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OBSAH

DIFFERENCES IN CHARACTERISTICS OF CYCLING EVENT PARTICIPANTS IN SLOVENIA IN YEARS 2005 AND 2006

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The main aim of this study is to find out some characteristics of randomly selected cycling event participants in the years 2005 and 2006. A two day recreation and active lifestyle promoting event provided a cycling offer that corresponded to both sexes and people of different ages and psychophysical abilities. Randomly selected recreational cyclists (261) were asked to complete the anonymous questionnaire. The results show a small but statistically significant negative correlation ($r = -0.268$, $p < 0.01$) between the frequency of participation in physical/sport activities and age. Close to 50% of participants in 2005 were active 4–6 times per week and in the next year 39% of the contestants were as active. There is also a statistically significant positive relationship between frequency of participation in physical/sport activities and self assessment of health status in 2005 ($r = 0.319$, $p < 0.01$) and 2006 ($r = 0.311$, $p < 0.01$). Participants assessed their health as being good or very good in 83% (in 2005) and in 77% (in 2006). The coefficient indicates also a small but statistically significant negative correlation ($r = -0.219$, $p < 0.01$) between the importance of physical/sport activities and age.

The knowledge of some characteristics of recreational cyclists could contribute to the improvement of mass cycling (and other) events and, at the same time, also to the development of cycling tourism in Slovenia which has excellent natural features for this type of activity.

Keywords: Cycling, physical/sport activity, promotion of health, festival of cycling.

INTRODUCTION

Slovenians first acquainted themselves with cycling as early as 1869 when the first bicycle "appeared" in Slovenia. The first race, however, took place two decades later. The bicycle (etymology: Latin "bis" – "twice" and Greek "kylos" – "wheel") was rather impractical as it was driven directly by the pedals placed on the enlarged high front wheel (oversized penny-farthing wheel), while the back wheel served to maintain balance (Milošević, 1999). Slovenia was introduced to the bicycle almost simultaneously with the rest of Europe. As a bourgeois fashion vagary, the bicycle initially stood for prestige; later on it become a practical and light means of transport. The first Slovenian cycling club, the so called "Der Laibacher Byciklisticher Club" (Ljubljana Cycling Club), was established in 1885 by the pro German Ljubljana bourgeoisie. Two years later, however, the Slovenians established the Slovenian Cyclists Club of Ljubljana (Vehar, 1996).

Everyday cycling is an effective form of aerobic exercise, as it is well known that regular physical/sport activity (this term refers to any movement of the body that results in energy expenditure and has the aim of maintaining or improving physical fitness or health) has a beneficial effect on the human organism, inhibits the development of a series of health disorders and diseases, and contributes to the strengthening of mental health (Cavill, Kahlmeier, & Racioppi, 2006; Dixon, Mauzey, & Hall, 2003) and improvement of the individual's physical self concept and self appreciation (Fox, 1999). Everyday cycling also reduces the risk of serious conditions such as heart disease, high blood pressure, obesity and the most common form of diabetes (Carnall, 2000). At low speed, cycling, this "group sport of individuals", triggers accelerated activity of the lungs and the cardiovascular system and is most beneficial to leg muscles as well as arms when ascending, while the joints do not suffer. Activities of this kind result in great energy consumption and may help cope with stress and psychological exhaustion (Ropret & Tomc, 1989).

A sedentary lifestyle, a reflection of our contemporary lifestyle, is fast becoming one of the most pressing social concerns as it triggers numerous, to the human body adverse effects. A passive lifestyle gives rise to diverse health problems (Blair et al., 1989; Kyle, Morabia, Schutz, & Pitchard, 2004; Leon & Connett, 1991; Rodriguez et al., 1994) and, (in)directly, also to social (Tarlov, 1996) and economic problems (Ruhm, 2000).

The level of participation in physical/sport activities in Slovenia is low, but the share of organized recreational activities increases on a yearly basis – in 2007 there were 45 organized recreational activities planned to take place from March to October (as much as two a day at different locations).

As people all around the world are more and more aware of the negative effects of our contemporary (sedentary) lifestyle (Jeffery, 2001; Rzewnicky, 2003), organized physical/sport activities have been well attended for several years now. The "Lake Taupo Cycle Challenge" event was launched in 1977 and today it is one of the biggest recreational sporting events in New Zealand – in 2006, 12.000 recreational cyclists pushed the pedals at the160 kilometre long one day event. In Australia, there is the "Festival of Cycling" – active families challenge people's day at Albert Park. The aim of the festival, which takes place in April, is to promote an annual day of healthy participation for all families. Closer to Slovenia is the Dutch "Fietsvierdaagse" which consists of four days of recreational cycling and offers daily tours of 30 to 100 kilometres which are attended in mass numbers, by families and pensioners, in particular.

In 2005, a cycling event was launched in Slovenia which represented a link between competitive and recreational sport, namely the "Festival of Cycling," which took place conjointly with the "Franja Barcaffe Marathon", the latter being accompanied also by shorter races (family and mountain bike race). As the event was also attended by some foreign participants, it could be ranked side by side with some other big sporting events taking place in Slovenia and Europe. A two day recreation and active lifestyle promoting programme provided a cycling offer that corresponded to both sexes and people of different ages and psychophysical abilities. With a view to popularizing cycling and triggering mass participation, the central motive of the event was to attract people to take part in it and give full vent to their abilities and potential, achieve goals, test themselves and socialize. In light of such a diverse attending population, we wanted to establish some characteristics of the people who participate in organized cycling events.

The main aim of this study is to find out age, gender and educational level differences in randomly selected cycling event participants in 2005 and 2006 and compare it with the thesis that the most frequent participants in physical/sport activities are middle aged people with college or higher education, who are active 2–3 times a week and assess their health status as being very good.

METHODS

Participants

Altogether 261 randomly selected participants (including 201 males) were included in the study, which was conducted on two occasions. The measurements were performed in two years (2005 and 2006). TABLE 1 shows the distribution of participants regarding their age group and the year of the test. The participants were grouped into six age groups for every decade of age.

Data collection

Using an anonymous questionnaire as a data collection instrument, we have collected data for: basic socio-demographic characteristics (gender, age, level of education), sport activities (self perceived significance, frequency of participation, forms and modes of physical/sport activities, participation in individual sports, organization of physical/sport activity, participation in sporting events), and assessment of health and amount of income spent on recreation (appendix).

Data processing

All basic data manipulations were performed using Microsoft Excel (Microsoft Office 2003, Microsoft Co., USA) and statistically analysed with the SPSS 12.0 (SPSS Inc., USA). Different variables (the significance of physical/sport activity, frequency of participation in physical/sport activity and self assessment of health status) were used and correlations between them calculated. We used Spearman's rank coefficient (between participation in physical/sport activities and age, be-

TABLE 1
Classification of respondents according to age groups

		Age group													
		20 years and below		21–30 years		31–40 years		41–50 years		51–60 years		61 years and above		Total	
		2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Male	f	20	12	40	22	18	38	9	25	2	9	1	5	90	111
	F %	22.2	10.8	44.4	19.8	20.0	34.2	10.0	22.5	2.2	8.1	1.1	4.5	100.0	100.0
Female	f	2	2	8	9	12	10	6	6	0	2	2	1	30	30
	F %	6.7	6.7	26.7	30.0	40.0	33.3	20.0	20.0	0	6.7	6.7	3.3	100.0	100.0

tween physical/sport activities and age and between participation in physical/sport activities and self-assessment of health status) and Pearson's chi-square for testing our thesis. We tried to extract sufficient information from the data to confirm our thesis and we expressed appropriate conclusions in terms as described below.

RESULTS AND DISCUSSION

In the pioneer year of the "Festival of Cycling", 40% of participants were aged between 21 and 30 and a quarter of the participants were aged between 31 and 40 (TABLE 1). Among participants in the following year, 34% were between 31 and 40, 22% aged from 21 to 30 and 22% aged from 41 to 50. The participants aged over 61 represented the lowest share (3.4%). Our data correspond to the data of cycling participation provided by the Australian Sports Commission (2005) which show that cycling is most popular with those in the 35–44 year age group and least popular with those 65 years and over.

As ageing results not only in failing physical and mental strength, but also in greater life experience, sports programmes should be designed in such a manner as to correspond to the needs and personal characteristics of individuals as well as their social and economic conditions.

The research carried out in 2002 on physical/sport activity in the second half of the life of the Swiss population included over 9000 inhabitants aged over 50. More than one third of the population failed to engage in physical/sport activity on a sufficient basis (Meyer, Rezny, & Stuck, 2005). The connection with our research therefore exists, since the negative trend in the lack of physical/sport activity exists. As it seems older contestants were less active than younger ones – there is a small but statistically significant negative correlation ($r = -0.268$, $p < 0.01$) between frequency of participation in physical/sport activities and age.

It is well known that moderate forms of exercise significantly contribute to both improvement of health and longevity, if pursued over a longer period of time. It has been proven that regular physical/sport activity preserves the health of people of all ages. As sport for the third life period still lacks attention, professional guidance and perfected programmes should aim at improving this area, as well.

The coefficient indicates a small but statistically significant negative correlation ($r = -0.219$, $p < 0.01$) between the significance of physical/sport activities and age – the higher the age of contestants was, the smaller was the significance of physical/sport activities. Therefore society does not consider sport to be a value in and of itself, since sport activity most frequently serves as a means of achieving general and particular social goals. Participation in sport is motivated by social and personal factors. The underlying social value of sport is in that it can, as a special social activity, contribute significantly to the balance between social and individual needs and goals (Tušak & Bednarik, 2002).

Physical/sport activity was of high significance to 57% of the respondents interviewed in 2006 and to 46% of the respondents interviewed the previous year (TABLE 4). They were mostly with secondary education (57% in 2005 and 49% in 2006), followed by the respondents with higher education (18% in 2005 and 15% in 2006) (TABLE 2).

More than half of the female respondents interviewed in 2005 and 60% in 2006 participated in physical/sport activities 2–3 times a week. Almost 60% of the male respondents interviewed in 2005 were active 4–6 times a week, while one year later 44% male respondents were as active (TABLE 3).

We find these data satisfactory, considering that half and slightly less than 40% of the respondents interviewed in 2006 devoted to physical/sport activities 120 days and approximately 240 days a year, respectively. These data are most likely the result of a varied sports offer, further, of a lifestyle that incorporates physical activity into everyday life, and of a great awareness of the significance of exercise.

In 2004, the 15th study was carried out within the framework of the target research programme "Competitiveness of Slovenia 2001–2006" under the title "Physical/sport activity for health" and under the auspices of the Science and Research Centre of Koper, University of Primorska.

TABLE 2
Classification of respondents according to education level

		Educational level													
		Primary		Vocational		Secondary		College		Higher		Other		Total	
		2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Male	f	11	12	7	16	54	53	5	13	12	14	1	3	90	111
	F %	12.2	10.8	7.8	14.4	60.0	47.7	5.6	11.7	13.3	12.6	1.1	2.7	100.0	100.0
Female	f	0	0	1	1	14	16	4	6	10	7	1	0	30	30
	F %	0	0	3.3	3.3	46.7	53.3	13.3	20.0	33.3	23.3	3.3	0	100.0	100.0

TABLE 3
Classification of respondents according to frequency of participation in physical/sport activity

		Frequency of participation in physical/sport activity							
		Up to once a week		2–3 times a week		4–6 times a week		Total	
		2005	2006	2005	2006	2005	2006	2005	2006
Male	f	8	13	29	49	53	49	90	111
	F %	8.9	11.7	32.2	44.1	58.9	44.1	100.0	100.0
Female	f	8	6	16	18	6	6	30	30
	F %	26.7	20.0	53.3	60.0	20.0	20.0	100.0	100.0

TABLE 4
Classification of respondents according to significance of physical/sport activity

		Significance of participation in physical/sport activity									
		Poor		Medium		High		Great		Total	
		2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Male	f	1	3	26	31	44	63	19	14	90	111
	F %	1.1	2.7	28.9	27.9	48.9	56.8	21.1	12.6	100.0	100.0
Female	f	0	0	9	10	11	17	10	3	30	30
	F %	0	0	30.3	33.3	36.7	56.7	33.3	10.0	100.0	100.0

The interviews were conducted by the public opinion and mass communication research centre within the framework of the Research Institute, Faculty of Social Sciences (2004/2), and within the framework of the wider European social sciences research. 1442 individuals were interviewed, namely, 46% male and 54% female respondents aged between 15 and 95. As regards the question of frequency of participation in physical/sport activities and share of physically active individuals, the majority of respondents, who came from very diverse socio-demographic environments, participated in physical/sport activities on a more frequent and regular basis. Inactive, occasionally active and regularly active respondents were at an approximate ratio of 4:3:3 (Sila, 2005).

Within the framework of the project "Physical/sport activity for health" (Završnik et al., 2004), which was carried out in 2003 and 2004, 34% of male and as much as 43.5% of female respondents (out of a total of 749 respondents) declared that they did not participate in sport activities in their leisure time whereas 21% of male and 17% of female respondents declared they were physically active once a week, which results are similar to the results of our research, which found that 13.5% were active up to once a week in 2005 and 2006, respectively (TABLE 3). One quarter of male and one quarter of female respondents participated in physical/sport activity several times a week, according to the findings of the project "Physical/sport activity for health"; our research, however, obtained much better results (as already mentioned here above).

The following are the results obtained by three French preventive medicine centres which, for research purposes, have asked 3019 healthy adults (aged above 18) from diverse socio-demographic environments to complete a questionnaire relating to leisure time activities, reasons for (non)participation in physical/sport activities, frequency of participation in physical/sport activities, the relationship between physical/sport activity and health, and level of stress: 44% of respondents participated in physical/sport activities on a regular basis; almost 90% of them equated the said activities with the sense of being healthy; following exercise, 33% felt their energy level was greater and 25% felt they were more relaxed (Perrin et al., 2002).

Recreational cyclists included in our research were also asked to assess their health status (their own opinion) (TABLE 5). Participants assessed their health as good or very good in 83% (2005) and in 77% (2006), while only 3% (2005) and 4% the following year claimed that their health status is very poor or poor. There is also a statistically significant positive relationship between frequency of participation in physical/sport activities and self assessment of health status in 2005 ($r = 0.319$, $p < 0.01$) and 2006 ($r = 0.311$, $p < 0.01$). That confirms the fact that contestants who engage more in physical/sport activities assess their health status higher. This result relates to the above fact of frequent participation in physical/sport activity, considering that it contributes enormously to one's well being. General health self assessment provided by the cyclists who participated in the above mentioned event is therefore rather positive

TABLE 5
Classification of respondents according to self-assessment of health status

		Self assessment of health status							
		Very poor or poor		Satisfactory		Good or very good		Total	
		2005	2006	2005	2006	2005	2006	2005	2006
Male	f	3	6	7	18	79	87	89	111
	F %	3.4	5.4	7.9	16.2	88.8	78.4	100.0	100.0
Female	f	1	0	9	8	20	22	30	30
	F %	3.3	0	30.0	26.7	66.7	73.3	100.0	100.0

TABLE 6
Classification of respondents according to frequency of participation in mass sporting events

		Frequency of participation in mass sporting events									
		Very rarely		Rarely		Often		Very often		Total	
		2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Male	f	2	19	28	48	43	38	15	6	88	111
	F %	2.3	17.1	31.8	43.2	48.9	34.2	17.0	5.4	100.0	100.0
Female	f	0	4	5	19	19	6	6	1	30	30
	F %	0	13.3	16.7	63.3	63.3	20.0	20.0	3.3	100.0	100.0

as it testifies that they are well aware and conscious of the fact that participation in physical/sport activities constitutes a key element of quality lifestyle.

The most frequently listed among the physical/sport activities in which the interviewed recreational cyclists participate are two seasonal sports, namely cycling and alpine skiing, which are followed by running and mountaineering.

The respondents most frequently participated in cycling (113 answers), alpine skiing (47 answers), outdoor running (43 answers) and mountain climbing or mountaineering (39 answers).

The following physical/sport activities comparable with our results were presented within the framework of the public opinion survey: Slovenians most frequently exercise by walking (59%), swimming (29%), cycling (26%), skiing (16%) and running (12%) (Sila, 2005).

Outdoor activities are evidently predominant owing to the fact that daily we spend too much time in enclosed spaces, for which reason we want to spend as much of our "leisure time" as possible outdoors. Many people instinctively associate physical/sport activity with the outdoors, which throughout the year offers various forms of recreation in which more and more people tend to participate despite the indoor trend. According to Cankar (2003), human corporality constitutes a fundamental starting point of one's connection with nature. The feelings of connectedness are equally accentuated in contact with nature. Family and other social milieus, which increasingly fail to exercise their functions, assume an especially important function in our relationship with nature.

The research data attesting to increased participation in organized activities are positive.

In 2005, 52% of the festival participants often attended mass sporting events (TABLE 6). Almost half of the respondents interviewed the following year attended similar events rarely. 18% of the respondents interviewed in 2005 and only 5% of the respondents interviewed in 2006 declared that they attended mass sporting events very often.

We can conclude on the basis of the data given in TABLE 6 that there exists a visible trend in increased participation in mass sporting events. Greater participation could possibly be triggered by greater media support (previous announcements, preparations for certain physical/sport activities, introduction of new equipment, and similar). Our research aims at encouraging the organizers of future physical/sporting events to devote even greater attention to the preparatory organization of events, adapt programmes to all age groups, and maybe adapt to and cooperate with other similar events in terms of contents (e.g. in the context of seasons).

Road cyclists dominated both years: 38% the first year and almost 60% the following year. In 2005, 34% of respondents opted for mountain biking and as little as 10% in 2006. Further, 26% of the festival participants opted for a combination of mountain biking and road cycling in 2005 and 31% in 2006, while 56% of all respondents are members of sport clubs.

TABLE 7
Classification of respondents according to the proportion of income given for recreation

		Income given for recreation							
		Very small or small		Medium		High or very		Total	
		2005	2006	2005	2006	2005	2006	2005	2006
Male	f	33	24	37	52	17	35	87	111
	F %	37.9	21.6	42.5	46.8	19.5	31.5	100.0	100.0
Female	f	7	8	15	20	8	2	30	30
	F %	23.3	26.7	50.0	66.7	26.7	6.7	100.0	100.0

We were also interested in the proportion of their income that the participants in the said event devote to physical/sport activities. The results have shown that 44% (2005) and 51% (2006) of respondents spend a medium proportion of their income on recreation (TABLE 7). In realistic terms, this is the most favourable of answers, considering that the price of equipment is relatively high and that, in addition to the payment of requisites, participation in certain sports also requires payment of membership fees, use of recreation grounds, and the like.

Of the respondents, 21% (2005) and 26% (2006) declared that they spend a very high or high proportion of their income for physical/sport activities and 34% (2005) and 23% (2006) of respondents declared that they spend a very small or small proportion of their income for recreation. The latter most likely participate in seasonal physical/sport activities which do not require additional expenditures (hiking, running, walking, swimming, etc.); however, they nevertheless attend organized events such as the "Festival of cycling".We have found that the Slovenian model of sport financing corresponds to the European model. The data clearly show that the majority of income is spent on membership fees and sport courses. According to the revenues of sport associations, football (16%), as a sport discipline, is undoubtedly the most popular and is followed by skiing and basketball (9%) and handball and mountaineering (Meyer et al., 2005) which, however, are lagging far behind. We have established that, in general, the total sport expenditure amounts to 2.33% of Slovenian GDP, a share that is greater than that of the majority of the EU Member States (Retar, 2006).

CONCLUSION

Knowing the differences in characteristics of sport event participants could help us to identify additional factors that could encourage and motivate further participation in sporting events or would attract newcomers.

As we found out, the most frequent participants in physical/sport activities are middle aged people – the questioned population aged over 51 attended events (4%) and aged under 21 years (14%). For improving this fact, routes and time limits should be adapted in such a manner to suit respective age groups.

We find encouraging that the results attest to the significance of physical/sport activity – more than half of the respondents consider physical/sport activity to be very important. Also encouraging is the data which shows that 44% of the participants engage in physical/sport activities 4–6 times a week.

There exists a link between sporting participation and quality of life (or well being) which in recent years started to constitute one of the principal values of society. Although development (or "progress") brought sedentariness to society, physical/sport activity has become extremely popular and important for the life of individuals and, consequently, society as a whole. Participation in physical/sport activities has a positive impact on aspects of quality of life as it relates to social inclusion, which brings well being, expressed as satisfaction with life as a whole, and social well being, too.

That is why it would be reasonable to base sporting events on the motivation, in particular, of the population aged over 50 and, as we have found that the share of female cyclists is lower than the share of those attending similar events abroad, it would be reasonable if the media focused more strongly on them in terms of recreational cycling.

The most crucial is the awareness of the fact that all forms of exercise contribute significantly to both the improvement and preservation of health and longevity if pursued over a longer period of time. The types of exercise that people find most attractive, that they can most easily include in their everyday life and that correspond to their physical abilities, age and health status should constitute the contents of such physical/sport activity as would ensure an adequate, healthy and active lifestyle.

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Appendix
Questionnaire – festival of cycling

Sex: M F

Age ___

Educational level:
Primary education
Vocational education
Secondary education
College
Higher education, College
Other

Significance of physical/sport activities in life:
Zero
Poor
Medium
High
Great

How often do you participate in physical/sport activities?
few times a year
1–3 times per month
once per week
2–3 times per week
4–6 times per week

How would you assess your health?
Very poor
Poor
Satisfactory
Good
Very good

Name the sports you engage in most frequently____________________
How many days you approximately engage in it? __________
Do you do it organised or not? ___________
Do you do them alone, with friends, with your family or with the club? ______

How often do you participate in mass sporting events?
Very rarely
Rarely
Often
Very often

Do you prefer road cycling or mountain biking? ___________

What is the proportion of income given for physical/sport activities?
Very small
Small
Medium
High
Very high

ROZDÍLY V CHARAKTERISTICE ÚČASTNÍKŮ CYKLISTICKÝCH AKCÍ VE SLOVINSKU V LETECH 2005 A 2006

(Souhrn anglického textu)

Hlavním cílem této studie je nalézt určité charakteristiky náhodně vybraných účastníků cyklistických akcí v letech 2005 a 2006. Dvoudenní rekreační akce na podporu aktivního životního stylu poskytovala možnost cyklistického vyžití pro osoby obou pohlaví, různého věku a různých psychických a fyzických schopností. Náhodně vybraní rekreační cyklisté (261) byli požádáni, aby vyplnili anonymní dotazník. Výsledky ukazují malou, avšak statisticky významnou negativní korelaci ($r = -0{,}268$, $p < 0{,}01$) mezi frekvencí zapojení do pohybových/sportovních aktivit a věkem. Téměř 50 % účastníků v roce 2005 bylo aktivních 4–6 × týdně a v následujícím roce to bylo 39 % soutěžících. Je zde také statisticky významný pozitivní vztah mezi frekvencí zapojení do pohybových/sportovních aktivit a subjektivním hodnocením zdravotního stavu v roce 2005 ($r = 0{,}319$, $p < 0{,}01$) a 2006 ($r = 0{,}311$, $p < 0{,}01$). Účastníci hodnotili svůj zdravotní stav jako dobrý či velmi dobrý v 83 % (v roce 2005) a v 77 % (v roce 2006). Koeficient také vyjadřuje malou, avšak statisticky významnou negativní korelaci ($r = -0{,}219$, $p < 0{,}01$) mezi důležitostí pohybových/sportovních aktivit a věkem.

Znalost některých charakteristik rekreačních cyklistů může přispět ke zlepšení masových cyklistických (i jiných) akcí a zároveň také k vývoji cykloturistiky ve Slovinsku, které má pro tyto aktivity skvělé přírodní podmínky.

Klíčová slova: cyklistika, pohybová/sportovní aktivita, podpora zdraví, festival cyklistiky.

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First-line publications

Šetina, T., Volmut, T., Pišot, R., Dolenc, P., Štemberger, V., Videmšek, M. et al. (2007). Measurement of children's physical activity related to age and gender. In G. Bala (Ed.), *Proceedings of Interdisciplinary Scientific Conference Anthropological Status and Physical Activity of Children, Youth and Adults* (pp. 31–40). Novi Sad: Faculty of sport and physical education.

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APPLYING GESTALT THERAPY PRINCIPLES IN COUNSELING A FEMALE ORIENTEER

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The article aims to suggest how a Gestalt therapy (GT) framework can be applied in sport psychology consultations and research. An explanation of GT's theoretical basis (Perls, Hefferline, & Gododman, 2004) and its three pillars (the field theory, phenomenology and the existential dialogue) is followed by a concrete example of its application in a particular performance analysis of a selected youthful orienteer. It is expected that this runner can get a restructured view of her strengths and weaknesses by acknowledging and becoming aware of her actions in successful as well as in failed performances. Since the research topic is relevant and significant only for athletes with the specified experience, a focussed sample has been drawn (Giorgi, 2005; Stake, 2005). In this article, the selected participant is an elite level 16 year old female orienteer who has reached medal positions in national and international competitions. Following GT principles (the field theory, phenomenology, a horizontal level of work in existential dialogue), a phenomenological interview (Pollio, Henley, & Thompson, 1997) was conducted. This case study shows that GT techniques assist the orienteer in benefitting from experience she gained through both successful as well as failed performances. The runner spotted discrepancies between them and figured out that "a step by step" navigation (secure attack points) would support her performance. Importantly, it was the runner who became aware of how she influences her performance in a positive as well as in a negative way, regardless of the fact that she used to be taught such a strategy before. Instead of getting advice from coaches, the runner formulated it herself. The crucial contribution of Gestalt therapy principles application to sports consists of encouraging athletes to take their own initiative, acknowledge and fully realize the relationship between actions and performance outcome, thereby getting the chance to participate actively and accept the responsibility for their development. Additional investigation is needed in order to estimate the contribution of the Gestalt approach to different age groups and at various performance levels. Further research might also be directed towards applying Gestalt coaching principles, used in organizations, in working with team sports.

Keywords: Gestalt therapy, performance analysis, awareness, orienteering, young athletes.

INTRODUCTION

Sport psychologists have increasingly become interested in the experience of athletes during the past ten years. Dale (1994, 1996, 2000) emphasizes the role of athletes' experience in sport psychology research as a way to improve performance, because it provides athletes with insight into experience where they have handled a difficult situation, or acknowledges how a mistake occurs. The tendency to focus on experience is also echoed in Gestalt therapy (GT). GT focuses on a person's own experience and presumes that becoming aware of one's own functioning in the organismic/environmental field can support personal growth, development and fulfillment of one's potential (Perls, Hefferline, & Goodman, 2004). Therefore, this paper aims to introduce the basis of the GT theoretical concept, suggest its application in the field of sport psychology and present some practical examples arising from exploring one selected athlete's experience.

The researcher's personal experience of orienteering and GT training facilitates the application of GT principles in a performance analysis in a case study of one female orienteer, described in this article. This 16 year old runner participated in a dialogue in which she explored her experience of both good and bad performances. Evaluation of which performance is good or bad was done subjectively according to the runner's opinion.

A THEORETICAL FRAMEWORK

Gestalt therapy is a phenomenological-existential approach to personal development and growth. As presented by its founders Perls, Hefferline and Goodman (2004), it offers a framework to advance and develop any part of human life. By exploring the individual's complex functioning in context, the Gestalt perspective provides a system capable of surpassing problem resolution and of achieving full potential and joy in life

(Barrett, 1997). Unlike other psychological approaches, Gestalt theoretical psychology and therapy aims to understand and expand the health and freedom of actions in all kinds of situations people encounter in their lives, as opposed to focussing only on pathology and its treatment. Moreover, Gestalt recognizes the inborn drive of all human beings towards health and growth (Andersson, 2008). Changes in direction are realized through awareness. When considering this, it is presumed that the holistic Gestalt theoretical perspective, including Gestalt therapy, can be beneficial to athletes in order for them to learn more about their performances and themselves and move towards prowess in their sport as well as fulfillment in other areas of their lives.

