

**ACTA UNIVERSITATIS CAROLINAE
KINANTHROPOLOGICA, Vol. 50, 1 – 2014**

**Charles University in Prague
Karolinum Press**

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MK ČR E 18584

ISSN 1212-1428 (Print)

ISSN 2336-6052 (Online)

A C T A U N I V E R S I T A T I S C A R O L I N A E
K I N A N T H R O P O L O G I C A V O L . 5 0 , 1 – 2 0 1 4

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CHANGES OF SELECTED HEMATOLOGICAL PARAMETERS AND MORNING REST RATE DURING TEN DAYS HIGH ALTITUDE STAY AND TRAINING

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ABSTRACT

This article describes the influence of a ten day stay and training in a high altitude area (1850 m ASL) on selected blood count parameters and morning resting heart rate. Three tests were performed on a group of young cross country skiers ($n = 10$, age: 18.7 ± 4.8): two days before, two days after and ten days after the altitude training camp. Two day after the return, significant ($p < 0.05$) increases in hemoglobin level (5.4%), red blood cell (3.2%) and hematocrit (4.3%) were observed. Ten days after the return to the lowland, were found significant increases in concentration of hemoglobin and red blood cell ($p < 0.05$) compared with the check measurement before high altitude. Increases in hematocrit were not significant. The heart rate was higher during the camp than before ($p < 0.01$). The average decrease in heart rate (2.6%) ten days after the return in comparison with basal data was not statistically significant ($p > 0.05$).

The study in a group of young cross country skiers has shown positive effects of a ten-day training camp in high altitude on blood count parameters and morning resting heart rate monitored in lowland two and ten days after the return from high altitude.

Keywords: altitude, blood count, morning heart rate, sports training

INTRODUCTION

Utilizing lower partial pressure of oxygen is currently one of the most frequently discussed legal ways to influence sports performance. Lower partial pressure of oxygen can be evoked naturally (i.e. by altitude stay) or artificially (i.e. by staying in special tents, barochambers or “oxygen” houses). Exposure to hypoxia induces number of physiological changes – decrements in arterial oxyhemoglobin saturation and maximal oxygen consumption, changes in heart rate (HR), hydration status, immune function etc. These changes may limit athlete’s ability to train or compete. Monitoring of morning resting heart rate as a part of cardiovascular response of the body is one of the possibilities how

to control athlete's adaptation to altitude training (Schmitt et al., 2008). An important part of the training (not only for the lower partial pressure of oxygen) is regular blood analysis. It is necessary to monitor, above all the parameters that are directly affected by the altitude (Sherry & Wilson, 1998; Weineck, 1997). Of the biochemical variables are mainly used: hemoglobin, hematocrit, iron metabolism parameters in blood serum and blood oxygen saturation. Furthermore, variables characterizing acidosis after training such as lactate, pH, base excess (Suchý, 2012).

The significance of stay and training in high altitude for sports training has been confirmed by numbers of published papers. One of the first monographs on the topic was published by Jokl (1968) who summarized data from the first Olympic Games which took place in high altitude (Mexico, 1968). A synthesis of data gained throughout twenty years since the breakthrough Olympics in Mexico was published by Fuchs & Reiss (1990) and Marajo & Réga (1989). A monograph by Wilber (2004) introduces methodology and approaches on the issue of utilizing altitude, which results from his long term experience in researching the impact of altitude on human organism in USOC center in Colorado Springs (1850 m ASL). Millet & Schmitt (2011) summarize theoretical and methodological aspects of altitude training as well as results of their own research.

The meta-analysis of articles published by Bonetti & Hopkins (2009) on this topic in past 30 years showed that elite athletes increased their sea level athletic performance about 5.2% after staying and training in altitudes of about 2000m ASL compared with staying and training in lowland.

Adaptation to high altitude is a relatively long complex process. There is a general agreement that 21-day stay and training is an ideal period to get adapted to altitude successfully (Jokl, 1968; Marajo & Réga, 1989; Millet & Schmitt, 2011). The majority of analyses of classical three week stay and training in natural altitude (1800–2400 m ASL) have found positive effects on aerobic performance and changes in biochemical parameters of endurance athletes (Dovalil et al., 1999; Fuchs & Reiss, 1990; Jokl, 1968; Pupiř & Korčok, 2007; Suchý, 2009; Wilber, 2004). In past 20 years, artificial altitude (Rusko, 1996; Wilber, 2004) has been used to increase aerobic performance and blood count parameters; this issue is, however, not dealt with in this paper.

In our previous qualitative research with Czech coaches of various sports branches, we found out that many of them used stays shorter than classical 21 days in high altitude areas – usually from ten to twelve days. These shorter stays are convenient due to socioeconomic reasons and it is also evident from empiric experience of the addressed coaches that even short stays have a positive influence on the conditioning level of the endurance athletes (Suchý & Dovalil, 2009). Our analysis showed that the vast majority of relevant research revealed positive effects of a classical three week stay in natural high altitude areas (1800–2500 m ASL) on aerobic performances and changes in biochemical parameters of endurance athletes (Bonetti & Hopkins, 2009). However, there are only a limited number of relevant studies focusing on the issues concerning high altitude acclimatization in an approximately ten day period. Klausen et al. (1991) researched the influence of a seven day stay in altitude of 1700 m ASL and training in altitude of 2760 m ASL on selected blood count parameters with cross country skiers ($n = 7$). The majority of observed blood count parameters were higher during the stay and also after coming back to lowlands than as found out by check measurement before leaving

for the stay. Svedenhag et al. (1991) were concerned with a two week altitude stay and training (2000 m ASL) with middle distance runners (n = 7) and found out that it had no impact on aerobic performance increase but a change in the circulatory regulation during submaximal exercise was observed. This paper was not designed to include blood analysis.

PURPOSE

The aim of our study was to monitor selected hematological parameters before and after a short-term altitude stay and training. The results of the research may be valid in verifying if a shortened ten day stay and training in 1850 m ASL is influential increasing observed blood count parameters immediately and in a ten days' time after coming to lowlands in comparison with check values measured before leaving for the stay. Another aim was to check the influence of altitude on morning resting HR. Morning resting HR is considered to be an easy indicator of acute changes in the inner state of the organism often used by coaches and athletes (Suchý, 2012; Wilber, 2004).

PROCEDURES

Participants

The study was conducted on a group (n = 10, men: 7, women: 3) of young (under 18) and junior (under 20 and 23) cross country skiers. All participants were members of the Youth Sports Center in Jilemnice (Czech Republic). All of them take regularly part in the contests of Czech Cross country cup and they are subjects to regular training (for the period of 7 ± 3.3 year on average). At the time of conducting the research, three participants were members of Czech junior national team. Characteristics of the probands are shown in Table 1. The skiers were in a good health condition during the research period and under regular medical supervision during the whole training year. Considering the fact that the research took place during a training period, the training process was aimed to an aerobic training, with high volumes and low intensity load, which took 27–32 hours per microcycle. During the training camp in altitude (1850 m ASL, Livigno, Italy), competitors practiced 29 to 33 hours in 9 training and two rest days. Within the framework of the training process, the skiers spent approximately 12 hours in an altitude of about 2200 m ASL. Detailed description of the training program is provided in Suchý (2012).

Table 1. Probands characteristics (n = 10)

Variables	Age (years)	Years of training (years)	Body fat (%)	Height (cm)	Weight (kg)
Average \pm S.D.	18.7 \pm 4.3	7 \pm 3.3	9.4 \pm 4.5	175.6 \pm 4.7	67.5 \pm 8.1

S.D. – standard deviation

Measures

To get input check data, selected values of blood count in observed persons were gathered after long-term stay in lowlands (500 m ASL) two days before leaving for altitude training session (T1). The same blood count parameters were gathered again two days after coming back from the ten-day altitude training session – 1850 m ASL (T2) so that they were not affected by possible dehydration after a ten hour journey from Livigno. The last test was carried out ten days after finishing the training session (T3); all participants spent the ten days in lowlands (500 m ASL).

Morning resting HR [beat.min⁻¹] was continuously checked by the participants themselves during the whole course of the research.

Procedures

All the participants were repeatedly tested for selected hematological parameters in the blood count, namely those which are important for assessment of the influence of high altitude on the human body:

- hemoglobin (g/l)
- red blood cell count ($10^{12}/l$)
- hematocrit (%)

The blood samples were taken in the morning on an empty stomach by a medical doctor who participated in our study and samples were analyzed and evaluated in the certified laboratory of Jilemnice Hospital.

Body fat values were obtained according to the model of Pařízková (1977).

The morning resting HR was monitored individually with the help of sport testers. Monitoring was carried out after the participants woke up, still lying in bed. Input values started to be gathered 24 days before their departure for the training camp and ended 26 days after their return, which is consistent with the theory of the performance peak within the 21st day in lowland after three-week stay and training in altitude (Dovalil, 1999). It meant 60 days of every day resting HR monitoring. The lowest value in one minute of measuring was recorded in a special record which was handed in after the research was finished.

Statistical analysis

Microsoft Excel 2007 was used for subsequent processing and analysis. With regard to the nature of the research (Hendl, 2004) and in accordance with similar published researches (Bonetti & Hopkins, 2009), we decided to judge statistical significance of differences at the level of significance $p < 0.05$ and $p < 0.01$. We monitored the substantive significance for the differences in the variables monitored using Cohen's d effect coefficient (Hendl, 2004) with the conventional parameter d as follows: $d > 0.8$ means large effect, $d > 0.5$ – 0.8 means medium effect, $d > 0.2$ – 0.5 means small effect, $d < 0.2$ very small effect.

The research was performed in accordance with World Medical Association declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects amended in October 2008 in Seoul. The Ethical committee of the Faculty of Physical Education and Sport, Charles University in Prague approved of the research design in August 23rd 2009. All the participants signed the informed consent.

RESULTS

Following the set methodology, we took blood samples of all observed athletes on afore determined dates (T1, T2, T3) which are summarized in Table 2 and Table 3.

Table 2. Selected blood count parameters of all participants (n = 10)

Variables/date	T1	T2	T3
	Red blood cells ($10^{12}/l$)		
Average \pm S.D.	4.96 \pm 0.15	5.12 \pm 0.06	5.07 \pm 0.17
	Hemoglobin (g/l)		
Average \pm S.D.	145.2 \pm 11.7	153.1 \pm 10.97	148.3 \pm 11.81
	Hematocrit (%)		
Average \pm S.D.	43.8 \pm 2.9	45.7 \pm 3.0	44.5 \pm 3.5

T1 – check measurement prior to altitude; T2 – immediately after return; T3 – ten days after returning from altitude

Table 3. Statistical significance and size effect of chosen blood count parameters changes

Variables / no. of the test	Red blood cells ($10^{12}/l$)		Hemoglobin (g/l)		Hematocrit (%)	
	d	P	d	P	d	P
T1 vs. T3	0.41	0.044	0.55	0.005	0.19	n.s.
T1 vs. T2	0.65	0.004	0.88	0.000	0.61	0.001
T2 vs. T3	0.25	n.s.	0.33	0.028	0.41	0.026

T1 – check measurement prior to altitude; T2 – immediately after return; T3 – ten days after returning from altitude); S.D. – standard deviation; d – size effect; n.s. – not significant

Average increase in observed blood count parameters found immediately after returning from the ten day altitude training session in comparison with the values taken before leaving for altitude camp (T1 vs. T2 measurements): red blood cells by 3.2% ($p < 0.05$), hemoglobin by 5.4% ($p < 0.05$), hematocrit by 4.3% ($p < 0.05$).

Significant increase (d) between T1 and T2 measurements was found in all parameters. Large effect (d) was observed with hemoglobin, while medium effect (d) occurred with red blood cells and hematocrit.

Ten days after returning from altitude camp, the increase in observed parameters was still visible in comparison with check measuring before leaving (T1 vs. T3): red blood

cells by 3.3% ($p < 0.05$), hemoglobin by 2.1% ($p < 0.05$), hematocrit by 1.5% (n.s.). The increase in observed parameters between T1 and T3 measuring had medium effect (d) for hemoglobin. The increase in hematocrit and red blood cells had small effect (d).

The revealed positive influence of ten day altitude stay and training on observed parameters of blood count is in compliance with the results of Berglund (1992), Faulkner et al. (1967), Klausen et al. (1991), Suchý (2012), Svedenhag et al. (1991), who evaluated similar blood indicators in athletes after one to two week altitude stay and training.

Resting heart rate monitoring

Acute changes of the inner state of organism exposed to high altitude were longitudinally tracked by the sportsman themselves by means of the values of morning resting heart rate immediately after waking up (Figure 1).

3.7% of morning HR results are missing because in some cases some of the participants failed to record it. We did not use the heart rate parameters from the days on which the athletes travelled to and from the training camp.

Average values of morning resting HR in altitude were by 9.4% ($p < 0.01$) higher than within check measuring in lowlands before leaving for altitude camp. Gained results confirm that altitude brings increase in morning resting heart rate which culminates on the second day and subsequently decreases but always stays at a higher level than in lowlands.

After returning to lowlands, average values of morning resting HR were by 11.4% ($p < 0.01$) lower than during altitude stay. Gathered values are in compliance with estimations and they confirm that the reaction of organism to initial days spent in altitude results in increasing morning resting HR.

Average values of morning resting HR after returning from altitude camp were by 1.6 [$\text{beat}\cdot\text{min}^{-1}$], i.e. 2.6% (n.s.), lower than before leaving; size effect (d) of this change was small as well. Even though the measuring has not proved statistical difference or size effect of HR decrease before leaving and after returning, we suppose that, from the point of view of sports training and the inner reaction of organism, average decrease by 1.6 [$\text{beat}\cdot\text{min}^{-1}$] is an important change.

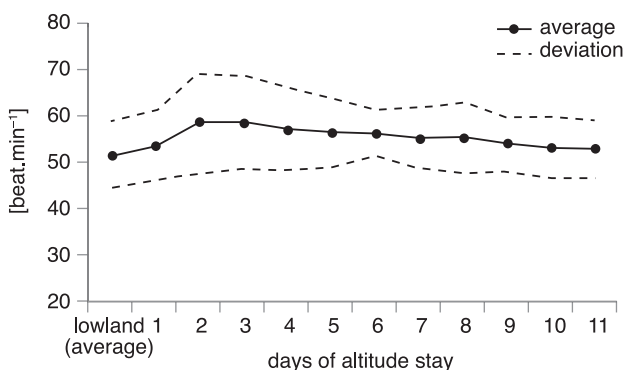


Figure 1. The average values of morning resting heart rate during each day of altitude stay

Table 4. Results of the morning rest HR measurements in lowland, in altitude and after return to lowland from altitude

Variables / measurements	Before altitude [beat.min⁻¹]	In altitude [beat.min⁻¹]	After altitude [beat.min⁻¹]
Average ± S.D.	51.6 ± 6.4	55.9 ± 7.0	50.2 ± 6.0

Table 5. Statistical significance morning rest HR measurements in lowland, in altitude and after return to lowland from altitude

Variables / no. of the test	p
T test ∅ before vs. after	0.002
T test ∅ before vs. altitude	0.042
T test ∅ altitude vs. after	0.016

DISCUSSION

The results of the measuring confirmed that shortened ten day altitude stay and training is influential in increasing the observed blood count parameters immediately after returning from altitude camp (T2) in comparison with check values before leaving (T1). Likewise, ten days after coming back to lowlands (T3), observed values were higher than before leaving (T1). On the basis of this observation, we assume that it is possible to induce that a ten day stay and training in high altitude may positively affect the increase in performance. It is clear, that also the other functional systems are necessary for the final use of oxygen in the body and thus better athletic performance. But improvement in hematological parameters, which is assumption for better transportation function of blood, is only one of the conditions for aerobic performance improvement. Our results are for instance in compliance with the findings of Klausen et al. (1991) who found significant increase in erythrocytes after seven days spent in altitude of 1700 m ASL; but the training load with cross country skiers was carried out in altitude of 2700 m ASL. Friedman et al. (1999) found significant increase in both erythrocytes and hematocrit. Similar results were presented by Strzala et al. (2011) or Wilber (2004).

The information value of the results would be greater if the observed parameters could be checked also during altitude stay. More frequent sample taking after returning to lowlands (not only on the second and tenth days) would make the information more accurate. The same range of hematological parameters measurements as morning resting HR measurements wasn't possible for technical and organizational reasons.

The results of (not only) the observed blood count parameters are significantly affected by current hydration of the organism. We attempted to reduce this negative influence by checking liquid and energy intake and body weight of the observed skiers. In the course of the research, all observed skiers kept the same weight. Twelve hours spent on the bus on the way from and to Livigno (where the training session took place) influenced hydration negatively. For this reason, we did not take blood immediately, but two days after coming back to lowlands.

A theoretical possibility to increase the information value of the results was including a bigger number of athletes into the research. This possibility was considered as early as within preparations of the research design but with respect to socio-economic and organizational aspects; we were not able to secure a bigger number of probands. However, meta-analysis by Bonetti & Hopkins (2009) shows that a similarly small number of persons (most often from 5 to 15) are used in this kind of research, which means the same number of probands as we used in our research. We have also considered presentation of individual data for each person, but given the scope of this article and gender difference we have rejected it.

On the basis of the feedback on the research design, we suppose that it would be interesting to increase supply of iron to the athletes (e.g. with food supplements). Chapman & Levin (2000) or Stray-Gundersen et al. (2001) state that there is a possible relationship between higher values of hematocrit and bigger iron supplements during the course of altitude stay. On the contrary, Friedmann et al. (1999) state that the influence of iron supplements on the increase in the amount of hemoglobin in high altitude cannot be proved.

As is well known, high altitude also affects morning resting heart rate. The higher average values of morning resting HR of our group correspond to other results (Dovalil et al., 1999; Jokl, 1968; Friedmann & Burtsch, 1997; Chapman et al., 1998; Wilber, 2004). The highest values were observed from the 2nd to the 6th day of the stay, while papers usually refer the time period between the 2nd and 4th days as crisis days, and recommend diminishing training volume.

Morning HR could be affected during the first days of altitude by fatigue after a long journey and shorter rest on the first day. After the stay in altitude camp, the level of HR was relatively quickly adjusted little bit lower compare to original values. But it is a matter of suitable reacclimatization process during the first several days after returning to lowlands (Chapman et al., 1998; Dovalil et al., 1999). We suppose that the lower value of HR after altitude stay is a consequence of cumulative effect of the unusual environmental stimulus during a ten day stay in a high altitude area and proper training in altitude and before the camp (Wilber, 2004).

Average values of morning resting heart rate may be influenced by different times and methodology of individual measuring by individual research participants (e.g. the time period between waking up and measuring or the position of the body at the time of measuring). With respect to the bigger number of research days, we consider the consequences of this error relatively insignificant.

It would be more suitable to use variability of morning heart rates which has bigger information value (Melanson, 2000) or orthostatic reflex. We were considering both the tests during the preparations of the research design but abandoned them. The reason for this was the fact that the skiers recorded the morning values individually and they might not pay sufficient attention to a more complicated test, which might negatively affect the data.

A comparison of the influence of high altitude on the values of hematological and physiological parameters in men and women might bring interesting findings. In measurements carried out by us, women reached lower values of all hematological indicators and higher morning HR in comparison with observed men. This finding corresponds to commonly present physiological differences (Millet & Schmitt, 2011). Intersexual differences

are not dealt with in the chapters on results in greater detail because the data were gathered on a small sample and the representation of men and women was not proportional either. Within data analysis of observed men and women, we were trying to find whether there are researches which focus on this issue. The majority of papers present only overall data for both sexes.

Aerobic tests (Suchý, 2012) were performed as a part of this research, but regarding to the range of this article are not included.

CONCLUSION

The changes in selected hematological parameters of monitored cross country skiers confirm the positive effects of a ten day stay and training in high altitude areas (1850 m ASL).

The values of mean morning resting HR proved that altitude is considerably significant in increasing the values of morning resting HR in comparison with lowland values. The changes of average values of morning resting HR in high altitudes which have been found out unambiguously prove that monitoring morning HR is a necessary part of the training process.

Altitude stay had an effect on average decrease in values of morning resting HR in lowlands (if compared to check measuring) which were not factually or statistically significant. Nevertheless, decrease by 1.6 [beat.min⁻¹] (i.e. 2.6%) is in our opinion important from the point of view of sports training.

On the basis of the results and their comparisons with references in literature, it can be concluded that it is desirable to make use of a ten day altitude stay and training with the aim to increase fitness during subsequent stay in lowlands, above all in endurance sports.

This study was financed from the institutional support for the development of research organizations and supported by The Ministry of Education, Youth and Sports Czech Republic (MSM0021620864), PRVOUK P38 and specific research (267 602).

No additional funding was received from any other organization. The authors have no conflicts of interest to report. Special thanks to Michael Allen for language corrections.

