Individual self-perceptions are often associated with physical activity [5, 7]. The main benefits of physical activity are disease preventions (82%), stress management (54.5%), to have a fun cycling (44.5%), the improved body beauty 43.5% [8]. The decline of physical activity in young adulthood when many attend college or university is a disturbing trend [7, 8]. Recent research suggests that a significant percentage of college students do not get adequate physical activity The main reasons not to participate in physical activities were the lack of time (63%), the activities schedule (40%) the price (24%), and the distance (22.0%) in most of the students. The preferred activities identified by are collective sport with friends (64.4%) and cycling (63.4%), group outdoor activities (54,1%) [7].

The information concerning eating habits, sports habits, life styles are very useful. The target of the paper is to evaluate the principle anthropometric characteristics, the levels of students' physical activity. Physical activities assessment became more and more popular especially in outdoor physical activities. Many individuals attend the sport clubs, sport halls group exercises, swimming pools, but at the same time there are large groups of young people (students) who are physically inactive. The most frequent reasons for physical activities are healthy, life beauty; enhancing socializing between participants, a time spending way. Many of the habits of the healthy lifestyle and behaviours are developed during the late adolescence and early adulthood. The decline of the individual physical activities level in that period have an input for the future life period. Very acute is the problem of overweight.

MATERIAL AND METHODS

We have provided the assessment of the principal anthropometric characteristics (height and body mass) as well the anthropometric indices (the Body Mass Index and the height-weight coefficient) for the students from different higher schools (the National Defence Academy (NDA); the Riga Teacher Training and Education Management Academy (RTTEMA); the Latvian University Medical faculty (LU); the Riga Medical College; the Fitness program students). Respondents were female-students (n=88) in the age from 19 years to 33 years. We have provided a questionnaire for students concerning physical activity [6]. The questionnaire includes the positions that allow us to collect information about sports and physical activity during the time of the working day and after it. The questionnaire embraced all the fields of the week's physical activities. We have included the questions related to health problems – diseases (cardiovascular, respiratory, gastrointestinal) traum, ect. – and the duration of medical incapability (days per year). The data of the questionnaire were evaluated according to the scale (in points) and calculated. Those allow us to divide respondents into subgroups according to the levels of physical activity (low, moderate, and good, high). The respondents whose future speciality demanded a high level of physical activity and fitness (from the National Defence Academy; the Riga Teacher Training and Education Management Academy and the Fitness program) were included in the 1st group. The respondents whose future speciality does not require a high physical fitness level from the Latvian University Medical Faculty; the Riga Medical College) were included in the 2nd group.

RESULTS AND DISCUSSION

We have determined the main anthropometric characteristics in the groups of respondents. The height parameters in some respondents' groups did not reveale any difference. So the students from the NDA had the average data of height 170.1±2.5cm, the average data of height for the students from RTTEMA was 170.7±1.0 cm. The average data of height in the Fitness program students' group was 170.1±0.9cm. but the average height parameters in the students group from the University was 167.1±1.8cm. The average data of the height of the students from the Medical college was 166.9±1.2 cm (Figure 1).

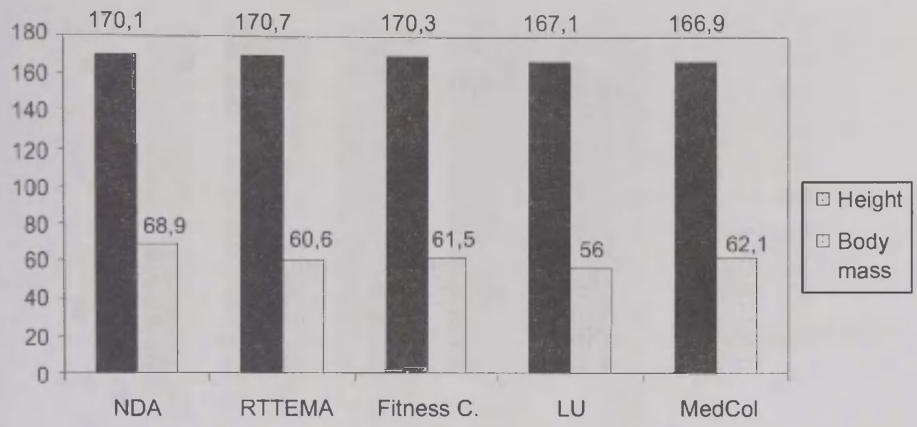


Figure 1. Distribution of respondents according to the height and the body mass characteristics.

The body mass characteristics were different in the examined students' groups. The highest level of the body mass we have determined for the students from the NDA 68.9 ±3.78 kg with the variation between 57 kg and 92 kg, the lowest level of the body mass we have found for the students of the Medical faculty from Latvian University 56.0± 2.2 kg (Figure 1).

Respondents from different high schools were divided into two groups. The first group (1st group) included the students whose future speciality demanded a high level of physical activity and fitness (students from the National Defence Academy; the Riga Teacher Training and Education Management Academy, the Fitness program students). The second group (2nd group) included the students who have not any obligation to keep to a high level of physical activity (medical specialty), whose future speciality does not require a high physical fitness level. There were students from the Latvian University Medical faculty and the Riga Medical College. We have evaluated the anthropometric indices' levels (the Body mass index (BMI) and the weight-height index) in the respondents groups. We did not reveal the overweight problem in the respondents' groups, we have determined the tendency to overweight. The numbers of students with the tendency to overweight were equal in the 1st group (13.1%) and the 2nd group (12.5%). We have noticed the number of individuals with a low level of the BMI in the 1st group – about 4.3% and in the 2nd group 10%. (Figure 2)

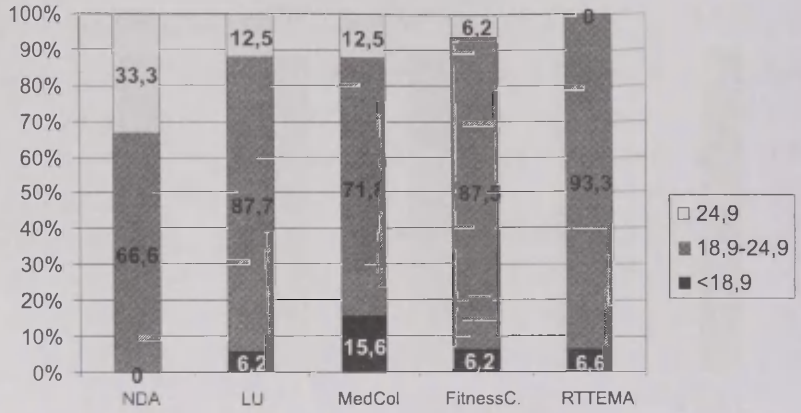


Figure 2. Distribution of respondents' Body mass index (%)

The weight – height index value indicated the body constitution type. The respondents with a weight – height index value under the standard value had the asthenic body constitution type. The were about half of the respondents in the Fitness students program (50%) and in the students' group from Latvian University (43.7%) with the asthenic body constitution type. I/3 of the respondents from the Riga Medical College and only 1/10 of respondents from the NDA had the asthenic constitution type. The normasthenic constitution type is characterized by the standard value of the weight-height index. The 5/6 of respondents from the RTTEMA (86.3%), the 1/3 of respondents from Latvian University (37.5%) and the Riga Medical College (28.1%), and 1/10 of the respondents from NDA (11.1%) had the normasthenic constitution type. The hypersthenic body constitution type is characterized with the weight-height index that is over the standard value. There were ¾ of respondents from the NDA (77.7%) with the hypersthenic constitution type. There were about ¼ respondents in Latvian University (25%) and the student of the Fitness program (25%) with the hypersthenic constitution type and 40.6% of the students from the Medical College had the hypersthenic constitution type (Figure 3).

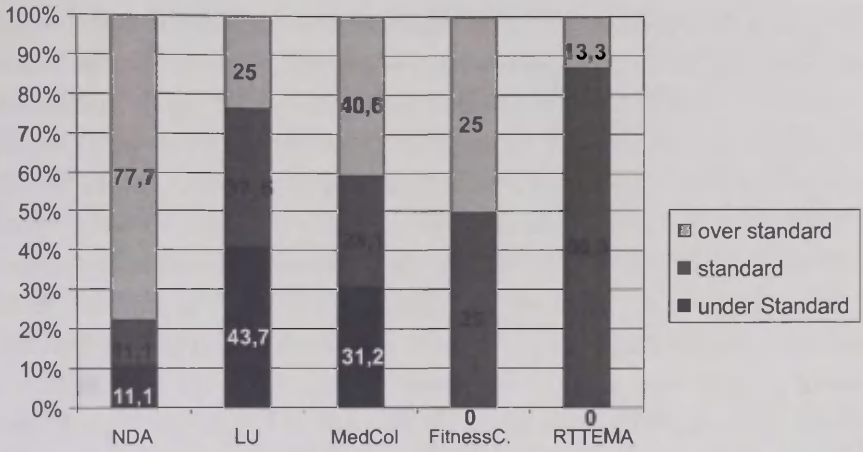


Figure 3. Distribution of respondents according to the weight-height index levels (%).

According to the questionnaire's results the average physical activity level in the 1st group (58.6 points) – is about 70% higher than the results of the physical activity level in the 2nd respondents group (34.4 points). Different levels of the physical activities depended on administrative, organizing, economic and financial reasons. The comparative analysis of physical activity in the different students' groups revealed that the highest level of physical activity was in the students' group from the National Defence Academy – 72.3±4.8 points. The level of physical activity in the students' group from the RTTEMA (47.1±5.6 points) and the Fitness program students (56.1 ±3.2 points) were lower. The level of physical activity for the students from Latvian University Medical faculty was 38.1±3.9, and the level of physical activity in the students' group from the Medical College was 30.9 ±3.9points (Figure 4).

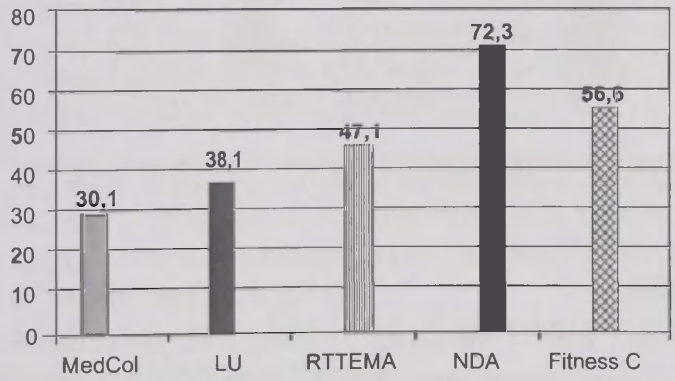


Figure 4. Distribution of respondents according to the physical activity level (%)

The data of the questionnaire were evaluated according to the scale (in points) and calculated. Those allow us to divide respondents into subgroups according the levels of physical activity (low, moderate, and good, high). The analysis of the physical activity level in different students' groups allow us to determine that the high level of physical activity was fixed for 44.4% of respondents from the NDA, for the 25% of students of the Fitness program and for the 20% students from the RTTEMA The low physical activity levels were revealed for 37.5% students from the Latvian University Medical Faculty and 43.7% of students from the Riga Medical college. There were no students with the low level of physical activity in the students' groups from the NDA. Half of the students from the RTTEMA (53.3%) and Latvian University (43.7%) had the moderate physical activity level. There are about 31.2% of the respondents from the Medical College and the Fitness program students group with the moderate physical activity level. The good level of physical activity was found for 44.4% of students from the NDA and 43.7% students of the Fitness program group. There were about 18.7% of the respondents with the good physical activity level in the students' group from Latvian University and 21.9% of the respondents from the Medical College (Figure 5).

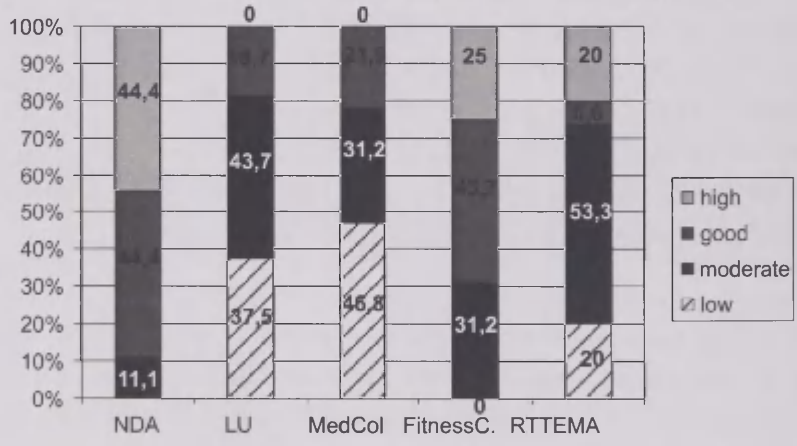


Figure 5. Distribution of Physical activity levels in different students' groups.

CONCLUSION

1. The average value of the height parameters for the students-female from different higher schools was 169.02±0.73cm. The individual variations of the height were in the interval between 154 cm and 185.5 cm. The

respondents of the 1st group (where the demands of physical fitness were high) had higher height parameters than the respondents from the 2nd group (whose future speciality did not need high physical preparedness).

2. The average value of the body mass in the examined group was 61.82±1.09 kg The problem of overweight exists in the students' population. There were 13.1% of the students of the 1st group (where the demands of physical fitness were high) and 12.5% of the students in the 2nd group (whose future speciality did not need high physical preparedness).
3. The average value BMI in the 1st and the 2nd groups corresponded to the standard.
4. According to the questionnaire's results the good Physical activity level (58.6 points) is about 70% higher than the results of the physical activity level in the 2nd respondents group (34.4 points) that corresponded to the moderate physical activity level. The low physical activity levels were revealed for 37.5% of the students from the Latvian University Medical Faculty and 43.7% of students from the Riga Medical College.

REFERENCES

1. Bras R., Rodrigues R. G., Pinheiro P., Esteves D., O'Hara K.(2011). Dimensions of physical activity expectations: Implications for designing and marketing exercise. In: Book of Abstracts of 16th Annual Congress of the European College of Sports Science. 6–9 July, 2011, Liverpool, UK, 148.
2. Bula I., Jansone R., Grants J. (2010). Habits of physical activities in Families (Empirical investigation). Scientific Journal of RTU, 17, 114–118.
3. Fairclough S. J., Ridgers N. D. (2010). Relationship between maturity status, physical activity and physical self-perception in primary school children. J. of Sports Sciences, 28, 1, 1–9.
4. Moreno Gomez C., Tauler P., Aguilo A. (2011). Factors affecting practice of Physical, Activity Among University Students// Book of Abstracts of 16th Annual Congress of the European College of Sports Science. 6–9 July, 2011, Liverpool, UK, 152.
5. Porozovs J. (2010). Evaluation of Physical activity, lifestyle and health condition of students. In: 5th International Scientific Conference RTTEMA Scientific Articles and Conference Proceedings. Theory for Practice in the Education of Temporary Society. Riga, Latvia, 253–259.
6. Виленский М. Я., Ильинский В. И. (1987). Физическая культура работников умственного труда. Москва. Знание.

7. Ruiz Tendero G. (2011). Is University a good environment for physical activity. In: Book of Abstracts of 16th Annual Congress of the European College of Sports Science. 6–9 July, 2011, Liverpool, UK p149.
8. Veira S., Esteves D., Bras R., Pinheiro P. (2011). Physical activity levels, preference and impairments among Portuguese college students. In: Book of Abstracts of 16th Annual Congress of the European College of Sports Science. 6–9 July, 2011, Liverpool, UK, 247–248.

Address for correspondence:
Liana Pļaviņa
National Defence Academy of Latvia
LV-1014, Ezermalas str. 8, Riga, Latvia
Tel. +371 29208611

Papers on Anthropology XXI, 2012, pp. 221–231

MORPHOTYPOLOGICAL CRANIUM VARIABILITY IN THE POPULATION OF CENTRAL BELARUS IN THE 2ND – EARLY 3RD MILLENNIUM A.D.

N. N. POMAZANOV

Anthropology and Ecology Department,
Institute of History of the National Academy of Sciences of Belarus, Minsk, Belarus

ABSTRACT

The article investigates cranial variability in the inhabitants of, for the most part, central Belarus within the space of the second to early third millennium AD. In analysing the craniometric and cephalometric material we have used the morphotypological approach. We have used the classification of skull morphotypes proposed by V. V. Bunak, which is based on the correlation of the classes of the absolute values of the transversal and longitudinal braincase diameters. Co-variability of the basic diameters of human skulls on the Belarusian territory in the above-mentioned period has been taking place within the paraeuroid-mesoid *(pm)*, i.e. mediumbroad medium dolichocephalic (long-headed) morphotype (10–13th centuries, 18–19th centuries and the early 21st century) with transition to the euroid-mesoid *(em)*, i.e. to broad medium dolichocephalic (second half of 20th century) and with the subsequent return to paraeuroid-mesoid (mediumbroad medium dolichocephalic) morphotype in the early 21st century. Thus, on the basis of the morphotypological approach (Bunak, 1922), we can state that the contribution of the transverse diameter both in epochal and in intergenerational typological variability of the cerebral part of the head appears to be more significant.

Key words: *morphotypological approach, skull morphotypes, epochal and intergenerational variability*

INTRODUCTION

Studying the patterns of the spatial organization of the skull as a whole and in separate parts, the exploration of the individual variability of the skull and identifying the confines of the norm considering sexual, age, ethnic and other characteristics is a timely task of modern craniology [19]. A temporal analysis of the variability of the geometry of the skull also acquires special significance. The epochal change of the spatial peculiarities of the skull against the background of the general variability of the skull broadens the conception of the range of the normal and pathological variability in contemporary and fossil human populations [14–17, 19].

The ratio of the transversal to longitudinal diameter of the skull in the norm from the above (*norma verticalis*), expressed in units, is what is known as the cranial index. In spite of its great significance in ethnoracial morphological studies of human populations, we should note that this index, as well as other anthropometric indexes, has disadvantages.

The hungarian anthropologist A. Terek (A. Török) was one of the first to draw attention to the disadvantages of the cranial index. In the early 20th century he undertook an in-depth research of the variability of the given index and the anthropometric measurements that comprise it [26].

Although the cranial index does give an idea about the outward similarity of the contours of the skull, it does not reflect the entire variety of the combinations of the elements making up its form. The same cranial index on the individual and moreover, on the average group levels, does not yet denote skull uniformness. Therefore, besides the cranial index, it is expedient to furnish the morphological analysis with the classification of skull forms based on a rubrication of the absolute values of cranial diameters [7].

Thus, the primary purpose of our research is to identify in time the morphotypical peculiarities of epochal and intergenerational variabilities of the crania of the humans who populated the territory of Belarus.

MATERIALS AND METHODS

The morphological study of the cephalic peculiarities of Belarusians at the beginning of the 21st century was based on the materials collected in 2004–2006. The sample included 205 Belarusians of 16–18 years of age, 102 of whom were young men and 103 girls, who were inhabitants of small and average towns in central Belarus – Molodechno, Slutsk, Berezino, Dzerzhinsk

and Smolevichy. One or both parents of the majority of the surveyed (senior) schoolchildren and college students (the town of Smolevichy) were natives of the rural area.

In the research of the morphotypological peculiarities of the epochal variability of the crania of the Belarusian population, we have derived data from the works of V. P. Alekseyev, T. I. Alekseyeva, G. F. Debets and I. I. Salivon [1, 3, 9, 15].

In the Middle Ages, the territory of central Belarus was populated by the Dregovichies (a Slavic tribe). In the north they bordered on another Slavic tribe – the Krivichies. "... Other (slavs) settled between the Pripyat and the Dvina (rivers) and were called the Dregovichies, still others settled along the Polota river (a tributary of the Dvina) and that is why were called Polotians... From those Polotians come the Krivichies, with the lands of the upper Volga, the lands of the upper Dvina and the lands of the upper Dnieper as their home, and the city of Smolensk is their city" [11]. According to the absolute values of the average sizes of basic braincase diameters, the anthropological type of the representatives of all the groups of the population in the 10–13th centuries on the territory of Belarus was predominantly homogenious [9, 21]. For this reason our analysis included other Slavic samples such as the Radimichies – another Slavic tribe that dwelt on the Belarusian territory and bordered the Dregovichies in southeast.

The analysis of the racial peculiarities of modern Belarussians has shown the existence of two anthropological types – northern and southern [4, 8]. The northern Belarussian type differs from the southern Belarussian type in smaller brachiocephaly, a longer and a broader face, lighter hair pigmentation and other anthropological characteristics. The modern population of Belarus has formed on the basis of older anthropological types: the Dnieper-Carpathian type and that from the region of the Dvina and the upper Dnieper, which in the course of time formed the southern and northern anthropological types [4].

The materials we used for the cephalometric analysis of the morphological features of the crania were mostly of the northern anthropological type of Belarussians to which the population of the central Belarus also belongs.

For revealing typological peculiarities of the intergenerational variability of the crania of Belarussians, additional scientific data have been drawn from the works of M. V. Vitov, V. V. Bunak, K. N. Ikov, A. N. Rozhdestvensky, I. I. Salivon, A. Smirnov, E. M. Chepurkovsky, N. A. Yanchuk and Yu. Talko-Grintsevich [2, 4, 10, 13, 17–18, 22–23, 25].

Anthropometric measurements were performed in accodance with the conventional method developed by R. Martin [5, 20, 24]. Studying the dynamics (in time) of the distribution of different types of skull forms, we followed the classification proposed by Prof. V. V. Bunak [7].