In this study, the theoretical basis of Gestalt theoretical psychology and Gestalt therapy are adopted – especially its field theory, phenomenology and existential dialogue (Perls, Hefferline, & Goodman, 2004) – in order to explore this runners' experience with successful and failed performances chosen subjectively by the runner. Moreover, it gives full respect to the individual and her phenomenology and aims to find areas of this athlete's growth through awareness supported by horizontal work in existential dialogue. Further, general conclusions will be suggested based on this one case.

The field theory

According to the field theory, the field is a whole in which all the parts relate and are responsive to each other. Every single part is under the influence of occurrences which happen elsewhere in the field (Yontef, 1993). An individual and his/her environment in the broadest sense is contained by the field. In GT, therapists work with here and now, the current state of the field, also encompassing remains of the past and serving as the starting line for the future. It means that all aspects of the field are potentially important at any moment and a person through his/her phenomenology determines what becomes figural and what stays in the indifferent background. In other words, it is the person who defines the field and it is possible to understand its meaning only when we know the observer's viewpoint and circumstances. Therefore, a descriptive approach and observation appear to be the most powerful tools when we attempt to understand the structure of the studied phenomenon (the athlete's experience).

Similarly, this study views the athlete as a whole and in mutual interaction with the surrounding environment. All parts of her field interact continuously and are connected. The athlete influences the field and is formed by interactions with it as well. Even though it is not possible to separate the athlete and the field, there is a contact border – a space where contact processes between the athlete and the field are held. In this space, the athlete develops her specific ways of behavior as a reaction to interactions with the outside world. An understanding of these contact processes and of the athlete's perception and reactions can highlight areas of further personal growth. In other words, if the athlete understands how she actively forms and lives this contact, identifies and fulfills her needs, she has the chance to explore and fulfill her potential.

Phenomenology

Phenomenology and Gestalt have the same goal "to study multiple possibilities of the field or situation in the way how people, who continuously interchange the field, experience it subjectively" (Mackewn, 2004, 71). The goal of Gestalt phenomenological exploration is awareness, insight and clear understanding of situation by the client. It is presumed that one objective reality does not exist and we can only be opened to various subjective interpretations of reality. According to Resnick (Resnick & Parlett, 1995, 3), the way "how people choose, organize, and contribute to the construction of what becomes figural for them and what background(s) they bring to bear", is critical. In other words, Yontef (1993) agrees that it is crucial how a person becomes aware and what the process of becoming aware is. Moreover, awareness is not possible without a systematical exploration. Awareness has sensory, affective and cognitive facets – it incorporates sensation, thinking and feelings. To be fully aware means that "you know *what* you do, *how* you do it, that there are alternatives, and that you *choose* to do what you do and are the way you are" (Andersson, 2008, 2). A person feels that he/she is in control of and responsible for his/her own feelings, choices and behavior. Therefore, awareness represents the primary goal of exploration in Gestalt therapy.

Each person creates his/her own subjective meaning of the experience and in the phenomenological exploration he/she learns how to become aware of awareness. Transferred to the sport environment, e.g. training, can be effective only when it respects the specificity of each individual and his/her phenomenology. Also mental training cannot be started without detailed information about the athlete's way of organizing his/her perception and experience in practice and competitions and becoming aware of his/her functioning in the organismic/environmental field. During training, athletes learn how to manage their tasks, even though they do not have to be aware of the concrete actions they are taking. Similarly, athletes adopt their styles of failing, also mostly without understanding the process itself. There are many ways of task solution in sports. Athletes learn to use those which serve as *a creative adaptation* (Perls, Hefferline, & Goodman, 2004) to manage the goal. On the other hand, athletes get into difficulties when it becomes a stereotyped strategy and is used in all kinds of situations and cannot be changed flexibly according to the present settings. It becomes a rigid action, not a choice. The first step towards free choice leads through deeper awareness of what happens at the contact border when the athlete manages or fails and how it serves the athletes needs and goals and fulfills his/her potential as an athlete and as a person as well.

The existential dialogue

In GT, the existential dialogue is a means of awareness development, learning, problem solving and self growth. Relationship grows out of contact (Yontef, 1993). This represents a core concept of Gestalt psychotherapy (Mackewn, 2004). The relationship between the therapist and the client provides space to study the ways how the client creates his/her perception in some stereotyped way and thereby prevents himself/herself from personal growth. Therefore the quality of the relationship is crucial. The contact is a process and is experienced as a boundary between me and not me. The boundary separates me and not me and at the same time represents a space for connections between them (A. Polák, unpublished lecture). In this boundary space, a person can experience contact with not me aspects of the field while preserving his/her own identity. Therefore, a person needs support in order to be able to enter and experience the dynamic of contact and withdrawal.

From the Gestalt therapy point of view, people are their own best experts on themselves and on what is best for them. Since they survive in the world, they have managed creative adaptation at certain periods of their lives and learnt to overcome problems. However, once such a behavior or perception becomes stereotyped, it limits the person from full contact with reality and reduces support for self standing decisions and free choice. In therapy, by engaging in dialogue, they can move towards the desired change with full responsibility. In other words, the therapist refuses to be the agent of the change; however he/she helps the person to find new ways and possibilities to change what they are not satisfied with. It is the person who makes the change.

Similarly, the approach of the researcher in this study is inspired by a horizontal level of work in the existential dialogue and the function of the contact and withdrawal. The basis for such a contact lies in acceptance, authenticity, common language and self responsibility (Perls, Hefferline, & Goodman, 2004). It requires respect for two different phenomenologies – those of the athlete and the researcher. Klajnšček (1997, 445–446) is probably the only coach who has applied the Gestalt approach in his work with a karate competitor, and described that "his attitude towards the competitor is personal, on an experimental level. He is trained to enter the phenomenological world of this competitor to experience his point of view and his opinions together with him". Moreover, this requires a close and personal contact and a constant focus on the competitor's here and now. Contrary to a traditional top down approach, such a coach attempts to have the competitor direct his/her training himself/herself as much as possible and take responsibility. At the same time, the coach also has to be self confident, trained and has to accept an active and creative role in training adaptation and planning.

With regard to the fact that an athlete is the best expert on himself/herself and knows the most suitable way of development in his/her sport, it is supposed that he/she can move towards his/her potential when he/she becomes involved in the exploration of patterns through which he/she actively creates his/her functioning in training and competitions. In terms of the field theory, participation in sport is an inseparable part of the organismic/environmental field with a direct contact at the contact border. This is closely connected with the paradoxical theory of change. Even though Frederic Perls did not explicitly delineate this theory, he is considered to be its author since it underlies most of his work and the Gestalt techniques he developed. It was Beisser (1970, 77) who wrote the most referenced article about this phenomenon, named it *the paradoxical theory of change* and defined "that change occurs when one becomes what he is, not when he tries to become what he is not", which also means that "change can occur when the patient abandons, at least for the moment, what he would like to become and attempts to be what he is". Put simply, no one else can directly change the person passively. Help is attainable only through contact with the present situation. It is only possible to find a way towards the intended change when the person is aware of the present position and settings and then he/she is able to move further.

Contrary to analytical approaches, the Gestalt therapist refuses the role of "the changer" (Perls, Hefferline, & Goodman, 2004). "The premise is that one must stand in one place in order to have a firm footing to move on and that it is difficult or impossible to move without that footing" (Beisser, 1970, 77). The therapist encourages the client to be where and what he/she is. The main goal of Gestalt therapy is to elaborate the client's awareness as means which enlarges the scale of the client's possible reactions and strengthens his/her flexibility (Mackewn, 2004). Similarly, Yontef (1993) states that in GT the person learns to use his/her internal and external sense to become self responsible and self supportive by the process of awareness.

SAMPLING AND METHODS

The presented data describes one case which is also a part of a doctoral thesis about youth orienteers (n = 8). Since the research topic is relevant and significant only for people with this specified experience, a focussed sample was drawn (Giorgi, 2005; Stake, 2005). Permission to conduct this research was given by the Ethical Committee of the Faculty of Physical Cultural (email communication, March 21, 2007). The participant (female, age 16) and her parents signed an informed consent statement following the requirements of ethical principles and the code of conduct (American Psychological Association, 2002). The data was collected by means of Phenomenological Interview (Pollio, Henley, & Thompson, 1997) and IAW GT principles (the field theory, phenomenology and existential dialogue).

The described case presents a 16 year old elite level female orienteer who placed among the top five in the national ranking for 2006 and 2007 and has experience with international competitions.

PRACTICAL EXAMPLES OF GT PRINCIPLES IN A PERFORMANCE ANALYSIS

The author of this article used her own experience with orienteering and her GT training and attempted to apply Gestalt therapy principles in post competition analysis with an orienteer. They focused on the orienteers' experience with her successful and failed performances as she evaluated them subjectively.

In this case study, the athlete and the researcher explored relations between the athlete and her environment – how the athlete handles practices and competitions (or their parts) to satisfy her needs and how the sport influences her back. They searched for the athlete's self support in order to help her to be in charge of changes leading towards fulfilling her personal and athletic potential. The focus was put on the process. In general, an athlete becomes aware of his/her reactions and emotions and learns to understand them in the context of the given sport and the broader environment. Moreover, according to the paradoxical theory of change (Beisser, 1970), if the athlete finds these reactions and emotions inefficient, he/she has the possibility to acquire more effective ones. In other words, acknowledgement of the present state of perception and experiencing is the only way to change what a person is dissatisfied with.

In the existential-phenomenological dialogue, maps with drawn route choices were used to help the runner to recall situations in competitions. Contrary to the usual post competition analyses, they focused on failed as well as on flawless performances in order to capture all aspects of the organismic/environmental field.

Trying to keep a horizontal plane in the existential dialogue, the researcher made every effort to stay on the level of the runner's experience without imposing her experience with orienteering; however, she shared her experience and ideas in the dialogue when she considered them as contributing.

In order to show the strategy based on Gestalt principles and its use in performance analysis in orienteering, examples from the dialogue follow:

Note: researcher's quotes are written in <u>*underlined italics*</u>, participant's quotes are written in *italics*.

- Exploration of runner's previous experience:

<u>*„Do you analyze maps with your coaches? Have you found out something by doing so?"*</u>
"We kind of don't analyze it. We always... I just make some mistakes and don't know about more analyzing. I always know how I made that mistake."

Here, it was revealed that only performances with mistakes were considered to deserve some more attention. At the beginning, the researcher had to help the runner to overcome the feeling that it is not worth talking about her good performances because she felt it happened without her contribution. Therefore, they focused on small concrete parts of successful races.

- Exploration of how she managed to find some control points without mistakes in her successful performances:

<u>*"And how did you do it that you found this control point just fine?"*</u>
"...that I went to the path, around this (pointing on the map), *that I could see this and I knew that the control point would be here. From this one I set my direction and this was visible so much that you'd recognize it easily and I followed the direction...and this control point – I run down here perfectly, to the path, over this and towards this."*
(...)
<u>*"...try to describe this race further."*</u>
"Afterwards I went down, on the path and knew that I had to climb up here and along the meadow and then I saw the control point. So I found it ok."
<u>*"I see. Can you continue?"*</u>
"After that I set the direction, that I couldn't run too much down because then I'd have to go up again... so I had my bearings, but didn't know precisely where to but I followed the direction and knew that these trees would stop me. So I knew exactly that I'm passing these two valleys and here I knew perfectly where I was. Then here I knew that I was by these trees here."
<u>*"I see."*</u>
"And also up here I knew it very well. I didn't plan to see this but it was just there so I checked it with the map and it was there... Then I ran and ran and so this tree and the control point just popped up in front of me."
<u>*"Hmm. Does this mean that you didn't focus at all?"*</u>
"No,... I had an idea."
<u>*"Did you enjoy that?"*</u>
"Yes, very much, the whole race!"
<u>*"How did you feel before the start of this race?"*</u>

"Well, I looked forward to it. I felt at ease, completely. Not that I'd prepared too much that I'd have to run excellently, not that..."

- Enhancing awareness:

"And this control – I just went towards the tree and it was visible."
"What did you follow, then?"
"This was a bigger valley and I held the bearing and ran this direction and saw this tree."

It occurred many times throughout the interview that the runner remarked some control point as having been easy and well visible and did not feel that she had done certain steps in order to nail it so precisely. However, when she was asked what she followed to find it, she always reported properly planned attack points and/or directions and felt herself to be in full control over the leg (a leg = the space between two control points).

- Checking her experience and leading her to deeper awareness:

"Here I just went... I needed to get here and start to read the map, so I got there and got to this control point. I was lucky to find it."
"Only lucky?
"Ehm, I had the direction, a rough direction, I didn't know I was going to find it."
"Could you have done it differently?"
"Set the bearing turning the wheel precisely, look and run there following the compass."
"What made you not do it in that way?"
"I just decided differently. It seemed to be unnecessary, I though that I'd just find it somehow and I was lucky."
"Does this mean that when this appears – I'll find it somehow – you need to be lucky as well?"
"Yes, I guess so."

- Giving an opportunity to realize how losing focus and refocusing occur:

"...when I know that I'm on the right path and I find the control point, I don't think about it, I just know that I'm right. But when I have an idea that it's wrong, and a couple of times it happened that I felt that it was wrong, but it was right..."
"According to me, it sounds like a matter of balancing the speed of running and the speed of map reading." (Reflection of the researcher's idea.)
"Yes, I think so.
"And it also seems to me that it doesn't fit sometimes."
"Yes, that's right. Or more like that I think about something else and run without paying attention to the map so much... that I don't notice a crossing and continue running. And then I can't see this on the map because I don't expect it to come."
"Do you use some tricks to get back to your map?" (Exploration of her strategy.)
"Yes, I have some. That I run and must tell myself – well this point, after this one I have to get to this feature and so on."
"Does this keep you attention focused?"
"Definitely, it does. It makes me know that this feature is coming and this one does afterwards. And then it just has to be there."
"What do you do when you don't see the expected feature?"
(Exploration of polarities which leads to new discovery.)
"But it is there – almost always! Because when I want it, it is there."

- Getting to new awareness through reflecting and reformulating:

"So you didn't try to relocate in the map. What did you do instead?
"When I'm thinking about it now, I rather continue running in order not to lose than to look and look for something, because it takes time."
"I wonder if it doesn't take time when you continue running."
"I don't think so because I may be at the right place."
"I see." (Pause.)
"Because for example I don't know yet that I've got lost."
"Is there some sense that something is not alright?"
"Yes, there is. But I can say that when I do it like this, even though when I sense it, sometimes it's right and I find the control point."
"Well."
"That's like that I'm waiting till then and that's why I make those huge mistakes."
"I see... Have you ever realized this?"
"No, not at all."
"It makes sense to me."
"Because when I make a mistake, I know it intuitively at the beginning."
"Do you mean that you can recognize the beginning of the mistake by some kind of intuition?"
"Yes, it kind of doesn't match there a bit. But I tell myself: ehm, it doesn't fit, it doesn't have to, maybe the map... and I just think that something fits approximately and that's why I might be right. So I wait a bit longer and sometimes it happened that I found the control point at that moment. So I wait even longer and start to look for it and then I find out... when I find out that I'm completely wrong, then it's been quite a while."

- Exploration of *catching* her refocus after she made a mistake and comparison with other successful performances:

"That I told myself – you'd screwed up now and you'd find the next one clearly, so you have to follow those points. So now, when we are talking, I know that I'll follow these features."
"Is that right?"

"Of course. Because it's a way of finding a control point. This may work."
"Did you do it this way now at the Saturday's competition?
"But I've figured it out just now at this very moment that I'll follow the points! So far this fall, I've been running so... that it went just by itself. I didn't have to think too much about it."
"Can you show me which competition, for example?"
"For example this one... I didn't think about it so much as before and it just went fine... I just knew that I'll go there and there."
"Can you describe it?"
"Well, that I knew I had to go there. And then I saw this path, so it was possible to run around. Then I found out it was much better to run this way. So I got there, followed the path up to this, down, along this tree... all the way down and I found the control point beautifully..."
"I see."
"But I really didn't think about where to go."
"OK, you didn't."
"No."
"That what you've just described now didn't seem to me to be 'not thinking'."
"Maybe in the forest. But not like that I'd focused especially that now I'll go to this..."
"What did you focus on then at this place? (Pointing to the place on the map.) *What you were gonna do in the evening?"*
"No, not at all. But like, that now I'll go to this, this, this and this. That's what I focused on there but it went just by itself. Do you understand?"
"What does it mean for you that 'it went by itself'?"
"It means that I didn't have to think and it went fine in this race, I didn't have to tune in."
"How did you feel? Were you tuned in?"
"Yes, I was."
"It seems to me that you did what was needed without pushing yourself into it."
"Yes."

- A deeper exploration of the situation when the runner meets an opponent in the forest:

"I don't know, it usually happens when I read the map to the next control point in advance. So I just can't plan the next one, otherwise I shift."
"I see."
"But here it wasn't that case... I don't know why. I just was here but thought that I was here and was looking for this control point."
"Well, when you turned from this road, what did you start with? I mean in your mind."
"Oh, now I know, from this path I wanted to go in between this and this all the way down to this small valley. But I caught some girl – and thought that she must also go there. So I looked at the map to find out where I was, but the shift occurred (she looked at the next control point). *It shifted because of this."*
"Because of that girl?"
"Yes that I got stuck here. I was heading the right direction, but I saw she was looking for something there as well, so I wanted to check the map once again but I moved my finger..."

- The researcher offers her phenomenology as a description:

"Well, you are looking at the map."
"Yes, I do but here it was a kind of a blackout, I don't know. I'd usually run around and the path to the control point."
"I just have an idea but I don't know if it is right. That this control point, when you started to be little bit insecure, so you wanted to speed up afterwards and that's why you checked the next route choice quite shortly to consider possibilities. You just thought that it's clear."
"Yes, I think that it might have been that way."

When the researcher wants to test her hypothesis, it is allowed to bring it into the dialogue. However, it has to be stated as an idea of the researcher in a descriptive manner, so the runner has the possibility to refuse it. Even if the runner does not accept it, it can bring up some other association and deepen awareness.

- Exploring her experience in successful races in order to enhance her awareness of her contribution.

"How do you feel when it goes fine?"
"When I enjoy the race, I don't have to even think about it. Everything just pops up itself as it should, I do the right steps without even thinking about them, so as..."
"Well, how does it happen then? How do you do it that it pops up?"
"Well, probably that I even... when I'm at some place that I tell myself that now I'll get there, over the valley, there will be this... I make sure that I'm there, take another path, then, for example, take off and follow one direction up to something and get there following the landmarks."
"For me, it sounds like you participate very actively and make choices."
"That's right, I create it. But I don't think about how I should be doing that."
"Oh, I see."
"That's what it's about!"
"I wonder what makes you do it this way."
"Well, now, to run the race well, I'd do it in this way – I'll tell myself those points where to go. I'll be making sure that they are there and that I'll find control points. I don't have to be afraid of getting lost because I'll know where I am at every moment."
"Has this been your tactic?"
"No, I've just created it. I've just found out how to do it."

We tried to use her newly gained awareness of tactics in the preparation for the next race. It was a national championship. Even though it was one of the most important races of the year, she suggested using this, seemingly simple, "step by step" tactic there. She felt very self confident and sure that it would help her to perform at her best.

The "step by step" strategy is shown on Fig. 1. As mentioned before, flawless legs and competitions were usually omitted from post competition analyses with her coach. The whole focus was mostly directed towards failed races and she got advice about how to avoid such a mistake next time. However, in the dialogue with the researcher, she was encouraged to describe her good performances thoroughly as well.

When talking with the researcher, the runner was encouraged to describe her strategy on many good legs and route choices in order to formulate her routines. On the other hand, she described also the competitions in which she failed. The runner herself spotted discrepancies between them and figured out what kind of navigation tactic works for her. The researcher suggested that the runner can draw single landmarks directly onto maps with successful route choices (Fig. 1). She made a new discovery about what helps her to find control points flawlessly. Moreover, considering the stress inducing situation (e.g. at important races), she said that she *"can perform well only when I follow this. I must follow attack points"*. Once she has become aware of this, she reported that she feels calmer and more self confident before races because her strategy is clear and she knows what to do. She has a trustworthy plan to follow. It has to be said that her coaches had been teaching her this strategy for a long time; however, now she felt that she had made a new discovery.

Even though she had not been asked to report her performance on the next competition to the researcher, she sent an email spontaneously and wrote that during our meeting, *"I realized how I should run in the forest and now at the weekend I tried it and it really worked. We came to the conclusion that I should run from a point to a point* (step by step). *When I said this to my coaches, they smiled and asked if I'd ever listened to them when they were giving me advice. I think that it was because you made me find it out myself."* She won this important race. Such spontaneous feedback from the runner underlines the importance of one's own experience for performance enhancement.

In conclusion, this orienteer sometimes struggles with bigger mistakes (usually for at least some minutes), particularly in national and international level competitions; however, she manages to complete flawless races as well. Before the exploration based on Gestalt principles, this orienteer understood why she made some mistakes, but she was not able to describe how she managed to orient precisely. Since she had an opportunity to describe and share her experience with failed as well as successful performances and compare them in the dialogue with the researcher, she enhanced her awareness of the process and her experience. Based on new findings, her self support was fostered and she got actively involved in the application of the new strategy in the next competition. This does not necessarily mean that this orienteer will not make these mistakes, but now she has acquired sensitivity to these situations and become aware of them. Therefore, self support is mobilized and a way to possible change is open. Responsibility for the work on the intended change emerges from the orienteer herself and seems to have a stronger meaning for her.

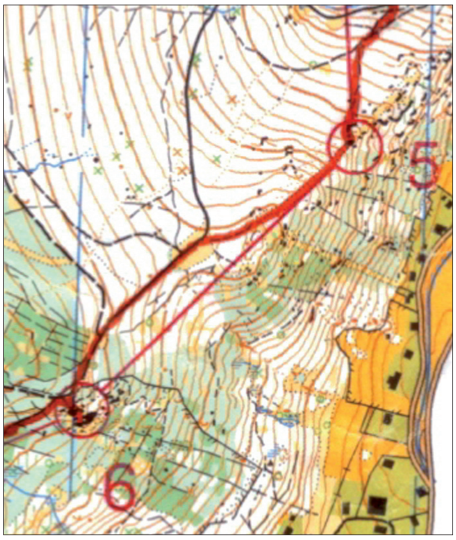
CONCLUSIONS

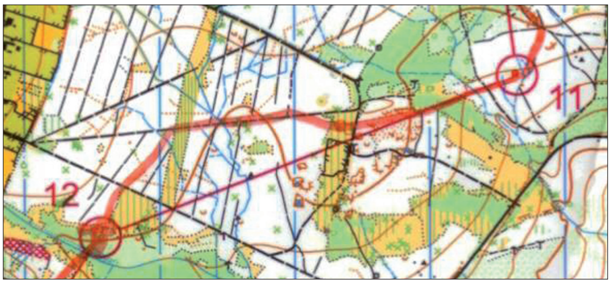
The article introduces the basis of Gestalt therapy principles and seeks opportunities to test its applicability in the field of sport psychology. Based on theoretical assumptions, it seems that various topics and problems in training and competitions can be approached within the framework of Gestalt therapy due to its phenomenological-existential background, the field theory and the presumption that people have a natural drive to personal development and growth.

From a practical point of view, the experience with the application of Gestalt principles in performance analysis in orienteering showed changes in the orienteer's awareness. Performance-enhancing and performance-debilitating actions, thoughts and feelings were identified and thereby the runner's awareness was extended considerably. Although characteristics of failed performances are well known among orienteering coaches, it was the orienteer who found out and understood the influence of these concrete characteristics in her case. The crucial contribution of Gestalt therapy principles application in sports is that the athlete is encouraged to take their own initiative, acknowledge and fully realize the relationship between her actions and performance outcomes. Then he/she can find the place from where to start and what to work on in training sessions. At the same time, her own understanding and awareness bring along stronger individual involvement.

In general, the Gestalt approach emphasizes awareness as an important means of personal development. Therefore, in coaching praxis, a more horizontal relationship between a coach and an athlete might be considered to be a topic for further research. Furthermore, additional investigation is needed in order to estimate the contribution of the Gestalt approach for different age groups and various performance levels in orienteering and other individual sports. It also seems interesting to try to apply Gestalt coaching principles, used in organizations, in working with team sports.

Fig. 1
Examples of "a step by step" strategy





It was drawn by the female runner. Circles with numbers (connected by straight lines) are control points and legs of the printed course. The crooked line shows the route choice the runner took and was drawn after the race. Full points are the attack points she chose when she was carrying out the route choice. During the dialogue, she became aware of this navigation technique because she used it only unconsciously. Now it is accessible in her mind when she decides to use it in competition.

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VYUŽITÍ PRINCIPŮ GESTALT TERAPIE V PORADENSTVÍ PRO ORIENTAČNÍ BĚŽKYNI

(Souhrn anglického textu)

Článek prezentuje základní teoretické principy Gestalt terapie (GT) a hledá možnosti jejich aplikace ve sportovní psychologii. GT (Perls, Hefferline, & Goodman, 2004) vychází z existenciálně-fenomenologických základů, teorie pole, existenciálního dialogu a předpokladu, že lidé se rodí s přirozenou tendencí k osobnostnímu rozvoji. V druhé části příspěvku je uveden příklad použití rámce GT v rozboru výkonů orientační běžkyně

dorosteneckého věku. Předpokládali jsme, že dorostenka může lépe pochopit své silné a slabé stránky, pokud bude podporována, aby si uvědomila souvislost svých reakcí při úspěšných a neúspěšných výkonech. Vzhledem k relevantnosti výzkumného tématu pouze pro úzce specifikovanou skupinu osob byl proveden záměrný výběr výzkumného souboru (Giorgi, 2005; Stake, 2005). V této studii je participantem šestnáctiletá orientační běžkyně, která dosáhla medailových pozic v národních i mezinárodních závodech. Za použití GT principů byl proveden fenomenologický rozhovor (Pollio, Henley, & Thompson, 1997). Z rozhovoru vyplývá, že GT techniky napomohly dorostence profitovat ze zkušeností z úspěšných i neúspěšných výkonů. Sama identifikovala rozpor mezi nimi a došla k tomu, že navigační strategie podle záchytných bodů (krok za krokem) podporuje její dobrý výkon. I přesto, že jí trenéři tuto taktiku radili již dříve, považujeme v tomto případě za klíčové, že ji uchopila dorostenka sama a pochopila její konkrétní použití ve svém individuálním případě (místo přijímání rad na ni přišla sama). Zásadní přínos aplikace GT principů do sportovní psychologie tkví v tom, že podporuje sportovce v převzetí iniciativy, uvědomění si svého vlivu na výkon, a tím dostává šanci se aktivně zapojit do svého rozvoje a převzít za něj zodpovědnost. Vedení dalšího výzkumu by mohlo směřovat k zhodnocení přínosu GT přístupu v práci s různými věkovými skupinami a výkonnostními úrovněmi a také k longitudinálnímu sledování vývoje jednotlivých sportovců. Zajímavá by mohla být aplikace Gestalt coachingu v týmových sportech.

Klíčová slova: Gestalt terapie, analýza výkonu, uvědomění si, orientační závod, mladí sportovci.

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THE ASSESSMENT OF THE LONGITUDINAL ARCH OF THE FOOT IN DEAF AND HEARING CHILDREN AGED 9 TO 11 YEARS

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Submitted in November, 2008

The aim of the study was to establish the condition of the foot arch in deaf and hearing children and to determine whether there are differences in the foot arch between children with impaired hearing and healthy children aged 9–11 years.

