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OBSAH

THE HUMANIZATION OF THE HELP OFFERED TO THE DISABLED

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Submitted in June, 2005

Modern development of rehabilitation is guided by humanistic ideas. The problem is that many specialists cannot define the term "humanism" itself. This article analyses the concept in terms of its application in the rehabilitation practice. Two aspects of humanism are distinguished. The first one refers to the perception of the disabled and the other concerns humanization of the rehabilitation process.

Keywords: Rehabilitation, disabled person, humanism.

The subject discussed below is so broad that a whole book could be written to explore it. Thus, this article will only outline the solution to the problem signaled in the title. Therefore, humanism will be treated here in a non-humanistic way i.e. very concisely. In principle, I will confine myself to providing the basic theses which are the effects of my reasoning, each of them presented as a separate point. I hope such a form of presentation will not make the reception of the article more difficult.

I. After the end of the year devoted to the problem of providing help to the disabled, it can be easily stated that social concern for this category of people is gradually rising. The evidence for this phenomenon can be observed in: improving professional, medical, movement, psychological and social rehabilitation; the change in social attitudes towards the disabled; increase in the number of volunteers taking part in the rehabilitation process, the development of the scientific research concerning the issue of the help provided to the disabled; the ever growing standardization of the lives of the disabled (Ostrowska, 1994). The situation of the disabled is far better when compared to that of the recent past. It is especially important now as community of the disabled is growing significantly.

II. I would like to present several arguments which can serve as the evidence of the progress in the care provided to the disabled. Firstly, more and more categories of the disabled are being integrated in the rehabilitation activities. For instance, before the Second World War rehabilitation via movement was used on a limited scale and was provided only to patients with orthopedic, ophthalmic or neurological problems (Seyda, 1965). Presently, numerous forms of physiotherapy are being applied to various kinds of illness or disability (patients with organ transplants, geriatric patients, pulmonary patients etc.). Secondly, special education for the disabled children and teenagers is developing rapidly. According to the American data from the nineties 655$ were spent on the education of a healthy child, whereas 897$ on an intellectually disabled child, 2336$ on a deaf child and 2516$ on a child with sight impairments (Sherrill, 1998). One can predict that the educational expenses in Poland are divided in a similar manner. What is more, it is noteworthy that in the last 20 years the forms of educating disabled children have been enriched, and special school's teacher training system has been improved (Doll-Tepper, 2001). Thirdly the growing number of people has a chance to participate in professional sport activities. The popularity of sport for the disabled is growing among the disabled, and, moreover, such activities are widely accepted by the rest of the society. The number of participants taking part in Paralympics Games proves that the popularity of the sport among the disabled is growing. In 1985, only 48 individuals participated in the Games, 30 years later, in the next Paralympics there were as many as 3950 disabled participants (Paciorek, 2000). What is more, the involvement of the disabled in community life is increasing gradually. According to Duckworth (1995), due to the development of the internet, the disabled find employment much easier, form international organizations, which are lobbying groups, or take part in the activities of self-help groups.

III. Taking into account the above mentioned facts, one can state that there are good reasons to feel satisfied among both the disabled and people responsible for the development of rehabilitation. At the same time numerous concerns appear pointing to the fact that the standardization of the rehabilitation service results in the disabled being treated not as subjects but as objects. The disabled individual withdraws from the community life because of frustrations caused by social rejection and discrimination. Integration of the disabled children in schools and kindergartens is too superficial, social rehabilitation is directed only towards the elite of people with lesser disabilities or those who are better off

(Kowalik, 1996). These voices show the demand for humanistic approach towards the disabled, introducing humanistic values to the whole process of rehabilitation, the change in special education so that it would meet the needs of the disabled children. The effect of these insistent efforts to introduce a more humanistic approach towards the help offered to the disabled is surprising. My own research allows me to draw the conclusion that people professionally involved in rehabilitation process (including teachers in special schools, social workers and physiotherapists) hardly ever know what humanistic approach should look like (35% are not familiar with the issue, others form vague definitions and statements related to the issue). Usually, humanism is thought of as humanitarianism, understood as providing care to the disabled.

IV. Before we want to improve the quality of the help offered to the disabled we should realize, however, what humanism really is. It is definitely not enough to state that most people are familiar with the term and use it on every-day basis. In this way we will not avoid the issue of definition and understanding of the term. Moreover, these ideas, unlike many people would expect, do not boil down to popularization of humanitarianism, often expressed in the form of charity activities. A thorough analysis conduced by specialists concerned with this issue is required, since the clear-cut stands on that matter are missing. Philosophers, art theoreticians, historians usually have their own view on that matter, pertinent to the discipline they represent (Backer & Barnes, 1964; Kuderowicz, 1989; Suchodolski, 1985). Quite often they want their own interpretation of humanism to become a universal concept. In my opinion not enough attention is paid to the fact that the humanistic ideas have been undergoing various transformations throughout the ages. Not being aware of this fact could be the cause of many misunderstandings related to the concept of humanism. Thus, it is often the case that scientists, professionals relating to different versions of humanism are right though their views can be varied. There is a need for defining humanism in such a way which will meet the needs of rehabilitation and special education.

V. When analyzing the literature on the discussed topic, I came to the conclusion that it is possible to distinguish three major versions of humanistic views. Esthetic humanism is the oldest of them. It originates from Renaissance and Petrarch, who is considered as its creator (Kuderowicz, 1989). He was the first to discover the culture of Greek Hellada and the idea of giving human being a special place. In accordance with the ideas offered by this culture, Petrarch promoted the cult of the values, connected with the beauty of the human. Esthetic humanism lost its significance quickly. Its new version appeared in the Netherlands in 17th century. There are doubts as to who created it. Spinoza is thought of as one of its main propagators (Tatarkiewicz, 1990). Ethic humanism put emphasis on different human values from esthetic humanism. In brief, according to ethic humanism every man was obliged to make the most of his developmental abilities throughout his whole life. Each individual was responsible for performing this task and later was accounted for it by the society. Social response to the ethic humanism was relatively insignificant. It was accepted in protestant societies, but humanistic ideas were impoverished there. Finally, in 19th century a completely new concept of humanism was formed. Its ideas were the response to the actual social need. That is the reason why we can call this kind of humanism a pragmatic one. The exceptional popularity it gained has twofold meaning: a) many societies in the world recognized it as their own ideology and b) it is characterized by exceptional durability. It seems that the ideas of pragmatic humanism influence the shape of the life of the societies in the contemporary world. For this reason it is worth analyzing this concept in more detail.

VI. The outstanding Polish sociologist – Florian Znaniecki (1991) points to three sources of the revival of humanistic ideas in 19th century, namely evolutionism, cultural relativism and positivistic variant of social studies. I would add one more very important factor to the above mentioned set of elements – the industrialization of productive activities. Darwin's theory of evolution induced, quite unexpectedly, the growth of interest in the search of special attributes characteristic of human being – as the highest stage of evolution. It was expected that Darwin's humanized ape should have more human than animal features. Therefore the need for contrasting human being with the rest of organic world appeared. This, in turn, resulted in attributing certain unique features to human beings and putting emphasis on those special qualities of every man. On the other hand, the discoveries of ethnographers, studying different exotic peoples in Africa, both Americas and Oceania, challenged the traditional stereotypes concerning these civilizations. The research shows that the representatives of these exotic societies are not as primitive as it was generally thought. They have their own cultures, complex norms of behavior which determine relations within the society, skills and abilities necessary to satisfy their needs etc. Thus, common convictions regarding the poor level of development among those peoples were denied by this research. However, on the other hand, the evidence justified the thesis concerning diversity in developmental capabilities of human being. Consequently, ethnocentric attitudes were weakened and in their place tolerant attitudes, which regard distinctiveness as a valuable emerged. These conditions were greatly favorable to the development of humanistic thought. It is worth noting that social studies of the 19th century modeled on sciences. Positivistic methodology dominating at that

time rejected the possibility of including value issues to scientific consideration. It was soon revealed that without including those issues it was impossible to answer such questions as: What is social progress? What are the goals of the civilization? What is social norm and what is pathology? What personal pattern should be promoted? Therefore, the need for a field of study which would deal with those difficult issues appeared. As a result, humanistic thought – complimentary to positivistic social studies – was developed. Finally, it has to be emphasized how important the dynamic development of industry is for the increase in the demand for humanistic ideas. The industrial revolution from 19th century resulted in significant changes in the organization of production. Discovery and popularization of the assembly-line type of work, hierarchical management, concentrating on executing more and more ambitious tasks led to objectifying the workers, who became like cogs in the machine, totally subordinated and incapacitated. The situation of a man participating in such an organization became difficult. The development of humanism could change this situation (Giddens, 2003).

VII. Pragmatic humanism met social demands in two ways. First of all, it attributed certain features to people, features which made them more worthy. These attributes were varied: spiritualism, rationality, creativity, wisdom, noble intentions, responsibility for one's actions etc. This ennoblement of man was unconditional and there were no exceptions to it. The process of assigning those special qualities was automatic. This view is characteristic of pragmatic humanism. Ethical humanism, on the other hand, requires a lot of effort and self-development of man and proving to the society that human potential is not wasted. Only than could a human being deserve the respect accordingly to the cost one had to bear or results one achieved. In pragmatic humanism, in contrast, man's special social value was determined by the simple fact of being born as a man. I do not want to judge if the process of unconditional attributing features to every human being is justified, or if it is only the expression of peculiar megalomania. In any case it would be difficult to settle this dilemma of philosophical nature. However, it is worth analyzing social and individual consequences stemming from the discussed way of introducing humanism to social practice. The other way of satisfying social need for humanism consists in organizing human activities which are characterized by special features. Moreover, the activities should be organized in accordance with strictly defined rules. Thus, there appeared the demands for humanizing work, sport, medicine, or martial service. The problem was that the slogan "to humanize" was applied to every domain of human life, for instance it involved healthy relations between people, eliminating conditions which encourage social alienation etc. Generally speaking, humanizing actions is an ideological proposal of enriching every social practice which is conducted in such a way which relates to a collection of humanistic features characteristic of people taking part in the practice. This ideology consists in formulating hints which direct actions of people who participate in executing common social goals. Unfortunately, particular specialists exploring humanizing actions are not unanimous in what should be the desired way of human co-operation.

VIII. It seems that the idea of pragmatic humanism is still valid since some of its functions from 19th and 20th century need to be continued in the 21st century. There is one aspect of living in the society, providing help to the disabled, where the necessity of popularizing humanistic ideas is very significant. In the light of the interpretation of humanism presented above, the consequences of implementing its ideas could be considered in two dimensions: a) unconditional assigning features mentioned above to the disabled, b) adjusting assistance service offered to the disabled in a way which would reflect humanistic image of a disabled person.

IX. Boosting the self-esteem of the disabled by unconditional assigning specific characteristics to them might be considered as controversial. It is worth emphasizing that humanizing the disabled is the procedure which distinguishes this group of people in a special way (constant repeating of the phrases: "you deserve social respect", "you are equal member of the society"). We can ask: "Is it necessary to distinguish the disabled from the rest of the society?" In this way prominence is given to their distinctiveness. Such actions are meaningful as long as we are of the opinion that the life in the community is still characterized by the unfounded devaluing of the disabled. Then the process of boosting the self-esteem of the disabled may level negative attitudes towards this group of people. However, the normalization of those attitudes should be accompanied with gradual eliminating the special form of promoting nobleness of the disabled (Ostrowska & Sikorska, 1996). There is also another reason for assigning humanizing features to the disabled. The 20th century can be characterized as the glorification of corporality of man (Grogan, 1999). We can assume that the more important those values are, the harder the psychological situation of the disabled and without employing preventive measures (humanizing which boosts self-esteem), their self-esteem may debase. It should be noted that continuous deluding somebody into how worthy he/she is, can lead to abandoning self-development and, what is more developing demanding attitude towards other people. Both these types of behavior render providing help to the disabled. To sum up, the above analysis suggests that boosting self-esteem of the disabled is pertinent, because it protects those people from the cult of the body characteristic of our civilization and counteracts the existing

discrimination; at the same time it is wrong because it can emphasize their distinctness and reduce the motivation for independent improving quality of life.

X. There is no doubt that the process of humanizing help offered to the disabled is necessary (Kowalik, 2003). However, as I noted before it is not yet clear what this process should consist in. It is often emphasized that humanizing is about removing distortions occurring in rehabilitation (e.g. eliminating the situation where they are pampered and protected or discontinue rehabilitation process before it is actually completed). It can also consist in enhancing social sensitivity to problems experienced by the disabled (which could make their social integration easier). Finally, humanizing can lead to the increased involvement in solving problems by the disabled themselves (by developing abilities to decide about their own lot). Undoubtedly, the list with different interpretations of the idea of humanizing help is very long. I would like to present in this place my own suggestion of understanding this term. To this end I am going to use an inspiring distinction, introduced by Nagel (1997).

XI. According to Nagel (1997) it can be assumed that the people who offer professional help can choose between two attitudes. The first one is characterized by professionalism. People with this attitude make use of scientific knowledge in their job, do not get personally involved in their work but are very effective in what they do. Adopting this attitude results in making their work and the work of other specialists very alike. The help service offered by people representing the first attitude, can be called offering help out of nowhere, i.e. the help is provided here in a standard manner and the disabled are treated in a standard way. The second type is in direct opposition to the first one. It involves offering help which is their own initiative. The individual offering help determines his/her own perspective of looking at the problem of a disabled person and acts accordingly. Thus, he/she can treat such a person in an individual manner. This is an example of subjective action, based on individual experience. The help of this kind is unique because it cannot be compared with the help provided by other individuals. It encourages deeper involvement in the help process.

XII. The first attitude is becoming more common as far as offering help to the disabled is concerned. We try to accept different criteria which help to make an objective recognition if any individual is disabled, to what extent, finally, what kind of help is required. We also obey the standards defining rehabilitation. It is harder and harder to introduce the individualized procedure of activating a disabled person and all that is done in the name of improving effectiveness of rehabilitation. The objective perspective on rehabilitation is supposed to guarantee more complete knowledge about the disabled and their effective rehabilitation. However, a question should be asked here: "Are we not going too far in imposing objective standards providing help to the disabled?" The demands to include humanistic ideas in assistance help programs offered the disabled, can be understood as efforts to provide better balance between the distinguished attitudes. In other words, not only outer standards should decide about relations between givers and receivers of help but both parties should have a chance to influence the nature of help and derive satisfaction from the helping process.

XIII. In the light of the presented analysis a problem of effective but individualized help arises. "Unspecified help" is perceived as the desired rehabilitation procedure due to its apparent better effectiveness. In the "specified help" the particular individuals, who often are nor qualified to provide professional help, are responsible for the effects of the helping process. Many years of work with the disabled allowed me to formulate a few rules which rehabilitation therapists should follow. These rules are strictly connected with the ideals of humanism.

XIV. The first rule could be formulated in the following way: "Be self-confident". This rule refers to the essence of humanism, which makes people feel more worthy by attributing certain features to human beings. In this way man's self-confidence is growing, he becomes more optimistic in evaluating the effects of his actions and is more resistant to possible failures. The therapist who trusts his professional skills is more successful in work with the disabled. First of all, he can instill his optimism in other people and, in consequence, they become more confident, are more persistent in overcoming difficulties, challenge ambitious rehabilitation tasks and engage more in independent solving their own life problems. The second rule is as follows: "Take into account the point of view of your partners when you act". This rule is also a consequence of humanistic approach to man. It is assumed here that we recognize the reality in a rationalistic way, judge it accordingly and take actions which are beneficial to us. Thus, a rehabilitation therapist should not underestimate the views of the disabled. He cannot hold opinion that only he knows the truth about how to improve the quality of life of the individuals who are offered help. In this way the help to the disabled has individual character and is adjusted to the needs of the disabled. According to the third rule the communication between the parties working together should have an open character. It is, to a large extent, the consequence of application of the previous rule. Not only should a therapist take into account what view the disabled have on the rehabilitation process but also negotiate with them how to solve the problems. In this way the relation between the giver and the receiver of help will be based on partnership and a disabled individual will feel like an equal subject in this relation. The conse-

quence of such an attitude might be a full involvement of a disabled person in self-help activity. The fourth rule states as follows: "Take advantage of the good moments in the process of giving help". It seems that it is least of all based on humanistic ideals. However, in truth, it refers to those ideals and is mainly based on the thesis that human being is an autonomous individual standing in opposition to the environment. This autonomy is relative, obviously. Sometimes human plasticity is greater in relation to outer influences and sometimes an individual is totally resistant to any influences. A disabled person like any other individual has fluctuation of moods, is characterized by greater or smaller motivation to take action, can change the significance assigned to a given situation in a short time intervals. Thus, the same form of help may be perceived in different ways by the disabled. One time it will be accepted and an individual will make the most of it, while the other time it will be totally rejected. The point is to deliver help when the person is fully aware of existing deficiencies. It cannot be offered either too early or too late. The last, fifth rule can be formulated in the following way: "Don't force anybody to be happy". Humanism emphasizes how important it is to protect human freedom and refrain from bringing pressure on people. We got used to thinking of pressure only in relation to influencing other people. It should be remembered, however, that, the acceptance of our help can be enforced too. A disabled individual can think that accepting our help can put in jeopardy the feeling of dignity. Thus, providing help should never be imposed. A disabled person should always have the right to choose whether to accept it or resign from it. He/she should also feel respected by the person offering help.

XV. My individual conception of interpreting humanistic ideas and introducing them to rehabilitation practice can be considered as controversial. The fact of placing pragmatism alongside humanism may seem to be a misuse of understanding the role that humanism should play in the life of the society. However, I am not of the opinion that the presented here conception of the humanization of the help offered to the disabled denies the value of humanistic attitude. On the other hand, it proves that it is possible to combine the effectiveness of action with respecting values assigned to human beings. It can be easily noted that applying the presented above rules to the practice of helping the disabled should contribute to a better coordination of actions of people working on solving problems of the disabled and it should enrich the purpose of those activities.

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HUMANIZACE POMOCI NABÍZENÉ OSOBÁM S POSTIŽENÍM

(Souhrn anglického textu)

Moderní vývoj rehabilitace (léčebného cvičení) je řízený humanistickou myšlenkou. Problémem je, že mnoho odborníků neumí definovat termín „humanismus (lidskost)". Tento příspěvek analyzuje návrh v rámci jeho aplikace v rehabilitační praxi. Rozlišujeme v něm dva aspekty humanismu. První odkazuje na vnímání osob s postižením a další se týká humanizace rehabilitačního procesu.

Klíčová slova: rehabilitace (léčebné cvičení), osoby s postižením, humanismus.

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DIFFERENCES IN PERSONALITY TRAITS OF MOUNTAIN CLIMBERS AND NON-ATHLETES IN SLOVENIA

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Psychology of personality in sport is very interesting about the specific psychological profile of elite athletes. Our research was oriented in personality of mountain climbers. Mountain climbing is a very specific sport discipline. Although it is hard to talk about classic competition in mountain climbing, it gets more and more the reference of sport. New possibilities of competition also appear. However, mountain climbing still remains a different discipline. One of the most important characteristic is the stress, since mistakes can be lethal. In our work we investigated personality traits of Slovene mountain climbers.

Keywords: Personality, mountain climbing, high risk sports.

INTRODUCTION

Personality studies need an integral approach that includes biological, psychological and sociological aspects of athlete's being and behaviour. Personality, in a psychological sense, can be understood as a complex set of characteristics of physical and mental functioning (Musek, 1993). These include intellectual abilities, perceptive motor abilities as well as characteristics of moral judgment, human feelings, social activities (communication, relationships, conflicts, etc.), character and temperament. Communication of an athlete with his environment includes his views, motivation and values.

In our study we investigated the personality of mountain climbers, since mountain climbing is a specific sport activity. Although mountain climbing can hardly be considered a competitive sport, new characteristics that make mountain climbing a sport branch appear. More and more competitions are also being organized. There are, however, some distinctive differences. One of the most important ones is the presence of highly stressful situations, where a mistake can even lead to the loss of life.

Psychological profile of a top athlete

Statements resulting from the comparison of personal traits between athletes and non-athletes are very consistent. The athletes are usually more extraverted, emotionally stable and express stronger need for productivity and stimulation (Eysenck, Nias, & Cox, 1982).

Especially the top-level athletes show a distinct psychological profile, which is different from the profiles of recreational athletes, amateur athletes and non-athletes (Davis & Mogk, 1994; Tušak & Tušak, 2001). Eysenck, Nias and Cox (1982) established that extraversion and some aspects of stimulation needs are connected with sport involvement and performance quality.

Despite the fact that some contradictions exist among some of the statements (mostly due to different researched samples) the hypothesis about specific psychological profile of athletes in comparison with non-athletes can be confirmed. Athletes are usually more aggressive, more psychologically stable, have better emotional self-control, are more emotionally stable, less anxious, more self-confident, show higher degree of dominance and responsibility, have higher degree of frustration tolerance and tolerance for unpleasant stimulation and pain and higher degree of self-confidence and positive self-view (Tušak & Tušak, 2001).

The second factor that influences the personality of an athlete is a sport branch. The athletes involved in individual sports show dominance, individualistic tendencies, sometimes on the margin of selfishness, endurance, high level of self-control, self-motivation and self-responsibility.

Mountaineering in Slovenia

Some experts include mountain climbing among the most tiring sports from both physical as well as psychological points of view. They include it among sport activities such as long run, cross-country skiing, rowing, cycling and similar. One of the most outstanding differences is that mountain climbers usually don't compete directly with one another as other athletes do. There are some exceptions, however, like overall climbing and ice climbing competitions.

In Slovenia climbing is well developed and popular sport and our climbers are among the best in the world.

Many factors have contributed to this fact. Climbing has developed from mountaineering which is inseparable part of Slovenian identity and it's culture legacy and psychological profile. Mountains have been appearing in Slovenian culture and art, poets and writers wrote about them. The mountains have inspired our composers and painters. They are also present in our movies and artistic photographs. Mountaineering has helped Slovenian people fight and win the battle to save our nationality in the time of Austrian-Hungary monarchy. Our Mountaineering association – club was established in 1893 mostly to protect our mountains against germanization. German and Austrian alpinists were building mountain paths and huts and considered our mountains to be their own. The fact that Jakob Aljaž – the preacher from Mojstrana, bought the top of Triglav, our highest mountain, showes us the depth of this fight.

After the second world war we started to establish alpine clubs and to educate young climbers. Our alpinists climbed in West European mountains. In that time the best world alpinists climbed the first eight thousand meters high mountain Annapurna (1950). Than followed Everest – 1953, K2 – 1954, Kanchendzenga – 1955 and all the others. After that the world elite climbers started climbing in Himalayas big, high and difficult walls. At that point Slovenian climbers joined the world elite. Our way was shorter but steeper than theirs. We have been among them since 1975 when our climbers climbed south face of Makalu.

Our first Himalayan expedition was in 1960 on Trisul 2 and 3, following Kangbachen (west summit – 7535 m) in 1965, Annapurna 2 (7937 m) and 4 (7526 m) in 1969, Makalu (no summit) in 1972, again Kangbachen in 1974 with summit and in 1975 south face of Makalu (8463 m) with the new way. That made us the third on the world to climb the new direction of the big Himalayan wall on an 8000 m high mountain. This was our earlier mentioned touch with the best world climbers. In two years we were again successful by climbing the new way of the south west ridge of the Gasherbrum 1 (8068 m). Our biggest success was climbing the west ridge of Everest in 1979. Than followed the other eighttousenders: Manaslu – 1984, Broad Peak – 1986, Gasherbrum 2 – 1986, Daulagiri – 1987, Cho Oyu – 1988, Lhotse – 1989, Shisha Pangma – 1989, Nanga Parbat – 1990, Kangchenjunga – 1991, K2 – 1993 and Annapurna – 1995.

Slovenia is the eighth country that has reached the all 14 eightthousenders.

In view of mountain climbing, another Slovenian characteristic exists. Beside top sport achievements, Slovenians have also produced numerous literary works about mountain climbing. They show that mountain climbing means for Slovenians more than sport. Mihelič and Zaman (1987) described a part of this phenomenon: One of the most important distinctions and values of mountain climbing is the experience of nature as well as oneself during a climb. Defence mechanisms, triggered in a human body in dangerous situations, change the body into a quivering antenna. The human senses are insufficient, one is all absorbed in the experience. Human being is completely uncovered. Tuma (1930) classified mountain climbers into different types: sport, aesthetic, ethic and religious. Virk (1995) tried to define the meaning with yearning, death, eternity and seeking. The meaning is also explained with the Zaplotnik's work "The Way" (Zaplotnik, 1999). It says that the goal is not important. The only thing that really counts is the way. There is also a thought by Tomazin that there is no goal. There is only what one meets, feels and learns on the way towards it. Virk considered modern mountain climbers a sort of seekers of the Holy Grail, which is – like mysterious power of a mountain that attracts a mountain climber – indefinable, is a value by itself like the Absolute. Mountain climbers are not only athletes, they are also philosophers, seekers of the way, truth, eternity (Zaplotnik, 1999). They do not only care for a sport achievement, which is why it shell be even more interesting to study their personality characteristics from the point of view of sport results as well as their analysis.

Psychological profile of Slovene top mountain climbers

Markič (1990) found that Slovene top mountain climbers differed from the usual population. He stressed their introversion, independence and individualism. He said that mountain climbers were sensitive, sentimental and artistic people. He especially emphasized their introversion and shyness. He found them temperate, serious and calm. On the other hand they showed dominance and self-confidence that are supposed to be the characteristics of successful people. Markič (1990) said that they also showed strong need for exploration and experiences.

The study entitled "Personality of Slovenian mountain climbers" (Burnik & Tušak, 1999) gave contradictory results. We investigated 24 categorized Slovenian mountain climbers between 21 and 30 years of age. The control group consisted of 26 students from different faculties, between 20 and 27 years of age, which practiced sport only recreationally. The study confirmed some statistically important differences between the mountain climbers and control group. Statistically, the mountain climbers appeared less neurotic, less introverted, more extraverted and social. The control group showed a little higher degree of sincerity.

Other studies have been made on the same subject – Manfreda (1996) found mountain climbers to be explorers that find satisfaction and happiness in achieving the top of a mountain. During the Norwegian expedition Everest 1985, it was concluded that their mountain

climbers had very impulsive personalities with strongly expressed dominance and tendency towards new, unusual, exciting experiences. During the Lhotse expedition, the Slovenian mountain climbers stated among the most important personality characteristics: diligence, endurance, comradeship, courage, resourcefulness, considerateness, determination, sincerity, responsibility, tolerance and self-sacrifice. Comparing personality characteristics of mountain climbers and overall climbers, Zaplotnik found overall climbers to be more neurotic and introverted, while mountain climbers appeared to have strongly expressed masculinity.

AIM OF THE STUDY

Within the frame of our study, we tried to determine and compare the personality characteristics of mountain climbers and of the control group in order to support some previous studies, which are stated in the introduction part of this article and to show that there are really differences in personality characteristics of investigated groups.

METHOD

Subjects

- 58 male mountain climbers from alpinistic clubs in Ljubljana, Celje, Maribor, Tržič, Kranj, Jezersko, Kamnik and Velenje, aged between 22 and 45 years (M = 31.54; SD = 4.43). All of them have been a part of at least one alpinistic expedition to the Himalayas.
- 50 male non-athletes who never climbed, aged between 19 and 29 years (M = 26.54; SD = 2.43). The differences in age are significant (t = 7.05, sig (t) = = 0.001). The best climbers needs several years more than other top athletes to reach the best results.

Instruments

FPI 114 (Freiburg Personality Inventory) (Bele-Potočnik, Hruševar, & Tušak, 1990).

The Freiburg personality inventory is a multidimensional personality questionnaire, which can be used on all populations with persons above 15 years of age. It consists of 114 statements, to which the subjects answer with YES or NO. It measures 9 personality dimensions:

Neuroticism: it is shown in frequent pains and problems with one's health, motoric disturbances, sleep disturbances, sensitivity to the weather.

Spontaneous aggression – impulsivity: it is shown as restlesness, need for constant change and emotional immaturity.

Depression: it includes bad moods, lability in emotions, pesimism, fears, anxiety, loneliness, lack of concentration, constant worries...

Irritability: it is demonstrated in tension, sensitivity and low frustration tolerance, even in everyday situations.

Sociability: sociable people are lively, friendly, have a strong need for associating with other people, have many friends and acquaintances, like to talk and have well developed communication skills.

Control: it is demonstrated in self-confidence, persistence, optimism, good spirits.

Reactive aggression: it is shown as physical, verbal or imaginary acts of aggression, in enforcing one's interests, egocentrism, lack of confidence in others.

Repression: it is demonstrated in shyness, confusion and repression in contacting with others, it can also be shown in problems with establishing contacts with others, fear of performing or speaking in front of an audience.

Sincerity: high values indicate that the person is capable of admitting their own flaws, whereas low values indicat that the person is trying to impress others.

Secondary factors of the questionnaire are:

Extraversion: extraverted persons are sociable, have a strong need for establishing and maintaining contact with other people, are lively, impulsive, are well capable of putting effort in achieving their goals. They like changes and fun. The opposite of extraversion is introversion.

Emotional lability: it is shown in fast changing of moods, depression, irritability, sensitivity, day dreaming, tension, it can also be shown as troubles with establishing contacts.

Masculinity: it is shown in traits, which are often understood as typically male activity, also physical enforcing of oneself, confidence, enterpreneurism, reliability, stability of moods, absence of physical and psychosomatic disorders.

Reliability of FPI is satisfactory, the lowest values appear on the dimension od honesty, Cronbach's alpha 0.61. Other dimensions show reliability coefficients of 0.70 and higher. Timm (1970), Bele-Potočnik et al. (1990) confirmed also the manifest validity of the questionnaire.

Procedure

The application of the questionnaires was carried out individually on alpinistic associations, the results were evaluated and calculated using the SPSS 11.0 program. The differences between mountain climbers and non athletes were determined with a t-test.

RESULTS AND DISCUSSION

Analysis of results as shown in TABLE 1 confirms that there are several significant differences between mountain climbers and the control group. The largest differences between the means of both groups appear in depression, emotional lability, neuroticism, extraversion and repression. The differences in means are somewhat smaller in irritability, impulsivity and sincerity, whereas the differences are smallest in sociability, masculinity, control and reactive aggression.

TABLE 1
Differences in personality traits between mountain climbers and the control group

Trait	Group	M	SD	t	sig (t)
Neuroticism	Climbers Control	3.22 5.00	2.49 3.00	11.333	.001
Impulsivity	Climbers Control	3.78 4.92	2.09 1.86	8.919	.004
Depression	Climbers Control	3.84 6.22	2.59 3.14	18.495	.000
Irritability	Climbers Control	2.60 3.92	2.14 2.27	9.644	.002
Sociability	Climbers Control	8.84 8.68	2.69 2.82	.096	.757
Control	Climbers Control	5.79 5.12	1.70 1.93	3.697	.057
Reactive aggression	Climbers Control	3.03 3.98	1.96 2.10	5.824	.018
Repression	Climbers Control	3.48 4.08	1.77 2.04	2.657	.106
Sincerity	Climbers Control	7.84 8.70	2.63 2.31	3.173	.078
Extraversion	Climbers Control	6.64 7.12	2.46 2.46	1.029	.313
Emotional lability	Climbers Control	4.33 6.26	2.76 2.69	13.447	.000
Masculinity	Climbers Control	8.36 7.88	1.70 2.11	1.728	.191

Legend
Climbers – mountain climbers; Control – control group; M – mean; SD – standard deviation; t – t-statistic; sig (t) – statistical significance of t

T-test has shown that there are significant differences in the case of emotional lability, where the mountain climbers obtained a lower mean than the control group, the differences between the groups are largest in this trait. The control group is more emotionally labile, which means that they more often experience mood swings, depression and negative emotions. This is the result that was expected on the basis of previous research, since mountain climbing is a sport, which requires a great amount of confidence, belief in one's abilities, it also requires good concentration and a good physical condition, because it involves long lasting physical strains, carrying heavy gear, long climbs, that can last a whole day. The preparation for a climb itself demands self-discipline, self-motivation and emotional stability. Some other factors can also influence the outcome of the climb – they can make mountain climbers to take action in what can appear to be hopeless situations, difficult conditions and occasions, when there's no turning back. A smooth wall can appear in front of them, steep cliffs, avalanches and storms can happen... In such situations they need to be able to think clearly, calm down and find a solution that can mean saving their life. They have to persist till the end of the climb and even till they come back from the mountain and a person with a low amount of control over him or herself, with low discipline and low emotional stability has very few chances to survive such experiences.

Congruent with these findings are also the significant differences in depression and neuroticism. These two traits are similar already in their description – depression is described as bad mood, irritability, fear, high levels of anxiety, pessimistic views, loneliness and worrying to a great extent. The results of previous research show that mountain climbers are lower in depression when compared to sport climbers (Zaplotnik, 1999) and when compared to recreational athletes (Burnik & Tušak, 1999). The comparison with sports climbers in related with the competitive situation – a mountain climber's competition is a lot different, since there is no direct comparison with other competitors and since there is an immediate presence of objective danger, which can lead to serious injury or even death. Thus a mountain climber gets no second chances in his decisions, whereas a sport climber has an opportunity to change his mind and select a different course almost at any moment with no danger to his health or threat to his life. With respect to these circumstances in mountain climbing it is obvious that there can be very little depression, neuroticism and repression, since all these traits present a problem when facing difficult decision making and problems.

A significant difference appears also in irritability, where mountain climbers obtained a lower score. In control group we can find higher levels of tension, they are more irritable, they have a lower frustration tolerance, are more uneasy, feel enraged more often... Significant differences appear also in impulsivity – the control group is more impulsive, it is also less controlled, but the differences were not significant in this trait. According to our results we could describe the control group as more irritable, with more worries, with lower confidence and self-control than the mountain climbers, they appear to avoid decision making and taking fast actions, which could not be said for alpinists.

Sincerity also almost reaches significance, the control group appears to be more sincere. Mountain climbers could be described as less sincere, with a lower level of criticism for themselves, which can result in them being more successful when achieving their goals, since we

have seen that they are also more confident and spontaneous and also more stable.

Studies have shown alpinists to be more withdrawn, that they are socially shy and more serious than the rest of the population (Markič & Pogačnik, 1981). They appeared to be more introverted, they were supposed to prefer solitude and true friendships to numerous acquaintances. The descriptions regarding introversion were denied in some studies as well as in our own. The value of extraversion was high in both groups, the differences between both groups were not that high. The same trend appeared in sociability. High extraversion can help with group problem solving, which has to take place in a mountaineering expedition, to better understanding among members of an expedition and better cooperation, all of which can contribute to safer and more successful climbs.

CONCLUSIONS

The results of our research deny the stereotype of mountain climbers being loners, introverts and people who shut themselves from others, with suicidal tendencies and of them trying to direct their aggression towards themselves and seeking a way to death. Our results show them as emotionally stable, extraverted and sociable. Many accidents and deaths that happen in alpinism are a consequence of real environmental dangers and of the characteristic of a sport they are involved with, of a sport, where mistakes are often paid for with lives, not just with bad results. It is assumed that their lifestyle is due to different values (Burnik & Tušak, 1999), which they build throughout their lives and in which the length of life may not be the most important value, but its quality and intensity.

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ROZDÍLY V OSOBNOSTNÍCH RYSECH HOROLEZCŮ A NESPORTOVCŮ VE SLOVINSKU

(Souhrn anglického textu)

Psychologie osobnosti ve sportu, zabývající se specifickým psychologickým profilem špičkového sportovce, je velmi zajímavá. Náš výzkum byl zaměřen na osobnost horolezců. Horolezectví je velmi specifická sportovní disciplína. Ačkoliv v něm sotva můžeme hovořit o klasickém soutěžení, je čím dál tím více považováno za sport. Objevují se nové možnosti soutěžení. Horolezectví přesto stále zůstává odlišnou disciplínou. Jednou z nejdůležitějších charakteristik je stres, protože chyba může způsobit smrt. V naší práci jsme zkoumali osobnostní rysy slovinských horolezců.

Klíčová slova: osobnost, horolezectví, rizikové sporty.

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SOCIAL AND RELATIONAL INTERACTIONS IN DIFFERENT TYPES OF PE LESSONS DURING STUDENT TEACHERS' PRACTICE TEACHING

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The main goal of the study was to analyze social and relational characteristics of student PE teachers' practice teaching. The results should be used to increase the quality of pre-professional PE teachers' preparation from the interaction point of view and should allow the effective transfer of theoretical knowledge into school practice. The experiment included evaluations of student teachers from seven PE colleges in the Czech Republic and in Poland. The analysis was focused on the difference between habitual and progressive PE lessons evaluation. All main characteristics of education were observed. Special emphasis was placed on social and relational factor in pupils according to different types of leadership in PE lessons and to changing pupils' role in school PE. Progressive interventions were positively valuated in both the social [$H (1, 18489) = 107.18$; $p = .00$; $\eta^2 = .01$] and relational [$H (1, 18489) = 25.89$; $p = .00$; $\eta^2 = .00$] dimension. Student teachers valuated relational dimension more positively in habitual PE lessons [$H (1, 18489) = 25.89$; $p = .00$; $\eta^2 = .00$], but social dimension was evaluated by them more positively in progressive PE lessons [$H (1, 1270) = 48.94$; $p = .00$; $\eta^2 = .04$]. Although there is distinction between PE teachers' preparation in the Czech Republic and in Poland, the difference in PE lessons evaluation was not significantly different.

Keywords: Education, questionnaire, student teacher, pupil.

INTRODUCTION

Practice teaching in PE teachers' preparation programs is necessary for determination of absolvent model (Švec, 2000), professional standards and competencies (Bellz & Siegrist, 2001; Brooker, Miller, Mylonas, & Hansford, 1998; Hozman & Frömel, 2000; Knitt et al., 2000; Senne, 2002), pedagogical skills (Švec, Fialová, & Šimoník, 2000) and other professional requirements (including ethics which we still miss in our educational system). Current social tendencies depend on transformation of the educational system. For example in school PE we observe changing role of pupils in education, therefore it is necessary to change goals, adapt organizational and didactic forms, didactic progress and PE methods. All these should respect pupils' personality. Education in current school PE is more aimed at pupils, their independence, creativity, more freedom in decision making, self-diagnostics, self-regulation and at the highlighting of increasing pupils role on leading classes. It is expected that pupils are more motivated to activity that they can decide about (Cuddihy, Corbin, & Dale, 2002; Frömel et al., 2000; Mandigo & Holt, 2000; Zakrajsek & Carnes, 1986).

Innovative interventions into education depend on a spectrum of teaching styles. Mosston (1992) says, that teachers need more than their "personal" teaching style, they have to accept a variety of the spectrum of teaching styles. Byra (2000a, 2000b), Cai (1997), Dobrý (1998), Goldberger (1992) and Mareš (1998) expect that the spectrum of teaching styles allows for better understanding of educational reality and increase the possibilities for teachers' preparation.

A new conception of practice teaching is characterized by change of student teachers' role and can support and increase students' position during their pre-professional preparation at the university. The preferred conception of education in new educational programs requires more targeting the pupil, but requires that the feedback for student teachers would be superior (Coulon & Lorenzo, 2003; Hynes-Dusel, 1999; Knudson, 1998; Quezada, 2004).

Another serious problem in pre-professional PE teachers' preparation is searching for new approaches to changing "pupils' role" in education and with regard to change in interaction between teachers and pupils. For better understanding of the problem it is suitable to compare studies between different lesson types, a variety of conditions for teaching PE, different PE teachers and other didactic differences. The analysis of differences in pupils' and teachers' evaluation of PE classes in the Czech Republic and in Poland was set as one of the goals. This comparison can improve didactic predictions.

THE GOAL OF THE STUDY

The main goal of the study was to find out how student teachers and their pupils evaluate PE classes with regard to social and relational characteristics.

METHODS

A fundamental experimental sample was made by all student teachers from selected universities and their pupils. Data were obtained during the student teachers' practice teaching from faculties preparing PE teachers in the Czech Republic (Pedagogical Faculty of University in Ostrava, Pedagogical Faculty of the Southern Bohemian University in České Budějovice and Pedagogical Faculty of the Western Bohemian University in Plzeň, Faculty of Physical Culture Palacký University in Olomouc and Faculty of PE and Sports, Charles University in Prague) and in Poland (Academy of Physical Education in Wroclaw and in Katowice) during the years 2002 and 2004. The current conception of practice teaching at the Faculty of Physical Culture in Olomouc makes for a close connection between the methodic leadership of PE lessons and didactic diagnostics. The main goal is to increase PE students' responsibility for pre-professional preparation and their independent access into practice teaching including results processing. Students get didactic tasks that they should perform during the lessons leading. After that they use standardized method for lesson evaluation by using the standardized questionnaire "Students' relation to PE lessons" (Frömel, Novosad, & Svozil, 1999). The questionnaire is used for finding out pupils' opinions of PE lessons they have just participated in. The questionnaire for teacher and other modifications have a similar structure and they differ only in modified questions. The purpose of the questionnaire use is to get information about PE lesson which is very difficult to get by observing, monitoring, etc. The questionnaire has 24 questions that characterize 6 dimensions (TABLE 1), is anonymous and universal for age groups 10–18. It means that its use is most suitable for pupils of basic and high schools. Data were processed by using special software "Dotazník 2002" (Chytil, 2002) and its output provides the feedback for student teachers. After the practice teaching is over, student teachers have a special seminar where they solve and discuss most serious pedagogical problems, differences between didactic theory and school practice and evaluate their work during practice teaching.

TABLE 1
Questionnaire structure

Nr.	Dimension:	Questions Nr.:
I.	Cognitive	1, 7, 13, 19
II.	Emotional	2, 8, 14, 20
III.	Health	3, 9, 15, 21
IV.	Social	4, 10, 16, 22
V.	Relational	5, 11, 17, 23
VI.	Creative	6, 12, 18, 24

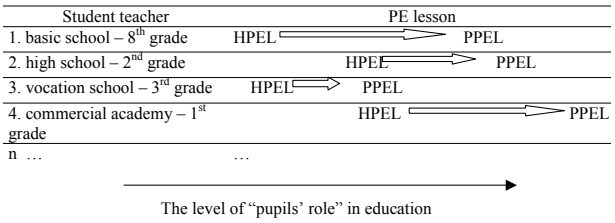
All student teachers and their pupils took part in two types of PE lessons:

Habitual PE lesson (further only HPEL) means a lesson which is, for student teacher and the given class, led in the best way, in the way most suitable, usual and already verified in practice. Every student teacher uses a different way of leading and each of them has the task of giving optimal lessons according to his/her personal or learned experience.

Progressive PE lesson with similar content and structure to habitual lesson was organized to more often involve pupils into leading of the lesson, with a variety of choices during exercising, offering the freedom in decision making and an orientation to independence, self-evaluation, creativity and other teaching interventions, according to the preferred conception of school physical education.

It is difficult to set the border between habitual and progressive lesson because we have to include individual differences among student teachers and their pupils (Fig. 1). Every student teacher starts on different level for teaching habitual or progressive lessons with the same content.

Fig. 1
Experiment scheme



Notes: HPEL habitual PE lesson
PPEL progressive PE lesson
⇨ quantity of "pupils' role" change
n number of student teachers

All participating university workplaces were able to progressively intervene in student teachers' practice teaching. Evaluation by student teachers and pupils during each practice teaching was requested. 9742 pupils and 655 student teachers took part in habitual PE lessons, while 8747 pupils and 615 student teachers took part in progressive PE lessons.

Data from questionnaires were further statistically processed by using the software Statistica 6.0 (StatSoft CR, 2002). To compare individual variables Kruskal-Wallis non-parametric test was used. Statistical significance was set by *$p \leq .05$ and **$p \leq .01$, with regard to the effect size. Kendal's coefficient η^2 (Morse, 1999) was used to find out the effect size and was set at low, middle and high level of significance with values of .01, .06 and .l4.

RESULTS

The general evaluation of practice teaching by student teachers was more positive in progressive PE lessons [H (1, 1270) = 114.51; p = .00; η^2 = .09]. Positive evaluation was noted in progressive lessons in the following dimensions: cognitive [H (1, 1270) = 7.93; p = = .01; η^2 = .01]; emotional [H (1, 1270) = 3.66; p = .06; η^2 = .00]; further in dimensions: health [H (1, 1270) = = .18; p = .67; η^2 = .00]; social [H (1, 1270) = 48.94; p = = .00; η^2 = .04]; creative [H (1, 1270) = 300.18; p = .00; η^2 = .24] and in the supplementary dimension "pupils' role" [H (1, 1270) = 293.28; p = .00; η^2 = .23]. Only in the emotional and health dimensions was the difference in evaluation neither statistically nor subjectively significant. The relational dimension [H (1, 1270) = .08; p = = .87; η^2 = .00] was evaluated more positively in habitual lessons, but the difference was neither statistically nor subjectively significant (Fig. 2).