Table 1. A rubrication of the morphological types of the head with the cephalometric range (after V. V. Bunak, 1922)

Width, mm	Length, mm		
	brachioid type short M. 149–176 (M.177–182) F. 149–168 (F. 169–173)	mesoid type medium long M. 177–194 (M. 183–188) F. 169–183 (F. 174–178)	dolichoid type long M. 195–230 (M.189–194) F. 184–230 (F. 179–183)
	MORPHOTYPES		
Stenoid type Narrow M.106–135 (M. 136–142) F. 106–130 (F. 131–136)	***sb*** *stenoid-brachioid* **narrow short**	***sm*** *stenoid-mesoid* **narrow medium long**	***sd*** *stenoid-dolichoid* **narrow long**
Paraueroid type Medium broad M. 136–155 (M. 143–149) F. 131–149 (F. 137–143)	***pb*** *paraueroid-brachioid* **medium broad short**	***pm*** *paraueroid-mesoid* **medium broad** **medium long**	***pd*** *paraueroid-dolichoid* **medium broad** **long**
Euroid type Broad M. 156–179 (M. 150–155) F. 150–179 (F. 144–149)	***eb*** *euroid-brachioid* **broad short**	***em*** *euroid-mesoid* **broad medium long**	***ed*** *euroid-dolichoid* **broad long**

Note: M, F. – male and female accordingly. The limits of the morphotypes formed by the division of the mesoid and paraeuroid types of male and female skulls are quoted in brackets.

In analysing the values of the longitudinal and transversal diameters of skulls and heads and their ratio, with a view of demarcation, comparisons were drawn according to diameters and the cephalic index. For diameters of the skull in this case, additions were made – 5 mm to the value of the longitudinal diameter of the skull, 6 mm [12] added to the value of the transversal diameter, and 2 units [10, 12] – to the value of the cranial index.

RESULTS AND DISCUSSION

As follows from the data in Table 2, all variability of the craniometric and cephalometric characteristics reflecting the form of the head in norm from above (*norma verticalis*), is concentrated within the paraeuroid-mesoid *(pm)* morphotype. Only between the 1950 s and 1980 s of the 20th century do the average group parameters attribute the population of central Belarus to euroid-mesoid *(em)* type of the skull. In that period, brachiocephalization manifested itself to the greatest extent. Thereafter, in the process of brachiocephalization the average group morphotype again returned to the paraeuroid-mesoid *(pm)* variant.

For greater specification of the orientation of the epochal variability of the form of the skull *norma verticalis*, skull morphotypes for the average range of longitudinal (mesoid) and transversal (paraeuroid) diameters were singled out [7]. Between the 11th and the 13th centuries, the average range of the longitudinal and the transversal diameters was predominantly paraeuroid-dolchioid *(pd)*, i.e. the medium broad dolichocephalic morphotype. The process of debrachicephalization continued, and the 18–19th centuries showed tendencies towards a predominance of the euroid-dolichoid *(ed)* or broad dolichocephalic morphotype of men and the euroid-mesoid *(em)*, i.e. broad medium dolichocephalic morphotype of women. At the beginning of the 21st century, when the period of the greatest manifestation of brachicephalization (1970–1980) was over, the average group morphotype of the head shifted into the scope of the euroid-mesoid *(em)* or broad medium dolichocephalic morphotype, both in men and women.

Figure 1 presents skull morphotypes and the ranges of variability of the basic diameters of male skulls from the territory of Belarus in the second to early third millennium AD.

The greatest average group longitudinal diameter of male crania dates back to the beginning of the second millennium, the smallest diameter is found in the samples between the 18th and the 19th centuries. Later, when craniological data began to be supplemented with cephalometric ones, again we note an increase in average group values of the longitudinal skull diameter. In the last quarter of the 20th century it reached the greatest average group value of the 10–13th centuries, and was the greatest in the 20th century. Thus, the averge group longitudinal skull diameter on the territory of Belarus has altered within the range of 180–192 mm.

The average group transversal skull diameter in the 18–19the centuries, in contrast with the 10–13th centuries, behaved quite differently. Its values grew

till 1970–80, reaching by that time maximum average group values and varying in the Belarusian samples from 142.5 to 159.5 mm.

Table 2. Typological peculiarities of the skull of Belarusians in the 2nd–early 3rd millennium AD

Territorial group	Sex					
	male			female		
		Morphotypes			Morphotypes	
	n	entire range	medium range	*n*	entire range	medium range
	Craniometry					
	11–13 centuries					
Slavic tribes from Belarusian territory [9]	101	*pm*	*pd*	–	–	–
Novogrudok (urban population) [15]	26			11	*pm*	*pd*
Total (from Belarusian territory) [3]	164			74		
	18–19 centuries					
Nosilovo village Molodechno district [15]	5	*pm*	*pm*	4	*pm*	*pd*
Prousy village Kopil District [15]	28		*em*	26		*em*
Total (from Belarusian territory) [15]	136		*ed*	133		
	Cephalometry					
	20th – early 21st century					
Slutsk uyezd, 1901 [13]	57	*pm*	*em*	17	*pm*	*em*
Slutsk, 1955 [4]	60			42		
Total (central Belarus) 1891 [25]	961			141		
Total (central Belarus) 1958 [2]	284	*em*	–	–	–	–
Total (central Belarus) 1970–1980 [17]	112			141	*em*	–
Total (central Belarus) 2004–2006 [author's data]	102	*pm*	*em*	103	*pm*	*em*

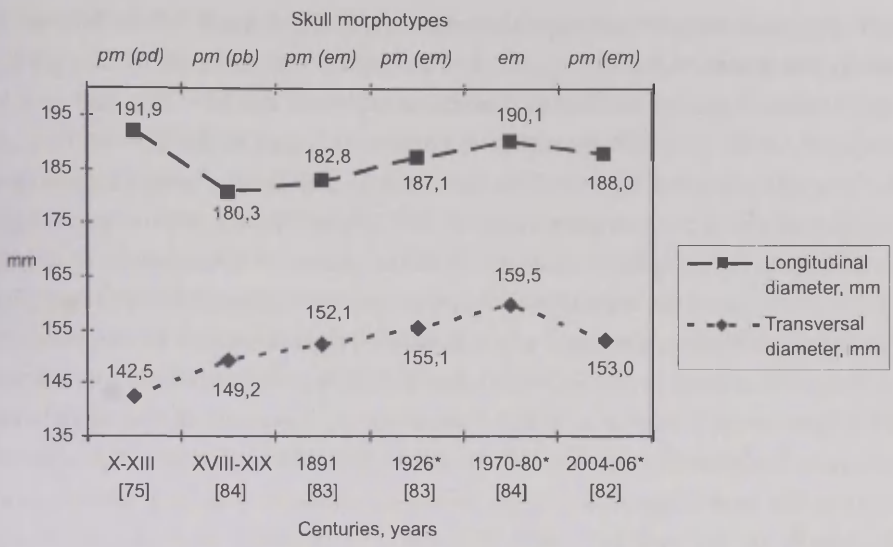


Figure 1. Anthropometric characteristics of the morphotypes of male skulls from the Belarusian territory within the second millennium to our day.

* – human samples from the central Belarus; dashed lines denote inequivalence of time peroids and territoritory of samples analysed; the square brackets enclose values of the cranial index.

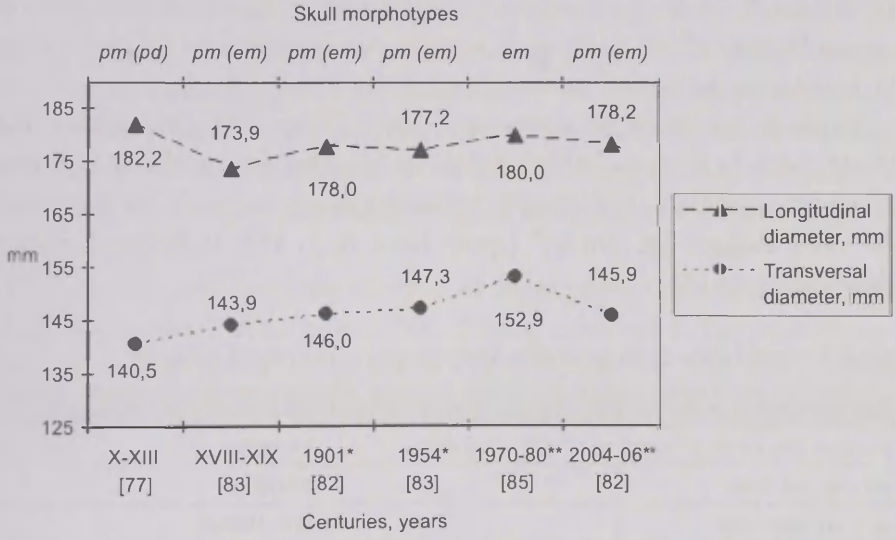


Figure 2. Anthropometric characteristics of female skull morphotypes from the territory of Belarus in the second to early third millennium AD.

* – samples from Slutsk and ** – samples from central Belarus; dashed lines denote inequivalence of time periods and territorial samples; cranial index values are enclosed in square brackets

Both by craniological and cephalometric data, the female inhabitants of the Belarusian territory display a pattern of variability similar to men. The greatest longitudinal diameter is observed in the samples of the 10–13th centuries, the smallest – in the 18–19th centuries; it starts to increase in the 20th century, not reaching the medieval figures. The diameter, just as that of male samples, grew steadily, reaching a maximum in the 1970–1980s. The cephalometric range of variability of the longitudinal diameter in the second millennium in females is: 174–182 mm, and the transversal diameter amounting to 140.5–153 mm. Both characteristics have a narrower cephalometric scope than in male samples.

Since the cranial index is the index which comprises two basic diameters of the cranium and reflects epochal variability of the form of the skull *norma verticalis*, its dynamics is accounted by their ratio. Between the 10th and the 13th century the craniological series was of dolichocranian character. Subsequently, the vector of the epochal variability, both in Western and Eastern Europe, including that on the territory of Belarus, directed towards brachicrania. In the process, all alterations both in the longitudinal and the transverse diameter occurred initially within the paraeuroid-mesoid *(pm)* morphotype, forming in the last quarter of the 20th century the euroid-mesoid *(em)* morphotype. The character of this transition is reflected in the morphotypes of the average group of the variations of the medium broad (paraeuroid) and the medium long (mesoid) types of the skull. Male samples are expressed as: *pd-pb-em* (Figure 1), females are less varied: *pd-em* (Figure 2).

Based on results of the works by G. Frets (Frets 1925), S. Hilden (Hilden 1924) and S. D. Sinitsyn (1930), Table 3 is intended for a probable explanation of the nature of the morphological variability of the crania. "Conclusions of all the cited authors are similar" [quot. from 6, p. 14]. V. V. Bunak achieved identical results [6].

Table 3. Combination of morphotypes and changes in the cranial index [6]

Combination of morphotypes	Changes in the index
pb x *pb*, *pm* x *pm*, *pd* x *pd*, *em* x *em*, *sb* x *sb*	increase
ed x *ed*, *eb* x *eb*	decrease
sd x *sd*, *sm* x *sm*	not defined

As follows from Table 3, the combination of certain diameters, forming morphotypes in individuals, lead to alterations in the average value of the cranial index in their descendants.

The data in Tables 2 and in Figures 1 and 2 indicate that the predominance of the medium broad medium dolichocephalic *(pm)* morphotypes of the head, both in men and women, lead to an increase in the value of the cranial index, i.e. to brachicephalization. The succeeding generation may have begun to debrachicephalize, reflecting further co-variability of the basic diameters of the crainium, and, hence, resulting in the frequency alterations of skull morphotypes. If the brachiocephalization process characterizes the general direction of the epochal variability of the cranial index, the biological meaning of the shown manifestation of debrachocephalization (at the beginning of the 21st century) consists in a leveling of the sharp deviation of the values of the cranial index from the average populational value, and the results in the establishment of the neutral and harmonious form of the skull in human populations [6].

SUMMARY

All metric alterations in both male and female crania during the second to early third millennium AD are basically concentrated within the paraeuroid-mesoid *(pm)*, i.e. medium broad medium dolichocephalic morphotype (the 10–13th centuries, the 18–19th centuries, and the late 19th – the first half of 20th century). The maximum increase in the cranial index in the second half of the 20th century marks a transition to the euroid-mesoid *(em)*, i.e. broad medium dolichocephalic morphotype. The beginning of the 21st century has shown a return to the paraeuroid-mesoid (medium broad medium dolichocephalic) morphotype. Hence, the contribution of the transverse diameter, both in the epochal and the intergenerational typological variability of the cranium proves to be more significant.

The analysis performed has allowed to supplement the mosaicism of the cephalometric data already available, having confirmed the evolutionary directions, and to define the nature of cranial variability, and also to reveal morphotypological peculiarities of cranial variability in the population of Belarus.

REFERENCES

1. Алексеев В. П. (1969). Происхождение народов Восточной Европы (краниологическое исследование). Москва: Наука, 324 с.
2. Алексеев В. П., Витов М. В., Тегако Л. И. (1994). Расовая география белорусов и проблемы этногенеза. Минск: Наука и техника, 127 с.

3. Алексеева Т. И. (1979). Этногенез восточных славян по данным антропологии. М., 330 с.
4. Бунак В. В. (1956). Антропологические исследования в южной Белоруссии // Тр. Ин-та этнографии им. Н. Н. Миклухо-Маклая. Новая серия, т. XXXIII. Антропологический сборник, вып. 1. М. С. 3–36.
5. Бунак В. Б. (1941). Антропометрия: Практический курс. М., 367 с.
6. Бунак В. В. (1968). Об эволюции формы черепа // Вопр. антропологии. Вып. 30. С. 3–16.
7. Бунак В. В. (1922). Основные морфологические типы черепа человека и их эволюция // Русский антропологический журнал. Т. 12, кн. 1–2. С. 6–57.
8. Восточные славяне. Антропология и этническая история. (2002) 2-е изд. под ред. Т. И. Алексеевой. М., 342 с.
9. Дэбец Г. Ф. (1932). Чарапы Люцынскага магільніку і старажытных славян Беларусі і месца апошніх у палеаантрапалогіі Усходняй Еўропы // Працы секцыі археалогіі Інстытута гісторыі Беларускай АН. Т.3. Мн. С. 69–81.
10. Иков К. Н. (1890). Заметки по кефалометрии белорусов сравнительно с велико- и малорусами (предварительное сообщение) // Известия Императорск общества любителей естествознания, антропологии и этнографии. Т.68. Труды Антропологическ отдела. Т.12. Дневник Антропологическ отдела. Вып. 4. С. 99–106.
11. Повесть временных лет / Пер. Д. С. Лихачёва. (1991) Петрозаводск. С. 17, 19.
12. Рогинский Я. Я., Левин М. Г. (1978). Антропология: Учебник для студентов ун-тов. – 3-е изд., перераб. и доп. М., 1978. С. 528.
13. Рождественский А. Н. (1902). К антропологии белорусов Слуцк уезда Минской губернии // Русский антропологический журнал. №1. С. 49–57.
14. Саливон И. И. (1998). Межпоколенная изменчивость некоторых структурных особенностей черепа у населения Беларуси в свете эпохальных процессов // Вестник антропологии. Альманах. Т. 4. М. С. 103–114.
15. Саливон И. И. (1969) Палеоантропология Белоруссии и вопросы происхождения белорусск народа (по краниологическим материалам II тыс. н.э.): Автореф. дисс. ... канд. ист. наук. М., 23 с.
16. Саливон И. И. (2008). Процесс формирования пропорций мозгов отдела черепа у школьников Беларуси в начале 1980-х и 2000-х гг. // Актуальные вопросы антропологии: Сборник научных трудов. Вып. 3. Мн. С. 19–30.
17. Салівон І. І. (1994). Фізічны тып беларусаў: Узроставая, тыпалагічная і экалагічная зменлівасць Мн., 239 с.
18. Смирнов А. (1928). Антропологическая характеристика группы белорусов Минской округи // Этнография. Антропология. Психология. Психотехника и научная организация труда. История искусств. Сборник статей. Изд. Ин-та Бел. культ. Мн. С.71–87.
19. Сперанский Б. С. (1983). Медицинская краниология, ее предмет, направления и методы // Проблемы современной антропологии. Мн. С.166–167.

20. Тегако Л. И., Марфина О. В. (2003). Практическая антропология. Учебное пособие. Ростов-н/Дону, 320 с.
21. Чаквин И. В. (1983). Некоторые итоги изучения нового палеоантропологического материала X–XIII вв. с территории северной и центральной Белоруссии // Проблемы современной антропологии. Мн. С. 64–65.
22. Чепурковский Е. М. (1922). Распределение головного показателя русских крестьян по уездам // Русский антропологический журнал. Т. 12. Кн. 1–2. С. 119–130.
23. Янчукъ Н. А. (1890). Некоторые данные к вопросу об антропологическом типе белорусов // Известия Императорского общества любителей естествознания, антропологии и этнографии. Т.68. Труды Антропологического отдела. Т.12. Дневник Антропологического отдела. Вып. 3. С. 65–74.
24. Martin R. (1928). Lehrbuch der Anthropologie in systematischer Darstellung. Jena. Bd 1–3.
25. Talko-Hryncewicz J. (1893). Charakterystyka fizyczna ludow Litwy I Rusi. Krakow. 172 s.
26. Török A. (1906). Versuch einer systematischem Charact. der Kephalindex. Arch. f. Anthr. Bd. 4.

Address for correspondence:
N. N. Pomazanov
Institute of History of the National Academy of Sciences of Belarus
Academicheskaya Str, Building 1, Minsk 220072 Belarus
E-mail: pomnik@pisem.net

Papers on Anthropology XXI, 2012, pp. 232–245

ANTHROPOMETRIC AND PSYCHOPHYSIOLOGICAL CHARACTERISTICS OF TOP FEMALE VOLLEYBALLERS IN RELATION TO THE PLAYERS' POSITION ON THE COURT

KEIU PÕLLUVEER, RAINI STAMM, MEELIS STAMM

Tallinn University, Estonia

ABSTRACT

The aim of the current study was to find if the players who play in different positions in Estonian top female teams can be differentiated by their body build and psychophysiological characteristics. The study involved four female teams of the Estonian league: Viimsi Spa, Viljandi Metall, Tallinn University and the Junior National Team. In total, 41 female volleyballers were studied; they were divided as follows: first tempo attackers – 13, setters – 8, diagonal attackers – 6, second tempo attackers – 9, liberos – 5. Twelve anthropometric measurements were taken and eight indices were calculated from the measurement results. Psychophysiological tests were conducted, using the computer program Win Psycho, on all the 41 subjects three times during the season. Psychophysiological studies consisted in measuring simple and complex reaction times and anticipation time. Anthropometric and psychophysiological variables were statistically analysed according to the players' positions on the court. The mean values of variables of the four participating teams were also analysed.

Anthropometric data – both basic characteristics and indices – show great individual variability. However, there were statistically significant differences between the groups of players only in height, weight and horizontal arms spread. The results of psychophysiological tests did not differ statistically significantly between players in different positions. Still, the reaction times shortened towards the end of the season. The analysis of volleyballers' mean reaction times according to teams showed that the reaction times of three teams improved during the season. Tallinn University was the only team whose

reaction times worsened. Viljandi Metall was statistically significantly better compared to Viimsi Spa. Both of them were also the strongest clubs during the 2011/2012 season. Consequently, psychophysiological tests reflect the intensity and level of coaching in the teams.

Key words: *female volleyballers in different positions, anthropometric measurements, psychophysiological tests.*

INTRODUCTION

Literature shows that top female volleyballers differ by their anthropometric and psychophysiological characteristics. The differences are mainly physiological and constitutional, but some differences are also related to tactical tasks in accordance with the players' position on the court.

Thus, a difference is made between first tempo attackers, diagonal attackers, second tempo attackers, setters, and liberos. The player in each position is expected to have certain skills and qualities. First tempo attackers have to be tall, and quick at block. Diagonal attackers have to be strong, and dominant at attacks. Setters have to be quick and often make decisions quicker than players in other positions.

The aim of the current study was to find if the players who play in different positions in Estonian top female teams can be differentiated by their body build and psychophysiological characteristics. Another aim was to study if the players' psychophysiological characteristics change during the season and are related to the place achieved by their team in the Estonian championships of the 2011–2012 season.

METHODS

The study involved four female teams of the Estonian league: Viimsi Spa, Viljandi Metall, Tallinn University and the Junior National Team. At least ten players from each team took the tests and gave the measurements – in total, 41 female volleyballers (mean age 20.37 ± 4.76 years). Each team was represented by at least one player in each of the positions. According to positions, the subjects were divided as follows: first tempo attackers – 13, setters – 8, diagonal attackers – 6, second tempo attackers – 9, liberos – 5.

Methods of anthropometric measurements

Twelve anthropometric measurements were taken: body height, body weight, upper chest circumference, waist circumference, hip circumference, upper thigh circumference, upper and lower leg circumference, arm circumference, arm circumference flexed and tensed, wrist circumference, and horizontal arms spread. Weight was measured on electronic scales and circumferences with a metal measuring tape. The measurements were taken with the precision of ± 0.5 kg and ± 0.5 cm by the same person at all times according to the method of Martin (Knussmann 1988) [5]. The measurements were taken once during the period October-November 2011 and, based on their results, the following anthropometric indices were calculated:

Body mass index $\frac{weight}{height^2} \times 10\,000$

Relative upper chest circumference $\frac{upper\ chest\ circumference}{body\ height} \times 100$

Relative waist circumference $\frac{waist\ circumference}{body height} \times 100$

Relative wrist circumference $\frac{wrist\ circumference}{body\ height} \times 100$

Relative hip circumference $\frac{hip\ circumference}{body\ height} \times 100$

Relative arm circumference $\frac{arm\ circumference}{body\ height} \times 100$

Relative upper thigh circumference $\frac{upper thigh\ circumference}{body\ height} \times 100$

Relative waist-hip circumference $\frac{waist\ circumference}{hip\ circumference} \times 100$

Psychophysiological tests

Psychophysiological tests were conducted using the computer program Win Psycho 2000 [15, 16]. The tests were conducted on players of different

positions in all teams (n = 41) in three stages: stage 1 – beginning of the season, October 2011; stage 2 – middle of the season, January 2012; stage 3 – end of the season, April 2012.

The tests were of two kinds. Some measured simple reactions where the reaction time was measured by means of auditory stimulus to which the subject had to react immediately. Three series were performed, eight attempts in each series. The series differed from one another by the strength and pitch of sound. The program calculateed the mean reaction time for each subject separately for the right and the left hand.