A group of 19 deaf children and 33 hearing children, including 23 girls and 29 boys aged 9 to 11 years were studied. Their average age was 9.9 years.

The examination of the longitudinal arch of the feet was carried out in an nonloaded (in a sitting position) and in a loaded (standing) position, using a Podoskop (POSMED, Poland). In the preparation of impressions of the soles of the feet, a line method according to Wejsflog was used with the specification of an index of the longitudinal arch of the foot. It was noted that there was a statistically significant difference between the arch of the left and the right feet in loading in healthy children ($p < 0.05$). However, no statistically significant differences were noted between the studied groups of children in terms of the indicator of the arch of the foot in both an unloaded and loaded posture. It was noted however, that the condition of the arch of the foot in deaf children was characterised by a lower effectiveness of the muscular and ligament systems, which was confirmed by the values of the foot parameters of deaf children. The results of the Wejsflog index indicate that in deaf children a typical area of variables (the right foot in loading 20.55–39.85) was greater than in healthy children (the right foot in loading 17.05–34.75). Moreover, in both groups of girls greater differences were noted in the degree of foot arching than in boys. This confirms the tendency to generally a more labile body posture in girls and in the muscular and ligament system of the feet.

In conclusion, no statistically significant differences were noted between the studied groups of children in terms of the index of the arch of the foot in both a loaded and an unloaded posture.

Keywords: Medial longitudinal arch, deaf children, foot defects, podoscope.

INTRODUCTION

Epidemiological and screening tests carried out in Poland in recent years indicate than on average one in every three people has hearing problems and one in every six schoolchildren has hearing disorders. Two to four newborn babies per one thousand have serious in born hearing disorders (Association of Friends of the Deaf and Hard of Hearing Human to Human and Institute of Physiology and Pathology of Hearing, Stowarzyszenie Przyjaciół Osób Niesłyszących i Niedosłyszących Człowiek – Człowiekowi i Instytut Fizjologii i Patologii Słuchu, www.sponin.org.pl). The problem is beginning to relate to a greater and greater part of the population in Poland. In children with hearing disorders at preschool age walking anomalies appear. The change in their stereotype of walking causes changes in muscle work and the muscular strength of calves and feet may be weakened, which may affect the development of the arch of the foot during this period. The walking of deaf children may be heavy and not very springy. Body balance and coordination of individual activities are disturbed. Also speech is impeded, which translates to the work of respiratory muscles and chest function and indirectly affects the body posture of a child (Zwierzchowska & Gawlik, 2006). The assessment of the longitudinal arch of the foot is performed in various children, both healthy and also in those with disorders and diseases. Children with hearing disorders are characterised by a weak sense of the schema of their own bodies, difficulties in telling the right side from the left side and generally weaker body motorics (Zwierzchowska & Gawlik, 2006; Maszczak, 1994). The results of the few existing studies in the area of the assessment of body posture indicated greater irregularities in body posture in deaf children than in hearing children (Grabara, 2006). Moreover, the available literature notes few studies which present results of the assessment of the longitudinal arch of the foot in deaf children (Demczuk-Włodarczyk et al., 2005). A lot of attention is devoted to the assessment of body posture and feet in obese children (Mikle et al., 2006; Villarroya et al., 2007, 2008; Wearing et al., 2004).

The hearing organ and the vestibular system located next to it are integral parts of the system of neuromuscular control, taking part in coordination and body balancing processes (Selz et al., 1999; Horak et al., 1990; Cushing et al., 2008). The foot is the base of the biokinematic chain in the body's biomechanism, and besides performing a shock-absorbing function it participates in postural control. Changes in the spatial shape of foot joints may affect the coordination of motor patterns (Mitchell et al., 2008), movement stereotypes (Lewit, 2001), muscular balance and may cause disturbances in static and/or dynamic postural control (Wiernicka et al., 2008; Cote et al., 2005). In the children who are hearing impaired it may be expected that there will be disturbances in the functioning of the above mechanisms, which may contribute to changes in the foot's structure (Demczuk-Włodarczyk et al., 2005). Thus a question arises: are deaf children's feet really not as well arched as the feet of hearing children? It should be noted that the results of the studies of maintaining a stable standing posture of hearing and deaf children showed that deaf children are characterised by a better ability to maintain a stable standing posture than hearing children (Grabara, 2006).

Thus a question arises: Do deaf children have correctly arched feet, considering the integration of the nervous and muscular system and control of the nervous system?

The aim of the study was to establish the condition of the foot arch in deaf and hearing children and to check whether there are differences in the foot arch between children with impaired hearing and healthy children aged 9–11 years.

MATERIAL AND METHOD

Deaf children from a primary school for deaf children in Poznań were included, the reference group being made up of hearing children from Poznań schools. Groups of 19 deaf children and 33 hearing children were assessed, including 23 girls and 29 boys aged 9 to 11 years (TABLE 1).

For the assessment of the correct morphological structure of the feet, a podoscope called the Podoskop (POSMED, Poland) was used.

The assessment of the children's feet was carried out under statodynamic conditions in loading with the body weight – in a standing position with two feet on the podoscope and in an unloaded setting, i.e. sitting down.

The assessment of the longitudinal arches of the feet was carried out in loading, i.e. while standing on the podoscope with a straight body, arms hanging loosely, looking forward, with equal loading of the feet. After taking a photograph of the soles of the feet in the standing position, the participant sat on the table with adjustable height situated behind him or her. When sitting down he or she tried not to move their feet placed on the podoscope. The assessment in unloading was carried out while sitting on the table with their knee and hip joints bent at 90° angles, a straight body, looking forward. In this position, a photograph of the soles of the feet in unloading was taken. The analysis of the photographs of the soles of the feet using a linear method according to Wejsflog was used and an index of longitudinal arch of the foot was established (Śliwa & Śliwa, 2002).

Wejsflog index:

$$Ww = \frac{/x - x_1/}{/y - y_1/} \times 100$$

The examination was carried out in two positions: with loaded feet (a standing position) and with unloaded feet (a sitting position). The analysis of the footprint parameters was performed according to the Wejsflog linear estimation index of the foot (Nowotny & Saulicz, 1993; Napolitano et al., 2000). The Wejsflog index for

TABLE 1
Anthropometric data of the assessed children

Studied group	Deaf children N = 19		Hearing children N = 33	
Age [years]	9.93 +/–0.76	[9–11]	9.75 +/–0.75	[9–11]
Weight [kg]	33.75 +/–11.44	[21–55]	36.85 +/–9.83	[24–65]
Height [cm]	140 +/–14.78	[121–168]	140.70 +/–8.74	[126–166]
BMI	10.02 +/–8.68	[11.4–24.1]	18.35 +/–3.24	[13.2–27.4]
Foot width [cm]	7.72 +/–0.86	[6.1–9.4]	7.97 +/–0.86	[6.4–9.8]
Foot length [cm]	21.41 +/–1.82	[19.9–25.3]	21.96 +/–1.40	[19.5–25.4]
Hearing impairment [db]	90.77+/–23.09	[40–111]	Not applicable	

Legend:
mean +/–
standard deviation [min–max]

the scale of hearing impairment/loss:
20–40db – slight
41–70db – moderate
71–90db – significant
91–120db – deep
more than 120db – complete

a normal foot is 28–38, regardless of the experimental conditions (sitting or standing), 0–27 for a foot with a falling arch and 39–50, 51–66, 67–100 and >101 for I^0, II^0, III^0 and IV^0 degree of flat foot, respectively.

The assessment was carried out in the morning, after obtaining the prior written consent of the children's parents to take the measurements.

STATISTICS

The correspondence of variable distribution with normal distribution was tested using the Shapiro-Wilk test. Due to a lack of the normal distribution of results, the statistical analysis of the obtained data was carried out using non parametric tests.

The following were determined: minimum, maximum, upper quartile, lower quartile, median, quartile deviation and typical variable area.

Using the Wilcoxon's signed rank test it was checked whether significant differences were noted between the arch of the left and right foot in unloading and loading within the tested groups.

Moreover, using the Mann-Whitney U test it was checked whether statistically significant differences were noted between the index of the arch of the left and right feet in unloading and loading between the groups of deaf and hearing children.

On the basis of cross tabulation it was checked whether there were statistically significant correlations of the results between the groups of children in loading and unloading – the Spearman's rank correlation coefficient and Pearson's chi-square test were used. The level of significance $p < 0.05$ was adopted as statistically significant. Computer software Statistica 8.0 was used for computations.

RESULTS

1. In the groups of hearing and deaf girls under conditions of unloading, the largest percentage of hollow feet, both left and right, was noted (Fig. 1, 3). Under conditions of loading, the situation was slightly changed. Also for the left foot in hearing girls, a largest percentage of hollow feet was noted – 71.4% (Fig. 2) and in deaf girls 33.3% of both hollow feet and correct feet (Fig. 2).
2. In deaf girls in case of the left foot a greater difference in the arch depending on the conditions of the examination was noted (Fig. 1, 2).
3. In deaf girls in loading of the right foot, apart from hollow foot, many cases of flat foot of the 1st degree were noted – 50% (Fig. 4).
4. Under conditions of loading in deaf girls a larger percentage of correct left feet 33.3% (TABLE 2) and in hearing girls – right feet 28.6% (Fig. 4) was noted.
5. In both groups of boys the largest percentage of hollow feet in unloading – above 70% (Fig. 5, 7) and in loading around 50% of the right and left foot (Fig. 6, 8) was noted.
6. In hearing boys, a greater percentage of correct feet in loading, 21%, was noted than in deaf boys – 14.2% (Fig. 6).
7. In both groups of boys in loading a significant percentage of flat left feet of the 1st degree was noted (in hearing boys 26.3% and in deaf boys 42.8%) (Fig. 6).
8. Arching of the feet in unloading of deaf and hearing boys is very similar. Greater differences were noted in loading in terms of hollow feet in particular (in hearing boys 42.1%, in deaf boys 57.1%) (Fig. 7, 8).
9. In deaf children a greater variety of types of foot defects and a greater percentage of flat feet of the 1st and 2nd degree was noted on the left side than in hearing children in unloading (15%), in particular in loading (in total approximately 35%) (Fig. 9).
10. It should be emphasised that in loading of the right foot no case of flat foot of the 2nd degree was noted, neither in hearing or deaf children (as opposed to left feet) (Fig. 9, 10).
11. In hearing children on the right in unloading (6%) and in loading (24.2%) there are cases of a flat foot of the 1st degree and on the left in unloading no such case was noted (Fig. 9, 10).

Using the Wilcoxon's test it was found that there was a statistically significant difference between the arch of the left and right foot in loading in healthy children ($p < 0.05$) (TABLE 3) which indicates a varied level of the arching of the right and left feet in individual participants.

The results showed clearly that in deaf children (depending on their IQ range) the right foot in loading was measured at 20.55–39.85, while the left foot in loading was measured at 23.7–42.9) and was therefore greater than in healthy children (in whom the right foot in loading was measured at 17.05–34.75, while the left foot in loading was measured at 11.9–32.5).

On the basis of the Mann-Whitney U test, no statistically significant differences were found between the studied groups in terms of the index of the foot arch in loading and unloading. Only the tendency towards the significance of differences in the Wejsflog index was noted for left feet in loading in healthy and deaf children ($p = 0.079$).

Fig. 1
Assessment of the arch of the unloaded left foot in girls

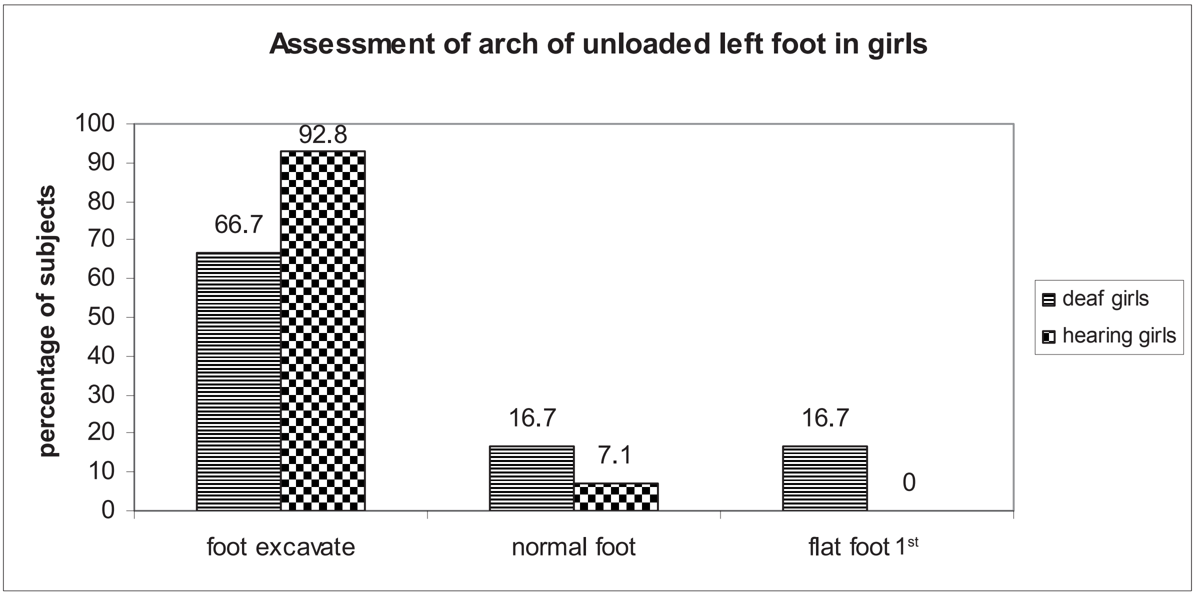

Fig.2
Assessment of the arch of the loaded left foot in girls

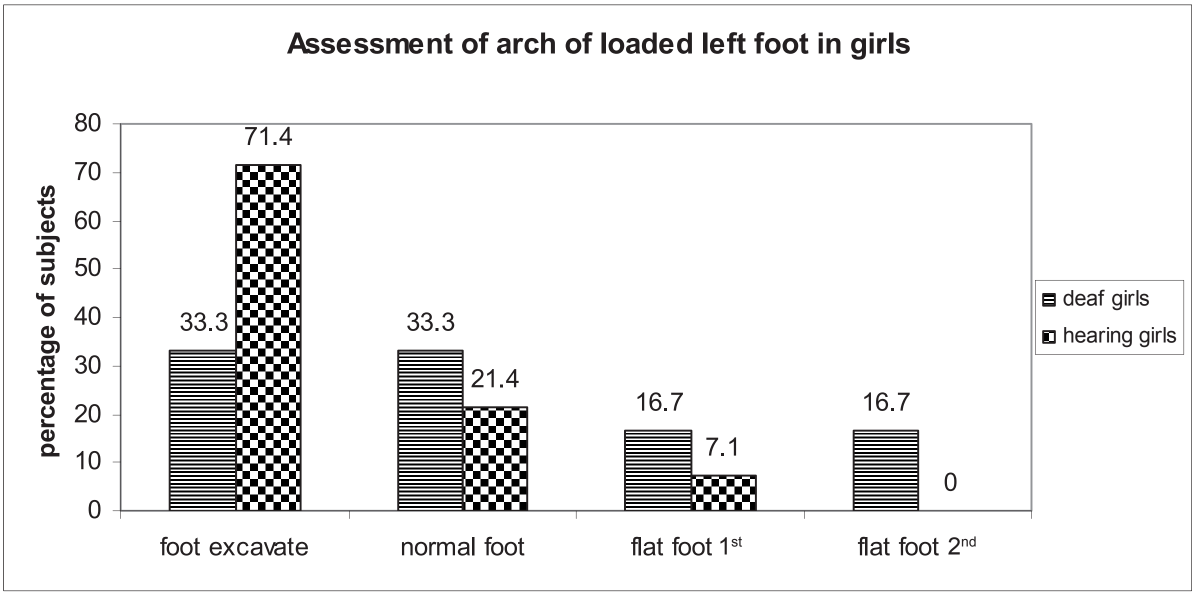

Fig. 3
Assessment of the arch of the unloaded right foot in girls

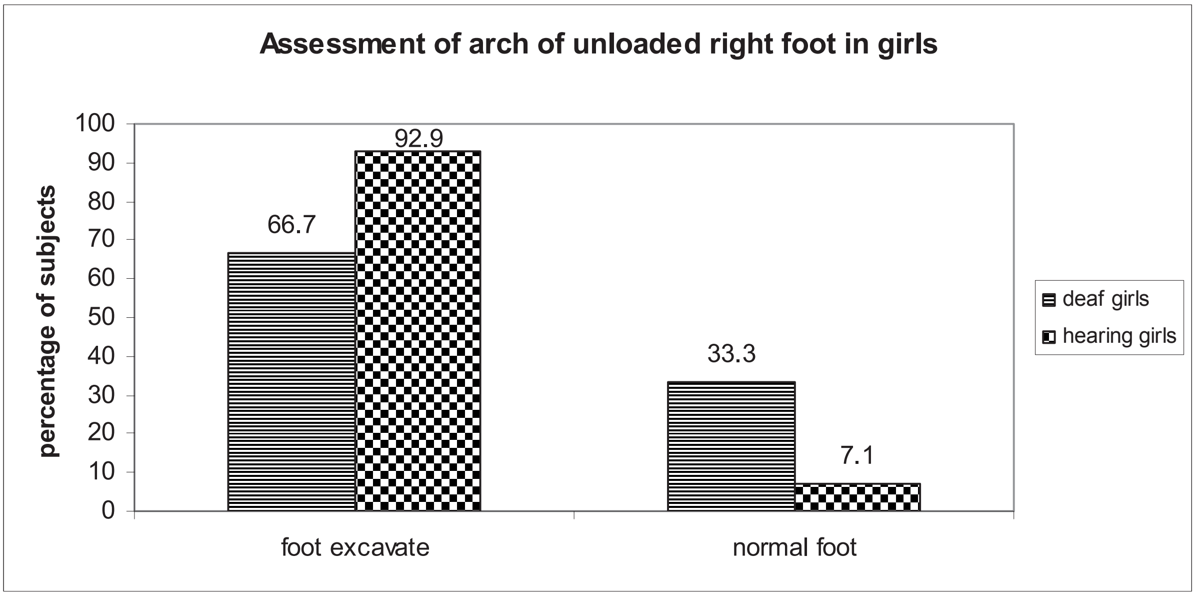

Fig. 4
Assessment of the arch of the loaded right foot in girls

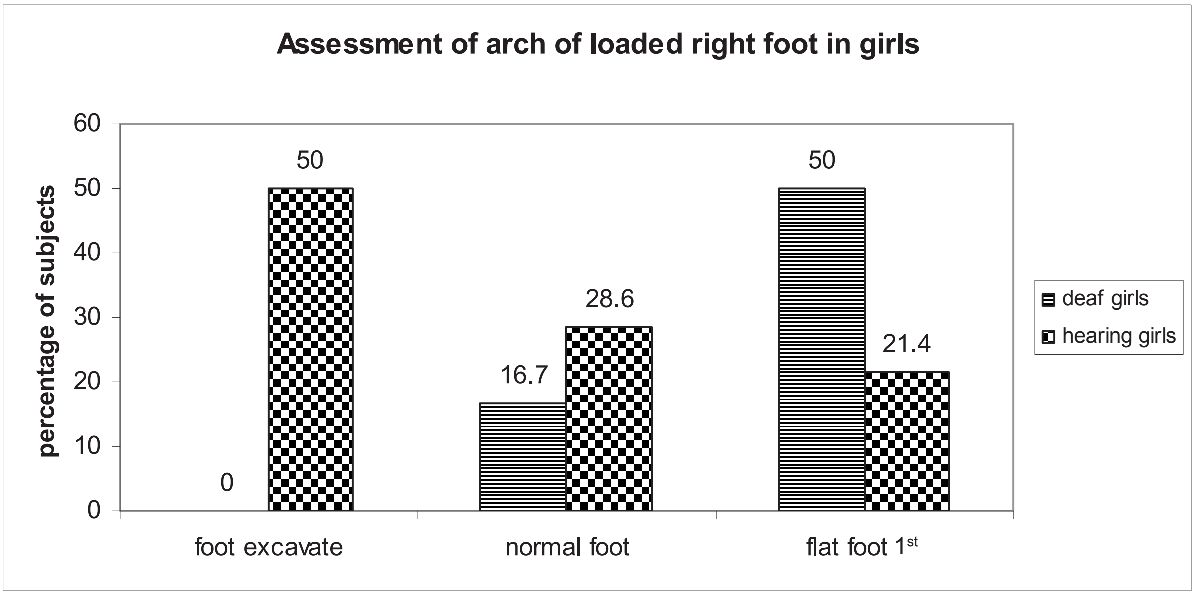

Fig. 5
Assessment of the arch of the unloaded foot in boys

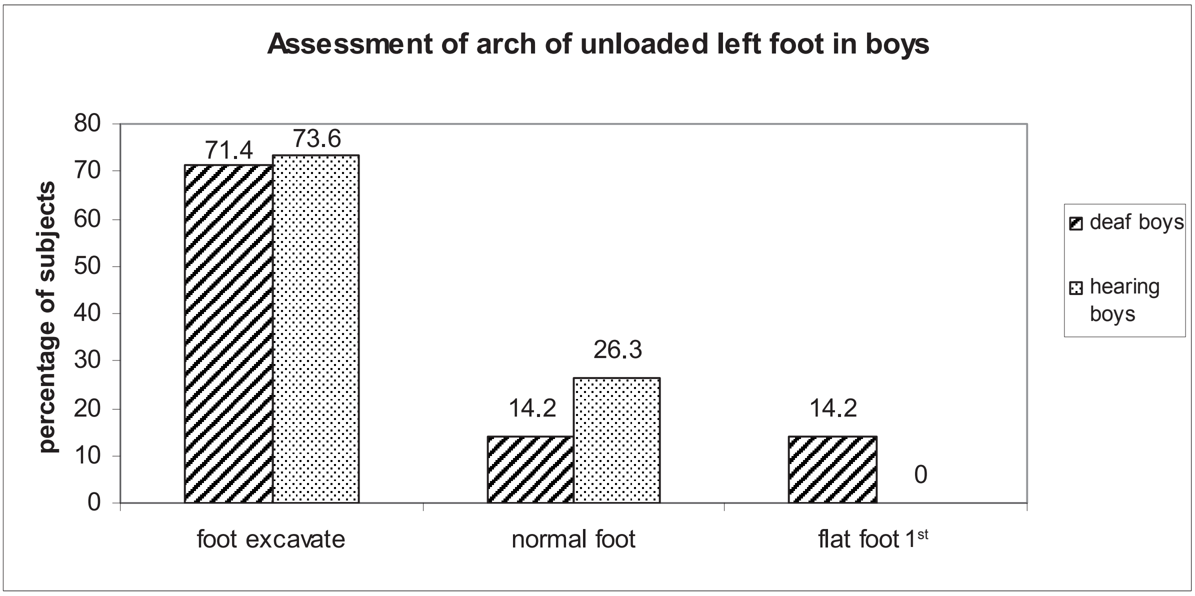

Fig. 6
Assessment of the arch of the loaded left foot in boys

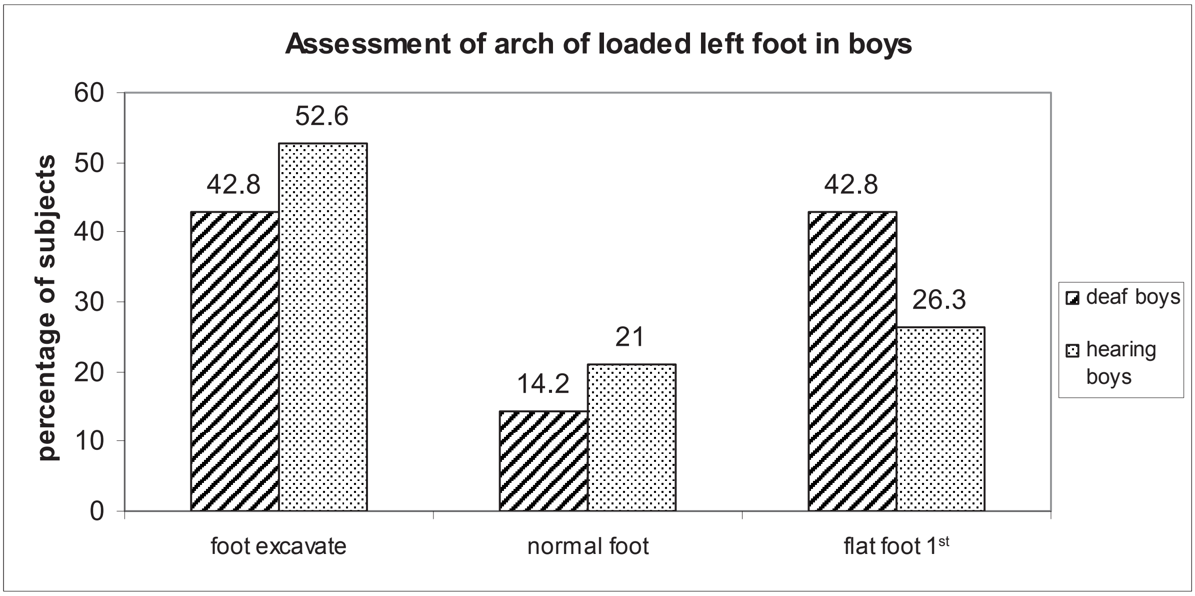

Fig. 7
Assessment of the arch of the unloaded right foot in boys

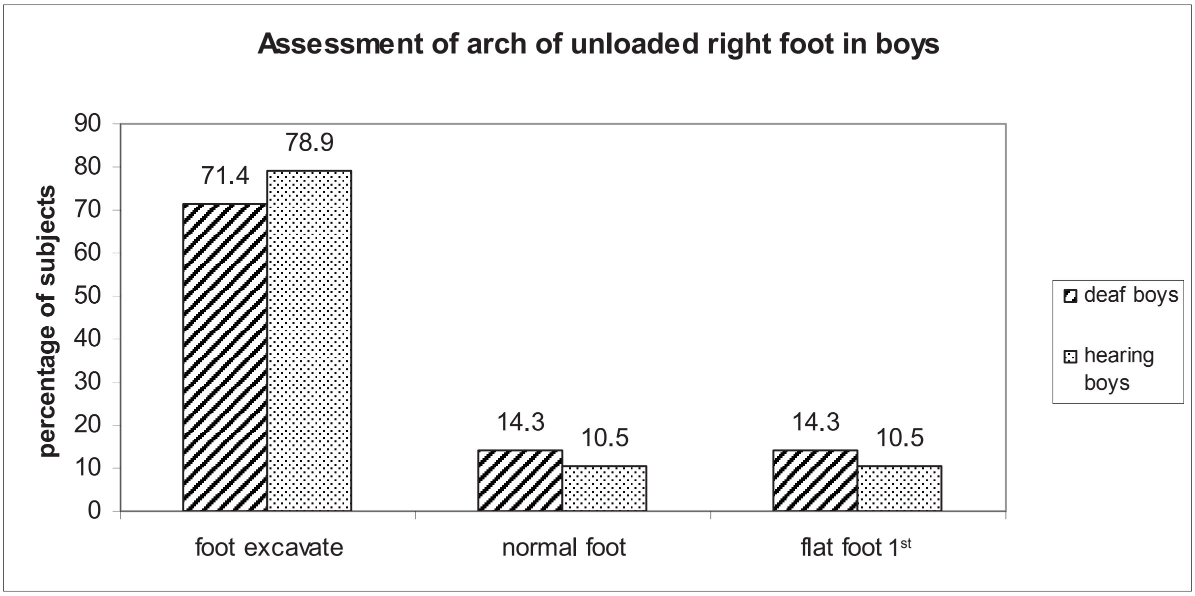

Fig. 8
Assessment of the arch of the loaded right foot in boys

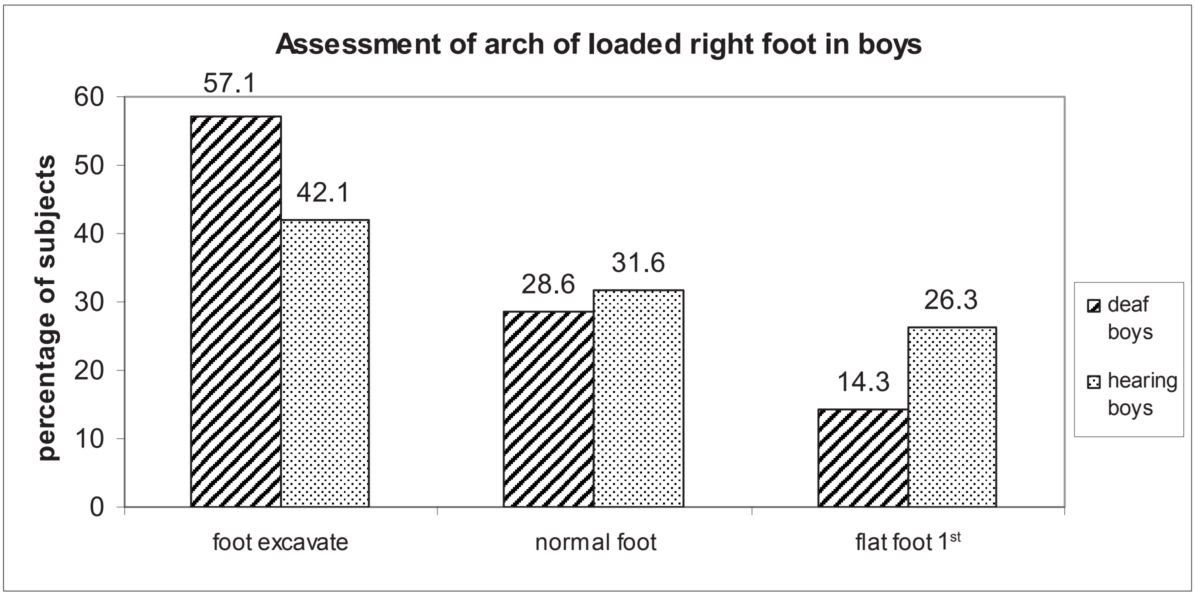

Fig. 9
Assessment of the arch of the unloaded and loaded left foot in all children