Pupils' valuation of the social dimension [H (1, 18489) = 107.18; p = .00; η^2 = .01] was more positive in progressive lessons and the difference was statistically and subjectively significant.

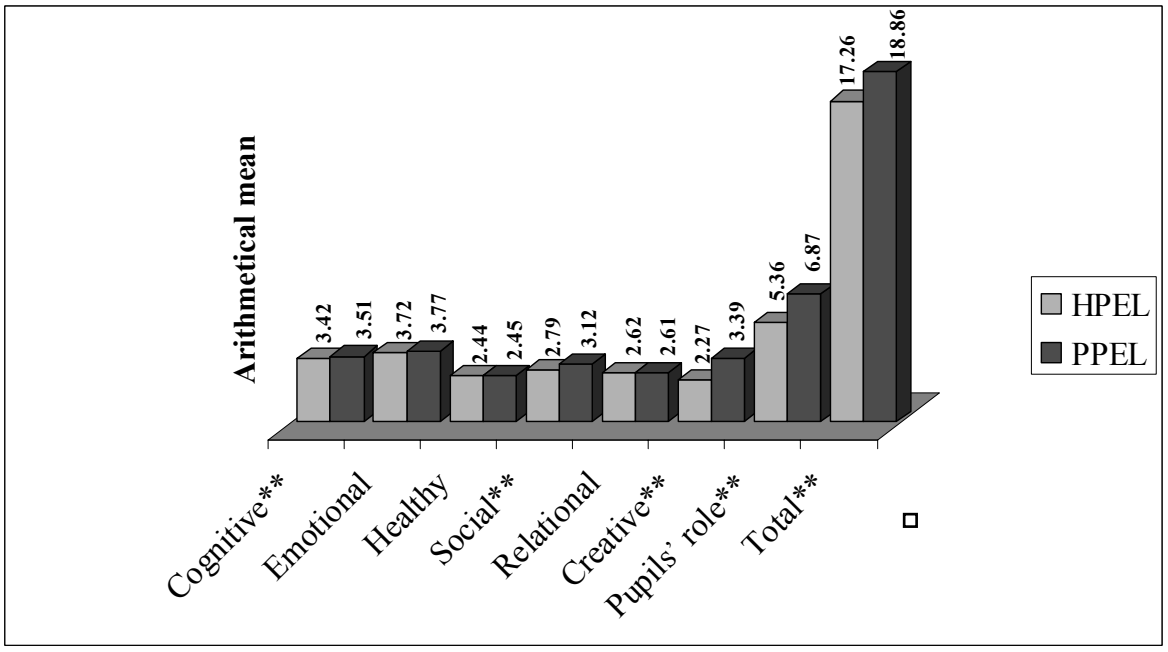
All four questions that characterize the social dimension were valuated by pupils more positively in progressive lessons (TABLE 2): Q. 1 [H (1, 18489) = 22.10; p = .00; η^2 = .00]; Q. 2 [H (1, 18489) = 42.10; p = .00; η^2 = .00]; Q. 3 [H (1, 18489) = 7.52; p = .01; η^2 = .0] a Q. 4 [H (1, 18489) = 72.16; p = .00; η^2 = .00]. The difference in valuation was statistically, but was not subjectively significant.

TABLE 2
Pupils' evaluation of social dimension

Question	*M*		*SD*		*H*	η^2
	HPEL	PPEL	HPEL	PPEL		
Q. 1	.76	.78	.43	.41	22.10**	.00
Q. 2	.66	.71	.48	.46	42.10**	.00
Q. 3	.51	.53	.50	.50	7.52**	.00
Q. 4	.30	.36	.46	.48	72.16**	.00
Dimension	2.22	2.38	.97	.99	107.18**	.01

Notes: Q. 1 Did you see the teacher as an adviser or friend?
Q. 2 Did people misbehave during the class?
Q. 3 Did you ask any questions during the class?
Q. 4 Did you correct any mistake made by your classmate or did a classmate correct your mistake?

Fig. 2
Student teachers evaluation of PE lessons



Statistically significant differences are highlighted by **$p \leq .01$ (if they are subjectively significant by at least $\eta^2 \geq .01$).

Pupils evaluation of the relational dimension [H (1, 18489) = 25.89; p = .00; η^2 = .00] was more positive in progressive lessons and the difference was statistically, but was not subjectively significant.

All four questions that characterize the relational dimension evaluated pupils more positively in progressive lessons (TABLE 3): Q. 1 [H (1, 18489) = 26.05; p = .00; η^2 = .00]; Q. 2 [H (1, 18489) = 22.80; p = .00; η^2 = .00]; Q. 3 [H (1, 18489) = 0.28; p = .60; η^2 = .00] a Q. 4 [H (1, 18489) = 6.58; p = .01; η^2 = .00]. The difference in evaluation was not subjectively significant and in Q. 3 the difference was neither statistically nor subjectively significant.

TABLE 3
Pupils' evaluation of relational dimension

Question	*M*		*SD*		*H*	η^2
	HPEL	PPEL	HPEL	PPEL		
Q. 1	.78	.81	.41	.39	26.05**	.00
Q. 2	.65	.68	.48	.47	22.80**	.00
Q. 3	.83	.84	.37	.37	0.28	.00
Q. 4	.70	.72	.46	.45	6.58**	.00
Dimension	2.96	3.05	1.18	1.15	25.89**	.00

Notes: Q. 1 Would you like to have the same or similar class next time?
Q. 2 Would an extra curricular activity be better than participating in this class?
Q. 3 I would have preferred attending another class.
Q. 4 If you have been allowed to leave the class and go home, would you have done so?

M Arithmetical mean
SD Standard deviation
H Value of Kruskal-Wallis ANOVA
η^2 Value of Kendal coefficient

Statistically significant values **p ≤ .01

DISCUSION

Student teachers indicate the biggest change in the creative dimension which is, with the supplementary dimension "pupils' role", one of the main indicators of the level and size of experimental intervention by increasing the pupils' role in education. Didactic skills were changed; it means that student teachers are able to realize different types of leading and organizing in education. Pre-professional preparation and experiences are shown in results by each student teacher. Although the level of student teacher teaching skills varies, we can observe that student teachers are able to solve the tasks we set them for their practice teaching.

Student teachers evaluate practice teaching positively with regard to innovations and are oriented at their pupils and their individuality, independence, creativity, self-evaluation and responsibility (Brown, 2000; Frömel, Novosad, & Svozil, 1999; Penney & Chandler, 2000). Results are similar to those found earlier (Mitáš, Frömel, Svozil, & Górna, 2003) in practice teaching evaluation. Our opinion that pupils like to have more influence on the leading and organizing of PE lessons was verified. It is a way how to develop the personality of each pupil and provide conditions for the development of social-relational norms and characteristics. Therefore it is necessary to modify all teachers' activities and curriculum which should respond to pupils' needs.

Evaluation of innovative interventions was characterized by pupils' more positive approach to progressive PE lessons. Girls' evaluation of the interventions was significantly higher. The comparison of all workplaces showed that girls evaluated habitual and progressive PE lessons more positively than boys.

Social dimension is characterized by interaction and social sensation of each pupil. Pupils valuated the dimension more positively in progressive PE lessons. They thought that the student teacher behaved as their friend and they thought that misbehaving in progressive PE lessons decreased. Further, pupils mentioned that they could ask more in the lesson and they had closer contact with classmates and with the teacher. The difference in the evaluation of all questions that characterize the dimension was not subjectively significant, but was statistically significant in progressive PE lessons. Therefore we say that the dimension was evaluated more positively in progressive PE lessons. Although pupils had more freedom in progressive PE lessons, they found more time in progressive lessons to correct classmates' mistakes or evaluated success in physical activities more than in habitual PE lessons.

The relational dimension was valuated more positively in progressive PE lessons by both girls and boys. They had more freedom and independence, but also responsibility and higher leading role in their education. It opened for them larger spaces for creating relations inside the lesson. All questions that characterize the dimension were evaluated by pupils more positively in progressive PE lessons. The difference in evaluation of all questions that characterize the dimension was not subjectively significant, but was statistically significant in evaluation of three questions in progressive PE lessons. Therefore we say that the relational dimension was evaluated more positively in progressive PE lessons too. Pupils noted that progressive PE lessons are more suited to the creating positive relationships between pupils in education. Pupils would like to participate in similar lessons and they don't think that an extra curricular activity would be better than participating in this class and they wouldn't like to leave the class if they could.

Department of Kinanthropology and Social Science — Faculty of Physical Culture Palacky University

Students' relation to PE lesson

School, class, sex: _____

Date: _____

	(sign X) YES	NO
1. Could you identity the aim of the lesson and what the teacher was attempting to do?		
2. Was the physical activity satisfying?		
3. Were you relaxed after the class?		
4. Did you see the teacher as an adviser or friend?		
5. Would you like to have the same or similar class next time?		
6. Did you have the chance to solve a problem on your own?		
7. Did you learn anything new?		
8. Was there a good feeling about the class?		
9. Was there a good feeling after the class?		
10. Did people misbehave during the class?		
11. Would an extra curricular activity be better than participating in this class?		
12. Did you have a chance to make a decision in the class to do something on your own and in your own way?		
13. Did you learn any new skills or improve old ones?		
14. Was the class fun?		
15. Do you think that the class improved your fitness?		
16. Did you ask any questions during the class?		
17. I would have preferred attending another class.		
18. Did you feel that you were always "directed" by the teacher?		
19. Did you give any demonstration in the lesson?		
20. Were you praised by the teacher or a classmate?		
21. Did you think about your posture during the lesson? Did you do any stretching?		
22. Did you correct any mistake made by your classmate or did a classmate correct your mistake?		
23. If you have been allowed to leave the class and go home, would you have done so?		
24. Were there any surprises or new things in the class?		

LIMITS

One basic limit that we can not always avoid is the "effect of newness" that appears in these types of experiments. Here it is necessary for pupils to adapt to new approaches, but the "effect of newness" can be represented by student teacher, too. With regard to the character and level of student teachers' knowledge and experience it is not possible to set exactly the progress of habitual lesson. Therefore we can not exactly find out the size of change and the displacement of student teachers' didactic skills with progressive intervention. The study doesn't attempt to describe exactly two lesson types. We wanted to look for relationships between them in terms of changed approaches to education. Every educator is influenced with any form of teaching styles (Mosston, 1992; Mosston & Ashworth, 2002). Pupils' evaluations are not sorted by age, but are characterized by an adolescent's view of current school PE.

CONSLUSIONS

Results showed that in general student teachers evaluated more positively progressive PE lessons. Student teachers evaluated the social dimension more positively in progressive lessons, relational dimension they evaluated more positively in habitual lessons, but the difference in valuation was not significant.

Pupils evaluated, as did student teachers, more positively progressive PE lessons. All observed dimensions were evaluated by pupils more positively in progressive lessons.

Girls evaluated in general and in each dimension more positively than boys in both habitual and progressive PE lessons.

The comparison of results from lesson evaluation by pupils in the Czech Republic and in Poland shows that the difference in evaluation was not significant.

Educational interventions influenced positively the evaluation of PE lessons by pupils and student teachers in all main didactical aspects. International comparison of results allowed for a better understanding the practice teaching problems and pre-professional teachers' preparation and verified the accuracy of educational considerations.

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SOCIÁLNÍ A VZTAHOVÉ INTERAKCE V RŮZNÝCH TYPECH VYUČOVACÍCH JEDNOTEK TĚLESNÉ VÝCHOVY NA PEDAGOGICKÝCH PRAXÍCH

(Souhrn anglického textu)

Hlavním cílem práce bylo analyzovat sociální a vztahové charakteristiky pedagogické praxe studentů učitelství tělesné výchovy a výsledky analýzy využít ke zkvalitnění profesní přípravy učitelů tělesné výchovy z interakčních hledisek a k účinnějšímu přenosu teoretických poznatků do školské praxe. V práci jsou zahrnuty výsledky hodnocení praktikantů sedmi vysokoškolských pracovišť v České republice a v Polsku. Analýza byla zaměřena na posouzení rozdílu v hodnocení habituálních a progresivních vyučovacích jednotek. Sledovány byly všechny základní charakteristiky edukačního procesu. Zvláštní důraz byl u žáků kladen na sociální a vztahovou složku s ohledem na různý typ řízení vyučovacích jednotek a měnící se roli žáků v edukačním procesu. Progresivní zásahy se pozitivně odrazily v hodnocení sociální [$H\,(1, 18489) = 107.18$; $p = .00$; $\eta^2 = .01$] i vztahové [$H\,(1, 18489) = 25.89$; $p = .00$; $\eta^2 = .00$] dimenze u žáků, praktikující studenti hodnotili míru změny vztahových ukazatelů pozitivněji v habituálních vyučovacích jednotkách [$H\,(1, 1270) = .08$; $p = .87$; $\eta^2 = .00$], sociální dimenze [$H\,(1, 1270) = 48.94$; $p = .00$; $\eta^2 = .04$] však byla rovněž hodnocena pozitivněji v progresivních vyučovacích jednotkách. I přes rozdíly v profesní přípravě učitelů v České republice a v Polsku nebyl rozdíl v jejich hodnocení výrazně odlišný.

Klíčová slova: edukační proces, dotazník, praktikující student, žák.

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First-line publication

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QUALITATIVE ANALYSIS OF OPINIONS, CONDITIONS AND EDUCATIONAL ENVIRONMENT IN RELATION TO PHYSICAL BEHAVIOUR OF ADOLESCENTS

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The aim of this study was to find and describe the possible causes of the interest, or lack of interest in adolescents in physical activity and physical education with use of qualitative analysis and to contribute to explication of other characteristics of physical behaviour. Further then to characterise "risky" behaviour of adolescents. Adolescents' opinions, the level of conditions and educational environment were gathered through semi-structured interviews and their following qualitative analysis with use of a paradigmatic model of axial coding of basic proven theory. Altogether 27 interviews with students from graduation classes were carried out following our four year long research project about physical activity. According to adolescents the principal cause of low level of physical activity is the lack of free time. School physical education is for most adolescents the only source of relatively intensive exercise. Favour of school physical education depends especially on the content of the lessons, the teacher's approach and the class team.

Keywords: Physical activity, physical education, basic proven theory, interview, behaviour.

INTRODUCTION

Recently problems connected with the use of qualitative and quantitative research methods are being relatively intensively discussed by scientific workers in sociology, psychology, pedagogy, kinanthropology and other scientific branches (Abusabha & Woelfel, 2003; Blahuš, 1997; Poggenpoel, Myburgh, & Linde, 2001). Only two ways of researching exist according to logical positivism; first logical deduction covering mathematical and second empirical experience covering scientific disciplines, for instance: physics, biology, psychology, etc. (Caelli, 2002). Just qualitative research methods allow for a deeper understanding of physical behaviour, not only in adolescents, because they observe an individual in the natural environment and under natural conditions (Abusabha & Woelfel, 2003; Poggenpoel, Myburgh, & Linde, 2001). Because the relationship between physical activity in childhood or adolescence and physical activity in adulthood is known where physically active behaviour in childhood is associated with lower risk of inactive behaviour in adulthood (Gordon-Larsen, Nelson, & Popkin, 2004; Tammelin et al., 2003) it is necessary to search for the possibility of positive influence of physical behaviour already in childhood and adolescence.

AIM

The aim of this study was to find and describe the possible causes of the interest, or lack of interest in adolescents' physical activity and physical education with use of qualitative analysis and to contribute to explication of other characteristics of physical behaviour and, further then, to characterise "risky" behaviour of adolescents.

METHODS

Qualitative analysis was a part of the four year long longitudinal monitoring of physical activity in youth. Basic information was obtained through informal interviews with teachers of physical education who taught, observing their associates, and at the beginning of the year 2004 by means of individual semi-structured interviews of selected students and their qualitative analysis with use of a paradigmatic model of axial coding of basic proven theory (Strauss & Corbinová, 1999). Questions concerned their relationship to physical activity, opinions on physical education lessons, conditions for physical activity in their place of residence, their way of spending leisure time, etc. Dialogues were recorded on dictaphone and afterwards rewritten word by word. In case of technical failure the dialogues were registered. Altogether 27 interviews with students of graduation classes at secondary grammar school (13 boys and 14 girls, aged 18.9 years) were carried out. Their selection was stratified. The requirement of choice was the participation in physical education lessons and student's agreement. In view of the relation to the longitudinal monitoring of physical activity the secondary grammar

school was chosen intentionally. The selected secondary grammar school does not belong among the prestigious schools in the region. Students were informed that interviews are anonymous and that they do not have to answer in case they do not want to. This partial research project was to contribute to an explanation of the lack of physical activity and the decrease in physical activity according to age (Sigmundová, 2005).

RESULTS

Qualitative interviews were for lucidity transferred into the paradigmatic model according to Strauss and Corbinová (1999), (Fig. 1). The central observed term was physical activity and the possibility of its being influenced by teachers, school, family and students themselves. The most frequent paradigmatic models are described in Fig. 2. These models include the most frequently mentioned components of particular interviews.

Smoking (or "occasional" smoking) is a characteristic lifestyle feature for 63% of questioned students, only 30% of the students do not smoke at all. Drinking alcohol was stated by 74% of students, mostly irregularly (11% drink alcohol regularly, 63% occasionally).

Fig. 1
Paradigmatic model (Strauss & Corbinová, 1999, 72)

(A) CAUSAL CONDTIONS → (B) PHENOMENON → (C) CONTEXT → (D) INTERVENING CONDITIONS → (E) STRATEGY OF CONDUCT AND INTERACTION → (F) CONSEQUENCES

Fig. 2
Selected paradigmatic models of adolescents' physical behaviour

1st interview - Boy
(A) *OTHER PRIORITY INTEREST ⇨* ***(B)*** *LOWERING OF PHYSICAL ACTIVITY (PA) INTEREST ⇨* ***(C)*** *TIME DEMANDS OF STUDY ⇨* ***(D)*** *PREFERENCE OF OTHER INTERESTS TO PA ⇨* ***(E)*** *PA ONLY IN SCHOOL PHYSICAL EDUCATION LESSONS (PE) ⇨* ***(F)*** *LACK OF PA*

7th interview - Girl
(A) *TIME DEMANDS OF SCHOOL ⇨* ***(B)*** *SMALL AMOUNT OF FREE TIME ⇨* ***(C)*** *CONFLICT OF INTERESTS AND DUTIES - SCHOOL/PA⇨* ***(D)*** *POSITIVE RELATION TO PE LESSONS ⇨* ***(E)*** *PA ESPECIALLY IN PE LESSONS⇨* ***(F)*** *THOROUGH PREPARATION TO SCHOOL/LACK OF PA*

11th interview - Girl
(A) *NEW PE TEACHER ⇨* ***(B)*** *CHANGE OF TEACHER'S APPROACH ⇨* ***(C)*** *MORE DIRECTIVE STYLE, LESS FAVOURED CONTENT OF PE LESSONS ⇨* ***(D)*** *HEALTH PROBLEMS OF A FEMALE STUDENT DETERIORATING IN THE GYMNASIUM ⇨* ***(E)*** *PASSIVE PARTICIPATION IN PE LESSONS, REQUEST FOR EXEMPTION FROM PE LESSONS ⇨* ***(F)*** *ONLY OUT OF SCHOOL PA*

13th interview - Girl
(A) *LACK OF FREE TIME ⇨* ***(B)*** *FINISHING OF OUT OF SCHOOL PA ⇨* ***(C)*** *ABSENCE OF PHYSICAL BASIS FROM CHILDHOOD ⇨* ***(D)*** *SMALL TO NONE INFLUENCE OF FAMILY ON PA + WORSE CLASS TEAM IN PE LESSONS ⇨* ***(E)*** *AVOIDING PE LESSONS – "REGULAR NON-EXERCISING" ⇨* ***(F)*** *LEVEL OF PA ON BORDER OF INACTIVITY*

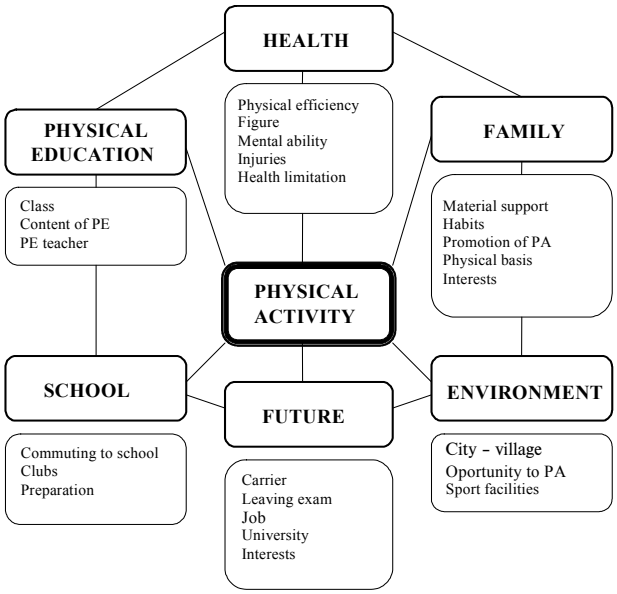
14th interview - Girl
(A) *TIME DEMANDS OF SCHOOL ⇨* ***(B)*** *LOWERING OF PA⇨* ***(C)*** *HEALTH LIMITATION ⇨* ***(D)*** *POSITIVE RELATIONSHIP TO PA, PE LESSONS AS WELL AS HEALTH PE LESSONS ⇨* ***(E)*** *PARTICIPATION IN HEALTH PE LESSONS AS WELL AS IN NORMAL PE LESSONS ⇨* ***(F)*** *BALANCE – THOROUGH PREPARATION FOR SCHOOL/ENOUGH PA*

18th interview - Boy
(A) *POSITIVE RELATIONSHIP TO PA ⇨* ***(B)*** *REGULAR PA⇨* ***(C)*** *POSITIVE RELATION TO PE LESSONS ⇨* ***(D)*** *PARENTAL SUPPORT ⇨* ***(E)*** *MAINTENANCE OF A STABLE LEVEL OF PA ⇨* ***(F)*** *ENOUGH PA*

23rd interview - Boy
(A) *TIME DEMANDS OF SCHOOL ⇨* ***(B)*** *LOWERING OF OUT OF SCHOOL PA⇨* ***(C)*** *DEMOCRATIC APPROACH OF PE TEACHER ⇨* ***(D)*** *POSITIVE RELATIONSHIP TO PE LESSONS, PA ⇨* ***(E)*** *REGULAR PA, PE LESSONS CREATE 50% OF TOTAL PA ⇨* ***(F)*** *ENOUGH PA*

Almost half of the questioned students had come into contact with drugs (besides smoking and alcohol) in the sense of their own experience or direct testimony of giving a drug to somebody else and also the possibility of obtaining a drug if they were interested. The most known drug is namely marihuana (if I leave aside the smoking of tobacco products), "hard" (unacceptable in society) drugs are refused by adolescents, whose main attention is oriented to their coming school-leaving examination and the following entrance exams to university where two thirds of students (67%) want to study. Physical activity, although regarded as an important part of a healthy lifestyle is thus shifted aside and as the main reason students state a lack of free time (in 74% of the cases).

Fig. 3
The main categories (factors) influencing physical activity at the level of the school physical education system



Approximately half of the questioned students assume that in future they will practise sport regularly. Also physical education teachers and the content of physical education lessons have an indispensable influence on present and future physical activity. For 52% of questioned students school physical education is the only source of relatively intensive physical activity.

During the observation of the factors that influence physical activity of adolescents (Fig. 3) realise the influence of physical activity on health ("...I should practise sport much more but I do not have time.", "I think about being free from PE lessons, because I'm asthmatic... I don't like these lessons." "I'm one of those girls, who do exercises regularly, ..., at least I do something for myself.") but it is not a sufficient motivation to physical activity for them. At this age family influences physical activity of adolescents minimally ("I think since I'm 18

they should not tell me what to do. If I want they will pay it for me."). The biggest influence they attribute to school in the sense of its time demand for preparation for lessons or vice versa as the only source of relatively intensive exercise ("I'd rather study than practise sport which would take much time", "...I exercise only in school during PE lessons.").

Fatigue after long lasting school classes adolescents (apart from some exceptions) again solve by inactive behaviour such as sleep, watching TV, reading or listening to music. Adolescents are mostly satisfied with their body figures nevertheless they would like to make some changes in this sphere ("...it should be better...", "...I'm too thin, I could put on some weight but I cannot manage."). Favour of school physical education is influenced mainly by a teacher and a class (relationship to physical education influences: "...definitely what we do in PE...", "...I don't know what because only four of us exercise in PE.", "democracy works there...", "...and one is not bored there...").

DISCUSSION

Qualitative analysis was, in this study, based especially on a semi-structured qualitative interview. The central topic of this paper was physical activity of adolescents, searching for causes of its lack, analysis of the environment including the educational one, etc. Because it is assumed that regular out of school physical activity or a high level of physical activity in adolescence positively influence physical behaviour in adulthood (Kraut, Melamed, Gofer, & Froom, 2003; Telama, Yang, Laakso, & Viikari, 1997; Trudeau et al., 1999), we pay more attention to adolescents' own opinions and direct information concerning their physical activity.

Similarly to what was found in the study by Brownson et al. (2001), our adolescents also indicate as a principal cause of the low level of their physical activity a lack of free time as the result of study demands at secondary grammar school. It is necessary to give warning that respondents were students of graduation classes preparing for school-leaving examinations. Similarly in the study of adolescent girls with a higher risk of inactive behaviour, Neumark-Sztainer et al. (2003) found two very strong factors that are associated with physical activity. First there is the lack of time that is inversely associated with physical activity and the second but positively associated factor is the support of parents, peers and teachers for physical activity. With regard to the finding that adolescents want to do more things at the same time the authors recommends teaching adolescents how to plan and manage their time schedules.

Apart from the lack of time to a small extent there appeared other reasons namely other interests, bad conditions for the performance of physical activity, health problems, "nobody" to exercise with or lack of interest in physical activity. In a study by Brownson et al. (2001) the authors mentioned as further barriers to physical activity the feeling of fatigue, physically demanding work and the missing motivation for exercising. The authors recommended longitudinal study for clear definition of the effects of the above-mentioned determinants.

Physical activity is, among others, connected with health and also with behaviour influencing health. Adolescents do not perceive health only from the physical side but are also influenced by personal, socio-environmental, behavioural and mental factors (Vingilis, Terrance, & Seeley, 2002). In this study adolescents were questioned about their experience with smoking, alcohol and drugs. These characteristics of adolescents' lifestyles are a frequent subject of research when a low level of physical activity is associated for instance with smoking, a low level of the consumption of fruit and vegetables and other risky behaviour (Kaplan et al., 2003). Similarly also Aarnio et al. (2002) in a questionnaire study of 5028 twins found that smoking, irregular breakfast, studying at vocational school and perceiving of actual current health as poor, are associated with inactive behaviour.

Altogether 63% of questioned adolescents stated that they smoke regularly or occasionally, "only" 37% of them labelled themselves as regular smokers, compared to 30% of adolescents who regard themselves as non-smokers. Kaplan et al. (2003) arrived at very different results when they studied adolescents of the Vietnamese ethnic group in the U. S. A. aged 12–17 years. They found that 84% of adolescents are non-smokers and they did not even try smoking and 77% of adolescents had not tried drinking alcohol yet. In this study, on the other hand, 74% of adolescents drink alcohol at least occasionally. A very low percentage of non-smokers (17.41%) was found by Chmelík et al. (2004) who from a questionnaire survey of a representative sample of the Czech population (n = 3549) aged 14–24 years learnt that youth who regarded themselves as non-smokers devoted their time more frequently to physical activity of moderate to high intensity than those who regarded themselves as smokers.

Apart from smoking and alcohol almost half of the questioned students came into contact with drugs either directly or as "spectators". Also they had the opportunity to obtain the drug if they were interested. In the centre of attention is especially marihuana but so-called hard drugs were refused by our questioned adolescents. Different legislation but mainly the way of its observance in our country and for instance in the U. S. A. contribute to the above mentioned differences.

Watching TV belongs among other risk factors of physical activity. Even if we did not note the high quan-

tity of time spent in front of the TV or PC monitor in the record of inactivity structure, this information is strongly influenced by the "honesty" and "conscientiousness" of respondents' recording. Besides from qualitative interviews it follows that adolescents solve their fatigue after long-lasting school classes in most of cases (81%) again by inactive behaviour namely watching TV, sleep, reading or listening to music.

The risk of maintenance of inactive behaviour until adulthood is great (Gordon-Larsen, Nelson, & Popkin, 2004). The authors noted a distinct decline of physical activity in physically active adolescents, but less distinct is the change in the sphere of inactive behaviour (watching TV, video or spending time at the PC). Further they assumed that in adolescents who spent more than 14 hours a week in front of a TV set or PC monitor (which was noted in one fourth of adolescents), this inactive behaviour lasts until adulthood and beyond. In adolescents who did not pass this limit, only in 17% of them did an increase of this inactive behaviour appear in adulthood. They confirmed thus the decline of physical activity with age and considered inactive behaviour to be stable with regard to age.

Since we know from previous studies that watching television (or sitting in front of a PC) makes up even 25% (or even 27%) of the total time spent in daily physical inactivity by adolescents (Sigmund, Frömel, Sigmundová, & Sallis, 2003) and moreover that the proportion of physical activity to physical inactivity is 1 to 3, it is necessary to search for ways to support physical activity in adolescent youth.

One of the possibilities is to respect preferences of different physical activities. The examined adolescents state that they do not have much time for exercising. If they organise some time and at the same time they have the possibility to realise a preferred physical activity they would like to participate (according to the statement of a student "so I would do it"). Together with the origin of new types of sports and physical activities adolescents are newly interested apart from classical ball games, in swimming, dancing, baseball and floor ball, in adrenaline sport or "rope activities". Tammelin, Näyhä, Hills and Järvelin (2003) found that a higher presumption for maintenance of a high level of physical activity till adulthood is especially found in boys with more frequent participation in out of school physical activity focusing on ball games, endurance activity or resistance exercises. In girls it is the participation in individual sports namely jogging, athletics, cycling, and gymnastics. Regardless of gender, adolescents' participation is, in relatively intensive endurance sports, associated with a high level of physical activity in adulthood or with participation in endurance sports, also in adulthood. The authors further state that participation in sport at least once a week in girls and twice a week in boys is associated with high participation in physical activity in adulthood.

Kaplan et al. (2003) drew attention to different effects of out of school activities on risky behaviour between boys and girls and they emphasise that girls' out of school physical activity does not enhance their risky behaviour in contrast to boys. In the existing situation they explain that boys' activities are more competitive, and the presentation of risky behaviour (for instance smoking) signalises success or dominance.

Another factor of physical activity can be the economic situation of the family. Our questioned adolescents (apart from exceptions) do not feel any limitation from the financial side when choosing physical activities but Tammelin et al. (2003) claimed that low incomes can narrow the possibilities of children's participation especially in financially demanding sports. Together with economic level they put into context also a lower level of education that is associated with a higher probability of inactive behaviour, which is a bad model for children. The authors place emphasis on promotion of physical activity in adulthood through being self-interested in one's juvenile years, further on positive experience, obtaining a wide scale of skills and the enhancement of motivation to habitual physical activity.

A unique opportunity to participe in regular physical activity but also to obtain necessary skills is offered by physical education lessons (MacKay, Fingerhut, & Duran, 2000). In this study only one fourth of people questioned stated that they practise sport at least three times a week. On the contrary in the remainder of the questioned people the main source of relatively intensive exercise is just physical education lessons. It seems that regular and thorough preparation for school lessons is an definitely limiting factor of out of school physical activity and physical education classes remain the main source of relatively intensive physical activity then. One of the possible and at the same time a systematic solution to physical activity enhancement in youth at secondary schools is to add at least one physical education lesson a week. This physical education lesson should have an optional character respecting the necessities and wishes of a wide range of students. The extracurricular character of the lesson should contribute also to creating co-educational and different age groups of students.

Favour of physical education in our observed boys depends mainly on the teacher's approach. Boys appreciate a democratic approach that enables them to intervene in the content of physical education lessons or to find a compromise ("...democracy works there only sometimes – we have gymnastics and so on."). The liberal approach of the teacher is very negatively appreciated especially if the lesson is not properly prepared ("he diddles it"). A freer teacher's approach together

with a worse class also do not contribute to favour of physical education ("I'm keen on sport but only in our PE class I cannot manage because only a few exercise. At primary school it was quite OK. This class is worse, the girls do not want to exercise and withal it would be better if they did exercise.", "Only a few of the students exercise so we can play almost nothing.", "I do not exercise regularly, I don't know, I don't want to exercise. I do not even know why I do not want to. Three fourths of the people do not exercise and only three of the students exercise..."). On the other hand a too directive approach is also not positively appreciated. In some cases girls indicated that they are even worried.

In the Czech Republic physical education instruction has got a different character than abroad, mainly thanks to non-coeducational physical education (in most the cases) and the multiple specialties of physical education teachers. The existence of multiple specialties of the teachers simplifies thematic integration and the possibility of using deeper knowledge of the second certified subject in physical education.

Whether co-educational physical education is more beneficial than non-coeducational regarding the level of physical activity cannot be clearly said, even though McKenzie, Prochaska, Sallis and LaMaster (2004) defended co-educational lessons by finding that girls in non-coeducational physical education lessons compared to boys definitely spend less of the time of the lesson in exercising, whereas in co-educational lessons the time spent exercising in girls is of moderate to higher intensity than in non-coeducational lessons. In the Czech Republic, co-educational instruction is normally present during the first grade at primary schools, in higher grades, co-educational instruction of physical education is, as a rule, quite rare.

In the observed sample of this study, one group of students appeared that was, for organisational reasons, taught co-educationally. Most of the girls viewed the presence of boys in lessons positively. But a reproach appeared that playing some sport games together with boys could be dangerous ("For instance when we play with boys our "life" is at stake", "...with boys it is dangerous to play basketball."). Boys valued co-educational lessons rather negatively. They missed the proper degree of enthusiasm in games and also the less frequent insertion of typically boys' sports ("I'd like to have the lesson only with boys in order to play more games."). McKenzie, Prochaska, Sallis and LaMaster (2004) presented different findings when girls during co-educational instruction felt disadvantaged against boys. In our case the unequal representation of boys and girls could effect the evaluation of co-educational physical education lessons. There were definitely fewer boys than girls.

Our country is not the only one in which the problem of participation in physical education lessons hasn't been solved.

Students who do not want to attend these lessons normally try to obtain exemption from physical education or they participate in the lessons only passively. Hassandra, Goudas and Chroni (2003) studied a similar problem of the relationship to inner motivation. They found two groups of factors of inner motivation supporting participation in physical education, namely individual and socio-environmental factors including the content of physical education, teachers, classmates, school equipment, physical behaviour of the family, support of the family, participation in out of school physical activities, media, cultural values and social prejudices.

School physical education cannot provide to all young people a healthy recommended amount of physical activity, but that is not its priority and main aim. School physical education should establish the foundation for future physical activity and a positive relationship to physical activity and lead students towards a physically active lifestyle. Not everybody is physically talented but for everybody it is possible to find some physical activity he/she inclines to which suits him/her.

CONCLUSIONS

According to adolescents a principal cause of the low level of physical activity is a lack of free time.

School physical education is, for most adolescents, the only source of relatively intensive exercise.

Favour of school physical education depends especially on the content of the lessons, the teacher's approach and the class.

For searching for possible causes of and decline in physical activity it is useful to use quantitative combined with qualitative methods of research.

For enhancement of favour of physical education lessons they recommend applying teaching styles enabling students to have more influence on the content of the lessons and increase the responsibility of students for the successful course of the lessons.

For most adolescents the only source of relatively intensive exercise is school physical education and that's why it is necessary in newly originated school programmes to promote an increase in the number of physical education lessons that will include physical activity.

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KVALITATIVNÍ ANALÝZA NÁZORŮ, PODMÍNEK A EDUKAČNÍHO PROSTŘEDÍ VE VZTAHU K POHYBOVÉMU CHOVÁNÍ ADOLESCENTŮ

(Souhrn anglického textu)

Cílem této studie bylo užitím kvalitativní analýzy najít a popsat možné příčiny zájmu, resp. nezájmu adolescentů o pohybovou aktivitu a tělesnou výchovu a přispět k objasnění dalších charakteristik pohybového chování. Dále pak charakterizovat „rizikové" chování adolescentů. Názory adolescentů, úroveň podmínek a edukačního prostředí byly zjišťovány pomocí semistrukturovaných rozhovorů a jejich následné kvalitativní analýzy užitím paradigmatického modelu axiálního kódování zakotvené teorie. Celkem bylo realizováno 27 rozhovorů se studenty maturitních ročníků v návaznosti na čtyřletý výzkum pohybové aktivity. Hlavní příčinou nízké úrovně pohybové aktivity je dle adolescentů nedostatek času. Školní tělesná výchova je pro většinu adolescentů jediným zdrojem intenzivnějšího pohybu. Obliba školní tělesné výchovy závisí zejména na obsahu vyučovacích jednotek, přístupu učitele a třídním kolektivu.

*Klíčová slova***:** *pohybová aktivita, tělesná výchova, základní prokázaná teorie, rozhovor, chování.*

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THE INFLUENCE OF TENNIS MOTOR ABILITIES AND ANTHROPOMETRIC MEASURES ON THE COMPETITION SUCCESSFULNESS OF 11 AND 12 YEAR-OLD FEMALE TENNIS PLAYERS

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A sample of 75 young female tennis players, aged 11 and 12, was included in a research project aimed at establishing the influence of selected anthropometric measures and tennis motor abilities on the competition successfulness of young tennis players. The selected tennis motor variables include: the muscular power of arms and shoulders, elastic power of the legs, repetitive strength of the trunk, speed of movement, speed of alternative movements with the arm, flexibility of the back, agility, and hand-eye coordination.

The results of regression analysis of anthropometric measures reveal a statistically significant connection with the criterion variable (0.36). The system of predictor variables can explain 13% of the variance of the criterion variable. The same applies to tennis motor variables, where the relevant value is somewhat closer, reaching 0.64, while the system of predictors explains 41% of the variance of the criterion variable.

Of the anthropometric measures three variables (calf girth, body weight and abdominal /suprailiac/ skinfold) explain the criterion variable with statistical significance. Among the tennis motor variables the above-mentioned variable is represented by the 2400-m run, used for measuring running endurance, and the 5-m run, used for measuring speed of movement.

Keywords: Tennis, successfulness, anthropometric measures, tennis motor tests.

INTRODUCTION

Tennis is a dynamic sports game played with a racquet and a ball. Success in tennis is defined by several factors that can be divided into social (sport infrastructure, sport popularity, etc.), external (competitor, coach, parents, training conditions) and internal factors (potential capacity, realisation of mobility capacity and competition experience).

In the present research, the competition successfulness of young female tennis players, aged 11 and 12, is explained on the basis of selected tennis motor tests. The selected tests measure the muscular power of arms and shoulders, the elastic power of the legs, repetitive strength of the trunk, speed of movement, speed of alternative movements with the arm, flexibility of the back, flexibility in the shoulders, flexibility of hips, agility, coordination, hand-eye coordination and dynamic balance.

Muscular strength is defined as the ability of a muscle or a group of muscles to exert maximal force during contraction. Muscular power is a combination of strength and speed. The test measures how quickly we apply our muscular strength.

In this field the following works of research have been consulted. Müller (1989) carried out 21 motor tests on 80 subjects, aged between 10 and 13. The criterion variable was the estimate of tennis strength. The highest correlation with the criterion variable was recorded in reaction tests, the 20-meter run and the Sargent jump.

Bunc, Dlouhá, Höhm, & Šafařík (1990) have conducted research on 80 boys and girls aged 13 and 14 with a test battery which was composed of eight tennis motor tests and anthropometric measures. Based on the comparison between tests and competition successfulness in tennis they established that speed was of high importance for young tennis players.

Filipčič (1993) compared competition successfulness with the results of basic motor and tennis tests on 43 tennis players between 15 and 23 years of age. The results of regression analysis show a statistically significant connection between the system of predictor variables and the criterion variable. By applying the system of used predictor variables approximately 40% of the criterion variance can be explained.

Unierzyski (1994) used a sample of 217 boys and 163 girls to – among other things – establish the connection between the national tennis scale ranking and seven mo-

tor tests. He succeeded in explaining 36.5% of competition successfulness with motor variables in 11-year old girls and 65.4% of the criterion variable in 14-year old girls. He discovered the great significance of first step acceleration in movement and of agility and strength in explaining competition successfulness.

Filipčič (1996) compared competitive and potential success to regression analysis and expert modelling on 87 young tennis players, aged between 12 and 14. Regression analysis was initially performed separately on motor, morphological and functional parts of the expert tree. Using morphological predictor variables, 50% of the criterion variable was explained, using tennis motor predictor variables, 63% of the criterion variable was explained, and using functional predictor variables, 53% of the criterion variable was explained. Regression analysis was furthermore performed on the highest level of the three dimensions, which helped explain 66% of the criterion variable. Congruity of the results obtained through expert modelling and regression analysis with morphological dimensions turned out to be 0.40, with motor dimensions being 0.65 and with functional dimensions at 0.58. On the highest level, i.e. the level of potential successfulness of young tennis players, the congruity of the results was 0.71. The congruity of the results obtained through expert modelling and regression analysis on the one hand and the criterion variable on the other hand turned out to be 0.53 considering the first method and 0.81 considering the second method.

Šerjak (2000) determined a connection between tennis motor tests and competition successfulness of 51 female tennis players aged 11 to 14. The results of regression analyses showed that the system of tennis motor variables had a statistically significant connection with the criterion variable. Variables of muscular strength, speed of movement, flexibility and coordination have the highest prediction value.

METHODS

Subjects

The sample of subjects consisted of 75 active female tennis players in the category 11 to 12 years of age. The study covered only the players satisfying the following conditions:

- tennis players were ranked on the STA ranking list for the U12 category;
- they participated in the process of regular training;
- they completed all the tests relevant to the research.

TABLE 1
General characteristics of the subject sample

	Minimum	Maximum	Mean	Std. Deviation
Age /years/	11.52	12.99	12.3442	0.42814
Height /cm/	140.9	171.5	157.814	6.8941
Weight /kg/	32.5	65.5	46.102	8.6037

Procedures

The measurements were carried out at the Faculty of Sport in Ljubljana within regular annual measurement – taking organised for the members of the Slovenian national team. Apart from these candidates, the best female tennis players from different tennis clubs were invited to take part in the project. The measurements were carried out within one day. The tests of speed of movement and speed of alternative movements of the arm were carried out immediately after warming up, while the tests of repetitive strength of the trunk were carried out last.

Anthropometric measures

Anthropometric measurements were carried out before the motor ones in accordance with the International Biological Programme. The battery consisted of 25 anthropometric measures which are often used, thus the descriptions are not given. Only some measures were selected for further research (Lasan, 1987).

TABLE 2
Predictor variables of anthropometric measures

Code	Name of measure	Area of measurement
BH	Body Height	Longitudinal measure
LL	Leg Length	Longitudinal measure
AL	Arm length	Longitudinal measure
CG	Calf girth (circumference)	Body circumference
CHG	Chest girth	Body circumference
KB	Knee breadth (diameter)	Body diameter
BW	Body weight	Body mass
AS	Abdominal (suprailiac) skinfold	Body fat
BS	Biceps skinfold	Body fat

Description of tennis motor tests

Medicine Ball Put (MBP)

TASK: The subject stands behind a line (a right-hander with his/her left side towards the direction of the throw), holding the ball in his/her dominant hand, the left hand supporting the ball from the bottom. After a slight arch backward, the ball is thrown straight ahead with a move similar to a serve. The distance from the line to the point where the ball landed is measured.

Quarter Jump (QJ)

TASK: The subject, from a sideways stance with his/her feet apart behind the line, takes four alternate jump steps, landing on both feet. The distance from the line to the last set of footprints (heel) is measured.

Sit-ups 60 s (SU60)

TASK: The subject lies back down with legs bent and the soles of the feet resting on the ground about 30 cm apart, hands behind the head, fingers interlocked. On the signal, the subject sits up, twisting the trunk and touching one elbow with the opposite knee, then lies back flat again. The sit-up is repeated, the other elbow touching the other knee; the test is continued without interruption as many times as possible for a period of 60 seconds or as long as the subject can continue.

5-m Run (R5)

TASK: The result is the time of the subject's running a 5 m distance, starting from standing position at the start.

Tapping 20 s with hand (TAP20H)

TASK: For twenty seconds the subject has to tap alternately two plates on the tapping board with his/her dominant hand, while holding the other hand in between the two plates. The result is the number of alternate double hits.

Tapping 20 s with leg (TAP20L)

TASK: For twenty seconds the subject has to tap alternately two plates on the tapping board with his/her dominant leg, while sitting on a chair. The result is the number of alternate double hits.