The tests of the second kind measured complex reactions or determination of the speed of a moving object. The subjects first had to assess the motion speed of an object on the computer screen (fast or slow) and then take a decision. The program fixed the time of taking the decision. Each subject had to perform three series, eight attempts in each series. The program gives the mean results of each subject about the correctness of assessing the speed and the length of the time taken on decision-taking. The results of the test are considered better if the subject achieves more correct results in shorter time.

In addition, the anticipation time was calculated for each player. By anticipation the volleyballer's speed and precision of reacting to different stimuli is assessed. To do so, from the best result of the test of assessment of the speed of a moving object, the shortest time of simple reaction to an auditory stimulus was subtracted.

Statistical analysis

Statistical analysis of data was performed by Master of Mathematical Statistics Säde Koskel. First of all, primary analysis of anthropometric and psychophysiological variables was performed where the arithmetic mean, standard deviation, minimum and maximum values were found.

Thereafter, the players were divided according to their positions on the court as follows: first tempo attackers, diagonal attackers, second tempo attackers, liberos, setters. For each position, the mean values of all anthropometric measurements and psychophysiological tests results, their minimum and maximum values and standard deviations were found. Then, the significance of differences in the means was checked by the t-test.

The players' anthropometric differences, times of simple reaction and perception of speed of movement were assessed by groups of players in different positions and also by teams, and the differences of the means were checked by the t-test.

As reaction speed tests and tests of perception of motion speed were performed at three stages, the players were longitudinally compared by teams to find if the reaction times the team shortened or lengthened. The tests results were also compared with the places achieved at the Estonian championships.

The height and weight of our volleyballers were compared with the mean height and weight of Estonian women of the same age.

Then, linear correlation analysis of anthropometric variables and psychophysiological tests results was performed, and thereafter correlations between anthropometric variables and tests results were found.

Volleyballers' body build data were divided into five body build classes – small, medium, large, pycnomorphous and leptomorphous [12].

RESULTS

Research results of anthropometric variables

Table 1. Basic statistics of female volleyballers anthropometric variables (n=41)

Value	Min	Max	$\bar{x}$	SD
Age	13	41	20.366	4.76
Weight (kg)	58	82.8	70.912	5.521
Height (cm)	167	187	177.09	4.87
Upper chest circumference (cm	68	95	88.61	4.97
Waist circumference (cm)	66	86	76.24	4.56
Hip circumference (cm)	90	113	101.81	4.55
Upper thigh circumference (cm)	53	66	59.42	2.91
Upper leg circumference (cm)	34	41	38	2.03
Lower leg circumference (cm)	21	28	24.51	1.50
Wrist circumference (cm)	15	18	16.56	0.74
Horizontal arms spread (cm)	163	194	179.93	7.05
Arm circumference (cm)	23	31	27.68	1.85
Arm circumference flexed and tensed (cm)	25	33	29.45	1.88

The table shows great individual variability of anthropometric characteristics – 24.8 kg in weight, 20 cm in height and 28 years in age. All the other bodily characteristics also vary accordingly.

Table 2. Mean values of female volleyballers' variables according to positions (n=41)

Value	Diagonal attackers $\bar{x}$	Liberos $\bar{x}$	Setters $\bar{x}$	First tempo attackers $\bar{x}$	Second tempo attackers $\bar{x}$
Weight (kg)	73.68	69.46	67.05	74.35	68.33
Height (cm)	176.3	171.5	175.1	181.58	176.0
Upper chest circumference (cm)	91.5	88.8	88.0	88.9	86.7
Waist circumference (cm)	78.7	75.6	74.3	76.9	75.8
Hip circumference (cm)	103.8	100.6	99.4	104.3	99.7
Upper thigh circumference (cm)	61.5	59.6	58.1	60.0	58.2
Upper leg circumference (cm)	38.0	39.8	37.0	38.2	37.7
Lower leg circumference (cm)	24.5	24.8	24.3	24.9	24.0
Wrist circumference (cm)	16.7	16.8	16.4	16.8	16.2
Horizontal arms spread (cm)	179.2	172.7	177.7	184.1	180.3
Arm circumference (cm)	28.8	28.6	27.3	27.3	27.3
Arm circumference flexed and tensed (cm)	30.5	30.0	29.1	29.1	29.2

Here we can see that first tempo attackers and diagonal attackers were the players with largest anthropometric dimensions. Five variables in both groups of players were greater than in players in all other positions.

First tempo attackers had the biggest body height, body weight, hip circumference, lower leg circumference and horizontal arms spread.

Diagonal attackers had the biggest upper chest circumference, waist circumference, upper thigh circumference, arm circumference, and flexed and tensed arm circumference.

The smallest among the Estonian top female volleyballers were setters who had as many as four anthropometric characteristics that were the smallest among all the groups. These were body weight, waist circumference, hip circumference and upper leg circumference.

Second tempo attackers also had smaller dimensions than players in other positions. They had the smallest values of the following three characteristics – upper chest circumference, lower leg circumference and wrist circumference.

Liberos also had two variables by which they were smaller than other players – body height and horizontal arms spread. Interestingly, their wrist circumference – 16.8 cm – was the largest, like that of first tempo attackers. Upper leg circumference – 39.8 cm – can be larger because liberos have to be half-squatting during most of the playing time.

Table 3. Basic statistics of female volleyballers' anthropometric indices and body composition characteristics (n=41)

Value	Min	Max	$\bar{x}$	SD
Body mass index	19.02	25.70	22.62	1.64
Relative upper chest circumference	37.36	54.39	50.08	3.09
Relative waist circumference	37.71	49.71	43.09	2.81
Relative wrist circumference	8.57	10.78	9.36	0.41
Relative hip circumference	51.78	63.13	57.51	2.59
Relative arm circumference	13.74	19.30	16.65	1.3
Relative upper thigh circumference	29.12	37.13	33.58	1.90
Relative waist-hip circumference	66.99	82.18	74.90	3.23

The table shows that the mean body mass index of top female volleyballers was 22.62.

Table 4. Mean values of anthropometric indices and body composition characteristics of female volleyballers in different positions (n=41)

Value	First tempo attackers $\bar{x}$	Diagonal attackers $\bar{x}$	Second tempo attackers $\bar{x}$	Liberos $\bar{x}$	Setters $\bar{x}$
Body mass index	22.57	23.75	22.07	23.63	21.84
Relative upper chest circumference	49.0	51.9	49.3	51.8	50.2
Relative waist circumference	42.4	44.7	43.1	44.1	42.4
Relative wrist circumference	9.2	9.5	9.2	9.8	9.4
Relative hip circumference	57.5	58.9	56.6	58.7	56.8
Relative arm circumference	16.0	17.3	16.6	17.5	16.6
Relative upper thigh circumference	33.1	34.9	33.1	34.8	33.2
Relative waist-hip circumference	73.8	75.8	75.9	75.2	74.8

Table 4 reveals that the players with the highest body mass index were diagonal attackers and liberos. They are followed by first tempo attackers and second tempo attackers. Setters had the lowest body mass index. Comparison of the indices of different groups of players shows that, despite the first tempo attackers' larger height and weight, even four indices of them were lower than in other groups of players. There were relative chest circumference, relative waist circumference, relative arm circumference, relative waist-hip circumference.

Diagonal attackers' indices had the highest value in four cases – relative chest circumference, relative waist circumference, relative hip circumference, and relative upper thigh circumference.

Despite their small height and weight, liberos had two indices with highest values. These were relative wrist circumference and relative arm circumference.

Statistical comparison of the mean values of all the above-mentioned basic characteristics and indices with the paired t-test according to the players' position on the court showed significant differences in weight, height and horizontal arms spread. Thus, the weight of first tempo attackers and setters differed significantly; height differed significantly between first tempo attackers and second tempo attackers, between first tempo attackers and setters, and between first tempo attackers and liberos. Horizontal arms spread differed significantly between first tempo attackers and liberos.

It is noteworthy that there were so great differences in horizontal arms spread – up to 31 cm. The shortest horizontal arms spread was 163 cm and the longest 194 cm. The difference of 31 cm is very big considering the range of the player's defence play; one player is able to cover an area 31 cm broader than another. This is particularly important at blocking.

Results of psychophysiological research

Table 5. Summary results of psychophysiological tests of female volleyballers (n=41)

	Stage 1 time sec	Stage 2 time sec	Stage 3 time sec
Simple reaction Best time	0.131	0.232	0.193
Slowest time	0.893	0.526	0.632
Mean time	0.327	0.323	0.305
Complex reaction (test of perception)	0.47	0.47	0.49
Slowest time	2.66	1.81	1.69
Mean time	0.885	0.812	0.734

Table 6. Comparison of simple reaction times (in seconds) of players in different positions (n=41)

	Stage 1 time sec	Stage 2 time sec	Stage 3 time sec
Diagonal attackers	0.301	0.31	0.332
Liberos	0.307	0.30	0.320
Setters	0.342	0.323	0.309
Second tempo attackers	0.344	0.292	0.292
First tempo attackers	0.304	0.303	0.298

Table 7. Anticipation time (best perception time – best simple reaction time) of players in different positions (n=41)

	Stage 1 time sec	Stage 2 time sec	Stage 3 time sec
Diagonal attackers	0.52	0.54	0.45
Liberos	0.49	0.51	0.41
Second tempo attackers	0.46	0.42	0.37
Setters	0.46	0.49	0.43
First tempo attackers	0.69	0.5	0.45

As Table 5 shows, both simple and complex reaction times were different in three stages of testing, but the mean reaction times gradually improved and were the shortest at the end of the season.

Comparison of simple reaction times according to positions (Table 6) also shows shortening of times at the third time of testing. The same can be seen when anticipation times of players in different positions are compared at three stages of testing.

In conclusion, however, statistical analysis did not reveal any significant differences between players in different positions.

Next, the volleyballers' mean reaction times were analysed according to teams.

Here we can see that the mean reaction times of three teams improved during the season. Tallinn University was the only team whose reaction times worsened.

Statistically significantly, the team of Viljandi Metall was better than Viimsi Spa. Those two were also the two strongest clubs during the 2011/2012 season.

Table 8. The best mean reaction times of four teams during the season

	Stage 1 Time sec	Stage 2 Time sec	Stage 2 Time sec
Viimsi Spa	0.331	0.288	0.274
Viljandi Metall	0.321	0.311	0.298
Junior national team	0.335	0.332	0.319
Tallinn University	0.295	0.309	0.312

Results of correlation analysis between anthropometric measurements and psychophysiological tests results

In the whole sample, the anthropometric characteristics in significant correlation were height and weight ($r = 0.453$). Height correlated significantly with horizontal arms spread ($r = 0.779$) and weight with all circumferences, most of all with hip circumference ($r = 0.884$).

Mutual correlations between anthropometric indices were also significant ($r = 0.5–0.8$) and between indices and basic characteristics.

Comparing the mean anthropometric variables of players in different positions by the t-test, we found that significant differences appeared in height, weight and horizontal arms spread. First tempo attackers were significantly heavier than setters. First tempo attackers were also significantly taller than second tempo attackers, setters and liberos. Horizontal arms spread was significantly larger in first tempo attackers than in liberos.

Thus, champion league players in different positions could be differentiated by their anthropometric variables. The reaction times in psychophysiological tests did not show any significant correlations with any basic anthropometric characteristics or indices.

Classifying of players into a 5 SD classification of height and weight

For simultaneous comparison of height and weight, we used a weight-height classification with the following SD classes: (1) small weight – small height, (2) medium weight – medium height, (3) big weight – big height, (4) pycnomorphs – big weight and small height, and (5) leptomorphs – small weight – big height.

We found that almost 50% of players were in classes of concordant height and weight; in the small and big class – equally 17% of players. The largest number of players (34.15%) belonged to the class of pycnomorphs and 17% to

the class of leptomorphs. Thus, it can be concluded that a relatively great part of female volleyballers have bigger weight compared to their height.

DISCUSSION

Our research results on significant anthropometric differences between players in different positions are compatible with those published in literature. In our sample, the players with the greatest height and weight were first tempo attackers and diagonal attackers. The same is confirmed by literature [1, 6, 13]

Literature data on the height and weight of setters differ. At professional and international level, it is customary to use tall setters. The reason is not only the quality of setting but also greater abilities at blocking [9]. Others [1] find that speed and agility are more essential for setters than their athletic qualities. Thus, Gualdi-Russo and Zaccagni [3] and Malousaris et al. [8] have found that setters can be the lightest, shortest and quickest, and thus, their body mass index is also the smallest. Our setters had small weight and height.

In addition to height, larger horizontal arms spread, larger ankle breadth and larger wrist circumference are important. According to Grantov's study [2], bigger height provides better reach above the net; bigger ankle breadth gives greater stability at landing and blocking. Bigger wrist breadth contributes to hitting the ball during the attack. Larger trunk and strong muscles guarantee better performance of all the elements of the game. Loko [7] has emphasized the significance of this at selection of young players.

Our results also showed that diagonal attackers and first tempo attackers had the largest horizontal arms spread. Wrist circumference was the biggest in first tempo attackers and liberos, and lower leg circumference the biggest in first tempo attackers.

Comparison of the height of our female volleyballers (177.09 cm) with the data of other countries shows that the height of the women in the Estonian championship league was most similar to the players of the US first division – 176.88 cm [10]. According to Zhang [14], the height, weight and body mass index of top female volleyballers have been increasing from the 26th to the 29th Olympic Games. Height had increased from 181 to 184 cm and weight from 71.4 to 73.4 kg. The mean weight of Estonian volleyballers in our sample was 70.912 kg.

The mean height of 20-year-old Estonian women was 167.89 cm [4], which is nearly ten centimetres shorter than that of top female volleyballers – 177.09.

The mean weight of 20-year-old Estonian women (60.65 kg) was also nearly ten kilograms smaller than that of top female volleyballers (70.912 kg).

Consequently, the top female volleyballers are a selected sample. The significance of the anthropometric factor in the physical abilities, volleyball technical skills and psychophysiological computerized tests in 13–16-year-old female volleyballers has been studied by R. Stamm [11, 12]. According to her results, body build determined 42–89% of the results of physical abilities tests, up to 32% of volleyball technical tests and up to 43% of psychophysiological tests. Proficiency in the game depended both on the girls' body build and the results of all the tests used. Thus, attack, block, and feint were better performed by girls with bigger weight bigger circumferences of the arm, upper and lower leg who reacted more quickly to the changing situation in the game (anthropometric models R^2 = 0.71–0.83, psychophysiological models R^2 = 0.60–0.98). Proficiency of reception of serve depended on anthropometric variables and all the tests results within 39–50%. The proficiency of serve was determined by anthropometric models within 1–32%.

In the current study, all the subjects took the simple reaction test based on sound and the test on the ability of differentiating the speed of motion. The tests were conducted three times during the season using the computer program Win Psycho 2000. The players' best mean simple reaction time improved during the season from 0.327 to 0.323 to 0.305 seconds. The best mean complex reaction time also improved – from 0.885 to 0.823 to 0.734 seconds. The anticipation times also shortened during the season. During the whole season, the quickest players were second tempo attackers and the slowest diagonal attackers and first tempo attackers. Although differences were found between groups of players in psychophysiological tests results, these were not statistically significant.

Attention should be paid, however, to the mean reaction times of the teams. The t-test revealed that the team of Viljandi Metall was significantly quicker than Viimsi Spa and the Junior National Team. Comparison of the results of the third testing of the teams showed that mean reaction times of the Estonian champion Viljandi Metall and the second place holder Viimsi Spa were better than those of the two last clubs of the championship league (Tallinn University and the Junior National Team). Consequently, psychophysiological tests reflect the intensity and level of coaching in the teams.

ACKNOWLEDGEMENTS

The study was supported by ESF and by Estonian Doctoral School of Educational Sciences project No. 1.2.0401.09-0070.

REFERENCES

1. Duncan M. I., Woodfield L., al-Nakeeb I. (2006). Anthropometric and physiological characteristics of junior elite volleyball players. Sports Medicine, 40, 649–651.
2. Grantov Z., Katie R., Jankovic V. (2006). Morphological characteristics, technical and situation efficacy of young female volleyball players. University of Split. Collegium Anthropologicum, 30, 1, 87–96.
3. Gualdi-Russo E., Zaccagni L. (2001). Somatotype, role and performance in elite volleyball players. J Sports Med Phys Fitness, 41, 256–269.
4. Kaarma H., Saluste L., Lintsi M., Koskel J., Veldre G., Tiit E.-M., Koskel S., Arend A. (2008). Height and weight norms for adult Estonian men and women (aged 20–70 years) and ways of somatotyping using a height-weight classification. Papers on Anthropology XVII, 113–130.
5. Knussmann R. (1988). Anthropologie. Handbuch der vergleichenden Biologie des Menschen. Band I: Wesen und Methoden der Anthropologie. Stuttgart, New York: Gustav Fischer, 139–309.
6. Liik E. (2003). Volleyball manual. Estonian Volleyball Association. Tartu (in Estonian).
7. Loko J. (1999). Selection of young athletes. Tartu: Atlex. (in Estonian).
8. Malousaris G. G., Bergelesa N. K., Barzoukaa N. K., Bayiósa A. L., Nasris G. P., Koskolaub M. D. (2008). Somatotype, size and body composition of competitive female volleyball players. Journal of Science and Medicine in Sport, 11, 337–344.
9. Papageorgiu A., Spitzley W. (2003). Handbook for competitive volleyball. Oxford: Meyer & Meyer Sport.
10. Schaal M. L. (2011). Physiologic performance test differences by competition level and player position in female volleyball athletes [Master's thesis]. Boise State University.
11. Stamm R., Veldre G., Stamm M., Thomson K., Kaarma H., Loko J., Koskel S. (2003). Dependence of young volleyballers' performance on their body build, physical abilities and psychophysiological properties. J Sports Med Phys Fitness, 43, 1–9.
12. Stamm R., Stamm M., Koskel S. (2006). Adolescent female volleyballers' (aged 13–15 years) body build classification and proficiency in competitions. Anthropologische Anzeiger, 64 (4), 423–433.
13. Zelesnjak J. D., Ivoilov L. N. (1991). Volleyball. Fizkultura I Sport. Moscow (in Russian).

14. Zhang Y. (2010). An investigation on the anthropometry profile and its relationship with physical performance of elite Chinese women volleyball players. [Master's thesis] Southern Cross University.
15. Thomson K. (1996). Software program for psychological research. Tallinn (in Estonian).
16. Thomson K. (2009). Study materials of sports psychology. PowerPoint slides (in Estonian).

Address for correspondence:
Meelis Stamm
Educational Science Institute
Tallinn University
Sireli 4, Tallinn, 10913, Estonia
E-mail: mella@tlu.ee

Papers on Anthropology XXI, 2012, pp. 246–255

ANTHROPOMETRICAL AND SPORT CONSTITUTIONAL COMPARISON BETWEEN YOUNG FIREFIGHTERS (≤ 30 YEARS) AND SPORT STUDENTS (≤ 30 YEARS)

CHRISTOPH RASCHKA, DENIS BAMBUSEK, JONAS TÜRK

Institute of Sports Sciences, Julius-Maximilians-University Würzburg, Germany

ABSTRACT

The goal of this study was to find the typical body composition of a professional firefighter from Frankfurt/Main in Germany. For this purpose, sport students and firefighter volunteers, who had not reached the age of 30 years at that time, were measured. 88 male test persons participated in the present study. From these 88 test persons, 30 where professional firefighters with the average age of 24.8 years (± 2.6), and 27 firefighter volunteers with the average age of 22.8 years (± 3.2). The control group contained 31 sport students from the J. W. Goethe-University Frankfurt/Main. The mean age of the students was 24.5 years (± 3.3). The standard data body height, body weight, BMI, body fat and 55 body parameters after Raschka (2006) where assessed. The measurements were taken under standardized conditions by the authors of this work. The results were analyzed statistically.

The tallest body height and the highest body fat were found within the firefighter volunteers, the lowest value among the students. Interesting differences were found at the upper extremities, shoulder length and sagittal chest width. The professional firefighters had the biggest values followed by the firefighter volunteers. The AKS-Index showed no significant differences in all the groups.

High significant differences between the three groups were only found for the endomorphy. The somatochart of Heath and Carter showed no other significant findings.

Both firefighter groups showed the same characteristic in their plasticity. So they had a higher classification in the Plastic index than the students. They are in a more hyperplastic area than the students. Both groups also show a high bias

towards the decreasing pyknomorph body shape and an approach to the metromorph body shape like the students.

All three groups were in the leptomorph-makrosom area of the Knussmann constitution system. The professional firefighters are obviously more leptomorph and more makrosom than the students and the volunteers.

INTRODUCTION

The target group of this anthropometrical study was the professional firefighter and firefighter volunteers from Frankfurt/Main Germany. The reason for the examination of this group was to find data in their daily work activities. These are protection against fire, technical salvage, operational readiness, accident ambulance, servicing the cars by tooling equipment and the technical installations like the extinguisher and several more. The main focus is the ongoing operational readiness for efficient fire- and rescue missions to save human life, animals, the environment and material assets.

An important task of a firefighter amongst others is to carry his heavy protective gear and equipment. Only the protective gear and the breathing apparatus weigh nearly 30 kilograms. This meant that a firefighter carries 40% percentage of his avoirdupois before he goes out to save human life by climbing stairs or robbing on the floor or to swing his axe. In addition a firefighter faces extreme heat and the exposure to fumes for his organism. Even more, the mental stress of shift work and traumatic deathtrap is often underestimated (Tempel 1998).

MATERIAL AND METHODS

All the subjects for this study were chosen randomly and all the participants had done it voluntarily. The age of the subjects was between 18 and 30 years. The measuring took place happened between the summer of 2010 and the summer of 2011. Every measurement took nearly 25 minutes and was done in the fire stations of Frankfurt/M and for the students at the Sport University Frankfurt/M. All the measurements were made forenoon. The firefighter volunteers were measured in the evening because of their meeting times.

For the study, 55 body parameters after Raschka (2006) were measured and a couple of questions about private sport activities and the respondents own state of health were asked. The heights and the lengths were measured with a standard anthropometer, the breadths and width were measured with a pelvi-

meter, the circumferences were measured with a ribbon, the skin folds were measured with a caliper of the brand Ti Xing and the body weight was measured with scales.