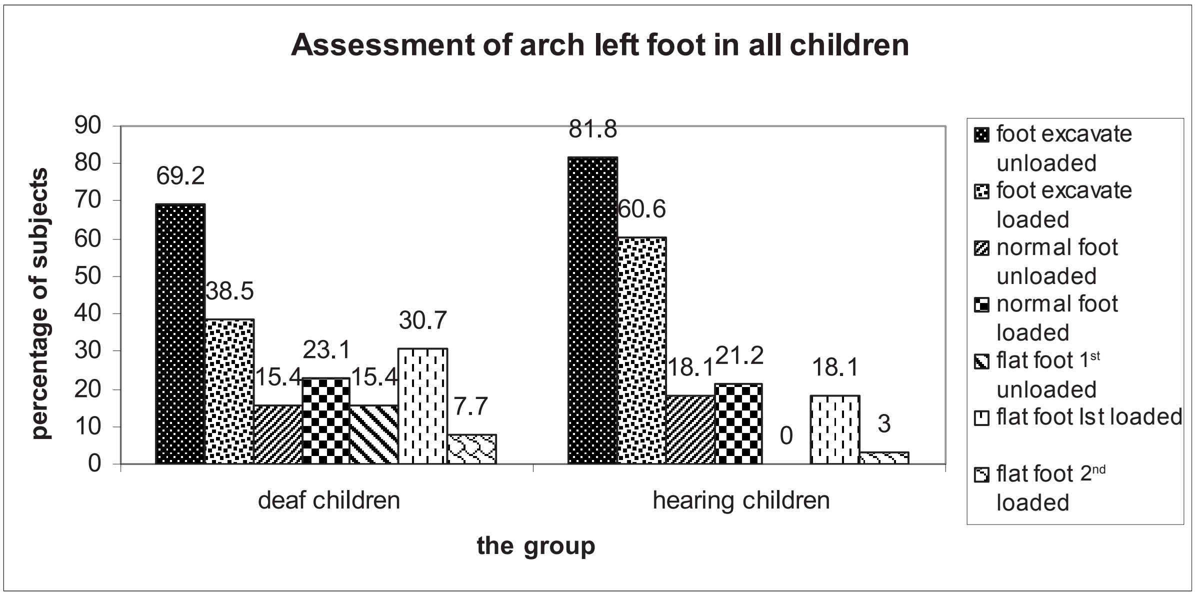

Fig. 10
Assessment of the arch of the unloaded and loaded right foot in all children

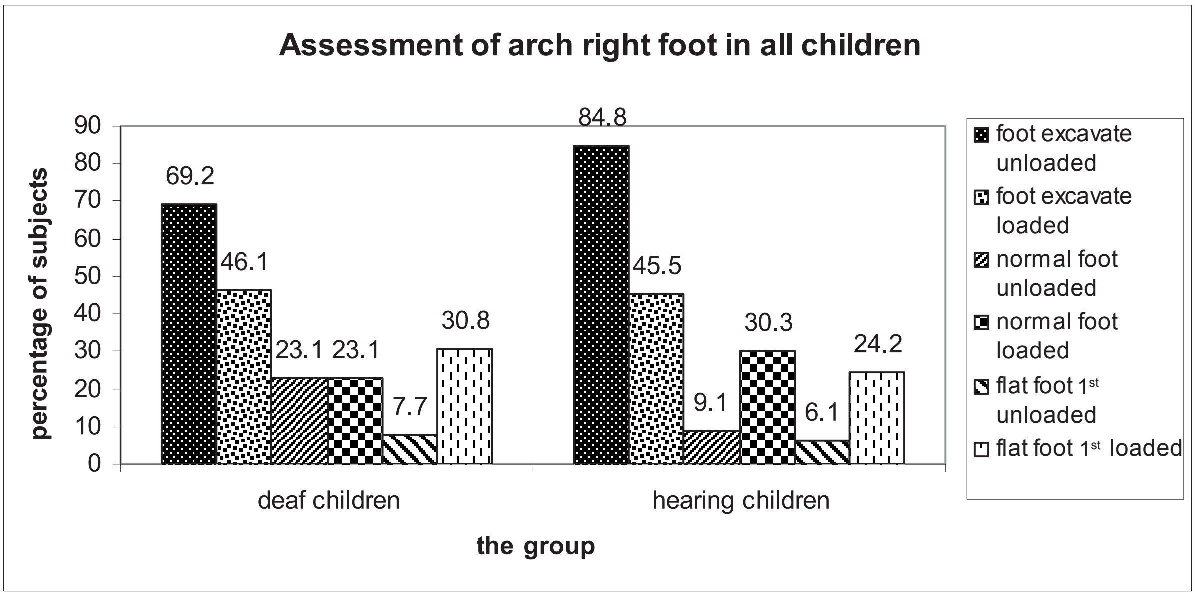

TABLE 2
The Wejsflog index in individual groups under both sets of test conditions for each foot

Variable	Group	Median	Minimum	Maximum	Q_1	Q_3	IQ range	Wilcoxon paired test
Wejsflog index loaded left foot	hearing children	22.2	2.0	77.4	12.2	32.8	11.9–32.5	$p < 0.05$
Wejsflog index loaded right foot		25.9	1.6	59.0	17.8	35.5	17.0–34.7	
Wejsflog index loaded left foot	deaf children	33.3	0.8	52.6	22.4	41.6	23.7–42.9	n. s.
Wejsflog index loaded right foot		30.2	11.6	45.3	20.6	39.9	20.5–39.8	
Wejsflog index unloaded left foot	hearing children	7.7	0.7	47.4	2.7	16.0	1.0–14.3	n. s.
Wejsflog index unloaded right foot		7.6	1.8	47.0	3.8	14.0	2.5–12.7	
Wejsflog index unloaded left foot	deaf children	18.3	2.0	46.7	2.3	30.8	4.0–32.5	n. s.
Wejsflog index unloaded right foot		15.3	2.2	38.7	2.6	30.1	1.5–29.0	

Legend:
n. s. – not significant

The analysis of relations between the properties describing the feet of deaf and healthy children (individual types of feet) using a Spearman's rank correlation coefficient showed a significant relation between the results of the assessment of the left feet in unloading $p = 0.031$, whereas under conditions of loading it showed a tendency to significance $p = 0.091$. Specifying the correspondence of properties using the Pearson's chi-square test showed us a tendency to significance $p = 0.094$, also in the case of the analysis of the results obtained for left feet in unloading. The results of the analysis of statistical correlations showed a similar distribution for typical left feet in unloading and a tendency to similarity of these types of feet in loading in both studied groups. No positive correlations nor any tendency towards similarities were noted for the right feet in neither test conditions nor in neither group.

DISCUSSION

In the analysis of the results of the tests it can be noted that deaf children had worse values of the parameters of the foot arch in both loading and unloading. However, in the comparison of both studied groups under both sets of test conditions, no statistically significant differences were noted.

Available literature includes only the results of the work of Demczuk-Włodarczyk et al. (2005) on the examination of feet in deaf children. In this work, a photometric method was used for the assessment of the correct structure of feet using the Mora effect. The longitudinal arch was examined on the basis of the height of the arching of five longitudinal arches according to the author's own typology and transverse arching on the basis of the analysis of the pressure of the metatarsal bones and toes on the podoscope panel (Demczuk-Włodarczyk et al., 2005). For the assessment of feet in the current study, a podoscope was used and feet were assessed under conditions of loading and unloading using a line method, according to Wejsflog, specifying an indicator of the longitudinal arch of the foot. The results of the quoted study and the current study should not, however, be compared, due to different methodologies as well as due to the range of age of the examined children (9–19 years). These are, however, the only recent studies of Polish children in Poland.

In the work of Demczuk-Włodarczyk regarding deaf children, the longitudinal arch of the foot was classified as being the correct arching of the foot and one threatened with developing into flat feet. No excessively arched feet and flat feet were noted in deaf children as opposed to the current study where a very high percentage (of hollow feet) was noted in unloading in both groups of examined children. In loading the situation changed. In hearing girls regarding the left foot, the highest percentage of hollow feet was noted (71.4%) and in deaf girls, 33.3% of hollow and correct feet, respectively. In both groups of boys in loading, over 50% of hollow feet were noted and in hearing boys a higher percentage of correct feet than in deaf boys was noted. Greater differences in arching in both groups were noted in girls than in boys.

The greatest variety of types of feet depending on the conditions of the conducted examinations were noted in the groups of deaf girls on the left side. Under loading conditions in deaf girls a higher percentage of correct left feet was noted and in hearing girls a higher percentage of the right feet. The presented results are in line with the results of Demczuk-Włodarczyk in terms of the differences between sexes, i.e. the irregularities relate to girls more often than to boys (Demczuk-Włodarczyk et al., 2005). Moreover, the results of the above work indicate that the majority of changes in the structure of feet relate to the left side both in boys and in girls, not to the right side. The results of the study of Schilling (1985) confirm also that changes in the structure of feet relate more often to girls. The author found also that medium longitudinal plantar arch is smaller in children with hypertrophy of the knee joints and hypermobility of the foot joints.

The results of the study of Demczuk-Włodarczyk also inform us that, in deaf children, there has been a lowering of the longitudinal arch and the appearance of disorders in the front segments of the foot. Grabara, in the assessment of the body posture in deaf children, noted a forward bending of the trunk (Grabara, 2006). This is a compensation mechanism which occurs in body balance disorders (Błaszczyk & Czerwosz, 2005). Deaf children may move their body weight towards the metatarsus and, therefore, a greater loading of the front segments of the foot was noted. The results of the study of Sipko and Skolimowski (1998) indicate that changes in the morphological build of all segments of feet in deaf children are a consequence of the impairment of the coordination processes of postural muscle function and fitness of balancing reactions. Some scholars claim that there is a statistical relationship between the type of feet and the BMI (Mikle et al., 2006; Morrison et al., 2007; Mauch et al., 2008).

Lin et al. (2006) examined hearing children (64 children) aged 4–5 years and 8–10 years. The relationships between six parameters of foot and postural stability were studied. The results of the study showed that, in younger children with a decreased height of the longitudinal arch of the foot, the range of body sway was smaller and these children had a better control of their posture, even only with their eyes closed. The authors explain it with a degree of compensation on the part of skin receptors in these children or the elasticity of the biomechanical structure of the feet under conditions of standing (statics). They also claim that the relationship between the parameters of foot structure and the range of sway is very subtle. Demczuk-Włodarczyk claims that the change in the shape of the foot disturbsthe deep sensibility of the impairing muscular balance and coordination of motor patterns (Demczuk-Włodarczyk et al., 2005). However, the results of the study of Wierzbicka-Damska et al. (2005) contradict this theory. The stability of posture in boys with hearing impairment and healthy boys aged 10–12 and 14–16 was also studied (Posturograf PE-90). All parameters describing the stability of their free straight posture were lower – better in deaf children than in healthy children. The results turned out to be surprising, also due to the fact that the control group consisted of boys practising shooting, which requires the best mechanisms controlling a stable posture. Probably the information from proprioceptors and skin receptors is so perfect that it compensates for any disturbances in the reception of information from the organs controlling balance. This is supported by the fact that the performance of the test with eyes closed resulted in a lowering of the value of the measured parameters.

The above results of the study indicate a greater degree of the occurence of disorders in the morphological structure of feet in deaf children, in particular in girls. Boys, on the other hand, who, in the current study, did not differ significantly in terms of the arching of the foot, are better able to control and maintain a stable standing posture, according to Wierzbicka-Damska et al. (2005). Moreover, the relationship between the structure of the feet and control of their standing position turned out to be subtle, as described by Lin et al. (2006) in their work.

This requires further verification, thus there is a need to examine foot arching in all children and body balance and symmetry of the loaded sides of the body (Wiernicka et al., 2007; Lewit, 2001). At the present time, diagnostic and training devices are available on the market, which can be used for examinations that would answer the question as to whether a child or an adult has a disturbance of the control of their posture under static or dynamic conditions, with open or closed eyes. Also in the therapy tests of sensomotoric control presented in the table below, the following can be used: (TABLE 1) – short foot training (Greenman, 1996) and Duncan's test, used for the assessment of body balance (Błaszczyk, 2004).

To sum up, in all children attention should also be paid to the position of the head in space. Reflex reactions, affecting the position of other body parts by tonic vestibular reflexes and neck reflexes are responsible for it. They regulate in this way the position of the trunk and lower limbs, including the feet.

CONCLUSIONS

1. No statistically significant differences between the studied groups of children were noted in terms of the indices of the foot arch in unloading and loading.

2. It was noted however, that the condition of the foot arch in deaf children was characterised by a lower effectiveness of the muscular and ligament system, which was confirmed by values of the foot parameters of deaf children in the test of feet in unloading and loading.
3. Moreover, in both groups of tested girls, greater differences in the degree of foot arching were noted than in boys. This confirms the tendency to a generally labile body posture of girls and their muscular and ligament systems of the feet.

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HODNOCENÍ PODÉLNÉ KLENBY NOHY U HLUCHÝCH A SLYŠÍCÍCH DĚTÍ VE VĚKU OD 9 DO 11 LET

(Souhrn anglického textu)

Cílem studie bylo zjistit stav klenby nohy u hluchých a slyšících dětí a určit, zda existují rozdíly mezi klenbou nohy u dětí s poškozením sluchu a u zdravých dětí ve věku 9–11 let.

Studie proběhla na skupině 19 hluchých dětí a 33 slyšících dětí, z nichž bylo 23 dívek a 29 chlapců ve věku 9 až 11 let. Jejich průměrný věk byl 9,9 let.

Vyšetření podélné klenby nohy bylo provedeno v poloze nezatížené (v sedě) a zatížené (ve stoje), za použití podoskopu (POSMED, Polsko). Při přípravě otisků chodidel byla použita lineární metoda dle Wejsfloga se specifikací ukazatele podélné klenby nohy. Byl zjištěn statisticky významný rozdíl mezi klenbou levé a pravé nohy v zatížené poloze u zdravých dětí ($p < 0,05$). Nebyly ovšem zjištěny žádné statisticky významné rozdíly mezi zkoumanými skupinami dětí, pokud jde o ukazatele klenby v nezatížené i zatížené poloze. Nicméně bylo zjištěno, že stav klenby nohy u hluchých dětí byl charakterizován nižší efektivitou svalového a vazivového systému, což potvrdily hodnoty parametrů nohou u hluchých dětí. Výsledky Wejsflogova ukazatele svědčí o tom, že u hluchých dětí byla typická oblast proměnných (pravá noha v zatíženém stavu 20,55–39,85) větší než u zdravých dětí (pravá noha v zatíženém stavu 17,05–34,75). Navíc byly u obou skupin dívek zjištěny větší rozdíly ve stupni klenutí nohy než u chlapců. Toto potvrzuje tendenci k všeobecně labilnějšímu držení těla u dívek a ve svalovém a vazivovém systému nohy.

Závěr: nebyly zjištěny žádné statisticky významné rozdíly mezi zkoumanými skupinami dětí, pokud jde o ukazatele klenby v nezatížené i zatížené poloze.

Klíčová slova: mediální podélná klenba, hluché děti, vady nohou, podoskop.

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PHYSICAL ACTIVITY IN PRE-SCHOOL CHILDREN FROM THE ASPECT OF HEALTH CRITERIA

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The main aim of this study was to assess potential differences between groups of pre-school children meeting and not meeting health recommendations for physical activity (PA) from the aspect of so called indicators of physical activity (active energy expenditure, number of steps). The number of steps was measured by Yamax Digi-Walker SW-200 pedometers (Yamax Corporation, Tokyo, Japan) and the active energy expenditure was measured by Caltrac (Muscle Dynamics Fitness Network, Torrance, California) accelerometers. Evaluation of PA from the aspect of so called health criteria was realized following the criteria of Frömel, Novosad and Svozil (1999), who recommend values of so called health criteria of PA. Meeting these criteria, it is possible to suppose that PA positively affects the healthy development of an individual. The sample consisted of 200 pre-school children. Forty nine of these children (30 boys and 19 girls) were labeled as group A (children who did not meet the recommended values at least in one of the health criteria of PA). Group B (children who met the recommended values at least in one of the mentioned criteria of PA) consisted of 151 children (74 boys and 77 girls). The Mann-Whitney U test was used to test the statistical significance of possible differences between groups A and B and also between boys and girls within these groups as well. In all monitored parts of a week, as well as in both monitored parts of a day, a significant difference ($p < .001$) was found between groups A and B in both indicators of PA. Regarding these variables, the smallest differences ($p < .02$) were observed within the time spent at school. Our results confirm that a stay at kindergarten belongs among the relevant parts of a day from the aspect of children's physical activity in the sense of a very "problematic" part of a day, when the values of active energy expenditure and steps are decreased almost by 50% even in children physically active outside the school. On the other hand, a kindergarten is a proper place for children with hypokinetic behavior, who can be activated by an adequate incidence of school physical regimen.

Keywords: Physical activity, pre-school age, health recommendations, environmental stimulation.

INTRODUCTION

Movement is not only an irreplaceable factor for the creating and coordinating of the individual development of a child, but also serves as a certain criterion for the longitudinal control of dynamic changes in child growth and development. At present, many experts (Cabrnochová, 2008; European Heart Health Initiative, 2001; Friedenreich, Courtneya, & Bryant, 2001; Katzmarzyk & Janssen, 2004; Sadler, 2003; U. S. Department of Health and Human Services, 2000) point out a growing discrepancy between the phylogenically given need for movement and a physical regimen of children, which could negatively affect the health status of an adult population in the future.

The aim of this study was to assess and analyze potential differences between groups of pre-school children meeting and not meeting health recommendations for PA from the aspect of so called indicators of PA (active energy expenditure in a $kcal \cdot kg^{-1} \cdot day^{-1}$, abbreviated as AEE; the number of steps in $steps \cdot day^{-1}$, abbreviated as STEPS). The data were collected as a part of participation in the research grant project approved by the Ministry of Education, Youth and Sports of the Czech Republic No. 6198959221 entitled "Physical activity and inactivity of inhabitants of the Czech Republic in the context of behavioral changes", realized at Faculty of Physical Culture, Palacký University in Olomouc.

METHODS

For the monitoring of PA, the following combination of techniques was used:

The 1st indicator of PA – STEPS ($steps \cdot day^{-1}$): was measured by Yamax Digi-Walker SW-200 pedometers (Yamax Corporation, Tokyo, Japan); whereas the 2nd indicator of PA – AEE ($kcal \cdot kg^{-1} \cdot day^{-1}$): was measured by Caltrac (Muscle Dynamics Fitness Network, Torrance, California) accelerometers.

With regard to anticipated difficulties related to using these devices in a group of a given age (Bayer et al., 2008; Metallinos-Katsaras, 2007), the measurements were preceded by motivating the children to learn how to carry the devices and how to not misuse them. In agreement with general recommendations (Armstrong et al., 1998; Lin et al., 2007; Pratt, Macera, & Blanton, 1999; Trost, McIver, & Pate, 2005; Ward, Evenson, Vaughn, Brown, & Troiano, 2006), the children wore the devices placed firmly on an elastic belt, above their clothes on the right hip. During the seven day monitoring period, the devices were taken off only at the times of sleeping and of possible contacts with water (washing, swimming, bathing, etc.). With respect to previous experiences, buttons on the accelerometers were covered by strapping, fortified by pasteboard and strapped again. Adults referred to a need of placing the devices right back into a "pocket" after recording the measured values. Each kindergarten had at its disposal the usual room conditions (game room, school playground/yard) and material conditions standard in the Czech Republic. Fully qualified teachers taught at all the involved schools. The school educational program of all kindergartens was based on the valid framework "Educational program for pre-school education" (MSMT CR, 2005). Elastic belts with monitoring devices were attached to children on the first day of monitoring in the assessment. The devices were set to zero with previously loaded data needed for the measuring (age, sex, body weight, and body height).

For any group of given age, minimum values of criteria of PA indicating a presumption of negative health impact when not meeting them are not available yet. With regard to the value of the mean age of a sample (5.71 years), the criteria of Frömel, Novosad and Svozil (1999) were used. Based on their measures, these authors recommend the following values of the health criteria of PA for individuals from the age of six, which should lead to the maintainence of health and positively affect healthy development:

- the daily active energy expenditure should be at least 11 $kcal \cdot kg^{-1} \cdot day^{-1}$ in boys and 9 $kcal \cdot kg^{-1} \cdot day^{-1}$ in girls, respectively, in a majority of the days within a week;
- the daily number of steps, hops or position changes should be, in primary school children, about 13,000 steps in boys and 11,000 steps in girls, respectively, in the majority of days within a week.

The health effect could be anticipated when at least one of these recommended values is met.

The sample consisted of 200 children of pre-school age (96 girls and 104 boys). With respect to the aim of this study, the sample was divided into two groups after the criteria mentioned above:

- group A – children who did not meet the recommended values at least in one of the health criteria of PA (i.e. AEE: boys less than 11 $kcal \cdot kg^{-1} \cdot day^{-1}$, girls less than 9 $kcal \cdot kg^{-1} \cdot day^{-1}$; STEPS: boys less than 13,000 $steps \cdot day^{-1}$, girls less than 11,000 $steps \cdot day^{-1}$);
- group B – children who met the recommended values at least in one of the mentioned criteria of PA (i.e. AEE: boys 11 $kcal \cdot kg^{-1} \cdot day^{-1}$ and more, girls 9 $kcal \cdot kg^{-1} \cdot day^{-1}$ and more; STEPS: boys 13,000 $steps \cdot day^{-1}$ and more, girls 11,000 $steps \cdot day^{-1}$ and more).

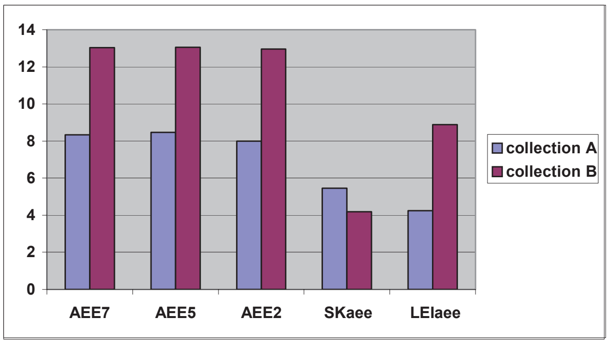
Forty nine children (24.5%) from the sample were included into group A, 30 of these were boys (61.22%) and 19 were girls (38.78%). The mean value of their BMI was 15.70 (15.60 in girls and 15.80 in boys). One hundred and fifty one children (75.5%) were included in group B, 74 of these were boys (49.01%) and 77 were girls (50.99%). The mean value of their BMI was 15.60 (15.63 in girls and 15.58 in boys). Regarding the diagrams for the calculation of the BMI of children in the Czech Republic (Vignerová et al., 2008), none of the monitored children was classified as obese.

The Mann-Whitney U test was used to test the statistical significance of possible differences between the groups A and B and also between boys and girls within these groups as well. The reason for the utilization of this test was thedifferent variance between the compared groups.

RESULTS AND DISCUSSION

Group B reaches significantly higher values ($p < .001$) in mean weekly AEE (AEE7 = 13.03 $kcal \cdot kg^{-1} \cdot day^{-1}$), on weekdays (AEE5 = 13.05 $kcal \cdot kg^{-1} \cdot day^{-1}$) and also on weekend days (AEE2 = 12.95 $kcal \cdot kg^{-1} \cdot day^{-1}$) compared to group A (AEE7 = 8.34 $kcal \cdot kg^{-1} \cdot day^{-1}$; AEE5 = = 8.47 $kcal \cdot kg^{-1} \cdot day^{-1}$; AEE2 = 8.00 $kcal \cdot kg^{-1} \cdot day^{-1}$). However, group A has markedly higher AEE ($p < .02$) on weekdays during their stay at school (SKaee = 5.46 $kcal \cdot kg^{-1} \cdot day^{-1}$) compared to group B (SKaee = 4.19 $kcal \cdot kg^{-1} \cdot day^{-1}$). Supposedly, the school regimen of the children from group A motivates and activates them more to be more physically active. At extracurricular time, again, group A (LEIaee = 4.24 $kcal \cdot kg^{-1} \cdot day^{-1}$) is considerably less active ($p < .001$) than group B (LEIaee = = 8.89 $kcal \cdot kg^{-1} \cdot day^{-1}$). These results correspond to the above mentioned AEE2 of the group A. Obviously, their time spent with family is more filled with inactivity. Kindergartens are set up by the framework educational program to have sufficient room for creating a quality physical regimen for children. Nevertheless, in those monitored kindergartens, the contemporary state is insufficient for more active children and, on the other hand, leads to a decrease in physical activity during their stay at school. Within the typical school regimen of kindergartens, lots of activities (e.g. time for food, rest in bed after lunch, etc.) can be characterized as "inactivity". However, with respect to a level of the ontogenetic development of children, it is necessary to include such inactivity in a daily program. In spite of this, it can be recommended to continue with the improving of the physical regimen at monitored schools (including an individualized approach to more active children) which would be more convenient to children and lead to meeting their high requirements for movement (Fig. 1).