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ZMĚNY VYBRANÝCH HEMATOLOGICKÝCH PARAMETRŮ A RANNÍ KLIDOVÉ SRDEČNÍ FREKVENCE V PRŮBĚHU DESETIDENNÍHO TRÉNINKU A POBYTU VE VYŠŠÍ NADMOŘSKÉ VÝŠCE

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SOUHRN

Článek popisuje vliv desetidenního tréninku a pobytu ve vyšší nadmořské výšce (1850 m n. m.) na vybrané parametry krevního obrazu a ranní klidové srdeční frekvence. U skupiny mladých běžců na lyžích ($n = 10$, věk: $18,7 \pm 4,8$) byly realizovány celkem tři odběry krve: dva dny před soustředěním ve výšce, dva dny a deset dnů po návratu do nížiny. Dva dny po návratu byly signifikantně ($p < 0,05$) zvýšeny parametry hemoglobinu (o 5,4 %), červených krvinek (o 3,2 %) i hematokritu (o 4,3 %) v porovnání s kontrolním měřením v nížině. Deset dnů po návratu ze soustředění ve výšce byly signifikantně ($p < 0,05$) zvýšeny parametry červených krvinek a hemoglobinu v porovnání s parametry před soustředěním. Hematokrit byl také zvýšený, ale nikoliv signifikantně ($p > 0,05$). Průměrné hodnoty ranní klidové srdeční frekvence byly během soustředění ve výšce vyšší než před odjezdem v nížině ($p < 0,01$). Po návratu do nížiny byly průměrné hodnoty ranní klidové srdeční frekvence o 2,6 % nižší než před odjezdem do výšky, ale změna nebyla statisticky významná ($p > 0,05$).

Námi realizovaný výzkum u skupiny mladých běžců na lyžích prokázal pozitivní efekt desetidenního pobytu a tréninku ve vyšší nadmořské výšce (1850 m n. m.) na sledované krevní parametry a ranní klidovou srdeční frekvenci v nížině po návratu.

Klíčová slova: vyšší nadmořská výška, krevní obraz, ranní srdeční frekvence, sportovní trénink

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EXCUSES IN PHYSICAL EDUCATION MADE BY PRIMARY SCHOOL PUPILS OF FOURTH AND FIFTH CLASS

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ABSTRACT

Researches show that children are mostly active at gym/sport in the school. So it is extremely important that they participate in physical education and aren't making excuses or aren't passive. Excuses for physical education were in the Slovenian area already a subject to a number of researches; however all deal with pupils in third triad and/or high school pupils. This research is the first of its kind dealing with younger pupils. Despite the fact that participation in physical education is a duty and right of every pupil, some pupils in physical education do not want to participate. Therefore, we wanted to find out how much and in what way the pupils of fourth and fifth class are making excuses for physical education. In the sample 319 pupils of fourth and fifth class were included. We found that absences of school children were within the expected range, because most children aren't long-term ill. Young pupils are expected to make excuses less often than older pupils, because the need for physical movement in this period is strongly expressed. When pupils excuse, this is most often due to illness or because of unsuitable premises and lack of time for personal hygiene after hours of physical education. Pupils in the case of non-participation in physical education often tell teacher the real reason, but often also bring an apology from parents. When pupils don't participate in physical education, they mainly observe it; less frequently the teacher finds another occupation for them.

Keywords: importance of movement, amount of physical/sports activities, participation in physical education, reasons for excuses

INTRODUCTION

Physical/sporting activity is extremely important for a child. Here we include activities both leisure and at work, as well as activities with intention reaching goal of everyday important and planned activities (e.g. travel to school). This type of gym is planned for all types of pupil's body muscles movements; the result is higher power consumption than

in resting. Body exercise is an intentional physical/sporting activity that is structured and is aimed building or improving one's health (Završnik & Pišot, 2005; Mutrie, 2005, in Pišot, Kropej & Volmut, 2006; Caspersen, Powell & Christensen, 1985). Regular physical/sporting activity is decreasing illness rate and mortality from chronic non-contagious diseases, has a positive effect on the levels of body fat and body weight, satisfaction with physical appearance, self-esteem, self-confidence, autonomy, better cognitive performance, better attention, social interaction, social development skills, emotional development of the child, the moral development of the child, reduces the risk of developing high-risk behaviors (smoking, alcohol, drugs), develops a healthy, active lifestyle (Haug, 2008; Planinšec & Fošnarič, 2006; Shephard, 1997; Sibley & Etnier, 2003; Brettschneider & Naul, 2004; Ewing, Gano-Overway, Branta & Seefeldt, 2002; Berčič, 2010; Fras, 2005; Goran, Reynolds & Lindquist, 1999; Boreham & Riddoch, 2001).

The amount and type of physical/sport activities necessary for maintaining good health is still the subject of many researches. In particular, there is a problem in defining the amount and type of children's physical/sport activities, since physical/sports activity for children is different than for adults. The children's physical/sports activities can also be considered as a spontaneous game, but they aren't for adults. Thus, some recommend 20–30 minutes of moderate intensive activity at least 3 times a week (Physical activity and health, 1996; Sallis & Patrick, 1994), the second 30 minutes of moderate activity at least 5 times a week (American Heart Association, 2005; Konec Juričič & Podkrajšek, 2007), 30 minutes of moderate activity a day (Roberts, Tynjala & Komkov, 2004), as well as 60 minutes or more of daily physical/sports activity to reach moderate to high intensity (Strong, Malina, Blinmke, Daniels & Dishman, 2005; Završnik & Science and Research, 2005). However, there are appropriate physical/sports active only 50% of 11 year old boys and only 33% of 11 year old girls (Bishop, 2007).

Researches shows that children are most active in exercises/sports namely in the school (65%) (Strel, Završnik, Pišot, Zorc & Kropej, 2005), so it is extremely important that children participate in physical education process and do not make excuses or are passive. In the second triad of primary school (4th–6th grade) pupils have 3 hours of physical education weekly, which would at optimum use of timing mean 45 minutes sport activity 3 times weekly. However, researches shows that the effective time hours of physical education are very low, which means that children are active in sports only for about 15 minutes 3 times weekly (taking into account that 50% of children out of the school are not active in physical/sports) (Stemberger & Krpač, 2009). All of this is certainly not enough being able to talk about the positive effects of physical education on the health of children and adolescents.

Pupils have the right and duty to attend POUKU school, which is tailored to its specific characteristics, as defined in the Regulation on the pupils rights and duties in primary school (2004). Pupil may be excused for health reasons from participating in certain class hours and other school activities (article 15 of the Regulation ..., 2004). Pupil must also in the case when excused from participating in a particular class lesson, attend on class and complete tasks that do not threaten his health condition, and carry them out in accordance with the medical service instructions. If a pupil for medical reasons can not perform any tasks, the school must organize alternative activities (article 15 of the Regulation ..., 2004).

PROBLEM

Excuses at the physical education were in Slovenian area subject to a number of research studies (Kovač & Jurak, 2010; Jurak & Kovač, 2011; Kovač & Jurak, 2011; Jurak, Leskošek & Kovač, 2010; Strel, Jurak & Kovač, 2007; Jurak, Kovač & Strel, 2006; Jurak, Kovač, Strel & Lorenci, 2005), but they all dealt with pupils in the third triad and/or high school pupils. This research is the first dealing with younger pupils.

Despite the fact that participation in physical education is a duty and the right of every pupil, some pupils do not want to participate in physical education. Therefore, we wanted to know how much and in what way the pupils of fourth and fifth class excuse them at the physical education.

METHODS

The pupils sample

In the sample 319 pupils were included, of which:

- 254 (79.6%) pupils were from the fourth class
- 65 (20.4%) pupils were from the fifth class
- 148 (46.5%) boys
- 170 (53.5%) girls

MODEL VARIABLES

Teachers questionnaire is a modified questionnaire survey for excuses in elementary school higher grades and middle school (Jurak, Kovač & Strel, 2004a; 2004b). Pupil's questionnaire included seven closed questions and was divided into four themes: (1) basic information, (2) the real reasons for excuses, (3) excuses when there is no justifiable reason and (4) pupil activity during the time, when he is justified to participate in sports practice.

ORGANIZATION OF MEASUREMENT

Data collecting took place during the regular school time in October and November 2012. Pupils meet the questionnaires under the research provider's supervision.

METHODS OF DATA PROCESSING

Data were analyzed with the statistical package SPSS (Statistical Package for Social Sciences inc., Chicago IL, version 18.0). With the subprogram Frequencies we calculated frequencies of individual responses to the questionnaires. For descriptive statistics the

program Descriptives was used. To determine differences between individual measuring groups (boys, girls, pupils of class 4 and 5) we used the program DESCRIPTIVES, sub-program CROSSTABS, and there we used contingency tables and Chi2 test.

RESULTS

Table 1. How many days of last school year have you approximately been absent from classes in all subjects due to health problems?

	Number of pupils	Valid percentage	Cumulative percentage
Up to 5 days	160	51.1	51.1
6–10 days	101	32.3	83.4
11–30 days	39	12.5	95.8
31–45 days	6	1.9	97.8
45–60 days	2	0.6	98.4
More than 60 days	5	1.6	100.0

Table 2. How many hours in last school year have you approximately excuse yourself from physical education, but you were present in the school?

	Number of pupils	Valid percentage	Cumulative percentage
Nothing	148	47.3	47.3
Up to 5 hours	138	44.1	91.4
6–10 hours	15	4.8	96.2
11–20 hours	9	2.9	99.0
21–30 hours	2	0.6	99.7
More than 30 hours	1	0.3	100.0

Table 3. Why do you make excuses or are missing from the physical education?

The reason of excuse		Never	Exceptionally	Sometimes	Often	Very often
			(1–2 times a year)	(3–5 times a year)	(6–10 times a year)	(more than 10 times a year)
Forgetting sports equipment	N	144	123	43	3	0
	%	46.0	39.3	13.7	1.0	0.0
General sickness	N	186	89	27	4	2
	%	60.4	28.9	8.8	1.3	0.6
Fear of exercise programs which are on the agenda	N	267	29	10	0	2
	%	86.7	9.4	3.2	0.0	0.6
Sports exercises on the agenda are demanding too much effort	N	265	37	6	1	1
	%	85.5	11.9	1.9	0.3	0.3
Not enough time for personal hygiene and adjusting after sports	N	264	28	6	6	2
	%	86.3	9.2	2.0	2.0	0.7
There are no adequate facilities for personal hygiene and adjusting after sports	N	265	23	9	5	7
	%	85.8	7.4	2.9	1.6	2.3
Indisposition to exercise, because others also didn't make gym	N	276	28	6	0	1
	%	88.7	9.0	1.9	0.0	0.3
Not being interesting in actual content	N	239	52	16	2	2
	%	76.8	16.7	5.1	0.6	0.6
Learning other subject	N	267	26	8	3	3
	%	87.0	8.5	2.6	1.0	1.0
I don't like the time physical education (first or last hour of day lessons)	N	267	28	6	4	4
	%	86.4	9.1	1.9	1.3	1.3
The teacher behaves inappropriate to me	N	273	25	7	1	4
	%	88.1	8.1	2.3	0.3	1.3
Inadequacy space for physical education	N	277	17	9	4	3
	%	89.4	5.5	2.9	1.3	1.0
Illness	N	98	131	68	5	8
	%	31.6	42.3	21.9	1.6	2.6
Injury	N	147	113	38	4	4
	%	48.0	36.9	12.4	1.3	1.3

Table 4. How many times a year do you excuse yourself from physical education, even if you do not have a justifiable reason?

	Number of pupils	Valid percentage	Cumulative percentage
Never	241	77.7	77.7
1–2 times a year	50	16.1	93.9
3–5 times a year	18	5.8	99.7
6–10 times a year	0	0.0	100.0
More than 10 times a year	1	0.3	

Table 5. What excuse do you use most often when you excuse yourself from taking a gym class but you have no justifiable reason?

Reason of excuse		Never	Exceptionally (1–2 times a year)	Sometimes (3–5 times a year)	Frequently (6–10 times a year)	Very often (more than 10 times a year)
I forgot my gym outfit	N	196	76	20	4	9
	%	64.3	24.9	6.6	1.3	3.0
I give a teacher a written excuse from my parents about my medical problems	N	177	84	28	5	12
	%	57.8	27.5	9.2	1.6	3.9
Medical excuse	N	209	68	15	4	6
	%	69.2	22.5	5.0	1.3	2.0
I feel seek	N	200	74	19	4	7
	%	65.8	24.3	6.3	1.3	2.3
I tell the teacher the real reason	N	124	86	22	18	50
	%	41.3	28.7	7.3	6.0	16.7
I skip gym class and I get one unexcused absence	N	287	9	1	0	4
	%	95.3	3.0	0.3	0.0	1.3

Table 6. What do you do during the gym class when you are excused?

What do you do		Never	Exceptionally (1–2 times a year)	Sometimes (3–5 times a year)	Often (6–10 times a year)	Very often (more than 10 times a year)
After the class starts, I go out of the gym	N	268	13	2	2	5
	%	92.4	4.5	0.7	0.7	1.7
I talk in the gym's dressing room	N	242	27	11	3	7
	%	83.4	9.3	3.8	1.0	2.4
I watch gym class	N	85	93	27	18	60
	%	30.0	32.9	9.5	6.4	21.2
I study for another class	N	247	17	10	4	8
	%	86.4	5.9	3.5	1.4	2.8
I do what I want, but I'm in the gym (I don't follow the gym class and I don't study for another class)	N	264	17	3	1	4
	%	91.3	5.9	1.0	0.3	1.4
Teacher includes me in exercises as an assistant	N	128	91	45	12	12
	%	44.4	31.6	15.6	4.2	4.2
I learn something for gym class	N	176	55	15	8	30
	%	62.0	19.4	5.3	2.8	10.6
I prepare didactically material (posters, learning sheets, exercise sheets ...)	N	242	26	10	2	5
	%	84.9	9.1	3.5	0.7	1.8
I do different things that teacher tells me to (clearing parts of the gym, picking up the trash on outdoor gym premises ...)	N	184	53	27	7	17
	%	63.9	18.4	9.4	2.4	5.9

DISCUSSION

During the school year pupils are absent not just from gym classes but also from other classes. Most often pupils were absent for a whole week of class (about 5 days) or cumulative for about 10 days (83.4%). This coincides with duration of illnesses suffering from cold that don't request long term treatments and long term absence from class. Pupils, that are absent from class for longer times are in minority. In Slovenia in 2006/2007 school year 0.25% of pupils were absent long term (Ložar, 2008). Among preschool children in 2011/2012 school year 0.14% of them were ill for longer time (Ložar, 2012). Yet this data is rather disunited, because the definition for a long term absent pupil is not the same in every research. Because we did not ask the kids about the cause for their long term absence we can only assume that it was because of their illness.

Pupil should attend 105 hours of gym class in one school year. Less than half of pupils never excuses themselves, which means, that they are present at all gym class hours. At the same time, approximately the same percent of pupils excuses themselves from attending gym class up to five times. (this is 4.8% of all hours, when half of the pupils are absent from gym class). There are no differences between genders. Comparison with older pupils (Jurak & Kovač, 2010; Jurak, Kovač, Strel & Starc, 2005; Jurak & Kovač, 2011) shows that younger pupils excuse themselves a little less often than their older coevals. We can find the cause for very low degree of excuses in the fact that gym class is very popular among pupils and in the child's stage of development (Cugmas & Burjak, 2008; Jurak, Kovač & Strel, 2002; Janečko-Goličič, 2012). The need for movement is very expressed in this period and pupils are very interested in everything that is new. They like to play, read and do sport. Thus it is expected that pupils will excuse themselves less in this period because of the characteristics in their stage of development (Meece, 2002, in Škof, 2007).

Two of the most often excuses for being absent from gym class frequently (more than 10 times a year) are illness (2.6%) and inappropriate rooms for personal hygiene after the gym class is finished (2.3%). And the others are following in that order:

- Inappropriate time of gym class (first or last hour of school) – 1.3%
- Inappropriate approach of gym teacher – 1.3%
- Injury – 1.3%
- Studying for another class – 1.0%
- Inappropriate conditions for exercise – 1.0%

If we take into consideration the answer to "how often" (6–10 times a year), then the most often excuse used is "illness", followed by "inappropriate rooms for personal hygiene after the gym class is finished", "injuries", "inappropriate time of gym class" and "not enough time for personal hygiene after gym class".

Among reasons for excuses at gym class up to 5 times a year "illness" prevails, then it is "forgotten gym equipment", "injuries" and "general weakness".

When comparing the results with researches from Jurak and Kovač (2011) and Jurak, Kovač, Strel and Starc (2005) we can see that at younger pupils the illness is also the main reason for not attending gym class. The second most often reason is inappropriate conditions for personal hygiene and not enough time for personal hygiene after gym class.

Probably, an insufficient fund for gym classes for pupils of first and second trimester is the reason for that (Štemberger, 2003; 2005). If there are more rooms for gym classes on school, usually, for younger pupils these classes are held in less appropriate rooms. For pupils, especially for girls ages between 9 and 12 appearances becomes very important. Some authors (Grogan, 1999; Kuhar, 2003) say that not being satisfied with her own appearance is a normal experience for women from age 8 on. In a time of puberty appearance becomes more and more important. Against expectations there are no differences in genders, which means that physical appearance these days is not only important to girls but also to boys (Kuhar, 2002). Elected pupils that are used for this research attend 4th and 5th classes. And during this period classes are mostly held in one classroom and teacher accompanies them to gym class and back to classroom. We can assume that because of that pupils have only short time to change and they have to leave the locker-room quickly and return to classroom, meaning they do not have enough time for personal hygiene after gym class.

Sometimes, pupils excuse themselves from attending gym class even if they have no justifiable reason for that. Most pupils do not excuse themselves without a justifiable reason (77.7%). In that percent the part of girls is much higher (85.4%) then the part of boys (69.7%) ($p = .009$). Results are a little surprising because they show that girls excuse themselves more often then boys. But we have to warn that comparisons with previous researches are not adequate because of the age difference among pupils. We could search the reasons for boys excusing themselves at gym classes more often in differences between on one hand the knowledge and interests in gym classes and the reality of taking this knowledge and interests into consideration on the other hand. During these stages the gym classes are held in gender heterogenic groups in which the exercises are often not demanding enough and are more suitable for girls then boys.

In cases where pupil has no justifiable reason for being excused at gym class, teacher states different excuses that follow in that order:

- I tell the teacher the real reason.
- I get an excuse signed from my parents.
- I say I forgot my gym equipment.
- I say I feel sick.
- I get medical excuse from my doctor.
- I just don't show up at gym class.

Pupils that do not attend gym class and they do not have any medical excuse for that, most of the time tell the teacher the real reason why they do not want to attend gym class. The results are similar to the results of the previous researches, but only in that variable. The second most often excuse is signed excuse from parents. Pupils bring it either after they recovered from real illness or either when they do not want to attend gym class and they ask parents to give them a fake illness excuse (42.4% of pupils brings this kind of excuse at least one time a year). Pupils of 5th grade use this fake excuses more often then pupils of 4th grade ($p = .010$) 45.7% of pupils uses forgotten gym equipment as an excuse at least one time a year, by which it is more often used at pupils that are in fifth grade ($p = .002$). Pupils from 5th grades also use the "I feel sick" excuse more often then pupils from 4th grade ($p = .030$). When asking pupils about what excuses they use to

get excused, 40.8% of pupils told us they bring a fake medical excuse at least one time a year. But we think that these results are not realistic, because there are doubts if the pupils understood the question correctly. As expected the percent of pupils that do not show at gym class at all and do not excuse themselves is the lowest. As we mentioned before because of the way the classes are held from 1st to 5th grade, pupil can not go out or in the classroom or the gym without being noticed, because they are with their teacher all the time.

Pupils occupy time when they are excused from gym differently. Most often activity during this time is watching the gym class (70%). This is opposite of teachers doctrine, because a teacher should find an activity for a pupils that was excused from gym class. According to the Book of regulations about pupil's rights and obligations in elementary school (2004) a pupil should assist the class and perform tasks that do not threaten pupil's health condition. If a pupil can not do any of the tasks, the school must organize a substitute activity for that pupil (article 15 in the Book of regulations about pupil's rights and obligations in elementary school, 2004). Because the gym class does not include only exercises but also theory, a teacher should give adjusted activity to the pupil that was excused. Helping the teacher during exercises is the second most often answer. This help includes preparing the room, requisites, helping judging and so on. Statement "studying for gym class" was misunderstood by the pupils, even if we tried to explain it, because teachers from 1st to 5th grade mostly do not teach theory in gym classes, even if these theories are the base for a good gym class. Even if "Doing activities that teacher told me to do" (like to put in order parts of the gym classroom) is on the 4th place of most frequent answers, the comments and questions from pupils during our research gave us to think that they did not differentiate between "doing activities what teacher told me to do" and "teacher includes me in the activities as his assistant". Namely teachers can not allow a pupil to leave the gym classroom and go out alone without escort. But what makes us concern is the fact that teacher do not think of the gym dressing room as a place where they have no supervision over pupils. Namely 16.6% of pupils did leave the gym classroom and went to the gym dressing room at least once during the gym class.

Comparisons with older pupils show that younger pupils similar like the older pupils mostly just watch during gym class and do not get any other tasks. Learning for other classes is as expected on the last place among answers pupils of 4th and 5th grades gave while this answer is on much higher place among answers that older pupils gave. We think that older pupils sometimes deliberately get excused just so they can prepare themselves for other classes.