RESULTS

Parameter	Professional firefighter (n=30)	Firefighter volunteers (n= 27)	Sport students (n= 31)	p
Age	24.8 (± 2.6)	22.8 (± 3.2)	24.5 (± 3.3)	$p \leq 0.001$
Body height (in cm)	182.0 (± 5.8)	181.2 (± 7.7)	179.7 (± 6.8)	n. s.
Body weight (in kg)	83.9 (± 9.5)	87.2 (± 16.0)	77.4 (± 8.8)	$p \leq 0.01$
Body fat (in %)	16.1 (± 3.7)	20.8 (± 8.9)	12.7 (± 3.5)	$p \leq 0.001$
BMI (kg/m²)	25.3 (± 2.7)	26.5 (± 4.0)	24.0 (± 2.2)	$p \leq 0.001$
Shoulder breadth (in cm)	43.0 (± 1.9)	41.7 (± 1.8)	41.1 (± 2.2)	$p \leq 0.01$
Sagittal chest breadth (in cm)	31.7 (± 2.1)	30.9 (± 2.1)	21.0 (± 2.0)	$p \leq 0.001$
Transversal chest breadth (in cm)	26.1 (± 2.2)	22.2 (± 2.6)	30.5 (± 1.7)	$p \leq 0.001$
Radio-Ulnar- width (in cm)	6.1 (± 0.3)	5.8 (± 0.4)	5.8 (± 0.3)	$p \leq 0.01$
Palm (in cm)	8.6 (± 0.4)	8.3 (± 0.6)	8.3 (± 0.4)	$p \leq 0.05$
Forearm breadth minimal (in cm)	18.3 (± 1.2)	18.3 (± 1.6)	17.2(± 0.8)	$p \leq 0.001$

Chart 1 Basic data

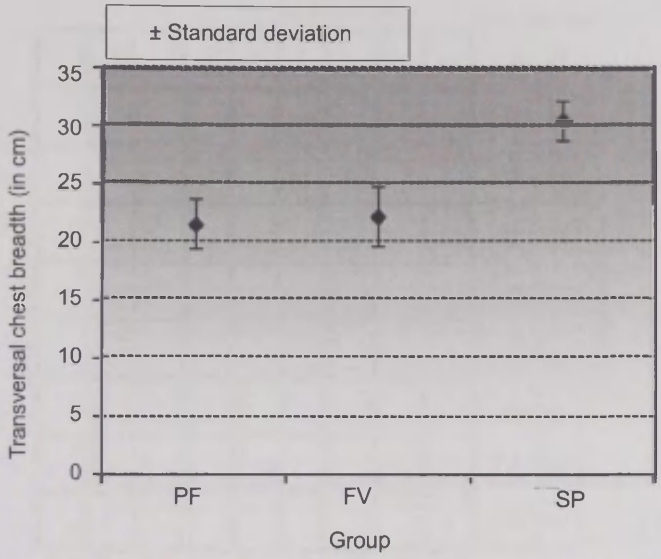


Figure 1. Mean values of the transversal chest breadth (in cm), divided into the groups (PF = professional firefighter, FV = firefighter volunteers, SP = Sport students)

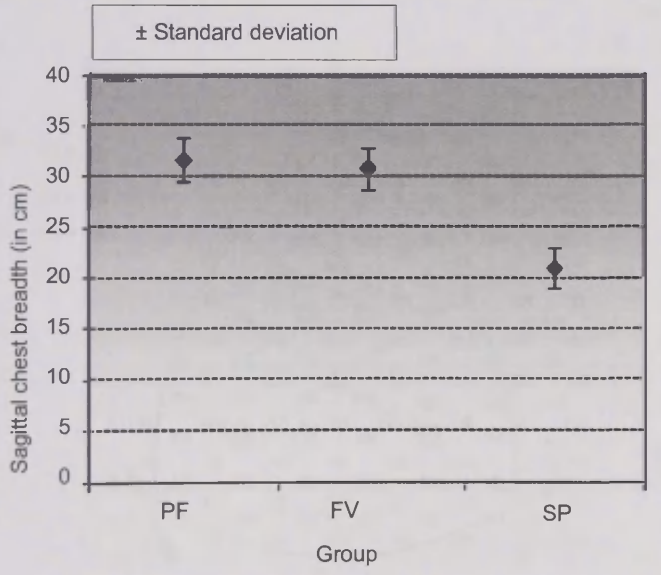


Figure 2. Mean values of the sagittal chest breadth (in cm), divided into the groups (PF = professional firefighter, FV = firefighter volunteers, SP = Sport students)

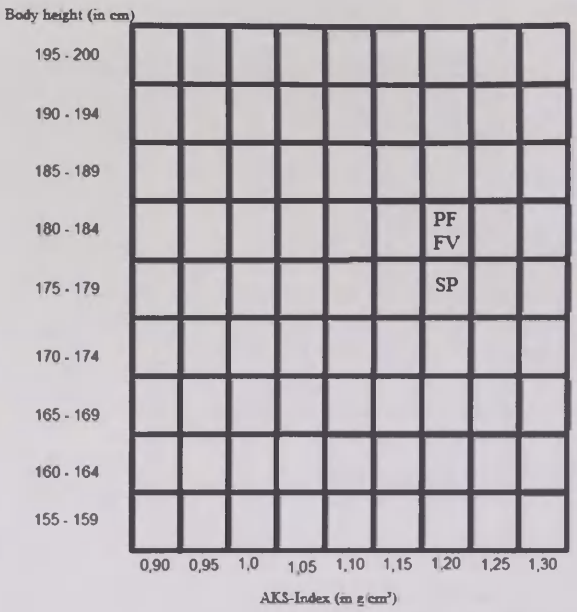


Figure 3. The average types of the professional firefighters (PF), the firefighter volunteers (FV) and the sport students (SP) in the AKS-Index/Body height – Diagram after Tittel andWutscherk

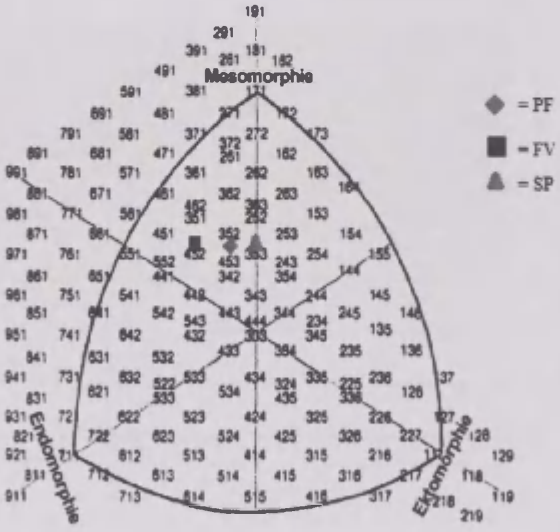


Figure 4. Somatochart after Heath and Carter for the average somatotypes of all three groups (PF = professional firefighter, FV = firefighter volunteers, SP = sport students)

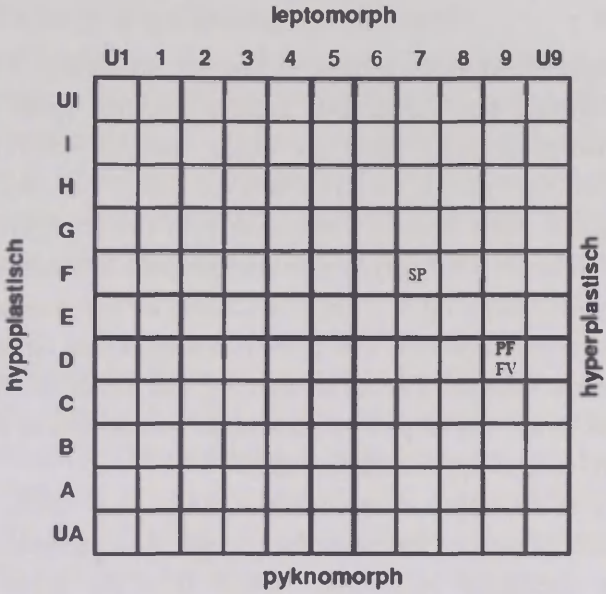


Figure 5. The average constitutional types of all the 3 groups (PF = professional firefighter, FV = firefighter volunteers, SP = sport students) in the chessboard pattern graphic after Conrad

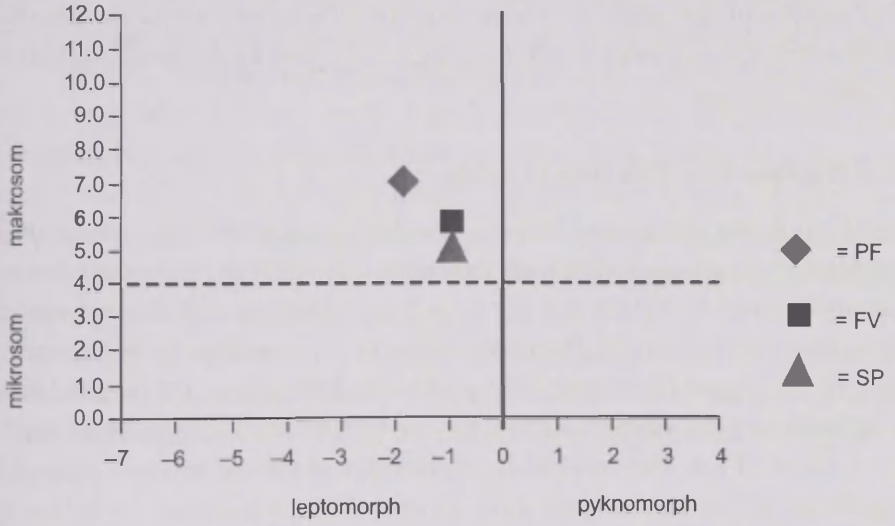


Figure 6. Average constitutional types after Knussmann (PF = professional firefighter, FV = firefighter volunteers, SP = sport students)

DISCUSSION

The body height of the three groups showed no significant differences. The firefighter volunteers are significantly heavier than the sport students. The professional firefighter had a significant bigger shoulder width than the sport students: 43.0 cm (s = 1.9 cm) vs. 41.9 cm (s = 2.2 cm). The sport students had the lowest sagittal chest breadth compared with the firefighters. The mean values were 21.0 cm (s = 2.0 cm) for the students and 30.9 cm (s = 2.0 cm) for the firefighter volunteers and 31.7 cm (s = 2.1 cm) for the professionals. This is highly significant and different. The authors interpret this difference with the regular use of the breathing mask in training and missions. Because of the respiration resistance, the respiration assistance muscle has to do more work. Research would help to approve the surmise.

In the area of the upper extremities the radio-ulnar- width and the palm show significant disparities between the groups. The professional firefighter had a higher significant radio-ulnar- width than the other groups. The examination of the palm revealed the same findings. This is probably the result of the daily work with the hands.

The AKS-Index after Tittel and Wutscherk

The analysis of the active body mass and the AKS-Index showed no disparities between the three groups. The index diagram (Figure 2) shows only disparities of the body height.

Somatotypes after Heath and Carter

High significant differences between the three groups were only found at the calculated components of the endomorphy. There were differences between the professional firefighter and the firefighter volunteers and also between the firefighter volunteers and the sport students. The endomorphy showed the level of the relative fat content. The professional firefighter had the level of 3.3. The firefighter volunteers had the level of 4.2 and the sport students had the lowest level of 2.6. The computed components of the mesomorpy showed no significant difference between three groups. The professional firefighter had with 5.4 the biggest muscle- and skeleton construction, the sport students the lowest with 5.2. Even the ectomorphy levels show no significant differences. The chart (Figure 3) showed both firefighter groups in the endo-mesomorphic area. The sport students can be found in the balanced mesomorphic area thus on the mesomorphy axis.

Discussion the body shape findings after Conrad

Both groups of firefighters showed the same characteristic of plasticity in the chessboard diagram (Figure 4). Because of that, they had a higher classification (9) than the sport students (7) in the plastic-index of Conrad. Both groups also showed a trend to the pyknomorph body shape and an approach to the metromorph body shape of the sport students. The sport students were in the leptomorph area of the classification with a minimum trend to the hypoplastic area.

Discussion of the body shape findings after Knußmann

All the groups (Figure 5) were in the leptomorph-makrosom area of the Knussmann diagram. The professional firefighters were more makrosom and leptomorph than the other two groups. The diagram classified the sport students and the the firefighter volunteers with the same leptomorph value but over all that the firefighter volunteers were more makrosom.

FINAL CONCLUSION

The eye-catching disparities between the three groups were found at the sagittal chest breadth and the width of the upper extremity. We found that the typical firefighter has a height of 180 cm and a BMI of 25.3 kg/m^2 ($\pm$ 2.7 kg/m^2). Further both firefighter groups were corpulent and massive; that means after Conrad more hyperplastic and after Knußmann more makrosom-leptomorph than the sport students. Both firefighter groups had broader shoulders, a higher body weight, a higher body height, a higher body range plus a specific shape of their upper extremities. The daily work with heavy tools makes the differences between the professional firefighter and the firefighter volunteers and sport students.

A national comparison of the professional firefighter could approve the results, because the amount and the type of work plus the requirement of the education of a professional firefighter are probably similar in all the regions of Germany.

REFERENCES

1. Fahs C. A., Smith D. L., Horn G. P., Agiovlasitis S., Rossow L. M., Echols G., Heffernan K. S., Fernhall B. (2009). Impact of Excess Body Weight on Arterial

Structure, Funktion, and Blood Pressure in Firefighter. Am J Cardiol, 104, 1441–1445.

2. Finteis T., Oehler J. C., Genzwürker H., Hinkelbein J., Dempfle C. E., Becker H., Ellinger K. (2002). Stressbelastung von Atemschutzgeräträgern bei der Einsatzsimulation im Feuerwehr-Übungshaus Bruchsal. Landesfeuerwehrschule Baden-Württemberg (STATT- Studie).
3. Garver J. N., Jankovitz K. Z., Danks J. M., Fittz A. A., Smith H. S., Davis S. C. (2005). Physical fitness of an industrial fire department vs. a municipel fire department. J Strength Cond Res., 19(2), 310–7.
4. Hahmann H., Czwlina C. (Hrsg.) (1973). Eignung zum Sport und ihre Korrelationen zu Körperwuchsformen: eine sportanthropologische Untersuchung an 404 Studenten. Sportwissenschaft und Praxis. Band 14. Ahrensburg, Czwalina Verlag.
5. Heath B. H., Carter L. J. E. (1990). Somatotyping- development and applications. Cambridge Studies in Biological Anthropology. Great Britain, Redwood Press.
6. Knußmann R. (1996). Vergleichende Biologie des Menschen. Lehrbuch der Anthropologie (2. Aufl). Stuttgart, Gustav Fischer Verlag.
7. Kales S. N., Christiani D. C. (1999). Correlates of Body Mass Index in Hazardous Materials Firefighters. Journal of Occupational and Environmental Medicine, 41(7), 589–595.
8. Raschka C. (2006). Sportanthropologie. Köln, Sportverlag Strauß.
9. Roberts M. A., O'Dea J., Boyce A., Mannix E. T. (2002). Fitness levels of firefighter recruits before and after a supervised exercise training program. The National Institute for Fitness and Sport, 16 (2) 271–7.
10. Schraub M. (2003). Gesundheitliche Auswirkungen des Dienstes in der Freiwilligen Feuerwehr. Eine Studie zu Belastungen und Stressreaktionen von Feuerwehrleuten in Mittelhessen. Inaugural- Dissertation zur Erlangung des Doktorgrades der gesamten Medizin. Fachbereich Humanmedizin der Philipps-Universität Marburg.
11. Sharon C., Antonio R., Wesley M. T., Muriel M. (2002). Association of Body Mass Index and Health Status in Firefighters. American College of Occupational and Environmental Medicine, 44 (10), 940–946.
12. TEMPEL, J. (1998). Lebensarbeitszeit der Feuerwehrleute. Stuttgart: (hg v. Gewerkschaft Öffentlicher Dienst, Transport und Verkehr).
13. Tittel, K, Wutscherk, H. (1972). Sportanthropometrie. Leipzig, Johann Ambrosius Barth.
14. Poston W. S. C., Haddock C. K., Jahnke S. A., Jitnarin N., Tuley B. C., Kales S. N. (2011). The Prevalence of Overweight, Obesity, and Substandard Fitness in a Population-Based Firefighter Cohort. American College of Occupational and Environmental Medicine, 53 (3), 266–273.

Address for correspondence:
Priv.-Doz. Dr.med. Dr.rer.nat. Dr.Sportwiss. Christoph Raschka
Institute of Sports Sciences
Julius-Maximilians-University Würzburg
Judenbühlweg 11, D-97082 Würzburg, Germany
E-mail: christoph.raschka@uni-wuerzburg.de

Papers on Anthropology XXI, 2012, pp. 256–263

SPORTS ANTHROPOLOGICAL COMPARISON OF PHYSICALLY EXERCISING PATIENTS WITH DIABETES TYPE I AND DIABETES TYPE II

CHRISTOPH RASCHKA, PETRA KOTHE

Institute of Sports Sciences, Julius-Maximilians-University Würzburg, Germany

ABSTRACT

In this study n=40 patients with diabetes (type I n=20, type II n=20; 20 males, 20 females), who were regularly practising sports, were examined anthropometrically. Anthropological basic data and computed somatotypical parameters correspond to international standards.

The higher age of athletes with diabetes type II corresponds to the later onset of this form of diabetes.

The registered significant anthropometrical differences between diabetes type I and diabetes type II in both genders correspond to the so-called truncal obesity in the metabolic syndrome and in diabetes type II. The remarkable results support the constitutional importance of the pyknic habitus in diabetes type II in comparison to the pure body fat percentage.

INTRODUCTION

Diabetes mellitus is a group of metabolic disorders, characterized by high blood sugar. The three main types of diabetes are type I diabetes mellitus, resulting from the body's failure to produce insulin due to the destruction of the islet cells in the pancreas, type II diabetes, resulting from insulin resistance and relative insulin deficiency, and gestational diabetes in pregnant women. Diabetes type II makes up about 90% of cases of diabetes. Globally an estimated 350 million people have type II diabetes. Obesity is thought to be the primary cause of type II diabetes in persons who are genetically predisposed to

this disease, whereas people with type I diabetes are frequently of slender build. 60–90% of patients with diabetes type II are obese (HARRISON et al. 2003).

The present study tries to clarify the constitutional and somatotypical differences between physically exercising patients with diabetes type I and II.

PARTICIPANTS AND METHODS

In this study n=20 patients with diabetes type I (10 males, 10 females; 70% of them practising an endurance sports, 30% ball games) who did work outs for 3 to 4 times per week, duration ca. 60–90 min per session) and n = 20 persons with diabetes type II (10 males, 10 females, 90% of them participating in general gymnastics sessions 1–2 times per week, duration ca. 60 min per session) were examined. Each proband participated voluntarily and the data were used anonymously.

Anthropometric data and computed constitutional and somatotypical parameters in this work correspond to international standards (Conrad 1963, Heath&Carter 1967+1990, Knussmann 1996, Martin&Knussmann 1988, Raschka 2006, Tittel&Wutscherk 1972). The analysis of differences was tested by ANOVA.

RESULTS

The results are summarized in Table 1 and in Figures 1–4.