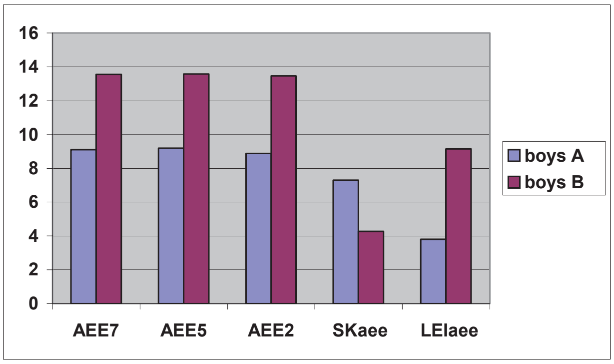
Fig. 1
The active energy expenditure (kcal·kg^{-1}·day^{-1}) – comparison of groups A (n = 49) and B (n = 151)



Legend:
AEE 7 kg – mean values of the active energy expenditure (kcal·kg^{-1}·day^{-1}) within the monitored week
AEE 5 kg – mean values of the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekdays
AEE 2 kg – mean values of the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekend days
SKaee – the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekdays at school
LEIaee – the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekdays in leisure time

Boys from group B exceed significantly ($p < .001$)the results of their counterparts from group A almost in all monitored variables of the AEE criterion. During the monitored week, mean values of their AEE7 reached 13.55 kcal·kg^{-1}·day^{-1}, AEE5 was 13.58 kcal·kg^{-1}·day^{-1} and AEE2 was 13.46 kcal·kg^{-1}·day^{-1}. High AEE can be observed also in leisure time out of school (LEIaee = = 9.14 kcal·kg^{-1}·day^{-1}). Boys from group A reach almost values one third lower compared to group B (AEE7 = = 9.10 kcal·kg^{-1}·day^{-1}; AEE5 = 9.19 kcal·kg^{-1}·day^{-1}). On the other hand, a stay at school is exceptional from this point of view, because these boys record significantly ($p < .001$) higher values of AEE (SKaee = 7.32 kcal·kg^{-1}·day^{-1}) compared to boys from group A (SKaee = 4.27 kcal·kg^{-1}·day^{-1}). Nevertheless, their AEE is very low outside school (LEIaee = 4.95 kcal·kg^{-1}·day^{-1}) and similarly at the weekend (AEE2 = 8.89 kcal·kg^{-1}·day^{-1}) (Fig. 2).

Fig. 2
The active energy expenditure (kcal·kg^{-1}·day^{-1}) – comparison of boys from groups A (n = 30) and B (n = 74)

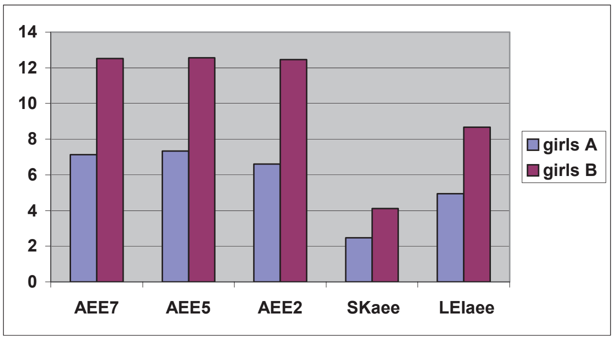


Legend:
AEE 7 kg – mean values of the active energy expenditure (kcal·kg^{-1}·day^{-1}) within the monitored week
AEE 5 kg – mean values of the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekdays
AEE 2 kg – mean values of the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekend days
SKaee – the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekdays at school
LEIaee – the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekdays in leisure time
Boys A – the sample of boys who do not meet health recommendations IAW the indicator of AEE (kcal·kg^{-1}·day^{-1})
Boys B – the sample of boys who meet the health recommendations IAW the indicator of AEE (kcal·kg^{-1}·day^{-1})

A similarly significant difference ($p < .001$) can be observed in the criteria of PA AEE7 and AEE5 between the groups of girls (group B: AEE7 = 12.53 kcal·kg^{-1}·day^{-1}; AEE5 = 12.56 kcal·kg^{-1}·day^{-1}; group A: AEE7 = 7.13 kcal·kg^{-1}·day^{-1}; AEE5 = 7.34 kcal·kg^{-1}·day^{-1}). A strong prevalence of inactivity in group A ($p < .001$) is observed particularly at the weekend days, when group A reaches approximately half values (AEE2 = 6.60 kcal·kg^{-1}·day^{-1}), when compared to group B (AEE2 = = 12.47 kcal·kg^{-1}·day^{-1}). Girls from group A (LEIaee = =4.95 kcal·kg^{-1}·day^{-1}) are also significantly ($p < .001$) less active than girls from group B (LEIaee = 8.68 kcal·kg^{-1}·day^{-1}) at weekdays outside school (Fig. 3). Even the school physical regimen of monitored kindergartens does not activate these girls (SKaee = 2.48 kcal·kg^{-1}·day^{-1}). A significant difference ($p < .001$) is also found when comparing girls from group A and boys from the same group, while the intra group comparison of boys and girls (SKaee = 4.11 kcal·kg^{-1}·day^{-1}) from group B does not generate any statistical difference.

Corbin, Pangrazi and Welk (1994) indicate the minimal daily limits of AEE 3–4 kcal·kg^{-1}·day^{-1} while some health effects could be expected in PA lasting 60 minutes with an AEE 6–8 kcal·kg^{-1}·day^{-1}. In the Czech Republic, the highest energy expenditure observed in

Fig. 3
Active energy expenditure (kcal·kg^{-1}·day^{-1}) – a comparison of girls from groups A (n = 19) and B (n = 77)



Legend:
AEE 7 kg – mean values of the active energy expenditure (kcal·kg^{-1}·day^{-1}) within the monitored week
AEE 5 kg – mean values of the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekdays
AEE 2 kg – mean values of the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekend days
SKaee – the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekdays at school
LEIaee – the active energy expenditure (kcal·kg^{-1}·day^{-1}) on weekdays in their leisure time
Girls A – the sample of girls who do not meet the health recommendations IAW the indicator of AEE (kcal·kg^{-1}·day^{-1})
Girls B – the sample of girls who meet the health recommendations IAW the indicator of AEE (kcal·kg^{-1}·day^{-1})

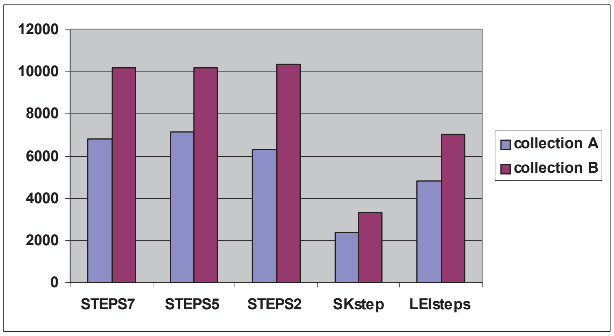
research done by Frömel, Novosad and Svozil (1999) at primary schools was 8.91 kcal·kg^{-1}·day^{-1} in girls and 10.94 kcal·kg^{-1}·day^{-1} in boys.

Mean values of the monitored sample of pre-school children as a whole are higher (AEE = 11.98 kcal·kg^{-1}·day^{-1}; girls 11.43 kcal·kg^{-1}·day^{-1}; boys 12.31 kcal·kg^{-1}·day^{-1}) than those recommended values. The recommended value of AEE is met by 112 children (56%) from the sample, sixty three of whom are boys (57.27%) and forty nine of whom are girls (44.55%). Eighty eight children from the sample (44%) do not meet this value (41 boys, i.e. 46.59% and 47 girls, i.e. 53.41%). The high percentage of pre-school children not meeting at least minimal recommendations for AEE is surprising, with regard to the expected effects of the physical activity regimens of children in kindergartens. Neither the quantity of physical activities implemented daily into the school regimen, nor PA outside school and at the weekend days is probably sufficient to compensate for the prevalence of inactivity during other parts of each day and week. In group A, the problematic parts of a week are the weekend days and the time after school on the weekdays. At such a time, the physical regimen of a child is left to the full competency of the child's family (parents), that is why we see (in concordance with other experts) a solution in the education of parents in the field of the importance of PA for the healthy development of a child (Kodat et al., 2006; Salonna et al., 2008; Sichieri, Taddei, & Everhart, 2000). It is necessary to prefer a fellowship of engagement in PA for children and their parents (National Center for Chronic Disease Prevention and Health Promotion, 1999). We consider quality and the qualified promoting of a healthy lifestyle within a family to be very important (Coakley, 1987), not only by means of policy, the influence of the mass media, and physicians but also by teachers at kindergartens. Similarly with Dowda, Pate, Trost, Almeida and Sirard (2004) or Timperio, Salmon and Ball (2004), we assume that it is necessary to improve the quality of the undergraduate education of kindergarten teachers. We identify with the opinion of the European Healthy Heart Initiative (2001) that school should become a center for the promotion of a healthy lifestyle for children.

Boreham and Riddoch (2001) claim that contemporary children expend approximately 600 kcal·kg^{-1}·day^{-1} less energy than children 50 years ago, despite their ontogenetically given need for movement, and this trend has been increasing in recent decades. Although the health consequences of reduced energy expenditure in adulthood are very well known, associations with inactivity in childhood have not been sufficiently described yet. In particular, juvenile obesity can be followed by many negative health effects in adulthood. Experts presume an increase in the growing quantity of overweight and obese children as seen in growing numbers of victims of chronic and fatal diseases in the oncoming decade (Chinn & Rona, 2001; Lee, Burgeson, Fulton, & Spain, 2006; Pender & Pories, 2005; The United Kingdom Parliament, 2001).

Significant difference ($p < .001$) between groups A and B was found also in all monitored variables of the STEPS criterion. Group A reached significantly lower values of the number of steps within a monitored week (STEPS7 = 6817 steps·day^{-1}), on weekdays (STEPS5 = = 7124 steps·day^{-1}), and on weekend days (STEPS2 = = 6307 steps·day^{-1}), when compared to group B (STEPS7 = 10182 steps·day^{-1}; STEPS5 = 10177 steps·day^{-1}; STEPS2 = 10338 steps·day^{-1}). The lower number of steps at school in group A (SKsteps = 2375 steps·day^{-1}) corresponds to the low number of steps during leisure time (LEIsteps = 4799 steps·day^{-1}) and on weekend days. On the other hand, children from group B significantly ($p < .001$) exceeded group A in the number of steps taken at school (SKsteps = 3296 steps·day^{-1}) and outside of school (LEIsteps = 7426 steps·day^{-1}) (Fig. 4). The smallest inter group difference in the criterion of STEPS is observed at school. The reason for such a small difference could be seen in school educational programs at monitored schools which, by their structure and content, do not take individual differences between children fully under consideration and probably takes part in the reduction of the number of steps in physically more active children.

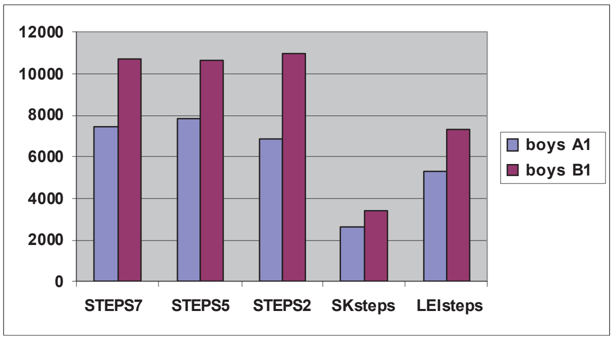
Fig. 4
The average number of steps (steps·day^{-1}) – comparison of groups A (n = 49) and B (n = 151)



Legend:
STEPS7 – mean numbers of steps within the monitored week
STEPS5 – mean numbers of steps on weekdays
STEPS2 – mean numbers of steps on weekend days
SKsteps – mean numbers of steps on weekdays at school
LEIsteps – mean numbers of steps on weekdays in their leisure time

Boys from group B reached a higher mean number of steps during the monitored week (STEPS7 = 10705 steps·day^{-1}), on weekdays (STEPS5 = 10632 steps·day^{-1}), and on weekend days (STEPS2 = 10990 steps·day^{-1}). Values found in group A were significantly lower ($p < .001$), i.e. STEPS7 = 7483 steps·day^{-1}, STEPS5 = = 7857 steps·day^{-1}, and STEPS2 = 6893.93 steps·day^{-1}. In their leisure time outside school on weekdays, the number of steps found in boys from group B was almost one third higher ($p < .001$) (LEIsteps = 7333 steps·day^{-1}), when compared to their counterparts from group A (LEIsteps = 5338 steps·day^{-1}). In spite of the significant difference ($p < .02$) in the number of steps taken during their stay at kindergarten by groups A (SKsteps = 2656 steps·day^{-1}) and B (3435 steps·day^{-1}) we find differences in other monitored values of the STEP factor between these groups of boys to be considerably higher. The school regimen probably does not allow boys from group B to saturate sufficiently their need of locomotion activities and that is why they carry out these activities during weekdays outside school and on weekend days in particular (Fig. 5). Compared to the values of the number of steps outside school, a stay at kindergarten lowers the number of steps considerably (approximately by 50%) not only in more active boys from group B, but also in group A.

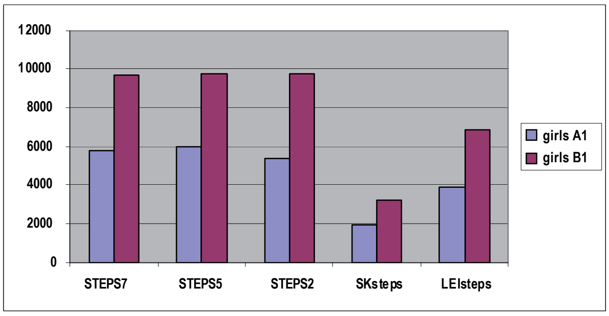
Fig. 5
The average number of steps (steps·day^{-1}) – comparison of boys from groups A (n = 30) and B (n = 74)



Legend:
STEPS7 – mean numbers of steps within the monitored week
STEPS5 – mean numbers of steps on weekdays
STEPS2 – mean numbers of steps on weekend days
SKsteps – mean numbers of steps on weekdays at school
LEIsteps – mean numbers of steps on weekdays in their leisure time
Boys A – the sample of boys who do not meet the health recommendations IAW the STEPS indicator
Boys B – the sample of boys who meet the health recommendations IAW the STEPS indicator

A significant difference ($p < .001$) in the daily number of steps during the monitored week can be observed also in girls from group A (STEPS7 = 5764 steps·day^{-1}) and B (STEPS7 = 9689 steps·day^{-1}). Girls from group A reached values lower by almost one quarter ($p < .001$) on weekdays (STEPS5 = 5968 steps·day^{-1}), when compared to group B (STEPS5 = 9747 steps·day^{-1}). In girls from group A, the number of steps taken during a weekend is even lower in comparison with weekdays (STEPS2 = 5381 steps·day^{-1}), while these values are almost the same in group B (STEPS2 = 9721 steps·day^{-1}). Thus, the significant difference ($p < .001$) between groups A and B can be found also on weekend days. With regard to the young age of these children, their PA on weekend days is mostly affected by the life style of their family, the activity of their parents and the approach of parents to the education of their child. However, when taking the STEPS criterion into account, girls from group B (SKsteps = 3181 steps·day^{-1}) are more active also at school ($p < .001$), when compared to girls from group A (SKsteps = 1906 steps·day^{-1}). In leisure time outside school, a significant difference ($p < .001$) was found in steps between girls from group A (LEIsteps = 3899 steps·day^{-1}) and B (LEIsteps = 6815 steps·day^{-1}) similarly as in boys (Fig. 6). The number of steps taken during weekdays at school is also, in girls, approximately half-length in comparison with leisure time outside school.

Fig. 6
The average number of steps (steps·day^{-1}) – comparison of girls from groups A (n = 19) and B (n = 77)



Legend:
STEPS7 – mean numbers of steps within the monitored week
STEPS5 – mean numbers of steps on weekdays
STEPS2 – mean numbers of steps on weekend days
SKsteps – mean numbers of steps on weekdays at school
LEIsteps – mean numbers of steps on weekdays in their leisure time
Girls A – the sample of girls who do not meet the health recommendations in the indicator of STEPS
Girls B – the sample of girls who meet the health recommendations in the indicator of STEPS

Tudor-Locke and Bassett (2004) assume 12,000 to 16,000 steps a day in children. Taking the STEPS criterion into account, seventy one children (35.5%) from the sample included in group A did not meet this health criterion. Thirty two (45.07%) of these were boys and thirty nine (54.93%) were girls. This result was probably influenced partly by the age of the children, because the above mentioned values for health criteria were developed for children from the age of six. The group of children meeting this criterion consisted of 129 (64.50%) children, seventy two (55.81%) of whom were boys and fifty seven (44.18%) were girls. It is possible to assume a rather positive trend of development in the daily number of steps with the growing age of children under conditions of maintaining dominant active transport to and from school and a gradual increase in their involvement in sport and children's organizations with respect to the interests of each child.

According to activity criteria for adults (Tudor-Locke, Hatano, Pangrazi, & Kang, 2008), the mean daily values reached in group B are classified as "active" and "somewhat active" or "less active" in group A. Jago et al. (2006) estimated that 8,000 steps per 60 minutes correspond to 60 minutes of moderate PA. Sigmund, Frömel and Neuls (2005) indicate 8,250–12,000 steps a day to be sufficient from the aspect of expected health benefits for pre-school children. Thus, in the STEPS criterion, the level reached could be classified as sufficient. However, it is necessary to perceive that, in pre-school aged children, locomotion activities are not only a source for meeting the requirements for movement but also a means for the development of cognitive functions and an important stimulus for the socialization of a child. According to measures made by Sigmund, De Croix, Miklánková and Frömel (2006) and Sigmund, Miklánková, Mitáš, Sigmundová and Frömel (2007), the criteria for PA in children and youth decline rapidly in older age categories, especially after the beginning of compulsory school attendance. In girls, these values fall down to the level of an "inactive norm" of senior women with at least one factor of metabolic syndrome (Křenková, Daďová, Novotná, & Matoušková, 2006).

CONCLUSIONS

Reviewing PA as a means for health support, there are many points of view and recommendations regarding the frequency, intensity and duration of PA from the aspect of benefits for the health of an individual. A relatively high percentage of pre-school children with hypokinetic behavior points to a necessity to target, in future research, factors causing this decrease and the area of interventional programs to promote PA under both school conditions and as a component of the life style of contemporary families. Extreme attention needs to be paid to unskillful children (Howell-Wechsler et al., 2000), children with special needs (Górny & Karásková, 2004; Janečka & Dostálová, 2007; Kudláček & Ješina, 2008) or children with problematic relationships to physical education and to enlighten them on possibilities of how to involve themselves in physical activities. Moreover, the problems of the undergraduate and postgraduate education of teachers with regard to the efficiency of school physical regimens and their influence in the PA level of children is deficiently assessed in the Czech Republic.

Our results confirm that a stay at kindergarten belongs to the relevant parts of a day from the aspect of children's physical activity in the sense of a very "problematic" part of a day, when the values of active energy expenditure are decreased almost by 50% even in children physically active outside the school. The same trend can be observed also in the number of steps. On the other hand, a kindergarten is a proper place for children with hypokinetic behavior, who can be activated by an adequate incidence of the fulfillment of a school physical regimen. In correspondence with school laws, kindergartens have at their disposal qualified pedagogical workers, certified tools and equipment and premises meeting the criteria of safety. The propriety and safety of the premises offered to children for play and locomotion activities of a spontaneous or organized character have been mentioned as a necessary determinant of an increase in PA by many authors (Barnett, O'Loughlin, Gauvin, Paradis, & Hanley, 2006; European Healthy Heart Initiative, 2001; Louie & Chan, 2003; Mori, 2004; Sallis et al., 2001). It can be recommended to do further research in the field of PA in children of pre-school age and at the following primary school age in association with environmental stimuli to PA which can play a very important, motivating and activating role in relationship to physical activities.

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POHYBOVÁ AKTIVITA U PŘEDŠKOLNÍCH DĚTÍ Z HLEDISKA ZDRAVOTNÍCH KRITÉRIÍ

(Souhrn anglického textu)

Hlavním cílem této studie bylo zhodnocení potenciálních rozdílů mezi skupinami předškolních dětí, které splňují a nesplňují zdravotní doporučení pro pohybové aktivity (PA) z hlediska takzvaných indikátorů pohybové aktivity (aktivní výdaj energie, počet kroků). Počet kroků byl měřen pedometry Yamax Digi-Walker SW-200 (Yamax Corporation, Tokio, Japonsko) a aktivní výdaj energie byl měřen akcelerometry Caltrac (Muscle Dynamics Fitness Network, Torrance, Kalifornie). Hodnocení PA z hlediska takzvaných zdravotních kritérií bylo uskutečněno dle kritérií Frömela, Novosada a Svozila (1999), kteří doporučují hodnoty takzvaných zdravotních kritérií PA. Při dosažení těchto kritérií je možné předpokládat, že PA má pozitivní účinky na zdravý vývoj jednotlivce. Vzorek sestával z 200 předškolních dětí. Čtyřicet devět těchto dětí (30 chlapců a 19 dívek) bylo označeno jako skupina A (děti, jež požadovaných doporučených hodnot nedosahovaly ani v jednom ze zdravotních kritérií PA). Skupina B (děti, které dosahovaly požadovaných doporučených hodnot alespoň v jednom ze zdravotních kritérií PA) sestávala ze 151 dětí (74 chlapců a 77 dívek). K ověření statistického významu možných rozdílů mezi skupinami A a B a také mezi chlapci a děvčaty v rámci těchto skupin bylo použito testu Mann-Whitney. Ve všech sledovaných dnech týdne, stejně jako v obou sledovaných částech dne, byl u obou ukazatelů PA zaznamenán významný rozdíl ($p < 0{,}001$) mezi skupinami A a B. Pokud jde o tyto proměnné, byly nejmenší rozdíly ($p < 0{,}02$) pozorovány v době strávené ve škole. Naše výsledky potvrzují, že pobyt v mateřské škole náleží k důležitým částem dne z hlediska pohybové aktivity dětí ve smyslu velmi „problematické“ části dne, kdy se hodnoty aktivního výdaje energie a kroků snižují téměř o 50 % i u dětí pohybově aktivních mimo školu. Na druhou stranu je mateřská škola vhodná pro děti s hypokinetickou poruchou, jež může aktivovat adekvátní působení školního pohybového režimu.

Klíčová slova: pohybová aktivita, předškolní věk, zdravotní doporučení, stimulace prostředím.

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POSSIBILITIES FOR THE USE OF SELECTED METHODS FOR THE DETERMINATION OF BODY COMPOSITION IN CHILDREN IN THEIR ADOLESCENT STAGE

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The variables of fat mass (FM), fat free mass (FFM) and total body water (TBW) are considered to be the most important components of the body's composition. At present, there are quite many methods for the evaluation of body composition. They differ in both devices used and personnel requirements and in the determination accuracy of the monitored data, which are the most important factors limiting their use under various conditions. The aim of our work is to find out more details about those methods for the determination of body composition that are available at present and to consider their possibilities in use for a group of children under laboratory and field conditions. Altogether, the following subjects were tested, n = 30, aged 10 to 14 years, 17 of whom were boys and 13 of whom were girls. A good match, of the DEXA method and other chosen methods for the determination of body composition, was found in both boys and girls, but from the statistical and objective significance points of view, we deduce a considerable differentness between various methodics mainly due to the differentness of prediction equations.

Keywords: Body composition, components of body composition, methods for determination of body composition.

INTRODUCTION

Generally, we can divide the human body into several components that form mutual relations with each other (Wang et al., 1992, 19; Pařízková, 1998a, 1). The variables of fat mass (FM), fat free mass (FFM) and total body water (TBW) are considered to be the most important components of the body's composition. All of the components of the body's composition are subject to the impact of many external as well as internal factors. Body composition, commonly approached as a proportion of active mass and depot fat, creates an expressive somatic marker that is associated with specific developments, based on age, gender and level of physical condition. Therefore, the determination of the proportion of active mass and depot fat is not defined only by a certain morphological feature, but it also provides a basis for organism assessment from the point of view of its functions (Pařízková, 1962, 123). Epidemiologic studies show that not only the total amount of the body fat, but also it's distribution, are important for the occurrence of cardiovascular diseases and type 2 diabetes. Central fat distribution is also connected with adverse effects on fitness characterized by hyperinsulinism, dyslipidemia and glucose intolerance, which mainly increase the risk of cardiovascular diseases (Chan et al., 2003, 445). Maffeis et al. (2001, 179) mention in their study the relationship between waist circumference and the risk factors of cardiovascular diseases as follows: there is a negative correlation between the waist circumference and the HDL cholesterol level, the results of lipid spectrum examination and blood pressure values in preadolescent children significantly relate to the anthropometric indexes evaluating fat mass distribution; they also found a high degree of dependence between the waist circumference and skinfold thickness at the triceps and subscapular area. According to Teixeira et al. (2001, 434) the sum of 3 trunk skinfolds (the abdominal, subscapular and the suprailiacal skinfold) strongly correlated with the total amount of trunk fat (measured by DEXA method). The sum of three trunk skinfolds further strongly correlated with HDL cholesterol values, the proportion of total cholesterol/LDL cholesterol and with apolipoproteins A-I being independent of body thickness. At present, there are quite many methods for the evaluation of body composition. We can divide them into three basic groups: direct methods (level I), indirect standard laboratory (reference) methods (level II), and field methods (level III) (Bunc et al., 1998; Pařízková, 1998a, 3, 4; Malá et al., 2008). They differ in both devices used and personnel requirements and in the determination accuracy of the monitored data, which are the most important factors limiting their use under various conditions (Roche et al., 1996, 15). The availability of the methods presented as so-called "reference" methods, is limited in our situation due to their high technical and financial operating demands; these methods are virtually impracticable for field population studies. They are also known as "once indirect" methods and the most widely used method at present is dual energy X-ray absorpciometry (DEXA). DEXA is considered to be a "gold standard", its availability is, however, limited, due to its high financial operating demands, therefore it is mostly used for verification of derived methods (i.e. level III methods) the availability and operation of which are much less demanding. The underwater weighing method of body composition analysis used earlier is being used less at present due to its technical demands (Malá et al., 2008). Regarding field methodics (level III) that are readily available, less time consuming, as well as being technically and financially manageable but less exact, we can mention anthropometry in particular (stature and body weight, BMI, WHR, estimation of body composition based on skinfolds – caliperation...) and bioelectric impedance (BIA) (Brodie et al., 1999, 801; Pařízková, 1998a, 3; Bunc, 2001a, 103). BMI however does not reflect an exact proportion of fat and fat free mass. The amount of fat mass (%) increases with age and is higher in women than men, but these differences may not be involved in BMI (WHO, 1995). In comparison to BMI, the fat mass (%) has a greater predicative ability and is more tightly connected with the health hazards that arise from its amount and distribution in the body (Deurenberg et al., 1989, 624; Deurenberg-Yap et al., 2003, 81). However, the determination of body composition using the BIA method determining total body water (TBW) and its fractions (ICT, ECT) is also not "trouble free" (Lukaski et al., 1985, 810). It is necessary to emphasize that the amount of water in an organism depends on the individual's age, weight and gender and that it individually varies according to intake and output (Heyward et al., 1996, 44).