CONCLUSION

Because of relatively small sample of results we can not generalize the whole population of 9 and 10 years old children. And because this is the first research made on samples that included younger pupils, we can not compare it with others. We can only compare it with older pupils but these comparisons are not always realistic because of the differences in the development stages of children. Even if the research showed that absence from gym classes is not a problem that would demand special treating it still needs more researches

and attention because the results show that the older are pupils the higher is the absence from gym class making the situation worse.

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OMLUVY Z TĚLESNÉ VÝCHOVY ŽÁKŮ ČTVRTÝCH A PÁTÝCH TŘÍD ZÁKLADNÍ ŠKOLY

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SOUHRN

Výzkumy ukazují, že ve škole jsou děti neaktivnější v tělocvičně – při sportu. Je tedy velmi důležité, aby se účastnily tělesné výchovy, tj. neomlouvaly se a nebyly pasivní. Omluvy z tělesné výchovy již byly na území Slovinska předmětem mnoha výzkumů, nicméně všechny se zabývaly středoškoláky. Tento výzkum je prvním svého druhu zabývající se mladšími žáky. Navzdory faktu, že účast v tělesné výchově je povinností a právem každého žáka, někteří se tělesné výchovy účastnit nechtějí. Proto jsme chtěli zjistit, jak často a jakým způsobem se žáci čtvrtých a pátých tříd omlouvají z tělesné výchovy. Do vzorku bylo zahrnuto 319 žáků čtvrtých a pátých tříd. Zjistili jsme, že absence žáků byla v očekávaném rozsahu, neboť většina dětí nebývá dlouhodobě nemocná. Od mladších žáků jsme očekávali méně omluv než od žáků starších, protože je potřeba tělesného pohybu v tomto období silná. Nejčastějším důvodem absence bývá nemoc, nevyhovující prostory a nedostatek času na osobní hygienu po hodinách tělesné výchovy. V případě neúčasti v tělesné výchově žáci často řeknou učitelů skutečný důvod absence, často také přinesou omluvenku od rodičů. Když se žáci tělesné výchovy neúčastní, většinou ji pozorují; méně často je učitelé zaměstnávají dalšími činnostmi.

Klíčová slova: důležitost pohybu, množství pohybových/sportovních aktivit, účast v tělesné výchově, důvody omluv

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THE INFLUENCE OF HYPO KINESIS AND FREQUENCY STRAIN OF A CAR RIDE ON MECHANICAL FUNCTIONS OF AXIAL SYSTEM CHANGES

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ABSTRACT

In our measurements, we used TVS method to detect mechanical changes of axial system. These mechanical changes can be base for discomfort feeling during monotonous driving in the car.

The TVS method is based on the use of consequent application of continuously changing harmonic stimuli, which periodically differ between 5 Hz and 160 Hz, to the vertebrae C7 and L5. This wave is carried through the axial system and its acceleration on the spinous processes between C7 and S1 is scanned with the help of accelerometric sensors. According to the measured data, it is possible to identify changes of the mechanical properties of the human spine before and after applying hypo kinesis and frequency loading by the car ride.

The research results proved the fact, that the TVS method is suitable for detection of the mechanical changes of axial system. It was also proved that changes caused by a monotonic and frequency loading influence the way of waves transfer through the axial system of the observed participants.

From our data results, that we can compare the subjects more intraindividual than interindividual. We found out that healthy and flexible spine oscillates like elastic bar. It is able to absorb more mechanical energy with higher elasticity and the spinal joints are more flexible. The resonant frequency of the healthy and flexible spine lies between 40 and 60 Hz or higher. In most of the cases we found higher damping and lower transmission of the vibrations after the loading. By some of the subjects we can find different reaction in thoracic and lumbar spine to the loading.

Keywords: Vibrations, hypo kinesis, frequency load, axial system, mechanical properties, vibrations transmission

INTRODUCTION

Monotonous static strain during the car ride together with vibrations from the roadside causes feelings of discomfort after a certain time. Ravnik (2008) found out, that feelings of discomfort when driving a car appeared in 77.8% in musculoskeletal system. Discomforts mostly manifested in the area of a spinal column (72.1%). According to him, the feeling of discomfort appears during the first hour of driving.

Thiffault (2003) made a study with 56 drivers, who drove for 40 minutes on a simulator under two different conditions. First time they drove with the repetitive and monotonous roadside stimuli and second time with visual stimuli disrupting the monotony. In his study they recognized signs of driver's fatigue during the first 20–25 minutes. To evaluate the impact of monotony of the roadside they used steering wheel analysis (SWA). During simulation tests, the location and speed of the vehicle are recorded. A potentiometer attached to the steering column allows detailed recordings of steering wheel movements (SWM).

According to Larue (2010), monotony of the roadside and roadside surroundings can lead to a decrease of a safe driving. According to Ravnik (2008), feeling of discomfort is a provable indicator of musculoskeletal problems, which are dependent on soft tissues strain and local chemical changes.

The work of Johnson (2001) brings us views on why discomfort and pain in the lower back occur due to the increased strain in lower back caused by a long term sitting in the car. His computations show, that even by low level of seat vibrations typical for the car ride (0.5 m/s^2 mean acceleration), the energy absorbed by lumbar spine is close to a power consumption of a small pocket torch. By his calculation is the work (displacement \times force) performed by lumbar spine or absorbed energy $0.40 \text{ J/cycle} = 1.8 \text{ J/s} = 1.8 \text{ W}$. The effect can cumulate in the form of deforming energy and reach dangerous levels after years of using a car, even by low momentary levels. That is caused by normally slow energy dissipation by biologic materials, and location of the effect to the lower lumbar vertebrae.

Sandover (1983) also shows that failure due to fatigue can appear in lumbar spine. A failure of the intervertebral disc can also appear due to fatigue caused by a vibrational strain of driving a car. That similar fatigue is also found in metals due to their cyclic strain.

PURPOSE

In our pilot study we used TVS (transfer vibrations through spine) method to detect mechanical changes of axial system. These mechanical changes can be the reason for discomfort during a monotonous car drive. The TVS (transfer vibrations through spine) method was proved on a mechanical model of spine from wood and silicone, which has similar shape, dimensions, and Young's modulus as a human spine (Kloučková, 2011). The course of detected data was also solved as damping of harmonic oscillator by external force (Maršik, 2010).

METHODS

TVS method (transfer vibration through spine)

The TVS method is based on a continuous change of harmonic stimuli, which periodically differs between 20 Hz and 160 Hz follow. The frequency is changing continuously, so that the subject doesn't get used to the specific frequency, and the vibrations don't harm the body. Harmonic stimuli are applied on C7 and L5 vertebra. A vibrator carries out the excitation. The contact between vibrator and spinous processes of excited vertebra was provided by sufficient contact pressure of vibrator, which was measured and differs around 3.5 N.

The wave is carried through the axial system and its acceleration on each spinous process between C7 and S1 is scanned with the help of the accelerometric sensors. It is expected that the wave transfer speed and its loss while detecting the responses of the human spine to the stimuli is dependent on the characteristics of a tissue, which the wave passes through. The mechanical tissue changes are retroactively characterized by a speed and other characteristics of the wave transmission.

Organization of experiment and subjects

The subjects lie on anti-decubitus mattress with muscles maximum relaxed during the experiment. This position is different from the driving position. On the other hand we could eliminate oscillations of other body parts, especially upper and lower extremities and head, which could devaluate measured signal. By this position, we also eliminate different body posture during measurement.

The whole experiment had different phases. During the first phase the physiotherapist made kinesiology tests with the subjects, tests of mental speed and examination of trigger points (in muscles of neck, back and pelvis). In the second phase the measurement by TVS method before the car ride was made. In the third phase the subjects was driving a car. After the car ride, the kinesiology tests, tests of attention, examination of trigger points and the measurement by TVS method was made for the second time. The details about subjects and length of the car ride are contained in Table 1.

Table 1. Detailed information about subjects and car ride

Subject	Age (years)	Occupation	Height (cm)	Weight (kg)	Length of car ride (hours)	Date of car ride	Sex
P	21	Student	175	62.5	5	21. 3. 2009	Male
L	22	Student	185	85	5	21. 3. 2009	Male
Š1	23	Student	170	74	2	19. 12. 2009	Male
LI1	20	Student	185	74	2	19. 12. 2009	Male
Š2	23	Student	170	74	5.5	20. 12. 2009	Male
LI2	20	Student	185	74	5.5	20. 12. 2009	Male

RESULTS

The model and results show, that it is possible to detect mechanical changes of axial system, especially spine.

In the following figures of graphs, the excitation frequency is on x axis and ratio of acceleration amplitudes, detected on two chosen vertebrae, on y-axis. As numerator are always data from vertebra more distant from the excited vertebra, and as denominator are always data from vertebra closer to excited vertebra. The ratio on y-axis in our graphs always means transmission of the vibrations between the two chosen vertebrae. If we would inverse the ratio on y-axis, we get damping between the two chosen vertebrae. The higher is the value of amplitude ratio on y-axis, the higher is the transmission of vibrations between the two chosen vertebrae and the lower is damping between the two vertebrae. With TVS method it is possible to observe transmission of vibrations in any section of the thoracic or lumbar spine.

In each graph, there is always transmission of the vibrations between two chosen vertebrae before and after the ride in the car by one subject.

To this chapter we chose some graphs to show, how it is possible to use TVS method for detecting changes in mechanical properties of subject's axial system after the car ride and what tendencies we saw by the subjects.

The transmission of vibrations by excitation from L5 vertebra is higher after the car ride, in the whole graph; the damping is lower (Fig. 1, left). After the car ride there is a different left-right reaction of the body – the resonant peaks are splitted. The stiffness is higher after the car ride – all resonant frequencies are shifting to higher values. By excitation from the C7 vertebra in the same segment (Fig. 1, right), the resonant peaks decrease after the car ride, first resonant peak of 22 Hz before the car ride is half after the car ride. Second resonant peak of 33 Hz before the car ride, we don't find after the car ride.

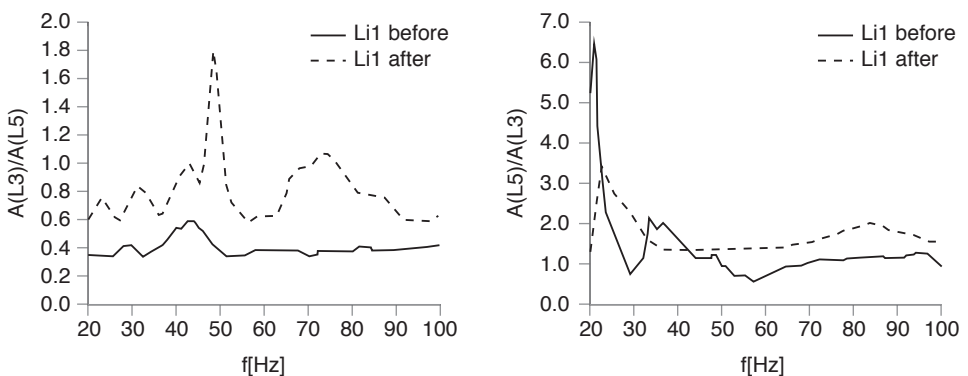


Figure 1. Transmission of the vibrations between L3 and L5 vertebrae before and after the car ride; subject Li1. Left: excitation from the L5 vertebra. Right: excitation from the C7 vertebra.

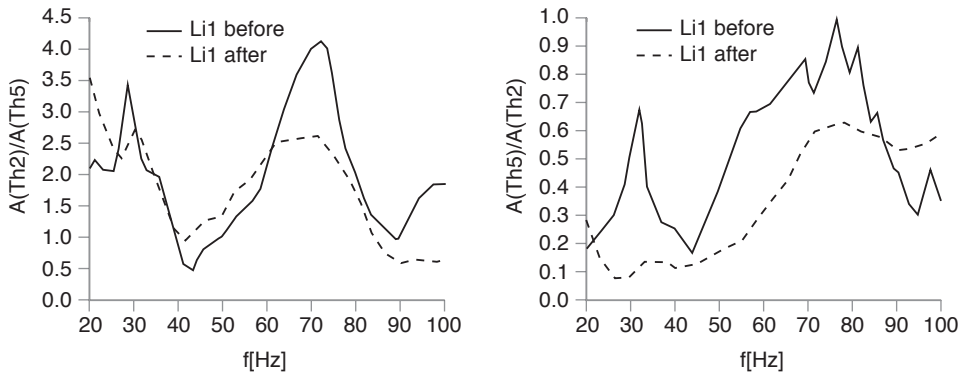


Figure 2. Transmission of the vibrations between Th2 and Th5 vertebrae, before and after the car rides; subject Li1. Left: excitation from the L5 vertebra. Right: excitation from C7 vertebra.

Excitation from L5

On figure 2 left, we can see transmission of the vibrations in thoracic segment, between vertebrae Th2 and Th5. Transmission is preserved in the whole area. Only in the small area of transmission peaks is the transmission after car ride decreased, and damping is increased. That means the opposite respond of thoracic spine to hypokinetic and frequency loading than in the lumbar area of the same subject (Fig. 1, left). First peak of 28 Hz, which occurs before the car ride, moves to 29 Hz after the car ride. Second peak of 70 Hz, which occurs before the car ride, moves to 64 Hz.

Excitation from C7

On the Figure 2 right, we can see almost in the whole graph lower transmission and higher damping after the car ride. That differs from lumbar area, where the transmission after car ride decreases only in the area of first two peaks (Fig. 1, right). The peak moves from 31 Hz before the ride to 32.5 Hz after the ride, it means that stiffness of the subject increases and the damping is higher after the car ride (Fig. 2, right).

By the excitation from L5, the transmission after the ride decreases and the damping increases in the whole frequency area by this subject (Fig. 3, left). We can see two resonant peaks. First moves from 20 Hz before the car ride to 22 Hz after the car ride. The second one moves more significantly from 36 Hz before the car ride to 30 Hz after the car ride. The damping after the car ride is three times higher, which happens to be the highest peak. The right-left symmetry of the body is slightly disrupted – the peaks are bifurcated after the car ride.

The transmission after the car ride was lower, while the damping was higher when excited from C7 (Fig. 3, right). We can see only one important resonant peak by the frequency of 61 Hz before the car ride and one of 62 Hz after the car ride. The resonant frequency moves to the higher frequency after car ride, the stiffness of connection to other vertebrae is higher and the damping is also increased. Damping in the main resonant peak is five times higher after the car ride.

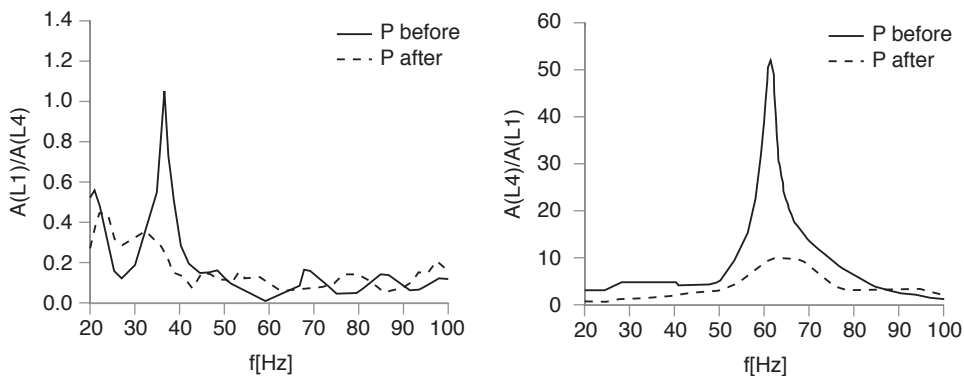


Figure 3. Transmission of the vibrations between L1 and L4 vertebrae before and after 5 hours of the car ride, subject P. Left: excitation from the L5 vertebra. Right: excitation from C7 vertebra.

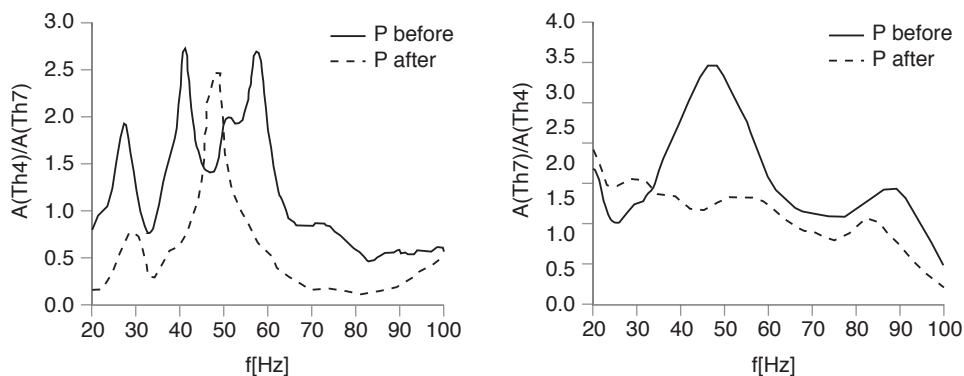


Figure 4. Transmission of the vibrations between Th4 and Th7 vertebrae before and after 5 hours of the car ride, subject P. Left: excitation from the L5 vertebra. Right: excitation from C7 vertebra.

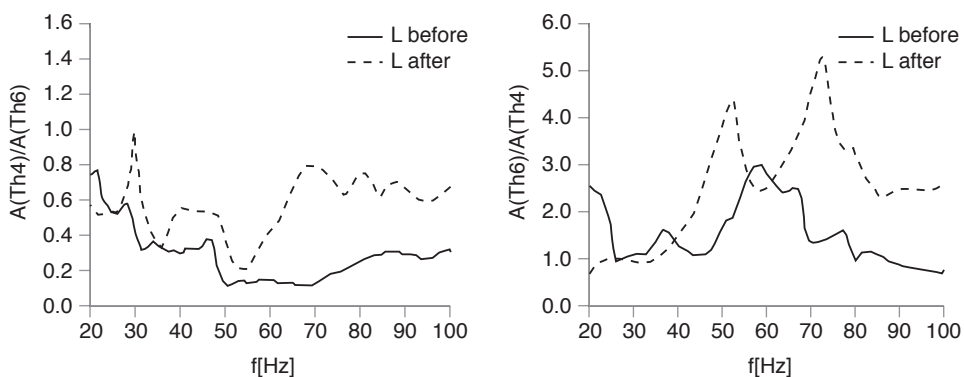


Figure 5. Transmission of the vibrations between Th4 and Th6 vertebrae before and after 5 hours of car ride, subject L. Left: excitation from the L5 vertebra. Right: excitation from C7 vertebra.

This subject shows higher damping and lower transmission between Th4 and Th7 vertebrae (Fig. 4, left and right) after exciting from both C7. At both graphs, the transmission is less than half after the car ride by the main resonant frequency, the resonant frequency moves from 45 Hz before car ride to 51 Hz after the car ride. Thoracic and lumbar segment react both the same by subject P, by excitation from C7 and also by excitation from L5 (Fig. 3 and 4). In all four cases the transmission is lower and the damping higher after the car ride.

By subject P, we can see lower damping and higher transmission in thoracic segment between Th4 and Th6 vertebra by the excitation from both sides – C7 and L5 vertebra. The course of the graph is similar before and after the car ride (Fig. 5, left and right). This differs from the previous subject P, by which the damping increases and the transmission decreases after the car ride in the similar thoracic segment between Th4 and Th7 vertebrae (Fig. 4). By the L subject (Fig. 5, right), the resonant peaks move from 36 Hz and 57 Hz before the car ride to 51 Hz and 72 Hz after the car ride, by the excitation from C7 vertebra.

DISCUSSION

Our model and measured data show, that it is possible to use the TVS method to detect changes in mechanical properties of the axial system before and after the strain. In this case, frequency strain when driving a car.

From our data results, that we can compare the subjects more intra individual than inter individual. The reaction of each subject to hypokinetic and frequency strain differs. It is clear, that different transmission of vibrations by each subject depends on body construction and rigidity of axial system, which may differ with muscle tension, hypermobility and water content by each subject. Our results confirm findings that were also made by Fairley in his study (1989).

By our measurements we found out, that healthy and flexible spine oscillates like elastic bar. It is able to absorb more mechanical energy with higher elasticity, and the spinal joints are more flexible. During our measurement with TVS method we found out, that the resonant frequency of the healthy and flexible spine lies between 40 and 60 Hz or higher. If the spine is less flexible, it tends to oscillate less and it reacts less to a vibratory excitation. Its joints are less relaxed and elastic (Panská, 2012). The resonant frequency is mostly determined by shear modulus of cartilage. The viscosity is responsible for damping of oscillations (muscles and ligaments). Transmission of the vibrations is, on the other hand, dependent mostly on elastic modulus (vertebrae and their joints) (Maršík, 2010). However, we didn't take into the account the lowest frequencies 0–20 Hz, for which we didn't have a vibrator.

In most of the cases we found higher damping and lower transmission of the vibrations after strain. However, with some of the subjects the monotony and frequency strain worked against our expectations positively and spine behaved like after physical exercises. We found bigger peaks with higher frequencies after the car ride with TVS method. The spine is oscillating better and it is more flexible after the car ride, the elasticity of the vertebrae joints increases (Fig. 1, left; Fig. 5, right).

By some of the subjects we can find different reaction in thoracic and lumbar spine to strain (e.g. subject Li1 by excitation from L5 in the area between L3 and L5 vertebrae and between Th2 and Th5 vertebrae – Fig. 1 and 2). It can be caused by different anatomy of thoracic and lumbar spine and also by the fact, that thoracic spine is connected to thorax and breathing, while there is abdominal cavity filled with abdominal organs in front of the lumbar spine.