Fandrill (FAN)

TASK: The subject runs with a racquet in his/her dominant hand, along a marked-out course of five directions of four meters. The subject must always step on the central marker and the other bases, or at least touch them with one foot. In addition, the racquet must touch the ground in front of the player at each of the outside bases. Leg number three must always be run backward, the other legs in any manner desired, as quickly as possible.

Forward Bend on the Bench (FBB)

TASK: The subject stands bare-footed on a bench. The legs are extended, feet are together and parallel. The toes are touching the tape measure. The subject bends forward and pushes the board which slides down the tape measure. The final position must be maintained for at least for 2 seconds.

Hexagon (HEX)

TASK: The subject stands in a hexagon with six sides 60 cm long. At the signal of the measurer the subject starts to jump with both legs in and out of the hexagon. Three rounds are made.

Rebounding Tennis Ball with the Racquet (RTB)

TASK: The subject holds the tennis racquet in one and the tennis ball in the other hand. At the signal of the measurer the subject starts rebounding the tennis ball alternately once with a string and once with the frame of the racquet. If the ball drops off, the subject picks it up and continues with the task. The task is done after 60 seconds.

2400-m Run (R2400)

TASK: The subjects are divided into groups of no more than 8 runners. The group of subjects stands behind the start line and at the signal, "Go!" starts to run. They run 6 laps (one lap is 400 m).

TABLE 3
Predictor variables of tennis motor tests

Code	Name of test	Ability
MBP	Medicine Ball Put (cm)	Muscular power of arms and shoulders
QJ	Quarter Jump (cm)	Elastic power of the legs
SU60	Sit-ups in 60 s (freq.)	Repetitive strength of the trunk
R5	5-m Run (.1 s)	Speed of movement
TAP20H	Tapping in 20 s with hand (freq.)	Speed of alternative movements with the hands
TAP20L	Tapping in 20 s with leg (freq.)	Speed of alternative movements with the leg
FBB	Forward Bend on the Bench (cm)	Flexibility of back
HEX	Hexagon (.1 s)	Agility
FAN	Fandrill (.1 s)	Agility
RTBR	Rebounding Tennis Ball with the Racquet	Hand-eye coordination
R2400	2400-m Run (1 s)	Running Endurance

In defining the criterion variable, all the competitions for female tennis players aged up to 12 which had taken place in the period of the last competitive season were taken into account. Since the players competed in a different number of tournaments, we selected the most suitable criterion variable (competition successfulness), which is the ratio between the number of points collected by an individual player in tournaments and the number of entered tournaments.

The number of collected points represents all the points received for ranking in a competition (depending on the competition's rank; from 1st to 3rd rank), while the points received for winning depend on the opponent's ranking – bonus points. Points received collectively are divided by the number of tournaments entered and on this basis the coefficient of competition successfulness is calculated.

Data analysis

The basic statistical parameters of all the variables were computed in the first phase of the data analysis. In the second part classic multiple regression analysis was used to asses the relation between tennis motor variables, anthropometric variables and competition successfulness of young female tennis players.

RESULTS

Basic statistical parameters of anthropometric measures are shown in TABLE 4. The results of Kolmogorov-Smirnov test of distribution normality indicate that all anthropometric variables have normal distribution.

TABLE 4
Basic statistical parameters of anthropometric variables

	Min.	Max.	Mean	SD	K–S	Sig. K–S
BH	140.9	171.5	157.814	6.8941	1.043	0.227
LL	68.70	108.00	93.968	5.455	0.872	0.433
AL	53.70	91.50	69.471	4.480	0.864	0.444
CG	28.00	38.00	33.330	2.320	0.882	0.418
CHG	46.10	87.60	70.542	5.233	0.884	0.415
KB	5.00	8.50	6.607	0.440	1.007	0.262
BW	32.5	65.5	46.102	8.6037	0.509	0.958
AS	1.00	30.00	12.550	5.690	1.418	0.036
BS	4.00	28.20	11.251	5.221	1.507	0.021

Legend:
Min.: minimal result
Max.: maximal result
Mean: arithmetic mean
SD: standard deviation
K–S: Kolmogorov-Smirnov test of distribution normality
Sig. K–S: probability of K–S ($p < 0.05$)

Basic statistical parameters of tennis motor variables are shown in TABLE 5. The results of the Kolmogorov-Smirnov test of distribution normality indicate that all tennis motor variables have normal distribution.

TABLE 5
Basic statistical parameters of tennis motor variables

	Min.	Max.	Mean	SD	K–S	Sig. KS
MBP	350.00	1190.00	711.870	161.410	0.978	0.294
QJ	540.00	925.00	741.480	73.250	0.830	0.496
SU60	24.00	71.00	48.940	9.040	0.880	0.421
R5	1.15	1.65	1.324	0.106	1.186	0.120
TAP20H	20.00	36.00	29.980	2.420	1.189	0.118
TAP20L	30.00	55.00	43.710	4.290	1.113	0.168
FBB	36.00	65.00	51.540	5.870	1.047	0.223
HEX	7.70	14.80	10.256	1.286	1.057	0.214
FAN	11.90	20.70	15.717	1.835	0.689	0.730
RTBR	7.00	81.00	41.490	11.580	0.764	0.603
R2400	438.00	879.00	676.280	75.990	0.632	0.819

Legend:
Min.: minimal result
Max.: maximal result
Mean: arithmetical mean
SD: standard deviation
K–S: Kolmogorov-Smirnov test of distribution normality
Sig. K–S: probability of K–S ($p < 0.05$)

Basic statistical parameters of the criterion variable (competition successfulness) are shown in TABLE 6. The results of Kolmogorov-Smirnov test of distribution normality indicate that the criterion variable has normal distribution.

TABLE 6
Basic statistical parameters of criterion variable

	Min.	Max.	Mean	SD	K–S	Sig. KS
CS	1.000	39.600	12.87727	10.756174	1.313	.064

Legend:
Min: minimal result
Max: maximal result
Mean: arithmetical mean
SD: standard deviation
K–S: Kolmogorov-Smirnov test of distribution normality
Sig. K–S: probability of K–S ($p < 0.05$)

TABLE 7 shows that the predictor system of anthropometric variables and the criterion variable are correlated with statistical significance. The coefficient of determination ($R^2 = .132$) indicates that the predictor system of tennis motor variables explains 13% of the variance of the criterion variable. The coefficient of multiple correlation ($R = .364$) indicates that the relation of the system of predictor variables to the criterion variable is .36.

Among the selected variables, three variables, namely calf girth (CG), body weight (BW) and abdominal (suprailiac) skinfold (AS), have the largest Beta coefficients and are statistically significant. The Pearson correlation coefficients with predictor and criterion variables are higher for abdominal (suprailiac) skinfold (AS) and body weight (BW). The abdominal (suprailiac) skinfold (AS) has a negative correlation to the criterion variable.

TABLE 7
Regression analysis of anthropometric variables

	R	**R^2**	**F**	**Sig. F**
	.364	.132	2.187	.027
	Correl	**Beta**	**T**	**Sig. T**
BH	.106	–.128	–.565	.573
LL	.058	–.080	–.603	.547
AL	.066	–.030	–.226	.821
CG	**.027**	**–.447**	**–2.432**	**.016**
CHG	.053	–.050	–.358	.721
KB	.133	.147	1.539	.126
BW	**.125**	**.796**	**2.878**	**.005**
AS	**–.161**	**–.290**	**–2.411**	**.017**
BS	–.075	–.020	–.146	.884

Statistically significant correlations ($p < 0.05$) are shown in bold.
Legend:
R – coefficient of multiple correlation
R^2 – coefficient of determination
F – F test of H0: $R^2 = 0$
Sig. F – significance of F test
Beta – standardized beta coefficient
Correl – Pearson correlation coefficient
T – t value for H0: Beta = 0
Sig T – two-tailed significance level of T

TABLE 8 shows that the predictor system of tennis motor variables and the criterion variable are correlated with statistical significance. The coefficient of determination (R^2 = .411) shows that the predictor system of tennis motor variables explains 41% of the variance of the criterion variable. The coefficient of multiple correlation (R = .641) indicates that the relation of the system of predictor variables with the criterion variable is .64.

Among the selected variables two variables, namely the 5-m Run (R5) and the 2400-m Run (R2400) have the highest Beta coefficients and are statistically significant. Pearson correlation coefficients with predictor and criterion variables are higher for the 2400-m Run (R2400), Medicine Ball Put (MBP), Rebounding Tennis Ball with the Racquet (RTBR) and 5-m Run (R5).

TABLE 8
Regression analysis of tennis motor variables

	R	R^2	F	Sig. F
	.641	.411	4.253	.000
	Correl	**Beta**	**T**	**Sig. T**
MBP	.412	.095	.612	.543
QJ	.273	-.031	-.179	.859
SU60	.205	-.075	-599	.551
R5	**-.370**	**-.363**	**-2.718**	**.008**
TAP20H	.273	-.042	-.295	.769
TAP20L	.079	-.143	-1.076	.286
FBB	.207	.124	1.129	.263
HEX	.014	.008	.067	.946
FAN	-146	.077	.535	.594
RTBR	.419	.240	1.662	.101
MT2400	**-.469**	**-.361**	**-3.046**	**.003**

Statistically significant correlations ($p < 0.05$) are shown in bold.
Legend:
R – coefficient of multiple correlation
R^2 – coefficient of determination
F – F test of H0: $R^2 = 0$
Sig. F – significance of F test
Beta – standardized beta coefficient
Correl – Pearson correlation coefficient
T – t value for H0: Beta = 0
Sig T – two-tailed significance level of T

DISCUSSION

The results of regression analysis of anthropometric measures (TABLE 7) point to the statistically significant yet low connection of the anthropometric measure system with the criterion variable. The same applies to the explained variance, which equals 13%.

However, the results of regression with tennis motor variables show relatively high values of explained variance of the criterion variable (41%) and high correlation between the tennis motor and the criterion variable.

Filipčič (1996) made a regression analysis of male tennis players (aged 14) covering different abilities and characteristics. The following values of explained variance were obtained: in 15 morphological variables the explained variance was 51%, in 22 tennis motor variables 63%, while in 6 functional variables the explained variance was 53%. The criterion variable in the present research also included competition successfulness, estimated with a coefficient of successfulness.

Anthropometric measures

The most significant predictor of the criterion variable is body weight (BW), which measures body mass. The reason for this could originate from two sources. The first is that there are developmental differences among girls of this age, as it is known that in puberty the body weight of girls increases more than body height (Žlebnik, 1975). And second, the development of body height and weight to a high degree depends also on sexual development and the related increase in body weight and height. This is reflected also by the results of basic statistical parameters of anthropometric variables, which show considerable differences in body weight (BW) and body height (BH) between individual subjects. Higher body weight in addition to greater body mass can also mean greater muscle mass and indirectly also more speedy tennis strokes. In any case, puberty is characterised by intensive psychomotor development and thus the transition to a higher level of motor abilities.

The next variable which explains competition successfulness with statistical significance is calf girth (CG). From the functional point of view a more hypertrophied muscle (larger volume and number of muscle fibres) can apply greater force on the load, which may be consequentially related to the speed of contraction. Based on electromyography research (Guissard, Duchateau, & Hainaut, 1992) it has been established that sprint start performance is associated with the enhanced contribution of the MG during eccentric and concentric phases of calf muscles contraction. In tennis, a faster sprint start means that the ball is caught in time, which increases the possibility of an optimal tennis stroke.

Body fat is one of the sets of anthropometric variables within which the abdominal (suprailiac) skinfold (AS) explains the variance of the criterion variable with statistical significance. Greater body fat represents an obstacle for tennis players, namely ballast, which becomes apparent mainly in fast movements and jumps and is also an additional burden during long-term activities, i.e. long tennis matches. Filipčič (1996) discovered that due to high level of intensity and dynamic character of a tennis match fat tissue represents an additional burden for the player and to a certain extent slows down a player's movements.

The importance of body fat can be greater in girls, since the fat tissue values differ depending on the gen-

der. Average fat value in young men is about 12% and in women 20% of their body mass (Lasan, 1987).

Tennis motor variables

One of the two significant predictors of the criterion variable is 5-m Run (R5), which measures speed of movement. Among other things, within the scope of this research the speed was measured at a 5 meter distance. Since this is a very short running distance, it has to be stressed that the first step acceleration is extremely important. Namely, variables influence the movement of tennis players, since the start and the first meters of the run are crucial to the preparation and realisation of the stroke. In a tennis match many short sprints are no longer than 11 metres. Usually they are five metres long (Schönborn, 2000).

In most research studies the speed of movement test includes running at a distance of 20 metres. Therefore the variable 20-m Run (R20) was, a number of times, (Müller, 1989; Bunc, Dlouhá, Höhm, & Šafařík, 1990; Filipčič, 1996) recognised as the predictor that can explain successfulness in tennis with statistical significance. They also established that the speed of movement and start speed were very important in tennis. The importance of speed will continue to grow in modern tennis, since the speed of strokes is constantly increasing.

In their research Clark, Martin, Lee, Fornasiero and Quinn (1998) investigated the relations between individual speed tests and agility tests. They discovered that a ten metre sprint time was highly correlated with sprint times in the cases of both 5 and 20 m. Correlations were weak for males and females between sprint times and Acceleration/Deceleration (5 m), Back Slide, and Tball Forehand with the exception of Tball Forehand for males, which was shown to be significantly correlated with 10 m and 20 m sprint times. For the remaining agility tests correlations with sprint times were generally moderate in females and strong in males. Correlations between agility tests and sprint times became stronger in males and females as the sprint distance increased.

The second predictor variable that explains the competition successfulness of female tennis players with statistical significance is the 2400-m Run (R2400). This variable belongs to the field of the energy component of movement, or, more precisely, to the field of running endurance. The test is frequently used and known as the Cooper test of aerobic endurance. In the research on tennis games (Filipčič, 1993), a similar variable was used (R2000), which was also found to act as an individual predictor to explain competition successfulness with statistical significance. Završki (1997) also established that functional abilities of an organism are very important, pointing to the fact that a young tennis player is well prepared in terms of endurance. For successful performance in the test 2400-m Run (R2400), the following factors are important: functional ability of organic systems for O_2 transport (respiratory and cardiovascular system and the capacity of the blood), morphological and functional characteristics of the muscles, and the mechanism for the regulation and excitation of the nerve–muscular system.

The importance of the above-mentioned mechanisms in tennis is reflected particularly in time-consuming matches, where a player must retain a high level of abilities throughout the entire match or must perform at her best at the very end of the match.

To conclude, it can be established that the selection of variables included in regression analysis was adequate, both in terms of individual tennis motor abilities covered and the aspect of explaining tennis successfulness. It is above all important that some significant bases were developed for further research of girls' tennis and the importance of tennis motor abilities in explaining the competition successfulness of female tennis players.

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VLIV MOTORICKÝCH SCHOPNOSTÍ A ANTROPOMETRICKÝCH MĚR NA ÚSPĚŠNOST V ZÁVODECH U 11 A 12LETÝCH HRÁČEK TENISU

(Souhrn anglického textu)

Soubor 75 mladých hráček tenisu ve věku 11 a 12 let byl zahrnut do výzkumného projektu s cílem zjistit vliv vybraných antropometrických údajů a tenisových motorických dovedností na úspěšnost v soutěžích mladých tenisových hráčů. Vybrané tenisové motorické proměnné zahrnují: sílu svalů paží a ramen, sílu nohou, opakovanou sílu trupu, rychlost pohybu, rychlost střídavého pohybu rukou, ohebnost zad, hbitost a koordinaci ruka – oko.

Výsledky regresní analýzy antropometrických měr odhalují statisticky významné spojení s kritérii proměnných (0,36). Skupina predikčních proměnných může vysvětlit 13% rozdílnost kritérií proměnných. To stejné se aplikuje na tenisové motorické proměnné, u kterých je důležitá hodnota poněkud bližší, dosahuje 0,64, zatímco systém prediktorů vysvětluje 41% rozdílnost kritérií proměnných.

Tři proměnné z antropometrických měr (obvod lýtka, tělesná váha, břišní kožní řasa) vysvětlují kritérium proměnné se statistickou významností. Mezi již výše zmíněné tenisové motorické proměnné patří běh na 2 400 metrů, který se používá pro měření vytrvalosti v běhu, a běh na 5 metrů, který se používá pro meření rychlosti pohybu.

Klíčová slova: tenis, úspěšnost, antropometrická měření, motorické testy v tenisu.

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TRAINING IN HIGH ALTITUDE ENVIRONMENTS AND ITS INFLUENCE ON THE CHANGES IN SELECTED PHYSIOLOGICAL INDICATORS OF A SLOVAK REPUBLIC REPRESENTATIVE IN WALKING

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Middle and high altitude preparation is a longterm part of the preparation of our Slovak race walking representatives. Martin Pupiš is one of those athletes whose regularly makes use of this system. In our paper we report his preparation at four high altitude camps, in preparation phases in the years 1998/99–2001/02. The period of the year when the camps took place were very similar. Also the duration was from 26 days to 36 days. The average amount of racewalking and running was, for one day, approximately the same during all four camps. The proportion of race walking in kilometres increased from 70% to 80%. The proportion of walking zones changed depending on the current specialisation with the highest number of km in tempo endurance. The reaction to high altitude preparation was very good, when in analysed blood components – hematocrit, haemoglobin, erythrocytes, and a medium quantity of erythrocytes we recorded positive changes, and only in leucocytes was there a decrease.

Keywords: High altitude surroundings, high altitude preparation, race walking, physiological indicators.

INTRODUCTION

A long process in the discovery of the influences of hypoxia on the organism of sportspeople preceded the utililization of high altitude preparation in preparation for sporting activity. Initial information in this area is connected with mountain touring, hiking and mountaineering. The most significant progress in this research into high altitude environments started in the 1960s shortly after the International Olympic Committee (IOC) decided to host the nineteenth Olympic Games (OG) in Mexico City, where the stadium is at an altitude of 2240 m above sea-level (a. s. l.). Even before the OG in Mexico City the first three, and later an additional high altitude training centre, were built. Since that time the utilization of a new form of preparation, the so-called hypoxic preparation, has started. The hypoxic preparation is characterised by a significantly lower atmospheric pressure and a substantially lower value of partial oxygen pressure. Hollman (1994) stated that already initial research had confirmed assumptions about acute reactions to higher altitudes and about chronic adaptation to physical work.

Later there were found longterm, prevalently positive influences of hypoxic preparation on the organisms of sportsmen. In sports practice the preparation for competition in the mountains, or in usual conditions, has used the following distribution of altitude grades:
low mountains – from 600 to 1200 m above sea-level, middle mountains – from 1200 to 2500 m above sea-level, high mountains – higher than 2500 m above sea-level (Suslov, Gippenrejter, & Cholodov, 1999).

As Hamar (1995) states, a very important factor is the determination of optimal training stay altitude. An enormous altitude may restrict the training load to the extent that the training could be finally insufficient and lead not towards improvement but towards deterioration of efficiency. Training in a hypoxic environment is a supplementary method to develop endurance abilities and this can apply only to those who have reached a sufficient level of VO_2max more than 65ml.kg.min^{-1} (Štulrajter, 1999; Kujaník & Štulrajter et al., 2001).

For the utilisation of high altitude preparation it is necessary to know the dependence between air-circulation and partial pressure from the sea-level. Suslov, Gippenrejter and Cholodov (1999) state changes in density of air, evaporation, air pressure and partial oxygen pressure with growing elevation. The above mentioned authors also follow two other additional important factors linked with preparation in high altitude environments – decreased temperature (in individual centres it is different) and the higher intensity of sun radiation with a growing elevation.

It is inevitable to know and respect the data about phase acclimatisation, as Bahchevanov (1994) states. Just as important are the facts about changes in circulation and respiration systems during adaptation and acclimatisation, as stated by Jungmann (1962) a long time ago. Knowing the conditions of specific adaptation for the preparation at Štrbské Pleso lake centre is

of particular importance for our sportspeople, using as they do often this centre for their preparation (Broďáni, 2002).

Luža, Klvaňa and Vilímová (2002) have recommended the use of high altitude training not only for the development of aerobic, but also of anaerobic endurance.

Referring to the circumstances that the high mountain centres with appropriate climatic conditions are divided amongst different continents, we have to take into account the movement of time as the distance movement causing biorythmic breaks (Jančoková, 2000).

High altitude preparation has become, in recent years, a part of top athletes' preparation for endurance events and in athletic pedestrianism as well. For walkers, who regularly prepare in a hypoxic environment it is essential to carry out systematic controls of the training process before, during and after preparation in high altitude environments. This is consistent with the fact that the reactions of organisms to a training load are very different from those which are usually observed in lowlands. In general, these reactions depend on the period of acclimatisation which the competitor allows him or herself. Obviously the time needed for global acclimatisation varies according to the individual and is not the same for every sportsperson. According to Kisiel (2000) total acclimatisation is different for everybody according to the place of high altitude training, the atmospheric conditions, the level of preparedness for global training and on the number of high altitude training preparations undergone as well as on other factors. Therefore it is necessary to remember the necessity of taking into account individual factors in the determination of the training load.

Based on this, training camps are anticipated in the altitude of 1000–1300 m, with the aim of avoiding the unfavourable influences of acclimatisation in high altitude preparations in the altitude of 1800–2500 m (Bichon, 1990; Kisiel, 1997). One important factor which influences high altitude training is the evaluation of the physiological reaction of the organism to its stay in the mountains and to its performance.

Kisiel (2000), the trainer of the Olympic winner and World Championship winner in walking Robert Korzeniowski, recommends that we carry out a thorough checkup everyday, including measurement of blood pressure and heart pulse, measurement of body weight with the use of a sport tester at every training session as well as the measurement of lactate acid values in the blood. Before every high altitude training camp and after every return to the lowlands walkers undergo a medical investigation, which includes the analysis of blood composition and endurance abilities measurement. During their stay in the mountains they monitor their blood composition – after the completion of the adaptation period. In addition to this, they evaluate consequently the walkers' walking technique by the frequent recording of the training in the field.

Gradually, the sportspeople began (instead of high altitude training) to utilize artificial facilities which simulate a high altitude environment, e.g. hypoxic chambers, hypoxic halls and hypoxic tents. As these facilities are very expensive, hypoxic preparation in the mountains is always realistic. They have begun to use the system of preparation "live high – train low".

The Slovak walker representatives have long utilised hypoxic training in their preparations. The competitors under the leadership of the trainer Benčík have a well-elaborated system of hypoxic preparation, which they have successfully applied together with the monitoring of functional status and physiological indicators. The aim of our paper is to make monitoring of the training in the hypoxic environment, and its influence on selected physiological indicators, representative of the Slovak Republic in athletic walking during a four-year period.

METHODS

Martin Pupiš (M. P.) – born on 19 October 1978, height 175 cm, weight 61 kg, was the monitored competitor. In 1997 he was awarded the bronze medal at the European Junior Championships in 10 km walking. His middle altitude preparation at 1343 m in Štrbské Pleso lake began in winter 1997. Over eighteen months he, several times, repeated his preparation in Štrbské Pleso lake and then in 1998 prepared himself at an altitude of 1900 m a.s.l. in the Austrian Alps. Only in 1999 he first prepared himself at an altitude above 2000 m a.s.l. We have observed in this paper the preparation of the competitor in four-year training cycles (YTC) 1998/99 – 2001/02. He attended in every year of the monitored years one high altitude training camp, anticipated by preparation in lower mountains (TABLE 1). Trainee M. P. was during the monitoring period a member of the Military sports club Dukla in Banská Bystrica and his trainer was Juraj Benčík.

From the selected physiological indicators were discovered blood components affecting oxygen binding – hematokrit, hemoglobin, erythrocytes and a medium volume of erythrocytes and leucocytes. The collection of blood was always taken during the second week after his return from training camp. The Spiroergometric Laboratories investigation was carried out in the same week and under the same conditions.

TABLE 1
Survey of the high altitude camps and middle altitude camps which were used

Year training cycle (YTC)	Camp in the middle altitude mountains	High altitude camp
1998/1999	15. 10.–5. 11. Š. Pleso (22 days) 27. 1.–7. 2. Š. Pleso (12 days)	14. 2.–14. 3. Toluca (Mexico) (29 days) 2640 m above sea-level
1999/2000	7.–14. 1. Malinô Brdo (8 days)	24. 1.–28. 2. Cochabamba, La Paz (Bolivia) (36 days) 2600–3600 m above sea-level
2000/2001	2.–20. 12. Š. Pleso (19 days)	2.–27. 2. Toluca (Mexico) (26 days) 2640 m a.s.l.
2001/2002	–	2. 2.–4. 3. Toluca (Mexico) (31 days) 2640 m. a.s.l.

We evaluated the training load during high altitude training camps in the following specific training indicators (STI):

1 – running (km)
2 – walking at speed to 4:05 km.min^{-1} (km)
3 – walking at speed 4:05–4:39 km.min^{-1} (km) – specific pace in 20 km
4 – walking at speed 4:40–5:22 km.min^{-1} (km) – specific pace in 50 km
5 – walking at speed 5:22–6:22 km.min^{-1} (km)
6 – walking at speed over 6:22 km.min^{-1} (km)
7 – walking total (km)
8 – running and walking total (km)

RESULTS

Trainee M. P. attended high altitude training camps in preparation periods within single YTC in similar periods with a different duration varying from 26 to 36 days. All training camps were adequately long in order to have sufficient effect on the organism of the sportsperson. The volume of training in kilometers in running went down on average in one day, as did the share of the overall volume of the absolved kilometres (Fig. 1, TABLE 2).

This trend is right if the share of walking is increased with the increased efficiency of the competitor in walking. His or her share of walking in total volume formed 80% in the last year. We consider this stressed 80% in accordance with Moc (1976) as adequate for walkers in the top class. Total volume in running and walking is on average in one day almost the same during all four observed training camps (21–22 km). The total absolved volume varies according to the number of days in the camp.

Fig. 1
Percentage proportion of running and special training zones (race walking) during high altitude camps in successive years

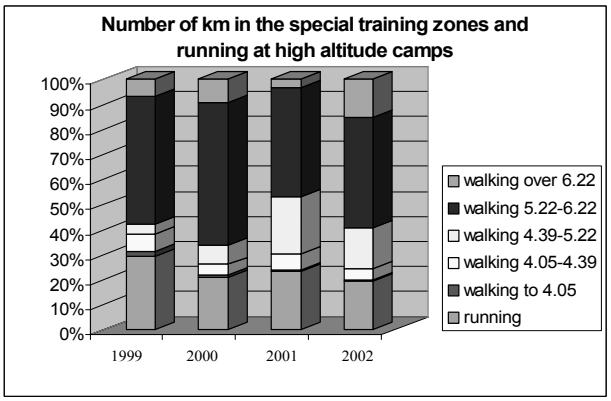


TABLE 2
Proportion of race walking zones (%) and part of race walking km in round numbers of km at high altitude camps

YTC/Training zones	2	3	4	5	6	7
1998/99	3.0	9.7	5.8	71.6	9.9	70.8
1999/00	1.3	5.6	9.5	71.9	11.7	79.4
2000/01	0.9	8.0	29.6	56.9	4.46	76.8
2001/02	0.9	5.5	20.3	54.5	18.8	80.9

Explications: 2 – race walking at speed under 4:05 km.min^{-1} (km), 3 – race walking at speed 4:05–4:39 km.min^{-1} (km) – specific pace at the 20 km, 4 – race walking at speed 4:40–5:22 km.min^{-1} (km) – specific pace at the 50 km, 5 – race walking at speed 5:22–6:22 km.min^{-1} (km), 6 – race walking at speed over 6:22 km.min^{-1} (km), 7 – race walking km from all zones (km), 8 – number of running and race walking km together (km)

High altitude preparation was the most intense in the first year, because from the observed training camps the trainee M. P. absolved the highest volume of kilometers in the highest speed walking zone. The share of walking in the highest speed zone within the total volume of walking was the highest in the training camp in 1999 (Fig. 1, TABLE 2). We explain this by the fact that in 1999 he specialised in walking 20 km and next year (2000) he has begun to specialise in 50 km walking.

The change of specialisation from YTC 1999/2000 in 50 km also caused a change in volume and in the share of absolved walking training indicators.

The camp in the year 2001 was the shortest one, but the most specialised in performance at 50 km. It was characterised by a very low portion in the fastest and the slowest zone. In essence he developed only tempo endurance, a special tempo, and tempo speed (special training zones 5, 4 and 3). Although the camp had the shortest duration, he did the highest number of km at the special rate of 50 km (special training zone 4) of

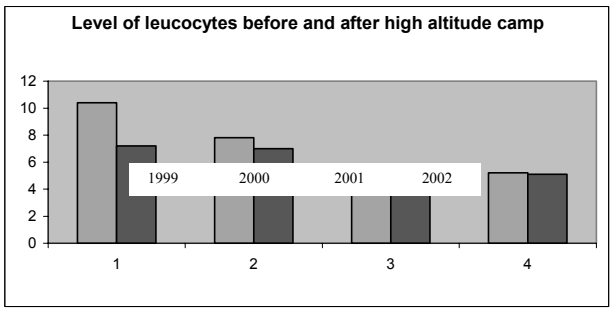
all the analysed camps. During the training camp in the year 2001 he did on average per day the highest number of km – 22.42 km (TABLE 2). This trend has been shown to be right, because M. P. in the season 2001 broke his personal record on 50 km, and also this system of preparation helped him to improve his performance at 20 km. During 3 weeks he improved his personal record at 20 km.

It turned out that an important influence on his growing tendency to improve in both events has been training in the special tempo zone at 50 km. M. P. was able to train in this zone in endurance training sessions at up to 40 km at a significantly stronger load of the circulatory system than in the lowland. M. P. similar to for example, Mráze's, Blažek's and Korčok's records after 3 parts of his high altitude preparation. There was a subjective improvement in his feelings during training sessions in the hypoxic surroundings, and there was also some objective growth in his performance, because in the following season he improved his personal bests in both walking events.

No increase in the intensity in high altitude surroundings was shown for the year 2002. M. P. did, in comparison with the camp a year before, a lower number of km in the special tempo at 50 km (special training zone 4), but also tempo speed (special training zone 3) and tempo endurance (special training zone 5 – Fig. 1, TABLE 2). A high number of km in the slowest zone (STZ-6) was, for a sportsman of top performance, unsuitable. Compared to two previous camps there was also a small decline in the average number of km per day. In that season he fell behind his own personal records in race walking at 50 and 20 km.

The analysed athlete had good proportions of blood components. The value of hematocrit was regularly more than 45%, which is the amount approaching the upper limit of reference values (the reference spread is 39–49%). Also, he was regularly tested on hydration at BODYSTATE, where the water content was at the level of 66%. His reactions to the preparation in the high altitude conditions was very good in all blood components he observed an increase (Fig. 3, TABLE 3). The only component in which he recorded a decrease at all three camps was leucocytes (Fig. 2, TABLE 3), but this phenomenon is not unusual, because in this period (when the organism is in the state of the highest sports performance) the proportion of leucocytes often decreases. It was because of this that the athlete in this period tended to sustain more injuries or diseases, because leucocytes create part of the immune system. This phenomenon also manifested itself at M. P. in the form of little problems with the skeletal and muscular system, and with influenza.

Fig. 2
Comparison of number of leucocytes before and after high altitude camps

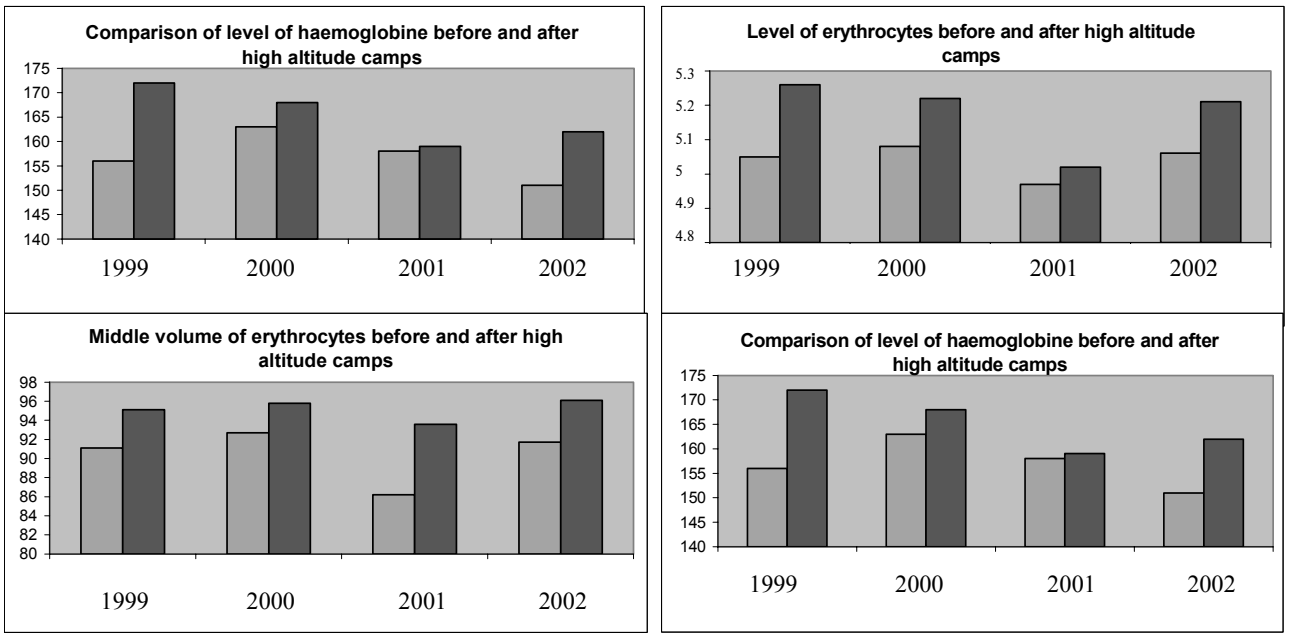


After the first two camps the proportion of hematocrit in his blood was 50%, and also the level of haemoglobin was at 170 $g.l^{-1}$, when haemoglobine too was at a level approximating the upper limit of reference values (140–180 $g.l^{-1}$– TABLE 2). Both these values are at a high level, nearly at the required level, when they approximate the upper limit of reference values, therefore the physiological possibilities of the organism. A conspicuous increase was evident too in the case of the remaining components, except the afore – mentioned leucocytes. The increase of hematocrit was 0.4–4.0%, on average more than 2.5%. The increase of haemoglobin was 1–16 $g.l^{-1}$, on the average 8 $g.l^{-1}$. It has been proven that, during hypoxicy preparation, there is usually a general increase of capacity of blood in the organism. The absolute increase is higher. It also shows an increase of erythrocytes of over 3.1–7.4 $g.l^{-1}$, which is on an average 4.725 $g.l^{-1}$. All these values are at a very good level and approaching the top levels which can be achieved by natural means. As we can see (Fig. 3) before the last high altitude camp (in the year 2002) entry values were lower than in previous years. The reason is that M. P. prepared in Australia (at sea-level), but not in the natural hypoxic surrounding as previously. It showed negatively in the whole structure of the blood from the view of its transport capacity. Also, in this case, after high altitude preparation there was a marked increase in blood components, which shares the transport of O_2 in the organism. Due to these values there is a marked growth in the utilization of oxygen in the organism during sports activity. It results also in an increase in endurance ability. All these facts were shown too on M. P. with regard to the increase of aerobic capacity of the organism, when after middle altitude preparation came an increase of the VO_2max at 11.9 $ml.min^{-1}.kg^{-1}$. After following the high altitude camp for more than 7.3 $ml.min^{-1}.kg^{-1}$. This fact too shows a bilateral linkage between quantitative increase of blood components and the increase of aerobic capacity of the organism. It also manifests iteself in actual sports performance, because a race walker takes a minimum of 90% of his track in the aerobic regime (Brandejský, Kratochvíl, Lapka, & Piták, 2001).

TABLE 3
Results of blood tests before and after high altitude camps

	12.2. 1999/ 17.3. 1999	18.1. 2000/ 3.3. 2000	9.1. 2001/ 14.3. 2001	16.1. 2002/ 11.3. 2002	Reference zones
Haemoglobin- Hmgl ($g.l^{-1}$)	156 / 172	163 / 168	158 / 159	151 / 162	140–180
Hematocrit - Htc (%)	46.0 / 50.0	47.1 / 50.0	45.7 / 46.1	42.8 / 45.6	39–49
Middle volume of erythrocytes - SOEry ($g.l^{-1}$)	91.1 / 95.1	92.7 / 95.8	86.2 / 93.6	91.7 / 96.1	81–100
Erythrocytes - Ery (pl^{-1})	5.05 / 5.26	5.08 / 5.22	4.97 / 5.02	5.06 / 5.21	4.3–5.3
Leukocytes- Leuko (nl^{-1})	10.4 / 7.2	7.8 / 7.0	4.6 / 4.8	5.2 / 5.1	4–9

Fig. 3
Comparison of blood components before and after high altitude camps



CONCLUSION

All high altitude camps were ranked right in the period of special preparation, always after preparation in middle altitude mountains (1000–1300 m above sea-level). A duration of 26–36 days of camps was sufficient. It brought the required effect. The authors claimed that the minimal length of stay in the hypoxic surroundings must be 14–18 days, which was in all cases kept.

The total number of kilometres at the special rate depends on the number of days at high altitude camps. The number of kilometres of race walking and running on average per day was approximately at the same level for all 4 camps. With the growth of age and increasing performance, the total number of km went up from 70% to 80%, which is in accordance with methodological recomendations.

The proportion of individual walking indicators has been changed also in the dependence on change of the specialization with the predominance of tempo rate and special rate, which showed that an important influence on the increasing performance at both tracks was training in the zone of special rate at 50 km.

The reaction of M. P. to high altitude preparation was very good, when in all analysed blood components, except leucocytes, important positive changes were recorded. An absolute increase in blood components was more marked, because under the influence of a hypoxic environment, not only does the capacity of blood components grow, which contributes its share to the transport of the oxygen in the organism (hematocrit, haemoglobin, erythrocytes, a medium amount of erythrocytes), but also there is a general increase in the capacity of the blood in the organism, under the influence of the increase in the capacity of blood plasmas.

The camp in the year 2001 has been considered from the point of view of the training indicators as best done, which reflected directly on the performance of M. P. But the most marked increases were only recorded in the middle erythrocytes and leukocytes. In M. P. we recorded, after the 3rd part of high altitude preparation in the year 2001, a subjective improvement of feelings

during training in the hypoxic surroundings. Generally we valued the influence of hypoxia on the organism of the analysed sportsman as positive.

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TRÉNINK VE VYSOKOHORSKÉM PROSTŘEDÍ A JEHO VLIV NA ZMĚNY VE VYBRANÝCH FYZIOLOGICKÝCH UKAZATELÍCH REPREZENTANTŮ SLOVENSKÉ REPUBLIKY V ZÁVODNÍ CHŮZI

(Souhrn anglického textu)

Příprava ve střední a vysoké nadmořské výšce je dlouhodobou součástí přípravy slovenských reprezentantů v závodní chůzi. Martin Pupiš je jedním z těch atletů, kteří pravidelně využívají tento systém. V tomto příspěvku popisujeme jeho přípravu ve čtyřech vysokohorských kempech v přípravných fázích v letech 1998/1999–2001/2002. Části roku, ve kterých se kempy odehrávaly, byly velmi podobné. Doba trvání byla rovněž stejná od 26 do 36 dnů. Průměrné množství závodní chůze a běhu bylo v rámci jednoho dne přibližně stejné během všech čtyř kempů. Poměr závodní chůze v kilometrech se zvýšil ze 70% na 80%. Podíl oblastí pro chůzi se měnil v závislosti na aktuální specializaci s nejvyšším počtem kilometrů ve vytrvalosti tempa. Reakce na přípravu ve vyšší nadmořské výšce byla velmi dobrá; když jsme analyzovali krevní složky – hematokrit, hemoglobin, erytocyty, střední množství erytocytů – zaznamenali jsme pozitivní změny; pouze u leukocytů nastal pokles.

Klíčová slova: vysokohorské prostředí, příprava ve vysoké nadmořské výšce, závodní chůze, fyziologické ukazatele.

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RESEARCH ON THE EFFECTS OF RESISTANCE TRAINING ON THE SPECIAL STRENGTH OF JUDOISTS

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The physical fitness of athletes holds a significant place in achieving results in competitions in all areas of sport. Apart from the inexhaustible multitude of technical elements that judo possesses, the improvement of physical and functional abilities is a good basis for achieving top results.

It is usual that the condition training of judoists is planned to incorporate three main phases, each of which is characterized by its own special dynamic:

- phase one consists of the work involved in a training program which is aimed at the development of the so-called basic foundations (strength and endurance), which take up a great part of general many-sided training,
- phase two requires a smaller amount of overall work, but a greater intensity of effort, in order to develop the so-called specific competitive foundations of judoists,
- phase three of condition training builds up specific abilities, the competitors' agility as well as motoric and situational motoric skills.

This research has as its aim to show the basic principles of the training process in the preliminary period, the application of the model for the training of the specific strength of judoists and the changes which take place due to the application of this training model, all during the period of time covered by this research. The research included judoists who participate in competitions at the national level. Six tests were used to check the special strength of judoists. The results of the research indicate that during the experimental treatment (the preliminary period), a statistically relevant increase in the special strength of judoists was detected by means of all the tests used for measuring it.

Keywords: Strength exercise, special strength, programme, judo.

INTRODUCTION

In this past decade, a rather swift and intense development in judo was observable. More and more, one could note the appearance of new throwing techniques or their variants with different moves which have been developed by the national teams of the former Soviet Union and of some of the western countries. The introduction of new rules and the change in weight categories, along with the decrease in the duration of the matches, increases the attraction, efficiency and the dynamics of the match. Since that during a match there are constant changes in the dynamic situation, the competitor is required to adapt the technically-tactical stereotypes which he uses, the ability to reorganize these stereotypes at a moment's notice and a continuous creation of new advance, defense and counter-attack programs of action. The fact that the judo match is carried out by means of a direct confrontation of the participants, not to mention the fact that the fight lasts for five minutes, tells us of a great consumption of energy on the part of the contestants in the competition.

It is precisely because of this great consumption of energy that functional abilities have priority in judo. Due to continuous pressure, where we have instances of a shift between the aerobic and anaerobic mechanisms of the body, the judoist subjects himself to a specific training process for the purpose of increasing his functional abilities. The functional abilities of judoists, and especially the aerobic ones, are quite emphasized because of the great energy consumption during a single match, which lasts continuously for five minutes. Judo competitions are mainly held in the form of tournaments and the contestants participate in a greater number of fights during one day (Ćirković, 1991).

Apart from the inexhaustible multitude of technical elements that are found in judo, the improvement of physical and functional abilities is a good basis for achieving top results.

The main goal of any judoist is to gain a good advantage over his/her adversaries during competitions. In order to achieve that, he must first achieve his/her set short-term goals for the ongoing season. The yearly cycle of condition training consists of various tasks performed

over certain periods; it requires a specific, directed development of strength, speed, and endurance and must match the phases and cycles of training.

It is common to plan the condition training of judoists so that it contains three main phases, where each of them is characterized by special dynamics:

- phase one consists of work as part of the training aimed at developing the so-called "basic foundations" (strength and endurance), and which requires a great part of the training sessions;
- phase two requires a lesser overall work load, but a greater intensity, in order to enable the development of the so-called specific competitive foundations of judoists;
- phase three of the condition training builds up specific abilities, competitors' agility and motoric and situational motoric skills.

The programming of a year-long training schedule for judoists depends on how many important competitions will be held during the course of that one year (Ćirković, 1991).

The initial part of each yearly plan will vary based on the individual needs of each contestant, and the circumstances under which it will be carried out.

THE AIM OF THE RESEARCH

In practice, what is meant by the periodization of sports training is the shaping of macro cycles which make up separate time and structure wholes, comprised of MEZO and micro cycles. A single macro cycle, lasting for one or more years, is divided into three periods: the preliminary period, the period of competition and the transition period. They last or replace each other depending on the competition calendar and the quality of the competitors. The division is made in order to facilitate the management of the state that the judoist is in due to his/her training, and the easier control of all the elements which will determine the form of the judoist. Depending on the duration of the season, a periodization consisting of one or two periods could take place, or to be more precise, a periodization consisting of one or two cycles. In the case of high quality competitors, a periodization consisting of two cycles is more characteristic.

The goal of every preliminary period is to satisfy all the requirements that could lead to the achievement of top results during the season, or to the achievement of top form. During this period, many of the basic tasks involved in the development of a high level of functional abilities are carried out, and they in turn ensure a successful completion of the great work load that needs to be carried out during any specific preparations, and the preparations for competition. The preliminary period has three phases made up of the basic, specific and situational preparations, and special attention is paid to the development of all kinds of strength, coordination, functional abilities, and the correction of mistakes in technique and in tactics, the learning of the technically-tactical elements of this theoretical and psychological preparation. The relationship between the basic, specific and situational preparations differs and depends on the quality of the competitor.