Each of the measuring methods has its error sources that have to be taken into account. Aside from the financial and technical demands, there are also prediction equations that represent the major difficulty of the usability of the current methods for the determination of body composition. Unfortunately, there is no universal prediction equation that could be used for all of the population groups. Many of the equations either have been taken over from foreign studies or were formed more than 25 years ago. Therefore, it is necessary to update these equations and mainly to determine such prediction equations as would respect not only age and gender, but also the individual's level of physical activity and individual variability in body composition. To minimalize any error of all of the indirect methods for the determination of body composition, it is necessary to use specific prediction equations formed from a sample of the factors of age, gender, nationality, health condition and level of motion activity corresponding with the examined person (Deurenberg et al., 1989, 628; Baumgartner et al., 1990, 223). Since the fat mass distribution varies based on age, gender, motion activity, etc., the validity of regression equations for the estimation of body composition from skinfolds is limited only to the population from which the equations were derived.

We can find a number of companies that offer an analysis of body composition by means of various methodics. Unfortunately, it has become a routine that the single methods are combined with each other and the results are often interchanged in spite of the fact that each of the methods is based on different principles and presumptions. Therefore, it is now necessary to consider the efficiency of individual methods for the determination of body composition as well as to solve the problem of the partial compatibility of these methods.

The aim of our work is to find out more details about those methods for the determination of body composition that are available at present and to consider their possibilities in use for a group of children under laboratory and field conditions. The partial aim was to find out about a suitable kind of laboratory equipment that would be available in our environment as well as abroad, and that would allow for not only a single analysis of body composition but also the monitoring of contingent changes in body composition within the framework of the long term observation of an individual or of population groups.

FILE CHARACTERISTICS AND APPLIED METHODS

The mixed file was comprised of 30 probands in total, 17 of whom were boys (10–14 years) and 13 were girls (11–13), without any special motion load (43% female gender, 57% male gender). All of the probands were monitored in the Biomedicine Laboratory, Faculty of Physical Education and Sport, Charles University in Prague. Testing by DEXA method was carried out in cooperation with the Densitometry Department, Central Military Hospital in Prague. The respective measurements were carried out all at once, i.e. the proband was tested by all specific methodics within one visit. The probands were apprised of the goal and process of all of the testing in advance. With respect to the probands' age, we sought their parents' approval. One of the basic requirements was to minimize the influences of the environment as well as the examiner because they affect the test results as errors. The examiner's influence was minimized in the following manner: it was always the same person who did all of the probands' values (except for that done by the DEXA method) and whose measurement reliability was verified using the test-retest method.

From the basic anthropometric parameters, we measured stature (cm) and body weight (kg). For measurement of the skinfolds' thickness we used the Best type caliper (face, chin, biceps, triceps, forearm, back, thorax I, thorax II, abdomen, hip, thigh I, thigh II, calf II) and the Harpenden caliper (skinfolds for somatotype – biceps, triceps, spina, scapula, calf I). The circumference measurements (cm) – particularly the circumference of the arm, forearm, thigh, waist and hip – were determined by using an inelastic measuring tape with an accuracy of 0.1 cm. The breadth measurements (mm) – particularly the wrist breadth, breadth of the distal epiphysis of the humerus and ankle breadth – were measured by using a slide gauge with an accuracy of 0.5 mm. The BMI index (kg.m^{-2}), WHR index and somatotype were determined according to Heath and Carter (1967) by using the SURVEY software in its 2.95 version.

To determine body composition, we used the DEXA reference method (HOLOGIC type, 11.1:7 version, Delphi W model (S/N 70522), measurement of the skinfolds' thickness according to Pařízková (1977, 38) – SKF_1 (prediction equations by Pařízková, 1977, 38), SKF_2 (prediction equations by Bunc et al., 1998, 1), method of body composition according to Matiegka (1921), bioelectric impedance – BIA (Bodystat 500 – BIA_1 – software ANTROPOS 2.3 (1995), BIA_2 – Bunc et al. (1998, 1), BIA_3 – OMRON BF 300, BIA_4 – TANITA TBF – 551).

TABLE 1
Values of the monitored probands' selected parameters (n = 30), the values are presented in the form of average ± standard deviation

		Boys (n = 17)	Girls (n = 13)
BMI (kg.m^{-2})		17.8 ± 2.0	17.9 ± 1.9
WHR		0.82 ± 0.04	0.78 ± 0.03
Somatotype components	**Endomorphic**	1.1 ± 0.7	1.1 ± 0.4
	Mesomorphic	3.3 ± 1.1	2.7 ± 1.1
	Ectomorphic	3.9 ± 1.1	4.0 ± 1.0
Skinfolds (mm)	**Face**	3.9 ± 0.8	3.0 ± 0.6
	Chin	3.4 ± 1.1	2.9 ± 0.7
	Thorax I	4.1 ± 1.2	3.3 ± 1.1
	Thorax II	3.9 ± 1.6	3.8 ± 1.3
	Arm (triceps)	3.6 ± 1.5	3.4 ± 0.8
	Arm (biceps)	4.0 ± 1.9	3.2 ± 1.2
	Forearm	3.5 ± 1.2	3.2 ± 1.3
	Hip	4.6 ± 2.2	5.1 ± 1.8
	Abdomen	9.1 ± 4.3	8.8 ± 3.3
	Back	4.6 ± 1.6	4.4 ± 1.1
	Thigh I	5.4 ± 1.4	5.0 ± 1.5
	Thigh II	7.6 ± 1.3	8.2 ± 1.5
	Calf I	5.9 ± 1.4	5.2 ± 1.0
	Calf II	6.2 ± 1.9	6.5 ± 2.1
Σ of 10 skinfolds (mm)		48.7 ± 14.6	45.0 ± 10.0

TABLE 2
Fat mass values (%) determined by different methodics

	Fat (%) SKF_1	**Fat (%) SKF_2**	**Fat (%) by Matiegka**	**Fat (%) BIA_1**	**Fat (%) BIA_2**	**Fat (%) BIA_3**	**Fat (%) BIA_4**	**Fat (%) DEXA**
Boys (n = 17)								
Average	12.1	9.9	12.6	5.5	6.9	16.8	15.0	16.6
SD	3.9	3.7	2.9	2.4	1.5	5.0	3.8	3.3
Min	7.2	4.4	8.7	1.5	4.8	10.1	7.9	12.1
Max	19.2	16.9	17.7	10.1	10.3	24.8	22.4	25.2
Girls (n = 13)								
Average	13.7	9.1	11.5	5.5	18.8	18.1	19.4	20.6
SD	2.5	2.8	2.5	2.3	2.7	3.3	2.6	3.4
Min	9.0	3.8	7.7	2.2	14.0	13.3	15.4	15.7
Max	17.7	14.6	16.1	9.7	22.6	22.8	24.8	26.9

Legend:
The values are presented as an average ± SD (standard deviation).
SKF_1 – measurement of the skinfolds' thickness, prediction equation according to Pařízková (1977)
SKF_2 – measurement of the skinfolds' thickness, prediction equation according to Bunc et al. (1998)
BC Matiegka – body composition by Matiegka's method (1921)
BIA_1 – Bodystat 500, ANTROPOS 2.3 software (1995)
BIA_2 – Bodystat 500, prediction equation, Bunc et al. (1998)
BIA_3 – OMRON BF 300 – prediction equation as part of the device software result
BIA_4 – TANITA TBF 551 - prediction equation as part of the device software result
DEXA – dual energy X-ray absorpciometry

TABLE 3
Correlation analysis and t-test for pairing values of DEXA methodics compared with other chosen methodics

A) Boys

	R^2	R	P (t-test)
SKF_1/DEXA	0.808	0.899**	< 0.01
SKF_2/DEXA	0.696	0.834**	< 0.01
BC Matiegka/DEXA	0.643	0.802**	< 0.01
BIA_1/DEXA	0.479	0.692**	< 0.01
BIA_2/DEXA	0.536	0.732**	< 0.01
BIA_3/DEXA	0.540	0.735**	N. S.
BIA_4/DEXA	0.493	0.702**	N. S.

B) Girls

	R^2	R	P (t-test)
SKF_1/DEXA	0.072	0.268	< 0.01
SKF_2/DEXA	0.895	0.946**	< 0.01
BC Matiegka/DEXA	0.548	0.740**	< 0.01
BIA_1/DEXA	0.672	0.820**	< 0.01
BIA_2/DEXA	0.579	0.761**	N. S.
BIA_3/DEXA	0.569	0.754**	N. S.
BIA_4/DEXA	0.137	0.370	N. S.

Legend:
* $p < 0.05$
** $p < 0.01$
R^2 – determination coefficient
R – Pearson's correlation coefficient
N. S. – insignificant difference
P (t-test) – significant difference of fat mass averages (%) by using the pairing t-test

We used NCSS 6.0.21 Jr – Demo (Copyright © 1996 by Jerry Hintze) and the Microsoft Excel 1997, 2002 programs for data analysis and its statistical treatment.

We used basic statistical characteristics, including position measurement (using an arithmetic average), variability measurement (using standard deviation) for the (quantitative data) file description. We used the linear regression method and correlation analysis to express relationships between the examined probands' body characteristics. We used correlation analysis and the pairing t-test to establish a mean value for the comparison of the results of fat mass measurements (%) by selected methods. With respect to the above mentioned errors in measurement, the objectively significant difference in the evaluation of the methods' differentness was determined at 1.5–2% of the fat mass value (Bunc, 2001, 48; Bunc et al., 2001, 105). The relevance of such relationships and differences between the single methods was considered at $p < 0.01$ and $p < 0.05$ levels.

RESULTS

We are not presenting the basic statistical characteristics of stature and body weight with respect to the examined probands' age spread (10–14 years) and to the low numbers of probands in the subfiles structured according to age. The aim of the study was focused on the examination of correspondence between the methods used for the determination of body composition; therefore, we present the basic statistic characteristics of selected indexes, somatotype components and skinfolds in TABLE 1. These data serve as a basis for assessment of the output values.

Inhomogenity of the anthropometric parameters and body composition parameters as well can be caused by many factors (biological age, individual's variability, etc.).

The single somatotype components were determined based on the anthropometric parameters. It is necessary to mention that a child's distribution and relationship of morphological components differ from an adult's. All three components can change in connection with the type of growth (Riegerová et al., 1998, 61).

DISCUSSION

Anthropometry serves as a basis for determining the morphological characteristics of body and body composition (FM, FFM). It does not include only the measurement of body circumferences, breadths and lengths but also the measurement of the skinfolds' thickness that further serve for the calculation of the amount of subcutaneous fat. The possibility of the determination of various subparameters, e.g. skinfold thickness in the abdominal area, or other coefficients, allows us, among other factors, to characterize the fat mass distribution. Epidemiologic studies show that not only the total amount of body fat, but also its distribution is important for the distribution of the so called lifestyle diseases. The intra abdominal fat in adults is referred to as clinically the most severe type of fat mass distribution (Maffeis et al., 2001, 179; Teixeira et al., 2001, 433; Chan et al., 2003, 441). There are various anthropometric parameters and indexes, such as, e.g. BMI and waist circumference, that are commonly used for the estimation of fat mass, assessment of its distribution and for the evaluation of the relationship between the obesity and risk factors of cardiovascular diseases. BMI, however, does not reflect the exact proportion of fat and fat free mass. The amount of fat mass (%) increases with age and is higher in women than men, but these differences may not be involved with BMI (WHO, 1995). In comparison to BMI, the fat mass (%) has a greater predicative ability and is more tightly connected with the health hazards

TABLE 4
Objectively significant/insignificant difference in fat mass quantity (%) observed by single methods for determination of body composition in boys and girls (the values are presented in %; < **1.5–2% = objectively insignificant difference**; > 1.5–2% = objectively significant difference)

		SKF_2	BC Matiegka	BIA_1	BIA_2	BIA_3	BIA_4	DEXA
SKF_1	**b**	−2.2	**+0.5**	−6.6	−5.2	+4.7	+2.9	+4.5
	g	−4.6	−2.2	−8.2	+5.1	+4.4	+5.7	+6.9
SKF_2	**b**		+2.7	−4.4	−3.0	+6.9	+5.1	+6.7
	g		+2.4	−3.6	+9.7	+9.0	+10.3	+11.5
BC Matiegka	**b**			−7.1	−5.7	+4.2	+2.4	+4.0
	g			−6.0	+7.3	+6.6	+7.9	+9.1
BIA_1	**b**				**+1.4**	+11.3	+9.5	+11.1
	g				+13.3	+12.6	+13.9	+15.1
BIA_2	**b**					+9.9	+8.1	+9.7
	g					**−0.7**	**+0.6**	**+1.8**
BIA_3	**b**						**−1.8**	**−0.2**
	g						**+1.3**	+2.5
BIA_4	**b**							**+1.6**
	g							**+1.2**

Legend:
The value with "+" sign signifies that it is higher in a column than in a row (e.g. value from BC Matiegka is higher by 0.5 against the value from SKF_1).
The value with "−" sign signifies that it is lower in a column than in a row (e.g. value from SKF_2 is lower by 2.2 against the value from SKF_1).

that arise from its amount and distribution in the body (Deurenberg et al., 1989, 624; Deurenberg-Yap et al., 2003, 81).

We find significant relationships in the group of boys, not only between the total amount of fat mass (%) from DEXA and anthropometric indexes BMI ($R^2 = 0.475$, $R = 0.689$, $p < 0,01$), WHR ($R^2 = 0.412$, $R = 0.642$, $p < 0.01$), but also between the amount of fat mass (%) from $DEXA_{TRUNK}$ and anthropometric indexes BMI ($R^2 = 0.297$, $R = 0.545$, $p < 0.05$) and WHR ($R^2 = 0.416$, $R = 0.645$, $p < 0.01$). On the other hand, we found an insignificant relationship in the group of girls between the fat mass (%) from $DEXA_{TRUNK}$ and anthropometric indexes BMI ($R^2 = 0.252$, $R = 0.502$, N.S.) and WHR ($R^2 = 0.131$, $R = 0.362$, N. S.), while the relationship of BMI and the total amount of fat mass (%) from DEXA is significant ($R^2 = 0.669$, $R = 0.818$, $p < 0.01$). We noticed a high interdependence between the waist circumference and the total amount of fat mass (%) as shown by DEXA in boys ($R^2 = 0.523$, $R = 0.723$, $p < 0.05$) and girls ($R^2 = 0.753$, $R = 0.868$, $p < 0.01$), but also between the amount of fat mass (%) from $DEXA_{TRUNK}$ in boys ($R^2 = 0.503$, $R = 0.709$, $p < 0.01$) and girls ($R^2 = 0.333$, $R = 0.577$, $p < 0.01$). Further, there are markedly close relations between the single somatotype components and the total amount of fat mass (%) from DEXA in boys ($R^2 = 0.276–0.743$, $R = 0.525–0.862$, $p < 0.01$, $p< 0.05$) and girls ($R^2 = 0.410–706$, $R = -0.640–0.840$, $p< 0.01$). We find a high dependence in boys between the skinfold thickness (mm), mostly in the upper part of body, and the total amount of fat mass (%) from DEXA ($R^2 = 0.419–0.702$, $R = 0.647–0.838$, $p < 0.01$), or the amount of fat mass (%) from $DEXA_{TRUNK}$ ($R^2 = 0.288–0.724$, $R = 0.537–0.851$, $p < 0.01$). We also noticed a high dependence in girls between the skinfolds' thickness (mm), mostly in the upper part of the body, and the total amount of fat mass (%) from DEXA ($R^2 = 0.359–0.872$, $R = 0.599–0.934$, $p < 0.01$), but the relationship between the amount of fat mass (%) from $DEXA_{TRUNK}$ and some of the skinfolds (mm) was less close ($R^2 = 0.328–0.618$, $R = 0.573–0.786$, $p < 0.05$, $p < 0.01$). There is a markedly highly significant relationship between Σ of skinfolds and the total amount of fat mass (%) as shown by DEXA in boys ($R^2 = 0.767$, $R = 0.876$, $p < 0.01$) and girls ($R^2 = 0.893$, $R = 0.945$, $p < 0.01$), or the amount of fat mass (%) as shown by the $DEXA_{TRUNK}$ measurement in boys ($R^2 = 0.610$, $R = 0.781$, $p < 0.01$) and girls ($R^2 = 0.417$, $R = 0.646$, $p < 0.01$). This different dependence between the skinfolds and the amount of fat mass (%) as shown by DEXA or determined by $DEXA_{TRUNK}$ methods, confirms intersexual differences in fat mass distribution (Baumgartner et al., 1990, 223).

We can suppose, for the DEXA method, based on the hints given in the literature, that it sufficiently represents an accurate technique for the determination of body composition and is able to recognize even small changes in the amounts of fat mass or fat free mass. The validity of the DEXA method was not the subject of this study, yet we supposed, based on the hints given in the literature (Maud et al., 1995, 217; Pařízková, 1998a, 3; Brodie et al., 1999, 807; Bunc, 2001, 48) that we could use it as a reference method. In evaluation of body composition by the DEXA method, we noticed higher average values of fat mass in girls (20.6 ± 3.4 %) than in boys (16.6 ± 3.3 %). Heyward et al. (1996, 90), Bláha et al. (2001, 97) mention the marked intersexual differences in the development of the values of the proportion of human body fat components, which already appear before adolescence. These differences mainly result from the different somatotype development of both genders and from different starting times of adolescence spurt. Sexual differentiation in fat distribution appears already in the middle infancy stage; it grows strong in adolescence and persists in adult age.

The positive advantage of the DEXA method is that it reduces measurement error caused by the person or persons providing the measurement (biological error). The indicated measurement error is smaller than 3% for fat tissue, 1.1 kg for muscle tissue and 30 g for bones (Maud et al., 1995, 216). On the contrary, the great disadvantage of most of the reference methods is that their availability is limited in our conditions due to their high technical and financial demands and therefore they are virtually impracticable for field population studies. For that reason there is a current trend to simplify the process of the field evaluation of body composition, and the DEXA method is mainly used today for verification of derived methods (so called III level methods) that are readily available, not time consuming, technically and financially acceptable but less exact (e.g. anthropometry, BIA) (Dlouhá et al., 1998, 8; Pařízková, 1998a, 1; Bunc et al., 2001, 103; Malá et al., 2008).

Each of the physical measuring methods has its error sources that have to be taken into account. It is partly the so called biological error, i.e. an error caused by the device operator. The errors of the methods itself can be divided into errors connected with software and so, with the use of prediction equations, in which errors can reach up to tens of a percentage (up to 80% of the measured value) and errors connected with the hardware (error of the measuring device itself, places of measurements, electrode configuration, measuring frequency, hydration, etc.). The total error is then the sum of the single fractional errors of both software and hardware (Roche et al., 1996, 15; Bunc, 2001, 50). The total error of the anthropometry and BIA method varies between ± 3–6% of the total fat mass and the error related to the prediction equations varies between ± 3–4% (Maud et al., 1995, 221). The observed differences in fat mass values (%) point to a considerable disparateness of the methodics, but they are mainly caused by the differentness of the single prediction equations used for the final calculation of the fat mass amount (%). We noticed a 15.1% difference in the group of girls between the lowest and highest measured value of fat mass (%), which is even bigger by 3.8% as measured against the boys' values (girls – minimal value – BIA_1 Bodystat 500 with use of prediction equation of ANTROPOS 2.3 software (1995) – 5.5 ± 2.3%; maximal value – DEXA – 20.6 ± 3.4%). We noticed a 11.3% difference in the group of boys between the lowest and highest measured value of fat mass (%). There was a minimal valuen of – BIA_1 Bodystat 500 with the use of a prediction equation calculated by ANTROPOS 2.3 software (1995) – 5.5 ± 2.4%; there was a maximal value of – BIA_3 (OMRON BF 300 – with the prediction equation being part of the calculation by the device's software) – 16.8 ± 5.0%. The average values of fat mass (%) determined by means of anthropometry and bioimpedance were lower by 1.2–15.1% in the group of girls in comparison to the amounts of fat mass as shown by the DEXA method. The average values of fat mass as shown by anthropometry and BIA were lower by 1.6–11.1% in boys in comparison to the amounts of fat mass as shown by the DEXA method. The values of fat mass (%) as shown by BIA measured by the OMRON BF 300 device (prediction equation as part of the calculation by the device's software) were higher by even 0.2% on average as opposed to the DEXA method. Most of the prediction equations used (BIA_{2-4}) provide lower values of fat mass (%) in comparison to the DEXA method, the most significant differences being in prediction equations for $SKF_{1,2}$, BIA_1. Gutin et al. (1996, 290) compared the DEXA method, the measurement of 7 skinfolds and the BIA method in children (n = 43; boys – 10.33 ± 0.58 years, girls – 10.27 ± 0.63 years). They found higher values of fat mass (%) in the group of girls based on the single methods: the value was higher by 3.7% in girls as opposed to the boys by the DEXA method; by 3.4% by the measurement of skinfold thickness and even by 4.4% using the BIA method. They also noticed that the highest average values of fat mass (%) were measured by the DEXA method while the lowest average values of fat mass (%) were determined by measurement of the skinfold thickness. The correlation analysis shows a good match of the DEXA method and other chosen methodics for the determination of body composition in boys as well as in girls (boys – R^2 = = 0.479–0.808, R = 0.692–0.899, $P < 0.01$; girls – R^2 = = 0.548–0.895, R = 0.740–0.946, $P < 0.01$). To assess the methods' mutual differences, it is necessary to observe the mutual correlation of the single methods. The differences' analysis, using the t-test for pairing values, showed that there mostly is statistically significant difference between the chosen prediction equations for the determination of body composition in both groups of boys and girls. Heymsfield et al. (1990, 216), Bunc (2001, 48; Bunc et al., 2001, 105) consider 1.5–2% to be the objectively significant difference between the amount of fat mass (%) measured by the comparative methods. That means if the difference in values of fat mass (%) measured by various methods is lower than 1.5–2% the methods can be considered to be compatible. In our case, we found mostly the objectively significant differences between the single methods for the determination of body composition (TABLE 4).

As we have already mentioned, the prediction equations represent, besides the financial and technical demands, the major difficulty of the usability of the current methods for the determination of the body's composition. Determination of prediction equations that will respect, besides the ages, gender, and level of physical activity, also the individual's body composition or its level of fat amount represent the basis for a successful use of the specified methods (Deurenberg et al., 1989, 625). There is no universal prediction equation that could be used for all of the population groups and that would respect the whole range of fat mass values at the same time (Slaughter et al., 1988, 722; Deurenberg et al., 1989, 625). It is necessary to remember that many of the prediction equations were formed more than 25 years ago (e.g. equation according to Pařízková, 1977). Today's population differs from the population the prediction equations were tested on. Many of the equations were designed for a normal population and its use for sportspeople is therefore not suitable. Some of the equations are often taken over from foreign studies, but somatotype and racial characteristics are again different.

We know, based on the hints given in the literature, that the minimal level of fat mass (%) that is considered to be physiological is 4–6% for men and 8–12% for women (Heyward et al., 1996, 92), and we can suppose that these values will be similar for children if not slightly higher. Based on this thesis it is evident that the minimal or average values of fat mass (%) calculated by some of the methodics seem to be unrealistic (TABLE 2).

Using caliperation, we calculate the percentage of fat mass (%) based on the sum of the corresponding skinfolds. We observed approximately the same dependence of Σ of skinfolds/DEXA ($R^2 = 0.767$, $R = 0.876$, $p < 0.01$) and SKF_1/DEXA ($R^2 = 0.808$, $R = 0.899$, $P < 0.01$), or SKF_2/DEXA ($R^2 = 0.696$, $R = 0.834$, $P < 0.01$) in the group of boys. While in girls, we noticed a highly significant relationship of Σ of skinfolds/DEXA ($R^2 = 0.893$, $R = 0.945$, $p < 0.01$) and SKF_2/DEXA ($R^2 = 0.895$, $R = 0.946$, $P < 0.01$), but insignificant SKF_1/DEXA ($R^2 = 0.072$, $R = 0.268$, $P < 0.01$). The above said results, in fact the mathematical approximations (using the equations for calculation of fat mass percentage), bring other errors into the final determination of the fat mass amount (%). Using the equations for the calculation of fat mass (%) from skinfolds' thickness or other anthropometric parameters, is, therefore, questionable. Although the public is used to this quantity, monitoring of the sum of the corresponding skinfolds or skinfolds itself (not excepting other anthropometric parameters) would be in many cases sufficient for the determination of body composition.

Riegerová (1995, 16, 17) draws attention to a difference between the final percentage of fat fraction determined by caliperation according to Pařízková and the value according to Matiegka. She sees this difference as a consequence mainly of the different localization of skinfolds in lower extremities that affects the calculation. The differences in evaluation increase with growing thickness of fat mass, yet the age, physique type and harmony of distribution of fat tissue represent, among others, important factors as well. The comparison of evaluations of fat mass by anthropometric methods and by Bodystat 500 (Riegerová & Přidalová, 1996, 32, 33) further shows that the bioimpedance measurement by Bodystat 500 fits in the results obtained by caliperation. They also mention in the results the possibility of using regression equations for the calculation of skeleton weight (kg) as a specification of another physique component when using bioimpedance. A decisive source of inaccuracy in the BIA method are mainly the prediction equations, much as in measurement by the skinfold thickness method. Bunc et al. (1999, 102) shows insignificant differences in resistance values when using Bodystat 500 and Bodystat 2000-M (in 50 kHz frequency). Nevertheless, he adverts to a problem with the use of prediction equations for the conversion of fat mass percentage from BIA. He mentions that the critical limit for the determination of fat mass is the age of 10 years. Therefore, it is necessary to use specific prediction equations that respect the proband's age. A fairly big problem is still represented by measurement conditions, also including the skill and experience of the measuring personnel.

However, the determination of body composition by means of the BIA method is also not trouble free. The BIA method measures the total body water (TBW) and counts on 72.3% of average body hydration and FFM and is determined based on the relationship of $FFM = TBW*0.732^{-1}$ (Lukaski et al., 1985, 811). It is necessary to emphasize that the amount of water in an organism depends on the individual's age, weight and gender and that it individually varies according to intake and output. The real measured hydration of FFM varies between 61–82% (Roche et al. 1996, 263). In children, the proportion of total body water in their weight is higher; it is approximately 77% in newborns. Sexual differentiation does not develop until the postadolescent period, when the hydration rate increases in boys and decreases in girls. From the development point of view, it is not only the development of total body water (TBW) but also the development of its fractions – ECT and ICT – that are substantial. The proportion of ECT is relatively stable at the age of 12–18 years, whereas the proportion of ICT increases in boys in this period and decreases in girls. The newest studies confirm that increasing age is accompanied by a decrease in body hydration, only in terms of a decrease in the TBW amount, and it was noticed that the decrease in TBW is different for men and women (Heyward et al., 1996, 99). We observed mostly a good match between BIA/DEXA in boys (R^2 = = 0.479–0.540, R = 0.692–0.735, P < 0.01, N. S.) and in girls (R^2 = 0.569–0.672, R = 0.754–0.820, P < 0.01, N. S.), but also among each other BIA (TABLE 4). To determine FFM and fat mass (%) it is, however, necessary to set out the corresponding prediction equations for each member of the group of persons, since these are a limiting element for the practical use of these methods (Bunc et al., 2001, 105).

CONCLUSION

The results confirm the possibility that anthropometric parameters can be used not only for the evaluation of body composition in terms of the amount of fat mass (%) in particular, but also for the assessment of its distribution. A significant match of a number of anthropometric parameters and the total amount of fat mass (%) as measured by DEXA or $DEXA_{TRUNK}$ was observed in both groups of boys and girls. A good match of the DEXA method and other chosen methodics for the determination of body composition was found in both boys and girls, but from the statistical and objective significance points of view, we deduce a considerable differentness of single methodics mainly due to the differentness of prediction equations. Most of the used prediction equations (BIA_{2-4}) provide lower values of fat mass (%) in comparison to the DEXA method, the most significant differences being in prediction equations for $SKF_{1,2}$, BIA_1.