ACKNOWLEDGEMENTS

This experiment was supported by grants: GAČR P407/10/1624, PRVOUK 38 and specific university research SVV 2013-267603.

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VLIV HYPOKINÉZY A FREKVENČNÍ ZÁTĚŽE NA ZMĚNU MECHANICKÝCH VLASTNOSTÍ AXIÁLNÍHO SYSTÉMU PŘI JÍZDĚ V AUTOMOBILU

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SOUHRN

V našem experimentu jsme použili metodu TVS k detekci mechanických změn axiálního systému. Tyto mechanické změny mohou být podkladem pro pocit diskomfortu během monotónního zatížení během jízdy v automobilu.

Metoda TVS je založena na aplikaci harmonického buzení plynule se měnícího od 5 Hz do 160 Hz na obratle C7 a L5. Toto vlnění se přenáší podél axiálního systému a akcelerometrickými snímači je snímáno zrychlení všech trnových výběžků obratlů, kterými se vlnění šíří mezi C7 až S1. Na základě naměřených dat lze vyhodnotit změnu mechanických vlastností páteře před a po hypokinéze a frekvenčním zatížení při jízdě v automobilu.

Náš výzkum prokázal, že metoda TVS je vhodná pro detekci změn mechanických vlastností axiálního systému. Dále bylo prokázáno, že změny způsobené monotónním a frekvenčním zatížením ovlivňují způsob přenosu vlnění axiálním systémem subjektů. Z našich naměřených dat vyplývá, že můžeme subjekty srovnávat spíše intraindividuálně než interindividuálně. Zjistili jsme, že zdravá a flexibilní páteř osciluje jako elastická tyč a je schopna absorbovat více mechanické energie a spojení na páteři jsou více flexibilní. Rezonanční frekvence zdravé a flexibilní páteře se při našich měřeních objevuje mezi 40 a 60 Hz nebo výše. Ve většině případů nacházíme po jízdě v automobilu vyšší tlumení a nižší přenos vibrací. U některých subjektů se objevuje odlišná reakce na zatížení v hrudní a bederní páteři.

Klíčová slova: vibrace, hypokinéza, frekvenční zatížení, axiální systém, mechanické vlastnosti, přenos vibrací

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OPTIMAL VELOCITY TO ACHIEVE MAXIMUM POWER OUTPUT – BENCH PRESS FOR TRAINED FOOTBALLERS

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ABSTRACT

In today's world of strength training there are many myths surrounding effective exercising with the least possible negative effect on one's health. In this experiment we focus on the finding of a relationship between maximum output, used load and the velocity with which the exercise is performed. The main objective is to find the optimal speed of the exercise motion which would allow us to reach the maximum mechanic muscle output during a bench press exercise. This information could be beneficial to sporting coaches and recreational sportsmen alike in helping them improve the effectiveness of fast strength training.

Fifteen football players of the FK Třinec football club participated in the experiment. The measurements were made with the use of 3D cinematic and dynamic analysis, both experimental methods. The research subjects participated in a strength test, in which the mechanic muscle output of 0, 10, 30, 50, 70, 90% and one repetition maximum (1RM) was measured. The acquired result values and other required data were modified using Qualisys Track Manager and Visual 3D software (C-motion, Rockville, MD, USA). During the bench press exercise the maximum mechanic muscle output of the set of research subjects was reached at 75% of maximum exercise motion velocity.

Keywords: output performance, dynamic motion analysis, cinematic motion analysis, model, bench press, motion velocity

INTRODUCTION

Maximum muscle output with a given load is the main determinant of performance during physical activities requiring one motion sequence aimed at reaching high velocities during the lift and lowering phases. Neuromuscular activities maximizing output power are necessary in many other exercises such as throwing, jumping and strokes. Apart from the mentioned exercises, sudden increases in output power are needed during sudden changes in

direction or acceleration in different sports and other sporting activities (for example: American football, basketball, football, baseball, gymnastics)” (Kraemer & Newton, 2000).

Same as in other sports the best possible output performance of the upper limb is essential in football. From the point of view of motion coordination, upper limbs play an irreplaceable role, as it is unimaginable for a footballer to undergo a clash with an opponent during a match without the use of upper limbs. The footballer must be able to coordinate his body movements in the shortest possible time. The upper limbs play an important role determining motion velocity. Nowadays it is impossible for a football player to be slow and successful at the same time, therefore the right, effective and dynamic movement of the arms contributes to the overall speed of a player. Modern football coaches thus put emphasis in speed training on exercising the upper limbs and finding the optimal speed for reaching the maximum mechanic muscle output, which would help to increase the effectiveness of training and at the same time increase the performance of player and decrease the risk of injury to the upper limbs.

Hill (1938) was one of the first to search for the optimal velocity of reaching maximal mechanic muscle output and was the first to demonstrate, that the optimal load for reaching maximal mechanic muscle output amounts to 30% of maximum isometric force F_0 . Hill’s measurements were performed on an isolated frog muscle at 0 °C, which may not correspond to the mechanics of a human muscle.

Our main objective is to identify relative motion velocity allowing the set of research subjects to reach the maximum mechanic muscle output during a bench press with counter-movement exercise. The establishing of an optimal velocity and load for reaching maximum mechanic muscle output would contribute to the rationalization of the base load for specific speed trainings (Jandačka, 2008).

METHODS

Tested subjects

15 trained football players participated in the experiment at the beginning of the season (summer). Their age, height and weight (average \pm st.dev.): 26.1 ± 3.9 years, 183.3 ± 6.7 cm, 78.8 ± 7.2 kg. All tested subjects signed an informed consent form. They were members of the same football club. Other information on the subjects is presented in Table 1.

Table 1. Average values of the 15 member football team FK Třinec

Complex	The average age of the test persons	The average age of people tested in the interval	The average of body height	The average of body height in the interval	The average of body weight	The average of body weight in the interval
15 trained football players in the club FK Třinec	26.11 ± 3.87 years	19–33 years	183.3 ± 6.73 cm	1.70–1.96 m	78.8 ± 7.17 kg	65–91 kg

Test proceeding

Each tested subject visited the laboratory twice in a one week interval. During the first visit the subjects were instructed in the correct technique of the bench press. The degree of movement of each subject was established in the chest-touch position and was monitored by a sound signal at the lowest and highest points of the movement's trajectory. The Body Segment Composition Analyzer (*TANITA 418 MA, USA*) was used to measure height, overall weight and the weight of individual segments of the upper limb. The first lab visit also included the testing of the maximum output with one repetition according to the protocol published by Kraemer, Ratamess, Fry and French (2006).

The second visit to the laboratory by the research subjects included the measuring of output during the bench press exercise with the base load being gradually increased from 0, 10, 30, 50, 70 to 90% with one repetition. Reflexive markers were placed on a subject's *acromion, medial epicondyle of humerus, lateral epicondyle of humerus, radial styloid process* and on the *lateral and central sections of the barbell*. Also, 4 light durable plates each carrying three markers were placed on the upper upper limb segment and the forearm.

As soon as the tested subject assumed the starting position on the bench with no load, the output power measuring platforms were calibrated to zero. The footballers assumed a bench press lifting position with their feet being placed on a footrest attached to the bench and chose individual grips of the barbell that they regularly use during the exercise. After capturing a static record, in which the subjects were asked to stand in a starting upper position with the barbell and three acceptable lifting attempts were recorded with each load. An accepted attempt is such an attempt in which the subject kept his movements in the specified range during the lift. The subjects were instructed to lower the barbell in a controlled fashion until they reach the lowest position. Once this position was reached a sound signal went off (*equipment FitroDyne Premium, Fitro, Slovakia*) and the subject was asked to perform a lift with maximum velocity. The subjects were also instructed not to raise their torso from the bench or toss up the barbell. A three minute rest period was set in between lifts. Three lift attempts were recorded for each load. Average values of the three attempts were used for further analysis.

Experimental settings

Two output power measuring platforms (*Kistler 9281CA and 9286AA, Switzerland*) built into the floor beneath the bench taking in data with a frequency of 988Hz were used to measure the contracting forces between the bench and the pad during the lift. 3D upper limb motion data was taken by a seven camera motion recording system (*Qualisys Oqus, Sweden*) with a recording frequency of 247 Hz during the bench press exercise. A linear position converter (*FitroDyne Premium, Slovakia*) emitted sound signals which were heard by the subjects. The sound signal changed when downward motion changed into upward motion. The testing exercise was performed with a loose barbell without the use of bearing rails.

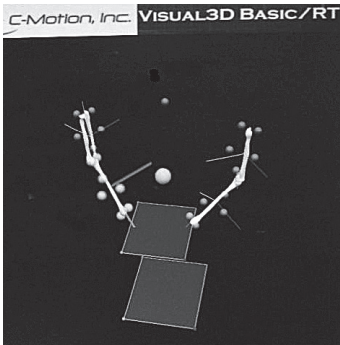


Figure 1. Representation of the model's processing in Visual 3D software (C-motion, Rockville, MD, USA). Note: The figure was taken at the Center for human motion diagnostics in Ostrava.

Data analysis

Output (**W**) was calculated as the multiple of the vertical force (**N**) and the vertical velocity (**m/s**) of the centre of gravity (center of gravity of the upper limbs segments and the barbell). The center of gravity's velocity was a necessary parameter which was calculated by the V3D software. The data acquired with the help of reflexive markers was processed by the Visual SD software (*C-motion, Rockville, MD, USA*). The processed data is shown in Table 1. All upper limb segments except for the palms were modeled as truncated cones, the barbell was modeled as a cylinder. Vertical force (**N**) was established as the sum of two signals from two force measuring platforms recording vertical forces applied on the pad (**N**) and the weight of upper limbs (**N**). The upper limb weight (**N**) was calculated as the multiple of the upper limbs mass (**kg**) and gravitational acceleration. Output power (**N**) was determined for each lift with each load. We analyzed the segment of a movement which demonstrated positive output (**W**).

By determining the velocity (**m/s**) of the center of gravity an acceleration and deceleration phase of upward movement (lift) was established. In this manner the average output for each lift with each load (**% 1RM**) during positive output motion and the acceleration phase was determined. The maximum output (**W**) was the absolute maximum for all loads.

STATISTICAL ANALYSIS

The output (**W**) to maximum output (**W max**) ration was established for each subject with each load (**kg**). The resulting average values for each load and velocity were used to create a multi-linear regression model, which describes the quadratic relationship between the output to maximum output ratio and the load to velocity ratio for two data sets.

This regression model (in Figure 2) was created in accordance with the least squares method using Matlab software. The created model may be expressed by this formula:

$$\frac{P}{P_{mm}} = b_1 \left(\frac{L}{1RM} \right)^2 + b_2 \left(\frac{v}{v_{mm}} \right)^2 + b_3 \left(\frac{L}{1RM} \right) \cdot \left(\frac{v}{v_{mm}} \right) + b_4 \left(\frac{L}{1RM} \right) + b_5 \left(\frac{v}{v_{mm}} \right) + c$$

Figure 2. The regression model (Hori et al., 2007)

P_{mm} being the average maximum output (**W**), P the average output (**W**), $1RM$ is the maximum load (**kg**), L is the load (**kg**), v_{mm} is the average maximum velocity (**m/s**), v is the average velocity (**m/s**), b_1 , b_2 , b_3 , b_4 and b_5 are regression coefficients and c is the regression constant. The validity of the two constructed linear regression models was established (Hori et al., 2007).

We used the Statgraphics Plus software to verify the key assumptions, which must be valid. The optimal load and the velocity of the regression model was established by the trust region method in combination with the Quasi-Newton method. We used the Levenberg-Marquardt implementation of the trust region method in the Matlab computer program. At the end we utilized the Statgraphic Plus software to calculate the **95% confidence interval**.

RESULTS

The determination coefficient for the creation of the regression model is **0.7353**. The created regression model may be seen in Figure 3. In the visual representation of the model we may see a color 3D pattern depicting the relative relation between the output (% P_{mm}), velocity (% v_{mm}) and the load (% $1RM$).

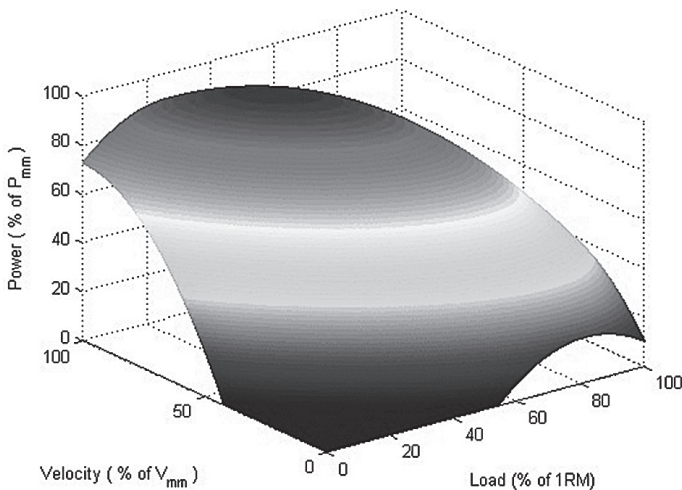


Figure 3. Regression model describing the relation between relative output (% P_{mm}), velocity (% v_{mm}), load (% $1RM$) (experimental data by author)

The resulting model is depicted from the side (slightly turned to the left) to allow us to see all axes. The **X axis** depicts the velocity of the explosive force of the performed bench press exercise expressed in percentage v_{mm} , which was the main objective of our research experiment. The optimal mass for attaining the maximum mechanical muscle output expressed in % $1RM$ is depicted on the **Y axis**. Prior research (Billich, 2010) shows, that the maximum mechanic power output of a set of tested subjects was attained with a relative percentage mass load of 52% $1RM$. This load figure could be the optimal load for non-ballistic training, during which the maximum power output during the shortest possible period of time should be achieved. The maximal mechanic muscle output expressed in % is depicted on the **Z axis**. The result may be observed in the color combination of stacked up layers, from which we can ascertain the optimal velocity for attaining the maximum mechanic muscle output which accounts to **74.5779%** v_{mm} by lowering a perpendicular from the center of the red field onto the X axis. The optimal velocity is dependent on the use of the optimal load (% $1RM$) and output (% P_{mm}).

Figure 4 depicts the contour of the regression model which represents the result in 2D representation when looked at from above. This contour is composed of two axes. The **X axis** representing the optimal load for attaining maximum mechanic muscle output expressed in % $1RM$, is dependent on the previous measurement of $1RM$, which is unique for each individual. The **Y axis** depicts the optimal velocity of the burst force of each bench press expressed in % v_{mm} . The resulting relation of these two quantities is represented by the red cross. This cross shows us that the maximum mechanic output which is attained when the value of the burst force velocity during a bench press exercise is **74.5779%** v_{mm} depending on the optimal load which is set at around 40% $1RM$.

The resulting optimal value of the velocity at which maximum mechanical muscle output is reached is **74.5779%** v_{mm} .

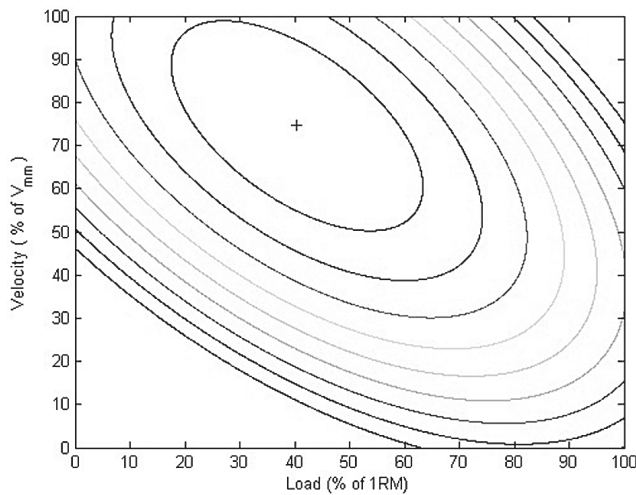


Figure 4. Regression model contour, which represents the relation between the relative output (% P_{mm}), velocity (% v_{mm}) and load (% $1RM$). The cross represents the point of the maximum mechanic output (experimental data by author).

DISCUSSION

The aim of this paper was to determine the optimal velocity for attaining the maximum mechanic muscle output during bench press performed by trained football players.

First we created a regression model describing the mutual relation between output, maximum dynamic force, maximum velocity, load, maximum output. The model corresponds with the acquired data. The value of the determination coefficient between the measured data and the model is 0.74 for the acceleration phase and 0.75 for the whole positive output period. This confirms that the regression model corresponds to the measured data. The model establishes the dependence of the output on the external load and incorporates data on motion velocity of a given exercise. It can be used not only for the determining of the optimal load for attaining the maximum output but also for determining any of the included parameters: load, output, velocity, maximum output, maximum velocity or the one repetition maximum.

From Hill's equation we were able to deduce that the maximum mechanic muscle output is attained by about a one third of the maximum force and maximum instant velocity (Hill, 1938). Our model projects that for the acceleration phase of the bench press lift with a 1RM load the optimal average velocity is 74.58% (lower boundary of the confidence interval being 70.32% and the upper boundary being 87.14%) v_{mm} . The optimal average velocity of motion established in our study significantly differs from the optimal 30% of the peak of the maximum velocity laid down by Hill. When approximating the optimal load and velocity needed to reach the maximum muscle output during the positive output phase of the bench press lift our model assumes the optimal velocity at 74.58% v_{mm} (with the lower boundary of the confidence interval being 65.62% and the upper boundary being 98.15%).

CONCLUSION

The optimal velocity for attaining maximum output in a set of trained football players with similar strength capacity was set at 75% v_{mm} . From the acquired data we were able to construct a regression model, which allowed us to calculate the optimal velocity of a bench press exercise. There is a number of myths among professional football coaches established in the past which unfortunately still influence the fashion in which they conduct training. The result is the low effectiveness of training exercises. Therefore we decided to focus our study on the widely used bench press exercise and its optimal lift velocity. The lack of knowledge of the optimal velocity in many cases leads to ineffective training sessions from the point of few of the power output but also increases health risks which can lead to injury such as biceps and triceps ruptures.

For trained football players with a similar strength capacity, this study set the optimal velocity for attaining maximum output at **74.5779%** v_{mm} . Instructing an exercising subject on the percentage of the maximum velocity he should comply with is in practice impossible. **74.5779%** of the maximum velocity cannot be determined without the use of special measuring equipment, such as Fitrodyne premium. Before beginning a bench press exercise it is necessary to measure the maximum lift velocity. This value

can subsequently be used to calculate the optimal velocity. For example the maximum velocity of a lift conducted by a football player with a load of 50 kg is 100m/s, the optimal velocity is therefore **74.5779 m/s**. The training session must be under the constant supervision of the couch, who can with the help of Fitrodyne Premium guide the subject on the optimal velocity which will improve the effectiveness of the exercise. The subject benefits by exercising in an effective and health-risk-free fashion. The set optimal velocity prevents overloads and at the same time guarantees effective muscle strength training.

LIST OF SYMBOLS

BP	The pressure of the touch lying on bench (Bench Press)
E	Energy
F	Strenght (N)
F_{mm}	Maximum achieved strength
F_0	Maximal isometric (static) strength (N)
FR	Reaction force (N)
m_{opt}	Optimal weight load (kg)
MDS	Maximum dynamic force
P	Power (W)
P_m	Maximum mechanical muscle performance achieved when the size parameters of motor task does not change (W)
P_{mm}	Maximum mechanical muscle performance achieved when the size parameters of the motor task systematically changing (W)
P_{max}	Maximum power (W)
RM	Repetition maximum (kg)
r	The correlation coefficient
s	Track (m)
sd	The standard deviation
t	Time (s)
TO	The test subject
v	Velocity (m/s)
v_{mm}	The maximum speed achieved when the size parameters of motor task systematically changing (W)
v_{opt}	Optimal speed (m/s)
1RM	One-repetition maximum (kg)

ACKNOWLEDGEMENT

The study was supported by the GAUK 364 811, SVV 2013-267603, PRVOUK 38, GAČR P407/10/1624.

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OPTIMÁLNÍ RYCHLOST POHYBU PRO DOSAŽENÍ MAXIMA VÝSTUPNÍHO VÝKONU – BENCH PRESS U TRÉNOVANÝCH FOTBALISTŮ

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SOUHRN

Dnešní svět silového tréninku přináší řadu mýtů o tom, jak cvičit efektivně a zároveň s co nejmenším negativním vlivem na zdraví člověka. V tomto experimentu se zabýváme nalezením vztahu mezi maximálním výkonem, použitou zátěží a rychlostí. Hlavním úkolem je nalezení optimální rychlosti pohybu pro dosažení maximálního mechanického svalového výkonu při cvičení bench press, což pomůže nejenom trenérům, ale i rekreačním sportovcům zefektivnit trénink rychlé síly. Tohoto výzkumu se zúčastnilo 15 fotbalistů týmu FK Trinec. Měření probíhalo za použití 3D kinematické a dynamické analýzy pohybu experimentální metody. Zkoumaná skupina se zúčastnila silového testu, u kterého byl měřen mechanický svalový výkon s 0, 10, 30, 50, 70, 90 % a jednoho opakovacího maxima (1RM). Získané hodnoty výsledků a potřebné údaje byly následně upravovány v programech Qualisys Track Manager a Visual 3D software (C-motion, Rockville, MD, USA). Při cvičení bench press bylo maximálního mechanického svalového výkonu dosahováno u výzkumného souboru při rychlosti cvičení 75 % maximální rychlosti.