Table 1. Averages, standard deviations and significance levels of selected parameters for both genders and Diabetes Type I v.s Diabetes Type II

Parameter	♂ Diabetes I	♀ Diabetes I	♂ Diabetes II	♀ Diabetes II	P
Age (years)	39.8±10.0	41.0±17.7	68.3±4.7	65.4±8.6	< 0.001
Height (cm)	182.0±5.2	170.3±8.1	176.7±8.6	163.3±7.1	< 0.05
Forearm length (cm)	26.2±2.5	22.9±2.8	25.1±2.3	23.5±1.6	n.s.
Morphological facial height (cm)	12.2±1.6	11.0±0.9	12.8±0.6	11.9±0.7	< 0.05
Neck length (cm)	11.6±2.0	10.1±1.6	9.0±1.5	8.4±1.5	< 0.001
Neck circumference (cm)	39.0±2.4	32.8±1.5	42.6±6.3	37.3±2.1	< 0.01
Chest circumference (cm)	97.8±10.7	78.2±4.6	107.4±9.8	101.3±10.9	< 0.001
Waist circumference (cm)	95.0±12.0	78.9±9.2	109.9±15.3	106.2±14.9	< 0.001

Table 1. Continuation

Parameter	♂ Diabetes I	♀ Diabetes I	♂ Diabetes II	♀ Diabetes II	P
Hip circumference (cm)	101.7±9.6	96.1±6.4	111.3±15.3	113.9±11.8	< 0.001
Biceps circumference (cm)	32.4±2.9	27.9±1.6	32.6±4.1	32.2±3.4	< 0.05
Forearm circumference (cm)	28.0±1.8	24.3±1.1	28.3±1.9	25.9±1.7	n.s.
Hand circumference (cm)	22.2±1.3	18.9±1.2	21.4±3.9	19.6±1.1	n.s.
Calf circumference (cm)	40.5±2.1	36.7±2.5	38.8±4.0	36.7±3.5	n.s.
Triceps skinfold (mm)	16.6±5.1	24.1±5.1	18.6±8.7	22.9±6.9	n.s.
Forearm skinfold (mm)	13.3±8.0	12.3±3.5	12.9±6.6	15.4±6.2	n.s.
Subscapular skinfold (mm)	18.9±5.9	17.3±3.6	20.6±7.1	25.0±5.6	< 0.05
Suprailiacal skinfold (mm)	10.9±4.3	15.5±2.9	10.2±3.7	12.8±3.8	n.s.
Calf skinfold (mm)	25.5±8.8	25.0±5.5	20.1±9.7	23.0±8.3	n.s.
Shoulder width (cm)	39.3±2.6	33.0±2.0	39.9±1.3	36.8±1.1	< 0.001
Chest width (cm)	30.6±3.2	23.8±5.9	33.0±2.1	30.4±1.6	< 0.001
Chest depth (cm)	23.1±4.1	19.3±2.4	27.2±2.8	27.2±3.3	< 0.001
Zygomatic width (cm)	13.7±1.8	12.2±0.4	13.8±0.4	12.8±1.6	n.s.
Epiphysis width humerus (cm)	9.1±1.7	7.1±0.4	8.5±0.7	8.0±1.1	n.s.
Epiphysis width femur (cm)	10.6±1.3	8.8±0.6	10.3±0.9	9.7±0.9	n.s.
BMI (kg/m²))	25.1±2.9	21.6±1.7	27.9±5.1	29.1±5.0	< 0.001
Lean body mass (kg)	70.7±9.7	47.6±6.2	72.6±13.7	59.8±8.7	< 0.05
Waist-to-hip-ratio	0.95±0.1	0.83±0.1	0.99±0.1	0.93±0.1	< 0.01
Rohrer Index (g*100/cm³)	1.4±0.1	1.3±0.1	1.5±0.2	1.8±0.3	< 0.001
Relative chest width (%)	16.8±1.5	14.6±1.8	18.7±1.1	18.6±1.2	< 0.001
Neck index (%)	29.8±4.2	31.0±6.1	21.8±4.3	22.8±4.9	< 0.001
Forearm length-circumference index (%)	107.6±11.4	97.0±32.7	122.4±28.3	110.9±12.7	n.s.
Forearm fat/circumference index (%)	4.7±2.9	5.1±1.4	4.5±2.1	5.6±1.9	n.s.
Morphological facial index	89.7±6.4	90.6±7.0	92.9±5.4	94.7±16.1	n.s.
Endomorphy (after Parnell)	4.1±0.5	4.7±0.5	4.0±0.7	4.5±0.4	n.s.
Mesomorphy (after Parnell)	4.6±0.7	3.2±0.9	5.0±1.0	5.7±1.6	< 0.001
Ectomorphy (after Parnell)	3.8±0.8	4.1±1.0	2.8±1.2	2.1±1.0	< 0.001
Endomorphy (after Heath / Carter)	4.4±0.9	5.6±0.7	4.7±1.4	6.0±0.9	n.s.
Mesomorphy (after Heath/Carter)	6.5±1.8	3.8±0.8	6.4±1.6	7.0±2.2	< 0.01

Table 1. Continuation

Parameter	♂ Diabetes I	♀ Diabetes I	♂ Diabetes II	♀ Diabetes II	P
Ectomorphy (after Heath(Carter)	2.1±1.0	2.7±1.0	1.2±1.0	0.7±0.7	< 0.001
Metrik-Index (after Conrad)	-0.2±1.0	–1.0±0.7	0.9±0.6	1.4±0.9	< 0.001
Plastik-Index (after Conrad)	89.5±5.3	76.2±3.6	90.6±3.2	82.2±3.1	< 0.01
Macrosomia (after Knussmann)	5.2±2.1	3.8±2.2	5.3±1.6	4.6±1.4	n.s.
Pyknomorphy (after Knussmann)	–0.5±2.5	–2.8±2.0	–1.4±3.4	–1.7±2.9	n.s.
AKS-Index (after Tittel; g*100/cm³)	1.2±0.1	1.0±0.1	1.3±0.2	1.4±0.2	< 0.001

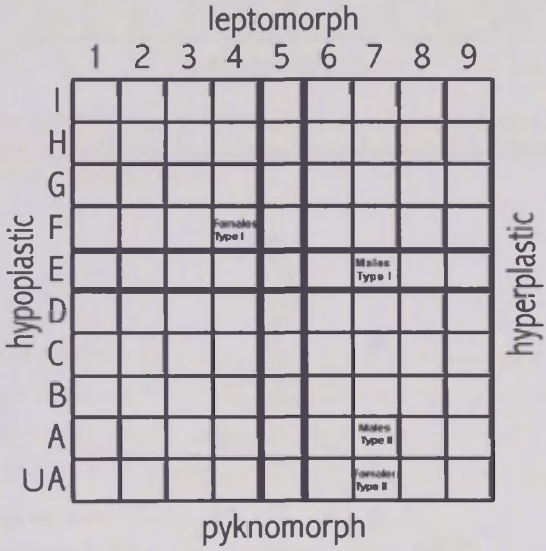


Figure 1. Average constitutional types of male and female athletes with Diabetes Type I and II in the chessboard pattern diagram after Conrad

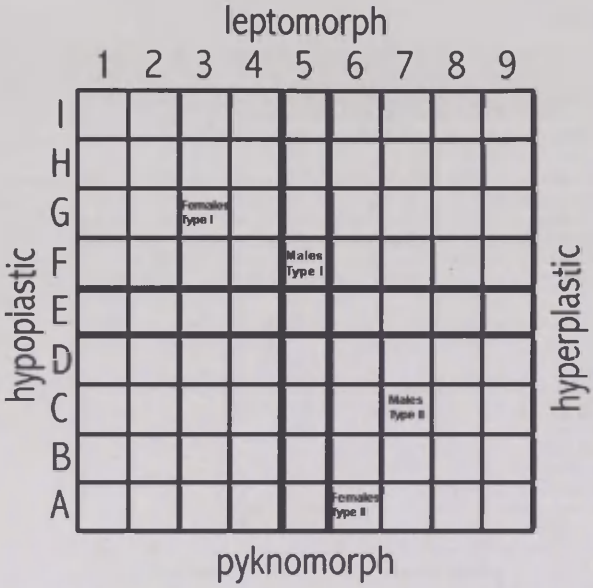


Figure 2. Average constitutional types of male and female athletes with Diabetes Type I and II in the chessboard pattern diagram after Conrad after the application of a correction factor for age

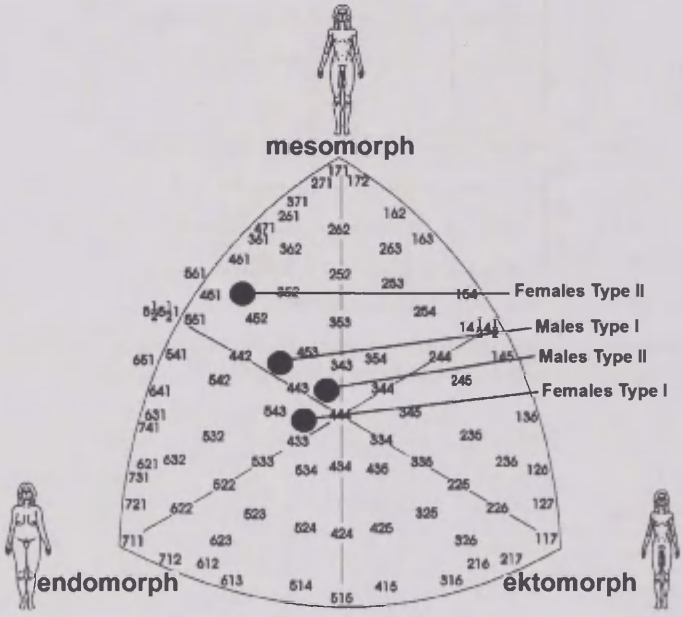


Figure 3. Average somatotypes of male and female athletes with Diabetes Type I and II in the somatochart after Parnell

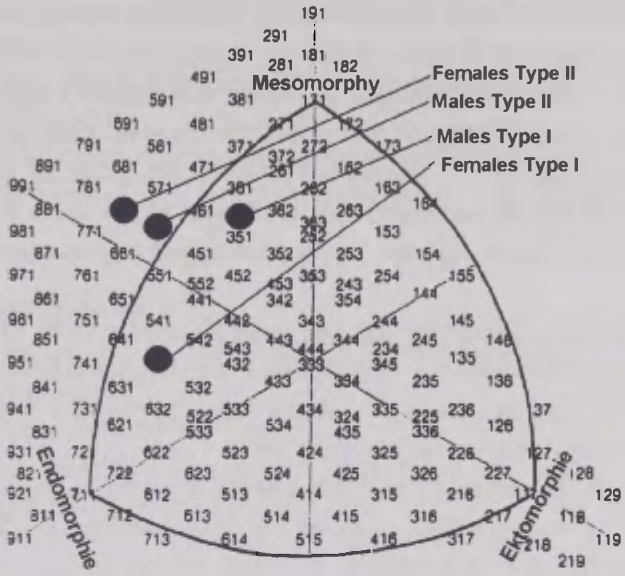


Figure 4. Average somatotypes of male and female athletes with Diabetes Type I and II in the somatochart after Heath & Carter

DISCUSSION

The higher age of athletes with diabetes type II is not surprising. Classically the onset of diabetes mellitus Type II (non-insulin-dependent diabetes mellitus = NIDDM, former category of adult(maturity)-onset of stable diabetes mellitus) is after the age of 40 years; however, this type of diabetes may be diagnosed at any age (Harrison et al. 2003).

The registered significant anthropometrical differences between diabetes type I and II in both genders underline the importance of the so-called truncal obesity in the so-called metabolic syndrome and in the development of diabetes type II. The metabolic syndrome, which is also known as syndrome X, is a combination of medical disorders, that, when occurring together, increase the risk of developing diabetes and the cardiovascular disease. The prevalence in the USA is an estimated 25% of the population, increasing with age (Harrison et al. 2003).

When using and interpreting the significant parameters in this study one might imagine the well known picture of the leptomorph type after Kretschmer (1921), Conrad (1963) and Knussmann (1996) for the diabetes type II compared to diabetes type I:

Shorter length of neck ("buffalo neck"), smaller figure, compacter form, higher circumferences of neck, chest, waist, hip, upper arm, higher BMI and Rohrer-indices, broader shoulders and chest dimensions (width, depth) thus representing truncal obesity, whereas the differences of other circumferences of the extremities and of the skinfolds (with the exception of the subscapular skinfold, which represents mainly the fat content of the upper trunk) were not significant. The results support the constitutional importance of the pyknic habitus.

For significant differences less the general development of subcutaneous adipose tissue, rather than the development of the regional body dimensions of the trunk towards a pyknomorph habitus seems to play the decisive role. This finding of this explorative study is remarkable.

In line with the reduced importance of the pure fat component differences (skinfolds) between the two types of diabetes mellitus are also the missing significances for the endomorphy in body somatotyping techniques after Parnell (1954) and Heath & Carter (1967), because this methodology is based on the determination of pure skinfolds. Instead, significant differences arise primarily for the ectomorphy after Parnell (1954) and Heath & Carter (1967), which is based purely on the body size and the weight by means of the height – weight – ratio (ponderal index). This is similar for the mesomorphy, which is calculated of corrected circumferences and the height.

As expected the results were also significant for the indices after Conrad (1963) and Tittel & Wutscherk (1972).

From an anthropological point of view these anthropometrical findings deserve further critical examination in clinical follow-up studies.

REFERENCES

1. Harrison T. R., Braunwald E., Dietel M. [Eds.] (2003). Harrison's principles of internal medicine. 15. Aufl. London, McGraw-Hill.
2. Conrad K. (1963). Der Konstitutionstypus. Berlin: Springer Verlag.
3. Heath B. H. Carter L. J. E. (1967). A modified somatotype method. Am J Phys Anthrop, 27, 57–74.
4. Heath B. H. Carter L. J. E. (1990). Somatotyping- development and applications. Cambridge Studies in Biological Anthropology. Great Britain: Redwood Press.
5. Knußmann R. (1996). Vergleichende Biologie des Menschen. Lehrbuch der Anthropologie. Stuttgart, Gustav Fischer Verlag.
6. Kretschmer E. (1921). Körperbau und Charakter. Berlin, Springer Verlag.

7. Martin R., Knussmann R. (1988). Anthropologie. Handbuch. Band I. Stuttgart, Fischer Verlag
8. Parnell R.W. (1954). Somatotyping by physical anthropometry. Am J Phys Anthrop, 12, 209–210.
9. Raschka C. (2006). Sportanthropologie, Köln, Sportverlag Strauß.
10. Tittel K., Wutscherk H. (1972). Sportanthropometrie, Leipzig, Barth.

Adress for correspondence
Priv.-Doz. Dr.med. Dr.rer.nat. Dr.Sportwiss. Christoph Raschka
Institute of Sports Sciences
Julius-Maximilians-University
Judenbühlweg 11, D-97082 Würzburg, Germany
E-mail: christoph.raschka@uni-wuerzburg.de

Papers on Anthropology XXI, 2012, pp. 264–275

LOCAL EXPRESSION OF INFLAMMATORY CYTOKINES IN THE FACIAL TISSUE OF CHILDREN WITH A CLEFT LIP AND PALATE

LIENE SMANE[1], MARA PILMANE[1], ILZE AKOTA[2]

[1] *Department of Morphology, Institute of Anatomy and Anthropology, Riga Stradiņš University, Latvia*
[2] *Institute of Stomatology, Riga Stradiņš University, Latvia*

ABSTRACT

The cleft lip and/or palate are among the most common congenital anomalies that occur in early development. Cytokines play an important role in the proliferation, growth, differentiation, survival and the functional activity of many cells and the upregulation of cytokines might be involved in the pathological processes of the maxillofacial region. The purpose of our study was to evaluate the expression of pro-inflammatory and anti-inflammatory cytokines in the facial tissue of children with the cleft lip and palate.

The study involved 14 patients with the unilateral cleft lip and palate at the age of three months to 10 years and five months. Soft and hard palate tissue samples were collected during the primary cleft operation if the parents had given their informed written consent. All the tissue samples were stained with hematoxylin and eosin and by immunohistochemistry for IL-1α, IL-6, IL-8, IL-10 and TNF-α. The intensity of immunostaining was graded semiquantitatively.

IL-1α containing structures were not detected in any of soft, cartilage and bone tissue samples, meanwhile IL-6, IL-8, IL-10 and TNF-α showed explicit expression. The expression of IL 6 was observed in the tissues of all the patients. IL-6 positive cells were found in the range from no positive to moderate of positive structures in the visual field. IL-8 positive osteocytes were found in the range from few positive to moderate, but IL-8 positive chondrocytes were found in abundance. IL-10 was richly secreted by osteocytes in bone and by chondrocytes in cartilage obtained from all the cases of plastic surgery. In all the cases we also observed numerous IL-10 positive gingival epithelial cells.

Despite these data obtained, moderate to numerous macrophages and neutrophils expressed TNF-α.

The sporadical and scarce expression of IL-6 indicates its insignificant role in the cleft lip and palate affected tissue. Rich cytokine IL-10 expression proves the compensated local anti-inflammatory effects of the cleft affected soft and hard tissue.

Key words: *cytokines, cleft lip and palate, human.*

INTRODUCTION

The morphogenetic cleft lip and/or palate (CL/P) affected tissue study has become very significant nowadays. CL/P is among the most common congenital anomaly that arise in the early development and affecting approximately 2 per 1,000 newborns worldwide [1, 2]. Abnormal facial tissue development during gestation is caused by multiple genetic and environmental factors and this may result in local changes in growth factors, the extracellular matrix, cell adhesion molecules and cytokines [1, 3].

Cytokines are pleiotropic peptides, which are involved in numerous biological processes such as in the proliferation, growth, differentiation, survival and functional activity of many cells [4]. There are data about the cytokines role in the embryo growth and differentiation, as well as inflammation and the tissue remodeling [5, 6]. Traditionally, these small, nonstructural proteins are subdivided into following families: interleukins, growth factors, chemokines, colony-stimulating factors, interferons, the transforming growth factor and the tumor necrosis factor families [7]. It should be noted that interleukins and growth factors are present in skull tissues at the time of active differentiation and morphogenesis [8]. Further cytokines are polymorphic, which means that the expression can vary widely between individuals, and this may be genetically controlled [9]. A number of studies showed that the damages in different sections of immunity are significant causes of the pathological processes of maxillofacial region [10, 11]. The analyses of cytokines distribution in the orofacial region constitute the key to understanding the etiopathology of various diseases. Therefore, using an immunohistochemical method many studies reported the expression of interleukin – 1 (IL-1), interleukin – 6 (IL-6), interleukin – 8 (IL-8) and tumor necrosis factor alpha (TNF-α) in the squamous cell carcinoma of the palate tissue and diseased periodontal tissues [4, 12, 13]. Inoyatov et al. (2012) reported that the cytokine level for IL-1,

TNF, interferon-gamma in the blood serum increasing under the congenital cleft [10]. Moreover, still a little is known about the local expression of inflammatory cytokines in the facial tissue of children with the cleft lip and palate.

The aim of this study was to evaluate the expression of pro-inflammatory cytokines such as interleukin 1 alpha (IL-1α), IL-6, IL-8, TNF-α and anti-inflammatory cytokine interleukin-10 (IL-10) in the facial tissue of the children with the unilateral cleft lip and palate.

MATERIAL AND METHODS

Patients

The study involved 14 children with the unilateral cleft lip and palate at the age of three months to 10 years and five months. The samples of soft and hard palate tissue were collected during the surgical procedure from the borders of the cleft region. All the information about the patients is summarized in Table 1. This study has been independently reviewed and approved by the local Ethical Committee of Riga Stradins University (2007), and written informed consent was obtained from all the parents after the nature of the study had been fully explained.

Table 1. Information about the patients

Patient	Gender	Age	Plastic surgery procedure	Material
No. 1	F	9 years 4 months	Rhinoplasty	Bone tissue from *spina nasalis anterior maxillae*
No. 2	F	9 years 4 months	Rhinoplasty	Cartilage from *septum nasale*
No. 3	M	7 years 7 months	Rhinoplasty	Bone tissue from *spina nasalis anterior maxillae*
No. 4	M	7 years 7 months	Rhinoplasty	Cartilage from *septum nasale*
No. 5	M	10 years 5 months	Osteoplasty	Bone tissue from processus alveolaris
No. 6	F	7 years 3 months	Osteoplasty	Bone tissue from processus alveolaris
No. 7	F	8 years	Rhinoplasty	Cartilage from septum nasale

Table 1. Continuation

Patient	Gender	Age	Plastic surgery procedure	Material
No. 8	F	8 years	Rhinoplasty	Bone tissue from *spina nasalis anterior maxillae*
No. 9	M	8 years 5 months	Osteoplasty	Bone tissue from processus alveolaris
No. 10	F	7 years 10 months	Osteoplasty	Bone tissue from processus alveolaris
No. 11	M	4 months	Lip plastic	Cleft lip region
No. 12	M	4 months	Lip plastic	Cleft lip region
No. 13	M	3 months	Lip plastic	Cleft lip region
No. 14	M	4 months	Lip plastic	Cleft lip region

Methods

For conventional light microscopy and immunohistochemistry tissues were fixed for a day in the mixture of 2% formaldehyde and 0.2% picric acid in 0.1 M phosphate buffer (pH 7.2). Following this, they were rinsed in the thyroid buffer, containing 10% sacharose for 12 hours, and then samples were embedded into paraffin. Five micrometer thick sections were cut from each block, mounted on glass slides, then de-paraffinized, rehydrated through graded alcohol solutions and colored with hematoxylin-eosin.

Five-micrometer thick sections were cut from the same blocks and placed on polylisine coated slides for the immunohistochemical analysis. Sections were proceeded for the detection of the following interleukins: interleukin-1 alpha (IL-1α (B-7): sc-9983, obtained from the mouse, working dilution 1:50, Santa Cruz Biotechnology, Inc., USA), interleukin-6 (IL-6 (NYRhIL6): sc-73319, obtained from the mouse, working dilution 1:50, Santa Cruz Biotechnology, Inc., USA), interleukin-8 (IL-8 (C-19): sc-1269, obtained from the goat, working dilution 1:50, Santa Cruz Biotechnology, Inc., USA), interleukin-10 (IL-10, code ab 34843, obtained from the rabbit, working dilution 1:400, Abcam, Cambridge, UK), tumor necrosis factor alpha (TNF-α, code ab 6671, obtained from the rabbit, working dilution 1:100, Abcam, Cambridge, UK) by use of Hsu et al. (1981) biotin – streptavidin immunohistochemical method.

Our findings were illustrated using Leica DC 300F camera and the image processing and analysis software Image-Pro Plus Version 6.0.

The intensity of immunostaining was graded semi-quantitatively. The scale was the following: "0" – no positive structures found in the the visual field, "0/+" – occasional positive structures seen in the visual field, "+" – few immunoreactive structures seen in the visual field, "++" – moderate number of immunoreactive structures seen in the visual field, "+++" – numerous immunoreactive structures seen in the visual field, and "++++" – the abundance of immunoreactive structures seen in the visual field (Pilmane et al. 1998).

RESULTS

Routine haematoxylin and eosin slides showed patchy infiltrates with inflammatory cells vacuolization in the polymorphic epithelial cell layer.

IL-1α-containing structures were not detected in any of the soft, cartilage and bone tissue samples, meanwhile IL-6, IL-8, IL-10 and TNF-α showed explicit expression.

The expression of IL-6 was also observed in the tissues of all the patients. IL-6 positive cells were found in the range from the absence to moderate (++) of positive structures in the visual field. We observed few (+) to moderate (++) positive osteocytes (Figure 1), few (+) to moderate (++) immunoreactive hyaline cartilage cells and many positive cells in the cartilage growth zone (Figure 2) and few positive epithelial cells (Figure 3) into the gingival epithelium.

IL-8 also was seen in the tissue samples of all the patients. IL-8 positive osteocytes were found in the range from few (+) positive to moderate (++) of positive structures in the visual field (Figure 4). It should be noted that IL-8 presented the abundance of richly stained hyaline cartilage chondrocytes (Figure 5).

Interestingly, IL-10 was richly secreted by osteocytes in bone obtained from all the cases of plastic surgery, as well as by chodrocytes in the hyaline cartilage obtained from all the cases of plastic surgery. IL-10 positive structures mostly varied from numerous (+++) positive structures to abundance (++++) of positive structures in the visual field. Therein we detected many immunoreactive hyaline cartilage cells and many positive cells in the cartilage growth zone as well as many osteocytes (Figure 6). In all the cases we also observed numerous (+++) IL-10 positive gingival epithelial cells.

Finally, despite these data moderate (++) to numerous (+++) macrophages and neutrophils expressed TNF-α (Figure 7).