Monitoring of various anthropometric parameters is, due to its noninvasiveness and relatively low demands on financial and technical needs, advisable for extensive epidemiological studies. The monitoring and use of anthropometric parameters and derived indexes in clinical practice help us to observe their relationships to the function of the organism, with other indexes characterizing health hazards. It would contribute, among others, to an evaluation of the healthy as well as the ill organism and to a definition of needed arrangements supporting human health.

Each of the physical measuring methods has its error sources that have to be taken into account. It is partially so called biological error, i.e. an error caused by the device operator. The errors of the methods itself can be divided into errors connected with hardware (error of the measuring device itself, places of measurements, electrode configuration, measuring frequency, etc.) and then errors connected with software and so with the use of prediction equations, in which errors can reach up to tens of a percentage (up to 80% from the measured value). The specific prediction equations that respect, not only the ages, gender, and level of physical activity of the persons examined, but also the individual's body composition or its level of fat amount represent the basis for a successful use of these methods for the determination of body composition. Unfortunately, there is no universal prediction equation that could be used for all of the population groups.

The observed relationships, presented results and output cannot be generalized for the entire population, they can be used only for this file.

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MOŽNOSTI VYUŽITÍ VYBRANÝCH METOD PRO STANOVENÍ TĚLESNÉHO SLOŽENÍ U DĚTÍ V OBDOBÍ PUBERTY

(Souhrn anglického textu)

Lidské tělo můžeme v podstatě rozdělit do několika komponent, které mezi sebou vytváří vzájemné vztahy. Mezi nejvýznamnější komponenty tělesného složení řadíme tělesný tuk (FM), tukuprostou hmotu (FFM) a celkovou tělesnou vodu (TBW). Tělesné složení, v nejčastějším pojetí jako velikost podílu depotního tuku a aktivní hmoty, vytváří výrazný somatický znak, který se charakteristicky rozvíjí v závislosti na věku, pohlaví a stupni tělesného rozvoje. Obecně lze parametry tělesného složení stanovovat množstvím metod, které se liší jak přístrojovou a personální náročností, tak i přesností stanovení sledovaných dat. Hlavním cílem této práce bylo posoudit možnosti využití metod pro stanovení tělesného složení, které jsou v současné době k dispozici v laboratorních a terénních podmínkách, u dětí.

Do studie bylo zahrnuto celkem 30 probandů, z toho 17 chlapců a 13 děvčat ve věku 10–14 let. Hodnotili jsme základní antropometrické parametry (tělesná výška, tělesná hmotnost, BMI, WHR, obvodové a šířkové rozměry, komponenty somatotypu podle Heathové a Cartera). Pro stanovení tělesného složení jsme použili referenční metodu DEXA (typ HOLOGIC), měření tloušťky kožních řas podle Pařízkové (Bestův kaliper), metodu podle Matiegky (1921), bioelektrickou impedanci – BIA (Bodystat 500, OMRON BF 300, TANITA TBF – 551). Pro přepočet na množství tělesného tuku (%) jsme zvolili různé predikční rovnice.

U chlapců i děvčat jsme nalezli významnou závislost mezi některými antropometrickými parametry (obvod pasu, obvod boků, komponenty somatotypu, tloušťka kožních řas) a množstvím tělesného tuku (%) z metody DEXA, resp. $DEXA_{TRUP}$. U chlapců i děvčat byla nalezena dobrá shoda metody DEXA a ostatních zvolených metodik pro stanovení tělesného složení. Významné rozdíly mezi jednotlivými metodami ukazují především na odlišnost zvolených predikčních rovnic.

Klíčová slova: tělesné složení, komponenty tělesného složení, metody pro hodnocení tělesného složení.

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CHANGES IN SPEED AND STRENGTH IN FEMALE VOLLEYBALL PLAYERS DURING AND AFTER A PLYOMETRIC TRAINING PROGRAM

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The goal of this article was the validation of a plyometric training program and the evaluation of the changes in monitored speed and explosive power predispositions during and after the end of the training program. The program was applied to a group of female youth volleyball players (n = 11) twice a week during an eight week period. Their actual level of explosive power and locomotor speed was evaluated before, during and after the intervention was completed. The levels were determined with the following tests: the standing vertical jump, the vertical jump with an approach and the shuttle run for 6 × 6 m. There were positive changes in the average values of test scores during the period of testing, but the dynamics of the changes in the explosive power and the speed were different. Other increases in all the characteristics were noticeable when the final measurements were made six weeks after the completion of the training program. Examination of the differences in the test scores by the follow up group, before the beginning and six weeks after finishing the intervention, was centred on objectively and statistically important changes in the volleyball players' motor predispositions ($p < .05$). The results of the program support the opinion that plyometric exercises are effective tools in the development of explosive power and speed in young athletes.

Keywords: Explosive power, speed, youth, training.

INTRODUCTION

Muscle strength is very important for most sport games at the present time. In volleyball, the achieved level of explosive power is fundamental. This explosive power is the most essential part of most player skills and enables players' activities during the game to be not only at the required height and with the necessary power but also at the right moment. A volleyball player's use of explosive power in vertical, horizontal and side movements is critical. The relationship between explosive power and the technical and tactical level of the player is especially evident when observing the player's activities at the net, attack from the field and spike serve.

The use of strength during the play is determined by the fact that the usage of maximum strength lasts from 0.5 to 0.7 seconds; however, most of the explosive movements take substantially less time. For this reason the optimal usage and transformation of the gained maximum muscle strength into the "explosivity" of the main muscle groups of the lower limbs, which take part in the takeoff, require special power training. This power training should be, according to Vechoshanskij (1995), clearly aimed and oriented and should activate the adaptation mechanism of the athlete's organism corresponding with the needs of the concrete sport activity. For the above reasons, an appropriate choice of training methods, exercises and individual intensity and volume of training load belongs among the key aspects in the preparation of the player's strength and power training program.

The plyometric method is ranked among the most frequently used methods for conditioning in volleyball. It leads to the development of explosive power and reactive speed of the muscle systems based on the improvement of the CNS reactivity and the power, which is needed for absorbing the stress when landing. The method is based on the reflex muscle fibre contraction, which gives a response to the quick stretch caused mostly by kinetic energy during the deceleration movement phase. In addition to contractile and elastic muscle attributes, we can see the improvement of the muscle proprioception and toleration for the stretching (stretching is producing elastic energy and with its release the energy of muscle contraction is growing). The method can influence muscle activity even with a well trained athlete and can evoke not only an adaptation of the neuromuscular functions, but also metabolic functions. The advantage of the plyometric method is that it increases functional power and enables the muscles to reach a higher power level than the maximum volitional power. The plyometric method also decreases muscle reflex inhibition, increases the sensitivity of the Golgi tendon organs, improves the sensitivity of the muscle spindles, increases muscle tension and at the same time can decrease the risk of injuries (Bompa & Carrera, 2005; Boyle, 2004; Chu, 1998; Gambetta, 1999; Potach & Chu, 2000; Zatsiorsky & Kraemer, 2006).

The topic of using the plyometric method in athletes' preparation, volleyball players included, has been the centre of attention for many authors (Beal & Elder, 1988; Bosco, 1985; Brittenham, 1999; Johnson & Halling, 1990; Miller et al., 2006; Sandler, 2005; Schmidtbleicher & Gollhofer, 1982; Schneider, Mielke, & Mester, 1998). A plyometric training program should consider the goal of the training for a particular period, should respect basic training principles, first of all the principle of individualisation, a progressively increasing load (from low intensity to high intensity exercises over a period of several years and also during the annual training cycle), the principle of specificity (advanced athletes with plyometric method experiences should prefer specific exercises). It is also very important to have in mind their participation in the training cycles based on their actual health condition, competitions, jump load and possible combination with other training exercises (Beachle & Earle, 2000; Bourne, 1994; Faigeubaum & Westcott, 2000; Fergenbaum & Wayne, 2001; Gambetta, 1998; Chu, 1998; Komi, 1992; Marullo, 1999; Radcliffe & Farentinos, 1999; Reddin & Johnson, 1999; Scates & Linn, 2003).

We share the view of those experts who say that the plyometric method can be used both by adults and, to an adequate extent and intensity, also by youth players. The choice of exercises corresponding to the demands of exercises, acquired technique and good muscle strength belong among the basic conditions. In the preparation for plyometric training for the lower limbs, coaches have to focus on structural adaptation with an emphasis on the development of muscles, which create the "core" of the body and, after that, on the lower limb muscles with an emphasis on the area of the hip, knee and ankle joint.

The goal of this article is to verify a training program for female junior volleyball players consisting of plyometric exercises aimed at the lower limbs and, at the same time, to evaluate the dynamics of changes in monitored motor predispositions during and after the training program. We would like to find an answer for the following research questions:

1) What will be the dynamics of the changes in the explosive power and the speed evaluated by means of motor tests during and after ending an eight week plyometric training program?
2) What changes in the explosive power and the speed evaluated by means of locomotor tests will come after an eight week plyometric training program?

METHODOLOGY

The plyometric training program was applied during an 8 week period to a group of female youth volleyball players (n = 11; average age 14.8 ± 0.9; height 169 ± 6 cm; weight = 58 ± 9 kg). The players had completed a three-month preparatory training program focused on general strength development before starting our program. The players were informed about the principles of the plyometric exercises and they became familiar with the techniques of exercises. The exercises were practised twice a week (Monday and Wednesday) after warming up and the resting period between exercises series was two minutes. The jumping load while training with the ball was reduced during the time of the training program. The training program was divided into three cycles. The first cycle lasted two weeks and included the following exercises:

TYPE OF EXERCISE	JUMPS/SET
Alternating push off (one foot on a 30 cm box)	10 (L, R separately)
Two foot ankle hop (using only ankles for momentum)	10
Front barrier hops (eight 30 cm boxes set up in a row)	8
Spike jump at the net	10*

* *After four repetitions a short rest followed.*

The group of players had 2 series of the exercise in the first week and three in the second week of the first cycle.

The second cycle lasted 4 weeks and consisted of:

TYPE OF EXERCISE	JUMPS/SET
Zigzag double leg jump over the line	10
Tuck jump with knees up	10
Lateral box jump (landing on two feet on the 30 cm box and on one foot on the floor)	10
Single foot side to side ankle hop over medicine ball	10

The group of players had 2 series of the exercise in the first week and three series from the second to fourth week of the second cycle.

The third cycle lasted two weeks and consisted of:

TYPE OF EXERCISE	JUMPS/SET
Lateral medicine ball hops with a 180 degree turn (five medicine balls lined up three feet apart)	10
Front barrier hops back and forth (five 30 cm boxes set up in a row)	10
Block jumps at the net	8*
Alternate bounding with single arm action	8

* *After four repetitions a short rest followed.*

The group of players went through 3 series of the exercises in the first week and through 4 series in the second week of cycle three.

Testing of the motor predispositions took place on the same day after the standard warm up exercises and was accomplished by a semi skilled person with the assistance of the coach. None of the players mentioned any health problems when asked. Actual level of the takeoff power and locomotor speed was evaluated by these motor tests:
- standing vertical jump (height of the jump in cm),
- vertical jump with approach (height of the jump in cm),
- shuttle run for 6 × 6m (s) (Ejem, 1998; Kouba, 1998).

We determined the logical significance of the average values differences in the test scores as follows:
- standing vertical jump 3 cm,
- vertical jump with approach 4 cm,
- shuttle run for 6 × 6 m 0.4 s.

Part of the testing was the measurement of the person's height and the height of the one hand touch in the standing position. We did not note any significant changes in these characteristics (not mentioned in the text). To diagnose changes in the chosen parameters during the monitored period players were tested:
1. Before the start of the program.
2. After four weeks of the program.
3. The first week after completion of the program.
4. The third week after completion of the program.
5. The sixth week after completion of the program.

Friedman's ANOVA and Sign test were used to assess the statistical significance of the differences in average values of the tests scores.

RESULTS AND DISCUSSION

Dynamics of motor tests scores

TABLE 1
Basic statistical characteristics of the observed indicators in individual measurements – standing vertical jump (n = 11)

Parameter	M	Med	Min	Max	SD
SVJ1	29.50	29.50	23.00	37.00	3.89
SVJ2	30.45	31.00	23.00	37.00	3.53
SVJ3	32.09	32.00	24.00	39.00	4.08
SVJ4	31.18	33.00	18.00	36.00	5.03
SVJ5	33.54	34.00	24.00	39.00	4.08

Legend:
SVJ1–5 – standing vertical jump in measurements 1–5 (height in cm)
M – average
Med – median
Min – minimum
Max – maximum
SD – standard deviation

TABLE 2
Basic statistical characteristics of the observed indicators in individual measurements – vertical jump with an approach (n = 11)

Parameter	M	Med	Min	Max	SD
VJA1	38.33	39.50	30.00	46.00	5.46
VJA2	39.63	42.00	25.00	47.00	6.56
VJA3	42.63	43.00	27.00	51.00	6.28
VJA4	41.63	42.00	25.00	48.00	6.21
VJA5	43.27	45.00	28.00	50.00	5.98

Legend:
VJA1–5 – vertical jump with approach in measurements 1–5 (height in cm)
M – average
Med – median
Min – minimum
Max – maximum
SD – standard deviation

TABLE 3
Basic statistical characteristics of observed indicators in individual measurements – shuttle run for 6 × 6 m (n = 11)

Parameter	M	Med	Min	Max	SD
SR1	11.08	10.90	10.40	12.00	0.55
SR2	10.77	10.30	9.90	12.70	1.03
SR3	10.70	10.40	10.00	12.20	0.68
SR4	10.59	10.40	9.90	11.80	0.61
SR5	10.38	10.20	9.50	11.40	0.58

Legend:
SR1–5 – shuttle run for 6 × 6 m in measurements 1–5 (time in seconds)
M – average
Med – median
Min – minimum
Max – maximum
SD – standard deviation

Although plyometric training is a strongly individual matter and its realization is influenced by the current level of sport performance, the adaptability of the organism and its momentary state, experience with the particular training load, etc., we intend to orientationally assess the dynamic of changes in the explosive power and the locomotor speed evaluated by means of motor tests during and after ending the training program in the whole group of players (basic statistical characteristics of observed indicators are mentioned in TABLE 1–3).

TABLE 4
Statistical significance of test scores in performed measurements

Parameter	χ^2	p
Standing vertical jump	15.91	**.003**
One hand touch in the standing vertical jump	18.52	**.000**
Vertical jump with an approach	23.184	**.000**
One hand touch in the vertical jump with an approach	22.018	**.000**
Shuttle run for 6 × 6 m	15.514	**.003**

Legend:
χ^2– value of the test criterion (Friedman's ANOVA)
Statistically significant values ($p < .05$) are in bold characters.

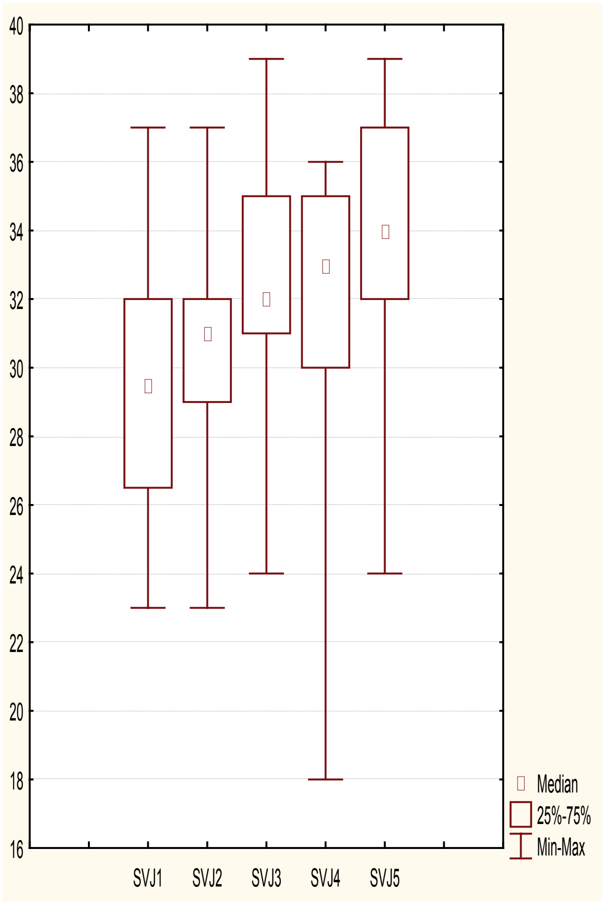
The results of the Friedman's ANOVA (TABLE 4) pointed to the relevance of the testing scores' differences for all monitored parameters (with respect to the specificity of game performance in volleyball, we also mentioned the significance of the testing scores' differences in the height of the one hand touch in the jump tests).

Furthermore we did a detailed comparison of the motor tests results, which were accomplished during and after completing the training program.

THE STANDING VERTICAL JUMP AND VERTICAL JUMP WITH AN APPROACH

The dynamics of the test scores' changes is similar and points to the sequential, even irregular, growth of the observed predispositions (Fig. 1, 2). There was a moderate increase in the average test score values (0.6 cm respectively 0.7 cm) between the first and the second measurement (before starting and five weeks after finishing the training program). According to Potach and Chu (2000) we can see bigger changes in the height of the vertical jump as early as after four weeks of plyometric training. Our results did not confirm this. We can suppose that a minor improvement can be associated with the lower intensity of the exercises, which were put on the first part of the program. We noticed other, statistically significant, improvements of over 1.64 cm ($p = 0.04$) respectively of over 3 cm ($p = 0.01$). These changes were noticed between the second and third measurements, respectively the fifth week of the training program and the first week after finishing the training program. We attribute these changes to a continuous adaptation to the specific training load. Between the third and the forth measurement (1st and 3rd week of the training program) there was a moderate lowering of the test scores. The reason for this fact is, in our opinion, the fatigue after the training program (0.91 cm, respectively 1 cm). Between the forth and fifth measurement (3rd and 6th week of the training program) there was another statistically significant increase in the average testing score values over 2.36 cm, respectively 1.7 cm ($p = 0.04$), and the values of the monitored indicators culminated. We suppose that the final improvement, which was noticed in the couple of weeks of distance measurements, is caused by usage of the, so called postponed (delayed) training effect. This effect can be cleared up by the fact that the human organism needs a longer time period for adaptation and relaxation after completing the training program (Zatsiorsky, 1995).

Fig. 1
Height of the jump in the test of the standing vertical jump in individual measurements (cm)



SHUTTLE RUN

The dynamics of changes in the test scores is typical of the continuous improvements made (Fig. 3). We noted the strongest reduction of the average time reached (0.31 s) at the beginning of the training program application (1st and 2nd measurement). This improvement is very surprising according to the time period of the adaptation. The possible explanation for the above can be the fact, that the type of the movement was repeated

Fig. 2
Height of the jump in the test of the vertical jump with an approach in individual measurements (cm)

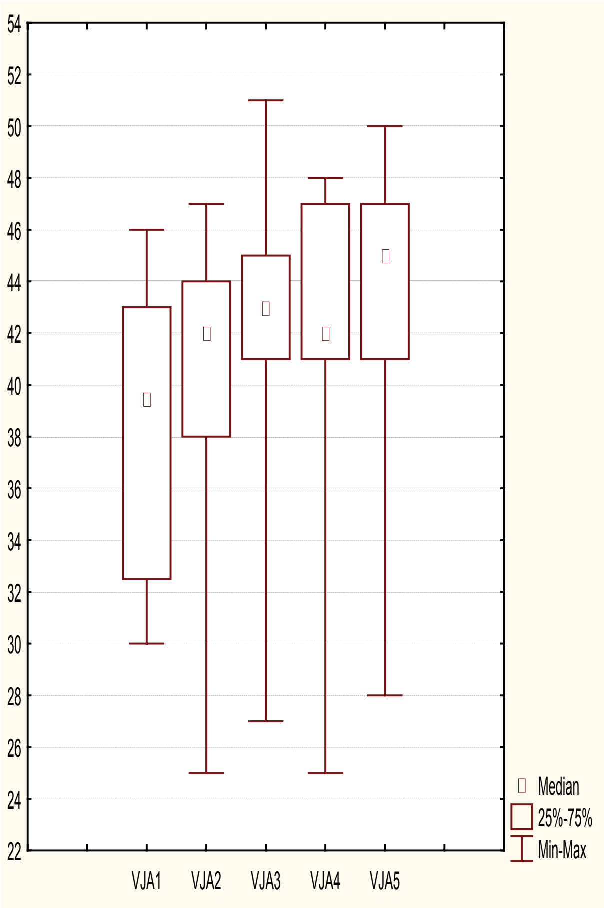
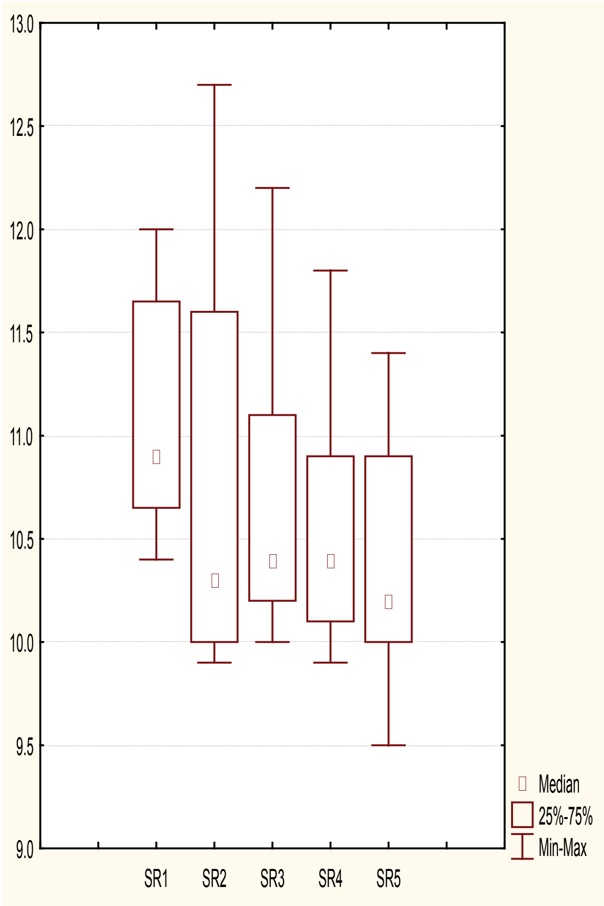


Fig. 3
Time in the test shuttle run for 6 × 6 m in individual measurements (s)



acceleration, respectively, deceleration and at the same time there are a lot of requirements for movement co-ordination.

We suppose that all these characteristics were strongly influenced by the exercises included in the programme. Differences between the results of the second and third measurement (approx. 0.06 s) show that the improvement in the second half of the plyometric training program was minimal, contrary to the results of the vertical jump testing. We noticed the very same trend (0.11 s) in the next period (between the 3rd and 4th measurement). The next increase in speed performance (0.21 s) can be seen between the 4th and 5th measurement (three and six weeks after finishing the training program). We suppose that the tiredness after the hard training program was already gone and the players could benefit from the training program. None of the above mentioned differences proved to be statistically significant.

We can summarize by saying that, according to the dynamic changes in the monitored speed and power characteristics, we noticed a positive, but, to some extent, different trend.

CHANGES IN MOTOR PREDISPOSITIONS – ENTRANCE AND OUTPUT MEASUREMENTS

The main criterion in the evaluation of the training program's efficiency is the difference in the sport performance. Examination in sport games is not, however, easy. So we set out from the basically acceptable presumption that the level of the speed and power demonstrated in the game skills connected with jumps and in locomotor movements is considered to be an important factor for game performance in volleyball. Taking into account the current literature (Zatsiorsky, 1995) and our experiences, we consider as decisive for the assessment of motor predisposition changes after the eight week training program the comparison of test results from the entrance measurement and the results from the output measurement (the 6th week after the end of the program). The comparison of the test results shows that the players were better in both the test of the standing vertical jump (the average improvement in height was about 4 cm) and in the test of the vertical jump with an approach (the improvement in the height was about 4.9

cm). Both results are statistically significant (TABLE 5). The greater improvement in the vertical jump with an approach could be caused by the higher similarity of the plyometric movement exercises and plyometric tests.

The results of the monitoring are similar to our previous study, which was made by volleyball players in the same age category (Lehnert, Šedá, & Zháněl, 2005). We can see an average improvement by this testing group after the plyometric training program in the test of the standing vertical jump (2.6 cm) and in the vertical jump with an approach (4.4 cm). The reasons for the greater improvement by the monitored group can be different. We consider that the positive factor could be the three month strength preparation, which was done before the plyometric program. Also, the logically and statistically significant improvements in average values in the test shuttle run for 6 × 6 m by 0.7 s coincide with the knowledge that plyometric exercises can stimulate athletes' speed. We didn't expect so strong an improvement. The similar progress in the dynamic speed changes during the ontogenetic improvement is typical for the longer time period (Zháněl & Lehnert, 2004; Zapletalová, 2002). The possible explanation for this efficiency improvement was presented in the previous text. In the face of the limits in the implemented study there is no objective chance to give a precise explanation of the relationship between the plyometric training program and monitored motor predispositions. Considering the age of the players it is important to keep in mind that it can be some impact of the training load also outside of the plyometric program and take into account biological development, which is still ongoing.

TABLE 5
The statistical significance of test scores – entrance and output measurements

Parameter	M	Med	d	Z
SVJ1	29.50	29.50	4.04	**2.41**
SVJ5	33.54	34.00		
VJA1	38.33	39.50	4.96	**2.41**
VJA5	43.27	45.00		
SR1	11.08	10.90	0.30	**3.01**
SR5	10.38	10.20		

Legend:
SVJ – standing vertical jump (cm)
VJA – vertical jump with an approach (cm)
SR1 – shuttle run for 6 × 6 m (s)
M – average
Med – median
d – difference
Z – value of statistical criterion (Sign test)
Statistically significant values ($p < .05$) are in bold characters.

CONCLUSION

1. The dynamics of changes in the monitored motor predispositions in female volleyball players showed a positive trend with differences between explosive power and speed values during the training program. We can see another increase of the test scores at time of the final measurement six weeks after finishing the training program.
2. We found logically and statistically significant improvements of explosive power tested by tests of the standing vertical jump and the vertical jump with an approach after eight week training period.
3. The results of the study support the opinion that plyometric exercises can be an effective tool for the improvement of the explosive power and speed predispositions of youth athletes.

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ZMĚNY RYCHLOSTNĚ-SILOVÝCH PŘEDPOKLADŮ VOLEJBALISTEK V PRŮBĚHU A PO ABSOLVOVÁNÍ PLYOMETRICKÉHO TRÉNINKOVÉHO PROGRAMU

(Souhrn anglického textu)

Cílem studie bylo ověřit v tréninkové praxi program sestávající z vybraných plyometrických cvičení a zhodnotit změny sledovaných rychlostně-silových předpokladů v průběhu a po jeho absolvování. Program byl aplikován u volejbalistek kadetské kategorie (n = 11) 2× týdně po dobu 8 týdnů. Aktuální úroveň výbušné síly a lokomoční rychlosti byla hodnocena před, v průběhu a po skončení intervence testy dosah jednoruč po výskoku z místa, dosah jednoruč výskokem po smečařském rozběhu a rychlostní člunkový běh na 6 × 6 m. V období realizace programu docházelo k pozitivním změnám průměrných hodnot testových skóre, avšak dynamika změn ukazatelů odrazové síly a rychlosti byla odlišná. Další nárůst výkonnosti u všech sledovaných ukazatelů byl zaznamenán při výstupním měření (šest týdnů po absolvování tréninkového programu). Posouzení rozdílů testových skóre sledovaného souboru před intervencí a šest týdnů po jejím skončení ukázalo na věcně i statisticky významné změny ve výkonnosti hráček ($p < .05$) Výsledky studie podporují názor, že plyometrická cvičení jsou efektivním prostředkem rozvoje výbušné odrazové síly a rychlosti sportující mládeže.