This research has as its aim to demonstrate the basic principles of the training process during the preliminary period, the application of the training model for the specific strength of judoists and the changes which take place during the course of the application of this training model during the course of the research.

THE RESEARCH HYPOTHESES

H1 What is expected is that the applied training models for the judoists during the preliminary period will influence the changes made to the special strength of the judoists in a statistically relevant manner.

METHODOLOGY

The sample of examinees

The sample numbered 16 selected judoists, where the basic criteria for making the selection was: that all the examinees were aged between 17 and 20; that they were all members of judo clubs; that they were all participants in competitions for a period no less than 6 and no more than 11 years; that they were all participants in official competitions in the country, while four of them were junior and two of them senior representatives of Serbia and Montenegro; that they all had 8 to 10 training sessions a week during the preliminary period; that the training sessions lasted from 90 to 120 minutes; that they all had a clean bill of health.

The output of variables

An analysis of the form they were in as a result of their training is as necessary and irreplaceable as the training plan and program can only be put together if there is enough relevant data on the morphological, motoric, functional and biomechanical status of the contestants. Only the qualities and skills that have a significant impact in the equation for success specification in judo are tested.

The sample of variables for this research included six motoric variables which measured the strength of individual muscle regions, that is:

- bench press (MSNBE)
- dead lift (MSNBE)
- shoulders (back press) (MSNNA)

- barbell squat (MSNDC)
- pull-ups (MSNZV)
- crunches (MSNPT)

All variables were measured at the beginning and at the end of the preliminary period.

The plan and program for the preliminary period

By analyzing the structural-biomechanical characteristics of judoists, we can see that the structure of the specification equation is not simple and that it contains a great number of anthropological characteristics. Some of them are quite necessary, some less and some more relevant when it comes to achieving top results.

The size of the coefficients for participation of particular characteristics is relative and they can only be discussed hypothetically. On the basis of long-term experience and some findings originating from the research that was carried out up till this point, it seems that the different forms of strength manifestation (explosive, repetitive, static) and of coordination are the most important elements which participate in determining the success in a judo match (Matveev, 1985).

The plan and program used for preparing judoists during the preliminary period had as its aim the improvement of basic skills, special motoric skills, and functional skills.

The special strength training was carried out five times a week and in such a manner that during one training session, as its main segment, exercises involving two to three great muscle regions were performed: bench press, dead lift, rowing, barbell squats, shoulders, pull-ups, crunches along with some support exercises, which were aimed at a smaller group of muscles. The training plan was made up of two phases, both of which lasted for three weeks. During each week, ten training sessions were held, lasting from 60 up to 90 minutes. The main goal of the first phase was the increase of the basic skills of aerobic endurance-training inside a gym or out in the open, and of strength-training in the gym. The second work phase consisted of five training sessions which were aimed at the development of endurance, and another five for the development of the special strength of judoists.

On the basis of the measured results at the initial measuring, a program was put together for each individual contestant. After the completion of the test, an initial status was obtained on the basis of which each examinee was allotted his/her own training programme for the week. Each completed week during the first and

TABLE 1
A weekly exercise schedule

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Gym training	Gym training	Gym training	Break	Gym training	Gym testing for as long as the competitor can endure	Break
Judo techniques or outdoor running	Judo techniques or outdoor running	Judo technique or outdoor running	Break	Judo technique or outdoor running	Judo technique or outdoor running	Break

TABLE 2
Phase one, three weeks

Day of training	Training exercises	t % of max	The number of repetitions	The number of sets
Monday Wednesday	1. main exercise: **bench press** Support exercises: bench press to the side, extensions, barbell upright rows, pull-downs.	55% 65% 75% 85% 65%	6–8 4–6 4 4 (as many times as the competitor can endure)	1 1 1 6 1
	2. main exercise: **dead lift** Support exercise: grip leverage row			
	3. main exercise: **rowing** Support exercise: altering from one side of the hip to another			
Tuesday Friday	1. main exercise: **dead lift** Support exercise: grip leverage row	55% 65% 75% 85% 65%	6–8 4–6 4 4 (as many times as the competitor can endure)	1 1 1 6 1
	2. main exercise: **squat** Support exercises: “front” squat, standing on one’s toes (calves)			
	3. main exercise: **shoulders** Support exercises: 3/4 dead lift, standing barbell curls, winding the barbell.			
Saturday	A testing for all the main exercises	100%		

second phase, actually represented a micro cycle of its own.

During this period, apart from the already mentioned main exercises, the program also included additional support exercises: *bench press to the side, extensions, grip leverage row, altering the barbell from one side of the hip to another, barbell upright row, ¾ dead lifts, pull-downs (triceps), winding the barbell, standing barbell curls, the "front" squat, standing on one's toes (calves).*

The support exercises were performed at 80% of maximum strength, and during the first phase within sets of four, and during the second session within sets of five, where the number of repetitions was no greater than ten and no smaller than six. The crunches exercise and the pull-ups were performed 25 to 35 to a set, or rather, every time until the competitor was worn out.

The training scheme

The main exercises that were included in the training programme:

1. – bench press,
2. – dead lifts,
3. – rowing,
4. – barbell squats,
5. – seated dumbbell press,
6. – pull-ups,
7. – crunches.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

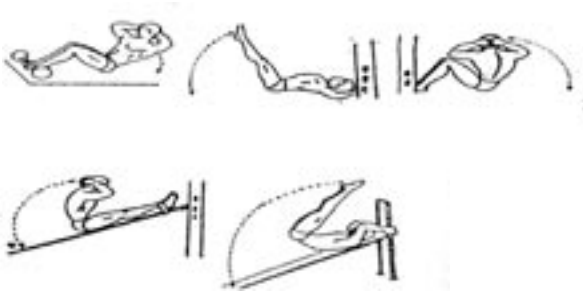

TABLE 3
Phase two, three weeks

Day of training	Training exercises	t % of max	The number of repetitions	The number of sets
Monday Wednesday	1. main exercise: **bench press** Support exercises: bench press to the side, extensions, barbell upright rows, pull-downs	55% 65% 75% 90% 65%	6–8 4–6 4 3 (as many times as the competitor can endure)	1 1 1 6 1
	2. main exercise: **dead lift** Support exercise: grip leverage row			
	3. main exercise: **rowing** Support exercise: alternating from one side of the hip to another			
Tuesday Friday	1. main exercise: **dead lift** Support exercise: grip leverage row	55% 65% 75% 90% 65%	6–8 4–6 4 3 (as many times as the competitor can endure)	1 1 1 6 1
	2. main exercise: **squat** Support exercises: "front" squat, standing on one's toes (calves)			
	3. main exercise: **shoulders** Support exercises: 3/4 dead lift, standing barbell curls, winding the barbell			
Saturday	A testing for all the main exercises	100%		

The methods of data analysis

Due to the outline of the experiment it was necessary to gather the information at both the initial and final measuring. For analyzing the changes that occur in the resulting values of the variables between the initial and final measuring, a t-test for the dependent samples was used, and the relevance of the conclusions was determined at the $p < 0.05$ level.

The following parameters were calculated:

M – means , SD – standard deviation, MIN – minimal results, MAX – maximum results, R – the result span, SKW – skewedness, KURT – kurtozis, r – the connection between the results of the two measuring, p – the relevance of that connection, T – the value of the t-test, and P– the margin of error while rejecting the hypotheses that the difference is not significant.

THE RESULTS OF THE RESEARCH AND THE DISCUSSION

TABLE 4

The basic statistical parameters of the measured variables at the initial measuring

Variables	SV	MIN	MAX	RASP	SD	SKW	KURT
MSNBE	82.18	65.00	110.00	45.00	14.60	.69	-.61
MSNRM	48.12	35.00	60.00	25.00	6.80	-.11	-.55
MSNNA	66.56	45.00	85.00	40.00	10.28	-.11	.21
MSNDC	92.81	75.00	120.00	45.00	15.27	.45	-1.44
MSNZV	14.31	7.00	22.00	15.00	4.70	.18	-1.02
MSNPT	113.81	60.00	200.00	140.00	39.90	1.06	.58

The analysis of the results of the initial measuring indicates that the registered variables for the Bench press (MSNBE) ranged from 65 kg to 110 kg. The mean was 82.18 kg with a standard deviation of 14.60 kg. Distribution-wise the results were spread out and the results are grouped more heavily around the lower values.

In the case of the shoulders (MSNRM) variable, the registered results ranged from 35 kg to 60 kg. The mean of the results was 48.12 kg with a standard deviation of 6.80 kg. Distribution-wise the results were spread out.

Analyzing the Dead lifts (MSNNA) variable, we can note that the registered results range between 45 kg and 85 kg. The means is 66.56 kg with a standard deviation of 10.28 kg. Distribution-wise the results are well placed.

In the case of the barbell squats (MSNDC) variable, the registered results range from 75 kg to 120 kg. The means of the results is 92.81 kg with a standard deviation of 15.27 kg. Most of the results are grouped around the lower values, and the range of the results has conditioned the results' being rather spread out on the graph.

Analyzing the pull-ups (MSNZV) variable, we can note that the registered values range from 7 to 22 pull-ups. The mean of the results is 14.31 pull-ups with a standard deviation of 4.70 pull-ups. The results are spread out equally distribution-wise.

In the case of the crunches (MSNPT) variable, the registered results range from 60 to 200 repetitions. The mean of the results is 113.81 repetitions with a standard deviation of 39.90 repetitions. The results are grouped around the lower values but due to the wide range of the results, the graph is extended, or rather, a smaller number of examinees had results with higher values.

TABLE 5

The basic statistical parameters of the measured variables at the final measuring

Variables	M	MIN	MAX	R	SD	SKW	KURT
MSNBEF	86.25	65.00	110.00	45.00	13.72	.47	-.62
MSNRMF	53.43	45.00	60.00	15.00	4.36	.02	-.55
MSNNAF	72.50	55.00	90.00	35.00	10.80	.29	-.86
MSNDCF	100.31	80.00	140.00	60.00	19.44	.73	-.64
MSNZVF	17.43	8.00	25.00	17.00	5.03	.11	-.56
MANPTF	123.37	71.0	208.00	137.00	39.38	1.11	.52

By analyzing the results at the final measuring we can clearly note that there has been a numerical increase in the values of all the measured variables. By analyzing the individual results we come to the following conclusions:

- The registered values of the results of the bench press test range from 65 kg to 110 kg. The means was 86.25 kg with a standard deviation of 13.72 kg. The distribution of the results showed that the results were well grouped around the means, but that a smaller number of examinees had significantly higher result values, which led to a greater result range.
- In the shoulders test, the registered values of the results ranged from 45 kg to 60 kg. The means was 53.43 kg with a standard deviation of 4.36 kg. Distribution-wise the results are spread out and they are evenly grouped around the means.
- The registered values of the dead lift test range from 55 kg to 70 kg. The means was 72.50 kg with a standard deviation of 10.80 kg. Distribution-wise the results are spread out and only a small number of examinees had low result values.
- In the case of the barbell squats variable, the registered values range from 80 kg to 140 kg. The range of the results is rather wide. The means was 100.31 kg with a standard deviation of 19.44 kg. Distribution-wise the results were spread out and more heavily grouped around the lower values.
- The registered values for the pull-ups variable range from 8 pull-ups to 25 pull-ups. The means was 17.43 pull-ups with a standard deviation of 5.03 pull-ups. The results are well grouped around the means and a small number of examinees had significantly larger result values compared to the means.

- In the case of the crunches variable, the registered results range from 71 repetitions to 208 repetitions. The mean was 123.37 repetitions with a standard deviation of 39.38 repetitions. The range of the results was very wide as a small number of examinees had extremely high result values. The rest of the results were well grouped around the means.

What is interesting is that in the case of all the measured variables at the initial and final measuring, a wide range of results was detected. The reason should be looked for in the different weight categories of the contestants, which ranged from 60 kg to 81 kg.

The quantitative aspect of the changes is determined by the testing of any significant differences between the results that were obtained at the initial measuring and at the final measuring. An analysis of the significance of the differences was done at the univariate level by means of the T-test.

In the following table we can find the means (SV), the standard deviation (SD), the connection between the results of the two measurings (R_{12}), the significance of that connection (Pr), the value of the T-test (T) and the margin of error for rejecting the hypothesis in view of the fact that the difference is not relevant (P).

The obtained results indicate that during the research period, statistically relevant improvements occurred in the measured results. The obtained values for the correlation between the first and second measurings are very high and range from 84 to 99. This fact indicates that during the research period, even and steady changes took place in all the examinees.

The values of the results, in all the tests of strength, were significantly increased during the preliminary period. The growth tendency of the results is such that we cannot determine whether the examinees made good use of the preliminary period and in that way made it possible for themselves to enhance their abilities and scopes.

TABLE 6
The differences between the initial and final measuring

Variables	M	SD	r	p	T	P
MSNBE	82.18	14.60				
MSNBEF	86.25	13.72	.97	.00	-4.96	.00
MANRM	48.12	6.80				
MSNRMF	53.43	4.36	.84	.00	-5.50	.00
MSNNA	66.56	10.28				
MSNNAF	72.50	10.80	.93	.00	-6.33	.00
MSNDC	92.81	15.27				
MSNDCF	100.31	19.44	.96	.00	-4.95	.00
MSNZV	14.31	4.70				
MSNZVF	17.43	5.03	.97	.00	-11.49	.00
MSNPT	113.81	39.90				
MSNPTF	123.37	39.38	.99	.00	-8.52	.00

CONCLUSION

Apart from the inexhaustible multitude of technical elements to be found in judo, the improvement in physical and functional abilities represents a good basis for achieving top results.

It is considered that what is of the greatest significant for a sports match are the various forms which are among the manifestations of strength (explosive, repetitive, static), coordination, speed, balance and flexibility. It should also not be forgotten that a top judoist is characterized by highly developed functional skills of the aerobic and anaerobic type.

Following the general principles for applying the method for the development of special strength of judoists, individual plans for each of the judoists were made.

It has been experimentally proven that a six-week training model designed for the special strength of judoists has an effect on the statistically relevant increase in the special strength of judoists. In this way, the proposed hypothesis has been validated.

We can conclude that without the development of optimal conditioning or physical fitness, it is not possible to achieve any number of results either on the national or international level.

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VÝZKUM ÚČINKU SILOVÉHO TRÉNINKU NA SPECIÁLNÍ SÍLU JUDISTŮ

(Souhrn anglického textu)

Tělesná kondice sportovců zaujímá významné místo v dosahování výsledků při závodech ve všech sportovních oblastech. Bez ohledu na nevyčerpatelné množství technických prvků, které judo obsahuje, zdokonalení fyzických a funkčních schopností je dobrý základ pro dosažení nejvyšších výsledků. Je obvyklé, že kondiční trénink judistů je plánován tak, aby zahrnoval tři hlavní fáze, přičemž každá z nich je charakterizována svou vlastní speciální dynamikou:

- fáze 1: skládá se z práce zahrnuté v tréninkovém programu, jehož cílem je rozvoj tzv. hlavních základů (síla a vytrvalost), což zabere velkou část celkového všestranného tréninku;
- fáze 2: vyžaduje menší množství celkové práce, ale větší intenzitu námahy, aby se rozvinuly tzv. specifické soutěživé základy judistů;
- fáze 3: kondiční příprava vytváří specifické schopnosti, hbitost, motorické a situačně-motorické dovednosti závodníka.

Cílem tohoto výzkumu je ukázat základní principy tréninkového procesu v přípravném období, aplikaci tohoto modelu v tréninku zaměřeném na specifickou sílu judistů a změny, které nastávají díky aplikaci tohoto tréninkového modelu; během celého období probíhal výzkum. Tento výzkum zahrnoval judisty, kteří se účastnili soutěží na národní úrovni. K ověření speciální síly judistů bylo použito šest testů. Výsledky výzkumu ukazují, že během experimentálního zpracování (přípravné období) bylo určeno statisticky významné zvýšení speciální síly judistů, a to prostřednictvím všech testů, kterých bylo pro měření použito.

Klíčová slova: silová cvičení, speciální síla, program, judo.

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PHYSICAL ACTIVITY OF YOUTH: EVALUATION GUIDELINES FROM THE VIEWPOINT OF HEALTH SUPPORT

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The main goal of this study is to develop guidelines for physical activity (PA hereafter) evaluation from the viewpoint of health support in Czech youth, based on 6 years of monitoring of PA with accelerometers and pedometers. For the guidelines proposal we used data from weekly triangular monitoring of PA (accelerometer Caltrac × pedometer Omron × individual logs = energy expenditure × steps × FITT characteristics of PA) in 1504 females and 1163 males aged 6 to 23. We expressed the guidelines by the means of relative values of active energy expenditure ($kcal \cdot kg^{-1} \cdot day^{-1}$) which enabled us to compare somatic different groups of females and males of different ages. Data analysis shows significant correlation ($r_S = .56 - .75$) between the active energy expenditure from Caltrac ($kcal \cdot kg^{-1} \cdot day^{-1}$) and the steps from Omron ($number \cdot day^{-1}$) in both working and weekend days. The developed guidelines can help to evaluate the level of PA and to create effective interventional PA programs. To express the guidelines in a daily number of steps seems to be a good step towards their larger and more popular use.

Keywords: Energy expenditure, accelerometer Caltrac, steps, pedometer Omron, age, gender.

INTRODUCTION

During recent decades we have been able to observe a dramatic decrease in physical activity (PA hereafter) in children and youth, an increase in their physical inactivity and health related complications as indicated by the rising incidence of children's obesity (Bradley, McMurray, Harrell, & Deng, 2000; Colditz, 1999; Dowda, Ainsworth, Addy, Saunders, & Rinner, 2001; Goran, Reynolds, & Lindquist, 1999; U. S. Department of Health and Human Services, 2000). This unsatisfying development of the present life style of the children and youth population forces many medical, behavioral and other groups of specialists to search for new ways to effectively increase PA in children and youth and to create their healthy relationship to everyday and lifelong performance of PA. Searching for and creating effective ways of increasing PA is based on thorough analysis of present PA, physical inactivity, dietetic behavior and life style. We fall back on recommendations for carrying out PA in view of health support as presented by (Blair et al., 1995; Corbin, Pangrazi, & Welk, 1994; Killoran, Fentem, & Carpensen, 1994; Sallis & Patrick, 1994; Pate et al., 1995; U. S. Department of Health and Human Services, 1996, 2000).

The main goal of this study is to develop guidelines for PA evaluation from the viewpoint of health support in Czech youth, based on 6 years of monitoring of physical activity using accelerometers and pedometers. The design of PA guidelines for health support was preceded by analysis of foreign PA guidelines for adults, youth, and their description, including advantages and hitches of field monitoring methodology and PA evaluation.

INTERNATIONAL PA GUIDELINES FOR HEALTH SUPPORT – ADULTS

In 1990, a marked change arose in designing these guidelines. Emphasis was placed on PA related to state of health and health in general, not only on fitness and physical performance as we have found in most previous studies (Sallis & Owen, 1999). For that reason, emphasis is placed on moderate PA (4–6 METs) (Corbin & Pangrazi, 1996), which also contributes to the reduction of risk factors for some chronic diseases and is closer to the broad nonsporting population. TABLE 1 shows an overview of chosen surveys dealing with designing PA guidelines for health support in adults.

Although the cited survey and many other surveys refer to and put emphasis on the connection between PA (represented by an optimal combination of duration, intensity, frequency and type of PA) and health and longevity, this relationship is not very often expressed by the value of energy expenditure.

On the base of numerous epidemiological studies using also monitoring by accelerometers Caltrac, Sallis and Owen (1999, 65) conclude that an increase of energy expenditure "...of about 150 kcals per day, or 1000 kcals per week, over the sedentary levels, was

TABLE 1
Physical activity guidelines for health support for adults

Author	Recommendations
• Hatano (1993)	• To carry out daily 10000 steps, which equals energy expenditure of 300–400 kcal·day^{-1}, creates conditions for maintaining health.
• Corbin, Pangrazi, & Welk (1994)	• People who are not involved in PA have higher risk of diseases and death than people regularly involved in PA. The mean daily energy expenditure of 3–4 kcal·kg^{-1} (30 minutes of PA equal to brisk walking) is related to the biggest decrease of the risk. Further decrease of the risk is related to increasing amount of carried out PA.
• Killoran, Fentem, & Carpensen (1994)	• For 10% reduction of weight in men and women aged 16 to 74 it is necessary to, regularly and for the long-term, carry out moderate PA for at least 30 minutes a week, preferably in a single lesson of 30 minutes of continuous exercising or in two lessons of a minimum of 15 minutes of exercising. • For 15% improvement of the body constitution of women and men aged 16 to 74 it is necessary to, for the long-term, carry out continuous, at least moderate, PA for 30 minutes, at least five times a week, preferably in a single lesson of 30 minutes of continuous exercising or in two lessons of a a minimum of 15 minutes of exercising. • For further improvement of the body constitution of women and men aged 16 to 74, long-term carrying out of vigorous PA, on average for 20 minutes three times a week is necessary.
• ACSM (1995)	• For health support in adults it is suitable to carry out PA three to five times a week, continuously for 20 to 60 minutes, at an intensity range of 50–85% of individual maximum.
• Blair et al. (1995)	• Adults should strive after a gradual increasing of habitual PA to meet the goal of daily carrying out moderate PA (brisk walking, going up or downstairs, etc.) for 30 minutes.
• Pate et al. (1995)	• Every adult American should carry out continuous moderate PA for 30 minutes, preferably every day. • Daily energy expenditure should come to 500 kcal at least.
• U. S. Department of Health and • Human Services (1996)	• A significant health benefit can be reached already by a mean amount of PA (30 minutes of brisk walking or raking, 15 minutes of running or 45 minutes of playing volleyball) carried out on most weekdays. • A further health contribution can be reached by carrying out a greater amount of PA. People keeping up a suitable PA routine (long-lasting or more intensive PA) also acquire a higher health benefit.
• U. S. Department of Health and Human Services (2000)	• Increase the proportion of adults who engage regularly, preferably daily, in moderate PA for at least 30 minutes per day. • Increase the proportion of adults who engage in vigorous PA that promotes the development and maintenance of cardiorespiratory fitness 3 or more days per week for 20 or more minutes per occasion. • Increase the proportion of adults who perform PA that enhances and maintains muscular strength and endurance and flexibility. • Increase the proportion of trips made by walking and cycling.

sufficient to improve health... The guiding principle is to do 150 kcals of physical activity every day, and activities can vary from day to day". Máček and Máčková (1999) lean towards more strict criteria for carrying out PA – intensity of 4.5 METs and energy expenditure of 1500 to 2000 kcal per week during brisk walking (that means 24–32 km), after a period of adaptation to reach an intensity of 9 METs and an energy expenditure of more than 2000 kcal. The figure of 6000 kJ per week is the minimum amount of PA recommended by Bunc (1999) for stabilization or minor increase of the fitness of Czech adults. According to him, a significant increase in fitness is noticeable in PA with an energy expenditure of 10000 kJ·week^{-1} and a minimum duration of 5 months. According to ACSM (1995) recommendations Cordian, Gotshall, Eaton and Eaton, III. (1998) calculated, that for a typical clerk, 11 kcal·kg^{-1}·day^{-1} is the minimum value of PA energy expenditure sufficient for keeping health intact. As an optimum for health benefit, they, however, present the value of 90 kcal·kg^{-1}·week^{-1}, that approximately means 12.86 kcal·kg^{-1}·day^{-1}.

TABLE 2
Physical activity guidelines for health support for children and youth

Author	Recommendations
• Corbin, Pangrazi, & Welk (1994)	• Children – daily 60 minutes of PA = energy expenditure of 6–8 kcal·kg^{-1}.
• Sallis & Patrick (1994)	• Adolescents aged 11 to 21 should be physically active every day or nearly every day. • Adolescents should carry out moderate or vigorous PA for 20 or more minutes three or more times per week.
• American College of Sports Medicine (1995)	• Children should be generally more physically active than adults and keep up an adequate level of fitness. • Healthy children should be, considering their accelerated psychosomatic evolution, lead to and involved in adequate PA.
• Pangrazi, Corbin, & Welk (1996)	• Vigorous PA is not recommended for children. • Moderate PA for 30 to 60 minutes per day is suitable. • Of the 30 to 60 minutes of daily PA, at least 20 minutes three times a week should be carried out continuously. • Children should carry out a greater volume of PA, but only moderate PA. Such PA can be carried out in the course of everyday playing. • To place emphasis on the convenience of usual acts of motion (walking to school, household work). • Children may acquire and develop skills and knowledge which lead towards an active life style. • Step by step children shall manage individualization of the level of carried out PA: duration, intensity and type.
• Biddle, Sallis, & Cavill (1998)	• All young people should daily carry out, at least, moderate PA for 60 minutes. • Young people, usually and regularly carrying out undemanding activity, should daily carry out, at least, moderate PA for 90 minutes. • At least twice a week, PA should be performed which leads to the enhancement and maintainence of muscular strength, flexibility and bone health.
• U. S. Department of Health and Human Services (2000)	• Increase the proportion of adolescents who engage in moderate PA for at least 30 minutes on 5 or more of the previous 7 days. • Increase the proportion of adolescents who engage in vigorous PA that promotes cardiorespiratory fitness 3 or more days per week for 20 or more minutes per occasion. • Increase the proportion of adolescents who participate in daily school physical education. • Increase the proportion of adolescents who spend at least 50% of school physical education class time being physically active. • Increase the proportion of adolescents who view television for 2 or fewer hours on a school day. • Increase the proportion of trips made by walking and cycling.
• President's Council on Physical Fitness and Sports (2001)	• For health support of children, it is recommended to reach a daily number of 11000 steps, at least five days a week.

INTERNATIONAL PA GUIDELINES FOR HEALTH SUPPORT – YOUTH

Orientation to PA in childhood and adolescence is a key factor in the prediction of active physical behavior in adulthood. A positive relationship between performing PA in childhood and in the future closely following thereafter was positively proved in both shorter (3 to 5 years) and longer (more than 10 years) intervals (Barnekow-Bergkvist, Hedberg, Janlert, & Jansson, 1996; Kraut, Melamed, Gofer, & Froom, 2003; Pate, Baranowski, Dowda, & Trost, 1996; Pate et al., 1999; Telama, Yang, Laakso, & Viikari, 1997). According to Kraut et al. (2003), the predictive relationship between attending organized PA in one's school period and PA in adulthood is invariable in different groups from the standpoint of age, body mass index, family status, change of occupation and faith. Similarly to the previous authors, Corbin (2002), Daley (2002) and Stone, McKenzie, Welk and Booth (1998) found, that PA of moderate and vigorous intensity carried out in school physical education positively influences PA in adulthood. In general, we can state, that physically active children will become physically active adults.

PA guidelines for health support in youth were, at first, inferred from the criteria for adults, for the reason that there were no distinguished studies on solving this problems in youth. Therefore, the criteria for minimal or optimal PA were, at first, very similar to the recommendations for adults (Sallis & Patrick, 1994). Lately, however, there are marked changes in requirements for PA in youth (TABLE 2) considering their worsening health state and accelerated psychosomatic development (American College of Sports Medicine, 1995).

These changes are supported by recommendations by Biddle, Sallis and Cavill (1998), who, unlike the criteria of the early 90's, put emphasis on repeated performing of PA to enhance and maintain muscular strength, and flexibility and bone health. Also recommendations for vigorous PA in youth are very simplified, in case duration and type of PA is not respected.

METHODOLOGY OF FIELD MONITORING AND EVALUATION OF PHYSICAL ACTIVITY

One week monitoring or retroactive monitoring of PA is a present day trend in the objective investigation of the level of PA in youth and adults (Craig et al., 2003; Trost et al., 2002; Washburn, Jacobsen, Sonko, Hill, & Donnelly, 2003) considering the possibility of comparing working and weekend days (Gavarry, Giacomoni, Bernard, Seymat, & Falgairette, 2003; Trost, Pate, Freedson, Sallis, & Taylor, 2000). In view of strongly lower PA on weekend days than on working days (Gavarry, Giacomoni, Bernard, Seymat, & Falgairette, 2003; Goran, Reynolds, & Lindquist, 1999; Hovell, Sallis, Kolody, & McKenzie, 1999), this kind of comparison becomes more and more topical and relevant.

We used evaluation of PA based on seven day long continual field monitoring of PA using the accelerometer Caltrac, pedometer Omron and individual logs (Frömel, Novosad, & Svozil, 1999; Sigmund, 2000). Using an appropriate triangulation mechanism (accelerometer Caltrac × pedometer Omron × individual logs = energy expenditure × steps × FITT characteristics of PA) we eliminated wrong or skewed data and enhanced the plausibility of the obtained results. Although, among these three techniques of monitoring PA, the individual log is most affected by the "subjectivity" of the proband (veracity, thoroughness), we use the duration and intensity of PA for correction of active energy expenditure from Caltrac according to Compendium of PA (Ainsworth et al., 1993, 2000), above all in such types of PA (static strengthening, swimming, skiing, skating, cycling and the like), which can not be accurately measured by accelerometer. Compendia of PA (Ainsworth et al., 1993, 2000) are, according to Harrell et al. (2005), more accurate for assessing energy expenditure in youth aged 8 to 18 than in adults.

For the guidelines proposal we used data from weekly triangular monitoring of PA (accelerometer Caltrac × pedometer Omron × individual logs = energy expenditure × steps × FITT characteristics of PA) in 1504 females and 1163 males aged 6 to 23.

Every participant got the information about manipulation with the accelerometer Caltrac (the pedometer Omron respectively) and filling in the individual log. The accelerometer Caltrac (the pedometer Omron respectively) was set on individual values (body height and weight, calendar age and gender; length of step and body weight respectively) to assess energy expenditure during PA (active energy expenditure) in kilocalories (number of steps respectively). All participants wore Caltrac and Omron continuously for one week except while sleeping, bathing, showering and swimming. Precise and tight-fitting placement on the right (left respectively) hip was provided by an elastic belt with a pocket for Caltrac, Omron, pencil and individual log.

Every morning after waking up and every evening before going to bed, participants recorded the time and values of energy expenditure (total and active energy expenditure) from Caltrac and the number of steps from Omron into their individual log. On working days of the school week, they also recorded energy expenditure and number of steps at the beginning of schooling, at the beginning and end of physical education lesson and at the end of schooling. In case of taking part in a training or exercise lesson they, as well, recorded time, energy expenditure and number of steps at its beginning and end. Every evening before going to bed, participants wrote down into their individual logs type, duration, and intensity (moderate or vigorous) of everyday PA and duration and type of physical inactivity.

For increasing the exactness of field monitoring of PA, it is recommended to use a combination of different approaches and techniques (Baranowski & de Moor, 2000), such as accelerometer + questionnaire, multifunctional kinetic sensors, dual heart rate sensors and kinetic sensors, direct observation + accelerometer or pedometer, self-evaluation techniques + direct observation and heart rate sensors or accelerometer (Baranowski & de Moor, 2000; Bassett, 2000; Lamonte & Ainsworth, 2001; Stone, McKenzie, Welk, & Booth, 1998). Although the sensitivity of accelerometers is lower for monitoring of static activities, cycling, skiing, wrestling and other activities, they provide a valid measurement of active energy expenditure and can be used to differentiate sedentary activities and PA of low, moderate and vigorous intensity (Puyau et al., 2004), by means of all day, all week or long term monitoring (Freedson & Miller, 2000; Janz, Witt, & Mahoney, 1995;

Trost, Pate, Freedson, Sallis, & Taylor, 2000; Welk, Corbin, & Dale, 2000; Westerterp, 1999).

The active energy expenditure from Caltrac represents the value of energy expenditure by PA that means the total energy expenditure minus the basal metabolism, which was individually settled according to age, gender, body height and weight (Puyau et al., 2004). It is recommended to express the active energy expenditure in relative value ($kcal \cdot kg^{-1} \cdot day^{-1}$) for comparison between somaticly different groups of boys and girls of different age categories (Puyau et al., 2004). Most validation studies in youth have used the accelerometer Caltrac solely as an activity monitor with energy expenditure given in "activity counts". However, valid caloric expenditure values obtained from the accelerometer Caltrac could provide a more meaningful estimation of PA patterns in children than activity counts alone (Bray, Morrow, Pivarnik, & Bricker, 1992).

In recent years, field monitoring of PA by pedometers has become more and more popular (Crouter, Schneider, Karabulut, & Bassett, 2003; Le Masurier, Lee, & Tudor-Locke, 2004; Ozdoba, Corbin, & Le Masurier, 2004; Schneider, Crouter, & Bassett, 2004; Tudor-Locke et al., 2004; Vincent & Pangrazi, 2002). The increasing popularity of pedometers is supported not only by improving their measure of precision in comparison to the past (Bassett, Ainsworth, Leggett, Mathien, Main, Hunter, & Duncan, 1996; Montoye, Saris, Kemper, & Washburn, 1996), but also by the fact, that walking is the dominant everyday PA of youth (Bassett, Cureton, & Ainsworth, 2000; Frömel, Novosad, & Svozil, 1999; Leslie, Fotheringham, Owen, & Bauman, 2001; Sigmund, 2000; Tudor-Locke & Myers, 2001). The mechanism of the pedometer is a spring-suspended horizontal lever arm responding to vertical moves of the centre of gravity. The lever arm opens and closes an electric circuit with each step (Bassett, 2000). Steps and hops are recorded and shown on the display of the device. In the past, pedometers were very inaccurate and therefore were not widely used in research, but, thanks to new technological advances, the present types of pedometers have a sufficient degree of validity and reliability (Bassett et al., 1996). After setting up (for length of step, body weight, age and gender respectively), pedometers can be used not only for counting steps, but also for the assessment of traveled distance and active energy expenditure. Recount to other units can cause a decreasing exactness of their measurement. Pedometers are most accurate for assessing steps, while less accurate for assessing traveled distance and even less accurate for assessing active energy expenditure (Bassett et al., 1996; Crouter, Schneider, Karabulut, & Bassett, 2003; Hendelman et al., 2000; Welk, Corbin, & Dale, 2000). Based on this finding Rowlands, Eston and Ingledew (1999) and Tudor-Locke and Myers (2000) recommend accepting a number of steps per time unit for a standard unit of assessing, judging and interpreting data.

Although to express the amount of PA for health support in a daily number of steps is not so frequent as the duration of PA or active energy expenditure, it is clearly popular for a wide range of people – from children up to elderly individuals. A daily walking minimum of 10000 steps is considered to be a "universal" standard for health support (Hatano, 1993; Yamanochi et al., 1995). According to Le Masurier, Sidman and Corbin (2003) and Tudor-Locke (2002), this standard is not based on an adequate empirical base. The number of 10000 steps a day is practically attainable for healthy adults, but unattainable for, particularly, older and ill people and too low for youth (Le Masurier, Sidman, & Corbin, 2003; Tudor-Locke, 2002; Welk, Corbin, & Dale, 2000). According to Hatano (1993), the number of 10000 steps is equal to an energy expenditure of about 300–400 $kcal \cdot day^{-1}$, which more than doubly exceeds the recommended health benefit level of 150 $kcal \cdot day^{-1}$ (Sallis & Owen, 1999; U. S. Department of Health and Human Services, 1996). For health support in children, the President's Council on Physical Fitness and Sports (2001) recommends reaching the daily number of 11000 steps, at least five days a week. Tudor-Locke (2002) found that people carrying out daily more than 9000 steps have more often normal body weight, while the number of 5000 and less steps is closely related to obesity. Leermakers, Dunn and Blair (2000) assert that reaching at least 15000 steps a day is necessary for reducing body weight.

EVALUATION GUIDELINES OF THE PHYSICAL ACTIVITY OF YOUTH FROM THE VIEWPOINT OF HEALTH SUPPORT

Based on six years of monitoring of PA by accelerometers and pedometers, we suggest the following evaluation guidelines for the PA level of Czech youth from the standpoint of health support, derived from active energy expenditure (Fig. 1) and daily number of steps (Fig. 2).

For the guidelines proposal we used data from a one week monitoring of habitual PA in 1504 females and 1163 males aged 6 to 23. Habitual weekly PA is considered as commonly organized and performed PA, including that done in leisure time, in one habitual week. The dates of monitoring were chosen in agreement with a common (habitual) week (weeks without festivals, holidays, school trips, all-day sport competitions and tournaments, weeks without stress at school, e. g. before final marking, etc.). Only the data of individuals, who completed the whole continual seven days monitoring and did not fall ill, were included in the analysis. Data

Fig. 1
Classification of active energy expenditure (kcal·kg^{-1}·day^{-1}) from the accelerometer Caltrac from the viewpoint of health support

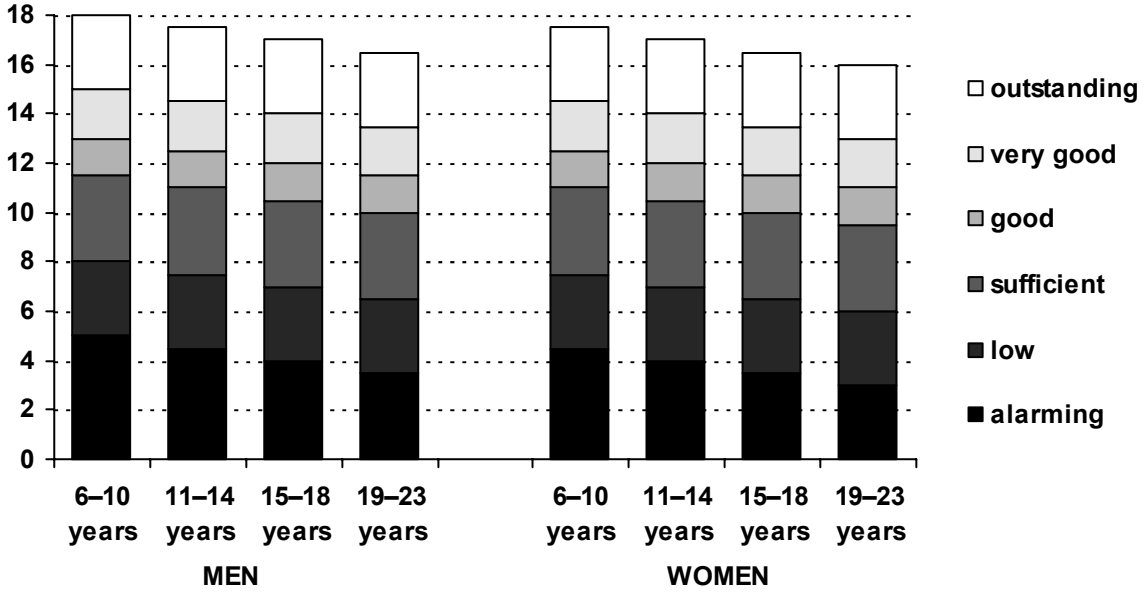
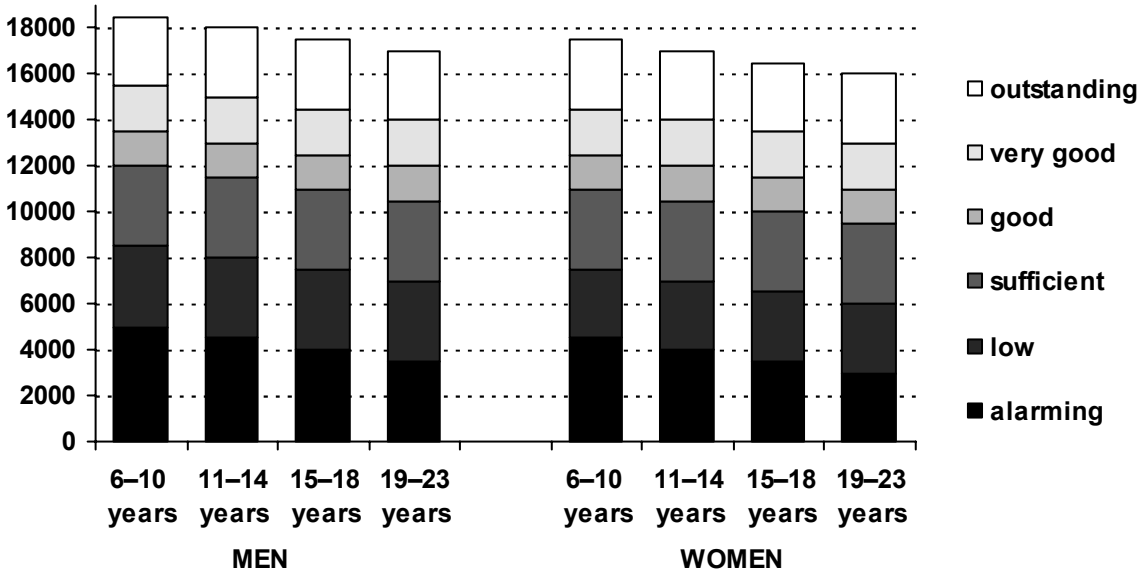


Fig. 2
Classification of number of steps (number·per day^{-1}) from the pedometer Omron from the viewpoint of health support



from monitoring "extreme" PA (sport summer camps and workshops, skiing courses, weeks for youth from special sports classes in different periods of conditioning, weeks of Christmas, spring and summer holidays) provided support for the suggestion of PA guidelines according to health benefits.

Selecting of the number of classification levels was done with regard to frequency histograms and with the necessity of avoiding inaccurate three levels of sorting (under average, average, above average). As an "alarming" level of PA (< 5 kcal·kg^{-1}·day^{-1}) we understand, in accordance with our methods, to be a whole day's stay at home. This activity is characterized by walking between the refrigerator, TV, toilet, bathroom and bed. A "low" level of PA category presents an increase in the performance of household chores (cooking, sweeping, gardening, cleaning, and watering) or walking to and from school (employment) in comparison to the "alarm-

ing" level. A "sufficient" level of PA includes more walking (> 45 minutes) or jogging, cycling or sport activity (basketball, volleyball, football, floorball, etc.) for more than 20 minutes at a time. Partial experiments show positive correlations between active energy expenditure in habitual and "extreme" PA and fitness level (r_S = = 0.32–0.68) in females and males as a "very good" or "outstanding" level of PA. Physiotherapeutic exams done in age groups 12–14 and 19–23 uncovered most inaccurate physical activity stereotypes and dysbalances in females and males at the level of "alarming" and at a "low" level of PA.

Even though each of the used instruments (Caltrac × Omron = active energy expenditure × steps) rate a different aspect of PA, a more complex view of the described PA can be obtained by their combination. The rightness of a more complex view of the described PA and proposal for PA guidelines according to health benefits are supported by high correlation coefficients (r_S = .56 – .75) between active energy expenditure from Caltrac ($kcal \cdot kg^{-1} \cdot day^{-1}$) and the daily number of steps from Omron.

With regard to significant correlations we express indicators of PA level for health support at the end of day amount of steps (Fig. 1). This expression allows for the lay public's general health orientation at the level of performed PA. A whole day's stay at home where the only activity is walking between the refrigerator, TV, toilet, bathroom and bed is characterized with less than 5000 steps. A daily amount of steps less than 8000 includes a stay at home with household chores or walking to and from school (employment). Vigorous training, such as soccer or a floorball match in the gym with an average game time of 60–75 minutes represents 8000–10000 steps.

CONCLUSION

The suggested evaluation guidelines of PA level, with a respect to gender and age, shall not be considered to be definitive and dogmatic. Time, socio-cultural, politic, economic, environmental and other factors will always determine their definition. The level of PA carried out must be evaluated individually with an account of the FITT characteristics (frequency, intensity, type and duration) of PA, the current state of health, weekly routine (school × holiday), days in the week (working or school × weekend or out of school), season, weather and the like. Expressing the guidelines for PA evaluation from the viewpoint of health support by the means of relative values of active energy expenditure ($kcal \cdot kg^{-1} \cdot day^{-1}$) enables us to compare somatic different groups of females and males of different age. The developed guidelines can help to evaluate the level of PA and to create effective interventional PA programs. The expression of the guidelines in a daily number of steps seems to be a good step towards their larger and more popular use.