Klíčová slova: výstupní výkon, dynamická analýza pohybu, kinematická analýza pohybu, model, bench press, rychlost pohybu

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TERRITORIAL JUSTICE AND SPORT: PUBLIC SUBSIDIES TO SPORT IN CZECH REGIONS

JAKUB POPELKA

ABSTRACT

This study draws upon the works of Gratton and Taylor (1991) and Gratton (1984). The article discusses the concept of territorial justice and its possible use with respect to the Czech conditions. Based on statistical data provided by the Czech Statistical Office (2013) and the author's own investigations, the relationship between regional subsidies to sport from the regional authorities and selected indicators of deprivation are examined. The analysis indicates that correlations between the indicators of deprivation and sport subsidies from the regional authorities are not statistically significant. Research findings may indicate that resources were not distributed efficiently. The evidence suggests that territorial distribution of the subsidies to sport is inconsistent with the needs of the regions. In discussion, limitations of this study and future research directions are discussed.

Keywords: territorial justice, sport, Czech Republic, regional authority, subsidy, deprivation

INTRODUCTION

Understanding of sport and reasons for sport subsidization have evolved over the years. In the context of this text, sport is seen in its wider meaning as organized or casual activity of all people for the purpose of performance or well-being. In the nineteenth century the principles of the support combined, for example, improvement of life of working classes; improvement of health for war reasons; and moral welfare (Coalter, 2007). In socialist countries, sport was understood as an instrument for workers' regeneration after working hours. Nowadays, sport is perceived more comprehensively (European Commission, 2007; Coalter, 2007; Bloyce & Smith, 2009). Most of the world operates under market economic system. However, market mechanism produces inefficiencies in allocation of resources. Gratton and Taylor (1991) distinguish two categories of market failure as the arguments for government involvement in sport: efficiency-related and equity-related. Regarding the efficiency-related arguments, market can be efficient for the participants

but it is not necessarily efficient for society as it fails to take account of any additional social benefits of sport. "Government, accepting responsibility for social welfare, has a reason to encourage higher production and consumption – by subsidizing consumers, subsidising suppliers in the commercial and voluntary sector, or directly by supplying the product at the lower price" (Gratton & Taylor, 1991, p. 56). Equity-related arguments may be used by government as a reason for subsidising consumers or suppliers in order to achieve equitable sport environment for all (Gratton & Taylor, 1991).

Regardless of market failure, Veal (2002) also mentions less technical arguments for government involvement. Veal names, among others, equity/humanitarian; economic management and development; and tradition as the reasons for the involvement of government in sport and leisure. The first argument – equity/humanitarian – is based on the assumption that certain goods and services should be available to all, regardless of their ability to pay, and that some leisure goods and services are among the minimal package required for satisfactory quality of life (Veal, 2002). However, Veal points out that this idea is controversial in application with regard to taxation and lack of interest of people in sport. Moreover, subsidizing everybody for the sake of a small number of poor users is costly. Veal suggests that some means of targeting should be found. Economic management/development arguments can be observed in practice at both national or local level. The authorities often feel justified in intervening directly to assist such industries that can provide jobs or income. Concerning tradition, some publicly provided services are maintained because of tradition. Veal proceeds that there can also be lobby or interest groups which causes such situations. Nevertheless, this case may be caused naturally by popularity of a particular sport at regional level. However, if the market is supplemented or supplanted, then resource allocation is based not on demand but on criteria of equity which are politically determined (Boyne & Powell, 1991).

The concept of territorial justice was developed by Bleddyn Davies (1968). He defined the territorial justice as an area distribution of provision of services such that each area's standard is proportional to the total needs for the services of its population. "If resources were allocated to each according to the needs of the particular area, we should get a perfect positive correlation between standards of provision and an index measuring the relative needs of each area for the service" (Gratton & Taylor, 1991, p. 107). In this context of the territorial justice, Davies has argued that the need indicator must be based on a normative theory of intervention. For the meaning of a need indicator to be clear, the indicator must be theoretically based (Davies, 1968).

Gratton (1984) and Gratton and Taylor (1991) expanded this concept to sport and its provision. According to the authors, it is important to show that inequality in the distribution of resources results in those most in need being in receipt of these resources. The process of assessing the effectiveness of government policy involves first of looking at how the distribution of resources is related to the distribution of recreational need and secondly the extent to which the most needy receive the resources directed at them (Gratton & Taylor, 1991). This study is focused on the first part of the process. Gratton (1984) observed tremendous variability in expenditures on sport and recreational facilities by local authorities in England and Wales. Then he proceeded to define measuring of recreational need. "The concept of recreational need is closely related to other areas of deprivation" (Gratton & Taylor, 1991, p. 109). According to Dower et al. (1981), some

official reports have shown that recreational disadvantage tends to coincide with social deprivation. Gratton and Taylor pointed out that recreation participation is positively related to income; occupational status; educational achievement; car ownership; and employment status. Gratton (1984) correlated three indicators (the number of unskilled manual workers per 1000 population in their area, the percentage of households in the area owning one car and the percentage with two cars) with subsidization of sport by local authorities. The results were surprising – every correlation coefficient had the sign if subsidies were distributed efficiently. The evidence suggested that the distribution of subsidies was consistent with resources directed to the neediest areas. In the next study (Gratton & Taylor, 1991), more indicators of social deprivation were used. They defined Economic Z-score as it was considered to be closely related to recreational deprivation. The economic Z-score consisted of unemployment with a weight of four; percentage overcrowded households; percentage single parent households; percentage of households lacking exclusive use of basic amenities; percentage pensioners living alone; percentage of residents living in households where the head of household was born in New Commonwealth or Pakistan. The authors added “recreational index” with the percentage of households with no car and the percentage of households with the head of household having an unskilled manual occupation. These indicators have been correlated with net revenue expenditure on particular sport facilities in English and Welsh districts.

Among more contemporary studies of territorial justice related to sport, Panter, Jones and Hillsdon (2008) examined associations between household income and access to sport facilities in an English city. For all facility types except gyms, mean income was lowest amongst people who lived farthest away. In general, those living farther from facilities reported that they were less active although they did not tend to report a desire to exercise more. Deng, Walker and Strager (2008) conducted a case study of distributional equity of golf courses as they relate to Chinese residents and other disadvantaged groups in Calgary, Canada, over a 10 year time span. A practical example of the use of linkage between deprivation and sport needs can be seen on a sport-based initiative in the UK, the Spaces for Sports programme in 2004. Among the main purposes of the programme was the development of community sport facilities and increase sport participation in areas of high social and economic deprivation (Bloyce & Smith, 2009).

Measuring deprivation is widely discussed in literature. Deprivation is often measured using indices valid for certain territories and for certain time period. During the last thirty years, there have been many different indices of socioeconomic deprivation. The indices combine different variables that can indicate potential deprivation. For example, for construction of Index of Deprivation in England in 1991, the following indicators were used: unemployment; children in low-income households; households who do not own a car; households lacking basic amenities; overcrowded households; persons aged 17 years who have not attend full-time study. The Index of Multiple Deprivation (IMD 2010) for England combines the following indices: income deprivation and employment deprivation; health deprivation and disability; education, skills and training deprivation; barriers to housing and services; crime; and living environment deprivation (Nolan et al., 2012).

Bureš (2010) from the Transparency International focused on financing of sport from the Czech regional authorities. The results of the study reveal significant differences in

financing but also in conceptual work and subsidy procedures. Bureš also highlighted year-on-year differences which could misrepresent results of this study. It coincides with Numerato (2009) who argues that regional sport policies in the Czech Republic are less strategic, less institutionally complex, less ideologically anchored and more pragmatic and ad-hoc. Moreover, it has been argued that Czech regional public support for sport rarely serves to deliver social welfare objectives as is currently common in other countries (Numerato, 2009).

PURPOSE

The main objective of this study is to find out whether the sport subsidies from regional authorities respond to the needs of the regions in the Czech Republic according to selected indicators of deprivation.

METHODS

Based on the work of Gratton (1984) and Gratton and Taylor (1991), the author used correlation analysis to investigate the direction and strength of relationships between regional subsidies on sport and chosen indicators of deprivation. Pearson correlation coefficient was used for the purpose of the study. The indicators were selected on the basis of Gratton's study (1984), literature review and deprivation indicators used in the United Kingdom. The author also used "number of sport facilities" indicator to observe the relationship between public subsidies and number of sport facilities. Thirteen regions, which cover the whole area of the Czech Republic apart from Prague, were chosen for the study. Prague region was purposefully omitted with regard to its specific status. For the purposes of this study, the following indicators were selected for each region:

- i. crimes per 1000 population (CRI);
- ii. percentage of unskilled head of household (UHH);
- iii. percentage of households with car (PCH);
- iv. registered unemployment rate (UNE);
- v. number of sport facilities per 10 000 population (QSF).

Apart from the last indicator (QSF) identified in 2006, all indicators and subsidies relate to 2011. As this is the first study of this type in the Czech Republic, the author decided not to define "sport need index" from the indicators. Thus, the indicators were separately correlated with sport subsidies per total expenditure of the authority and with the sport subsidies per head. The absolute values of all data were also ranked (1–13) to reduce the influence of extreme values.

RESULTS

Table 1 shows the amounts of sport subsidies as a percentage of total regional expenditure (Subsidy per expenditure) and per head (Subsidy per head). These "indicators"

correspond to the results of Bureš (2010). Subsidies per expenditure vary from 0.04% to 0.49% of the overall regions' expenditures. Regarding subsidy per head, the results are also quite varied. The difference between the highest (92) and the lowest (9) amount is more than ten-fold.

Table 1. Subsidies in the regions of the Czech Republic

Region	Subsidy per expenditure (%)	Subsidy per head (CZK)
STC	0.09	21
JHC	0.10	27
ULK	0.49	81
LBK	0.15	31
KHK	0.05	16
JHM	0.16	36
VYS	0.12	46
KVK	0.12	39
MSK	0.04	9
PLK	0.15	40
ZLK	0.24	61
OLK	0.32	92
PAK	0.13	36

The following figures (Figure 1–4) illustrate the correlations between the indicators of subsidy and selected indicators as “representatives of deprivation” (*r is significant if p-value < 0.05*). The fact that the results of correlations for CRI, UHH and UNE are positive and PCH is negative might indicate that the subsidies are distributed with regard to the needs of regions. However, with regard to the subsidy per head, Figure 2 illustrates generally smaller correlations than those reported in Figure 1 (subsidy per expenditure).

All the data in Figure 3 and 4 were ranked (1–13) in order to eliminate extreme values in Figure 1 and Figure 2. Some of the significant correlations from Figures 1 and 2 seem to be insignificant in Figures 3 and Figure 4. Moreover, all the Figures indicate that there is no significant correlation between subsidies and crime, car ownership or number of sport facilities in regions. On the other hand, positive significant correlation between unemployment and subsidies persist from Figure 1 to Figure 3.

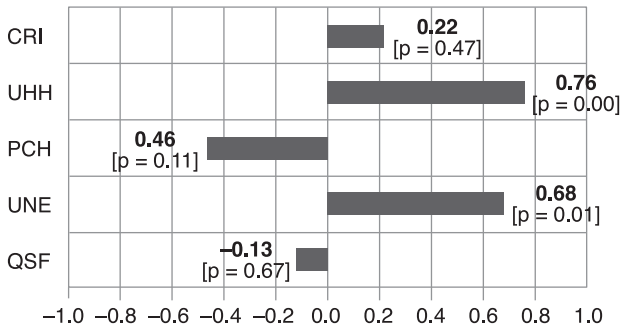


Figure 1. Relationship between deprivation and subsidies per expenditure

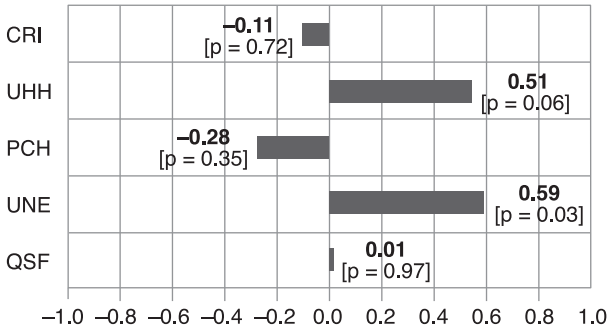


Figure 2. Relationship between deprivation and subsidies per head

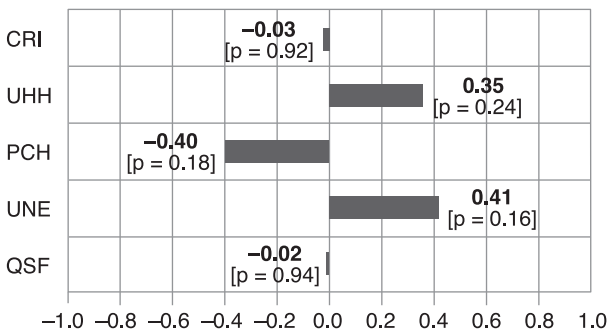


Figure 3. Relationship between ranked deprivation and ranked subsidies per expenditure

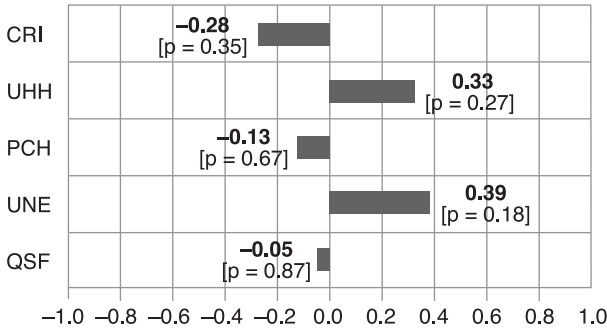


Figure 4. Relationship between ranked deprivation and ranked subsidies per head

DISCUSSION

With regard to the results, there are significant differences in sport subsidies by regional authorities in the Czech Republic. This coincides with the results of previous studies (Slepičková & Flemr, 2007; Numerato, 2009) which stress the differences among the regions and absence of conceptual approaches by the authorities. The results show that there is not any relationship between regional subsidies and the number of sport facilities. This could indicate that certain regions with the small number of sport facilities per head are not getting closer to the regions with the higher number of sport facilities. Nevertheless, it must be stressed that the data on number of sport facilities do not respond perfectly to the current state given the year of the data and the methods of the inquiry.

Regarding the concept of territorial justice, it seems the differences among regions are not caused by the needs in regions. The significant correlations in Figures 1 and 2 may be biased by the absolute values of the indicators. According to Figure 4, it seems that subsidies do not respond to the deprivation indicators. It is worth noting that this study uses only a limited number of indicators which may not correspond to the real deprivation and the associated “sport needs”. Moreover, there are further constraints which could bias the results: the size of the sample; regions defined according to administrative structure; intra-region inequity (Boyne & Powell, 1991); haphazard expenditures for large projects; annual fluctuation of the subsidies; subsidies from municipalities and the state. Nevertheless, the study proposes a possible approach to the assessment of resources allocated to sport. With regard to the growing importance of municipalities, it appears that another study at municipal level could provide more consistent results. In addition, cooperation with experts in the field of sociology and economics could provide better understanding of deprivation and its measurement.

CONCLUSION

Subsidies to sport from the regional authorities are at least just as important as subsidies from the state (Bureš, 2010). Nevertheless, the results suggest that the subsidies from regional authorities do not respond to the needs of the population. It could indicate that sport is still not understood in its wider meaning and potential by the regional authorities in the Czech Republic.

ACKNOWLEDGEMENTS

The study was supported by GAUK, project number 591812 – Municipal sports infrastructure and Specific University Research, number 267 602. I would like to express my gratitude to Girish Ramchandani from the Sport Industry Research Centre (Sheffield Hallam University, UK) for his support.

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ÚZEMNÍ SPRAVEDLNOST A SPORT: DOTACE V OBLASTI SPORTU V KRAJÍCH ČR

JAKUB POPELKA

SOUHRN

Článek se zabývá konceptem územní spravedlnosti a jeho možným využitím v českých podmínkách. Studie čerpá z prací Grattona a Taylora (1991) a Grattona (1984). Na základě statistických údajů poskytovaných Českým statistickým úřadem (2013) a autorova vlastního šetření jsou zkoumány vztahy mezi regionálními dotacemi do sportu z krajských úřadů a vybranými ukazateli deprivace. Analýza ukazuje, že korelace mezi indikátory deprivace a dotacemi z krajských úřadů nejsou statisticky významné. Výsledky šetření mohou naznačovat, že prostředky nejsou rozděleny efektivně a územní rozdělení dotací je tak v rozporu s potřebami regionů. V diskusi jsou zdůrazněna omezení a možné směry dalšího výzkumu.

Klíčová slova: územní spravedlnost, sport, Česká republika, krajský úřad, dotace, deprivace

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**ATTITUDES OF COMPANIES
TO SPORT SPONSORSHIP
IN THE CZECH REPUBLIC
DURING THE ECONOMIC CRISIS**

EVA ČÁSLAVOVÁ, JOSEF DVOŘÁK, JOSEF VORÁČEK

ABSTRACT

This research presents the approach of companies to sport sponsorship in the period of time of the economic crisis in the European territory, specifically in the Czech Republic. The research included 100 companies based in the Czech Republic and the method chosen was electronic mail survey of managers responsible for this marketing activity. The results show trends in sport sponsorship from the viewpoint of companies and can serve as a base for strategic decisions about new ways of sport financing in 2012–2020 with which the relevant authorities of the public administration of the Czech Republic are currently dealing at this time.

Keywords: marketing communication, sponsorship, sport advertising, sponsorship package donations

INTRODUCTION

In this current period of time during Europe's economic crisis, marketing expenditure has often been among the first cuts made to company budgets, including expenses related to sponsorship. After several years of this strategy, however, companies working in the European environment have found that this approach is quite narrow-minded and does not provide the required innovation in communicative politics whose channels can also be sponsorship activities. How can sponsorship be topical even during the economic crisis? In our opinion, there are globally two reasons; firstly, companies try to save money and reduce expensive commercials on TV and sponsorship costs can be cheaper by placing the advertisements in sports arenas which then appear on TV during televised sporting events. Secondly, in our opinion, companies have to follow even more daring combined perspectives on their communicative politics and use new modern connections with sport where the target group can be better and directly approached. However, it depends on a detailed work out of sponsorship activities related to sport and on the level of their integration.

One example of sport sponsorship in the Czech Republic is that of Skoda Auto. Skoda Auto, which is known as a twenty-year-old leading sponsor of the Ice Hockey World Championship, is looking for a link between product image and sport image in the following qualities – dynamic, fast, team. Within this marketing strategy the company chose to expand its sponsorship program to another sport sponsorship which, in relation to their business targets, would increase Skoda’s sales in Europe. The sport chosen was cycling related to Tour de France. This sporting event has been held by Skoda Auto since 2004 as a main sponsor and it definitely brought the company a significant movement in economic results.

Naturally, the size of companies reflects in their marketing capabilities and therefore in the expected results. Big and medium companies paid attention to proving the efficiency of sponsorship as a contribution to fulfilling their marketing and mostly communicative targets. For illustrative purposes we present perspective on their size as defined by authors (Kraft et al., 2011) from the economics area (Table 1) according to the amount of employees and economic indicators. The purpose is, with reference to various results on sizes of companies, to present evidence on their apparent size.

Table 1. General size criteria for companies

Company categories	Number of employees	Turnover	Balance sheet
Big	250 and more employees	more than 50 mil. EUR	more than 43 mil. EUR
Medium	fewer than 250	less than 50 mil. EUR	less than 43 mil. EUR
Small	fewer than 50	less than 10 mil. EUR	less than 10 mil. EUR
Micro	fewer than 10	less than 2 mil EUR	less than 2 mil EUR

What are the targets which companies aim for regarding sponsorship? According to the German agency UFA Sports Hamburg (2000) everything is about prioritizing the most important marketing decisions that lead to the choice of sponsorship. These are:

- to increase company/brand awareness,
- an increase of company awareness as a sponsor of a certain sport club,
- improving goodwill towards a brand,
- updating a brand image,
- transmission of individual image components of a sporting field as a whole or a specially sponsored sport club to the core of the sponsor’s brand,
- “business to business” contacts in hospitality programmes.

The results available from the former research in 2000 (research plan MSM 115 100 002) showed that big companies use integrated sponsorship more, they combine sport products with non-sport products or with products loosely attached to sport.

Small companies are more oriented to the usage of individual products directly in the sport area or places connected with the sport area. What companies expect from sport sponsorship is derived from their own marketing targets and it has already been possible to observe several differences. Big companies prefer targets from their marketing

strategies exactly the same way they are stated in the enumeration of the marketing agency UFA Sports.

After complicated discussions on how the decline of sponsorship in the Czech Republic can influence the next development of sport, we decided to carry out marketing research from the viewpoint of companies in 2011 within the research plan of the Faculty of Physical Education and Sport, Charles University in Prague, MSM 0021620864.