Figure 1. Few IL-6 positive osteocytes in the bone from *spina nasalis anterior maxillae* of 9 years and 4 months old child. IL-6 IMH, X 400.

Figure 2. Moderate number of IL-6 positive chondrocytes in the mature and proliferation zone. IL-6 IMH, X 250.

Figure 3. Few IL-1α positive epithelial cells into the gingival epithelium of 4 months old child. IL-1α IMH, X 250.

Figure 4. Moderate number of IL-8 positive osteocytes in the bone from *spina nasalis anterior maxillae* of 9 years and 4 months old child. IL-8 IMH, X 250.

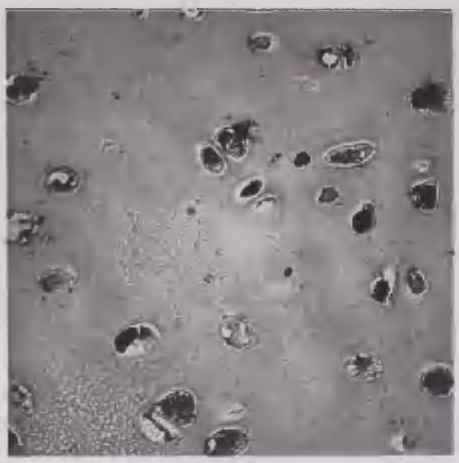


Figure 5. Abundance of IL-8 positive chondrocytes in the hyaline cartilage from *septum nasale* of 7 years and 7 months old child. IL-8 IMH, X 250.

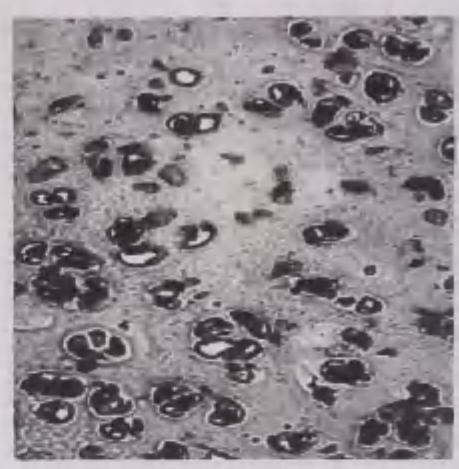


Figure 6. Abundance of IL-10 positive chondrocytes in the hyaline cartilage from *septum nasale* of 7 years and 7 months old child. IL-10 IMH, X 250.

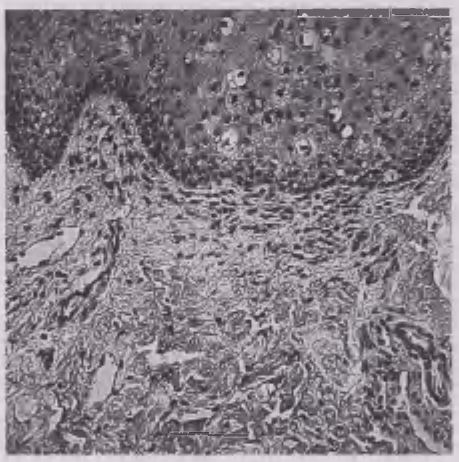


Figure 7. Moderate number of TNF-α containing macrophages and neutrophils in the soft tissue from lip region of 4 months old child. TNF-α IMH, X 200.

DISCUSSION

Cytokines are of central importance for the regulation of inflammation, tissue remodeling, and embryogenic development [5, 6]. Yet little is known about the local expression of pro- inflammatory cytokines in the cleft lip and palate tissues.

The expression of interleukin-6 (IL-6) was observed in the tissues of all the patients. Therein IL-6 showed slight elevated expression in gingival epithelial,

hyaline cartilage and hyaline cartilage growth zone cells as well as osteocytes. IL-6 is a well known major inflammatory and fibrogenic cytokine and it has a wide range of biological activities including the regulation biological functions of connective tissue cells (e.g. fibroblasts), the expression of proteases, inhibiting the formation of the extracellular matrix, the immune regulation and the stimulation of acute-phase reactants [14, 15, 16]. IL-6 is involved in the regulation of bone and cartilage cells functions, but its role in supportive tissue metabolism is uncertain [17]. Bodo et al. (1998) reported that changes between TGF-β3 and IL-6 signal transduction pathways are involved in the induction of the cleft palate [18]. The role of tumor growth factor beta3 (TGFβ3) expression in orofacial clefts has been investigated for several years. TGF-β3 significantly down-regulates IL-6 secretion in the cleft lip and palate fibroblasts [19]. Further IL-6 reduces connective macromolecule production unlike TGF-β [20, 21]. IL-6 expression in the material from clefts areas possibly might be explained with the necessity for an inhibitory effect on extracellular matrix components levels. In our material the sporadical and scarce expression of IL-6 indicates its insignificant role in the cleft lip and palate affected tissue. A number of studies reported that the TGF-β is involved in regulating not only the IL-6 network, but also interleukin-1 alpha (IL-1α) [22].

It should be noted that IL-1α containing structures were not detected in any of soft, cartilage and bone tissue samples from the patients with the clefts lip and palate. IL-1α is a major pro-inflammatory cytokine. In addition, this cytokine has been supported to be a potent regulator of fibroblast proliferation, and is also known to induce the synthesis of the basic fibroblast growth factor (bFGF) in human osteoblasts and gingival fibroblasts [23, 24]. In its turn, bFGF is involved in various cellular processes such as in cell proliferation associated with wound healing, differentiation and cell migration [25]. In this study TNF-α was observed in macrophages and neutrophils. Like IL-1, TNF-α induces inflammatory response and is a central regulator of the innate immune response as well as induces the expression of proteases and inhibits the formation of the extracellular matrix and promotes cells to secrete pro-inflammatory cytokines [15, 26, 27, 28], and these functions may play a role in our patients also.

Interleukin-8 (IL-8) was observed in the cells of hyaline cartilage, bone and soft tissue. Some variations in the distribution of cytokines may be explained by polymorphism of interleukins genes [9]. This pro-inflammatory cytokine is a neutrophil chemoatractant and activator, play a critical role in inflammation

and host defense and is synthesized by fibroblasts from different tissues, chondrocytes and several types of epithelial cells [29, 30]. A moderate number of IL-8 positive cells in our patients my play a role in these functions. IL-8 immunoreactivity is associated with many orofacial region diseases such as the periodontal disease [31]. In support of this, Huang et al. (2001) showed that the expression of IL-8 by gingival epithelial cells increases the following interaction with several periodontal microbes [31].

Interestingly, interleukin-10 (IL-10) presented the abundance of richly stained chondrocytes, osteocytes, fibroblasts, neutrophils, and macrophages, the cells of gingival epithelium, sebaceous glands and hair follicles in all the patients. This cytokine is a true anti-inflammatory cytokine [32]. Its presence suggests the presence of inflammation in the bone, cartilage and soft tissue, even though IL-1α absence may suggests the absence of inflammation in the same tissues.

We concluded that the sporadical and scarce expression of IL-6 indicates its insignificant role in the cleft lip and palate affected tissue. Rich cytokine IL-10 expression proves the compensated local anti-inflammatory effects of the cleft affected soft and hard tissue.

REFERENCES

1. Murray J. C. (2002). Gene/environment causes of cleft lip and/or palate. Clin Genet, 61, 248–56.
2. Murray J. C., Schutte B. C. (2004). Cleft palate: players, pathways, and pursuits. J Clin Invest, 113, 1676–1678.
3. Meng L., Bian Z., Torensma R., Von den Hoff J. W. (2009). Biological Mechanisms in Palatogenesis and Cleft Palate. J DentRes, 88, 22–33.
4. Jeng J. H., Wang Y. J., Chiang B. L., Lee P. H., Chan C. P., Ho Y. S., Wang T. M., Lee J. J., Hahn L. J., Chang M. C. (2003). Roles of keratinocyte inflammation in oral cancer: regulating the prostaglandin E2, interleukin-6 and TNF-a production of oral epithelial cells by areca nut exreact and arecoline. J Carcinog, 24, 8, 1301–1315.
5. Desai N., Scarrow M., Lawson J., Kinzer D., Goldfarb J. (1999). Evaluation of the effect of interleukin-6 and human extracellullar matrix on embryonic development. Hum Reprod, 14, 6, 1588–1592.
6. Austgulen R., Arntzen K. J., Vatten L. J, Kahn J., Sunde A. (1995). Detection of cytokines (interleukin-1, interleukin-6, transforming growth factor-beta) and soluble tumour necrosis factor receptors in embryo culture fluids during in-vitro fertilization. Hum Reprod, 10, 1, 171–176.

7. Charles A., Dinarello, M. D. (2000). Proinflammatory Cytokines. Chest, 118, 2, 503–508.
8. Carinci P., Becchetti E., Baroni T., Carinci F., Pezzetti F., Stabellini G., Locci P., Scapoli L., Tognon M., Volinia S., Bodo M. (2007). Extracellular matrix and growth factors in the pathogenesis of some craniofacial malformations. Eur Histochem, 51, 1, 105–116.
9. House R. V., Descotes J. (2007). Cytokines in Human Health. Humana Press Inc, 4.
10. Inoyatov A., Abdurakhmanov M., Sharopov S., Azimov M. (2012). The level of mediators of immune response in infants with congenital cleft lip and palate. MHSJ, 10, 30–36.
11. Yamada T., Yoshihide M., Katsuhiro M. (2002). Three-dimensional analysis of facial morphology innormal children as control data for cleft surgery. Cleft Palate Cranofac J, 39, 5, 517–526.
12. Mostefaoui Y., Claveau I., Ross G., Rouabhia M. (2002). Tissue structure, and IL-1β, IL-8, and TNF-α secretions after contact by engineered human oral mucosa with dentifrices. J ClinPeriodontol, 29, 1035–1041.
13. Garcia de Aquino S., Leite F. R. M., Stach-Machado D. R., Francisco da Silva J. A., Spolidorio L. C., Rossa Jr. C. (2009). Signaling pathways associated with the expression of inflammatory mediators activated during the course of two models of experimental periodontitis. Life Sci, 84, 745–754.
14. Hirano T., Ishihara K., Hibi M. (2000). Roles of STAT3 in mediating the cell growth, differentiation and survival signals relayed through the IL-6, family of cytokine receptors. Oncogene, 19, 2548–2556.
15. Sakao K., Takahashi K. A., Arai Y., Saito M., Honjo K., Hiraoka N., Asada H., Shin-Ya M., Imanishi J., Mazda O., Kubo T. (2009). Osteoblasts derived from osteophytes produce interleukin-6, interleukin-8, and matrix metalloproteinase-13 in osteoarthritis. J Bone Miner Metab, 27, 412–423.
16. Pedersen K. B., Steensberg A., Schjerling P. (2001). Muscle-derived interleukin-6: possible biological effects. J Physiol, 536, 2, 329–337.
17. Walsh M. C., Kim N., Kadono Y., Rho J., Lee S. Y., Lorenzo J., Choi Y. (2006). Osteoimmunology: interplay between the immune system and bone metabolism. Annu Rev Immunol, 24, 33–63.
18. Bodo M., Carinci P., Baroni T. (1998). Role of growth factors on extracellular matrix production by chick embryo fibroblasts in vitro. Antagonist effect of TGF-beta through the control of IL-1 and IL-1Ra secretion. Cytokine, 10, 5, 353–360.
19. Baroni T., Carinci P., Bellucci C., Lilli C., Becchetti E., Carinci F., Stabellini G., Pezzetti F., Caramelli E., Tognon M., Bodo M. (2003). Cross-talk between interleukin-6 and transforming growth factor-beta3 regulates extracellular matrix production by human fibroblasts from subjects with nonsyndromiccleft lip and palate. J Periodontol, 74, 1447–1453.

20. Rullo R., Gombos F., Ferraraccio F., Farina A., Morano D., Festa V. M., Guida L., Martinelli M., Scapoli L., Pezzetti F., Carinci F. (2006). TGFβ3 expression in non-syndromicorofacial clefts. Int J PediatrOtorhinolaryngol, 70, 1759–1764.
21. Roodman G. D., Kurihara N., Ohsaki Y., Kukita A., Hosking D., Demulder A., Smith J. F., Singer F. R. (1992). Interleukin 6. Apotentialautocrine/paracrine factorinPaget'sdisease of bone. J Clin Invest, 89, 46–52.
22. Schluns K. S., Cook J. E., Le P. T. (1997). TGF-beta differentially modulates epidermal growth factor-mediated increases in leukemia-inhibitory factor, IL-6, IL-1 alpha, and IL-1 beta in human thymic epithelial cells. J Immunol, 2704–2711.
23. Sato N., Fujii A. (2008). Effects of interleukin-1α on the production and release of basic fibroblast growth factor in cultured nifedipine-reactive gingival fibroblasts. J Oral Sci, 50, 1, 83–90.
24. Sobue T., Zhang X., Florkiewicz R. Z., Hurley M. M. (2001). Interleukin-1 regulates FGF-2 mRNA and localization of FGF-2 protein in human osteoblasts. Biochem Biophys Res Commun, 286, 1, 33–40.
25. Boonpratham S., Kanno Z., Soma K. (2007). Occlusal stimuli regulate interleukin-1 beta and FGF-2 expression in rat periodontal ligament. J Med Dent Sci, 54.
26. Aida Y., Maeno M., Suzuki N., Namba A., Motohashi M., Matsumoto M., Makimura M., Matsumura H. (2006). The effect of IL-1β on the expression of inflammatory cytokines and their receptors in human chondrocytes. Life Sci, 79, 764–771.
27. Aida Y., Maeno M., Suzuki N., Shiratsuchi H., Motohashi M., Matsumoto M., Makimura M., Matsumura H. (2005). The effect of IL-1β on the expression of matrix metalloproteinases and tissue inhibitors of matrix metalloproteinases in human chondrocytes. Life Sci, 77, 3210–3221.
28. Eda H., Shimada H., Beidler D. R., Monahan J. B. (2011). Proinflammatory cytokines, IL-1β and TNF-α, induce expression of interleukin-34 mRNA via JNK- and p44/42 MAPK-NF-kB pathway but not p38 pathway in osteoblasts. RheumatolInt, 31, 1525–1530.
29. Baggiolini M., Clark-Lewis I. (1992). Interleukin-8, a chemotactic and inflammatory cytokine. FebsLett, 307, 1, 971–01.
30. Ewington L., Taylor A., Sriraksa R., Horimoto Y., Lam E. W. F., El-Bahrawy M. A. (2012). The expression of interleukin-8 and interleukin-8 receptors in endometrial carcinoma. Cytokine, 59, 417–422.
31. Huang G. T. J., Kim D., Lee J. K. H., Kuramitsu H. K., Haake S. K. (2001). Interleukin-8 and Intercellular Adhesion Molecule 1 Regulation in Oral Epithelial Cells by Selected Periodontal Bacteria: Multiple Effects of Porphyromonasgingivalis via Antagonistic Mechanisms. Infection and Immunity Mar, 1364–1372.
32. Sienerth A. R., Scheuermann C., Galmiche A. (2011). Polycomb group protein Bmi1 negatively regulates IL-10 expression in activated macrophages. Immunol Cell Biol.89, 7, 812–816.

Address for correspondence:
Liene Smane
Department of Morphology
Institute of Anatomy and Anthropology
Riga Stradiņš University
Lugazu st. 15-39, Riga LV-1045, Latvia
E-mail:lienes.smanes@inbox.lv

Papers on Anthropology XXI, 2012, pp. 276–286

DYNAMICS OF CELL POPULATION STRUCTURE IN LIVER BIOPSY OF THE PATIENTS WITH CHRONIC HEPATITIS VIRAL INFECTION

IVAN I. TOKIN[1], IVAN B. TOKIN[2], GALINA FILIMONOVA[2], PIRET HUSSAR[3]

[1] *St. Petersburg Medical Academy, Russia*
[2] *St. Petersburg State University, Russia*
[3] *Institute of Anatomy, University of Tartu, Estonia*

ABSTRACT

The cell population analysis of liver biopsies from the patients with both chronic hepatitis, chronic viral hepatitis C (HCV) and chronic viral hepatitis B (HBV) included the comparative evaluation of the specific part of non-parenchymal elements, analysis of the liver plates and sinusoids areas, the cell population of liver plates and sinusoids, the caryometric description of different types of cells. The essential difference of similar quantitative indexes in the biopsy specimens of patients with HCV and HBV was revealed and discussed. In total, the quantitative analysis of cell population structure in liver biopsies during the course of chronic hepatitis, especially in the case of defective biopsies, could be used for diagnostics and prognoses by expert evaluation.

Key words: *liver biopsy, chronic viral hepatitis, morphometric analysis, caryometric analysis*

INTRODUCTION

The histopathological study of the liver biopsy in viral hepatitis is very important for the determination of the severity, stage and prognosis of the disease [1, 2]. Severity is graded according to the extent of necroinflammatory lesions; the staging of progression is based on the extent of fibrosis. At the same

time the information about the cell population structure of liver biopsy of the patients with chronic viral hepatitis is very scarce. So, the nuclei size and the nuclei shape measurement have been applied in normal liver and hepatomas [3]. The diameter of nuclei and the cytoplasm of HBsAg-positive hepatocytes was also measured [4]. This study attempts to determine quantitatively whether hypertrophy, hyperplasia, and dysplasia are associated with HBV-infected hepatocytes. In our investigation the cell population analysis of liver biopsies from the patients with both chronic hepatitis, HCV and HBV included the evaluation of the specific part of non-parenchymal elements, the analysis of liver plates and sinusoids areas, the quantitative calculation of different types of cells in the composition of liver plates and sinusoids.

MATERIAL AND METHODS

Patients

Different groups of patients with chronic viral hepatitis C (HCV) and chronic viral hepatitis B (HBV) were investigated. 15 HCV and 9 HBV patients with mild, moderate and severe degree of fibrosis according to the classification by Ishak and METAVIR [1, 5] participated in the study. The diagnosis of chronic HCV and chronic HBV was established after the careful examination of patients: the anamneses of diseases and life, laboratory analyses, virological and morphological studies. To refine the diagnosis as well as for the detection of activity of pathological processes in the liver, aspiration biopsy according to G. Menghini [6, 7] was taken from all the patients.

Histological evaluation

Samples of biopsies were formalin-fixed and paraffin-embedded. Serial paraffin sections were cut at 5 μm. Hematoxylin-eosin stain was used. Each biopsy for necroinflammatory activity and fibrosis was assessed by two hepatologists.

Stereometric analysis

The calculation was carried out using the standard graticule (400 squares) by microscope magnification 400×. In each field of vision a quantity of non-parencymal liver structures was calculated as a sum of portal areas, hepatic vessels and intralobular infiltrations. Other liver structures such as liver plates and sinusoids, were considered as parenchyma. The relationship between parenchymal and non-parenchymal elements was calculated in percentage.

Cell population analysis

The number of lytic necroses of necroses of hepatocytes, binucleated hepatocytes and polymorphous hepatocytes with large nuclei was calculated in the composition of liver plates. The number of Kupffer cells and endotheliocytes was determined in the composition of sinusoids. Calculation was performed in the standard field of vision of microscope at the magnification 400× in the region of the middle zone of the liver lobule. Twenty standard fields of vision were investigated for each biopsy. Statistical analysis was performed by the tabulated processor Microsoft Excel 2003 and STATISTIKA 9.0. Pearson and Spearman correlation coefficients were used to evaluate the structure of population.

Karyometric analysis

The measurement of the nuclei square of the different types of cells in the composition of liver plates and sinusoids was performed. We also calculated the square of nuclei of mononucleated and binucleated hepatocytes, The Kupffer cells and endotheliocytes. All the measurements were realized by the special computer program of the microscope "Microvisor" (Russia).

RESULTS

Cell population structure of liver biopsies from the patients with both chronic hepatitis, HCV and HBV

Only sufficiently large biopsies with 5–6 portal zones can be suitable for the quantitative evaluation of the parenchymal elements of the liver by the methods of stereological or computer morphometry. Nevertheless, biopsies used to have frequently small sizes or consist of fine fragments without portal zones in clinical practice. The quantitative analysis of parenchyma elements (liver plates and sinusoids cells) is advisable in these cases.

In our investigation the cell population analysis of liver biopsies from the patients with both chronic hepatitis, HCV and HBV included the comparative evaluation of the specific part of non-parenchymal elements, the analysis of the liver plates and sinusoids areas, the cell population of liver plates and sinusoids.

Comparative analysis of the specific part of non-parenchymal elements

The specific part of non-parenchymal elements in the liver biopsies of patients with HCV (Table 1) strongly varies: from 2.16% to11.93% (the mean value is 6.9 ± 0.8%).

The piecemeal and bridging necroses are presented (Figure 1 and Figure 2), as a rule, in the liver biopsies of the patients with a high index of non-parenchymal elements. The piecemeal necroses are described in 11 cases from 15, bridging necroses in 7 cases from 15. Such distribution shows that during the ordinary course of the disease the piecemeal necroses arise from the beginning, the bridging necroses are discovered later.