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POHYBOVÁ AKTIVITA DĚTÍ A MLÁDEŽE: UKAZATELE K HODNOCENÍ Z HLEDISKA PODPORY ZDRAVÍ

(Souhrn anglického textu)

Hlavním cílem této studie je na základě 6letého monitorování pohybové aktivity (dále PA) pomocí akcelerometrů a pedometrů stanovit ukazatele k hodnocení úrovně PA z hlediska podpory zdraví u českých dětí a mládeže. Pro návrh kritérií byla použita data z triangulačního týdenního monitorování PA (akcelerometr Caltrac × pedometr Omron × individuální záznam = energetický výdej × kroky × FITT charakteristiky PA) od 1504 děvčat a 1163 chlapců ve věku 6–23 let. Vyjádření ukazatelů k hodnocení PA z hlediska podpory zdraví pomocí relativních hodnot aktivního energetického výdeje (kcal·kg^{-1}·den^{-1}) umožňují srovnávat somaticky odlišné skupin děvčat a chlapců v různých věkových kategoriích. Při analýze dat zjišťujeme v pracovních i víkendových dnech výrazné korelační závislosti (r_S = 0,56–0,75) mezi aktivním energetickým výdejem z Caltracu (kcal·kg^{-1}·den^{-1}) a denním počtem kroků z Omronu. Stanovené ukazatele mohou přispět k posuzování stávající úrovně PA a k tvorbě efektivních intervenčních pohybových programů. Příslibem širšího, „populárnějšího“ využití navržených ukazatelů je jejich vyjádření prostřednictvím denního počtu kroků.

Klíčová slova: energetický výdej, akcelerometr Caltrac, kroky, pedometr Omron, věk, pohlaví.

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First-line publications

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ANALYSIS OF MORPHOLOGY OF FOOT IN MORAVIAN MALE AND FEMALE STUDENTS IN THE AGE INFANS 2 AND JUVENIS

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Morphological foot type, foot index for longitudinal foot vault, misalignment of the big and little toes, heel angle and lower limb muscles condition were monitored in 106 male students and 162 female students from the Gymnasium school in Šternberk and the Integrated secondary school in Ostrava ranging in age from 12 to 18 years. A considerably higher frequency of Egyptian foot incidence was noted in both girls and boys (71.69% and 70.99% respectively). The quadratic foot was found in boys in a very small percentage (2.83%) with particular individual asymmetry; it was not discovered in girls. Flatfoot diagnosis by means of the Chippaux–Šmiřák method provided very favourable results (4.94–10.38% flatfoot occurrence). On the other hand, results using the Szriter–Godunov method were considerably worse (38.27–43.21% flatfoot occurrence). Zero condition misalignment of the big toe was encountered in less than a quarter of the files. The frequency of valgose and varose manifestations being almost equal in boys; the right big toe varose position was the dominant feature. As for the girls, the valgose position was dominant. The average values ranged from 4 to 7 degrees. The average little toe angle value characteristic for a valgose little toe was high. (17.73–21.90 degrees). The average heel angle was diagnosed in the range of 15 to 18 degrees. When evaluating relations of the lower limb muscle shortening and conditional foot vault functional disorders (only in men) we found statistically significant relation between heel misalignment and m. triceps surae sin. shortening, and between the heel angle and knee flexors sin. shortening.

Keywords: Morphological foot type, foot index, misalignment of the big toe and little toe, heel angle, muscle dysbalances.

INTRODUCTION

Several independent scholarly works comprehensively validate the evolutionary development of the human foot into a supportive structure in habitual bipeds. The regression of loose skeletal elements and the enlargement of stable elements of the foot facilitated the change of this part of the limb into a supportive structure. The concurrent development of the longitudinal and transverse foot vaults and the strong ligamentary apparatus enables distribution of load on the individual parts of the foot. The further loss of mobility of the big toe to account for perfect shift of body weight represents as a typical feature of the human foot.

The longitudinal vault is formed by the tarsal and the tarsometarsal joints; it is primarily held in place by a system comprising of ligaments and aponeuroses. The big toe is situated on the axis of the foot and it moves almost entirely vertically, the lateral movement being very limited. The talus and calcaneus serve to lift the heel from the ground at the moment of shift of the body centre of gravity to the other side. The transverse vault is defined by the shape and arrangement of the ossa cuneiformia and the proximal metatarsi, the task here being to provide protection to some of the soft tissue structures in the sole. The second and third cuneometarsal joints are stable parts of the forefoot. They remain in the original position even when the transverse vault warps while the peripheral metatarsi shift into elevation.

The preservation of the longitudinal and transverse vaults is dependent on the bone structure, the ligaments of the foot, and the lower limb and shank muscles. The muscles play an important role in the preservation of the leg vault during dynamic load. All longitudinal muscles participate in the preservation of the longitudinal vault; the toe flexors and m. tibialis posterior are also significant in the preservation of the foot vault. As for the muscles, quiescent tension of the big toe muscles, especially m. abductor hallucis and m. flexor hallucis brevis, is essential for vault preservation. The tibial foot-ridge is lifted by m. tibialis anterior. This muscle together with the m. peroneus longus forms a tendon stapes that maintains the vault and draws it in such a way that the vault remains longitudinal. M. peroneus longus keeps the transversal vault through transverse traction.

If the system of longitudinal and transverse vaults is preserved, the pace is springy in nature and the foot adapts itself to the demanding conditions. Hence, the central nervous system and the flexible part of the spine are protected against shocks.

The term flatfoot refers to an abnormal lowering or disappearance of the longitudinal vault. There are two types of flatfoot: congenital flatfoot when a part of the flatfoot in children's feet is maintained into adulthood, and acquired flatfoot.

The imbalance in ratio between the load intensity and load capacity of the foot leads to the condition of static flatfoot. As for cultural factors, persistent work related stress, lack of exercise and rest, the wearing of unsuitable footwear, walking on hard grounds, and being overweight, among other factors, contribute to the development of static flatfoot. The cultural adaptations of the footwear are subject not only to the climate but also to the socio-economic conditions and the fashion, which tend to act as negative factors in the ontogenesis of the foot.

Flatfoot can be divided into four stages according to the degree of deformity:

1. Tired foot where the shape is still preserved. However, weariness and pains appear after physical labour. On examination a valgose heel posture is usually detected.
2. Flaccid foot where the longitudinal arch falls when load is applied. The vault reappears upon cessation of load.
3. Flatfoot, when the foot vault remains permanently flat; it is loose and it can be shaped passively into regular shape.
4. Flatfoot with fixed deformity; the heel is valgose, the dorsal foot verges into pronation with overloading of the medial beam, it is widened, the big toe is pushed into a valgose position and a plantar swelling forms because of elevation of the fringe metatarsi. Hammertoes develop as a result. Rigorous pace leads to pain in the hip joint and the lumbar spine (Hegrová, 2001).

Flatfoot correction by means of surgical socks or shoes is often mentioned in research publications. However, the need for foot exercise focused on simulating the evolutionary conditions of phylogenetic development of the foot vault is lacking. Diverse foot morphology is given by the length of the metatarsi and the length of the phalanxes. Judging by the external shape, Egyptian, Ancient and quadratic feet is distinguished. Regarding the length of the metatarsi it is possible to divide each into subtypes according to predominance of the metatarsal, phalangeal or metarsophalangeal features.

The morphological foot type can be a restrictive performance factor (Kučera, 1994). The Egyptian foot implicates a large contact area for the toes thereby distributing even load. From an athletic point of view, it is the best foot type but it is more predisposed to the development of hallux valgus and rigidus than the other types. The Ancient foot is characterised by a smaller contact area. Two toes are always dominant: the 1st and 2nd or 2nd and 3rd. The load peak is in the area of phalanx-metatarsi transition. The quadratic foot is the least efficient regarding mechanical load, subsequently having a considerable sensitive response.

MATERIAL AND METHODS

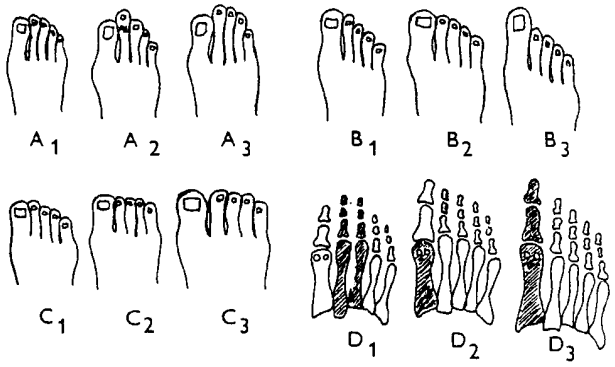
The research on foot morphology was carried out with a file of 106 male students and 162 female students belonging to the Gymnasium school in Šternberk and to the Integrated secondary school Na jízdárně in Ostrava. The age range of probands was 12–18 years and it included the age range of Infans 2 and Juvenis. Plantography was used to obtain the footprints. We monitored the morphological foot type, the foot index for evaluation of the longitudinal vault, the misalignment of the big toe and little toe, the heel angle and the condition of the lower limb muscles.

RESULTS AND DISCUSSION

TABLE 1
Frequency representation of morphological foot types

Files		Morphological foot type					
		Egyptian		Ancient		Quadratic	
		n	%	n	%	n	%
Boys sin.	n = 106	76	71.69	29	27.36	1	0.9
Boys dex.	n = 106	72	67.92	31	29.24	3	2.83
Girls sin.	n = 162	115	70.99	47	29.01	–	–
Girls dex.	n = 162	115	70.99	47	29.01	–	–

Fig. 1
Frequency representation of morphological foot types (A_1–A_3 Ancient, B_1–B_3 Egyptian, C_1–C_3 Quadratic, D_1–D_3 subtypes according to predominance of the metatarsal, phalangeal or metarsophalangeal features)



A considerably higher frequency of Egyptian foot was found in both the boys and girls. The quadratic foot

found in the boys was in a very low percentage showing some individual asymmetry. It was not ascertained in the girls.

Riegerová (1997) was monitoring the relationship of anatomical foot structure and somatype of 282 students from first year PE students of the Faculty of Physical Culture, the Pedagogical Faculty and the Faculty of Law of Palacký University. She states that important feedback was provided as to the prevalence of the Egyptian foot in the female PE students who, according to their somatype, belonged to a category of the proportional – medium type. The male PE students had the highest frequency of Egyptian foot in the category of somatype with dominant *ectomorphal* components. Even here the feedback comes into play because *mesomorph ectomorphs* and *mesomorphal ectomorphs* are very good prerequisites for locomotive endurance from the point of efficiency prediction. Riegerová also found a significant prevalence of the Ancient foot in the Law School and Pedagogical Faculty students (71.43%), which is much higher than the population average quoted by Kučera (1994).

Přidalová (2002) monitored the occurrence of particular morphology foot types with various population groups and with sportsmen. She discovered normal or higher proportion of Egyptian foot; prevalence of the Ancient foot was not apparent.

The above mentioned method is based on the evaluation of the proportion of the narrowest and widest part of the plantogram. Footprints with values of up to 45% are formally classified as vaulted foot, footprints over 45% are classified as flatfoot. With both men and women, the normal foot is prevalent; the number of high or flatfeet is relatively low.

Fig. 2
Chippaux-Šmiřák's method; Klementa, 1987

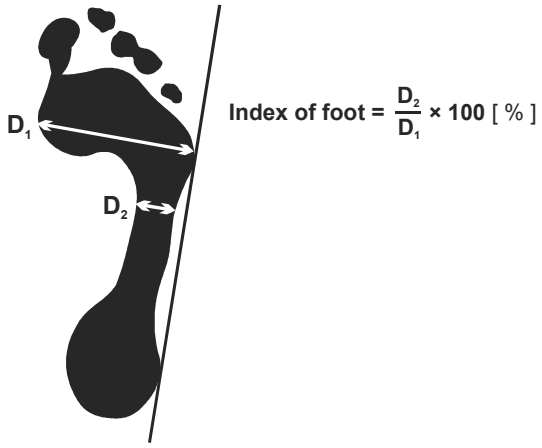


TABLE 3
Frequency and percentage of the individual foot vault categories (Szriter–Godunov's method)

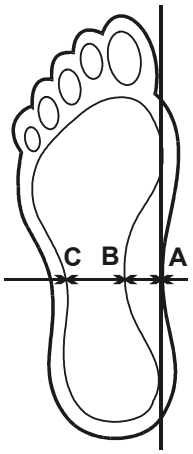
Files	Foot vault condition categories					
	High		Normal		Flat	
	n	%	n	%	n	%
Boys sin.	9	8.49	54	50.9	43	40.6
Boys dex.	4	3.77	61	57.6	41	38.7
Girls sin.	11	6.78	89	54.9	62	38.3
Girls dex.	8	4.94	84	51.9	70	43.2

TABLE 2
Frequency and percentage of particular foot vault condition categories (Chippaux–Šmiřák's method; Klementa, 1987)

Files	Foot vault condition categories																	
	High						Normal						Flat					
	1. gr.		2. gr.		3. gr.		1. gr.		2. gr.		3. gr.		1. gr.		2. gr.		3. gr.	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Boys sin.	2	1.89	–	–	4	3.77	28	26.41	54	50.94	7	6.6	6	5.66	2	1.89	3	2.83
Boys dex.	–	–	1	9.94	1	0.94	25	23.58	59	55.56	9	8	6	5.66	3	2.83	2	1.89
Girls sin.	–	–	3	1.86	8	4.94	60	37.03	77	47.59	6	3.7	7	4.32	–	–	1	0.62
Girls dex.	2	1.23	3	1.86	3	1.86	50	30.86	82	50.61	14	8.64	7	4.32	1	0.52	–	–

Files	Overall percentile and frequency representation in categories of the foot vault condition					
	High		Normal		Flat	
	n	%	n	%	n	%
Boys sin.	6	5.66	89	84	11	10.4
Boys dex.	2	1.89	93	87.7	11	10.4
Girls sin.	11	6.79	143	83.7	8	4.94
Girls dex.	8	4.93	146	90.1	8	4.94

Fig. 3
Sztriter–Godunov's method



$$\text{Index Ky} = \frac{B - C}{A - C}$$

Pes excavatus	0.00–0.25
Norma	0.26–0.45
Pes panus I°	0.46–0.49
II°	0.50–0.75
III°	0.76–1.00
Age: 8 years	0.44–0.54
9 years	0.41–0.53
10 years	0.40–0.53
11 years	0.39–0.54

Szriter–Godunov's method (Kasperczyk, 1998) belongs among the so-called index methods. Its evaluation is less vague than the Chippaux–Šmiřák's method and the percentage of flatfoot detection is much higher here.

As already mentioned in the beginning of this article, the foot can function properly if anatomical regularity is obeyed. Pursuant to the exogenous and endogenous factors, the resistance of a foot changes throughout life and subject to the footwear opted for typical deformities of the dorsal foot, such as misalignment of the big toe, transverse vault warping related to widening of the dorsal foot, hammertoes, etc., arise.

According to Hegrová (2001) the toe angle values are, from a minimum medical requirements perspective, graded according to the foot size, the limit being 6 grades, or, according to Wejsflog (1956), even 9 grades. We cannot fully agree with this statement and our opinion centres around the belief that misalignment of the big toe (even though the process might have just begun) shows a current muscular imbalance that will deepen in the absence of special exercise. Misalignment of the big toe also shows disorders of the dorsal foot, i.e. transverse vault warping. It is, therefore, necessary to develop both the foot and the shank flexors, including the big toe muscles on the basis of primary prevention. There are several devices for developing the foot vault as standard.

We have encountered zero misalignment of the big toe in less than 1/4 of our files. The frequency of valgose and varose manifestations was almost equal in boys. As a matter of fact, right big toe varose position was the dominant one. As for the girls, valgose position was the dominant one; the difference in frequency between positive and negative *misalignment* was statistically significant. The average values of the big toe angle ranged from 4 to 7 degrees, maximum misalignment reaching 18 degrees. It is essential to pay attention to misalignment of the big toe from pre-school age.

TABLE 4
Frequency and percentage of misalignment of the big toe

Files	Big toe angle					
	Zero condition		Positive misalignment (valgose big toe)		Negative misalignment (varose big toe)	
	n	%	n	%	n	%
Boys sin.	18	16.98	44	41.51	44	41.51
Boys dex.	21	19.81	35	33.02	50	47.17
Girls sin.	41	25.31	98	60.49	23	14.19
Girls dex.	35	21.6	81	50	46	28.39

The limit for right little toe position is set from 5 to 1 degree (Hegrová, 2001). In our study, the average value of the little toe angle was high in both boys and girls.

The average heel angle was diagnosed as a range from 15 to 18 degrees with high maximum values signifying valgose heel. It is necessary to point out that valgose heel anticipates or accompanies longitudinal flatfoot.

TABLE 5
Basic statistical features of the big toe, little toe and heel angle (±)

Files	$\bar{x}$	s	min.	max.
Boys toe angle sin.	4.20	3.29	2.0	12.0
Boys toe angle sin.	–5.63	–3.09	–1.5	–14.0
Boys toe angle dex.	4.53	3.60	2.0	13.0
Boys toe angle dex.	–5.87	–3.49	–1.5	–18.0
Girls toe angle sin.	5.09	4.65	1.5	18.0
Girls toe angle sin.	–6.96	–3.90	–1.0	–16.0
Girls toe angle dex.	5.76	3.06	1.5	14.0
Girls toe angle dex.	–4.27	–4.02	–2.0	–17.0
Boys little toe angle dex.	21.40	7.30	5.0	35.0
Boys little toe angle sin.	21.90	7.21	6.0	39.0
Girls little toe angle dex.	17.73	7.50	4.0	40.0
Girls little toe angle sin.	18.08	7.47	3.0	41.0
Boys heel angle sin.	16.16	2.39	10.0	21.0
Boys heel angle dex.	16.96	2.50	11.0	22.0
Girls heel angle sin.	15.58	2.47	10.0	21.0
Girls heel angle dex.	16.01	2.40	10.0	22.0

The condition of muscles and muscular groups in the lower limb was monitored only in men. Janda (1996) adapted to an alternative evaluation method. All monitored muscles and muscular groups were affected, shortening of the knee-joint flexors being the dominant feature (56.80%). The frequency of shortening was high with other monitored muscles – m. tensor fasciae latae (52.30%), m. rectus femoris (40.90%), thigh abductors (38.60%) and m. triceps surae (21.40%). The relation between the monitored foot parameters and condition of the lower limb muscles was evaluated by means of the chí square. Statistically significant triceps shortening frequency of the surae and knee-joint flexors in both feet

was discovered, which is logical in respect to the kinetic chains integration. We supposed that more relations between lower limb muscle shortening and foot vault functional condition disorders will be detected. However, we could only confirm statistically significant relation of heel misalignment and m.triceps surae shortening in the left limb in men. As for the right limb, the value was on the borderline. Similarly, significant relation between heel angle and knee flexor shortening was found.

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ROZBOR MORFOLOGIE NOHY U CHLAPCŮ A DÍVEK VE VĚKU INFANS 2 A JUVENIS

(Souhrn anglického textu)

U 106 studentů a 162 studentek z Gymnázia ve Šternberku a Střední integrované školy v Ostravě ve věku 12–18 let byl sledován morfologický typ nohy, index nohy pro hodnocení podélné klenby nožní, vyosení palce a malíku, úhel paty a stav svalstva dolních končetin. U chlapců i dívek byla nalezena výrazně vyšší frekvence výskytu nohy egyptské (71,69 % a 70,99 %). Noha kvadratická se vyskytovala u chlapců ve velmi nízkém procentu (2,83 %) s určitou individuální asymetrií, u dívek nalezena nebyla. Diagnostika plochonoží metodou Chippauxe–Šmiřáka poskytla velmi příznivé výsledky (4,94–10,38 % výskytu ploché nohy), metoda podle Szritera–Godunova naopak nález podstatně horší (38,2–43,21 % výskytu ploché nohy). S nulovým stavem vyosení palce jsme se setkali u necelé čtvrtiny souborů. U souboru chlapců byla četnost projevu valgozity a varozity palce téměř vyrovnána, věcně převažovalo varózní postavení palce vpravo. U souboru dívek dominovalo signifikantně valgózní postavení. Průměrné hodnoty se pohybovaly v rozmezí 4 až 7 stupňů. Průměrná hodnota úhlu malíku, charakterizující vbočený malík, byla vysoká (17,73 až 21,90 stupně). Průměrný úhel paty byl diagnostikován v rozmezí 15 až 18 stupňů.

Při hodnocení vztahů mezi zkrácením svalů dolní končetiny a poruchami funkčního stavu klenby nožní (pouze u mužů) jsme nalezli potvrzení statistické významnosti závislosti u vyosení paty a zkrácení m. triceps surae sin. a signifikantní závislost mezi úhlem paty a zkrácením flexorů kolen sin.

Klíčová slova: morfologický typ nohy, index nohy, vyosení palce a malíku, úhel paty, svalové dysbalance.

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CHILD'S FOOT MORPHOLOGY

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Submitted in April, 2005

The study describes the foot morphology as a basal element of supporting-movement system. Foot morphology was observed in 263 boys and 248 girls of pre-school and primary school age. Longitudinal foot vault was evaluated by Plantographic method by index method and processed by "Foot" software; the big toe and little toe axis in the sense of valgozity and varozity, the size of foot angle. Statistically significant differences were evaluated by means of Wilcoxon, Mann-Whitney tests, Scheffe test and chí-quadrate test (Statistica, vers. 6).

The state of longitudinal foot vault appeared as relatively satisfactory. The normal foot of I. and II. degree was determined with highest frequency. The occurrence of flat foot and high foot did not signify any principal problem in these age categories. The deformation of big toe and little toe occurred in high frequency in both genders and in all age categories. In boys the valgoze angle reached the range 2.6–7.9°, in girls 4.3–8.1°. The average values of big toe varozity were higher. Little toe angle (valgozity) in the group of boys reached the range of values 15.4° to 20.4°, in girls 14.4° to 18.6°.

At the end we can evaluate the longitudinal foot vault in child's age categories as corresponding with the ontogenesis phase. The analysis of morphological parameters in the area of anterior part of foot proved the deformations in medial and lateral foot rays in high frequency. The foot angle in posterior part of the foot responds the reference values of established age categories.

Keywords: Plantographic method, longitudinal foot vault, anterior part of foot (forefoot), foot angles.

INTRODUCTION

The care of supporting-movement system includes foot care as well – which is in the most cases neglected. The state and foot function in adult age correspond with care and foot development from the birth. Child's foot is in the early developmental stages cartilaginous, less resistant against load and is more prone to deformities, especially in the area of forefoot. To healthy foot development there are necessary congenital dispositions but essential influence lies in foot wear quality, the possibility of foot muscle and ligament apparatus daily exercises without regard to load level, compensatory exercise application after inadequate load or overload of feet, for instance after training or prolonged walking, standing etc.

Childs foot acquires definitive shape with developed longitudinal and transversal foot vault in the period between 4–6 years of age. Up to 12 year of age, the child has the routing of equator behind (American College of Foot and Ankle Surgeons, http://www.aofas.org/index.shtml; American Orthopaedic Foot and Ankle Society, http://orthoinfo.aofas.org/fact/thr_report.cfm?Thread_I). This routing is done in the time when foot development is not yet completed. During the beginning of school period, the range of deformities starts to manifest themselves. In this age the existence of foot deformation does not have to be subjected to its hurtfulness, the child does not subjectively perceive it yet. The pain manifestation comes usually in adult age.

Foot deformations include wide range of defects, which are not only connected to collapse longitudinal foot vault but are represented by forefoot deformations. We classify forefoot deformity – the toes deformities (hammertoe, event clutches-type toes, little toe axis declination, the incidence of toe valgozity or varozity, enlargement of the forefoot). These defects are in later phases accompanied by metatarzalgies (Dungl, 1989; Matějovský et al., 2002). The incidence frequency of forefoot deformities is related as well with the length of metatarsal and digital bones.

The foot is not solely the organ of walking but it is as well the sensitive detector, which provides in the frame of feedback the influence of negative and positive exogen and endogen effects. If the foot morphology is modified, the foot capability to react to signals is altered and thus its function is influenced in the sense of elasticity, plasticity and reactivity. There become to appear changes in quantity of force and pressure, which take effect in the foot sole. The unpleasant feelings related to foot deformities can trigger discomfort in psyche domain – irritability, concentration loss, fatigue etc. The alteration of foot morphology has impact on the joints and muscle function in the upper body areas. Subsequently the modifications of

footstep and stereotype of walking and the modification of ones motoric potency can occur (Přidalová et al., 2003).

Following study is attributed to foot morphology in pre-school and primary school age. It complements and ties together with previous published conclusions regarding child's foot morphology (Přidalová et al., 2003; Přidalová & Najdekrová, 2003; Přidalová & Riegerová, 2002; Přidalová & Rýznarová, 2000).

The study objective is to monitor the frequency of foot type, determination of the longitudinal foot vault state (whose condition did not appear problematic in older age categories) and evaluation of forefoot parameters. The study component is as the punctual characteristics of the morphological points on the foot sole and indexes, eventually further parameters such as angles. We fail to find these punctual characteristics in number of studies (with exception of for example Brázdilová et al., 1985) and results of two authors are subsequently incomparable. On basis of experience and to facilitate processing of foot prints there was built "Foot" software (Elfmark & Přidalová, 2003) which enables processing and back up of data by computer.

METHODOLOGY

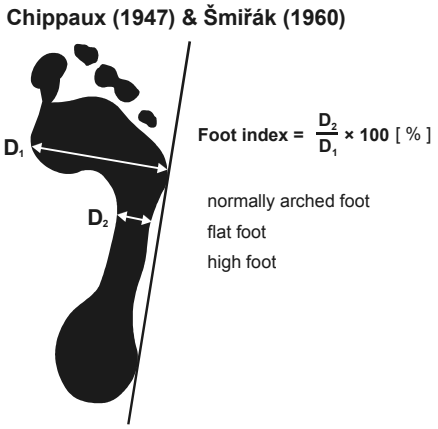
By way of plantographic method the footprints of 263 boys and 248 girls of pre-school and primary school age were evaluated. The children were considered asymptomatically healthy, they were divided according the gender and age which we regard as principal. Examination took part at the primary schools in Uničov, in Olomouc and in kindergarten in Litovel. The children's parents expressed approval with examination of their children.

The foot prints were taken throughout rubber membrane as a static plantogram on a France manufactured plantograph. After scanning, the foot prints were processed by "Foot" software which data identification is showed in Fig. 5. We worked with following anthropometrical parameters: foot index (Chippaux–Šmiřák, In Klementa, 1987), hallux angle, little toe angle – varozity and valgozity (Brázdilová et al., 1985; Dungl, 1989; Hegrová, 1999) a foot angle (Klementa, 1987). To divide the big toe angle we formed 3 categories: big toe without axis declination (0°), hallux misalignment to the lateral foot part – valgozity (> 0°), hallux misalignment to the medial foot part – varozity (with respect to differentiation possibility for statistical assessment, we choose negative values < 0°). The little toe angle division was similar: little toe without axis declination (0°), little toe misalignment to the lateral foot side – varozity, little toe misalignment to the medial foot side – valgozity. All monitored parameters are presented in Fig. 3 and 4. The foot types and its evaluation emerge from the Fig. 2. Statistically significant differences were evaluated by means of Wilcoxon, Mann-Whitney tests and chí-quadrate test (Statistica, vers. 6).

The children from kindergarten were divided into yearly age categories (3-, 4-, 5-, 6 years old) with regard to opportunity of longitudinal foot vault assessment by foot index since the formation of definitive longitudinal vault foot is not yet completed in pre-school age. Other age categories could be, on the basis of group homogenity (Scheffe test), integrated into the category 6–7 years old (it concerns children attending primary school) and 8–9 years old.

To monitor foot morphology there are problems with methodological differences and subsequently with incomparable results of various authors. Published results often summarize data without gender differentiation, regardless categorization in the junior phase of ontogenesis, which is fundamental for foot development. There is not always given punctual determination of individual morphological points. In Fig. 3 and 4 we attempted to make precise description of individual morphological foot parameters, which are further used in "Foot" software.

Fig. 1
Foot index – longitudinal normal and flat foot determination (modified according Klementa, 1987)



Normally arched foot:
1. degree from 0.1% to 25.0% (N1)
2. degree from 25.1% to 40.0% (N2)
3. degree from 40.1% to 45.0% (N3)

Flat foot:
1. degree from 45.1% to 50.0% – slightly flat (F1)
2. degree from 50.1% to 60% – medium flat (F2)
3. degree from 60.1% to 100.0% – severely flat (F3)

High foot:
1. degree from 0.1 cm to 1.5 cm slightly high (H1)
2. degree from 1.6 cm to 3.0 cm medium high (H2)
3. degree from 3.1 cm and above severely high (H3)

Fig. 2
Foot types (modified according Dungl, 1989)

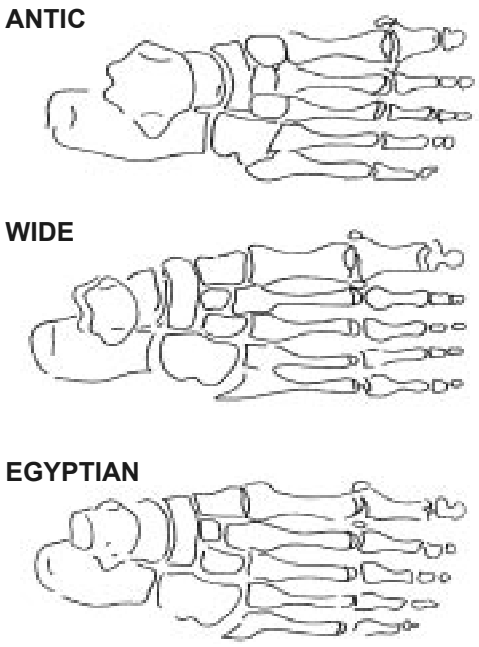
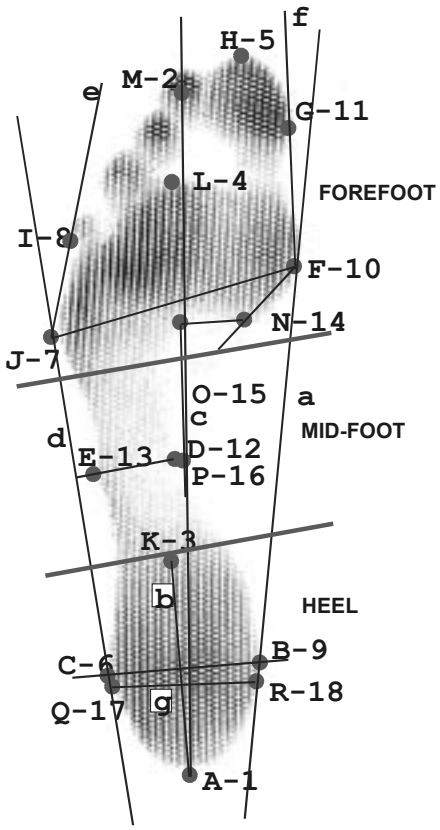


Fig. 3
Precise characteristics of morphological points on the foot sole

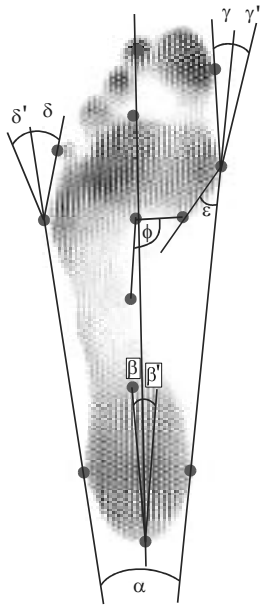


(the figures in the picture 3 respond
to the figures in the picture 5)

Specification of individual morphological points of foot sole

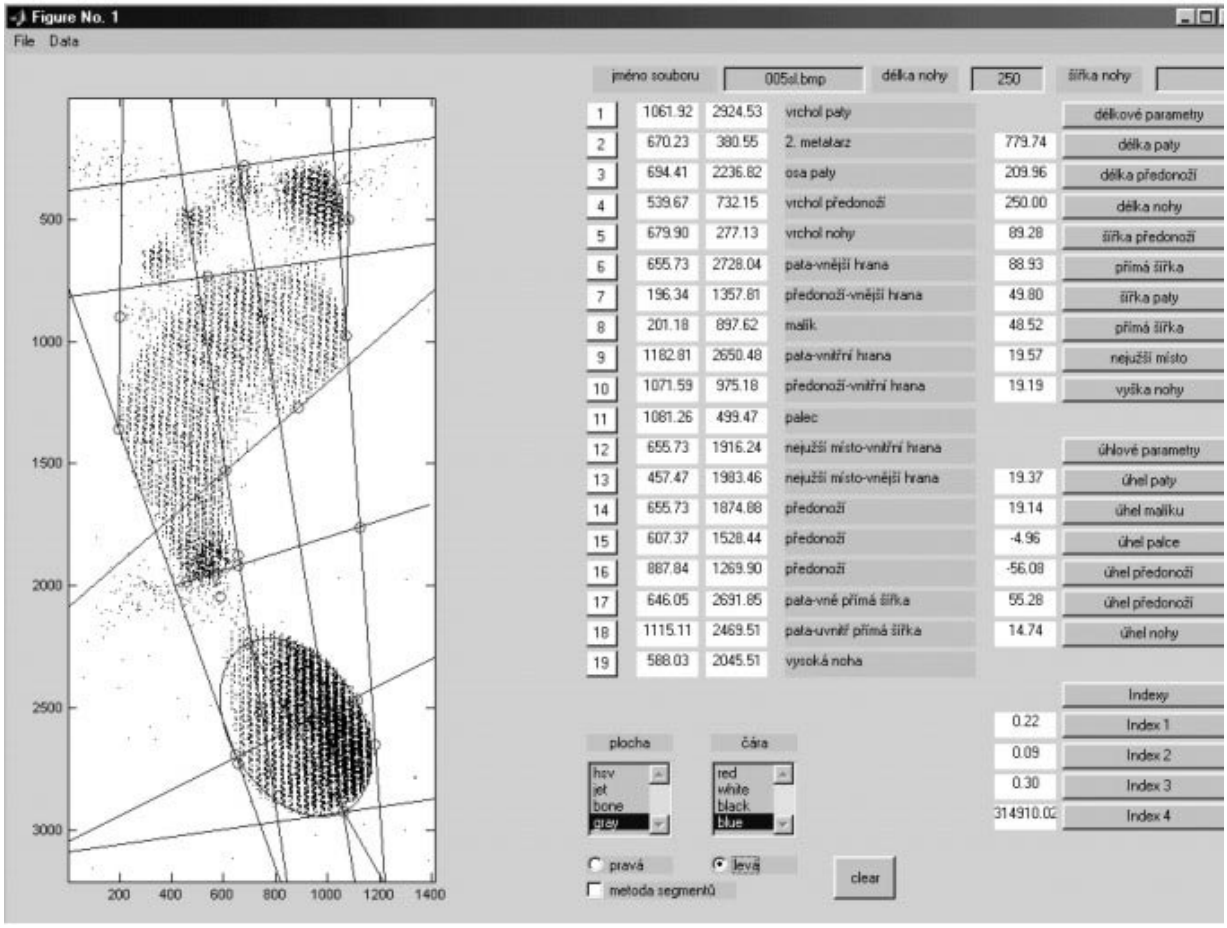
A	the most proximally positioned point of foot heel
B	the most medially positioned point of posterior part of foot
C	the most laterally positioned point of posterior part of foot
D	medially positioned point of medial part of foot on the vertical line in the narrowest part of foot
E	laterally positioned point of medial part of foot on the vertical line in the narrowest part of the foot
E=>D	the narrowest part of the foot (vertical line to lateral tangent of foot)
F	the most medial point of anterior-part of foot on the head I. of metatarsus
G	the most medially positioned point on the big toe
H	foot top
I	the most laterally positioned point on the little toe
J	the most laterally positioned point on anterior-part of foot
J=>F	the most wide part of foot, direct width of foot, vertical line to lateral tangent of foot
K	the top of posterior part of foot (the most distally positioned point of posterior part of foot)
L	the top of anterior-part of foot (the most distally positioned point of anterior-part of foot)
M	the centre of the second toe
N	the most proximally positioned point of anterior-part of foot
O	the top of arch of anterior-part
P	the point in the mid-part of medial part of the foot
Q	foot heel direct width – lateral
R	foot heel direct width – medial
a	medial tangent of the foot
b	foot heel axis
c	foot axis (its led through the centre of second toe)
d	lateral tangent of the foot
e	little toe tangent (straight line led through the most lateral point of the little toe form point J)
f	big toe tangent(straight line led through the most medial point of the big toe form point F)
g	the most width of foot heel

Fig. 4
The determination of individual angles on the foot sole



α	foot angle
β	foot heel angle in the direction to lateral side of foot sole (valgoze position of foot heel)
β´	foot heel angle in the direction to medial side (varoze position of foot heel)
γ	big toe angle in the direction to lateral side of foot sole (valgoze position of big toe)
γ´	big toe angle in the direction to medial side of foot sole (varoze position of big toe)
δ	little toe angle in the direction to medial side of foot sole (valgoze position of little toe)
δ´	little toe angle in the direction to lateral side of foot sole (varoze position of little toe)
ε	the Clark angle
ϕ	the angle of medial foot part

Fig. 5
The page of "Foot" software with evaluated planta figures



RESULTS

Longitudinal foot vault evaluation

In evaluation of the state of longitudinal foot vault in the group of boys and girls there were the most frequently the categories of normally arched foot. In all age groups it was the most frequent representation in the II. category. There was no statistically significant difference found in the sense of laterality. The I. category was minimally represented in kindergarten boys, in primary school boys the representation in this category increases and it reaches up to ¾ of the group in the oldest children. In younger girls this category was represented in mildly higher percentage than in boys. Normal vault foot III. degree occurred in lower percentage in boys, the frequency increases in the oldest boys. Higher frequency representation in older boys could be connected with indication of longitudinal vault foot decline – the representation in this category reflects it. Mildly higher frequency representation occurred in the category of normal foot type of III. degree in 4 years old girls (TABLE 1 and 2).

The flat foot category is most frequently represented in 3–4 years old boys, 8–9 years old boys and 5 years old girls. In pre-school children it is possible to explain the prevailing existence of fat-pad in the sole, which protects incompletely formed vault foot and this finding is physiological at this age.

Flat foot was found in mildly less frequent representation in 3 years old, 4 years old and 8–9 years old girls than in boys. We recorded significant difference in flat foot evaluation according to gender in the favour of 3 years old girls, on the contrary in 5 years old girls we find flat foot in significantly higher frequency in girls' group. High foot occurred sporadically in pre-school and the oldest age category (TABLE 1, 2).

TABLE 1
Longitudinal foot vault evaluation in boys' group

Boys (n = 263)	3 years (n = 29, 1 = 3.4%)				4 years (n = 28, 1 = 3.6%)				5 years (n = 32, 1 = 3.1%)				6 years (n = 27, 1 = 3.7%)				6–7 years (n = 65, 1 = 1.5%)				8–9 years (n = 82, 1 = 1.2%)			
	L		R		L		R		L		R		L		R		L		R		L		R	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
N1	1	3.4	1	3.4	2	7.1	4	14.3	2	6.3	4	12.5	1	3.7	1	3.7	9	13.8	10	15.4	21	25.6	19	23.2
N2	10	34.5	9	32.1	15	53.6	14	50.0	16	50.0	19	59.4	19	70.3	16	59.3	30	46.1	26	40.0	31	37.8	35	42.7
N3	4	13.8	7	24.1	2	7.1	2	7.1	6	18.7	5	15.6	2	7.2	3	11.1	7	10.7	13	20.0	11	13.4	14	17.1
∑ N	15	51.8	17	58.6	19	67.9	20	71.4	24	75.0	28	87.5	22	81.5	20	74.1	46	70.7	49	75.4	63	76.9	68	82.9
F1	5	17.2	3	10.3	3	10.7	4	14.3	3	9.4	1	3.1	3	11.0	0	0.0	4	6.1	3	4.6	5	6.1	2	2.4
F2	5	17.2	6	20.7	3	10.7	2	7.1	3	9.4	1	3.1	1	3.7	5	18.5	0	0.0	0	0.0	6	7.3	4	4.9
F3	4	13.8	3	10.3	3	10.7	2	7.1	0	0.0	0	0.0	0	0.0	1	3.7	1	1.5	0	0.0	3	3.7	5	6.1
∑ F	14	48.3	12	41.3	9	32.1	8	28.6	6	18.7	2	6.3	4	14.8	6	22.2	5	7.6	3	4.6	14	17.1	11	13.4
H	0	0	0	0	0	0	0	0	2	6.3	2	6.3	1	3.7	1	3.7	14	21.5	13	20.0	5	6.1	3	3.7

TABLE 2
Longitudinal foot vault evaluation in girls' group

Girls (n = 248)	3 years (n = 26, 1 = 3.8%)				4 years (n = 31, 1 = 3.2%)				5 years (n = 36, 1 = 2.7%)				6 years (n = 30, 1 = 3.3%)				6–7 years (n = 42, 1 = 2.4%)				8–9 years (n = 83, 1 = 1.2%)			
	L		R		L		R		L		R		L		R		L		R		L		R	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
N1	3	11.5	3	11.51	5	16.1	3	9.6	2	5.4	5	13.8	9	30.0	6	20.0	7	16.7	8	19.0	19	22.9	23	27.7
N2	11	42.3	12	46.1	15	48.3	12	38.7	18	50.0	17	47.2	13	43.3	16	53.3	16	38.0	18	42.8	36	43.4	40	48.2
N3	4	15.3	4	15.3	7	22.5	9	29.0	3	8.3	3	8.3	4	13.3	3	10.0	6	14.2	4	9.5	8	9.6	10	12.0
∑ N	18	69.2	19	73.1	27	87.1	24	77.4	23	63.8	25	69.4	26	86.7	25	83.3	29	69.0	30	71.4	63	75.9	73	88.0
F1	3	11.5	1	3.8	1	3.2	4	12.9	5	13.8	4	11.1	4	13.3	4	13.3	3	7.1	2	4.8	6	7.2	1	1.2
F2	2	7.6	2	7.6	2	6.4	1	3.2	3	8.3	0	0.0	0	0.0	0	0.0	1	2.4	2	4.8	2	2.4	2	2.4
F3	1	3.8	1	3.8	0	0.0	1	3.2	3	8.3	5	13.8	0	0.0	0	0.0	1	2.4	0	0.0	1	1.2	0	0.0
∑ F	6	23	5	19.2	3	9.6	6	19.2	11	30.5	9	25.0	4	13.3	4	13.0	5	11.9	4	9.5	9	10.8	3	3.6
∑ H	2	7.6	3	11.5	1	3.3	1	3.2	2	5.4	2	5.4	0	0.0	1	3.3	8	19.0	8	19.0	11	13.3	7	8.4

The average value of foot index ranged in 3 years old boys, both-sides above 40%. Index exceeded limit of 40% only in 3 years old girls on the left foot. In further age categories of boys we can observe the average value of foot index declination, with the statistically relevant difference in the sense of laterality in 4 years old boys. In the other age categories of boys the average value of foot index ranged from 30.8–37.6%. The average values in girls appeared mildly lower (27.9–35.9%).

The lowest average index value was found on the right foot in 3 years old boys (5.2% – the indication of high foot can be considered even though Klementa does not respect this index value as high foot indicator). The maximum value exceeded in younger age categories 70% the index limit. In older boys it ranged above 65% (TABLE 3, 4). Maximal values of index values in girls differed from boys categories, they were represented below 70% limits. In kindergarten girls we observe mild decrease of foot index in the process of development with the significant difference of index values in 3 years and 6 years old girls.

The anterior-part of foot (forefoot) parameters evaluation

In all groups the category of hallux without axis declination was represented maximally by 8 probands. Significant side difference is possible to observe only in the groups of 4 years old and 6 years old boys. We found this laterality trend in group of men of older age groups (Přidalová et al., 2000, 2002), in particular by probands in those with high physical activity.

Hallux valgozity occurred in boys' group with significantly higher frequency representation than hallux varozity, with the exception of 8–9 years old, where those two categories approximating in frequency. Hallux varozity in the oldest boys surpassed limit of 40% of group. We found balanced frequency occurrence of hallux varozity and valgozity as well in 3–5 years old girls.

In girls above 6 years old age limit the valgozity appeared in higher frequency than varozity. Valgozity surpassed 60% of group and in 6–7 years old girls affected more than 90%. There was no significant difference found in hallux valgozity occurrence between the groups of girls and boys. Statistically significant difference in hallux varozity occurrence was found in all groups of 3–6 years old children, with lower frequency of varozity in favour of boys.