There are many definitions concerning the area of sponsorship which analyse the mutual business relationship between companies and sport subjects. A wide range of authors from around the world have been dealing with this topic: Stotlar (1992, 1993), Pitts and Stotlar (1996, 2007), Pope and Voges (1994, 1995), Bruhn and Mussler (1998), Grey and Skildum-Reid (2003), Čáslavová (2009). Current sponsorship differs from the sponsorship in the 70s and 80s. Australian specialists on sponsorship Grey and Skildum-Reid (2003) say about the development in sponsorship: "If you want to succeed in modern-day sponsorship, it is important that everyone within your organisation understands that sponsorship is about creating win-win partnerships between your organization and a corporate sponsor. If the sponsorship is to succeed, you need to fulfil both partner's marketing objectives. This shift from fundraising and corporate philanthropy to marketing-driven sponsorship programs is the major point of difference from sponsorship programs in the 1970s and 1980s and sponsorship in the new millennium."

Topics of sport sponsorship are fundamental topics of sport marketing. These authors agree on the fact that current sponsorship represents communicative and marketing tools in the world of sport which lies in a clear distinction and performance compensation of the sponsor and counter performance of the sponsored entity. The differences between them are mostly in a various range of the relationship definition between the sponsor and the sponsored entity. However, the modern concept of sponsorship emphasizes these integrated programmes of this activity that are made-to-measure. It is basically a transition from classic sale to creating sponsorship programmed with a wide range of services offer enabling the company to fulfil their marketing and communicative targets. The interconnection of products goes beyond the framework of sports. The authors who support this aspect are for example Fullerton and Merz (2008) who do not emphasize either sides' aspects but present a so-called integrated marketing in sport based on very different products provided by both sides of companies and sport subjects which can even create a backbone of sport sponsorship.

Sport sponsorship can therefore be directly based on sports where companies choose the sports they want to sponsor, or at sporting events where they will be doing business. Sport popularity is very important within a specific geographic area, its ratings, number of fans, viewers' attendance at matches, advertising offers and spectator sport services in relation to sport venues and places that are at a sport's disposal.

Subsequently, sponsorship based on loosely affiliated products such as transport service to sporting events and competitions, medical services, refreshments, electronics and food are added to this aspect. The possibilities that can be offered in sponsorship are described by authors Grey and Skildum-Reid (2003). They analyze several types of sponsorship which can be based on the rights for using a name in the title of an event, premises, day, competition, rewards etc., various levels of sponsorship (e.g. leading sponsor × supporting sponsor), various levels of exclusiveness, distribution of licences and

official permits, public relations, hospitality programmes, information technologies, supporting events, provision of rights, labelling, researches and expertise etc. This enumeration can be taken as a key element even for designing an offer from the position of sport.

It is therefore obvious that sport and its environment is determining for sport sponsorship but according to Fullerton and Merz (2008) in relation to sport it is possible to base sponsorship even on products loosely connected to sport. However, to present on behalf of sport a motivating and modern offer of product that would match continuous requirements of companies' marketing and communicative targets is still alpha and omega of the success rate of sponsorship contracts conclusions. Sport sponsorship as a part of strategic marketing of sport is shown in a wide range of case studies done by sport organizations in relation to a wide range of stakeholders (Ferrand & McCarthy, 2009; Jurak et al., 2009).

The scope of integrated programmes is influenced by a sport's popularity with the public, or otherwise the popularity of a sporting event, direct spectator ratings of sport in competitions, fan support, media interest and the environment in which sport takes place, or else sport rules themselves. All these factors can be observed in mutual teamwork in football which is at the top of sport marketing events both in Europe and other continents. In Europe it can be illustrated in the studies of Deloitte (f.e., in 2011), more precisely its Sport Business Department.

PURPOSE

The main aim of our research is the detection of current attitudes of companies based in the Czech Republic to sport sponsorship during the economic crisis. The development of sponsorship in the Czech Republic grew significantly after the Velvet Revolution in 1989. First of all, sport clubs started with sales of advertising to partners in the 90s, then after 2000 broader programmes of sponsorship started to be used including mainly titular sponsorship at various levels and in the following years even other sponsorship tools increasing the level of marketing communication. However, some cases in which companies terminated their partnership with the most popular sport branches in the Czech Republic – football and ice-hockey – are known. This raised a discussion on how the economic crisis would influence the finance and support of sport, especially when strong state support of sport is lacking. According to Novotný's study (2011) the share of the overall public sport costs on GDP are currently at 0.38% in the Czech Republic. The author states that this value corresponds with values of the former Eastern bloc countries. The share of governmental costs on sport is according to the Ministry of Education, Youth and Sports 0.07% of GDP in the Czech Republic. It is therefore obvious that sport sponsorship represents a significant financial source for sport organizations activity and its development is in the centre of interest of organizations responsible for sport management. These were the reasons why we outlined the research mentioned above whose main aim was to fulfil the following tasks:

- sport branches the companies sponsored and those they currently sponsors,
- factors that influence the choice of sport, forms and types of sponsorship the companies used and are now using,

- finance they provide for sport sponsorship,
- reasons for leaving the sponsored sport branch,
- reasons that can a priori discourage them from sport branch sponsorship,
- aims sponsors see beyond sponsorship,
- reciprocal services considered the most attractive,
- whether they support sport even with donations,
- differences among the data gained in relation to the company size.

METHODS

There was a questionnaire created for the purpose of the research which was designed for electronic questioning in the form of an EMS (electronic mail survey).

The electronic questionnaire was sent via email from 23. 2. 2011 to 29. 6. 2011 to companies that sponsors sport. The research group was comprised by companies sponsoring any sport branch in the Czech Republic. The final sample contained in total 100 companies which were chosen on the ground of their visibility on websites of randomly chosen sport organizations (clubs, events, unions) in the Czech Republic.

The questionnaire was divided into seven parts. In total it consisted of 20 questions.

The first part was focused on basic identification details about a specific company (where it is based, size, province, subject of business) by means of which possible relations and tendencies were detected in the issues of sponsorship. The second part investigates sponsored sport branches in the period of time just before the economic crisis (i.e. 2005–2008) and the period of time of the economic crisis (i.e. 2009–2010) and observes the distinctive reasons between these periods of time. The third part looks into specific forms of sponsorship and the fourth part into amount of finance provided by companies for sport sponsorship. The change in the period of time before the crisis and during the crisis was also a subject of investigation. In the fifth part the questionnaire identifies facts concerning the choice of sport branch for sponsorship and in the sixth part the aims of sponsorship for companies and the attractiveness of reciprocal services required. The last part then illustrates another possible sport organization support via donations.

Some questions in questionnaires were not filled in, however, these were kept to a minimum. Such questionnaires are still incorporated into the research because the information from other questions is beneficial and useful for this research.

Content validity of the questionnaire was provided by independent consultations with three experts from Charles University.

RESULTS

Information on researched companies

For the companies that participated in our research the position of their headquarters in the Central Bohemian Region and in the capital city Prague was significant. Out of 85 companies which answered this question, there were 23 companies (27%) which had

Prague as the base of their company headquarters. Although the sample of companies is not representative, the representation of other regions is more or less balanced and therefore, the obtained results can be considered as a relevant basis for the assessment of the situation in sports sponsorship in the Czech Republic.

Other results monitored representation in regions according to company size. There we can see a logical phenomenon because participating medium and big companies are based in the capital city of the Czech Republic. The representation within smaller companies is then more balanced, including Prague. The representation of companies in the group researched according to number of employees (from which the size of a company is derived) is quite balanced, there are only fewer micro companies – micro companies (0–9 employees) 16%. Small companies (10–49 employees) make 29%, medium companies (50–249 employees) 28% and big companies (250 and more employees) 27%.

With respect to the scope of authority of companies surveyed, there was a sample researched (this question was answered by 99 companies out of 100) which was created mainly by companies operating on the international level (43 companies) or the nationwide level (38 companies). The companies operating on the regional level only were represented minimally – 7 regional, or more precisely 11 regional companies.

The last identifying figure was focused on the field of business. Therefore it is possible to discover which companies in the Czech Republic use sponsorship for their marketing activity and possible connections with other results. The division of research group according to field of business is shown in Table 2 which contains only the most frequent fields. 93 companies answered this question in total. Broadly speaking, every fifth company is, according to this research, associated with the building industry which is the most numerously represented in companies within the Czech Republic and at the same time includes companies of all size categories. Another interesting result could be observed in relation to the sport goods and services industry where it is frequently an obvious connection among services offered and fans, spectators and supporters of a specific sport. Other industries indicated more or less symbolic values.

Table 2. Division of companies according to field of business

Field of business	Frequency	Expression in %
Building industry	20	22
Sport apparel and equipment, services	13	14
Tax and financial consultancy, insurance industry	5	5
Trade, retail trade, wholesale	5	5
Hotel industry, accommodation services	4	4
Car sale and service	4	4
Power engineering	4	4
Mechanical engineering	4	4
Foodstuff production, bakery	3	3
Air and sewage water cleansing	3	3

Sponsored sport branches

Furthermore, we were interested in the development of sport branches sponsorship before the economic crisis and during the crisis. The research showed quite a surprising result, i.e. sport was not affected at all. Between 2009–2010, 15 more different sport branches were sponsored. This result could be recorded even for the reason that individual employees changed in companies during 2005–2010 and therefore they do not have to have a complete overview of past years. However, this result can still be considered positive from the point of view of sport sponsorship. During detailed investigation of individual sport branches the results show that the most significant moves forward were detected within winter sports and of summers sports it was mainly athletics. On the contrary, basketball and cycling were worse off. The development is clearly depicted in Figure 1.

The answers contained a wide range of branches. In Figure 1 no sports are recorded whose frequency reached lower values than 4. Among some of those less usual sports sponsored in the Czech Republic were children’s sports days, alpine expeditions, shooting competitions, bikeball, jumping boots, bowling, in-line competitions etc.

The research was then focusing on the reasons why companies in between the periods of time examined left the sponsorship of some sport branch. The change in sport sponsorship was done by 33 companies, where the respondents could mark more answers. Three answers reached major figures: lowered budget; money was invested into a different area and advertising seemed to be ineffective. It is therefore apparent that some sport branches suffered from the consequences of the economic crisis because the companies’

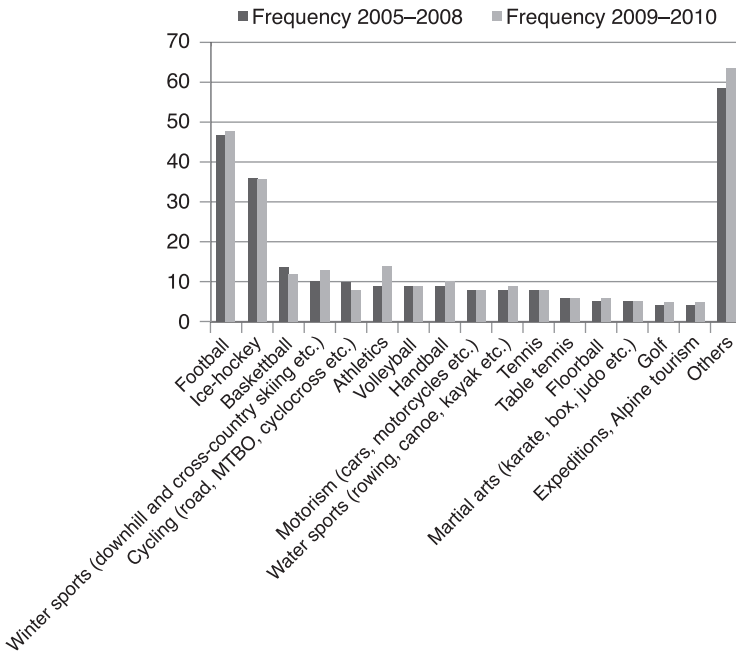


Figure 1. Sponsorship of sport branches during 2005–2010

representatives mostly gave answers related to finance. The answer represented the most frequently was on lower budgets in big companies where eight companies stated their withdrawal from a sport branch because of a lowered budget.

Forms and types of sponsorship

The part of the research focusing on used forms and types of sponsorship was also focusing on the past or the period of time closely before the crisis. Concerning both forms and types of sponsorship there was no significant change during the crisis in comparison with the period before the crisis. The influence of the economic crisis did not manifest at all in this area of sponsorship within the examined sample of companies. Table 3 represents the results of used forms of sponsorship.

Table 3. Currently used forms of sponsorship

Sponsorship (forms)	Micro companies	Small companies	Medium companies	Big companies	Total
Individual athletes	2	4	5	10	21
Sport events	6	17	12	13	48
Sport clubs	10	18	24	20	72
League competitions	1	6	2	3	12
Sport unions	2	–	2	5	9
Serials of competitions	–	6	1	2	9

Table 3 clearly shows that there are two prevailing forms within the set examined – sport clubs sponsorship and sport events sponsorship. It is then apparent that big companies support individual athletes much more. The least popular form of sponsorship is supporting unions and series of competitions.

It was also found that 81% micro companies use only one form of sponsorship, the figures concerning other company sizes are: small companies 38%, medium companies 50% and big companies 46%. It is interesting that the lowest percentage is shown by small companies, i.e. more than one form of sponsorship is more frequently used by companies with 10–49 employees.

The most frequent type of naming rights is definitely partner or product partner, then main partner, general partner and the least frequent is media partner. Still, there is one difference that should be noted between big companies in comparison with other companies. Big companies to some extent use the title main or general partner. It is obviously caused mainly by the fact that big companies can provide clubs with higher finance, therefore get a more lucrative contract which guarantees the above mentioned titles.

Finance intended for sport sponsorship

The key area for each company is its finance. This part of the questionnaire examined the situation reflecting providing finance to sport sponsorship by an examined group

of companies. This issue was not completed by 19 companies however the answers of 81 companies still have a great deal of reflective value. The overall results regarding the identifying division of companies examined clearly show that the overwhelming majority of companies examined invest in sport sponsorship max. 2% of their budget (52% of the examined group). There is one interesting fact which expresses that 24% of questioned companies spend at least 4% of their budget on sport sponsorship. It represents insubstantial amounts of money for sport branches which then become a significant communication tool. Examining changes before the crisis and during the economic crisis was also crucial for this research. Table 5 expresses that smaller companies registered increases in percentage of the budget for sport sponsorship, whereas medium and big companies registered percentual budgets lowering. Moreover, 43 organizations left the percentual budget share on the same level and 22 respondents did not answer this question.

Table 4. Frequency of percentual changes in budgets in comparison with 2005–2008

Change	Micro companies	Small companies	Medium companies	Big companies	Total
Increase	5	9	1	2	17
Decrease	2	4	6	6	18
Share without changes	5	12	16	10	43

However, the percentual changes must be completed with other data, regarding permanently changing company conditions and the size of their budgets. To give the complete picture about changes in finance provided it is necessary to complement the percentual changes with information about increasing or decreasing absolute amounts. Table 5 shows that the increase of the absolute amount reaches higher figures but it must not be omitted that medium and big companies registered a small increase in absolute amounts regarding the frequency. It is therefore very improbable that the total sum sent to sport sponsorship during the crisis was lower than before the economic crisis. However, it is still very interesting that smaller companies decided to invest more in sport sponsorship. It is evidence of small size companies realizing the need and advantageousness of marketing communication via sport.

Table 5. Changes of absolute amounts compared to budgets of 2005–2008

Change	Micro companies	Small companies	Medium companies	Big companies	Total
Increase	8	10	2	5	25
Decrease	1	7	6	8	22
Amount remained the same	3	8	14	7	32

The questionnaire was also focusing on the question of future plans with finance intended for sport sponsorship within the following 5 years. 65% of companies will keep

the finance for sport sponsorship on the same level. 14% of respondents are thinking about increasing invested finance in sport sponsorship and 20% are thinking about reduction. Unfortunately, 17 companies did not participate in this question. Generally, we can say that the future finance spent on sport sponsorship will be slightly declining.

Influence on cooperation and termination with a sport branch

Satisfaction of both parties in a business relationship such as sponsorship is a fundamental prerequisite for a satisfactory long-term cooperation. During negotiations with sponsors or potential sponsors it is necessary to know the important factors which could influence potential future cooperation. These factors can vary with each company.

The most significant factors that influence cooperation with sport branches by companies are: public popularity of sport branches, media attention, personal interest and spectator attendance. Another significant factor is sport popularity within a region and on the contrary an insignificant factor is the amount of TV broadcasts, even though sport popularity is interconnected with sport presentation on TV.

The respondents presented several interesting comments in the option “other”, significant for them is: business relations twice, regional support twice, agreement with product sponsorship, usefulness of sponsorship, effectiveness of resources used, number of participants in sport including recreational sport, possibility of technological partnership, managing relationships with customers, development of youth and children, good experience. Even though these can be taken as a marginal category, there can be some trends observed positive for Czech sport and modern integrated sponsorship. Further on they stated rather significant: aspiration to healthy lifestyle and marketing usage.

Other results are focused on negative factors influencing mostly the risk of terminating the cooperation between a company and a specific sport subject. The companies clearly indicated that corruption and financial problems are reasons which would discourage them from sponsoring a specific sport and the cooperation would be terminated. Similar situation is with doping, only the result is not as significant as concerning the previous two aspects. The respondents even gave their own reasons: breaching the conditions of a sponsorship contract, decisions of shareholders/owners, personal changes in club leadership, interruption of business relationships, loss of development finance, disloyalty, loss of confidence, impossibility of promoting technologies.

Business targets and reciprocal services offered

Overall activity of companies and sport subjects is aimed at fulfilling business targets. That is the reason even for sport sponsorship as a marketing and communicative tool of companies to participate in fulfilling these targets. The results in Table 6 of which targets are the most important during sponsorships show those with the most significance are targets of rising awareness of the company name and creating a positive company goodwill. Third best was the target of rising awareness of a company product or service. On the other hand of the ranking was the target of co-workers' motivation.

Table 6. Targets of sport sponsorship based in the Czech Republic

Target	Frequency of marks given				Mean Value
	1 (very significant)	2 (rather significant)	3 (rather insignificant)	4 (insignificant)	
Raise the awareness of a product/service	55	23	12	7	1.70
Raise the awareness of company name	65	24	4	2	1.40
Support company identification via sport	38	36	13	5	1.84
Improve local company awareness	42	37	10	3	1.72
Create good company name	38	27	20	6	1.93
Contact with customers, business people, partners	38	24	24	11	2.08
Creation of goodwill	63	27	4	1	1.40
Usage for communicative targets	20	28	31	13	2.40
Co-workers motivation	8	28	31	27	2.82
Social responsibility	27	32	26	8	2.16

The results did not prove any significant differences among individual groups of companies from the viewpoint of size. All types of companies basically copied the overall results of this issue with minor changes. During evaluating attractiveness of reciprocal services offered the companies ordered individual reciprocal services on this scale: 1 = the most attractive, 11 = the least attractive.

Among the most attractive reciprocal services in the group of micro companies are: 1. advertising on perimeterboards and banners, 2. advertising on sportswear and 3. naming rights in the event title. On the other side the least interesting reciprocal service for micro companies is products/services as prizes for winners.

The results within the group of small companies show the following most attractive reciprocal services: 1. advertising on perimeterboards and banners, 2. advertising on sportswear and 3. company logo on promotional materials. The least attractive reciprocal service evaluated was again products/services as prizes for winners.

The most attractive reciprocal services for medium companies are: 1. advertising on perimeterboards and banners, 2. company logo on promotional materials and 3. naming rights in the event title. Medium companies are not interested in advertising on sport apparel and equipment.

The last group is created by big companies which find the most reciprocal services these following: 1. advertising on sportswear, 2. naming rights in the event title and 3. advertising on perimeterboards and banners. Together with medium companies the least interesting reciprocal service was for big companies advertising on sport apparel and

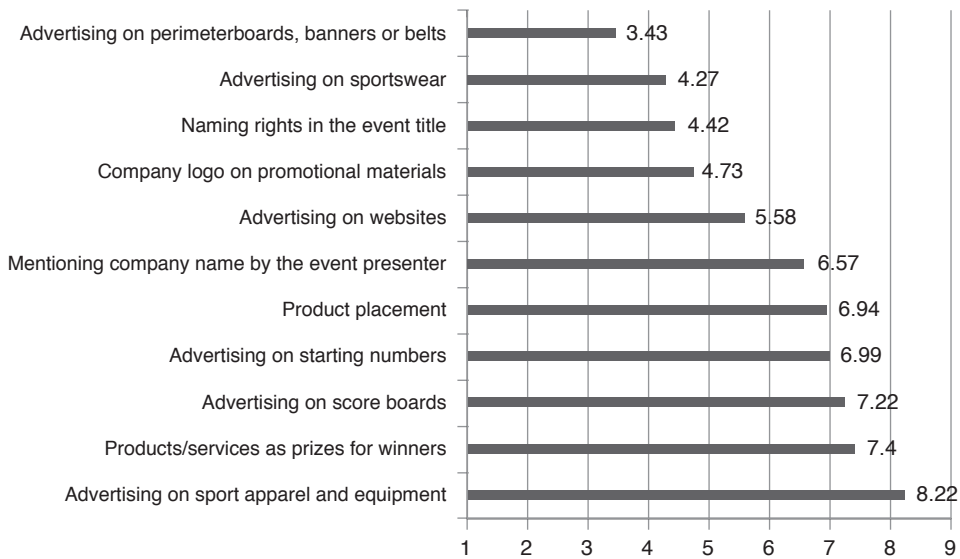


Figure 2. Sponsorship of sport branches during 2005–2010

equipment. The overall results without size company distinctions are indicated in Figure 2 where 1 is the most attractive and 9 the least attractive.