Table 1. Cell population structure of liver plates and sinusoids in the patients with HCV

Biopsy number	Non-parenchymal elements, %	Liver plates, %	Sinusoids, %	Lytic necroses of hepatocytes	Binucleated hepatocytes	Polymorphous hepatocytes	Endotheliocytes	Kupffer cells
1	2.16	96.77	3.23	2.70	0.90	0.40	5.80	11.10
2	2.46	92.68	7.32	1.60	2.40	0.90	7.30	6.90
3	3.6	94.23	5.77	3.80	2.70	0.60	8.00	9.10
4	4.3	95.10	4.90	3.50	1.00	1.30	7.20	5.30
5	4.63	94.90	5.10	4.60	1.50	0.80	10.20	10.90
6	4.7	93.74	6.26	2.80	0.30	0.00	8.90	6.90
7	5.06	95.42	4.58	5.70	1.30	0.10	12.00	6.90
8	5.18	93.32	6.68	2.60	0.30	0.10	7.60	10.70
9	6.64	93.55	6.45	5.20	0.30	0.50	7.70	9.80
10	9.46	94.68	5.32	4.40	1.70	0.80	12.80	15.80
11	9.68	94.35	5.65	5.70	0.50	0.70	9.90	8.80
12	10.56	92.16	7.84	4.60	1.10	0.90	11.30	12.00
13	10.89	94.94	5.06	5.50	1.30	0.00	7.20	7.00
14	11.76	93.00	7.00	3.80	2.70	1.90	9.70	14.00
15	11.93	92.87	7.13	3.10	0.90	0.60	10.40	9.20

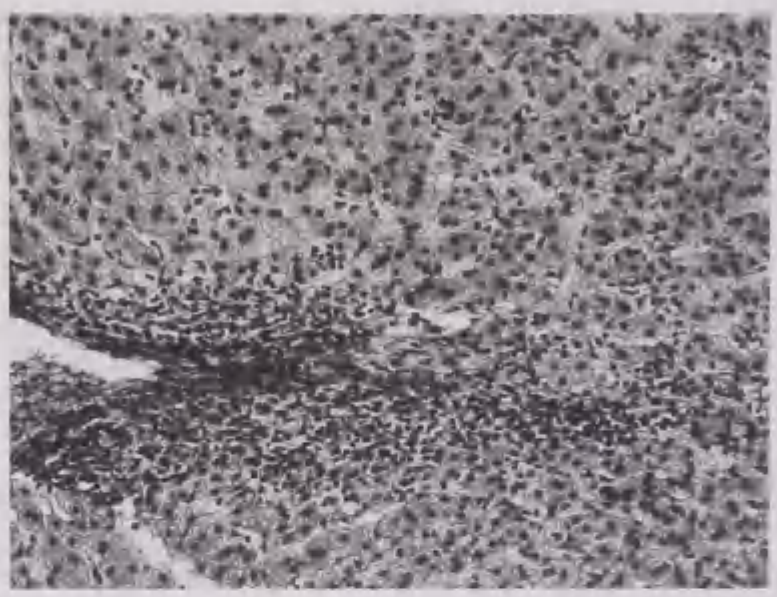


Figure 1. Fragment of portal tract with the damage of limiting plate and the development of piecemeal necroses in the liver of a patient with HBV. Hematoxylin-eosin. Obj.20x

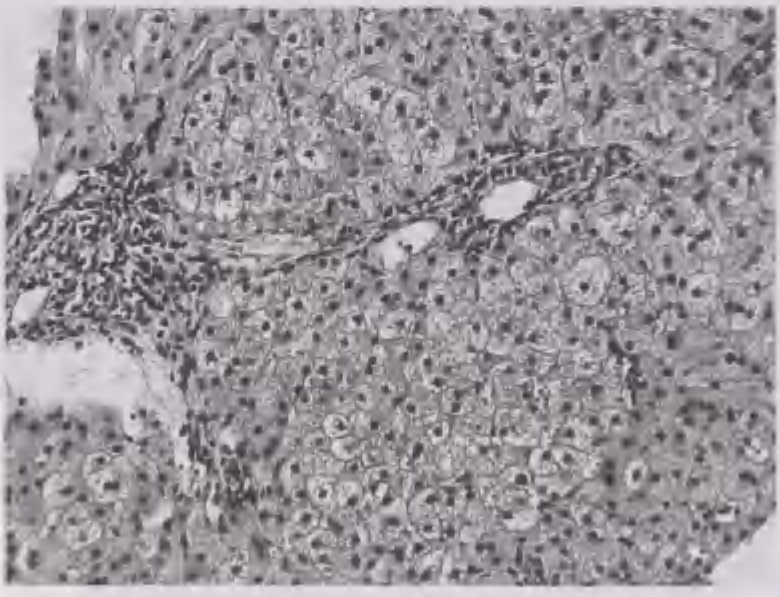


Figure 2. Fragment of portal tract with the damage of limiting plate and the development of bridging necroses in the liver of a patient with HCV. Hematoxylin-eosin. Obj.20x

The specific part of non-parenchymal elements changes from 2.39% to 8.41% (the mean value is 3.8 ± 0.9) in the liver biopsies of the patients with HBV (Table 2). The piecemeal necroses were observed only in one biopsy, the bridging necroses in two biopsies.

The data regarding the specific parts of non-parenchymal elements shows that liver damages of the patients with HCV are more significant in comparison with the analogical indexes of patients with HBV.

Analysis of the liver plates and sinusoids area

Morphometric investigation shows that the specific parts of the liver plates of patients with HCV slightly vary from 92.16% to 96.77% (the mean value is 94.1±0.31). The specific parts of sinusoids vary from 3.23% to 7.84% (the mean value is 5.9±0.4). Such variations are more significant in the livers of the patients with HBV. The specific parts of liver plates in this case vary from 85.77% to 93.87% (the mean value is 90.98±0.32), the specific parts of sinusoids vary from 6.13% to 14.23% (the mean value is 9.02±0.32). Morphological and morphometric studies show (Figures 3 and 4; Tables 1 and 2) that the sinusoids of the liver biopsies of the patients with HCV significantly more narrowed than such of the patients with HBV. Respectively the conditions of intralobular blood circulation are significantly differ under various types of hepatitis.

Thus, the connection between the disease severity and the specific parts of liver plates and sinusoids are not established.

Table 2. Cell population structure of liver plates and sinusoids in patients with HBV

Biopsy number	Non-parenchymal elements, %	Liver trabecule, %	Sinusoids, %	Dead hepatocytes	Binucleated hepatocytes	Polymorphous hepatocytes	Endotheliocytes	Kupffer cells
1	2.39	91.65	8.35	6.75	1.00	1.00	6.25	7.15
2	2.76	91.81	8.19	5.35	3.85	2.15	5.50	8.40
3	2.78	93.29	6.71	2.05	1.80	1.15	8.05	8.45
4	2.82	93.65	6.35	3.70	0.85	0.90	6.90	6.10
5	2.86	85.77	14.23	1.30	4.10	2.35	7.35	6.15
6	3.24	91.16	8.84	5.70	1.20	1.20	5.10	5.15
7	4.32	93.87	6.13	4.91	1.36	0.91	8.64	5.73
8	4.62	91.39	8.61	3.20	1.95	1.60	8.30	6.50
9	8.41	86.26	13.74	3.55	4.90	1.70	8.45	8.40

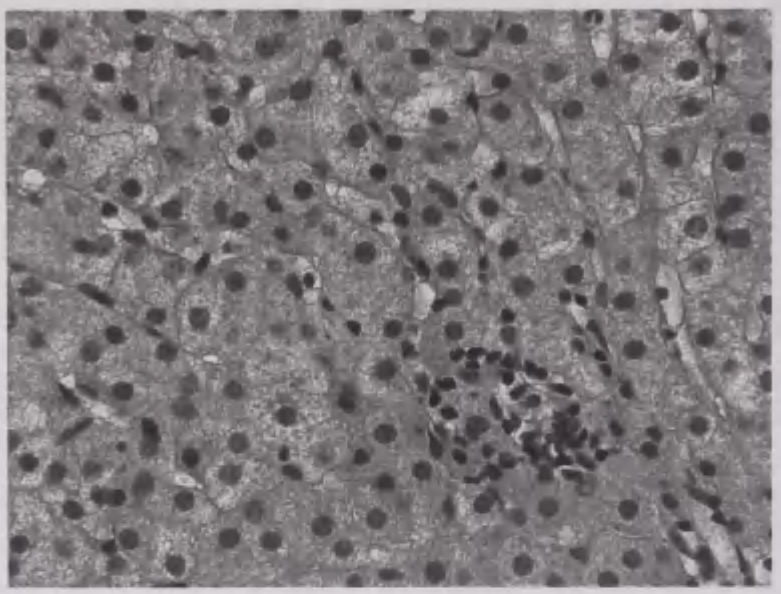


Figure 3. Fragment of parenchyma with intralobular necrosis, unimorphous hepatocytes and narrow sinusoids in the liver of a patient with HCV. Hematoxylin-eosin. Obj.40x

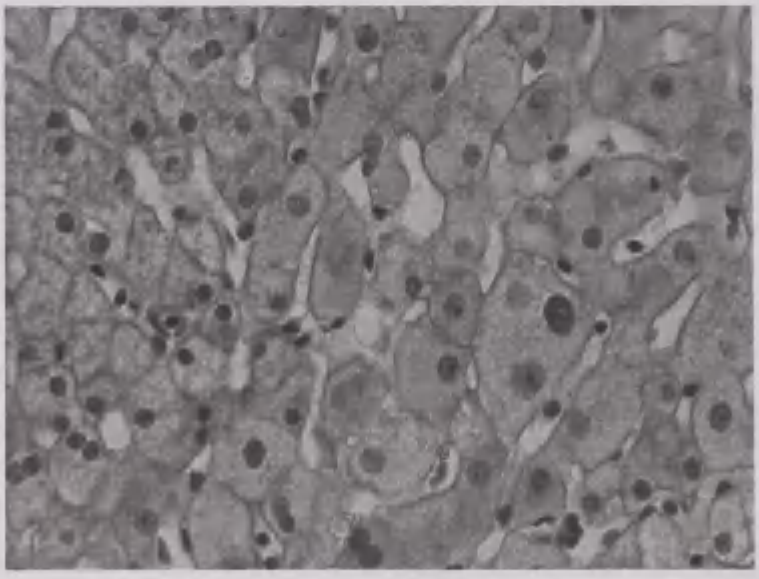


Figure 4. Fragment of parenchyma with polymorphous hepatocytes and distorted sinusoids in the liver of a patient with HBV. Hematoxylin-eosin. Obj.40x

Cell population of liver plates

In the liver biopsies of the patients with chronic HCV (Table 1) the amount of lost hepatocytes (lytic necroses) in liver plates varies from 1.6% to 5.7% in the standard field of vision (the mean value is 3.97±04). The number of binucleated hepatocytes varies from 0.3 to 2.7 (the mean value is 1.26±0.2). The number of polymorphous hepatocytes in the standard field of vision varies from 0.0 to 1.9 (the mean value 0.64±0.1).

In the liver biopsies of the patients with HBV (Table 2) the amount of lost cells varies from 1.3 to 6.75 (the mean value is 4.06±0.59). The number of binucleated hepatocytes varies from 0.85 to 4.9 (the mean value is 2.33±0.5). The number of polymorphous hepatocytes in the standard field of vision varies from 0.9 to 2.35 (the mean value is 1.44±0.3).

Thus, the amount of single lytic necroses of hepatocytes does not differ in the liver biopsies of the patients with HBV and with HCV. At that time the number of binucleated hepatocytes and polymorphous hepatocytes is certainly higher in the liver biopsies of the patients with HBV. This situation may be connected with the different level of processes of regeneration.

Cell population of liver sinusoids

The amount of endotheliocytes in the sinusoids of the liver biopsies of the patients with HCV (Table 1) strongly varies: from 5.8 to 12.8 cells in the standard field of sight (the mean value is 9.0±0.5). The amount of the Kupffer cells is also significantly differing from 5.3 to 15.8 in the field of sight (the mean value is 9.6±0.7). Nevertheless, the precise linear dependence between both of the indexes is not revealing.

The amount of endotheliocytes in the sinusoids of the liver biopsies of the patients with HBV (Table 2) weakly varies from 5.1 to 8.64 cells in the standard field of sight (the mean value is 7.17±0.13). The amount of the Kupffer cells changes from 5.15 to 8.45 in the field of sight (the mean value is 6.89±0.31).

Thus, the amount of endotheliocytes and the Kupffer cells is essentially bigger in the liver biopsies of the patients with HCV. This circumstance is probably connected with the peculiarities of virus influence on the vessel component of liver parenchyma.

The cell population structure of the liver biopsies of the patients with HBV and HCV changes unequally. So, the use of the Student and the Satterwhite criteria allows discovering the statistically significant distinctions between the

mean values of all the indexes with the exception of the amount of lost hepatocytes in liver plates.

The coefficients of correlation between the indexes of specific parts of liver plates and the number of binucleated cells, between the indexes of specific parts of liver plates and the number of polymorphous cells are statistically significant for the cluster of the liver biopsies of the patients with HBV.

The statistically significant coefficients of the Pearson correlation are not detected for the cluster of the liver biopsies of the patients with HCV.

The strong linear dependence between the indexes of the specific parts of liver plates and the number of binucleated cells and the number of polymorphous cells was revealed in the liver biopsies of the patients with HBV.

The use of the Spearmen coefficients of correlation allowed establishing the connection between the number of cells in sinusoids and the specific part of non-parenchymal elements in the liver biopsy of the patients with HBV. This circumstance could be used for indirect characteristics of the development of fibroses changes in liver.

In total, the quantitative analysis of the cell population structure in liver biopsies in the course of chronic hepatitis, especially in the case of defective biopsies, could be used for diagnostics and prognoses by expert evaluation.

Karyometric analysis

The Karyometric analysis was performed only in the liver biopsy from the patients with the mild degree of chronic HBV. Our investigation showed that the square of mononucleated hepatocytes strongly varied from 21 μm^2 to 76 μm^2. Following mononucleated hepatocytes were distributed into 4 groups depending on the nuclei square. So, the 1st group included hepatocytes with the nuclei square of 20–29 μm^2, 2nd group – with the square of nuclei 30–39 μm^2, 3rd group – with the square of nuclei 40–49 μm^2, 4th group – with the square of nuclei more than 50 μm^2. In each group the number of mononucleated hepatocytes was 35%, 39%, 12% and 3% correspondingly. The nuclear square of binucleated hepatocytes varied from 47 to 78 μm^2. The nuclei square of the Kupffer cells and endotheliocytes changed similarly from 10 to 18 μm^2. In future we are planning to realize the caryometric investigation in the patients with the different degrees of both chronic HBV and chronic HCV activity.

DISCUSSION AND CONCLUSION

In our investigation the morphometric analysis of the liver biopsies from the patients with both chronic hepatitis – HCV and HBV – included the comparative evaluation of the specific part of non-parenchymal elements, the analysis of the liver plates and the sinusoids areas, the cell population in the composition of liver plates and sinusoids, the karyometric analysis of hepatocytes, endotheliocytes and the Kupffer cells.

Non-parenchymal elements (portal zones with piecemeal and bridging necroses, intralobular infiltrates and occasional septa) are calculated by the stereometric analysis. The detailed morphometric analysis in liver biopsy specimens of the patients with chronic hepatitis C was presented. The comparative stereometric analysis of liver biopsy specimens from the patients with HCV and patients with HBV shows that liver damages of patients with HCV are more significant in comparison with the analogical indexes of the patients with HBV.

The morphometric investigation of liver plates and the sinusoids areas shows that the sinusoids of the liver biopsies of the patients with HCV are significantly narrower than such of patients with HBV.

The analysis of the cell population of liver plates demonstrates that the number of binucleated and polymorphous hepatocytes is certainly higher in the liver biopsies of the patients with HBV. The amount of endotheliocytes and the Kupffer cells is essentially bigger in the liver biopsies of the patients with HCV.

The caryometric analysis is important in the assessment of neoplasia, because the development of hepatocellular carcinoma is related to infection with the hepatitis B virus.

The quantitative analysis of the cell population structure in liver biopsies in the course of chronic hepatitis, especially in the case of defective biopsies, could be used for diagnostic and prognoses by expert evaluation.

REFERENCES

1. Ishak K., Baptista A., Bianchi L. et al. (1995). Histological Grading and Staging of Chronic Hepatitis. Journal of Hepatology, 22, 6, 696–699.
2. Brunt E. (2000). Grading and Staging the Histopathological Lesions of Chronic Hepatitis: The Knodell Histology Activity Index and Beyond. Hepatology, 31, 1, 241–246.

3. Jagoe R., Sowter C., Dandy S. et al. (1982). Morphometric study of liver cell nuclei in hepatomas using an interactive computer technique: nuclear size and shape. J Clinical Pathol, 35, 1057–1062.
4. Chen V. L., Gerber M., Thung W. et al. (1984). Morphometric study of hepatocytes containing hepatitis B surface antigen. Am J Pathol, 114, 217–221.
5. French METAVIR Cooperative Study Group (1994). Intraobserver and Interobserver Variations in Liver Biopsy Interpretation in Patients with Chronic Hepatitis C. Hepatology, 20, 1 (July 1994), 15–20.
6. Menghini G. (1958). One-second Needle Biopsy of the Liver. Gastroenterology, 35, 2, 190–199.

Address for correspondence:
Piret Hussar, M.D., D.M.Sc
Institute of Anatomy
Faculty of Medicine
University of Tartu
Ravila 19, 50411 Tartu, Estonia
E-mail: piret.hussar@ut.ee

Papers on Anthropology XXI, 2012, pp. 287–290

THE ACTIVITIES OF THE ESTONIAN NATURALISTS' SOCIETY IN 2011

TÕNU VIIK, SILJA KANA

Estonian Naturalists' Society, Estonia

ABSTRACT

The activities of the Estonian Naturalists' Society are described

Key words: *Estonian Naturalists Society*

INTRODUCTION

The Estonian Naturalists' Society ENS) was founded already in 1853 and though so many wars have swept over Estonia, our society was able to survive and live further through all these long and turbulent years. We started as *Die Dorpater Naturforscher Gesellschaft* at *Der Livländischen gemeinnützigen und ökonomischen Societät*. Since 1998 we are associated with the Estonian Academy of Sciences. This means that the state finances us through the academy. As we own a house, our maintenance expenditure is rather high so we have to earn a substantial part of our expenditures by carrying out different projects at diverse organisations among which the most important is the Centre of Environmental Investments.

Our activities are carried out in 22 subunits by 718 active members. These subunits are relatively autonomous and they present their annual reviews in March of the following year. Some of the subunits work as sections: amateur meteorologists, anthropology, botany, entomology, forestry, geology, theoretical biology. The other subunits are: the Commission of Lakes, the Estonian Society of Malacology, the Estonian Mycological Society, the Estonian Society of Theriology and the Jakob von Uexküll Centre. Commissions with special tasks focus on the history of natural sciences, the library, natural education,

observation networks, terms of ecology and plant names, botanical rarities. In addition, the Society has assemblies of ecology, of honorary members and the round table of nature conservation.

In 2011 we held nine General Assemblies with scientific presentations:

January 27 – Agu Laisk: " Photosynthesis – black and white and colourful".

February 28 – "The Baer day". Presentations by Marina Loskutova, Eduard Koltšinski and Anastassija Fedotova.

March 31 – Kalle Kirsimäe: "Searching for water and life on Mars: new challenges", a review meeting of 2011.

April 28 – Andres Tarand: "Climate change in Estonia".

May 26 – Tarmo Soomere: "On the possibilities of the modern maritime science to understand and protect Estonian seashores".

September 29 – Presentation of the Yearbook of the ENS no 86 "Rarities in Estonian nature" by Tiiu Kull. Mirt Gramann: "About the Universe and its evolution".

October 27 – Urve Miller: "Changes in natural environment in vicinity of Stockholm since the last ice age".

November 24 – Mihkel Zilmer: "The life on the waste ground of information".

December 15 – Tõnu Viik: "What are exoplanets and how we discover them?"

The subunits organized their traditional and non-traditional events:

1. Science day dedicated to Karin Mark "Studies of humans using different sources" March 18, Tallinn (together with the Tallinn University Institute of History and the NGO Centre of Archeology);
2. Mushroom practice, Kilingi-Nõmme, May 13–15;
3. Seminar organized by nature conservation round table "If and how the message of nature conservation reaches people?" May 20, the Estonian Naturalists' Society;
4. The Spring School of Theoretical Biology "Biological interactions" May 27–29, on the Ojako farm, the Pärnu county (together with the University of Tartu Institute of Ecology and Geosciences);
5. Gathering of the friends of mosses, May 28–29, in the Marimetsa bog, the Turvalepa broadleaf forest and the Palivere spring fen;
6. The 34th Naturalists' Day Käsmu July 2–3, the Lahemaa National Park;
7. The Summer School of Ecosemiotics together with the Institute of Philosophy and Semiotics of the University of Tartu, July 28–29, Rutja;

8. Gathering of amateur meteorologists and thunder observers July 23, Lelle, the Rapla county;
9. Mushroom practice October 6–9, Kilingi-Nõmme;
10. Conference commemorating Juhan Aul (1897–1994) October 20, Tallinn
11. The Autumn School of Theriology October 23–25, Oonurme;
12. The Autumn School of Geology VII "Resources of the Earth" October 7–9, Taevaskoja, the Põlva county;
13. Exhibition "Snails, mussels and the human" compiled by the people from the Estonian Malacology Society, October 25 – November 25, in the Tartu Environmental Education Centre;
14. Seminar organized by the nature conservation round table "Natural disasters and human psyhology" November 3, the Estonian Naturalists' Society;
15. Meeting of the Mycological society "Actiones" December 10, Tartu, the University of Tartu, the Botany department.

The Society participated in fulfilling the projects funded by the Environmental Investment Centre, the Tallinn Botanic Garden and the Ministry of Environment.

The ENS and the Estonian Environment Information Centre developed the Nature Observation Database. The link to it (as of 2011): http://loodus.keskkonnainfo.ee/lva/LVA.aspx?type=Artikkel&content=-1936342045. The commission of plant names continued to complement the database of plant names. During 2011 altogether 398 records were entered. In December 2011 there were 17,376 units in the database. In 2011 nine seminars of the series "From natural scientists to teachers of natural sciences" were held.

Members from different sections compiled expert opinions and held exhibitions (the Commission of botanical rarities made an expertise about the protected species in III category, the Theriology Society passed their opinion about the Saaremaa bridge to decision makers and they were involved in monitoring and inventory work, The Estonian Society of Malacology collected data about invasive species and monitored species, etc.). In 2011 the initiative of the repository of reports and inventories of Estonian nature underwent the first development period and it can be seen at the following address: http://elurikkus.ut.ee/eluv.php?lang=est.

In December 2010 there were 162,244 printed items in the ENS library. Within a year the library acquired 184 new books and issues of 169 periodicals.

The publications were exchanged in the reporting year with 54 institutions and organizations in 18 countries.