The average values of valgoze hallux in boys ranged from 2.6° do 7.9° and were on average lower than in varozity. The lowest values of valgozity were determined in the group of 3 years old. In further age groups the values of valgoze big toe occurred approximately on the

TABLE 3
Basic statistical characteristics of monitored morphological parameters of foot in boys' group

Parameters		3 years (1 = 3.4%)		4 years (1 = 3.6%)		5 years (1 = 3.6%)		6 years (1 = 3.6%)		6–7 years (1 = 1.5%)		8–9 years (1 = 1.2%)	
		L	R	L	R	L	R	L	R	L	R	L	R
Hallux angle >0°	n	15.0	13.0	24.0	17.0	18.0	14.0	14.0	16.0	61.0	63.0	44.0	43.0
	%	51.8	44.8	85.7	60.7	56.3	43.8	51.9	59.2	93.8	96.9	53.6	52.4
	$\bar{X}$	3.1	2.6	4.5	5.8	5.0	5.7	4.7	5.5	7.9	6.5	4.8	4.7
	SD	2.1	1.8	2.0	1.6	0.9	1.6	0.8	1.1	3.5	3.8	4.2	4.5
	Min.	2.0	2.0	1.0	2.0	3.0	3.0	2.0	2.0	1.7	1.0	2.0	384 73
	Max.	10.0	11.0	12.0	18.0	10.0	11.0	12.0	10.0	18.5	14.2	14.0	18.0
Hallux angle <0°	n	6	8.0	4.0	3.0	6.0	10.0	5.0	10.0	2.0	2.0	34.0	34.0
	%	20.7	27.6	14.2	10.7	18.8	31.3	18.5	37.0	3.1	3.1	41.5	41.5
	$\bar{X}$	–8.6	–8.3	–6.5	–6.7	–6.4	–7.9	–6.8	–6.8	–5.7	–6.1	–6.9	–4.8
	SD	3.2	2.9	2.2	1.9	0.7	2.9	1.6	1.2	0.8	1.2	1.4	1.1
	Min.	–2.0	–5.0	–4.0	–3.0	–3.0	–5.0	–2.0	–2.0	–2.0	–3.0	–3.0	–2.0
	Max.	–15.0	–11.0	–13.0	–9.0	–12.0	–15.0	–13.0	–13.0	–12.0	–14.0	–13.0	–12.0
0°	n	8.0	8.0	0.0	8.0	8.0	8.0	8.0	1.0	2.0	0.0	4.0	5.0
	%	27.5	27.6	0.0	28.0	25.0	25.0	29.6	3.7	3.1	0.0	4.9	6.1
Little toe angle	$\bar{X}$	16.0	19.1	20.1	15.4	19.5	17.8	20.4	18.3	16.4	15.9	17.4	17.1
	SD	6.1	5.9	6.5	5.9	6.4	6.8	7.6	5.4	7.2	7.1	7.6	7.2
	Min.	9.0	9.0	7.0	7.0	9.0	7.0	11.0	7.0	2.0	3.0	7.0	6.5
	Max.	29.0	23.0	39.0	38.0	39.0	29.0	36.0	35.0	34.1	33.9	29.3	31.8
Foot index	$\bar{X}$	47.1	41.9	40.4	35.7	35.4	32.8	37.6	36.9	31.6	34.8	34.9	30.8
	SD	6.1	5.9	6.5	5.9	6.4	6.8	4.2	5.4	9.8	9.4	6.1	8.6
	Min.	24.1	5.2	12.0	12.0	7.6	6.9	25.0	25.0	7.5	9.1	10.9	14.2
	Max.	68.3	70.1	75.9	66.7	50.9	51.5	59.0	60.0	56.7	65.3	51.8	47.7
∑	n	29.0	29.0	28.0	28.0	32.0	32.0	27.0	27.0	65.0	65.0	82.0	82.0

TABLE 4
Basic statistical characteristics of monitored morphological parameters of foot in girls' group

Parameters		3 years (1 = 3.9%)		4 years (1 = 3.2%)		5 years (1 = 2.8%)		6 years (1 = 3.3%)		6–7 years (1 = 2.4%)		8–9 years (1 = 1.2%)	
		L	R	L	R	L	R	L	R	L	R	L	R
Hallux angle >0°	n	9.0	11.0	17.0	13.0	15	15.0	18.0	17.0	40.0	40.0	54.0	52.0
	%	34.6	42.3	54.8	41.9	41.7	41.7	60.0	56.6	95.2	95.2	65.1	62.6
	$\bar{X}$	5.9	7.0	5.2	4.3	6.7	4.6	7.8	5.5	8.1	7.0	6.4	5.9
	SD	2.4	1.8	1.9	1.6	1.5	1.9	2.1	1.6	4.1	3.3	1.5	1.3
	Min.	2.0	3.0	3.0	4.0	3.0	2.0	2.0	2.0	2.0	1.3	1.5	1.5
	Max.	9.0	10.0	15.0	8.0	16.0	14.0	9.0	13.0	17.0	13.2	15.8	15.2
Hallux angle <0°	n	11.0	9.0	10.0	14.0	14.0	14.0	9.0	11.0	2.0	2.0	23.0	27.0
	%	42.3	34.6	32.3	45.2	38.8	38.8	30.0	36.7	4.8	4.8	27.7	32.5
	$\bar{X}$	−7.6	−6.1	−6.8	−8.5	−6.3	−7.1	−6.3	−6.6	−4.3	−5.3	−5.0	−6.2
	SD	2.8	1.3	1.8	2.0	2.1	2.0	1.8	2.3	1.5	2.1	1.1	0.6
	Min.	−3.0	−5.0	−2.0	−2.0	−2.0	−2.0	−2.0	−2.0	−2.0	−2.0	−3.0	−2.0
	Max.	−11.0	−10.0	−8.0	−15.0	−8.0	−15.0	−9.0	−21.0	−16.0	−12.0	−13.0	−8.0
0°	n	6.0	6.0	4.0	4.0	7.0	7.0	3.0	2.0	0.0	0.0	6.0	4.4
	%	23.1	23.1	12.9	12.9	20.6	20.6	10.0	6.6	0.0	0.0	7.2	4.8
Little toe angle	$\bar{X}$	16.9	15.9	17.4	18.6	18.3	14.8	18.4	21.7	18.6	16.6	15.7	14.4
	SD	4.3	3.9	3.7	3.4	4.1	5.4	5.5	5.8	4.8	7.3	8.9	4.8
	Min.	5.0	4.0	4.0	4.0	4.0	4.0	6.0	10.0	6.4	2.5	4.3	5.6
	Max.	34.0	39.0	28.0	36.0	34.0	36.0	28.0	37.0	28.5	29.7	29.8	31.2
Foot index	$\bar{X}$	42.8	39.5	35.9	35.4	35.9	32.5	30.7	31.3	27.9	30.9	31.4	32.8
	SD	5.1	2.9	5.7	3.8	6.2	5.3	4.2	4.1	11.2	9.1	7.9	9.5
	Min.	12.7	20.9	20.0	5.4	22.6	10.9	21.2	10.0	6.5	11.2	18.9	25.2
	Max.	65.1	66.1	58.6	48.3	66.7	57.4	44.4	42.9	50.0	46.9	49.8	47.8
∑	n	26.0	26.0	31.0	31.0	36.0	36.0	30.0	30.0	42.0	42.0	83.0	83.0

same level, with exception of 6–7 years old boys from primary school where we meet relatively high value of axis aberration. That one is 6.5° right-sided and 7.9° left-sided.

We find the average values of varozity in the interval 4.8°–8.6°. We can see the highest values (> 8°) in 3 years old boys which probably relates to kineziologic patterns of walking at this age. The maximum values of valgoze and varoze big toe reached relatively high values in all the age groups (TABLE 3).

The valgoze big toe values ranged in girls from 4.3° to 8.1°. Values of varozity were found in interval 4.3° to 8.5°. Differences between the varozity and valgozity values in the girls' group were smaller than in the boys' group. The maximum values of valgozity and varozity surpassed 15° (TABLE 4).

The little toe axis (valgozity) in boys' groups reached interval values 15.4° to 20.4°, in girls' group 14.4° to 18.6°. The little toe angle maximal values (more than 30°) evidence great misalignment and great deformation of anterior-part of foot in lateral ray area. The little toe misalignment appears on average lower in girls, minimal values ares lower as well.

Although little toe ray appears as "less significant" in the process of taking off, it surely has its foundation and its deformation has impact on the walking pattern. There was no occurrence of a foot without little toe misalignment. The little toe varozity was not present. In more than 80% of all groups there was determined little toe axis aberration above 9°, which can be considered according Hegrová (2001) as a border of high axis-declination. In hallux this border line is axis aberration of 6°.

The average values of foot angle ranged in boys' group from 15.5° to 16.8°, in girls' group from 15.9° to 16.8°. Minimal values were around 10°, maximal values, on the contrary, extend above 20° border. The frequency representation in individual categories is displayed in TABLE 6. Its obvious that the highest number of probands is in categories 15–18°. There were no significant differences in frequency representations between individual groups in the aspect of gender.

Foot type evaluation

In all groups the Egyptian foot, which seems to be the most optimal from the aspect of vertical force distribution in planta area, prevailed. Its related to achievement of maximal performance in sport and it can be supposed to have lower incidence of feet hurtfulness and collapse vault foot. In boys' group from kindergartens, the occurrence of Egyptian foot type – two sided – was reaching 87.9%. In girls' group from kindergartens the

occurrence frequency of Egyptian foot shifted in favour of Antique foot, right sided reached 78.8% of groups, on the left side 77.2%. This difference probably relates with higher occurrence of forefoot deformations in girls' groups.

TABLE 5
The average values of foot angles (Brázdilová et al., 1985)

Age	Hallux angle		Little too angle		Foot angle	
♀	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
3 years	3.2	5.8	7.9	5.1	14.2	2.2
4 years	3.5	5.4	9.8	4.8	14.3	1.9
5 years	3.4	5.4	8.9	4.9	14.3	1.9
6 years	4.6	5.3	9.2	4.9	14.4	3.4
7 years	4.8	4.8	9.8	4.6	13.9	1.9
8 years	5.4	5.1	9.5	4.7	14	1.9
9 years	6.1	5.3	9.6	4.3	14.1	1.8
♂	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
3 years	4.6	5.4	9.4	5.4	14.1	2
4 years	5.2	5.4	10	5.3	14.4	2.3
5 years	3.8	5.3	10.1	4.8	14.4	2.4
6 years	4.7	5.2	9.4	4.6	14.3	2.4
7 years	4	5.2	9.8	4.6	14.5	1.9
8 years	4.5	5.1	9.6	4.4	14.4	2
9 years	3.9	5.1	10.9	4.8	14.1	1.9

After starting to attend school the girls' group keeps similar ratio of foot type distribution, the shifting is again in favour of Antique foot type. In boys' group we recorded almost balanced distribution of foot types in the categories of Antique and Egyptian foot type. There is significant difference between genders in Antique type foot occurrence in the frame of individual age categories.

In 8–9 years old children the representation ratio is shifted in favour of Antique foot, however even Antique foot frequency is not trivial and it runs over 20% of group. In this age category there was not discovered statistically relevant difference in foot type occurrence between genders.

TABLE 7
Histogram of foot typology

Type foot		Egyptian				Antic				Wide			
		L		R		L		R		L		R	
		n	%	n	%	n	%	n	%	n	%	n	%
3–6 y.	♂	102	87.9	102	87.9	14	11.5	14	11.5	0	0.0	0	0.0
	♀	95	77.2	97	78.8	28	22.7	26	21.1	0	0.0	0	0.0
6–7 y.	♂	38	58.5	40	61.5	27	41.5	25	38.5	0	0.0	0	0.0
	♀	32	76.2	27	64.2	10	23.8	15	35.7	0	0.0	0	0.0
8–9 y.	♂	52	63.4	47	57.3	25	30.5	27	32.9	5	6.1	8	9.8
	♀	58	69.9	51	61.4	19	22.9	20	24.1	6	7.2	12	14.5

DISCUSSION

The monitoring of foot morphology in children in the sense of primary prevention is neglected abroad as well as in home workplaces. There were national researches realised in the Czech Republic, under the guarantee of Footwear Research Institute in Zlín followed by Technological faculty T. Baťa in Zlín, which are gradually completed by researches on the regional level, event in specific population groups (e.g. according sports specialisations, ethnic etc). The studies of various authors in abroad usually concern already progressive clinical syndromes which are nevertheless diagnosed in adult age. The relation between the structure and foot function in adult population is being tried to solve in the range of studies with various levels of technical devices.

The soft tissues with regard to their impairment were observed by Gooding et al., Cavanagh, Hennig, Rodgers and Anderson (1985) and they established reference data of measured foot parameters by radiographic method.

Rodgers (1995), Kapandji (1987), Sammarco (1995), Hamill and Knutzen (1995), Valmassy (1996) and the others occupied themselves with the configuration of medial area of longitudinal foot vault.

TABLE 6
The occurrence frequency of probands in individual categories of foot angle

Foot angle		< 15.0°				15.0°–18.0°				> 18.0°			
n/%		R		L		R		L		R		L	
		n	%	n	%	n	%	n	%	n	%	n	%
3–6 y. (n = 116)	♂	18	15.5	22	18.9	84	72.4	79	68.1	14	12.1	15	12.9
3–6 y. (n = 123)	♀	21	17.1	23	18.6	87	70.7	91	73.9	15	12.2	9	7.3
6–7 y. (n = 65)	♂	14	21.5	14	21.5	42	64.6	39	60	9	13.8	12	18.5
6–7 y. (n = 42)	♀	9	21.4	10	23.8	29	69	26	62	4	9.5	6	14.2
8–9 y. (n = 82)	♂	17	20.7	20	24.4	51	62.2	45	54.9	14	17.1	17	20.7
8–9 y. (n = 83)	♀	15	18.1	12	14.5	59	71.1	50	60.2	9	10.8	21	25.3

Varelas, Wessel, Clement, Doyle and Willey (1993) confirmed on the basis of monitoring the pressure and distribution of vertical forces in the area of foot sole that inadequate maximal physical load as well as insufficient one are always risk factors for foot sole deformation. Its overloading and failure is projected into total and local performance both physical and psychical.

In the clinical and research workplaces in various countries they apply laboratory technique devices for the evaluation of foot condition and function. Various companies offer various devices based on similar principals of detecting the static and dynamic pressure proportion on the foot sole, eventually in punctually defined areas of foot. Devices EMED-SF2-system, EMED-F01 system, FootScan®System, Musgrave Footprint, Pedar S5 and others enable the analysis of pressure forces for foot evaluation, further the establishment of the influence of various illnesses for the loading of the foot and the whole locomotory system, finding out the pressure distribution enables more quality manufacturing of footwear in the form of orthopaedic pads or orthopaedic footwear (utensils inserted directly into the shoe – such as F-Scan in Shoe transducer), (Meyring, Diehl, Milani, Hennig, & Berlit, 1997; Razeghi & Batt, 2002; Rosenbaum, Hautmann, Gold, & Claes, 1994; Přidalová, Seifertová, Elfmark, & Janura, 2003; Virmavirta & Komi, 1993; Virmavirta, Pettunen, & Komi, 2001).

The comparison with the data of other authors is usually problematic in regard with utilization of different methodology for longitudinal foot vault evaluation and other foot parameters.

Brázdilová et al. (1985) was occupied in monitoring of longitudinal foot vault state in her Grant K-76-322-003 final report. The concept of boot-tree innovation on the basis of carried out foot measurements in Czech population. The foot indexes and frequency differentiation are not mentioned.

As far as the length and width, the parameters of our observed groups of children do not differ from the parameters established by Brázdilova et al. (1985).

Similarly there was examination carried out in Czech childs' population in the years 1997–1999, where there were monitored morphological and health parameters of feet in 10 236 children aged 3–19 years (Šťastná, 1997, 2002a, b). Flat foot was diagnosed in boys with higher frequency than in girls (similarly as in our groups). The flat foot occurred in 53.3% of 3 years old boys, only 36.4% in girls. In the process of development the flat foot decline was determined. The flat foot occurrence ranged from 11.1–13.7% in 6 years old up to 8 years old age categories. In girls' group of 6 years old the flat foot was found in 11.5%, in 7–8 years old girls it occurred only up to 5%.

The flat foot in our groups is typical for younger age categories which is conditioned by fat-pad existence in the foot sole. In older children resp. 8–9 years old boys the flat foot can be characterised as pathological deviation of longitudinal foot vault. In this way the orthopaedist or general practitioner should approach it – as a starting point of primary care. The average values of foot index logically decline with age.

In Polish pre-school population there were foot parameters monitored by Nowakowski (2002) and Zeyland-Malawka and Nowakowski (2002), however they evaluated longitudinal foot vault by Wejsflog index (1955). Thus our data were not comparable. Polish colleagues recorded as well the trend of index value decline with age. The representation of flat foot categories was higher in boys than in girls. In the interval 3–6 years was the frequency of flat foot representation declining in individual age categories: in boys from 54% to 16%, in girls from 38% to 3%. In general the decline of foot index with age can be observed both in our children and in Polish children.

Volpon (1994) directed his study to child's foot of new-borns up to 15 years old children with yearly age categorisation. His contact index II. (Qamra et al.) does not enable comparison with our outcomes in regard with to dissimilar index calculation. Again there is obvious its decline from the birth to 6 years. Subsequently the discontinuance of index decline happens and its values appear constant. The frequency of flat foot (resp. low vault foot) occurrence was very low. In 3 years old to 6 years old it ranged to 5%.

Anderson, Blair and Green (1956) published in the predated study the relation between body weight, foot length and the length of lower limbs in children in the age 1–18 years. The authors apart from other things state that the boy's foot is growing even after the age of 12 whereas the girl's foot growth is completed. Concerning the acceleration trends, which express themselves in the area of foot, this statement is probably already unacceptable.

Rose, Welton and Marshall (1985) occupied themselves with flat foot in children as well. They confirmed the occurrence of flat foot in frequency 10% in children over 6 years age limit.

The big and little toe axis aberrations belong to the toes and anterior part of foot deformities and is usual in high frequency already in child's age categories. Valgozity occurs especially in female gender, varozity in male gender.

The comparison with responding fugues was not possible because authors usually don't differ big toe axis aberration to the medial and lateral side. If we compare with results of Brázdilová et al. (1985), it's evident that their values are lower, which is related to the given fact (TABLE 5). We believe that valgozity and varozity should be observed separately for varozity relates to inner rotation (adduction) of anterior-part of foot, it

evidences dissimilarly loaded muscle groups, another distribution of force in planta area, event. shortening of plantar aponeurosis. According Šťastná (2002) the big toe valgozity occurred with lower frequency than in our groups. In boys the frequency went up to 8.5% representation, in girls the valgoze hallux occurrence was up to 12.5% of group.

Contrary those authors Zeyland-Malawka and Nowakowski (2002) mentioned representation of valgoze big toe in more than half of the group and they evaluated the hallux axis aberration (again impossible to compare due to the methods using different means of evaluation) as very high.

Foot deformities in the area of anterior part of foot which we confirmed in our groups of children as well as in Polish population (Zeyland-Malawka & Nowakowski, 2002) are certainly in relation with wearing anatomically unsuitable footwear. This phenomenon has deepened recently in the Czech Republic in last years.

Comparing our results of little toe and the results of Brázdilová et al. (1985), its obvious that our average values of little toe angles are higher in all age groups. In some age groups it reaches double values. Comparing our average values of angle foot with the results of Brázdilová et al. (1985) we can see again higher values in our groups (TABLE 5).

CONCLUSIONS

The principal result was the determination of individual morphological points and parameters on the foot sole so that there would be no methodological inconsistencies in the case of comparing the results of various authors.

Longitudinal foot vault was evaluated in high frequency as normally physiologically developed in both genders. In the highest frequency was represented the category of normally arched foot of II. degree. The category of foot index of I. degree was represented with low frequency. Flat foot was determined in lower percentual representation with regard to normal foot type. In gender differentiation the flat foot was found in 3 years, 4 years and 8–9 years old girls in slightly lower occurrence than in boys of the same age. High feet occurred rarely in younger age categories in both genders.

In younger age categories, we meet higher values of foot index, crossing 40% limit. The average foot index value in boys' groups reached mildly higher limit than in girls. Maximal values of foot index were in boys' groups higher than in girls – over 70% of limits. We can notice mild decline of foot index in both genders in the process of development, with significant difference of index in 3 years old and 6 years old girls.

Relatively satisfactory finding in the foot vault area was completed with alarming results in forefoot deformations. Hallux axis aberration implicates anterior-part of foot deformations on the medial ray of foot. Hallux misalignment was monitored in the sense of valgozity and varozity, we consider this differentiation conditional. Hallux and little toe deformations can implicate traversal vault foot falling in. Hallux axis without aberration was found maximally up to 8 probands in groups. The average values of varozity reached in boys' groups higher values than in girls' group, on the contrary, valgozity values appeared higher in girls. Valgozity representation was higher in boys' groups. In 3–5 years old girls the frequency occurrence of varoze and valgoze hallux was represented almost equally. In girls over 6 years age limit valgozity occurred in much higher frequency than varozity. Maximal values of hallux misalignment were alarming and elusive.

Little toe axis aberration in boys and girls reached similar values. Maximal values crossed limit 30°. In spite that lateral ray has less significant importance for taking off of the foot, it indeed participates anatomical on manifestations and mechanisms of walking. Its deformation is thus projected into the walking pattern in a certain way.

The foot angle reached in individual girls' groups similar values as in boys. In all groups we find the highest frequency representation in category 15° to 18°. The size of foot angle could be in relation to foot valgozity or varozity, even though so far the relation appears not so clear.

The most frequently represented was the Egyptian foot, which appears optimal from the aspect of force and pressure distribution in planta area. Less favourable Antique foot type was represented with much lower frequency. The wide foot type almost did not occur.

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MORFOLOGIE DĚTSKÉ NOHY
(Souhrn agnlického textu)

Studie vypovídá o morfologii nohy jako bazálním článku podpůrně-pohybového systému, jehož stav a funkce ovlivňuje vyšší etáže a psychiku člověka. Morfologie nohy byla sledována u 263 chlapců a 248 dívek předškolního a mladšího školního věku. Děti byly považovány za asymptomaticky zdravé, byly rozděleny dle pohlaví a dle věku. Otisky nohou byly sejmuty plantografickou metodou jako statický plantogram a zpracovány softwarem „Noha".

Stav podélné nožní klenby odpovídal vývojové fázi, jevil se jako uspokojivý, v nejvyšší frekvenci byla determinována normální noha II. stupně. Výskyt ploché a vysoké nohy neznamenal zásadní problém u těchto věkových kategorií.

Ve vysoké četnosti se u obou pohlaví a ve všech věkových kategoriích vyskytovaly deformace palce a malíku, které řadíme k deformacím předonoží. Průměrné hodnoty úhlu palce ve smyslu varozity i valgozity a průměrné hodnoty úhlu malíku se jevily jako relativně vysoké. U chlapců dosahovaly hodnoty úhlu valgózního rozmezí, 2,6–7,9°, u dívek 4,3–8,1°. Průměrné hodnoty varózního vyosení byly vyšší. Úhel malíku se pohyboval u chlapců v rozmezí hodnot 15,4° až 20,4°, u dívek 14,4° až 18,6°. Maximální hodnoty vyosení byly překvapující.

V nejvyšší frekvenci se vyskytoval typ egyptské nohy, který se jeví z hlediska rozložení vertikální síly jako nejoptimálnější. Široká noha, jako méně optimální typ, se téměř nevyskytovala.

Hodnocení podélné nožní klenby odpovídalo jednotlivým fázím ontogeneze. Stav se jevil jako relativně uspokojivý. Analýza morfologických parametrů předonoží prokázala vysoký frekvenční výskyt deformací laterálního a mediálního paprsku.

Klíčová slova: plantografická metoda, podélná nožní klentba, přední část nohy, úhly nohy.

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CATHETER ABLATION FOR ATRIAL FIBRILLATION AND SPECTRAL ANALYSIS OF HEART RATE VARIABILITY

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The results of a short term recording of spectral analysis (SA) of heart rate variability (HRV) in 22 patients with paroxysmal atrial fibrillation (aged 53.69 ± 11.95; 20 male and 2 female) in whom circumferential catheter ablation (CA) was done are presented in this article. Measurement was done in the morning before CA and one day after CA. A standard orthoclinostatic test in three positions (supine–standing–supine) was used. The influence of catheter ablation on SA HRV was identified by standard and complex parameters (Stejskal, Šlachta, Elfmark, Salinger, & Gaul-Aláčová, 2002).

After CA, heart rate increased and almost all individual and complex indexes decreased. This finding gives evidence of reduction of activity in both branches of the autonomous nervous system. Vagal activity reduction was larger, so the sympathovagal balance shifts towards sympathicus.

Keywords: Spectral analysis of heart rate variability, autonomous nervous system, vagal activity, sympatho-vagal balance, atrial fibrillation, catheter ablation.

INTRODUCTION

Spectral analysis (SA) of heart rate variability (HRV) is a non-invasive method enabling us to quantify the activity of the autonomous nervous system (ANS) (Stejskal & Salinger, 1996).

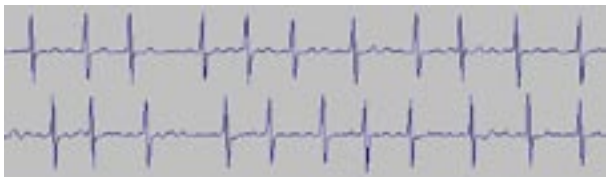
There are three main spectral components in the spectrum of short term HRV recording: VLF (very low frequency, in our modification – 0.02 to 0.05 Hz) – its output is related to the thermoregulatory sympathetic activity of blood vessels, to the level of circulating catecholamines or to oscillations in the rennin-angiotensin system; LF (low frequency – 0.05 to 0.15 Hz) – reflects baroreflex activity in which sympathetic and parasympathetic activity participate; HF (high frequency – 0.15 to 0.50 Hz) – is influenced by efferent vagal activity only (Opavský, 2002; Stejskal & Salinger, 1996; Task Force, 1996).

Atrial fibrillation (AF) is the most common supraventricular tachyarrhythmia characterised by uncoordinated atrial activation with consequent deterioration of atrial mechanical function (Haïssaguerre et al., 1998; Prystowsky et al., 1996). Its prevalence is increasing along with the aging of the population (Fuster et al., 2001; Kannel, Abbott, Savage, & McNamara, 1982; Krahn, Manfreda, Tate, Mathewson, & Cuddy, 1995). On the electrocardiogram (ECG), AF is described by the replacement of consistent P waves by rapid oscillations or fibrillatory waves that vary in size, shape, and timing, associated with an irregular, frequently rapid ventricular response when atrioventricular conduction is intact (Fig. 1) (Gregor & Widimský, 1994; Lukl, 2004; Štejfa et al., 1998).

Symptoms associated with AF vary and depend on several factors including ventricular rate, cardiac function, concomitant medical problems and individual patient perceptions. Most patients complain of palpitations, chest pain, dyspnoea, fatigue, lightheadedness, or syncope (Fuster et al., 2001; Prystowsky et al., 1996). The ANS is a commonly accepted factor participating in arrhythmogenesis (Fuster et al., 2001).

One of the possible treatments for AF is catheter ablation (CA). This ablation procedure is used to terminate AF by introducing a catheter into the heart and

Fig. 1
Atrial fibrillation on the ECG



directing radiofrequency energy to specific areas of the heart's tissue found to be a source of irregular rhythm and the tissue is destroyed (Štejfa et al., 1998). AF often originates from the pulmonary veins (PVs) in many patients, thus circumferential radiofrequency lesions are created around the ostia of PVs with the aim to isolate these veins from the left atrium (Pappone et al., 2001; Stejskal, Fiala, & Salinger, 2003). It assumes that a rather large intervention in the left heart atria produces a disruption of the conduction system and heart innervations and ANS activity will be influenced.

The aim of the study was to analyze and to interpret changes in ANS activity after catheter ablation in patients with AF. The influence of catheter ablation on SA HRV was identified by standard and complex parameters (Stejskal et al., 2002).

METHOD

This research was done in 2002–2004 in the Faculty hospital in Olomouc and the Podlesí hospital in Třinec. We tested 22 patients aged 53.69 ± 11.95 years (20 men, 2 women), who had been suffering from atrial fibrillation for 8.45 ± 6.67 years. In these patients, circumferential catheter ablation (CA) was done. Measurement of SA HRV was done in the morning before CA and one day after CA. All patients were informed about the SA HRV examination in advance and they agreed to it.

We measured HRV by means of the original VarCor PF5 hardware and software, which was produced by the Faculty of Physical Culture in Olomouc (Salinger et al., 2003). Information about measurement is displayed in graphical (graphical output of an ECG signal and a column graph of calculated R-R intervals) and numerical forms (duration time of all examinations, duration times of individual procedures and values of current HR) on the Pocket PC display (Fig. 2), which enables direct visual control of the recording while measuring (Salinger, 2004).

Fig. 2
Graphical and numerical output on the Pocket PC display during measuring

The number of the recordings of cardiac cycles was increased from 300 to 330 in each position of the orthoclinostatic test because of the time data stability and the possibility of improving the filtration of heart contractions not related to the regular activity of the sinus node (Stejskal & Salinger, 2003). The more frequent multiple arrhythmias and artefacts are, the less reliable the analysis of the record is (Stejskal & Salinger, 1996). Artifacts can be cleared away automatically or manually at the end of the measurement. Only patients with sinus rhythm on the ECG during measuring were chosen for this research. For the SA HRV calculation the standard number of 256 R-R intervals was used.

The SA HRV measurement was done in a standardized manner – in the morning, on an empty stomach, in a quiet room and before all other examinations. The patients kept their eyes closed during the entire testing process in order to reduce disturbance in perception. The patients were examined by means of an orthoclinostatic test in three positions (supine-standing-supine). In each position subjects stayed until 330 heart contractions had been recorded (approximately six minutes). ECG registration started 45 seconds after changing each position, thus all periods of measurement were carried out in steady state. The ECG record from the first position was not evaluated and this was only used for measurement standardization.

The following individual SA HRV parameters for statistical processing were chosen: total spectral power (P_T), spectral power of individual components (P_{VLF}, P_{LF}, P_{HF}), coefficients of variance of the individual component (CCV VLF, CCV LF, CCV HF), percentage of the individual components (%VLF, %LF, %HF), frequencies of the individual components (fVLF, fLF, fHF) and ratios between individual components (VLF/HF, LF/HF, VLF/LF) in a second supine position from the supine-standing-supine test. From among time domain parameters the MSSD parameter was chosen; this parameter is accepted as a vagal activity index. Further, the heart rate (HR) was monitored and recorded.

In addition to these parameters, also the complex indices of SA HRV were calculated: a complex index of the total score of SA HRV (TS), a complex index of vagal activity (VA), and a complex index of sympatho-vagal balance (SVB) (Stejskal et al., 2002). The values of complex indexes are expressed in points within a range of 10 points (from –5.0 to +5.0 points). Normal values of TS range from –1.5 to +1.5 points, normal values of VA and SVB range from –2.0 to +2.0 points (Stejskal, Jakubec, Přikryl, & Salinger, 2004).

Of basic statistical characteristics, mean (M) and standard deviation (SD) were calculated. The overwhelming majority of the data was not up to normal data distribution standards (according to the Kolmogorov-Smirnov and Anderson-Darling statistical tests), that is

why the nonparametric paired Wilcoxon test was used. The data were statistically processed by means of software programs SPSS and Microsoft Excel. The α level was established at the 0.05, 0.01 and 0.001 levels.

RESULTS

HR significantly increased after CA (on an average of 12 beats/min), complex TS and VA parameters significantly decreased while the complex SVB index decreased insignificantly. P_T, P_{VLF}, P_{LF}, P_{HF}, its coefficients of variance (CCV VLF, CCV LF and CCV HF) and the time domain index MSSD after CA, significantly decreased. The average values of %HF decreased and %VLF increased; both shifts were insignificant, while %LF significantly decreased. The increase in VLF/HF ratio and LF/HF ratio after CA was not significant; VLF/LF increased significantly. The frequency of the LF component significantly decreased while fVLF increased insignificantly; the frequencies of both components moved closer to each other significantly ($p < 0.01$); fHF significantly increased after CA (TABLE 1).

DISCUSSION

HRV is influenced by many external and internal factors, therefore standardization of measurement is necessary (measuring at the same times of day, minimizing sensual stimulations – quiet room, closed eyes during

TABLE 1
Comparison of SA HRV parameters in the morning before and one day after catheter ablation (n = 22; 20 men, 2 women, age 53.69 ± 11.95 years)

Index		Before CA	After CA		Index		Before CA	After CA	
TS [points]	*M*	-2.24	-4.62	**	**% VLF [%]**	*M*	32.11	44.39	ns
	SD	2.41	0.96			*SD*	22.68	23.61	
VA [points]	*M*	-2.01	-4.04	**	**% LF [%]**	*M*	30.73	22.72	*
	SD	2.11	0.97			*SD*	17.17	13.67	
SVB [points]	*M*	-0.56	-1.49	ns	**% HF [%]**	*M*	37.16	32.89	ns
	SD	2.28	2.69			*SD*	24.41	29.79	
P_T [points]	*M*	-1.43	-4.54	***	**VLF/HF**	*M*	2.83	3.93	ns
	SD	3.37	1.20			*SD*	5.36	4.65	
P_T [ms^2]	*M*	1522.81	149.34	***	**LF/HF**	*M*	1.57	1.64	ns
	SD	2272.15	244.76			*SD*	1.46	1.51	
P_{VLF} [ms^2]	*M*	456.63	72.66	**	**VLF/LF**	*M*	2.03	3.81	*
	SD	1050.31	142.62			*SD*	3.05	5.27	
P_{LF} [ms^2]	*M*	385.89	39.03	***	**fVLF [mHz]**	*M*	27.71	29.11	ns
	SD	497.25	67.75			*SD*	6.22	8.08	
P_{HF} [ms^2]	*M*	680.29	37.65	**	**fLF [mHz]**	*M*	85.63	66.92	*
	SD	1506.32	58.38			*SD*	32.15	14.84	
CCV VLF [%]	*M*	1.63	0.72	**	**fHF [mHz]**	*M*	245.54	299.63	**
	SD	1.57	0.50			*SD*	82.08	64.30	
CCV LF [%]	*M*	1.68	0.51	***	**fLF-fVLF [mHz]**	*M*	57.91	37.80	**
	SD	1.29	0.36			*SD*	33.73	19.49	
CCV HF [%]	*M*	1.82	0.50	***	**MSSD [ms^2]**	*M*	1908.96	144.53	***
	SD	2.04	0.30			*SD*	4033.08	197.36	
					HR [beat/min]	*M*	62.59	70.87	**
						SD	12.75	16.00	

M – average value; *SD* – standard deviation; CA – catheter ablation; TS – total score of SA HRV; VA – complex index of vagal activity; SVB – complex index of sympatho-vagal balance; P_T [points] – total spectral power (point value). Indexes from the second supine position from the supine-standing-supine test: P_T – total spectral power; P_{VLF}, P_{LF}, P_{HF} – spectral power of VLF, LF, HF components; CCV – coefficient of variance; % – relative part of individual component in total power; VLF/HF, LF/HF, VLF/LF – ratio of spectral power of individual components; fVLF, fLF, fHF – frequency of individual components; fVLF–fLF – distance between fVLF a fLF; MSSD – root mean square of consecutive R-R intervals; HR – heart rate; *** $p < .001$; ** $p < .01$; * $p < .05$; ns – no significant difference.

the examination, etc.) (Opavský, 2002; Stejskal & Salinger, 1996). In spite of the effort of the nursing staff it was not possible to maintain all conditions; especially the length of time of the examination oscillated within the range of more than two hours.

Patients used antiarrhythmics (most often propaphenone, sotalol and amiodaron), which may have influenced the HRV measurements. However, Vikman et al. (1999) did not find significant differences in AF patients who were on medication as opposed to in those who were not on medication, which suggests that cardiac medication itself had no major effect on HRV observations. In any case, the important fact is that within our measurement (before and after CA) each patient was on the same medication, because potential changes of medication occur after one month following CA.

Before CA the average values of age adjusted P_T were, in comparison to the healthy population (Stejskal et al., 2002), slightly reduced (–1.43 points). This finding confirmed that in patients with AF is changed ANS activity (Stejskal, Fiala, & Salinger, 2003) and a significantly lower P_T in comparison with the healthy population (Galuszka, Stejskal, Lukl, & Zapletalová, 2002) can often be found. The main reason for ANS activity reduction (the low average value of TS) is, in the first instance, vagal activity reduction: the complex index of vagal activity (VA) is decreased and individual parameters of vagal activity (P_{HF} a CCV HF) are low as well. Galuszka et al. (2004) came to a similar conclusion that, in patients with AF, in comparison to healthy population, P_{HF} is reduced.

However, in lower ANS activity, relatively low sympathetic activity participates as well – the average value of the complex index of sympatho-vagal balance (SVB) is normal and %VLF and VLF/LF and VLF/HF ratios do not point to a noticeable predominance of sympathicus. This finding proved also an average value of HR, which corresponds to normal values of HR in the healthy population.

From individual patient data it is evident that it is not possible to generalize that all patients with AF have lower ANS activity. A criterion for an ANS state can be TS values – TS < –1.5 points (low ANS activity), –1.5 points > TS < 1.5 points (normal values of ANS activity), TS > 1.5 points (high ANS activity). According to this criterion our group of patients can be divided into three subgroups: 16 patients had lower ANS activity, 3 patients had normal ANS activity and 3 patients had higher ANS activity. This finding means that approximately in 27% of the patients ANS activity reduction was not found. According to Huang, Wen, Lee, Chang and Chen (1998), minimally two types of AF can be distinguished – the vagal and sympathetic type. The so called sympathetic type of AF can be found mostly in patients with organic based disease; in these patients there is usually a low value of P_{HF} and an increased LF/HF ratio. In our patients we found this type of AF in approximately 32% of cases. Patients with the so called vagal type of AF usually have an idiopathic form of AF. The beginning of paroxysm is connected with P_{HF} increase and LF/HF ratio decrease. We found this type of AF in almost 14% of our patients. In the rest, 54% of the patients, 40% of them had ANS activity rather lower, but a dominance of some branch of ANS was not unambiguously expressed; in about 14% of the patients ANS activity corresponds to the normal healthy population.

All complex parameters (TS, VA and SVB) decreased after CA (Fig. 3). The decrease of all spectral power components (P_T, P_{VLF}, P_{LF}, P_{HF}) and their coefficients of variance (CCV VLF, CCV LF a CCV HF) and time domain index MSSD was significant as well. This finding gives evidence of reduction activity in both branches of ANS after CA; vagal activity reduction was larger.

This finding was more evident in patients with normal or higher ANS activity and dominance of vagal activity before CA. On the contrary, in patients with reduced vagal activity before CA, the changes after CA were lower. This fact influenced statistical evaluation of SA HRV results only in indexes of sympatho-vagal balance (SVB, %VLF, VLF/HF and LF/HF), where the shift from parasympathetic towards sympathetic was not statistically confirmed (TABLE 1). Thus we can say that ANS activity in both branches of ANS was reduced; vagal activity reduction was larger so sympatho-vagal balance shifts towards sympathicus.

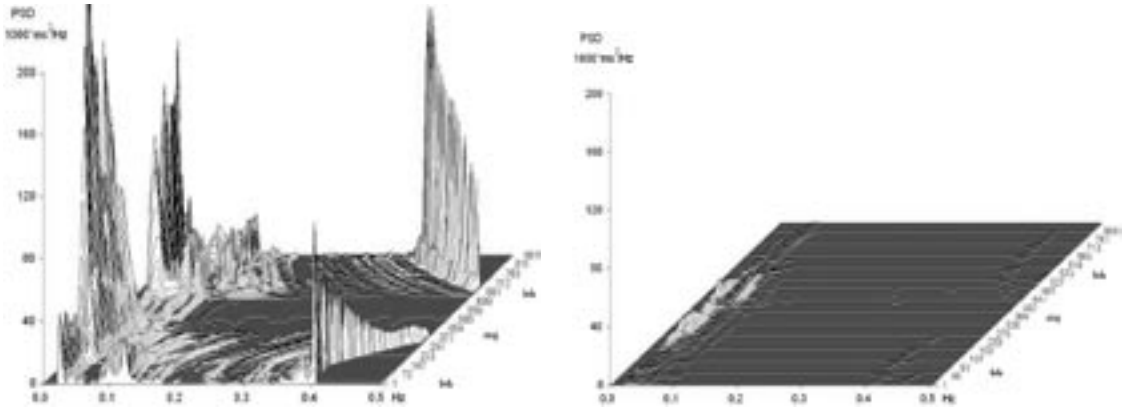
The decrease of HRV parameters and increase of LF/HF ratio after CA was also found by Pappone et al. (2004). This fact is, according to them, evidence of parasympathetic attenuation by pulmonary vein denervation during CA. However their previous study (Pappone et al., 2001) pointed to P_{HF} increase and LF/HF ratio decrease after circumferential CA. The authors described it as a shift of sympatho-vagal balance towards vagus, which is an opposite finding to that in their study of 2004. If we take the results of our patients with different levels of ANS activity separately, we can find in most of our patients with low ANS activity a decrease of LF/HF ratio after CA and, on the contrary, in most of the patients with normal or higher ANS activity, LF/HF ratio increased after CA. The possible explanation of different results of Pappone's et al. studies is then a different level of ANS activity of their patients in each study.

Vagal activity reduction after CA resulted in a significant increase of HR, which corresponds with results of Pappone et al. (2004); according to these authors HR returned to preablation values within six months after CA.

The significant decrease in activity in the sympathetic and mainly in the parasympathetic part of ANS is evidence of the isolation of the area starting up AF and also of the interruption of vagal afferentation from the

Fig. 3
Three-dimensional graph of SA HRV and tabular comparison of complex SA HRV parameters in the morning before and one day after CA in a 46-year patient with AF
CA – catheter ablation; TS – complex index of total score; VA – complex index of vagal activity; SVB – complex index of sympatho-vagal balance; P_T [points] – total spectral power (point value).

Before CA ***After CA***



Index	*Before CA*	*After CA*
TS [points]	1.48	–5.00
VA [points]	0.81	–4.27
SVB [points]	2.75	–2.00
P_T [points]	3.76	–5.00

pulmonary vein region after CA. Restoration of a new balance comes up after one (Hsieh et al., 1999), six (Pappone et al., 2004), or more months; for instance according to Stejskal et al. (2003), ANS activity gradually increased even one month after CA. Detailed investigation of ANS activity after CA over time will be the topic of our next research project.

CONCLUSION

Although the number of examined patients with paroxysmal atrial fibrillation is not large, it does not seem correct to say that all patients have altered ANS activity. CA gets to decrease ANS activity in all patients with AF, first of all because of vagal activity reduction. SA HRV evaluation using complex indexes enables us to make a more complex evaluation of both branches of ANS.

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KATETROVÁ ABLACE PRO FIBRILACI SÍNÍ A SPEKTRÁLNÍ ANALÝZA VARIABILITY SRDEČNÍ FREKVENCE

(Souhrn anglického textu)

Cílem studie bylo zkoumání vlivu katetrové ablace na parametry spektrální analýzy (SA) variability srdeční frekvence (HRV). Krátkodobý záznam SA HRV byl snímán u skupiny 22 pacientů s paroxysmální fibrilací síní (FS) ve věku 53,69 ± 11,95 let (20 mužů a 2 ženy), u kterých byla provedena cirkumferenční katetrová ablace (KA). Měření probíhalo ve třech polohách (leh-stoj-leh), za standardizovaných podmínek, ráno před KA a jeden den po KA. K vyhodnocení výsledků byla použita jak standardní, tak nová metodika hodnocení SA HRV pomocí komplexních ukazatelů.

Po KA pro FS došlo ke zvýšení srdeční frekvence (SF) a zhoršení většiny jednotlivých i komplexních ukazatelů. Tento nález svědčí o redukci aktivity obou větví autonomního nervového systému. Protože snížení aktivity vagu je výraznější, posouvá se sympatovagová rovnováha mírně směrem k sympatiku.

Klíčová slova: spektrální analýza variability srdeční frekvence, autonomní nervový systém, aktivita vagu, sympatovagová rovnováha, fibrilace síní, katetrová ablace.

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Scientific orientation

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MEASUREMENT OF BREATHING FREQUENCY FROM ECG IN THE EXAMINATION OF AUTONOMOUS NERVOUS SYSTEM ACTIVITIES: SUGGESTED METHODS AND THEIR VERIFICATION

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From a wide range of methods pertaining to breathing frequency measurement we opted for the less frequent method of breathing frequency diagnosis originating from the assessment of changes in ECG signal parameters pursuant to changes in thoracic volume during expiration and inspiration. The principal reason for selecting this method was in the fact that in the assessment of autonomous nervous system (ANS) activity the ECG signal is monitored and this can also be used for diagnosing breathing frequency. Changes in ECG signal parameters were analysed by the method of spectral analysis of heart rate frequency (BFrr), the method of spectral analysis of variability amplitudes of QRS complexes (BFqrs) and time analysis of periodicity in amplitudes changes of QRS complexes (BFv) in order to suggest the optimal method of measuring breathing frequency. Monitoring of the ECG signal and calculation of ECG parameters, including the mentioned analysis, were processed by the VarCor PF6 system with modified programme equipment. Statistical verification of the selected method and recommendation of the optimal method for breathing frequency measurement was carried out with the help of reference values of breathing frequency at 9 and 12 cycles/min that were via acoustic signals transmitted to the tested subjects.