Among the most attractive reciprocal services quite unequivocally belongs to advertising on perimeterboards, banners or belts, advertising on sportswear and naming rights in the event title. These three reciprocal services appeared randomly on top places of particular company types from the viewpoint of their size. All in all, the least attractive reciprocal service is then within the examined set of companies and similarly to medium and big companies advertising on sport apparel and equipment.

Gift donations

The last part of the research, or questionnaire, was to discover whether the companies examined support sport branches also by donations. In total more than 64% of examined companies support sport also by donations. This form is mostly used by big companies, the least by micro companies. Small and medium companies are even in this issue. Managers stated that the trend of donations is declining in their companies.

DISCUSSION AND CONCLUSION

Data presented in the research provided us with a lot of surprising findings about the direction towards which sport sponsorship is heading in the Czech Republic, i.e. the European environment which is affected by the economic crisis.

A very surprising finding for us was that sponsorship targets in the area of sport did not prove any significant difference among particular groups of companies from the

viewpoint of size. All types of companies basically copied the same targets, even though there were minor shifts in ranking. All types of companies prefer goodwill, awareness of company name, alternatively of product. Small companies and micro companies add even regional company awareness. In this respect we were expecting more regarding social responsibility and motivation of co-workers than fulfilling classic marketing targets. Unfortunately, social responsibility was stated in front positions only by big companies because this activity is there a part of overall strategy planned by multinational headquarters of a mother company. Unfortunately, this situation is usually in post-socialist states because managements of medium and small companies have already been catching up with marketing knowledge and big companies are one step ahead. Big companies represent this state by the usage of integrated sponsorship more and they combine sport products with non-sport or with products loosely attached to sport more. If we compare our results with a research with the same focus on Slovenian companies from 2005 (Jurak et al., 2009) the shift of targets is obvious in both states. Big companies in the Slovenian research from 2005 prefer targets connected with involvement into social environment, communication with public and increasing awareness of company name. To some extent purely business targets are not in the first place which are more presented by medium-sized companies. More important are the tasks of involvement in social environment which unfortunately is not represented in the Czech Republic. There were 494 companies participating in the Slovenian research.

Small companies are in the Czech environment more focused on the usage of individual products, sport or connected with sport environment. What companies expect from sport sponsorship is derived from their own marketing targets.

Another interesting aspect is that big companies do not find sport advertising ineffective, whereas small and medium companies have a different opinion. The reason can probably be that big companies can invest more finance in clubs and get a more lucrative contract and therefore they are more visible in media where the effect of advertising is highly increased. It is surprising that since 2000 medium companies have not learned how to operate sport advertising more. An important aspect can also be worsening sport results of the sponsored entity, but this possibility was given only by two medium companies.

Provision of reliability in case of a research like this is also a part of the discussion. According to time consuming workload of company managers responsible for sport sponsorship it is difficult, practically impossible, to repeat the research in a certain time interval. The problem can also be in circulation of employees in these managerial positions.

The research presented is more significant in comparison with research having been so far undertaken in the Czech Republic. More questionnaires were collected and above all this research can be applied to all companies sponsoring sport environment because it was not focused only on one sport branch. The results can be applied to all companies in the Czech Republic because the questionnaires were collected evenly according to company sizes.

The research study has several limits. The first limit is obviously the chosen period of the economic crisis which beginning is determined by the year 2008. Theoretically it could be assumed that the data of this period of time would always be unique or atypical and it could certainly be assumed that they would be unfavourable for the area of sport such as a wide range of professional articles focused on this topic shows. This is exactly

the reason why we considered this period of time beneficial for our research because the results can influence current managerial decisions in the area of sport financing which are currently being discussed in the Czech Republic and which should be influenced by sport financing from the state position. Because authors (Kraft et al., 2011; Lawson, 2009; Ohanian, 2010) dealing with the economic crisis in theory themselves state that it is important to not only understand but mainly deduce an appropriate type of reformatory arrangements.

The second limit is represented in the Czech conditions by company's willingness to make these data public, mostly those related to finance. In order to reach the amount of 100 companies in approximately the same amount we had to extend the questioning to the period of time of 3 months. In spite of the entire research team's effort, some questions remained unanswered, especially those related to financial investment in sport sponsorship, by approximately one fifth of companies, which has already been mentioned in the chapter dealing with this topic. It is difficult to motivate companies to publish information on invested finance for such type of research.

We think that further research on this topic would be required after new adjustments of managing and financing sport in CR are realized in practice and they gain a proper stability. Afterwards it would be desirable to gain an overview of trends in sport financing by business companies and create a new research. It is difficult to set a time horizon just now.

If we sum up the results of our research we can say that the economic crisis did not affect the sport environment in the Czech Republic as heavily as we had assumed. Moreover, the research results show that companies accepted more sport branches which they were willing to sponsor. However, it does not mean according to the results that there would be more finance in sport. The data gained show that mostly smaller companies registered an increase in their amount of money for sponsorships, whereas big companies registered the opposite tendency. It is possible to say that via the form of sponsorship sport in the Czech Republic has been receiving less finance since after 2008.

The development of sponsorship activity is mainly supported by sport having high public popularity and also media attention and viewers' attendance. It is mainly football and ice-hockey, traditional sports such as tennis, athletics, skiing, basketball, volleyball, cycling, swimming, handball including 1–2 sports as young as floorball or snowboarding which have increasingly boosted their membership mainly among the youth.

In spite of the fact that a decline has been recorded in the advertising activity of sport clubs, advertising is in the Czech Republic still the main reciprocal service offered to sponsors. Czech clubs mostly offer it to regional partners. In order to create sufficient incomes from this activity, which takes into account even prices lower for its saleability, a lot of marketing partners overstep these amount up to several tens. National partners, i.e. big companies are provided with complex marketing programmes by professional football and hockey clubs, from naming rights sponsorship to hospitality programmes but their part is also selling advertising.

It is obvious that the cooperation with sport branches in the Czech Republic is significantly supported by public sport popularity, media attention and spectator attendance. This would not be very special but another phenomenon dominantly projected into these factors is owners', agents' or company directors' personal interests. The reason why

personal interest influences the Czech sponsorship market is that the market is small. Therefore the personal relationship of managers to a specific sport is easily enforced because it culminates in company willingness to sponsor said sport.

What is not very satisfying among the research results is the lower ranking of social responsibility among marketing targets. If we at the same time take into account the trend in the area of donations, it is possible to say that there should not be expected any excessive commitment in charity. The only exception can be formed by big companies where this can represent a company-wide targets set up by multinational headquarters.

ACKNOWLEDGEMENTS

This contribution was created with support of the research plan of MŠMT ČR MSM 0021620864 and Specific Research 260 116-2014 the Programme of scientific areas development P39 at Charles University in Prague.

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POSTOJE FIREM KE SPONZOROVÁNÍ SPORTU V ČESKÉ REPUBLICĚ V OBDOBÍ EKONOMICKÉ KRIZE

EVA ČÁSLAVOVÁ, JOSEF DVOŘÁK, JOSEF VORÁČEK

SOUHRN

Tento výzkum prezentuje přístup firem ke sponzorování sportu v období ekonomické krize v evropském teritoriu, konkrétně v České republice. Výzkum zahrnoval 100 firem působících v České republice. Byla uplatněna metoda elektronického dotazování manažerů odpovědných za tuto marketingovou činnost. Výsledky výzkumu ukazují trendy ve sponzorování sportu ze strany firem a mohou sloužit jako podklad pro strategické rozhodování o nových cestách financování sportu na léta 2012–2020, které v tomto období řeší příslušné orgány státní správy České republiky.

Klíčová slova: marketingová komunikace, sportovní sponzoring, sportovní reklama, sponzorský balíček, dar

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VARIOUS LIFESTYLE FACTORS OF FLIGHT CREW MEMBERS

MARTA BON, MAJA PORI, TANJA KAJTNA

ABSTRACT

The main aim of the research was to analyze certain lifestyle factors of flight crew members. This profession has rather high demands relating to body type, basic skills, as well as good mental and physical condition. The sample of respondents included 76 members of the Adria Airways d. d. cabin crew (19.7% men and 80.3% women) with the average age of 30.3 years ($SD = 9.88$), most of them (74.1%) finished high school and only one third had a full-time work contract. Using a questionnaire, we investigated the amount of exercise they get during work and in their free time, as well as their health conditions. Results show that in their free time most of the respondents participate in sports, with outdoor sports being the most popular form of exercise (running and walking, hiking, skiing, and swimming). The respondents spend most of their time at work standing up (18.4%) and walking (27.6%). Many of them (35%) find that they have to maintain postures that are uncomfortable. Most of them experience a combination of all the above. Most (38.2%) do sports at least twice a week, and as many as 84.2% 3 to 5 times a week. Only 4% of the respondents participate in sports activities organized by their employer. Most (77.6%) believe themselves to be in good health and only 6.6% believe themselves to be often under stress. Relatively many smoke. Among health problems, the highest percentage (46.1%) of respondents list fatigue, followed by back pain (34.2%) and neck pain (30.3%). Considering the characteristics of this profession, we recommend cabin crew members do aerobic exercise as well as more complex and preventative sport exercises intended to prevent back pain, and also to do more exercises for strength, core stability and flexibility.

Keywords: lifestyle, cabin crew members, sport exercises

INTRODUCTION

Lifestyle can be defined as a particular way individuals lead their lives defined by a group of distinct behaviors which occur regularly in a certain time period. In the literature,

lifestyle is most often described as beneficial/healthy and detrimental/unhealthy (Solterhed, Ejlertsson and Apitzsch, 2005; Aarnio, Winter, Kujala and Kaprio, 2002; Craig et al., 2003). Broader physical, social, environmental, economic and cultural factors that influence and condition the decisions of individuals, groups and communities are often more important than family factors. The type of work and the work environment are two of the most defining lifestyle factors. We spend as much as a third of our lives at work, thus promotion of good health in the workplace is a common interest of employers and employees (Stergar, 2005). Professions performed in special conditions, such as on an airplane, usually have specific demands. To be able to perform the tasks required of this profession, candidates, in addition to other demands, have to fulfill special health criteria (Official Gazette of the Republic of Slovenia, nr. 72/02, 62/08, and 7/09; Regulations on Cabin Crew Licensing in Farčnik, 2012) and obtain a special medical certificate (MC). Because of work requirements they have to stay in good physical condition. The staff has to watch their diet (possible food poisoning) and of course get enough rest. Thus this is a group of people that absolutely needs to take care of their health and physical condition.

The Slovenian airline Adria Airways (AA) was founded in 1961 and has rich experience in charter and scheduled flights and provides good connections around the world (Adria Airways, 2012). They employ people of a variety of professions, among them cabin crew members. Since 2008, when there were 183 cabin crew members (Lah, 2009), this number has decreased due to cost cutting. New members are employed more as an exception and only under strict terms of reference, such as:

- the candidates have to be between 20 and 24 years of age, good-looking and gracious, and have to be of appropriate height (women from 160 to 175 cm, and men between 179 and 185 cm) and weight,
- they need to be physically and mentally able to perform the job,
- they have to fulfill requirements to move in a constricted area.

In addition to the aforementioned, the cabin crew has to take annual medical exams before an authorized medical committee. This job is performed standing up, in small work spaces and usually on a special schedule (nights, Sundays, holidays), and strain is variable and hard to predict. Work is usually connected with staying abroad and therefore with changes in climate and geographic conditions. Constant physical and mental condition is a job requirement. The cabin crew also faces numerous hazards and risks of injury. They are particularly exposed to (Lah, 2009):

- significantly increased physical effort,
- noise: sound intensity between 97 and 117 dB,
- vibrations: frequencies between 1.6 and 80 Hz,
- radiation,
- dirt and the risk of viral infection due to an unfavorable microclimate (low humidity, large temperature differences); drafts during boarding and disembarking,
- risk of work accidents: burns, bruises, physical assaults by passengers, terrorist attacks and airplane crashes.

Because the cabin crew has direct contact with passengers, they need to be polite and helpful at all times. Above all, they are expected to be emotionally and mentally stable

and be in control of stressful situations even in possibly extremely stressful or even chaotic circumstances.

To reach and preserve an optimum level of all health aspects, numerous actions are needed, such as exercise, a healthy diet, stress relief, building and maintaining healthy relationships, balance between work and rest (Tierweiler and Butler, 2001). These activities are seven components of lifestyle (Anspaugh, Hamrick and Rosato, 2003) as defined as a particular way individuals lead their lives. In the second half of the 20th century, interest in lifestyle or certain safety factors and health hazard factors grew, especially because of the connection that was discovered between chronic non-contagious diseases and unfavorable lifestyle (Škof, 2010). The physical aspect of lifestyle, with exercise as its main component, is particularly important due to many positive effects it has on health (Hettler, 2007). Researchers mention positive effects of exercise on health, not only in that it prevents or limits disease progression, but also that it improves one's physical condition, muscle strength and quality of life (Petersen and Saltin, 2006). Researchers and experts emphasize that prolonged sitting and lack of exercise lead to muscle fatigue, causing bad posture and over a longer time period also leading to spinal deformations (Avikainen, Rezasoltani and Kuhanen, 1999; Kosinac, 1992; Nissinen, Hielovaara, Seitamo and Pussa, 2000).

According to Bilban (2005), in 1969 the World Health Organization dedicated the World Health Day to "Work, health and productivity", and its main messages were: 1) A healthy employee at a well-organized workplace is the most productive employee. 2) Health, work and productivity are the most important factors of economic development and social progress. 3) In the international world, levels of life security, health and work capacity are used to assess the position of the working class in a particular society. Berčič and Dodič Fikfak (2008) emphasize that discoveries in ergonomics show the need to facilitate models of exercise and sports activities at workplace and elsewhere (they suggest small parks in the vicinity of companies) and that exercise should be a constituent part of the "culture of exercise/sports", work and management.

PURPOSE

The main goal of this research was to determine various lifestyle factors of cabin crew members by studying how they spend their free time, how much exercise they get and how much stress they believe themselves to be exposed to. Cabin crew members also reviewed their state of health.

METHODOLOGY

Respondents

The research included 76 employees, 15 men and 61 women, between the ages of 20 and 55. The average age was 30.3 years (SD = 9.88). The results show that most (75.9%) finished a four-year high-school, 9.4% a vocational college and 14.7%

a university program. In terms of work contracts, 5.3% of respondents have a contract for a specified period of time, 35.5% are full-time employees, 2.3% work part-time and almost two thirds are student employees, i.e. as many as 56.9% of employees are students no older than 27 years of age.

Tools and implementation

Research was performed with the help of a survey that included 35 variables. The questionnaire comprised of two sections. The first section was intended for gathering data on socio-demographic characteristics of respondents (gender, age, height, weight, education and work-contract) and the second section was intended for a review of their exercise habits and state of health, i.e. information about lifestyle.

The respondents were informed that the survey was performed for research purposes and that it was anonymous. The statistical analysis of the data was done with the program SPSS 15 for Windows. The acquired data is presented below in greater detail with descriptive statistics and graphs.

RESULTS

Quality of life

The respondents spend most of their time at work standing up (18.4%) and walking (27.6%). Many of them (35%) find that they have to maintain postures that are uncomfortable.

Mostly the job is a combination of all of the above. Everyone answered the question *How many workdays over the last week did you spend walking?* and as many as 84.2% responded 3 to 5 days.

All employees work in shifts. 70.7% are satisfied with their work, 25.3% are partially satisfied and 4% are dissatisfied.

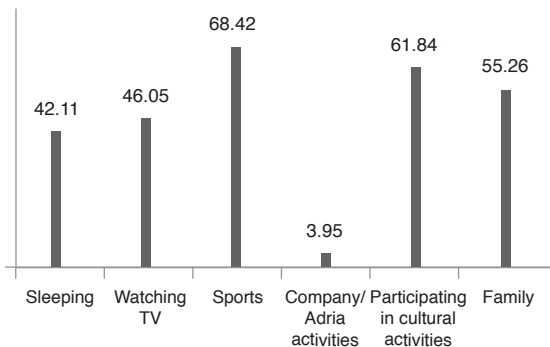


Figure 1. Free-time activities (in %)

Exercise

The main part of the study focused on researching exercise activities as a particular aspect of lifestyle. The research was performed in three sections: the way work is performed/ stress at the workplace, frequency of exercise and the type of exercise.

1. How do you spend your free time (choose all that apply)

Results show that 42.1% of individuals spend their free time sleeping, 46.1% watch television, 68.4% do sports, 61.8% participate in cultural activities and 55.3% spend their free time with their families.

2. How often do you do sports or work out?

Almost 38.2% of all respondents do sports 2 to 3 times a week. 17.1% of respondents are active every day. Thus, considering the recommended amount of exercise, more than half of the respondents are very active (every day) or moderately active (up to 3 times a week). Relatively many work out once a week (23.7%) or less (21%). 3.9% of respondents do sports only once a month.

The most common free-time activity among employees is sports.

The acquired data show that more than 33% of employees work out up to twice a week and that most (38.2%) respondents do sports 2 to 3 times a week.

3. Three of the most popular sports activities (from the most popular, to the second and third most popular)

The graph shows the percentage of individuals per sports activity.

Adria Airways employees take part in various sports activities, and outdoor activities are the most common – as many as 53.9% of all respondents prefer walking, 36.8% running, 26.3% cycling and 22.4% rollerblading. 17.1% of respondents go hiking and

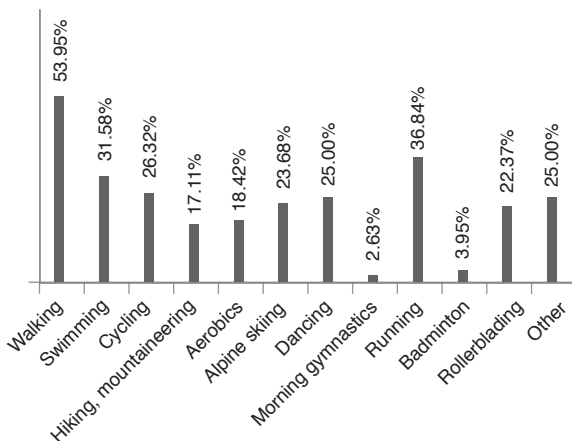


Figure 2. Most popular sports activities (in %)

mountaineering. Two popular sports among the interviewees are also swimming with 31.6% of respondents and dancing with 25%. 18.4% of the respondents do aerobics. Among winter sports, alpine skiing is a quite common activity chosen by 23.7%. A small percentage (3.9%) of respondents play badminton. Morning gymnastics is not that popular either, as only 2.6% chose this activity. 25% of all respondents also listed other sports.

As many as 26.3% of respondents do not go on walks in their free time and as many as 57.9% of respondents do not go for a walk even once a week. 21.1% of respondents spend 2 hours a day walking, and 5.3% walk for two hours a week. 17.1% of respondents spend an hour of their free time walking and 2.6% walk for an hour a week. A particularly high percentage, 10.5% of respondents, spends 3 hours a day walking and 2.6% walk between 30 and 40 minutes a day. 7.9% of respondents spend 10 hours a week walking in their free time.

6. How many days over the last week did you do intensive workouts (aerobics, running, fast cycling, fast running)?

As many as 40.8% of respondents answered that they did not do intensive workouts. Over the last week, 21.1% of all respondents spent 1 hour of their time for such an activity, 14.5% spent two hours and 7.9% spent as many as 3 or 4 hours. 5.3% spent 5 days a week doing such activities and 2.6% did this every day, i.e. 7 days a week.

7. How much time per day did you spend doing intensive workouts (aerobics, running, fast cycling, fast swimming)?

Almost half (46.1%) of all Adria Airways employees did not do any intensive workouts at all. A large share of respondents (31.6%) spent 1 hour of their free time doing intensive workouts and one tenth (10.5%) spent 2 hours a day doing intensive workouts.

State of health estimate

All state of health variables are shown by frequencies and percentages for both genders together.

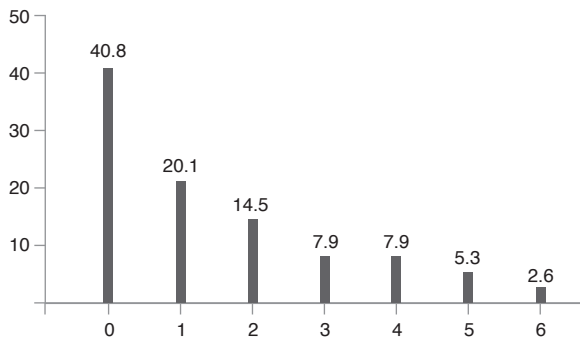


Figure 3. Intensive workouts

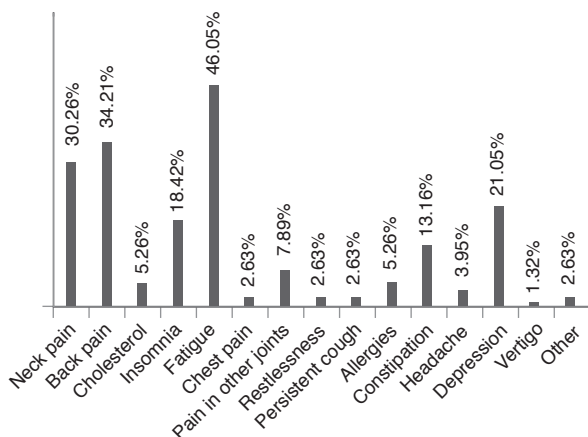


Figure 4. Types of ailments

Most respondents believe their health to be excellent (18.7%) or good (77.6%), whereas 2.6% of employees believe their health to be poor.