Klíčová slova: výbušná síla, rychlost, mládež, trénink.

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THE EFFECT OF LISTENING TO TECHNO MUSIC ON REACTION TIMES TO VISUAL STIMULI

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The aim of the research was to establish the influence of techno music on the reaction times of participants in the research. Our hypothesis was that stimulating music, such as techno, would shorten the participants' reaction time to visual stimuli while, without music, the reaction time would be longer. To define the reaction time to expected light stimuli we used a special apparatus for measuring the angle of elbow extension, an electric goniometer and a red colour LED diode attached to it. We also used a computer programme as well. The athletes, 10 students at the Faculty of Sports, aged between 20 and 45, participated in the research, representing the control group as well as the experimental group. In our research we established that listening to techno music does affect the shortening of participants' reaction time. Their reaction time shortens significantly according to a measurement taken after 30 minute of listening to techno music, nevertheless it is not shortened during the listening. The control group established that 35 minutes of waiting between the measurements does not significantly affect the reaction time. Moreover, it was established that 30 minutes of listening to techno music affected the shortening of the reaction time 45 seconds after the music was turned off. For further research, it would be necessary to engage more participants. However, the research results are useful data and may serve as a starting point for further research.

Keywords: Simple reaction time, techno music, expected light (visual) stimulus, apparatus for measuring the angle of elbow extension, goniometer.

INTRODUCTION

Reaction speed is the ability to give a quick motor response to a definite stimulus, while the time that elapses between the sensory stimulation and the motor reaction is called reaction time (Štrulc, 1989). This is the time that elapses between a stimulus and the response to it. This process consists of sensory and perceptual processing. After a stimulus is perceived by our receptors (in our eyes and ears, for example), identification in the central nervous system begins. If we recognize a certain stimulus to be significant for us, we response, in the opposite case we do not. The speed of identifying the stimulus is an essential factor in this process. The last stage of the response to the stimulus is muscle tensing which is followed by a motor reaction (Sanders, 1980). Reaction times can be subdivided according to the stimulus, which can be expected or unexpected. An unexpected stimulus cannot be anticipated in advance, which means that it appears when the subject is not ready to react. This is common for all types of sports, but most likely for those where participants face a high number of unpredictable situations. An expected stimulus can be anticipated in advance, but we cannot tell when it will appear. With the expected stimuli, reaction times can be subdivided according to the number of diverse stimuli that the subject already expects and responds with a specific automatic motor reaction. In the case where the number of stimuli is higher than one, this reaction time is defined as choice reaction time; if not higher than one, it is defined as simple reaction time. According to Colavita (1974) and Cooper, Edwards, Gibton and Strokes (1998), simple reaction time is shorter than choice reaction time. Simple reaction time is defined as the interval between the onset of the signal (stimulus) and the beginning of the movement. During this time, the physical signal is transformed into nerve information which is then transmitted to our nervous system to the centres for detecting, processing and interpreting, even though conscious recognition is not indispensable (Alvero, Erik, Joaquim, Leonardo, & Mark, 1992). The accepted figures for mean simple reaction times for college age individuals are about 190 ms (0.19 sec) for light stimuli and about 160 ms for auditory stimuli (Galton, 1899; Fieandt, von Huhtala, Kullberg, & Saarl, 1956; Welford, 1980; Brebner & Welford, 1980). The reason for faster reactions to auditory stimuli is most likely due to the fact that auditory stimuli reach the brain in 8 to

10 ms (Kemp, 1973), while visual stimuli in 20 to 40 ms (Marshall, Talbot, & Ades, 1943). There are several methods to measure the reaction time. We can perform the measurements with a goniometer by which we can observe the angle changes within a chosen time period (Nagasawa et al., 1991). There are several other factors that influence the reaction time, besides those previously mentioned (type of reaction time experiment, type of stimulus and stimulus intensity). These are arousal, age, gender, left vs. right hand, direct vs. peripheral vision, practice and errors, fatigue, fasting, distraction, warnings about impairment by alcohol, order of presentation, finger tremors, personality type, exercise, punishment, stimulant drugs, brain injury, illness and others factors (Brebner, 1980; Brebner & Welford, 1980; Welford, 1980).

Attempting to explain sound perception and how it affects human beings is complicated. Sound has a physical and a psychological component. The physics of sound has its origin in changing the blood pressure and pulse rate. There are studies showing increased pulse rates as a result of stimulating music and decreased pulse rates associated with sedative music (Besson, Faita, Peretz, Bonnel, & Requin, 1998; Platel, 2002). Techno music seems to produce a significantly increased pulse rate, systolic blood pressure and stress related hormones. Classical music produces no significant changes in these parameters (Gerra et al., 1998). Research on students of music and people without special musical education has shown that music exerts complex influences on the central nervous system (CNS), manifested in changes to a number of neurophysiological reactions attesting changes in the flow of excitations in the cortico-thalamic and cortico-limbic circles. Listening to music is accompanied by a partial replacement of the dominating alpha rhythm by activity in the frequency range of beta, theta and delta waves and with a change to some vegetative reactions (Zakharova & Avdeev, 1982). The psychology of sound is based on the perception of its characteristics. Sounds and music affect the emotions and mood of a human being and provoke various feelings (Besson et al., 1998; Platel, 2002).

When listening to music, most people do not realize the noise equivalence of the volume of their music. Everyday conversation is approximately 55 decibels while the threshold of pain is about 120 decibels. A jet airplane is 150 decibels, and a rocket engine is 180 decibels. Experts have recommended that people should not be exposed to noises louder than 85 decibels for extended periods of time (Friedhoffer, 1992; Gardner, 1991).

A study on the effect of music on motor reaction time and interhemispheric relations showed that music shortened reaction time, and its stimulating effect was stronger in the case oflonger initial reaction times without music. The influence of various other types of music was more effective than of classical music (Zakharova & Ivashchenko, 1984). Listening to stimulating (techno) music can influence certain factors (e.g. arousal) affecting reaction time. Reaction time is faster at an intermediate level of arousal and slower if the subject is either too relaxed or too tense (Welford, 1980).

The principle aim of the research was to establish if listening to techno music affects the reaction times of the participants. Considering data from previous research (Zakharova & Ivashchenko, 1984), we expected that techno music would shorten the reaction times of the participants of the research.

METHODS

Participants

Ten athletes (6 women and 4 men) aged between 20 and 45 years participated in the research. They represented the control group and the experimental group. All participants included in the research participated in the research voluntarily and were informed about the research either by the announcement on the notice board or during their lectures. All the participants signed a special form, confirming their voluntary participation in the research and were briefly informed about the purpose and the procedure.

Instruments and procedure

Measurements were performed in the Laboratory for Biomechanical Measurements at the Faculty of Sports, University of Ljubljana. We used a special apparatus for measuring the angle of elbow extension which was designed exclusively for this research and a computer programme to calculate the reaction time to light stimuli. The apparatus was designed to prevent body turns as well as upper arm and wrist movement of the fastened arm. However, a controlled elbow extension in a horizontal plane was possible. The elbow was leaned against the axis of the rotating part which was made of a light material in order to reduce the inertia moment.

The angle between the moving and the fixed part of the apparatus was measured in relationship to time with an electric goniometer that was attached to the apparatus fixed on the table. Next to the table, there was a sitting participant with his hand fastened to the apparatus in parallel position with the table surface. In the starting position, the arm was raised up to the shoulder height with an elbow angle of 90 degrees and the palm turned downwards. At the starting position, the angle of the participant's arm attached to the moving part was set by a fixed obstacle. There was a red LED diode placed at eye level, one meter in front of the participant. It was used as a light stimulus. The diode was triggered manually and each time it was turned on, a control signal was sent to the computer and indicated that the light was on.

Three trials were performed before the testing began. Each measurement was repeated three times. After the arm signal, the participant had to focus on the diode and wait for the light to come on. It was turned on unexpectedly between the third and the fourth second after another arm signal by the researcher. The participant's task was to react to the light signal as soon as possible with the extension of the upper arm which was fastened to the apparatus. Signals were saved if they were credible, if they were not, the measurement was repeated again. All the participants used headphones while listening to the same music (techno winter megamix 2005, various artists) with the sound level of 85 decibels. The sound level was measured with a Minilyzer ML1 (NTI, Schaan, Liechtenstein).

All the participants took part in the control group as well as in the experimental group. The task of the control group was to measure the participants' reaction time to the visual stimulus in the experimental group. Each measurement was repeated twice after a 40 minute interval. The task of the participants in the experimental group was listening to the music with the sound level of 85 decibels. The reaction time was measured before the music started, as soon as it started, before the end and after the end.

The time schedule of measurements for each participant of the research is shown in the following scheme (Fig. 1).

Methods of processing statistical data

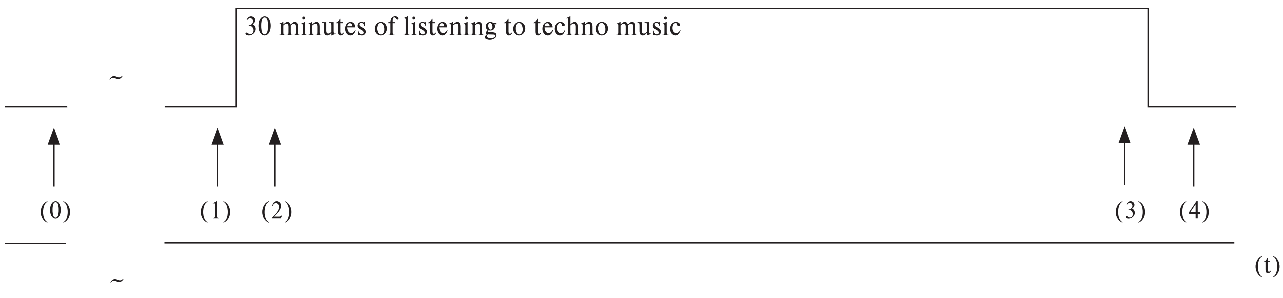
The obtained data were saved to the computer at the same frequency – 2000 HZ. For further processing, the data record was transformed from a graphic into a numerical format using a programme for processing analogical signals. The beginning of the movement was determined by the moment of a one degree change indicated by the goniometer. The device also detects the appearance of light stimuli. The simple reaction time measurements (measured in ms) to a light stimulus were gathered separately for each measurement and for each individual.

For the evaluation of the obtained data we used statistical package SPSS. Basic descriptive parameters, mean value (M) and standard deviation (SD) are displayed in the table. To determine statistically significant differences in measurements we used a t-test for two dependent samples at ($P < .05$ risk interval). We used a Kolmogorov-Smirnov test to perform the normal distribution test. A normal distribution test is assumed for using the t-test.

RESULTS

Due to the small sample size, the findings of the research cannot be generalized to apply to the whole population of athletes; they refer only to the participants in the research (students of the Faculty of Sports in Ljubljana).

Fig. 1
Diagram of the measurement time schedule for one of the participants



Legend:
(0) = measurement 35 minutes before the testing
(1) = measurement without music at the beginning of the testing
(2) = measurement with music at the beginning of the testing
(3) = measurement after 30 minute listening to the music
(4) = measurement without music after the testing

TABLE 1
Participants' age, height, weight and the sport practiced

Participants	Age	Height	Weight	Sport
Pa1	21	160 cm	51 kg	Gymnastics
Pa2	20	190 cm	100 kg	Athletics (shot put)
Pa3	35	172 cm	70 kg	Unprofessional
Pa4	25	177 cm	64 kg	Athletics
Pa5	31	169 cm	63 kg	Skiing
Pa6	45	186 cm	89 kg	Middle distance running
Pa7	21	162 cm	52 kg	Athletics, climbing
Pa8	20	160 cm	53 kg	Basketball
Pa9	23	179 cm	65 kg	Sport climbing
Pa10	21	167 cm	61 kg	Gymnastics

TABLE 1 displays age, height, weight and the sport practiced for each participant in the research.

TABLE 2
Mean value, standard deviation and Kolmogorov-Smirnov test of the reaction time of the measurements

Measurements	M	SD	K-S	p
measurement 0 (ms)	256.9	47.96	.472	.979
measurement 1 (ms)	272.1	77.89	.465	.982
measurement 2 (ms)	266.3	48.87	.453	.986
measurement 3 (ms)	256.5	40.01	.560	.913
measurement 4 (ms)	233.0	43.95	.704	.704

Legend:
measurement 0 = measurement 35 minutes before beginning of the testing
measurement 1 = measurement without music at the beginning of the testing
measurement 2 = measurement with music at the beginning of the testing
measurement 3 = measurement with music after 30 minutes of listening to the music
measurement 4 = measurement without music after the testing
M = mean value
SD = standard deviation
K-S = Kolmogorov-Smirnov
p = statistical significance for Kolmogorov-Smirnov test

TABLE 2 displays the basic descriptive statistics of the data for the whole group: mean reaction time, standard deviation and Kolmogorov-Smirnov test. We can see the variability of the measurement results by standard deviation. We used the Kolmogorov-Smirnov test for testing normality of distribution. The advice from SPSS is to use the latter test when sample sizes are small ($n < 50$). The null hypothesis, that there is no difference between your variable distribution and a normal distribution, is evaluated. A finding of statistical significance means we cannot reject the null hypothesis. What is the null hypothesis? It means that our distribution is not significantly different from a normal distribution. The conclusion is that measurements are assumed to come from a normal distribution with the given mean and standard deviation.

TABLE 3
T-test for two dependent samples for control group

	M (ms)	SD (ms)	df	t	p
measurement 0	257	48	9	–.632	.543
measurement 1	272	78			

Legend:
(0) = measurement 35 minutes before the testing
(1) = measurement without music at the beginning of the testing
M = mean value
SD = standard deviation
ms = milliseconds
df = degrees of freedom
p = statistical significance

TABLE 4
T-test for two dependent samples for experimental group

	M (ms)	SD (ms)	df	t	p
measurement 1–2	272 266	78 49	9	.325	.752
measurement 1–3	272 256	78 40	9	.967	.359
measurement 1–4	272 233	78 44	9	2.519	.033*
measurement 2–3	266 256	49 40	9	.712	.494
measurement 2–4	266 233	49 44	9	2.073	.068
measurement 3–4	256 233	40 44	9	4.545	.001**

Legend:
* = $p < 0.05$
** $p < 0.01$
(1) = measurement without music at the beginning of the testing
(2) = measurement with music at the beginning of the testing
(3) = measurement after 30 minute listening to the music
(4) = measurement without music after the testing
ms = milliseconds
df = degrees of freedom
p = statistical significance

TABLES 3 and 4 display the statistically significant differences in mean values between measurements in pairs. The dependent t-test is a test of the significance of differences between means of two sets of scores that are related, such as when the same participants are measured on two occasions (Thomas & Nelson, 2001). The results of the t-test for two dependent samples with the control group (TABLE 3) do not display statistically significant differences between the results of the measurements 35 minutes before the beginning of the testing and the results of the measurements without music before the beginning of the experimental part of the research. The results of t-test for two dependent samples with the experimental group (TABLE 4) display statistically significant differences among the results of the measurements without music at the beginning of the testing, the results of the measurements without music after the testing, the results of the measurements with music after 30 minutes of listening and the results of the measurements without music after the testing.

DISCUSSION

The aim of this research was to determine the influence of techno music on the reaction times of the participants in the research. Considering the data from the previous research by Zakharova and Ivashchenko (1984), we presumed that techno music, being a stimulating type of music, shortens reaction times, which in turn means that reaction times are longer if a person is not subjected to the influence of music. Supposing that listening to stimulating techno music affects the state of arousal, which in turn influences reaction times, we could expect a higher level of engagement during the exercise and consequently its stronger effect. Reaction times get shorter at a higher level of arousal (Welford, 1980; Broadbent, 1971). In the present study, the participants listened to music at the volume of 85 decibels – the volume which does not result in hearing impairment not even with longer exposures to music (Friedhoffer, 1992; Gardner, 1991). The music was played at an above average volume, which is one of the factors that contributes to a stimulating effect of music.

The data presented in the descriptive statistics by the participants showed that the standard deviation of reaction times in separate measurements, calculated on the basis of three consequent measurements, was rather high and that the reaction times vary substantially in 9 participants. The mean standard deviation in all reaction time measurements in this research was 63.5 ms. This was almost twice as high as with measurements of reaction time to visual stimuli (which were highly controlled), where the mean standard deviation was 32 ms (www.utm.edu/staff/gbrown/running_head.pdf). However, it is not much higher than the mean standard deviation of reaction time measurements where the visual stimulus was not carefully controlled and amounted to 57 ms (Gomez, Vaquero, Vazquez, Gonzalez-Rosa, & Cardoso, 2005). We can see the reason why there are so many varying results in our research in a small number of measurement trials and repetitions of reaction time measurements, as according to Sanders (1998) and Luce (1986), there should be a higher number of reaction time measurements for the purpose of adequate results. Another reason for such high result variability may be found in the diminished attention paid, due to nervousness at the beginning of testing and also due to boredom while waiting for the repetition of the measurement or while listening to music.

There are no significant statistical differences between the results of measurements taken 35 minutes before the testing and those taken before the experimental part of the research conducted without music, e.g. in the part of the research performed by the control group. Therefore, 35 minutes of waiting for the next reaction time measurements do not significantly lengthen or shorten reaction times. However, the reaction times before the testing are 35 minutes longer than those at the beginning of the experimental part without music, which can be explained by a slight decline in the amount of attention paid or the occurence of boredom while waiting for the next reaction time measurement.

There are no significant statistical differences between the reaction times measured without music and reaction times measured after 30 seconds of listening to techno music. Therefore, it may be concluded that listening to techno music for a short period does not affect the length of reaction times in the participants. Nevertheless, there are significant statistical differences between the measurements without music at the beginning of the testing and those at the end of the testing. Our hypothesis about shorter reaction times of the participants while listening to techno music was partly proven as they are shorter when measured without music after 30 minutes of listening to techno music. However, they do not shorten 30 seconds before turning the music off. Likewise, no significant statistical differences were found between the measurement results 30 seconds after turning the music on and those 30 seconds before turning the music off. The measurement results with music at the beginning of the testing differ substantially ($p < 0.068$), however, this difference is not statistically significant. The reaction times measured without music at the end of testing are shorter than those measured with music at the beginning of the testing. Statistically significant differences also appear between the measurement results with music after 30 minutes of listening and the measurement results without music at the end of testing. The results may also reveal that people while listening to music at a higher volume (85 decibels) pay more attention to lyrics or musical rhythm and less attention to their surroundings and what is happening around then (www.drdriving.org/music_strick_report.html).

CONCLUSIONS

To sum up, we can conclude that listening to techno music has the effect of shortening the reaction times of the participants. However, they are shortened significantly at the measurement without music after 30 minutes of listening to the music, but not during the listening. These findings differ from previous ones, which established that stimulating music shortens the reaction time to visual stimuli and that the reaction time is longer without music (Zakharova & Ivashchenko, 1984). The difference can be explained by the research findings which showed that the reaction times were not shortened during listening to music but 45 seconds after 30 minutes of listening to techno music. The control group established that 35 minutes of waiting between the measurements does not significantly affect the reaction time. Moreover, it was established that 30 minutes of listening to techno music affected the shortening of the reaction time 45 seconds after the music was turned off. For the purpose of result evaluation, we should consider the small sample size. Moreover, the research results were probably affected by the participants' specific characteristics. They are all actively involved in sports and most of them are students at the Faculty of Sports in Ljubljana.

For further research more participants should be involved. The results of this study have raised new questions to be answered in the future: e.g. the effects of different types of music, volume level or a person's favourite music (as the results could be influenced by a person's emotions) on reaction time. Further research could also include monitoring the EMG signal of an active muscle and measuring physiological parameters, such as the heart rate frequency and blood pressure. Above all, more participants should be involved in order to obtain results which could be generalized to apply to a broader population.

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ÚČINKY POSLECHU TECHNO HUDBY NA DOBU REAKCE NA VIZUÁLNÍ PODNĚTY

(Souhrn anglického textu)

Cílem výzkumu bylo stanovit míru vlivu techno hudby na reakční časy účastníků výzkumu. Naše hypotéza byla ta, že stimulující hudba, například techno, zkracuje dobu reakce účastníků na vizuální podněty, zatímco bez hudby je reakční čas delší. K určení doby reakce na očekávané světelné podněty jsme použili speciální zařízení na měření úhlu extenze lokte, elektrický goniometr a k němu připevněnou červenou LED diodu. Také jsme používali počítačový program. Výzkumu se zúčastnili sportovci, 10 studentů Fakulty sportu, ve věku 20 až 45 let, kteří představovali kontrolní i experimentální skupinu. V našem výzkumu jsme zjistili, že poslech techno hudby zkracuje reakční doby účastníků. Dle měření provedených po 30 minutách poslechu techno hudby se jejich doba reakce významně zkracuje, nicméně nezkracuje se během poslechu. Kontrolní skupina stanovila, že 35 minut čekání mezi měřeními reakční dobu významně neovlivňuje. Navíc bylo zjištěno, že 30 minut poslechu techno hudby mělo vliv na zkrácení reakční doby 45 sekund poté, co byla hudba vypnuta. Pro další výzkum by bylo nezbytné zapojit více účastníků. Výsledky výzkumu ovšem poskytují užitečné údaje a mohou sloužit jako východisko pro další výzkum.

Klíčová slova: prostá doba reakce, techno hudba, očekávaný světelný (vizuální) podnět, zařízení na měření úhlu extenze lokte, goniometr.

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AUTHOR GUIDELINES

FOCUS AND SCOPE

The journal "Acta Universitatis Palackianae Olomucensis. Gymnica" focuses on presenting results of research studies and theoretical studies from the field of kinanthropology. The scope of the journal covers topics related to biomechanics, exercise physiology, physiotherapy, somatometry, sports psychology, sports training, physical education, public health, etc. The journal also welcomes submissions that present results of interdisciplinary research.

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"Acta Universitatis Palackianae Olomucensis. Gymnica" journal bibliographic and formatting standards are based on *Publication Manual of the American Psychological Association* (APA), 5th edition, 2001 (see www.apastyle.org).

Language

The main language of the journal is English. Article title, abstract, and keywords are published also in Czech. All texts submitted to the journal are accepted only in English. Czech speaking authors are required to provide article metadata both in English and Czech. In Non-Czech speaking authors, the Czech version of article metadata will be completed by the journal.

Text Formatting

The submission file is in Microsoft Word (.doc) document file format. The text is single-spaced, left justified, uses 12-point Times New Roman font, and all illustrations, figures, and tables are placed at separate pages, rather than within the text. The maximum length of a submission allowed is 15 pages in total.

Abstract and Keywords

The recommended length of an abstract is 300 words and it should not exceed 400 words. Where applicable, the abstract will be structured in following sections: BACKGROUND, OBJECTIVE, METHODS, RESULTS (including relevant statistics), and CONCLUSIONS. Authors are required to provide 3 to 10 keywords (not used in the title).

Submission Structure

Typical article is structured as follows: INTRODUCTION, METHODS, RESULTS, DISCUSSION, CONCLUSIONS, and REFERENCES. The titles of the chapters are capitalized and left justified.

Tables and Figures

Tables and figures are placed at separate pages, rather than within the text. In addition, illustrative figures (if possible in high resolution; e.g., uncompressed TIFF) should also be uploaded as supplementary files with the submission and their file names should contain the number of the figure (e.g., figure01.jpg, figure02.tiff). In the text, place an identification above each table and figure. The identification is left justified and consists of a label (e.g., TABLE 1, Fig. 1) on the first line and a title of the table or figure starting on the next line.

References

References are placed at the end of the submission in alphabetical order and must comply with the APA style (see examples on www.gymnica.upol.cz). Footnotes can never be used for references. Carefully check references to assure they are correct and included only when they are cited in the text. Only references which have been published or accepted for publication can be included. Where available, provide URLs for the references.

We look forward to our further cooperation!

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POKYNY PRO PŘÍPRAVU RUKOPISU

ZAMĚŘENÍ

Časopis „Acta Universitatis Palackianae Olomucensis. Gymnica" je zaměřen na publikaci výsledků výzkumných studií a teoretických studií z oblasti kinantropologie. Zaměření časopisu pokrývá témata související s biomechanikou, zátěžovou fyziologií, fyzioterapií, somatometrií, sportovní psychologií, sportovním tréninkem, tělesnou výchovou, veřejným zdravotnictvím atd. Redakce časopisu také vítá příspěvky, které prezentují výsledky interdisciplinárního výzkumu.

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FORMÁT PŘÍSPĚVKU

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Standard časopisu „Acta Universitatis Palackianae Olomucensis. Gymnica" je založen na publikačním stylu Americké psychologické asociace – *Publication Manual of the American Psychological Association* (APA), 5th edition, 2001 (viz www.apastyle.org).

Jazyk

Hlavním jazykem časopisu je angličtina. Název článku, abstrakt a klíčová slova jsou publikovány také v češtině. Všechny texty zaslané do časopisu jsou akceptovány pouze v angličtině. Od česky mluvících autorů je vyžadováno, aby poskytli metadata článku v angličtině i v češtině. Za autory, kteří nemluví česky, doplní českou verzi metadat redakce.

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Soubor příspěvku je ve formátu souboru Microsoft Word (.doc). Text má jednoduché řádkování, je zarovnaný doleva, používá dvanácti bodový font Times New Roman a všechny ilustrace, obrázky a tabulky jsou umístěny na samostatné stránky. Maximální povolená délka příspěvku je 15 stran celkem.

Abstrakt a klíčová slova

Doporučená délka abstraktu je 300 slov a neměla by přesáhnout 400 slov. Pokud je to možné, bude abstrakt strukturován do následujících částí: VÝCHODISKA, CÍLE, METODIKA, VÝSLEDKY (včetně relevantní statistiky) a ZÁVĚRY. Autoři uvedou 3 až 10 klíčových slov (nepoužitých v názvu příspěvku).

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Typický článek je strukturován následujícím způsobem: ÚVOD, METODIKA, VÝSLEDKY, DISKUZE, ZÁVĚRY, a REFERENČNÍ SEZNAM. Názvy kapitol jsou napsány velkými písmeny a zarovnány doleva.

Tabulky a obrázky

Tabulky a obrázky budou umístěny na samostatných stránkách. Obrázky a ilustrace (pokud možno ve vysokém rozlišení; např.: nekomprimovaný TIFF) by měly být nahrány spolu s příspěvkem jako doplňkové soubory a názvy těchto souborů by měly obsahovat číslo obrázku (např.: figure01.jpg, figure02.tiff). V textu umístěte nad každou tabulku a obrázek identifikaci. Identifikace je zarovnaná doleva a sestává z popisku (např.: TABLE 1, Fig. 1) na prvním řádku a názvu tabulky nebo obrázku začínajícím na dalším řádku.

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Reference jsou umístěny na konci příspěvku v abecedním pořadí a musí být v souladu s APA publikačním stylem (viz příklady na www.gymnica.upol.cz). Pro reference nelze nikdy použít poznámky pod čarou. Pečlivě překontrolujte reference, abyste se ujistili, že jsou správně a zařazeny pouze v případě, že jsou citovány v textu. Uvedeny mohou být pouze reference, které byly publikovány nebo jsou přijaty k publikování. Kde je to možné, uveďte URL adresu odkazující na referenci.

Těšíme se na další spolupráci!

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