Characteristics of the sample set: 55 men and women aged 22.7 ± 2.4 years, measurement was done in the positions supine 1 – standing – supine 2, the total number of statistically processed sets was n = 118.

Based on the statistical results where the significance of differences between average values regarding reference values were tested by t-test and furthermore, based on the calculation of values based on absolute differences between breathing frequencies, the BFqrs method was recommended since it allows for diagnosing breathing frequency in the range of 6–25 cycles/min. The designed method will be applied to the existing algorithm of the diagnostic system VarCor PF6, thereby helping to specify the interpretation of the results of ANS examination.

Keywords: ECG signal, QRS complex, breathing frequency, heart rate variability, spectral analysis, autonomous nervous system.

INTRODUCTION

The autonomous nervous system (ANS) function is distinctively influenced by respiration (Kolisko et. al, 2003), manifesting itself (from the frequency point of view) mainly in the vagal (HF) frequency spectrum between 0.15–0.4 Hz that corresponds with a breathing frequency of 9–24 cycles/min. Dividing ANS into two subsystems – parasympathetic (n. vagus) and sympathetic (truncus sympathicus) coheres with optimal control of the body either under resting conditions or with a different physical as well as psychological (stressful) load. This is why diagnostics of neuro-vegetative reactivity in the body, defined as the actual condition of both subsystems of ANS, is steadily increasing and the focus here is on determining, as precisely as possible, the factors that may negatively influence the results of examination and in some cases may cause misinterpretation of the conducted ANS examination. One of the effects significantly influencing heart rate (HR) values is the breathing pattern, respectively the relation between breathing volume and breathing frequency (BF). The principle of ANS examination, originating from frequency (spectral) analysis of heart rate variability (SAHRV) lies in calculating the parameters of power spectral density (PSD) in a total frequency zone of 0.02–0.4 Hz divided into zones VLF (0.02–0.05 Hz), LF (0.05–0.15 Hz) and HF (0.15–0.4 Hz) and further, among others, also in calculating the average values of frequencies f_PSD_{VLF}, f_PSD_{LF} and f_PSD_{HF} corresponding with maximal values of PSD in particular frequency zones. With regard to the fact that respiratory frequency characterises respiratory bound activity of the parasympathetic system, resp. vagus, Kolisko et. al.

(2004) and with regard to the fact that the inter-relation between breathing, vagus activity and the occurrence of respiratory sinus arrhythmia is known (Grossman, Kollai, & Mitzey, 1990; Grossman, Karemaker, & Wieling, 1991; Grossman, 1992a; Grossman, 1992b; Saul et al., 1989), we find that in people with spontaneous breathing frequency higher than 9 cycles/min the respiratory bound activity of vagus lies in the frequency zone HF. It is possible to verify this fact by observing the values of the frequency of maximal values PSD in the HF zone, or eventually, the LF zone, during different values of rhythmised breathing. The problem during assessment of SA-HRV results is the decline of breathing frequency below 9 cycles/min, transitioning from HF frequency zone to the LF zone (Kolisko et al., 1997, 2001, 2004). This fact causes distortion of examination results of vagus activity using the SAHRV method, leading to misinterpretation of the actual functional state of ANS. This situation appears in people with spontaneous bradypnoea of 9 or less cycles/min when the breathing frequency is not observed by the examiner during examination. The second reason why it is necessary to diagnose breathing frequency during ANS examination is the documented positive enhancement of the spectral power of respiratory bound vagus activity together with a decrease in breathing frequency (Kolisko et al., 1997; Kolisko et al., 2004) and even in the range of the HF frequency zone (Vlčková et al., 2005).

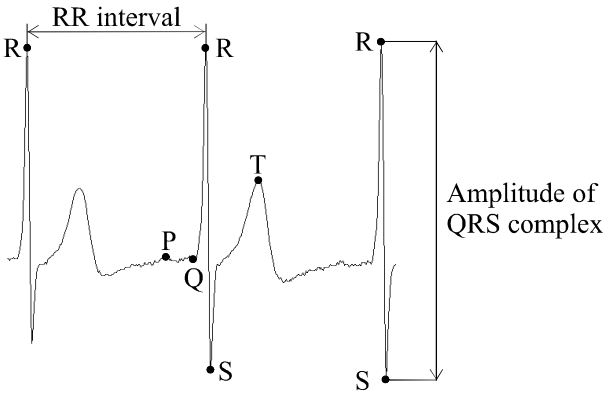
These facts purposefully proclaim the introduction of an innovated diagnostic system that allows, in addition to the existing ANS examination, monitoring of actual BF value at the same time. For reasons of minimal influence on ANS examination results it was necessary to propose and verify the methods of BF measurement originating from changes in ECG signal parameters pursuant to changes in thoracic volume during inspiration and expiration.

METHODS

For precise interpretation of SAHRV results permitting accurate assessment of ANS activity it is necessary to determine the breathing frequency as well. From the entire range of BF measurement methods we concentrated on the less used method originating from evaluation of changes in ECG parameters secondary to changes in thoracic volume during inspiration and expiration. The principal reason for selecting this method lay in the fact that for the purposes of diagnosing ANS activity, the ECG signal is monitored, which can also be used for BF diagnosis. For this objective, when monitoring the ECG signal, calculation of SAHRV parameter and calculation of BF values from the ECG pattern were adopted in the existing diagnostic system VarCor PF6 (Salinger et al., 2003) with modified programme equipment.

Among the changing ECG parameters as a consequence of BF belong the heart rate (HR), characterised by the size of RR intervals that increase during breathing in and decrease with breathing out. Another significant changing parameter dependent on BF is the sum of amplitudes of R and S waves (amplitude of QRS complex) – Fig. 1, which increases during inhaling and during exhaling it attains minimal values. These changes in amplitudes of QRS complexes of ECG during breathing are caused by change of position in the electrical cardiac vector with respect to tightly placed electrodes on the ventral side of the chest that during breathing out exhibit changes in volume (Kapandji, 1974; Véle, 1997).

Fig. 1
ECG parameters dependent on breathing frequency



A complete summary of the methods assessing breathing frequency (BF) on the basis of ECG changes is presented in the block scheme in Fig. 2. The periodicity of these changing parameters dependent on breathing frequency allows BF calculation by standard mathematical means suitable for data processing in time and frequency (spectral) spheres. In the block scheme in Fig. 2 the broken line depicts the method using assessment of the changes in the time parameters of RR intervals, which is not suitable for BF measurement since, in changes to RR intervals also participate, apart from BF, the activity of ANS subsystems – sympathetic and parasympathetic causing equivocation or impossibility of detection maximums and minimums.

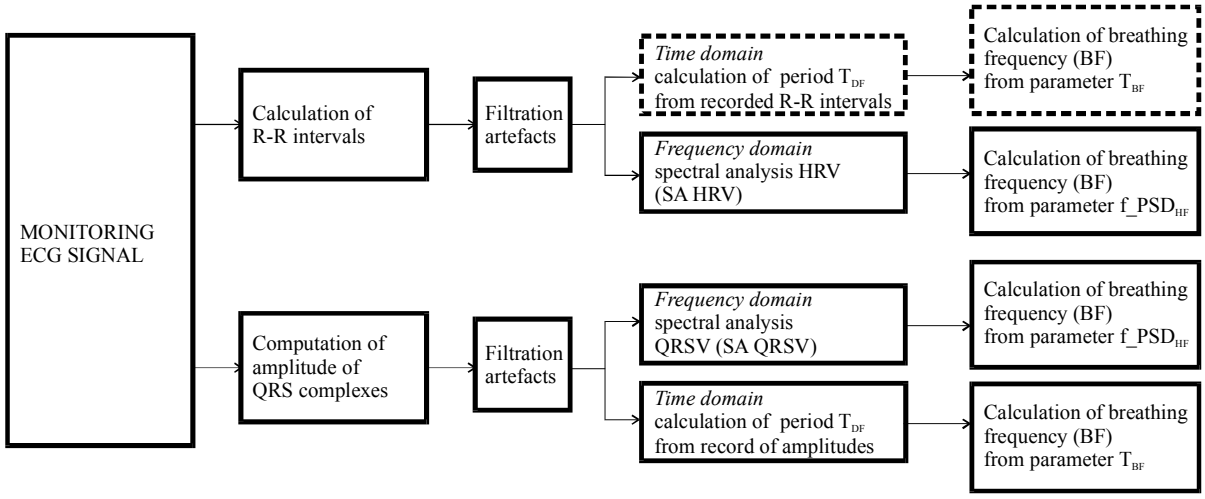
Principles of experimental methods

The remainder of methods stated in the block scheme in Fig. 2 were verified with respect to BF measurement accuracy and their utility during ANS examination. The following are methods of BF measurement:

- *Method BFrr*

The principle applied here is spectral analysis of heart rate variability (Salinger et al., 2003) where the

Fig. 2
Summary of methods allowing assessment of breathing frequency from ECG signal

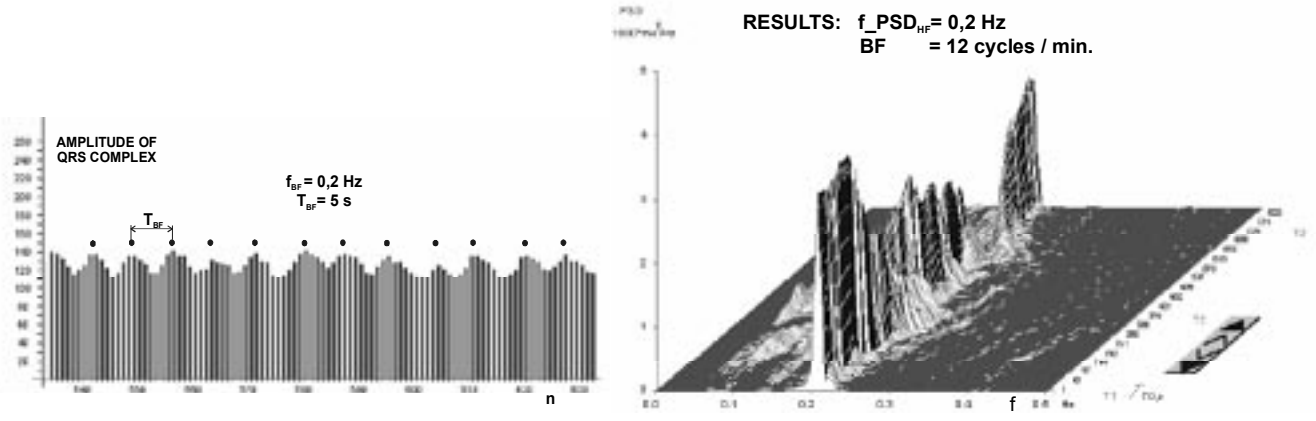


input is a time series formed by 300 RR intervals, measured with 1 ms accuracy. The output parameter for calculating BFrr is the average value of frequency f_PSD_{HF}, corresponding to the maximum of power spectral density (PSD) in the HF zone.

- *Method BFqrs*

The algorithm of this method is consistent with the previous method of SAHRV where the input is in the form of time series formed by 300 amplitudes of QRS complexes. The results are parameters of the spectral analysis of amplitudes variability in QRS complexes (SAQRSV) from which the parameter f_PSD_{HF} corresponding to maximum PSD in frequency sphere LF and HF is used for calculating BFqrs value, as graphically illustrated in Fig. 3. Measurement was carried out in the positions supine 1 – standing – supine 2. From Fig. 3 the differences in maximal PSD values in particular positions is evident and these are caused by the differing extent of changes in thoracic volume in the supine 1 (2) and standing positions. These changes, however, do not influence either f_PSD_{HF} or BFqrs values.

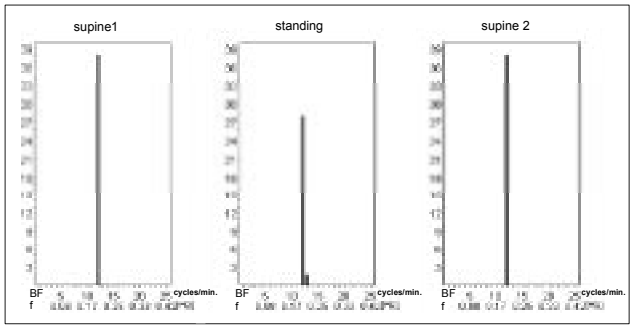
Fig. 3
A – Record of amplitudes of QRS complexes; B – Graphic output of spectral analysis of variability amplitudes of QRS complexes for controlled breathing BF12, measured by VarCor PF6 system



A B

Legend
PSD – power spectral density; f – frequency of spectrum of zones VLF, LF and HF; T1, T2 and T3 – moments of starting position supine 1– standing – supine 2

Fig. 4
Histogram BF in positions supine 1, standing, and supine 2 for value of controlled breathing at 12 cycles/min



Legend
n – number of breathing cycles in measured intervals of 300 amplitudes QRS complex; f – values of BF [cycles/min]

- *Method BFv*

It implies a time series resulting from the measurement of maximum/minimum periods (T_{BF}) formed by amplitudes of QRS complexes – see Fig. 3 A. The results are the values of BFv mentioned in Fig. 4 in the form of histograms for specific measured positions (intervals).

Course of experiment and collection of data

Verification of accuracy of each method and their mutual comparison was performed with the help of reference values of BF9 breathing frequencies corresponding to the constant of 9 cycles/min and BF12 corresponding to 12 cycles/min. Reference values of breathing frequency were transferred to the tested subjects through acoustic order.

Data sets were divided according to the realised experimental methods – BFrr, BFqrs and BFv. Measurement encompassed monitoring of ECG signals by means of electrodes placed on the ventral side of the chest and by calculating RR intervals and amplitudes of QRS complexes further in BF calculation according to the algorithms of the already mentioned methods. A total of 55 men and women aged 27 ± 2.4 years participated in the measurement where each passed the measurement for particular reference breathing frequency BF9 and BF12. Each measurement was carried out in the positions supine 1 – standing – supine 2. Due to artefacts in ECG records and severe faults in experimental methods caused by application of the automated measurement of amplitudes of QRS complexes, still unverified in practise, a total of n = 118 records for each of the verifying experimental methods remained to be statistically processed. The VarCor PF6 diagnostic system, together with the source of acoustic signal, type Smarton SM 88, was used for obtaining data.

Statistical processing of experiments

Measured and calculated values of particular breathing frequency in the selected experimental methods were statistically processed through the STATISTICA programme, version 6.0. Besides calculating fundamental statistical parameters, the results of particular experimental methods encompassing BFrr9, BFqrs9 and BFv9 were indicated by reference value BF9, and BFrr12, BFqrs12 and BFv12 by reference value BF12, tested from the aspect of normal distribution with the help of the Kolmogorov–Smirnov test and from the point of view of the significance of differences with the help of t-tests of averages regarding reference values of controlled breathing BF9 and BF12, characterised by a zero value of standard deviation. With the exception of statistical assessment of results of the experimental method, individual methods were judged also from the aspect of absolute differences calculated from average values of single experimental methods and reference values of BF.

RESULTS

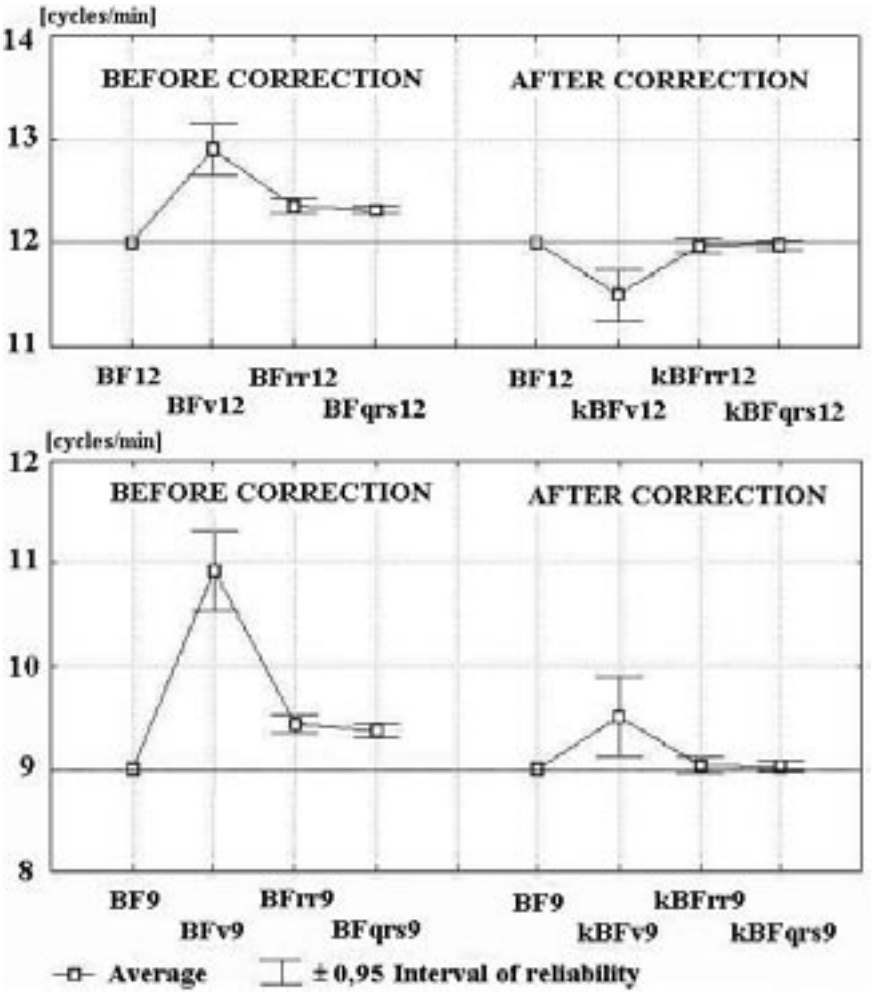
The average values and interval of reliability of particular experimental methods for reference value BF9 for BFrr9, BFqrs9 and BFv9 and for BFrr12, BFqrs12 and BFv12 by reference BF12 are graphically displayed in Fig. 5. With regard to the fact that differences in average values of breathing frequency in using the applied method mutually differ, for BF9 and BF12 values we calculated correction coefficients common to the given experimental methods and to the selected frequency range of BF. The stated correction coeficients were determined with the help of average values of differences between reference values BF9 and BF12 and the particular methods of BFv, BFrr and BFqrs – TABLE 1. In doing so, the existing values of breathing frequencies BFv, BFrr and BFqrs, with the help of correction coefficients, were transformed to kBFv, kBFrr and kBFqrs values.

TABLE 1
Calculation of correction coefficients for BFv, BFrr and BFqrs methods

	BFv	BFrr	BFqrs
BF12	0.9045	0.3521	0.3181
BF9	1.9158	0.4304	0.3690
Average (correction coefficient)	**1.4101**	**0.3912**	**0.3435**

Calculation of transformation values of breathing frequencies for particular experimental methods and for selected values of controlled breathing BF9 and BF12 was implemented according to the formulas described in TABLE 2. The average values of breathing frequen-

Fig. 5
Average values of breathing frequency and their reliability interval before and after performed correction for values of controlled breathing at 9 and 12 cycles/min



cies including their interval of reliability at ± 0.95 before and after correction are presented in graphical form in Fig. 5.

TABLE 2
Transformation formula

kBFv12 = DFv12 – 1.4102	**kBFv9** = DFv9 – 1.4102
kBFrr12 = DFrr12 – 0.3912	**kBFrr9** = DFrr9 – 0.3912
kBFqrs12 = DFqrs12 – 0.3435	**kBFqrs9** = DFqrs9 – 0.3435

From the results presented in Fig. 5, it means that before and after correction there is evidently a low value of the interval of reliability in the BFrr and BFqrs methods, and additionally, in the corrected values there are small systematic errors, thereby inferring a difference in their averages from the defined values of controlled breathing (BF9 and BF12).

All measured as well as corrected values of breathing frequencies were judged from the perspective of the statistical significance of differences in the results of particular methods. For this judgement we used the t-test of averages against a reference constant, for our purposes the values of BF9 and BF12. The results for reference value BF12 and for n = 118 are presented in TABLE 3. From the results of this test there is an evident statistically insignificant difference between the average values of kBFqrs12 and kBFrr12 with regard to reference value BF12, that means corrected values of the methods BFqrs and BFrr. In the method of BFv measurement, a significant statistical difference in averages against the reference value of BF12 in corrected values on a significant level of $p < 0.05$ (bold line) was proved.

The results of the t-test for statistical significance of differences among results of experimental methods toward the reference constant BF9 for n = 118 are presented in TABLE 4. An insignificant statistical difference

TABLE 3
Test of averages of experimental methods against reference constant BF12

	t-test of averages against reference constant (value)						
Variable	Average	St. dev.	n	St. error	RC	t	p
BF12	12.00000	0	118		12.00		
kBFv12	***11.49434***	***1.349597***	***118***	***0.124240***	***12.00***	***- 4.06998***	***0.000086***
kBFrr12	11.96097	0.407754	118	0.037537	12.00	-1.03966	0.300642
kBFqrs12	11.97460	0.224060	118	0.020626	12.00	-1.23135	0.220662

TABLE 4
Test of averages of experimental methods against reference constant BF9

	t-test of averages against reference constant (value)						
Variable	Average	St. dev.	n	St. error	RC	t	p
BF9	9.00000	0	118		9.00		
kBFv9	***9.50565***	***2.096417***	***118***	***0.192991***	***9.00***	***2.62009***	***0.009956***
kBFrr9	9.03920	0.450679	118	0.041488	9.00	0.94492	0.346645
kBFqrs9	9.02550	0.307266	118	0.028286	9.00	0.90150	0.369173

Legend
St. dev. = standard deviation, n = number of those which are valid, St. error = standard error, RC = reference constant, t = value of tested criterion, p = level of statistical significance

in averages was also found in the values kBFqrs9 and kBFrr9, that means in corrected values of the method BFqrs and BFrr. In experimental method of measurement BFv, a statistically significant difference of averages against reference value BF9 in corrected values on the significance level of $p < 0.05$ (bold line) was proved.

Besides assessment of statistically significant differences among particular methods the results of BF were also used for determining absolute differences in the applied methods. For this assessment we used average values and values of standard deviations of individual experimental methods for controlled breathing at 9 and 12 cycles/min and the values of variation coefficient (V) expressing the ratio of average value and standard deviation. The lowest values of variation coefficients were reached in using the method BFqrs (TABLE 5) where for kDFqrs12 the value of variation coefficient is V = = 1.9% and for kDFqrs9 it is V = 3.4% . These values are in bold characters in the TABLE 5.

For integrity we present in TABLE 6 the average values and standard deviation of absolute differences in BF results for particular experimental methods and reference values BF9 and BF12. The lowest difference in averages and standard deviation were reached in the BFqrs method for both values of controlled breathing when (BF12 - kBFqrs12) = 0.138678 ± 0.159407 cycles/min and (BF9 - kBFqrs9) = 0.179110 ± 0.250426 cycles/min. These values are in bold characters in TABLE 6.

TABLE 5
Calculation of variation coefficients

Variable	Average [cycles/min]	St. dev. [cycles/min]	V [%]
kBFv12	11.49434	1.349597	11.7414
kBFrr12	11.96097	0.407754	3.409038
kBFqrs12	***11.97460***	***0.224060***	***1.871127***
kBFv9	9.50565	2.096417	22.05443
kBBFrr9	9.03920	0.450679	4.985828
kBFqrs9	***9.02550***	***0.307266***	***3.404421***

Legend
St. dev. = standard deviation, V = variation coefficient

TABLE 6
Calculation of absolute differences of methods used regarding reference values DF12 and DF9

Variables	Average [cycle/min]	St. dev. [cycle/min]
BF12 - kBFv12	1.171525	0.834837
BF12 - kBFrr12	0.208288	0.350758
BF12 - kBFqrs12	***0.138678***	***0.159407***
BF9 - kBFv9	1.587765	1.452684
BF9 - kBFrr9	0.192783	0.408875
BF9 - kBFqrs9	***0.179110***	***0.250426***

Legend
St. dev. = standard deviation

DISCUSSION

From the attained results it can be clearly inferred that for measuring breathing frequency from ECG, from the point of accuracy, the least suitable method is kBFv. The reason for this is probably in the inadequate amount of sampling levels of the 8 bit analog-digital converter used, because during analysis of maximal amplitudes of QRS we repeatedly observed two identical values of amplitudes. From the time aspect, this means inaccuracy in determining maxima of QRS signal amplitudes within the time range 2 s, that can correspond with the discovered inaccuracy of this method. Hence it would perhaps be suitable to verify, for kBFv method analog-digital converters with the number of sampling levels corresponding to 9 or 10 bits. The advantage with the kBFv method is monitoring of immediate breathing frequency unlike kBFrr and kBFqrs methods that, from the accuracy perspective, are suitable but allow assessing only of the average value of BF in the measured interval.

CONCLUSIONS

From statistical processing of the results characterising particular experimental methods of diagnosis of breathing frequency regarding reference values of 9 and 12 cycles/min, it is evident that insignificant statistical differences were observed in BFrr and BFqrs methods. These methods analyse, as far as the spectral aspect is concerned, sets created by heart rate and amplitudes of QRS complexes of the ECG. With respect to the fact that ANS immediately, by its own subsystems – sympathetic and vagus effects the size and changes of heart rate, the set given by heart rate values is used for reflexive assessment of their activities.

For this purpose a method spectral analysis of heart rate variability is used that in frequency zones VLF, LF and HF quantifies, through parameter spectral power, the effect of sympathetic and vagus. With respect to the fact that frequency zone HF is mainly characterised by breathing bound activity of the vagus which corresponds to breathing frequency in the range of 9 to 24 cycles/min, in case of bradypnoea, it means BF less than 9 cycles/min representing a shift of breathing bound activity of vagus from the HF zone to frequency zone LF characterising baro-receptor activity. This ambiguity in interpretation during bradypnoea causes ambiguity in interpreting ANS activity assessment. From this it ensues that the BFrr experimental method using SA-HRV is usable only for measuring breathing frequency in the range of 9 to 24 cycles/min.

The BFqrs method derived from SAQRSV is minimally influenced by ANS activity and that's why it is possible to cut the lower border of the HF zone down to 0.1 Hz, which corresponds with the extent of monitored breathing frequency in the range 6 to 24 cycles/min. As demonstrated by the statistical assessment as well as by evaluation of absolute differences, this method is demonstrably more accurate and from the point of view of the extent of measured breathing frequency it is more suitable than the other observed methods of measuring breathing frequency from ECG.

On the basis of the results of single analysis and on the basis of the mentioned negatives and positives of the experimental methods, we regard the BFqrs method as most suitable for ascertaining breathing frequency from ECG. To this end we recommend equipping the existing diagnostic system VarCor PF6 with the proposed algorithm.

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MĚŘENÍ DECHOVÉ FREKVENCE Z EKG SIGNÁLU S OHLEDEM NA VYŠETŘENÍ AKTIVIT AUTONOMNÍHO NERVOVÉHO SYSTÉMU: NÁVRH METOD A JEJICH OVĚŘENÍ

(Souhrn anglického textu)

Z celé řady metod měření dechové frekvence se autoři zaměřili na méně používanou metodu diagnostiky dechové frekvence, vycházející z hodnocení změn parametrů EKG signálu, které jsou způsobeny změnami objemu hrudníku v průběhu expiria a inspiria. Hlavním důvodem volby této metody byla skutečnost, že pro diagnostiku aktivity autonomního nervového systému (ANS) je monitorován EKG signál, který je tak k dispozici i pro diagnostiku dechové frekvence. Pro návrh optimální metody měření dechové frekvence byly změny parametrů EKG signálu analyzovány metodou spektrální analýzy variability srdeční frekvence (BFrr), metodou spektrální analýzy variability amplitud QRS komplexů (BFqrs) a časovou analýzou periodicity změn amplitud QRS komplexů (BFv). Monitorování EKG signálu a výpočet parametrů EKG signálu, včetně uvedených analýz, bylo provedeno systémem VarCor PF6 s modifikovaným programovým vybavením. Statistické ověření zvolených metod a doporučení optimální metody měření dechové frekvence bylo provedeno pomocí referenčních hodnot dechových frekvencí 9 a 12 dechů/min, které prostřednictvím akustických signálů byly předávány probandům. Charakteristika souboru: 55 mužů a žen ve věku 22,7 ± 2,4 roků, měření bylo provedeno v polohách leh 1 – stoj – leh 2, celková velikost statisticky zpracovávaného souboru byla n = 118. Ze statistických výsledků, kde byla testována pomocí t-testu významnost rozdílů průměrných hodnot vzhledem k referenčním hodnotám a dále z výpočtu hodnot absolutních rozdílů dechové frekvence byla doporučena metoda BFqrs umožňující diagnostiku dechové frekvence v rozsahu 6 až 25 dechů/min. Navržená metoda bude aplikována do stávajícího algoritmu diagnostického systému VarCor PF6, čímž se významně zpřesní interpretace výsledků vyšetření ANS.

Klíčová slova: EKG signál, QRS komplex, dechová frekvence, variabilita srdeční frekvence, spektrální analýza, autonomní nervový systém.

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DETERMINATION OF DIFERENCES IN RUNS BETWEEN BOYS AND GIRLS AGED 5.5

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The aim of this research is to determine whether there are distinctions in runs among five and a half year old boys and girls. The research is based on studying 80 girls and 64 boys from seven kindergartens in Slovenia. The following five measurement methods have been used in our research: a 10-meter run, a 150-meter run, a 10-meter run with a flying start, 4-times 5-meter run, and a 300-meter run. The results of the t-test indicate a statistically characteristic difference among boys and girls in 300 m run test results only, that is, a method used for measuring aerobic endurance. Other motor skills results have shown that there are no statistically characteristic differences among boys and girls. It is important that sport activities for boys and girls are organized for both groups of children equally. Especially girls must take part in a variety of running exercises in order to increase their aerobic endurance. They should be encouraged to take part in a variety of games which require activating the energy component of movement. Based on the results of this research we can say that physical education (PE) of preschool children should be planned regardless of sex and the PE program should be the same for both boys and girls.

Keywords: Preschool children, runs, speed, general endurance, comparing by sex.

INTRODUCTION

For children to optimally develop their potential skills, it is essential that PE is systematically and professionally planned already in the preschool period. PE must be based on professional grounds and findings in order for children to optimally develop their motor and functional skills (Kropej & Videmšek, 1996).

Just like any other human ability, motor and functional skills are both innate and acquired. At birth each one of us is given a certain degree to which one's potential could be developed when considering a normal course of development. The basic degree of motor skills development can however be exceeded by means of developmentally appropriate movement activities.

The most appropriate time for developing skills and personality is early childhood when the entire organism, in particular the nervous system, is most receptive for influences from the environment (Armstrong & Welsman, 2000). Due to the fact that we are, at the present time, limited by the space within our homes, endangered more and more by street traffic and recurringly facing a lack of time, children have fewer opportunities and less encouragement to fulfill their needs for movement activities. As a consequence, children do not obtain their development optimum given by their genetic potential. Skills and characteristics that children fail to gain in due course are very hard to or even not possible to make up for at a subsequent time (Videmšek & Karpljuk, 1999).

Generally speaking, testing preschool children is a very demanding process. The tests as well as the course of testing must be adapted to the children's early developmental period which causes quite some difficulties. Our lack of knowledge in the matter of preschool motor skills development represents an urgent situation. This is even more so true knowing that motor activities represent a major developmental stimulus for non-motor skills and characteristics. Besides that, contemporary children (primarily town children) grow up in an environment which impedes their need for movement activities and therefore all the activities they are involved in are planned (teachers, parents). Professionally planned motor activities are undoubtedly based on experts' findings but unfortunately those pertaining to the preschool period are quite rare. Since there are so many difficulties involved in testing preschool children, rather little researche is available in the field of preschool education (Kalar, Videmšek, & Zavrl, 2003).

If boys and girls participate in different activities and games, their learning in a number of areas of their development will also be different (Doupona, 1996). Boys generally love to run around the playground and play with a ball, while girls on the other hand quickly get bored and avoid games that require any kind of running. Girls usually look for some quiet game which takes place in one spot, and they like playing with dolls. Parents worry for their "princesses" who are usually dressed in pretty clothes. They do not let them run around and rather suggest quiet games.

Some other researchers have come to the conclusion that boys achieve better results in movement activities where explosive strength, speed and aerobic endurance play an important part. Girls however are more successful in rather quiet activities, like activities engaging fingers, arms and those that require balance skills. Morris, Williams, Atwater and Wilmore (1982) who have studied three to six year old children have ascertained that boys of all ages achieve statistically characteristic better results in tests of ball throwing whereas six year old girls have achieved better results in tests measuring static balance. These same authors have also established that five year old boys are better in speed running. Similar conclusions have been made by Miler (1993) who has studied some motor skills of five and a half year old boys and girls; boys have been more successful in running various distances (5 m, 10 m, 100 m, 150 m and 300 m) and in different motor tasks requiring strength (linked long jumps), thrusting a ball in a seated position, ball throwing, bent arm hang and side jumps. Studying a sample of six year old children, Bučar (1996) has ascertained that the results of motor skills tasks that require agility skills are not statistically characteristic. In her research studying differences of some motor skills among six year old boys and girls, Rošker (2001) has not ascertained huge differences in efficiency of performance. However, boys have on average been more successful in the long jump, side jump, and running with changing directions (in two tests to measure movement coordination). Videmšek (1996) has studied differences in performing motor tasks among three year old boys and girls using 23 tests. She has established that differences between three year old boys and girls are not statistically characteristic, except in some tasks which require the ability to manipulate with hands where boys were less successful.

Van Praugh (2000) has studied the responses of the cardio-vascular system on various types of strain. He has ascertained that heart beat rate in children rapidly adapts to increased strain as it abruptly increases from the very start of strenuous exercising. At the same time, children (particularly of younger age) have the ability to maintain a relatively high heart beat rate frequency during various movement exercises of either a competitive or entertaining nature – like games and dancing (Karpljuk, Videmšek, Kondrič, & Štihec, 2000).

Based on five metric test procedures, the aim of this research is to establish whether there are distinctions between five and a half year old boys and girls in some motor test results, which hypothetically define motor ability (speed) and functional ability (endurance). The aim is to ascertain whether it is reasonable to consider sex when planning sport activities for preschool children.

METHOD

Participants

The sample of subjects studied included 144 children, 64 boys and 80 girls from seven kindergartens in Slovenia. All the children were five and a half years old (± half a year) and they attended kindergartens which offered the same or similar working and material conditions. PE in all four kindergartens was conducted by a kindergarten teacher.

Instruments

Five metric test procedures used in this research can be divided into two hypothetical factors:

SPEED

- 10 m run (a 10-meter run)
- 150 m run (a 150-meter run)
- 10 m run (a 10-meter run flying start)
- 4 × 5 m run (4-times 5 meter run)

ENDURANCE

- 300 m run (a 300-meter run)

Procedures

Measured data has been processed at a computer data processing department, Faculty of Sport, Ljubljana, using the SPSS – 9.0 (Statistical Package for the Social Sciences).

Basic statistical parameters have been calculated for all variables. For the purpose of determining differences in motor skills among male and female subjects, the t-test has been used. Hypotheses were accepted or denied with a 5% risk (Q = 0.05).

RESULTS

Five metric test procedures have been used in this research.

With the tests 10-meter run (T10m), 10-meter run flying start (T10mL), 150-meter run, (T150m) and a 4-times 5 meter run (4 × 5m), we have measured the speed of five year old children.

A 10-meter run (T10m) is a metric procedure where the subjects have to, as fast as possible, run the 10-meter distance through the finish line. The main problem in testing was the understanding of the exercise's performance. Even though children have done a test run, there were still some individuals stopping before the finish line, which means that they started to slow down before the finish line.

Fewer problems were experienced in the 10-meter run at a flying start (T10mL). The aim of this test was to measure maximal speed; therefore, children started running 5 meters before the measuring start point, and

they were running through a seeming finish line that was 5 meters after the measuring end point (so the total distance run was 20 meters). This test made the children run a 10-meters distance that we measured for the maximum speed.

A 4-times 5 meter run (4 × 5m) is a metric procedure where a child running the distance steps over a marked line with at least one foot (upon running into the finish line, he/she runs as if the finish line is at least 1 m after the marked line).

A 150-meters run (T150m) was performed in a group. Children started running after a GO command and ran 3 laps. Upon each lap, they were told how many laps they had completed and how many they still had to overcome.

The results have shown that there are no statistically characteristic differences between boys and girls in the following tests: the 10-meter run, 10-meter run with a flying start, 150-meter run, and the 4-times 5 meter run. These results pertain to the sample studied (TABLE 1–4).

With a 300-meter test (T300m), the endurance of five and a half year old children was measured. A child's aerobic endurance is regulated by the cardio-vascular, respiratory and the thermoregulation subsystems. For children of this age, a 300-meter run represents a very long distance; therefore, not all children were motivated enough to overcome the entire distance. Some of them started off too fast and barely made it through the finish line. In terms of physiology, running activates all muscles, particularly the leg muscles, and the internal organs. It intensely affects the blood circulation and breathing.

The t-test results (TABLE 5) show that the difference between boys and girls in the 300-meter run is statistically characteristic. Within the subject sample studied here, boys have achieved a statistically characteristic better result than girls. Reasons for such results could be various – undoubtedly they could result from dissimilar activities and games which boys or girls participate in, leading into distinct functional capabilities.

TABLE 1
Results comparison among boys and girls – variable T10m

Variable	Group	Number	Mean	Std. dev.	Min	Max	t	**Sig.**
T10m	boys	64	319.84	46.67	241	398.00	0.536	0.594
	girls	80	314.95	30.52	266	381.00		

Legend:
T10m – 10 m run (tenths of seconds), T150m – 150 m run (seconds), T4 × 5 – 4 × 5 m run with flying start (tenths of seconds), T300m – 300 m run (seconds)
Number – number of subjects (pupils), Mean – average result, Std. Dev. – standard deviation, Min – minimal result, Max – maximal result, t – T value, Sig. – significance

TABLE 2
Results comparison among boys and girls – variable T150m

Variable	Group	Number	AS	Std. dev.	Min	Max	t.	**Sig.**
T150m	boys	64	49.81	7.84	38	65.00	–0.748	0.457
	girls	80	51.10	6.76	40	69.00		

TABLE 3
Results comparison among boys and girls – variable T4 × 5

Variable	Group	Number	AS	Std. dev.	Min	Max	t	**Sig.**
T 4 × 5	boys	64	104.81	11.56	86	133.00	1.315	0.193
	girls	80	101.47	9.96	78	116.00		

TABLE 4
Results comparison among boys and girls – variable T10mL

Variable	Group	Number	AS	Std. dev.	Min	Max	t	**Sig.**
T10mL	boys	64	246.25	33.83	199.00	298.00	0.377	0.707
	girls	80	243.43	29.68	198.00	302.00		

TABLE 5
Results comparison among boys and girls – variable T300m

Variable	Group	Number	AS	Std. dev.	Min	Max	t	**Sig.**
T300m	boys	64	103.00	13.28	81	131.00	-2.427	0.018
	girls	80	110.00	11.20	91	131.00		

Based on the independent samples from the t-test (TABLE 1–5), four out of five results compared between boys and girls are not statistically characteristic. The only statistically characteristic difference occurs in a 300-meters run (T300) endurance test.

DISCUSSION

This research results have shown statistically characteristic differences between boys and girls only in the 300-meter run – in the endurance run test, boys have achieved statistically better results than girls. In other metric procedures, which hypothetically define the motor ability (speed), the results of boys and girls are approximately equal.

In this age period, speed is evidently a motor ability with no statistically characteristic differences between boys and girls. It is most likely that there is no such sex distinction in children's sport activities, which could cause differences in skills development. Sport activities in later age periods differ between boys and girls and it is assumed that as such, they do affect the differences in results between the two sexes. Certainly additional differences are affected by diverse physical development. As indicated by the results of a study by Štefančič et al. (1996), in the age period of five and a half years, there are no statistically characteristic differences between boys and girls in physical growth and development. Approximately the same physical development and the same exercise program therefore result in approximately the same speed skills results of boys and girls. Methods and instruments used to develop speed skills are very variegated and rather simple. For example, elementary games, various starts (initiated from different positions) continuously followed by short sprints, rhythmical hopping, up/downhill running, relay. All these types of running can be offered to preschool children and integrated into their games. Children should be offered an opportunity to get to know a variety of running activities and to participate in their first competitions (Škof & Milić, 2002).

It is necessary to stress that demanding methods of exercising in childhood do not result in distinctive improvements as one could expect (Schmidt, 1999), although there are some sports where coaches introduce such methods at a very early stage. Schmidt (1999) futher on states that from a physiological point of view, there are no characteristic endurance improvements in children. Daniels and Oldridge (1991), and Daniels, Oldrige, Nagle and White (1997), who have studied various groups of young athletes have established that certain changes in endurance skills, which are based on physiological and hormonal elements, begin to improve effectively in the ages between 10 and 13. These authors have established that the absolute values of VO_2 max (l/min) have increased, while the relative values of VO_2 max (ml/kg.min) in correlation with body mass have not changed.

In terms of the exercise process, it is likely that every person planning an exercise program (coach, PE teacher, sport amateur) tends to plan the program so as to have a positive effect. Particularly great is the significance of comparing the initial and the final (or intermediate) results. Improvements achieved by exercising are always gratifying; however, special attention should be paid when choosing the contents of exercising in the childhood period up, to the age of 16 (Noakes, 1991).

One of the principal reasons that girls have achieved lower statistically characteristic results in the 300-meters run undoubtedly lies in different activities and games girls participate in during the preschool period.

Different authors have thus come to similar conclusions that preschool boys are slightly more successful in motor skill exercises where the energy component of movement dominates. Based on observations and interviews with children and their parents, Kocman-Kuhar (1999) is of the opinion that the social, cultural and educational environment (especially within the family) influences the children's orientation and interests. In most cases, girls in families are raised to be gentle and housekeeping oriented whereas boys are treated as strong individuals. Doupona (1996) has defined specifics in the playing of preschool boys and girls: boys play in larger groups, with a variety of roles. Boys' games have rules which they often adapt according to the number of players but without losing the aim of the game. Boys are able to adapt their games according to their capabilities, and so the older they get, the more advanced and complex the games become. In their games, boys learn to stand for themselves and their friends which enables them to develop empathy and altruism. Just the opposite, girls games do not include many opportunities for them to develop various motor skills, neither are their games adventurous. Girls prefer to play indoors but do not show any interest in group and competitive

games. Girls' games require a lot of imagination and are based on a well established model. Their games in particular enable them to develop empathy and a better understanding of the surroundings. Rules of their games are clear and simple; negotiations in critical situations are rare. Girls' games require less strategy than boys' games and they do not offer sufficient opportunities for developing aerobic abilities. Girls' games also do not offer characteristics like contention, determination, and competitiveness.

Marjanovič, Umek and Zupančič (2001) have studied the differences between boys and girls in playing activities and defined six correlated differences:

- boys play more outdoors;
- the boys' social games differ with age more than the girls' social games;
- girls are more willing to play boy games than vice-versa;
- boys more often play competitive games for which they need a lot of space – team playing and competitions are characteristic for boys even with a non-sport game. Girls however are more cooperative in their games, they require less space – they play for example in a playground equipment, jump rope, and similar;
- boys are more tenacious in playing than girls: 72% of all boys' activities last for more than one hour, while there is only 43% of such activities with girls;
- boys' social games are played in larger groups than girls' social games.

Zalokar-Divjak (1998) says that children's play is in fact the best practice for endurance. Children have the ability to play for hours and hours. Unintentionally, they insert elements like walking, running, jumping, crawling and climbing. They have breaks which maintain their heart beat at the level of aerobic exercising. The "child" system alone functions on the principle of biological self-regulation, that is, their load of exercising is just right for their age and development phase. This is true only if we live in an unspoiled environment with no school and TV with long periods of sitting which excludes any muscle activity and additionally obstructs lung ventilation. To prevent such course of action, it is necessary to organize exercises with aerobic activities such as in kindergartens, sport centers and clubs. Both boys and girls must be encouraged to develop not only motor but also functional skills through games (Karpljuk, Videmšek, Kondrič, & Štihec, 2000). Some teachers are of the opinion that aerobic endurance (mostly based on the aerobic metabolism) is the first prerequisite for developing motor skills (Zalokar & Divjak, 1996; taken from Bingman, 1980). Based on the researcher's standpoint, encouraging endurance development in early childhood is very useful; not only for medical prevention (health) reasons, but also for developing the child's will and determination, and for creating a base ground for developing other skills at a subsequent time.