PUBLICATIONS

1. Kull T., Liira J., Sammul M. (eds.) (2011). Yearbook of Estonian Naturalists' Society 86. Rarities in Estonian nature. 304 pp.
2. Tulva T., Öpik M., Puura I. (eds.) (2011). Scola Biotheoretica 36 "Theory of movement". 88 pp. (together with University of Tartu Institute of Ecology and Geosciences and the Natural History Museum).
3. Öpik M., Tulva I., T., Puura I. (eds.) (2011). Scola Biotheoretica 37 "Biological interactions". 71 pp. (together with University of Tartu Institute of Ecology and Geosciences and the Natural History Museum).
4. Verš E., Preeden U., Lang L. (eds.) (2011). Schola Geologica 7 "Resources of the Earth". 148 pp. (together with University of Tartu institute of ecology and geosciences, Tallinn Technical University Institute of Geology and the Department of Mining).
5. Folia Cryptogamica Estonica 48. 158 pp. (with the University of Tartu).
6. Laumets L. (ed.) (2011). Nature of Lahemaa: 34th Naturalists' Day, July 2–3 2011, 63 pp.

INTERNET JOURNAL

Ingerpuu, N., Vellak, K. (eds.) 2010. Friend of mosses 14. 40 pp. (http://www.botany.ut.ee/bruoloogia/Samblasober14.pdf)

Address for correspondence:
Tõnu Viik
Tartu Observatory
Tartumaa, 61602, Estonia
E-mail: viik@aai.ee

Papers on Anthropology XXI, 2012, pp. 291–299

FUNCTIONAL BRAIN ASYMMETRY AND THE PROPER NAME

O. D. VOLCHEK

Saint Petersburg Institute of Humanities, Russia

ABSTRACT

There are several published works on the influence of long-term weak acoustic stimuli onto living organisms and their development. In this context, functional brain asymmetry (FBA) parameters were studied in correlation with the proper name. A. R. Luria sensorimotor tests (the dominant thumb when "locking" hands, the dominant eye, the dominant hand when crossing hands (the Napoleon's pose), the dominant palm when applauding, the dominant ear) were used. With the data collected, we calculated relative difference in the numbers of the "right" and "left" in the group of certain name bearers for each test, %: thumb – (R-L)t, eye – (R-L)e, hand – (R-L)h, palm – (R-L)p, ear – (R-L)e, total for all tests – Σ(R-L), %. 1,136 men and 2,140 women born in 1920–1991 were examined. With the Fisher's criterion, significant differences were detected in the bearers of various names, $p \leq 0.05 \div 0.001$, as well as the differences by 1–2 FBA parameters in the namesake persons belonging to different generations (born in 1971–1991 – "young" and born in 1920–1970 – "old"), $p \leq 0{,}05 \div 0{,}001$. The conclusion was that among the known functions of the proper name there is also an adaptive function.

Key words: *adjustment, long-term weak acoustic stimuli, proper name, functional brain asymmetry.*

INTRODUCTION

Sounds make an essential part of the environment an individual lives in. They are divided in biogenous and abiogenous, natural sounds. Acoustic communication is used by most living organisms. The sounds of biological origin,

including the sounds made by animals themselves – communicative signals, navigation sounds, etc. – are most important for all the animals with the auditory system. Notably, the sounds made by animals themselves can be incomparably weaker than the sounds of the environment.

For humans, the sounds of the proper name they have been hearing from early childhood have great significance. Names can be compared with inherited generic types in genetics, with constitutions and archetypes. Names are focuses of social energy [19]. The name is identified with corporal and spiritual individuality. As a part of self-consciousness, the name determines personal values and trends in the claim of recognition, gender identification, life priorities and prospects, the rights and duties system [14].

Cerebral functions are characterized with the highest individual variability under the influence from the environment, education and practice [1]. There is a weak response to acoustic stimuli in the auditory cortex and a simultaneous reaction in another area of the cerebral cortex, and the additional reaction intensifies as the volume of sound increases [6].

The cells of various human organs are sensitive to the acoustic vibrations of similar frequencies, especially of the frequencies to which the human ear is mostly adju ted. The latest data proves cumulative effect of low intensity sounds at long-term or repeated exposure [2, 7, 17, 18], the sounds influencing embryogenesis in animate beings [9], facilitated with the phenomenon of multy-frequency parallel resonant capture [11].

In the light of the aforementioned, our work was aimed at a thorough research of the name as a complex acoustic signal and a vibration stimulus affecting individual. The study of many years resulted in the monograph Sounds, Words, Names [3].

The study results showed that there is an uneven ratio of names belonging to prominent representatives of certain occupations, especially when related to the names' popularity. There is a correlation between the name and the occupational trend, the success in a certain professional field, $p \leq 0.05 \div 0.001$.

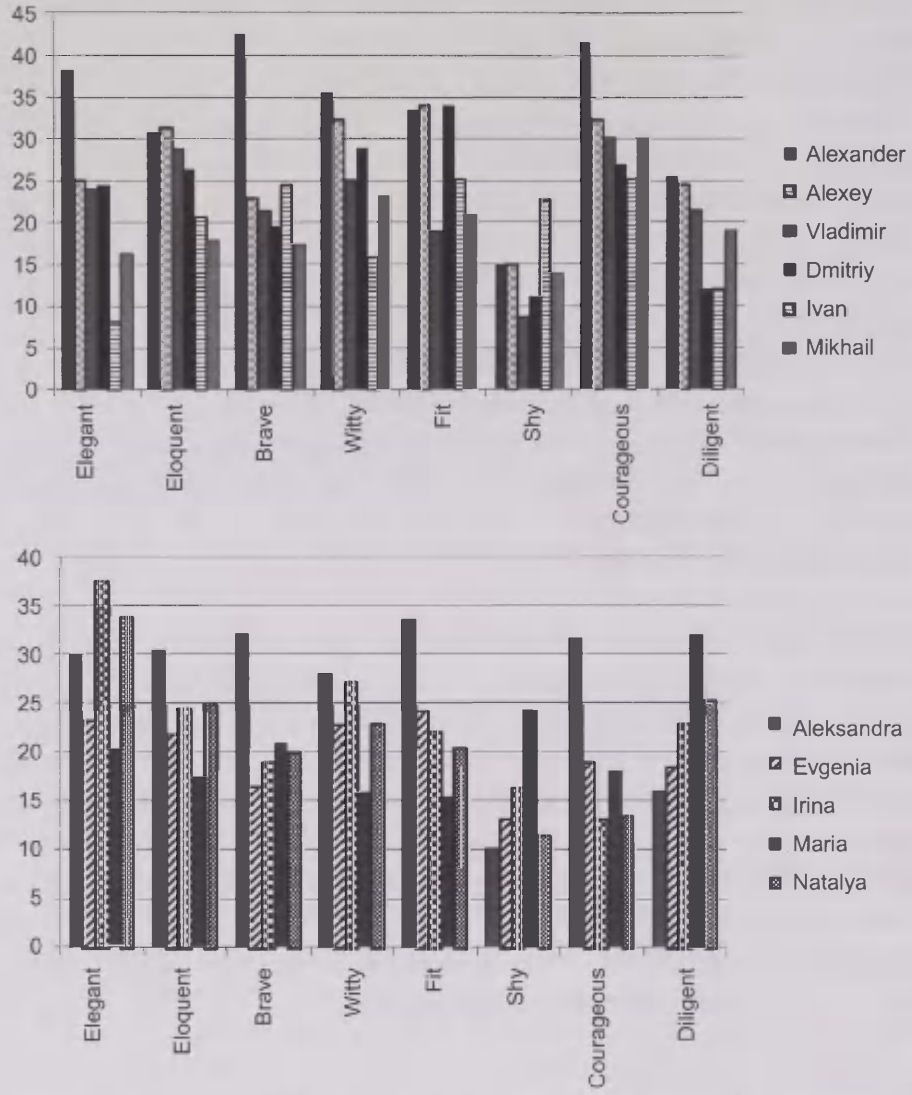
The multicomponent image of the name – color, emotional, characterologic – was revealed. The characterologic image was studied with the 100-scale method by M. Goklen [7], in two stages. Responding biology and psychology students were asked to tick in the test forms those personality traits which, in their opinion, are common in the bearers of 20 men and 20 women names. The respondents filled out one test form including the first 50 or the last 50 scales for 10 men or women names in one day. Then a percentage index was calculated for each scale, regarding the sum of all the ticks for a certain name. Signi-

ficant and reliable differences in the characterologic images of the studied names were detected for every scale at $p \leq 0.05 \div 0.001$. Picture 1 illustrates it for 6 men and 5 women names and 8 scales of the Goklen's method.

There is a psychological phenomenon of the first impression self-proving effect [16]. It can be assumed that the existing multicomponent image of the name influences first impressions and determines both primary expectations regarding a new person and the new person's responses. Consequently, the image of the name helps intuitively set a correct behavior pattern from the first minutes after meeting a new person.

The complex study of the representative groups of namesake persons revealed profound differences between the bearers of different names. For each name, there is a unique set of the following indices of individuality: functional brain asymmetry, the circadian chronotype, the adjustment to sleep-wake cycle, masculinity-femininity, the thinking style, temperament, personality traits, self-esteem, motivation, etc. These differences are significant and reliable, $p \leq 0.05 \div 0.001$ [5].

The results of the research on functional brain asymmetry – the lateral profile – are of high importance. Functional brain asymmetry (FBA) characteristics provide the base for a unique personality. To a large degree, they determine one's perception and sense of time, academic achievements, professional and personal characteristics, trends for longevity. They are reflected in the anxiety level, stress resistance, susceptibility to mental and somatic illnesses. The individual and population ability of adjusting to given conditions of natural and social environment also depends on FBA parameters. There is a correlation between the FBA parameters and some indices of natural environment at early embryogenesis and ontogenesis [3].



Picture 1. Examples of brief characterologic images for 6 men and 5 women Russian names by the Goklen's method, the number of respondents varying from 180 to 220 persons.

MATERIAL AND METHODS

We studied BFA with Luria sensorimotor tests: the dominant thumb when "locking" hands, the dominant eye, the dominant hand when crossing hands (the Napoleon's pose), the dominant palm applauding, the dominant ear. With the data collected, we calculated relative difference in the numbers of the "right" and the "left" in the group of certain name bearers for each test, %: thumb –

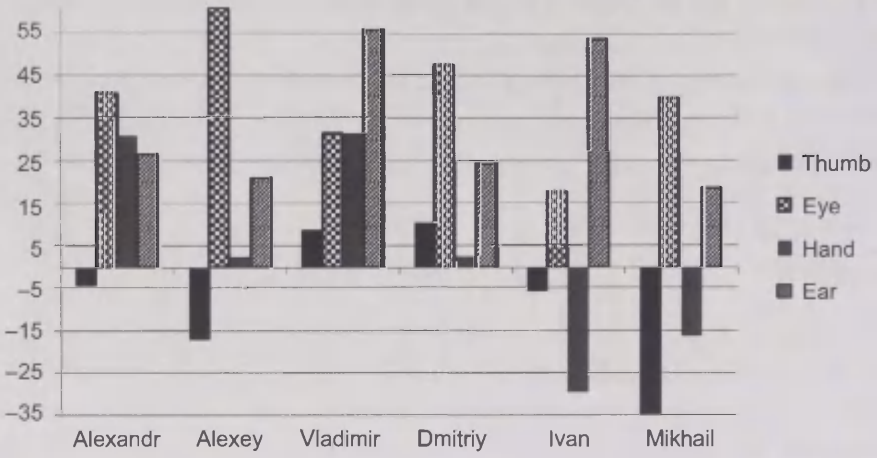
(R-L)t, eye – (R-L)e, hand – (R-L)h, palm – (R-L)p, ear – (R-L)e, total for all tests – Σ(R-L), %.

Data on bearers of tens names (2,140 women and 1,136 men born in 1920–1991) was collected. Significant and reliable differences of the studied indices in relation to names were detected with the Fisher criterion, $p \leq 0.05 \div 0.001$.

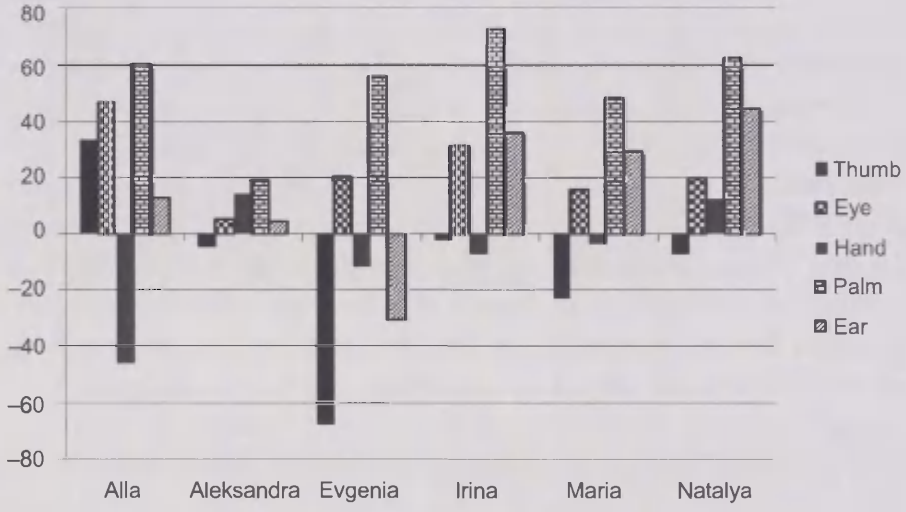
RESULTS

The bearers of a certain name can be characterized with a definite combination of lateral profile averaged values. It is most obviously manifested if the FBA values in persons with common and rare names are compared. Gender differences in the FBA were revealed, as well as certain variations in the namesake persons belonging to different generations. Pictures 2 and 3 present examples of lateral profiles for the bearers of some men and women names born in 1971–1990.

It must be mentioned that some of the studied psychophysiological values, including the FBA index, can vary in the namesake persons belonging to different generations due to the conditions of social and natural environment influencing personal development. The comparative analysis of the FBA values in the namesake persons born in 1920–1970 ("old") and in 1971–1991 ("young") witnesses the similarity of their lateral profiles. Significant variations, if there are any, normally include one index in women and up to three indices in men. The changes for the bearers of different names can be oppositely directed – towards the right asymmetry increase as well as towards left asymmetry (see Table 1). For example, significant and reliable variations of the dominant thumb sensorimotor test (R-L)t were detected in the bearers of the names Ekaterina and Olga. Left asymmetry prevailed in the persons of the "young" generation bearing the name Ekaterina compared to the persons of the "old" generation, and in the bearers of the name Olga it was right asymmetry, (R-L)t, $p \leq 0.001$; 0,05. Similar changes of dominant palm sensorimotor test values were detected in the persons bearing names Andrey and Evgeny: the values of the index (R-L)p shifted towards right asymmetry in the "young" generation of Andreys compared to the "old" generation and towards left asymmetry in bearers of the name Evgeny, $p \leq 0.005$.



Picture 2. Features of lateral profile in relation to names. Vertical are the values of sensorimotor tests: dominant thumb, eye, hand, palm, ear, (R-L)%. Numbers of men names bearers were: Alexandr – 110, Alexey – 82, Vladimir – 35, Dmitriy – 76, Ivan – 17, Mikhail – 43 persons.



Picture 3. Features of lateral profile in relation to names. Vertical are the values of sensorimotor tests: dominant thumb, eye, hand, palm, ear, (R-L)%. Numbers of women names bearers were: Alia – 15, Aleksandra – 42, Evgenia – 25, Irina – 97, Maria – 83, Natalya – 138 persons.

Table 1. FBA values in namesake women from different generations

Generation	N	Name	Finger	Eye	Hand	Palm	Σ(R-L)
Old	9	**Ekaterina**	77.8	33.3	11.1	77.8	48.7
Young	95		–11.6	24.2	1.0	49.5	18.0
		Up	2.89**	---	---	---	1.95*
Old	34	**Elena**	5.9	23.5	0.0	70.6	25.0
Young	136		–8.8	33.8	2.9	50.0	18.7
		Up	---	---	---	1.36	---
Old	38	**Irina**	0.0	21.0	–15.8	78.9	19.7
Young	97		–5.1	38.1	–3.1	73.2	26.1
		Up	---	---	---	---	---
Old	25	**Natalya**	16.7	–8.3	8.3	58.3	18.4
Young	138		–10.8	26.6	9.3	64.0	25.9
		Up	---	–1.62	---	---	---
Old	32	**Olga**	–54.8	16.1	–22.6	74.2	3.1
Young	142		–11.3	28.2	–8.4	52.1	15.6
		Up	2.39**	---	---	1.47	–1.31
Old	33	**Svetlana**	–15.1	21.2	21.2	63.6	19.1
Young	109		–27.9	15.3	–6.3	53.1	10.8
		Up	---	---	1.39	---	---
Old	28	**Tatyana**	7.1	21.4	–7.1	57.1	19.0
Young	73		–26.0	37.0	6.8	37.0	15.7
		Up	1.51	---	---	---	---

Note: N – number of persons studied. *Up* – Fisher criterion of significant difference. Table keys: --- – *Up* values no significant; 1.47÷1.62 – $p \leq 0.1$; * – $p \leq 0.05$; ** – $p \leq 0.01$; *** – $p \leq 0.001$.

DISCUSSION

Speech and language are permanently changing and developing. It is also true for proper names, their forms and tendencies in naming. Up to 10–25% of components of the name image change over one, ten and more years, which complies to the phenomenon of the shifting value – changes in word semantics [5, 10, 12, 13, 15].

Varieties in musical language, speech frequency values and the vocal vowel A are **synergetic** to seasonal and long-term variations and geocosmic fluc-

tuations [4]. Together with the facts of changing name forms, tendencies in naming and the evolution of the language, the name image and the characteristics of namesake persons from different generations, it allows assuming the name adaptive function regarding the changing environment.

Obviously, naming trends are to a certain degree determined with unconscious needs of society as a complex self-organizing system for specific acoustic "exposure" in relation to the present and future and in connection with dominant sounds of natural environment. Of all names, people choose, primarily, those which bearers will be able to adjust most successfully to upcoming natural and social conditions and to help the society with their activities.

Therefore, the name as a longstanding weak acoustic and vibration stimulus affects brain functions and, apparently, brain architectonics and shapes the development of personality.

The name on its own creates neither good nor bad personality. It is only a shape, while it is up to a person to choose one's path [19]. It is unquestioned that personality is defined mainly by genetics, parenting, social and natural conditions. However the name and naming contribute to the individual development of the person.

REFERENCES

1. Ananyev B. G. Person as Object of Cognition/ Ананьев Б. Г. Человек как предмет познания. Л., Изд-во ЛГУ, 1968. – 338 с.
2. Vibroacousics in Medicine/ Виброакустика в медицине: Матер. I Всеросс. научно-практ. конф. СПб.: Вита Нова, 2000. –160 с.
3. Volchek O. D. Geocosmos and Person/ Волчек О. Д. Геокосмос и человек: Монография. СПб.: Изд-во РГПУ им. А. И. Герцена, 2006. –331 с.
4. Volchek O. D. Significance of Music and Semantics of Sounds/ Волчек О. Д. Значение музыки и семантика ее звуков. СПб.: СПбИГО; «Книжный Дом», 2010, – 164 с.
5. Volchek O. D. Sounds, Words, Names/ Волчек О. Д. Звуки, слова, имена. СПб.: «Книжный Дом», 2011. – 294 с.
6. Godik E. E., Gulyaev Yu. V. Physical Fields of Humans and Animals/ Годик Э. Э., Гуляев Ю. В. Физические поля человека и животных // В мире науки. 1990-№5.-С. 74–83.
7. Goklen M. File on Cosmic Influences/ Гоклен М. Досье космических влияний / Пер. с фр. Н. Васильковой. М.: КРОН-ПРСС, 1998. – 352 с.

8. Dubrov A. P. Music and Plants/ Дубров А. П. Музыка и растения. М.: "Знание", 1990. – 64 с.
9. Egorov V. V. Low Frequences in Biology/ Егоров В. В. Низкие частоты в биологии: Проблемная лекция. М.: ФГОУ ВПО МГАВМиБ им. К. И. Скрябина, 2007. – 55 с.
10. Zhuravlev A. P. Sound and Sense/ Журавлев А. П. Звук и смысл. М.: "Просвещение", 1991. – 160 с.
11. Zaguskin S. L., Prokhorov A. M., Savranskiy V. V. Method of biosynthesis facilitation in normal cells and its inhibition in cells with pathological changes/ Загускин С. Л., Прохоров А. М., Савранский В. В. Способ усиления биосинтеза в нормальных или его угнетения в патологически измененных клетках. //А.С.СССР N1481920 "Т" от 22.01.89. Приоритет 14.11.1986.
12. Krongauz M. A. Russian Language on the Brink of Collapse/ Кронгауз М. А. Русский язык на грани нервного срыва. М.: Знак: Яз. славянских культур, 2008. – 229 с.
13. Ktorova A. The Past / Кторова А. «Минувшее...» Язык. Слово. Имя. М.: Минувшее, 2007. – 392 с.
14. Mukhina V. S. Developmental Psychology/ Мухина В. С. Возрастная психология. Учебник для студентов вузов. М. Издательский центр "Академия", 1997. – 432 с.
15. Nikonov V. A. Name and Society/ Никонов В. А. Имя и общество. М.: "Наука", 1974. – 278 с.
16. Pines E., Maslach K. Practical Social Psychology/ Пайнс Э., Маслач К. Практикум по социальной психологии. СПб.: "Питер", 2000. – 528 с.
17. Romanov S. N. Biological Effect of Mechanical Vibrations/ Романов С. Н. Биологическое действие механических колебаний. Л.: Наука, Л. О. 1983. – 209 с.
18. Romanov S. N. Biological Effect of Vibration and Sound/ Романов С. Н. Биологическое действие вибрации и звука. Парадоксы и проблемы XX века. А.: Наука, 1991. – 158 с
19. Florenskiy P. A. Names. Archives by papa Pavel Florenskiy/ Флоренский П. А. Имена. Архив священника Павла Флоренского. Кострома: "Купина", 1993. – 320 с.

Address for correspondence:
Olga D. Volchek
volchekod@mail.ru

Papers on
Anthropology