However, some past researchers (Sallis & McKenzie, 1991) have shown just the opposite. It has been established that endurance skills that are based on aerobic processes develop much sooner than those skills based on anaerobic processes. Furthermore, some findings about the maximum oxygen input have proved that children's aerobic skills are quite high (Rajtmajer, 1993).

Van Aaken (1993), Rajtmajer (1997) and many other researchers, doctors, coaches and teachers have ascertained that even very young children have the ability of running for 12 minutes or more. Van Aaken (1993) has established that five to six year old children could run up to even 10 kilometers a day while playing.

Children's load of running should be moderate and planned in minutes not in distance that they run. In real life however, this is very difficult to achieve. Children tend to compete with each other on every occasion. An exercise like "run by yourself" represents a rather "long-lasting" task for them. And yet a teacher must use this method and teach the children in this direction (Rajtmajer, 1993).

It is important that sport activities for boys and girls are organized for both groups of children equally. Especially girls must take part in a variety of running exercises in order to increase their aerobic endurance. They should be encouraged to take part in a variety of games which require activating the energy component of movement. Sport activity programs for preschool children should be planned for both boys and girls equally.

Despite the fact that this research has included a relatively small sample of children tested and the conclusions cannot be generalized, the research results have well contributed to the existing findings in the field of studying motor abilities of preschool children. With this research, we have moved yet another step forward to better professionally planned and conducted preschool physical education.

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URČENÍ ROZDÍLU V BĚHU MEZI CHLAPCI A DÍVKAMI VE VĚKU 5,5 ROKU

(Souhrn anglického textu)

Cílem tohoto výzkumu je určit, zda existují odlišnosti v běhu chlapců a dívek ve věku 5,5 roku. Výzkum je založen na studii 80 dívek a 64 chlapců v sedmi mateřských školách ve Slovinsku. Bylo použito těchto pěti měřicích metod: běh na 10 metrů, běh na 150 metrů, běh na 10 metrů s letmým startem, běh 4 × 5 metrů, běh na 300 metrů. Výsledky t-testu vykázaly statisticky významný rozdíl mezi chlapci a dívkami jen v běhu na 300 metrů, což je metoda používaná pro měření aerobní vytrvalosti. Výsledky ostatních pohybových aktivit vykazují, že mezi chlapci a dívkami není žádný statisticky významný rozdíl. Je důležité, aby sportovní aktivity byly organizovány rovnoměrně jak pro chlapce, tak pro dívky. Obzvláště děvčata se musí účastnit různých běžeckých cvičení v zájmu toho, aby vzrostla jejich aerobní vytrvalost. Měla by být povzbuzována, aby se účastnila různých her, které vyžadují aktivaci energetické složky pohybu. Na základě výsledků tohoto výzkumu můžeme říci, že tělesná výchova (TV) předškolních dětí by měla být plánována bez ohledu na pohlaví a že tělovýchovný program by měl být pro chlapce i dívky stejný.

Klíčová slova: předškolní děti, běhy, rychlost, celková vytrvalost, srovnání pohlaví.

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AN ANALYSIS OF THE FORWARD STROKE AS USED IN A WILD WATER KAYAK ON FLAT WATERS

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The forward stroke is one of the basic motion activities that are typically used for canoeing in white water. Kinematic analysis (4 women, 5 men; junior representatives and talented competitors) of records from three cameras was used. The movement of the kayak was carried out with maximal velocity. General parameters of the stroke on the left and right side of the kayak were determined utilizing the APAS system. Lower velocity losses in the catch and pull phase of the paddle, a shorter time of the pull phase, higher frequency of the strokes are typical for kayakers with better levels of efficiency. The movement of the right and left wrist of these competitors in the frontal plane is more symmetrical. The deviation of the trunk is less in the sagittal plane as well as the sideways movement of the kayak.

Keywords: Kinematic analysis, forward stroke, kayak, wild water.

INTRODUCTION

Technique in the movement activities is sometimes defined as "mechanical skill in art". In the art of kayaking it is necessary to balance the body and the boat simultaneously with producing of the greatest boat speed. Experience and research studies (Lauder & Kemecsey, 1999) have shown that the quality of the forward stroke (in connection with other efficiency factors) is the limit for the maintenance of the maximal velocity of motion. This stroke is the prerequisite for a good level for steering the kayak. The forward stroke is usually divided into four phases: catching the water with the paddle, a pull phase, a recovery (transfer) phase and air-work of the paddle. The first three phases are active and cause the forward motion of the kayak. The most effective is the pull phase with the paddle in a vertical position and with a maximal pull area. Therefore a longer paddle is better, because the paddle is in the optimal position a longer time. In the course of paddling with a shorter paddle, the strokes are shorter. There exist losses in the moment when both blades are out of the water. The tilt of the "upper" hand at the site of the stroke is further disadvantageous. It is not economical because the direction of force of the "push" by the upper extremity is not parallel with the resultant direction of the movement. It produces a lean of the trunk of the paddlers as well as the kayak. The turning of the kayak from the straight direction is considerable if the path of the blade is not close to the kayak. The holding of the paddle in a vertical position, perpendicular to the direction of the movement for a longer part of the stroke is a key sign of the effect. However it is necessary to adjust the length of the paddle to the somatic and physiological properties of the paddler (Bunc et al., 2002; Kračmar et al., 1998).

The aim of the study was to determine valid parameters and use them for the quantification of the differences among the kayak paddlers with various efficiencies in the forward stroke.

METHOD

The training canal, part of the gentle watercourse area was used for recording of the movement of a group of women (n = 4, average age 15.6 ± 3.4) and men (n = = 5, average age 19.5 ± 7.5) who took part in the recording. All these individuals were experienced paddlers, either junior representatives or talented competitors. The number of training units differed from 4 to 8 per week. The banks of the canal were well acceptable for the location of the cameras. The space was delimited by means of two slalom goals (9 m long and 3 m wide; Fig. 1). The track in front of this space was sufficiently long enough to gain the maximal velocity. The space was calibrated by placing a 1 m cube on the canoe (was stabilized with stretched ropes) at the start and finish of the recording space.

The kayakers performed three sprints each with maximal velocity in the calibrated space. Each position was characterized by 10 points: the grip of the hand on the shaft of the paddle (left and right), the elbows (l, r), the shoulders (l, r), the chin, glabella, the ends of the kayak.

Fig. 1
The schema of the analyzed space and the location of the cameras

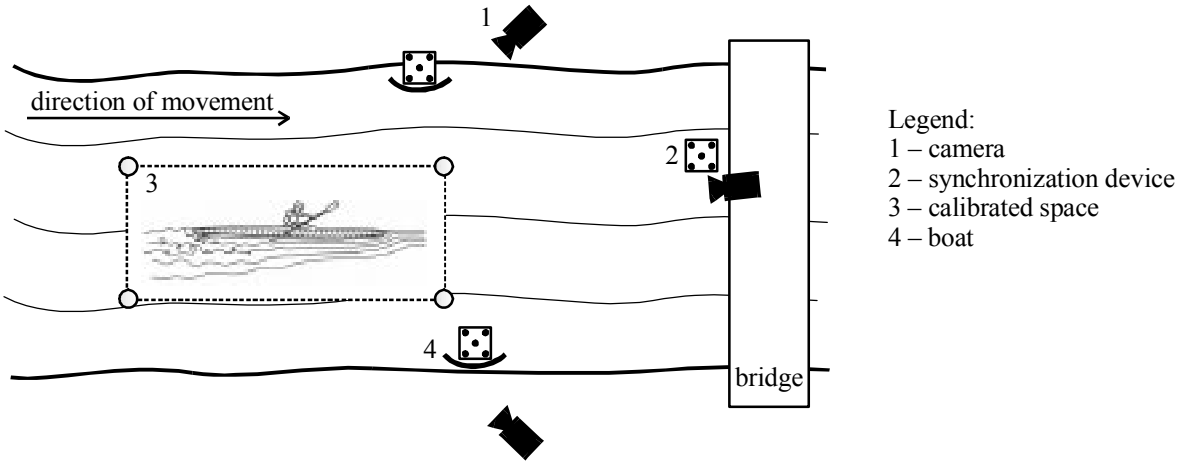


TABLE 1
The basic time parameters in the course of the forward stroke

Parameter	AA*	BB*	CC*	DD*	EE	FF	GG	HH	JJ
V	3.48	3.56	4.12	3.66	3.67	4.30	3.31	3.68	3.79
F	1.75	1.96	2.33	1.96	2.17	2.38	1.82	2.08	1.89
Ts	0.57	0.51	0.43	0.51	0.46	0.42	0.55	0.48	0.53
Tp	0.42	0.38	0.30	0.38	0.33	0.30	0.43	0.37	0.41
Tpp	74	75	70	75	72	71	78	77	77
Ta	0.15	0.13	0.13	0.13	0.13	0.12	0.12	0.11	0.12
Tap	26	25	30	25	28	29	22	23	23

Legend:
V – average velocity in the course of the forward stroke, F – frequency of the strokes, Ts – time of the stroke, Tp – time of the pull phase, Tpp – share of glide time in stroke time (%), Ta – time of the air-work, Tap – share of air-work time in the stroke time (%), * – female

TABLE 2
Basic angle parameters of the forward stroke

Parameter	AA*	BB*	CC*	DD*	EE	FF	GG	HH	JJ
Cr	41	28	35	36	35	39	21	38	30
PUr	20	18	19	22	9	8	20	5	13
Cl	36	28	38	34	39	35	26	35	23
PUl	15	17	12	12	4	5	17	6	18
ECr	135	149	122	135	132	138	133	150	154
EPUr	65	82	66	70	110	72	91	99	91
ECl	117	138	110	133	144	124	137	108	143
EPUl	46	85	62	62	91	71	66	91	94

Legend:
Cr (Cl) – the angle of the catch = the angle between the shaft of the paddle and the horizontal plane in the catch phase on the right (left) side of the kayak
PUr (PUl) – the angle of the pull-up = the angle between the shaft of the paddle and the horizontal plane in the pull-up phase on the right (left) side of the kayak
ECR (ECl) – the angle of the elbow in the catch phase on the right (left) side of the kayak
EPUr (EPUl) – the angle of the elbow in the pull-up phase on the right (left) side of the kayak
* – female

Records were digitalized by means of the APAS system at the frequency of 50 Hz. A sequence of 30 pictures which represented one double stroke (one stroke on the left and right side of kayak) was selected. The parameters were chosen on the basis of researchers and coaches (Plagenhoef, 1979; Kendal & Sanders, 1992; Baker et al., 1999) who had solved similar problems. The numerical data was completed with the graphic interpretation of selected points and body segments.

RESULTS AND DISCUSSION

The basic time parameters of the analysis are given in TABLE 1.

To compare the possibilities of these parameters with the best flatwater kayaking competitors a share (%) of the pull phase in the total time of the stroke (Tpp) was used. These values range from 70% to 78%. Plagenhoef (1979) presents the ideal value of 69%. Kendal and Sanders (1992) measured a range from 65–72%.

The basic angle parameters for the detail analysis of the technique are given in TABLE 2.

The angle of the catch on the right (21–41°) and left (23–39°) side of the boat differs slightly and are similar to the values presented by Plagenhoef (1979). The differences between the angle of the elbow in the catch (left side: 108–144°, right side: 122–154°) and pull-up (left side: 46–94°, right side: 65–110°) phase are bigger. The smaller angle of the elbow is typical for the slalom competitors. They are all always prepared to perform the driving strokes. The average value of the elbow measured from the speed kayak paddlers (Baker et al., 1999) was 146° in the catch and 114° in the pull-up of the paddle.

The inter-individual trajectory differences of the right and left wrist in a frontal plane are illustrated in Fig. 2.

GG – A nearly symmetrical path with maximum range in a horizontal direction. The shape of the paths suggests a big overlapping of the hands over the lengthwise axis of the kayak.

JJ – An expressive asymmetry in the vertical direction influences the deviation of the kayak from a straight direction. For short time activity the asymmetry need not mean errors in the performance of the movement. In this case the difference in size is however a negative phenomenon.

CC – The movement of the right and left hand is fast to a minimum extent in a horizontal direction. It means that exceeding over the lengthwise axis of the kayak does not exist.

Interesting information is afforded by the graphic demonstration of the hands movement with regard to the kayak (in the system paddlers–kayak) in the sagittal plane (Fig. 3).

FF – The greater extent of the right hand in the vertical direction is typical for the dominant extremity.

AA – Trajectories are similarly symmetrical from the point of view of the extent of the vertical and horizontal direction. The pull phase is also similar (the oblique part of the bottom). The different position of the hands in the catch phase on the opposite side of the kayak causes the interruption of the curve.

CC – The similarity of the curve with the trajectory of the best competitors is the greatest. The speed of the left hand in the direction towards the water surface is lower in the first part of the pulling.

CONCLUSIONS

A higher average velocity of the kayak and a lower loss of velocity in the transfer and pull-up phase were found in the group of the best paddlers.

A higher stroke frequency and a higher share of glide time in stroke time are typical for a better performance of the stroke.

The effective technique of the best paddlers can be described as a symmetrical span of the movement of both hands, minimum movement of the trunk in an antero-posterior direction, and a greater rotation of the shoulders.

Fig. 2
Comparison of motion between the left and right wrist in a frontal plane (point C is the position of the paddle at the moment of the catch)

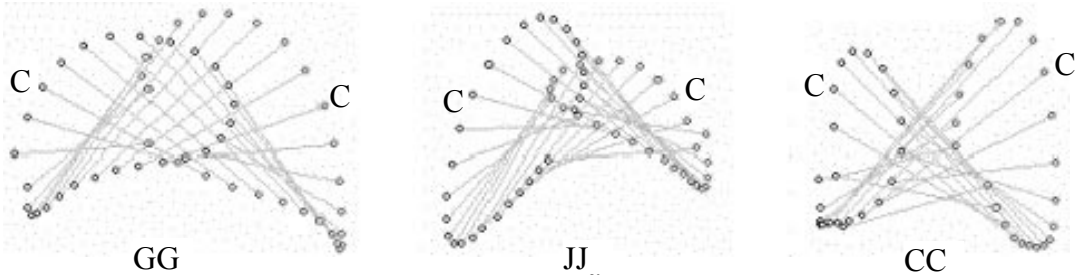
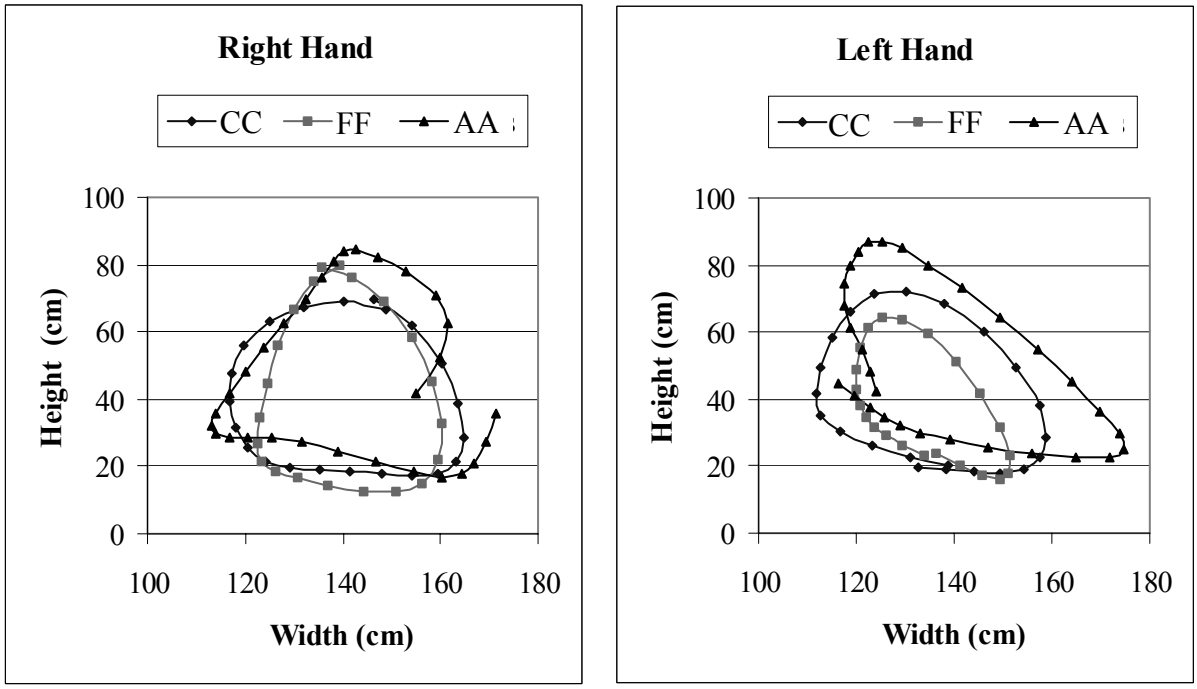


Fig. 3
Trajectory of the right and left hand with regard to the kayak in a sagittal plane



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ANALÝZA ZÁBĚRU VPŘED NA KAJAKU PRO JÍZDU NA DIVOKÉ VODĚ V PŘÍRODNÍCH PODMÍNKÁCH

(Souhrn anglického textu)

Přímý záběr vpřed je jedna ze základních pohybových činností, jejichž zvládnutí je nezbytné pro dosažení kvalitní výkonnosti v kanoistice na divoké vodě. Analýzou záznamů přímého záběru (4 ženy, 5 mužů; juniorští reprezentanti a talentovaní závodníci) jsme ze tří kamer, pomocí systému APAS, určili základní kinematické parametry této pohybové činnosti na pravé a levé straně lodi. Pohyb lodi ve sledovaném úseku byl realizován maximální rychlostí. Pro provedení záběru u lepších kajakářů je typická: menší ztráta rychlosti ve fázi zasazení a přenosu pádla, zkrácení doby trvání fáze tažení, větší frekvence záběrů. U těchto závodníků jsme dále nalezli lepší symetrii pohybu pravé a levé horní končetiny, minimální pohyb trupu v předozadním směru a zmenšení výchylek lodi do stran.

Klíčová slova: přímý záběr vpřed, kinematická analýza, kajak pro jízdu na divoké vodě.

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VARIOUS AGE CATEGORY – RELATED DIFFERENCES IN THE VOLUME AND INTENSITY OF THE LARGE-SCALE CYCLIC MOVEMENTS OF MALE PLAYERS IN TEAM HANDBALL

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The aim of this study was to identify differences in the volume and intensity of large-scale cyclic movement activities performed by handball players of three age categories – cadet men (aged between 15 and 17 years), junior men (aged between 17 and 20 years) and senior men (aged 20 years or over). For this purpose six experimental model matches (2 × 20 min), played by the Slovenian male handball teams, were analyzed. The sample consisted of 84 players of twelve teams (average age 20.26 ± 4.28 yrs; average height 182.51 ± 6.59 cm; average body mass 80.61 ± 10.37 kg) and was divided into three sub-samples by age (cadet men, junior men and senior men). The collection of large-scale cyclic movement data in a handball match was based on the computer-aided automatic tracking method SAGIT (Ljubljana, Slovenia) based on computer vision. The data output on large-scale cyclic movements obtained by the SAGIT program were processed by selected descriptive statistical methods. There were statistically significant differences between different age categories in terms of the volume of the total distances walked and run during the matches. The greatest distance was achieved by senior men, followed by junior men and cadet men. In all analyzed age categories the volume of total distances was greater in the first than in the second half of the match. Statistically significant differences also appeared in the average share of time recorded in all speed classes (SC – speed class), except for the second one (2nd SC). In the 1st SC some statistically significant differences were seen between cadet men and senior men as well as between cadet men and junior men, while there were none between junior men and senior men. In the 3rd SC statistically significance differences appeared between all of the analyzed age categories. Similarly to the 1st SC there were statistically significant differences between cadet men and senior men as well as cadet men and junior men in the 4th SC, while no differences were seen between senior men and junior men. In view of the different age categories of handball players, we expected some differences in the analyzed variables, as the athletes belonging to older categories are biologically more mature and are subjected to functional training for a longer time. That reason enables them to perform more large-scale cyclic activities during a match and spend a higher percentage of time in higher speed classes.

Keywords: Team handball, time and motion analysis, large-scale cyclic movements, age categories.

INTRODUCTION

Handball is a team sport in which the players of the two opposing teams alternately take the role of either attackers or defenders, depending on the criterion of possession of the ball. The aim of the team during the attack is to play the ball past or through the opposing team (Šibila, 2004). Due to advances in information and video technology the analyses of various activities and the loading of individual players, performing in game contexts, are ever more diversified and thorough. The purpose of such analyses is to improve the comprehension of factors determining the performance capability of a whole team or also individual contribution to team effort (Reilly, 2001).

The intensity and volume of work-rate or loading in handball are very heterogeneous. In a handball match acyclic (intermittent) activities (passing the ball, various kinds of shots, jumps, etc.) occur along with the player's cyclic movements (running, walking, moving sideways, etc.). In handball the loading of players is a combination of both, cyclic movements and acyclic activities. Therefore, during the course of play, the work-rate of loading, which may vary in intensity and volume, alternates continuously with periods of relative rest, i.e. standing or slow walking. Large-scale cyclic movements are fundamental because they allow the player to move across the court area in two dimensions. They include walking and running without a ball as well as dribbling the ball when walking or running (Bon, 2001).

The type, intensity and duration (or distance) of movements and activities performed can be observed by time-motion analysis. Numerous studies have used

time-motion analysis to access the demands of soccer players and referees (Ali & Farraly, 1991; Krunstrup & Bangsbo, 2001; Krunstrup, Mohr, & Bangsbo, 2002; Reilly & Thomas, 1976), rugby players (Coutts, Reaburn, & Abt, 2003; Deutsch, Maw, Jenkins, & Reaburn, 1998) and other sports. Also in team handball in recent years the researchers have tried to analyze the volume and intensity of the large-scale cyclic movements of handball players by using different methods and samples. Cuesta (1988, in Cardinale, 2000) analyzed cyclic movements of the players of the Spanish teams who played different positions in the attack. The author did not describe the methodology he used in collecting data. He established that the left outside players on average ran a distance of 3464 ± 256 meters, the right outside players 2857 ± 189, left wings 3557 ± 311, right wings 4083 ± 286 and pivots 2857 ± 145 meters. The above data shows that the wings on average cover a greater distance in the attack compared to other playing positions. By means of a video analysis Al-Lail (1996) established the volume and frequency of large-scale cyclic movements by using a sample of eight Kuwaiti national team players. His sample of variables included five types of movements (walking, slow running, sprint, backward running, sideway movements) as well as the share of movements with the ball and without it. The total distance covered by all types of cyclic movements with and without the ball averaged 2478 ± 224 meters, of which walking accounted for 620 ± 88 meters, running 707 ± 134 meters, sprint 451 ± 162 meters, running backwards 158 ± 73 meters and sideways movements for 540 ± 123 meters. The analyzed players on average played for 40 ± 7.2 minutes in a match. The bulk of the playing time, i.e. 54%, the players walked – with or without the ball (21.3 ± 5.4 minutes). On the basis of the results the author established, in the continuation, that the share of highly intensive activities (sprint) was relatively low, with results ranging between 2% and 4% of total playing time. After analyzing large-scale cyclic movements in an experimental match between two Slovenian premier-league teams, Bon (2001) established that players on average ran and walked a distance of 4790 m. Sprinting accounted for 7% of the playing time, fast running for 25%, slow running for 31% and walking or standing for as much as 37% of the playing time. As regards the distance covered by individual players during the match there were no great deviations from the average (from –7% to +6%). This study is even more interesting, because the author measured the volume and intensity of cyclic activities by applying the same method as we used in our study.

The aim of our study was to identify differences in the volume and intensity of large-scale cyclic movements performed by the players of three age categories – cadet men (aged between 15 and 17 years), junior men (aged between 17 and 20 years) and senior men (aged 20 years or over).

MATERIALS AND METHODS

The sample of subjects consisted of 84 male handball players of twelve teams (average age 20.26 ± 4.28 yrs; average height 182.51 ± 6.59 cm; average body mass 80.61 ± 10.37 kg) and was divided into three sub-samples by age – cadet men (average age 16.14 ± 0.76 yrs; average height 178.82 ± 6.74 cm; average body weight 73.86 ± 12.99 kg), junior men (average age 19.29 ± .98 yrs; average height 181.93 ± 5.90 cm; average weight 81.07 ± 7.11 kg) and senior men (average age 25.36 ± 3.03 yrs; average height 186.79 ± 4.45 cm; average weight 86.89 ± 4.78 kg). The subjects were members of four cadet teams, four junior teams, and four senior teams. The data on the work-rate of the loading of male handball players during a match were collected from six model matches in the categories of cadet men, junior men and senior men. In each category two matches were played and analyzed, i.e. four teams were observed. In each team we monitored the parameters of large-scale cyclic movements of the players who played in different positions, i.e. two wings, three backcourt players, a pivot and a goalkeeper.

In all the matches certain environmental conditions were standardized: the playing time for all the games was 2 times 20 minutes, all the teams played a 5–1 zone defense, selected players had to play the entire game, and a one-minute team time-out was not allowed.

The applied statistical methods required a sufficient number of entities and matches. Due to the fact that obtaining and processing data with the SAGIT system is complex and time-consuming (Bon, 2001; Perš, Bon, Kovačič, Šibila, & Dežman, 2002), we were forced for practical reasons to shorten the playing time.

The sample of variables included the ones pertaining to large-scale cyclic movements by definition. We established the volume (duration) of all cyclic movements and percentages of time spent in particular speed classes. Large-scale cyclic movements were divided into four speed classes according to the speed of performance (TABLE 1).

The collection of data on the large-scale cyclic movements of players in handball matches was based on a computer-aided automatic tracking method with the SAGIT (Ljubljana, Slovenia) system (made by Perš et al., 2002). It is based on the computer vision methods. The images were captured by two cameras placed directly above the court so that the optical axis of the camera and the court formed a right angle. The cameras were fixed while recording the match, each of them covering one half of the court. Their fields of vision partly overlapped, which enabled the tracking of players while

crossing the center of the court. Once the matches had been recorded, the video-recordings were digitized using the MiroVideo DC30 + video digitizer hardware with a resolution of 768 × 576 at a 2 MB/sec data rate. The captured images were synchronized before processing so that at any time the tracker was able to produce images recorded by both cameras at the same moment (Fig. 1).

The output data on large-scale cyclic movements obtained from the SAGIT program were processed by selected descriptive statistical methods. The differences in the volume and intensity of large-scale cyclic movements were established by a multi-factor analysis of variance. When establishing these differences, absolute values were used for the total of distances run and walked, whereas for the volume of movement in the individual speed class the average share of time spent in a certain speed class was used. The data of total distances run and walked during the matches were rounded off by five metres accurately, while the system SAGIT performances had certain error (Perš, Bon, & Kovačič, 2001).

A comparative (post hoc) analysis was made so as to additionally compare the age categories and thus establish any statistically significant differences between them. Owing to multiple comparisons, correction was necessary which is why the Bonferroni correction was applied. Statistical significance was set at $\alpha < .05$.

RESULTS

TABLE 2 shows the absolute values of all the distances walked and run during the matches played and the percentages of time the players of different age categories spent in individual speed classes. The senior men achieved the greatest volume of movements, as well as the highest intensity of movements in the 3rd and the 4th speed classes. According to the volume of movements, then follow the groups of junior men and cadet men. Cadet men achieved the highest average percentage of movement in the 1st speed class.

TABLE 2
Volume and intensity of the large-scale cyclic loading of players as regards the different age categories

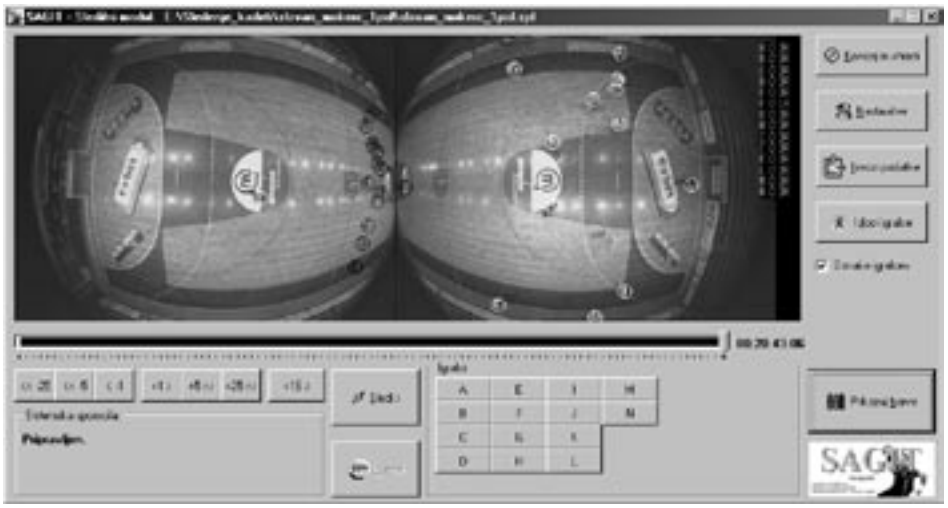
	CADET MEN	JUNIOR MEN	SENIOR MEN
TRD	3055 ± 465	3300 ± 275	3505 ± 285
1st SC	67%	62%	60%
2nd SC	23%	23%	21%
3rd SC	8%	12%	15%
4th SC	2%	3%	4%

Legend: TRD – total run distance; 1st SC – first speed class; 2nd SC – second speed class; 3rd SC – third speed class; 4th SC – fourth speed class

TABLE 1
The variables used for the evaluation of the volume and intensity of the cyclic movements in a handball match

VARIABLE	DESCRIPTION OF VARIABLE	UNIT
S (distance)	Total of all distances run/or walked in a match	m
First speed class (1st SC)	Percentage of time spent in the 1st SC (standing still or distances run/or walked at speed up to 1.4 m/s	%
Second speed class (2nd SC)	Percentage of time spent in the 2nd SC (running at a speed of 1.4 to 3.4 m/s)	%
Third speed class (3rd SC)	Percentage of time spent in the 3rd SC (running at a speed of 3.4 to 5.2 m/s)	%
Fourth speed class (4th SC)	Percentage of time spent in the 4th SC (running at a speed above 5.2 m/s)	%

Fig. 1
User interface of the module for analysing and tracking



The results of analysis of variance in the TABLE 3 showed that there were statistically significant differences between the cadet men, junior men and senior men in terms of volume of the total distances run (p = .000) and the percentage of time in the first, third and fourth speed class (p = .000). It was only in percentage of time in the second speed class, that there were no statistically significant differences (p = .673).

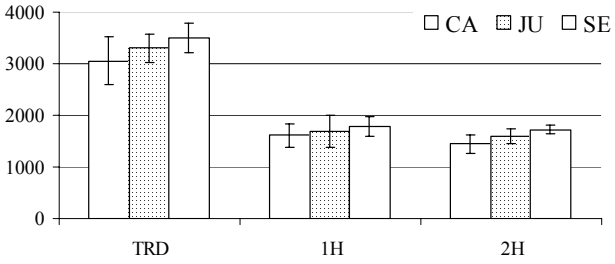
TABLE 3
Analysis of the variance of total run distance, the percentage of distances run in individual speed classes (SC) and average speed of movement by category

	F	p
TRD	20.268	.000
1st SC	11.669	.000
2nd SC	.399	.673
3rd SC	23.832	.000
4th SC	41.495	.000

Legend: TRD – total run distance; 1st SC – first speed class; 2nd SC – second speed class; 3rd SC – third speed class; 4th SC – fourth speed class; F – coefficient F; p – statistical significance of coefficient F

In the continuation, the nature of these differences is explained by a more detailed comparative analysis. Fig. 2 shows the average total distances run or walked by players of different age categories during the entire match and both of the half times.

Fig. 2
Volume of large-scale cyclic movements performed by players of different age categories



Legend: CA – cadet men; JU – junior men; SE – senior men; TRD – total run distance, 1H – 1st half time; 2H – 2nd half time

The average of all the distances walked and run were as follows, by age category: 3055 ± 465 m (CA), 3300 ± 275 m (JU) and 3505 ± 285 m (SE). The difference between the highest and the lowest value was 445 m. In all three categories the average distance covered in the first half (CA – 1615 ± 225 m, JU – 1700 ± 310 m and SE – 1780 ± 185 m) was higher than in the second half (CA – 1445 ± 180 m, JU – 1595 ± 135 m and SE – 1725 ± 90 m).

TABLE 4
Comparative analysis of variance between the group of players of different age categories in terms of volume of total distance walked or run

CATEGORIES		AV. DIFF.	S. E.	p
CA	JU	–238.32	57.07	.000
	SE	–443.89	57.07	.000
JU	CA	238.32	57.07	.000
	SE	–205.57	57.07	.002
SE	CA	443.89	57.07	.000
	JU	205.57	57.07	.002

Legend: CA – cadet men; JU – junior men; SE – senior men; AV. DIFF. – average differences; S. E. – standard error

The average distance covered by senior men was by 443 m and as much as 205 m greater than those of junior men and cadet men (TABLE 4). The average difference between junior men and cadet men was 238 m. The comparative analysis of variance revealed statistically significant differences between all age – related groups in terms of total distances walked or run throughout the match.

TABLE 5
Comparative analysis of variance betwen the group of players of different age categories shown as the percentage of time spent in the first speed class (1st SC)

CATEGORIES		AV. DIFF.	S. E.	p
CA	JU	5.0143	1.0616	.000
	SE	6.6054	1.0616	.000
JU	CA	–5.0143	1.0616	.000
	SE	1.5911	1.0616	.415
SE	CA	–6.6054	1.0616	.000
	JU	–1.5911	1.0616	.415

Legend: CA – cadet men; JU – junior men; SE – senior men; AV. DIFF. – average differences; S. E. – standard error

TABLE 5 shows the results of the comparative analysis of variance between the groups of players in different age categories expressed as the percentage of time spent in the first speed class. The results show statistically significant differences between the cadet men and the senior men as well as between the cadet men and junior men. The cadet men on an average recorded a 5% higher share of the first speed class than the junior men (p = = .000) and a 7% higher share than the senior men (p = = .000). The analysis of variance in which junior men and senior men were compared does not confirm any statistically significant differences in the share of the first speed class throughout the match (p = .415).

In the first speed class the achieved average values in the first and the second halves and in the entire match in all categories ranged between 60% (senior men) and 67% (cadets) (TABLE 2). Differences between the first

and the second halves also occurred. In the second half the share of the run or walked distance in the 1st SC was higher in all categories. The greatest differences were seen with junior men.

TABLE 6
Comparative analysis of variance betwen the group of players of different age categories shown as the percentage of time spent in the second speed class (2nd SC)

CATEGORIES		AV. DIFF.	S. E.	p
CA	JU	.127	.743	1.000
	SE	1.580	.743	.111
JU	CA	-.127	.743	1.000
	SE	1.454	.743	.163
SE	CA	-1.580	.743	.111
	JU	-1.454	.743	.163

Legend: CA – cadet men; JU – junior men; SE – senior men; AV. DIFF. – average differences; S. E. – standard error

There are no substantial deviations between the age categories in the average shares of the second speed class. The highest average shared in the entire match was achieved by the cadet men and junior men – 23%, followed by senior men – 21% (TABLE 2). A higher share in the second speed class was recorded with junior men and senior men in the second half of the match, while cadets saw a decrease in the above mentioned values in the second half.

The comparative analysis of variance show that there were no statistically significant differences in the average shares of the second speed class in the entire match between individual categories (TABLE 6). On average the cadet men achieved only a 0.1% higher share of the second speed class compared to junior men (p = 1.000) and a 1.6% higher share than senior men (p = .111). The analysis of variance does not confirm any statistically significant differences between the junior men and senior men in the share of the second speed class in the entire match (p = .163).

TABLE 7
Comparative analysis of variance betwen the group of players of different age categories shown as the percentage of time spent in the third speed class (3rd SC)

CATEGORIES		AV. DIFF.	S. E.	p
CA	JU	-3.709	.639	.000
	SE	-6.655	.639	.000
JU	CA	3.709	.639	.000
	SE	-2.946	.639	.000
SE	CA	6.655	.639	.000
	JU	2.946	.639	.000

Legend: CA – cadet men; JU – junior men; SE – senior men; AV. DIFF. – average differences; S. E. – standard error

The age-related differences between all analyzed groups of players in shares of the time spent in the third speed class in the entire match were statistically significant (p = .000) (TABLE 7). On average the above mentioned shares are lower by 3.7% (p = .000), if cadet men are compared to junior men and by 6.6% (p = = .000) if they are compared to senior men. The average differences between junior and senior men was 2.9% (p = .000).

Senior men achieved the highest shares of average values in the time spent in the third speed class, which was not the case in the first or second speed class. On average the third speed class accounted for 15% of the entire match. In the categories of both junior men and cadets the above stated shares in the entire match were substantially lower (junior men – 12%, cadet men – 8%).

TABLE 8
Comparative analysis of variance between the groups of players of different age categories shown as the percentage of time spent in the fourth speed class (4th SC)

CATEGORIES		AV. DIFF.	S. E.	p
CA	JU	-1.4125	.1466	.000
	SE	-1.6964	.1466	.000
JU	CA	1.4125	.1466	.000
	SE	-.2839	.1466	.170
SE	CA	1.6964	.1466	.000
	JU	.2839	.1466	.170

Legend: CA – cadet men; JU – junior men; SE – senior men; AV. DIFF. – average differences; S. E. – standard error

A comparative analysis of the variance of the three analyzed groups of players show some statistically significant differences between cadets and senior men (p = .000) as well as between cadets and junior men (p = .000) (TABLE 8). However, there were no differences between junior and senior men (p = .170). In all of the age categories the shares in this speed class are the lowest compared to other speed classes. The values range between 2% (CA) and 4% (SE).

DISCUSSION AND CONCLUSION

After analyzing the volume and intensity of large-scale cyclic movements we can establish that there exist differences between these three age groups of players during handball matches. The senior men achieved the greatest volume of movements, as well as the highest intensity of movements in the 3rd and the 4th speed classes. According to the volume of movements, then follow the groups of junior men and cadet men.

In view of the fact that the defense model was standardized (5–1 zone defense) and that the players in the phase of attack or defense were on specified playing positions, the possibility that these differences resulted from tactical characteristics of both teams playing was excluded. We presume than the principal reason for these differences lies in the player's capability of preserving a certain level of intensity. This is also proven by the fact that the difference between the distances run and walked by the senior-men teams in both halves was only 55 meters, while the relevant difference in the cadet category was 170 m.

The range of distance (2800–4800 m) reported previously (Al-Lail, 1996; Cuesta, 1988 in Cardinale, 2000), make comparison difficult, as the methods, playing level and duration of the matches in these previous studies were not reported. Comparing our result with that of Bon (2001), we can find similar share of the total work-rate as well as intensity speed classes during games, especially if we take under consideration that we used in our study the same methodology (SAGIT system) for collection and analyzing as Bon.

In view of the different age categories of the handball players, we expected some differences in the analyzed variables, as the athletes belonging to older categories are biologically more mature and are subjected to functional training for a longer time (Malina & Bouchard, 2004). That reason enables them to perform more large-scale cyclic activities during a match and spend a higher percentage of time in higher speed classes. Cadet men, being the youngest, differed from junior men and senior men in all of the discussed variables, except in the 2nd SC. The results of junior and senior men were slightly closer and did not differ in all variables. It is particularly interesting that junior men do not differ statistically significantly from senior men in terms of percentage of time spent in 4th SC. Biological development of most junior men (aged between 17 and 20) is nearly completed and, with an adequate training, the level of fitness of these athletes may be quite close to that of senior men (Šibila, 2004). Many junior men already take part in the training sessions of senior men and are modeling themselves on the absolute category from the individual and the team points of view. Smaller differences are probably the consequence of a shorter period of playing (2 × 20 minutes) compared to the official playing time of the category of senior men (2 × 30 minutes). Perhaps we expected to see somewhat different ratios between the cyclic movements of high and low intensity in the handball match owing to this shorter playing time, particularly with senior men. In all three categories 1st SC was predominant.

Of course it stands to reason that cyclic activities constitute only a part of the comprehensive game loading of handball players. Besides running at various intensities and of different duration (walking, jogging, cruising, sprinting, moving side-ways), handball players also have to perform many acyclic activities such as: shots at a goal, jumps, passing the ball, dribbling, falls and standing up. As a rule, these activities are carried out with high intensity and represent a substantial share of the player's work-rate in the match. Therefore, highly intensive running in the 3rd speed class (SC), and particularly the 4th (SC) is just one segment of the highly intensive loading in a handball match (Šibila, Vuleta, & Pori, 2004). The volume of less intensive activities or standing without additional acyclic loading actually represents a break between the highly intensive loading of the cyclic and acyclic types. Based on our findings we may prepare some instructions for handball players' conditioning, primarily from the point of view of cyclic loading.

In view of the modern model of handball, which has been substantially conditioned by a change of rules, it may be concluded that the time during which the players are subject to low- intensity loading has to be reduced. Already with cadets (or particularly with them) the training methods have to include a large number of highly intensive activities of both large-scale cyclic and acyclic types. The volume of less intensive cyclic movements has to be reduced and these should only be used as a relative break.

An effective training plan must be based upon intermittent drills in which handball players have to perform different motions with different paths/movements at the highest intensity possible, followed by lower intensity periods. General drills can be easily developed using cones, circles, small obstacles and small circuits, but, what is most important, game-like drills need to be used in training.

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RŮZNÉ VĚKOVÉ KATEGORIE VE VZTAHU K OBJEMU A INTENZITĚ ŠIROKÉHO SPEKTRA CYKLICKÝCH POHYBŮ HRÁČŮ MUŽSKÉ HÁZENÉ

(Souhrn anglického textu)

Cílem této studie bylo identifikovat rozdíly v síle a intenzitě cyklických pohybů ve velkém měřítku vykonávaných hráči házené ve třech věkových kategoriích – kadeti (chlapci ve věku mezi 15 a 17 lety), junioři (muži ve věku 17 až 20 let) a senioři (ve věku 20 let a více).

Pro tento účel bylo analyzováno šest experimentálních modelových zápasů (2 × 20 minut), odehraných slovinskými mužskými házenkářskými družstvy. Vzorek sestával z 84 hráčů ve dvanácti týmech (průměrný věk 20,26 let ± 4,28 let; průměrná výška 182,51 cm ± 6,59 cm; průměrná tělesná hmotnost 80,61 kg ± 10,37 kg) a byl rozdělen do tří dalších podskupin podle věku (kadet, junior a senior).

Soubor údajů širokého spektra cyklických pohybů v zápase házené byl získán metodou SAGIT (Ljubljana, Slovinsko), založenou na počítačovém zobrazování. Takto získané údaje byly zpracovány vybranými deskriptivními statistickými metodami. Zjistili jsme statisticky významné rozdíly mezi různými věkovými kategoriemi v objemu celkové vzdálenosti, kterou ušli a uběhli během zápasů. Největší vzdálenost byla dosažena skupinou seniorů, následně juniory a poslední byli kadeti. Ve všech analyzovaných kategoriích byly celkové vzdálenosti větší v první polovině zápasu než ve druhé polovině.

Statisticky významné rozdíly se rovněž objevily v průměrném podílu času zaznamenaném ve všech rychlostních třídách, kromě druhé rychlostní třídy. V první rychlostní třídě byly některé statisticky významné rozdíly spatřeny mezi kadety a seniory a rovněž mezi kadety a juniory, zatímco mezi juniory a seniory nebyly zaznamenány žádné rozdíly. Ve třetí rychlostní třídě se objevily statisticky významné rozdíly mezi všemi analyzovanými věkovými kategoriemi.

Podobně jako v první rychlostní třídě byly i ve čtvrté rychlostní třídě zaznamenány statisticky významné rozdíly mezi kadety a seniory a také mezi kadety a juniory, zatímco mezi seniory a juniory nebyly spatřeny žádné rozdíly.

Se zřetelem k rozdílným věkovým kategoriím u hráčů házené jsme očekávali rozdíly v analyzovaných proměnných, protože sportovci patřící do starších věkových kategorií jsou biologicky více vyzrálí a jsou již delší dobu vystaveni funkčnímu tréninku. Z tohoto důvodu mají možnost vykonávat více cyklických aktivit ve velkém měřítku během zápasu a strávit větší procento času ve vyšší rychlostní třídě.

Klíčová slova: týmová házená, analýza času a pohybu, cyklické pohyby ve velkém měřítku, věkové kategorie.

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INSTRUCTIONS FOR MANUSCRIPT

The Acta Universitatis Palackianae Olomucensis. Gymnica is an independent professional journal. The content of the magazine is focused on presentation of research notifications and theoretical studies connected with the problems of kinanthropology. The Editorial Board is looking forward to all manuscripts written on the above subject.

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The text of the contribution is in English. The contribution is not to exceed a maximum limit of 15 pages (including tables, pictures, summaries and appendices). A summary will be in the Czech language, and by rule 1 page at the most.

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