When comparing their health to other people of the same age, most think they are as healthy (39.5%) or healthier (42.5%), and only a minority (5.3%) thinks they are much more unhealthy than other people of the same age.

Types of ailments or health problems

As many as 46.1% of Adria Airways employees mention fatigue, followed by back pain (34.2%) and neck pain (30.3%). Respondents also suffer from headaches (21.1%), insomnia (18.4%) and various allergies (13.2%). Among other ailments mentioned by the respondents, the highest number of people (7.9%) have pains in various joints, and the lowest number of people suffer from depression (1.3%).

Stress exposure estimate

Two thirds of respondents (61.8%) are occasionally under stress, and a little less than a third of respondents (30.3%) are under stress very rarely. Only 5 out of all respondents (6.6%) believe themselves to be often under stress.

Smoking and alcohol consumption

Most respondents (65.8%) consider themselves nonsmokers, though 13.2% smoke occasionally. 3.9% of all respondents have been smoking for 10 years. Among individuals who have quit smoking, as many as 89.5% of them still did not smoke even one year later. 1.3% of respondents smoked 1, 2, 3, 6, 8 or 20 years. Two respondents have been smoking more than 15 years.

As many as 87.8% of all Adria Airways employees occasionally consume alcohol, whereas 5.4% never drink and 6.8% drink regularly.

52.7% of respondents never take pain medication, and 47.3% take it occasionally.

DISCUSSION

The work of the cabin crew is very specific. The job is performed under special conditions (humidity, fluctuating air pressure, flight altitude at around 10,000 meters above sea level). All of this influences the mentality of employees (Pavlič-Kobav, 2001). Cabin crew members are typically women, thus this profession was also included in a large study (Simpson, 2008) that investigated the ratio between genders in typically female professions (in addition to cabin crew members, this included nurses, librarians and teachers).

It is worth comparing the findings of this study with the findings of another study on the subject of free time among nurses and employees of the Slovenian Casino Hit. The research conducted on casino employees (Valentinčič, 2008) found that most respondents (17.4%) prefer to spend their free time with their families, and only 11.2% of respondents prefer to do sports in their free time. A similar discovery was made in a study of a sample of nurses (Mlinar, Karpljuk, Videmšek and Štihec, 2008) who prefer to spend their free time with their families and spend less time doing sports. Cabin crew members are legally (General Health Requirements OPS 1.085, in Farčnik, 2012) obliged to get an average or above average amount of exercise. In order to renew one's permit to work as a cabin crew member which is only valid for one year, one must have a valid medical certificate. Part A (Chapter 6: Crew Health Precautions) of the Operations Manual lists circumstances under which the cabin crew has to "cancel" a flight, see an authorized physician or declare themselves "unfit to fly".

Similarly to the Slovenian average, the most popular sports activity of cabin crew members is walking. If hiking is added to this, as many as 46.4% of adult Slovenians prefer walking. Various studies (Zaletel Kragelj, Fras in Maučec Zakotnik, 2004; Pori in Sila, 2010) confirm the correlation between sports activities and various healthy lifestyle decisions. Studies also confirm that regular daily walks of between 11 and 20 minutes reduce the risk of hypertension by 12% and that walks longer than 20 minutes reduce this risk by 24%. If regular walks are accompanied by any other additional form of exercise performed once a week, the risk of hypertension is reduced by as much as 38%. Because of the positive effects regular exercise has on health, it is important for the health of individuals and society to get regular exercise, which has been confirmed by many researchers (Bilban, 2005; Bilban, 2002; Divjak, Backović Juričan and Janežič, 2008; Knaflič, Svetina Nabergoj and Pahor, 2010; Mišigoj Duraković, 2003). The findings of this research show that more than 33% of employees who exercise are active at least twice a week. The acquired data show that 38.2% of all respondents do sports 2 to 3 times a week. These findings are similar to the results of the HIT Park Casino study (Valentinčič, 2008), where as many as 43% of respondents work out 2 to 3 times a week. This is comparable to modern trends in the increase of the active population in Europe and Slovenia. The research of exercise habits of Slovenians (Sila, 2010) based on the data of a Slovenian public opinion research states that almost all categories that have to do with some kind of sports activity (performed at least once a month or more often) have been significantly more represented than when this research was first conducted 12 years ago.

Findings concerning self-evaluations of stress exposure in the workplace are also insightful. Only 6.6% of the cabin crew members who were surveyed believe to be exposed to stress often, while others believe to be under stress only occasionally, even

though to a layman it may seem that everything connected with performing a job so “high up in the air” must be very stressful. A similar conclusion was made by the authors of a study on stress among managers, which is believed to be one of the most stressful professions with a high degree of responsibility. On average, managers participating in the research find their work moderately stressful or somewhat stressful (Luban-Plozza and Pozzi, 1994). The reason behind these results might be that managers enjoy their jobs and are content with them. In fact, Možina (1998) also finds that specific stressors in the workplace are connected with the fact that the individuals are not performing their jobs that they wish to and cannot become accustomed to their work. Unfortunately, this was not addressed in the present study, but this is quite definitely a topic suitable for further research.

Based on many studies (Anspaugh, Hamrick and Rosato, 2003; Bilban, 2005; Hettler, 2007; Petersen and Saltin, 2006) it was assumed that employees who are more active also consider themselves healthier. Nevertheless, it was discovered that in the sample the connection between these two aspects is weak ($r = 0.173$) and not statistically significant ($p = 0.133$). There are probably several factors that influence such results. The sample was mostly made up of young people who take health somewhat for granted. It is also possible that answers are connected with “Slovenian modesty” and that people do not like to “brag” about excellent health in order to avoid tempting fate. Other factors might also be at work here, or as other authors (Bilban, 2005; Cooper, Dewe and O’Driscoll, 2001) state, psychological aspects should also be considered when studying exercise habits in particular professions.

Several studies researched the connection between proper body and motor development as a counterweight to stress (Powell, Thompson, Caspersen and Kendrick, 1987; Spielberger, 1985; Tušak and Maten, 2008). It was also discovered that people with some more developed motor skills, such as coordination, are personally more stable, less neurotic, less inhibited and less impulsive (Valant Velepec, Pori, Tušak and Pori, 2009).

From the standpoint of sports science, the main conclusion is connected with the intensity, amount and scheduling of exercise routines. It seems that the intensity and the amount of exercise should be increased, especially for preventative reasons and to enrich one’s lifestyle.

CONCLUSION

Cabin crew member is a very specific profession that also has a special influence on the lifestyle of people practicing it. Above all, this article examined the aspects of exercise and sports, the importance of which is clear for a profession with such clear and high demands on the level of physical condition. While findings confirm this, they also provide opportunities for optimizing this part of lifestyle. The findings show that among free-time activities cabin crew members prefer walking and running which, when considering the level of intensity, fall into the group of moderate aerobic work-outs. Because of the nature of this profession, some time should perhaps be intended for (more) intense physical activities that improve physical strength and take care of the musculoskeletal system, i.e. the skeletal muscles, bones and joints. Different types of sports activities have different

effects on the human organism. Thus a balance between exercises is needed to ensure a healthy structure and posture, the functioning of organs, endurance and flexibility. This would reduce the presence of back and neck pain, and stress, as well as improve the general well-being. It must be emphasized that the findings are based on subjective evaluations. For a more objective approach, the respondents' physical abilities would have to be tested.

A look at the findings shows that there is room for improvement in the cooperation between the employer and the employees. Perhaps introducing a family friendly work environment should be considered, as is presented in a study on how successful coordination of professional and familial responsibilities is influenced by several factors originating at the level of individuals and their families as well as on the level of organizations and the state (Knaflič, Svetina, Nabergoj and Pahor, 2010). Adopting a healthy lifestyle on all levels is generally fulfilling or in simpler terms, "provides more effective employees and more satisfied employers" and thus the mission of sports activities achieves its purpose.

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RŮZNÉ FAKTORY ŽIVOTNÍHO STYLU ČLENŮ LETOVÉ POSÁDKY

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SOUHRN

Hlavním cílem výzkumu bylo analyzovat některé faktory životního stylu členů letových posádek. Tato profese klade vysoké nároky na tělesnou konstituci, základní dovednosti, dobrou psychickou a fyzickou kondici. Vzorek respondentů byl složen ze 76 členů Adria Airways – palubních průvodčích (19,7 % mužů a 80,3 % žen) s věkovým průměrem 30,3 let (SD = 9,88). Většina z nich (74,1 %) dokončila střední školu. Pouze jedna třetina měla pracovní smlouvu na plný úvazek. Pomocí dotazníku byla zjišťována frekvence cvičení, které respondenti provádějí v práci a ve svém volném čase, a jejich zdravotní stav. Výsledky dokumentují, že ve volném čase se většina respondentů účastní sportů v přírodě (běh, chůze, turistika, lyžování, plavání). Většinu času v práci tráví respondenti ve stoje (18,4 %) a při chůzi (27,6 %). Mnoho respondentů (35 %) si uvědomuje, že musí vydržet v pozicích, které jsou nepříjemné. Většina z nich zažívá kombinaci předchozího. Mnozí (38,2 %) sportují alespoň dvakrát týdně, 84,2 % uvádí 3–5krát týdně. Pouze 4 % respondentů se účastní sportovních aktivit

organizovaných zaměstnavatelem. Většina vyšetřovaných (77,6 %) se domnívá, že jsou v dobrém zdravotním stavu, pouze někteří (6,6 %) jsou přesvědčeni, že se často nacházejí pod tlakem. Poměrně mnoho respondentů kouří. Ze zdravotních problémů jsou v nejvyšší míře uváděny únava (46,1 %), bolesti zad (34,2 %) a bolesti krční páteře (30,3 %). S ohledem na charakteristiky této profese doporučujeme palubním průvodčím provádět zejména aerobní cvičení, ale i složitější preventivní pohybová cvičení, jejichž cílem je především prevence bolesti zad. Dále by měli provádět cvičení zaměřená na rozvoj síly a rovněž cvičení orientovaná na základní stabilitu a flexibilitu.

Klíčová slova: životní styl, palubní průvodčí, sportovní cvičení

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COMPETITIVE BALANCE IN THE AUSTRIAN, CZECH, HUNGARIAN AND UKRAINIAN SOCCER LEAGUES

JAN ŠÍMA, JAN PROCHÁZKA

ABSTRACT

This study deals with measuring and evaluating the static competitive balance in four chosen national soccer/football leagues. These are (in alphabetical order) the premier leagues in the Austrian, Czech, Hungarian, and Ukrainian soccer/football divisions.

Static balance shows how teams in the league tables of each year differ from each another. It is determined by a calculation of determinant divergences in the percentages of winnings.

The results of this work provide graphic illustrations of the development of the competitive balance in the aforementioned contests over the latest forty-two years. They identify the development trend of this phenomenon. Of the contests studied, it is the Czech premier league which used to show the highest static balance. However, nowadays, the Austrian and Hungarian leagues are more balanced in the short term. On the contrary, it is the Ukrainian league which is the least balanced. There is an apparent long-term decline of competition balance within all of the analyzed competitions. However, this decline varies a lot within the group.

Keywords: competitive balance, static competitive balance, football league, soccer league, Austrian league, Czech league, Hungarian league, Ukrainian league

INTRODUCTION

Without any doubts, football/soccer is one of the most favorite sports nowadays. It results interesting for the active players, stadium spectators and mainly TV viewers. It is the most frequently transmitted sport by the commercial sports TV channels (Jeanrenaud & Kesenne, 2006). From the statistics of these companies, we can deduce that these programs are between the most viewed ones (Buraimo & Simmons, 2009).

The public is not interested only in “their” soccer league, but also in those of other countries. For instance, the English Premier League, German Bundesliga and Spanish La Liga are broadcasted in several European countries. Both European Cup and World cup

take part in the most viewed sport events in the respective years. Champions League and also UEFA Cup/Europa League have been attracting viewers and thus also broadcasters for years. All these events generate large incomes, which are further redistributed also to the participants. Financial rewards for participating in the Champions League are between the most important income parts of the clubs that manage to participate (Kessenne, 2000). The assets of these clubs increase, they can afford better players to defend their participation in the Champions League in the following season. Already rich clubs become more rich, compared to the other poorer ones. Also the quality level differences increase. One of the results is the fact that national soccer leagues become even less balanced. As a consequence, usually the same teams finish in the positions ensuring participation in the Champions League. This is illustrated in Tab. 1, which indicates the most successful teams and the number of their championships in chosen European national leagues between the years 1970 and 2013.

Table 1. The most frequent champions of national leagues between the seasons 1970/71–2012/13

Spain	Real Madrid 18 , FC Barcelona 14
England	Manchester United 13 , Liverpool 11 , Arsenal 6
Scotland	Glasgow Rangers 20 , Celtic Glasgow 19
Germany	Bayern München 21
Italy	Juventus 18 , AC Milano 9 , Inter Milano 8
The Netherlands	Ajax 18 , PSV Eindhoven 17 , Feyenoord 5
Portugal	Porto 22 , Benfica 15 , Sporting 5
Greece	Olympiakos 23 , Panathinaikos 10 , AEK 7
Belgium	RSC Anderlecht 18 , Club Brugge 12 , Standard Liege 5
Norway	Rosenborg Trondheim 20

Source: Authors with data from www.rsssf.com

From the table, we can see that for instance the Scottish league was dominated by two clubs – Rangers and Celtic. Another team has won the championship for the latest time in the season 1984/85 (Aberdeen). The Portuguese football/soccer league is dominated by three teams – Porto, Benfica, and Sporting. In the shown period, these clubs had won 41 titles from 42 possible ones. This hegemony was disturbed only by one team – the Primeira Liga was won by Boavista FC in the season 2000/01. In the Netherlands, 39 from the possible 42 titles were won by the trio Ajax, PSV Eindhoven, and Feyenoord. Only three times, another team managed to win the title (AZ Alkmaar in the seasons 1980/81, 2008/09 and FC Twente in the season 2009/10). Greece is similar; 39 titles were there won by three teams – Olympiacos, Panathinaikos, and AEK. The other three titles were divided between PAOK (in the seasons 1975/76 and 1984/85) and Larissa (in the season 1987/88). Another interesting fact about the Greek league is that since 1927, when the teams began to compete in this country, the title was won only by six teams originated from four cities. These numbers show that the highest Greek league is not very balanced in the long term.

In the same time, it is the result uncertainty and the interest of the participants to reach the best possible result that keeps higher interest in the given sport and match, that stimulates tension and emotions, enriches both the sportsmen and the public, and brings the expected economic effect (Sanderson & Siegfried, 2003; Michie & Oughton, 2004).

The need of some balance on the field is getting more discussed not only for soccer leagues (Grier & Tollison, 1994; Zimbalist, 2002; Fort & Maxcy, 2003; Fort & Quirk, 2004; Michie & Oughton, 2004; Goossens, 2005; Groot 2007; Lee, 2010), but also for other team sports (Kesenne, 2000; Richardson, 2000; Schmidt & Berri, 2001; Humphreys, 2002; Utt & Fort, 2002; DuBois & Heyndels, 2007; Lenten, 2013). A few teams should not be too strong. Uncertainty and tension during the match are the main reasons for both active participation and for spectators to watch with emotions. Soccer, being by far the most popular sport in the world between tens of millions of players and hundreds of millions of spectators, is losing its natural attractiveness. Mostly the unbiased spectators prefer when a match finishes 4:3 rather than 7:0. The uncertainty of the winner should – in the best case – last till the last minute. For a few matches, such imbalance can be without consequences, but if it becomes a rule, we can expect the fans to lose interest. The idea of keeping more balanced leagues is discussed also by the league and team owners, by sport scientists and by the public.

A lot of research and diverse methods measurements have been done about the balance of soccer leagues. Usually, the researchers study the balance of big and rich soccer competitions. This study is intended to participate in the discussion by bringing information about the balance of less economically developed soccer leagues.

The Concept of Competitive Balance

Competitive balance can be defined as a balance between sport qualities of individuals or teams. It is thus a uniform physical and psychological outfit, similar quality and chances for success, and also uncertainty of result. Szymanski (2001) considers as main criteria of the competitive balance the following: match (result) uncertainty, seasonal (outcome) uncertainty or championship uncertainty, i.e. the state of dominance of several teams through a few seasons. Sloane (2003) stresses the multidimensionality of the competitive balance and differentiates between the long-term and short-term result uncertainty. From the long-term, dominance of one or two clubs is serious. Cairns, Jennett a Sloane (1986) have other interpretations of competitive balance – match result uncertainty, seasonal uncertainty, and absence of long-term dominance. Others focus on the results continuity between seasons or the absence of big team dominance on the market.

Since the 1980s, the research for team sports is already so large that it is impossible to cite all the contributing authors. American sources are dominant; the European research came later, mainly with the focus on the English football. This evolution was helped also by the appearance of important sport institutions (and journals), such as the North American Society for Sport Management – 1987, the European Association for Sport Management – 1994, and the International Association of Sports Economists in 1999.

Competitive Balance Types

A football league can be perfectly balanced or perfectly imbalanced. However, these are two extremes that are very unlikely. A perfectly imbalanced league means that the champion is known in advance or that a team wins all of their matches. On the contrary, a perfectly balanced competition gives a complete uncertainty of result. Diverse dimensions of competitive balance exist in the sports literature. The uncertainty of winning is related to a concrete match result. The higher the level of uncertainty, the more balanced is the match. Similarly, seasonal uncertainty shows the balance of a league in a certain period. Uncertainty has a huge influence on the play of a given team, if it is not clear which teams will fight for relegation and which will be promoted into the European leagues.

There are more types of competitive balance. We shall take into account only those that refer to a certain match, season, or result. It can happen that the order of the teams does not vary much during a season, but the uncertainty of the championship holder between seasons can be still very high. That is why, similarly to Groot (2007), we differentiate between static and dynamic competitive balance. Static competitive balance indicates the level of balance within one competition season. The level of dynamic competitive balance tells us about the variation of the order of respective teams in different seasons. A league is perfectly dynamically balanced if the order of the teams in one season is independent of the order in adjacent seasons. On the contrary, the league is perfectly imbalanced if the order of teams is constant in time. However, in this article, we focus only on the static competitive balance.

METHODS

As a subject of our research, we chose the highest football/soccer leagues in Austria, Hungary, Ukraine, and the Czech Republic. Forty-two seasons were studied in the period beginning by the seasons 1970/1971 and ending with the season 2012/2013. Of course, many changes occurred during this time. These changes include changes of the names of the leagues, of the rules, and also geopolitical changes (independence of Ukraine and division of Czechoslovakia). All the changes of rules influenced the competitive balance, but we take account only of the change from two points for a win to three points for a win.

Static competitive balance

To calculate the static balance of the leagues in a season, we used the standard deviation of the proportional wins in the league at the end of the season. Such a method was used also by other authors (Huphrey, 2002; Zimbalist, 2002; Fort & Maxcy, 2003; Mitchie & Oughton, 2004). The lower is the standard deviation, the higher balance the league has. On the basis of this data, we can state if there was one (or a few) team(s) that was (were) much stronger than the rest of the league.

To calculate the standard deviation of the proportional success of the teams, we needed data on the sum of wins, draws, and losses and on the number of matches of the individual teams in the given season. The proportional success of each team in the league, together

with the number of teams in the competition, helped us to estimate the standard deviation level for each season.

We also calculated the maximal possible standard deviation in each season. This one would hypothetically happen in the case of perfect imbalance, which corresponds to one team winning all his matches, the second team winning all his matches except with the champion, and so on till the last team being without any point. This maximal (hundred per cent) standard deviation has been used as the basis for the final proportional imbalance in each season. That means that the calculated standard deviation for each year has been divided by the respective maximal possible standard deviation for the respective years. Of course, we had to take into account the sometimes varying number of the teams and the changes in grading two or three points for a win. The long-term imbalance evolution is shown in the respective graph of the proportional imbalance level of each league.

RESULTS

Austria

The Austrian Bundesliga is the smallest from the studied leagues, at least in the terms of number of participating teams. These are only ten, but they used to be sixteen of fifteen till 1973 and from 1982 till 1985 and twelve for some years afterwards till 1993. Nowadays, each two teams meet four times, instead of the usual two times. Altogether, there are 36 rounds.

As we can see from the Graph 1, the static balance of the Austrian league has slightly worsened in the long term. However, the trend is not very strong. We could even say that the static balance remains stable in the long term.

We can find a few periods in the evolution. The first one is ending in the season 1981/1982 when the static imbalance is the lowest one in the whole studied period of time. In the following season, on the contrary, it more than doubled and a new period begins.

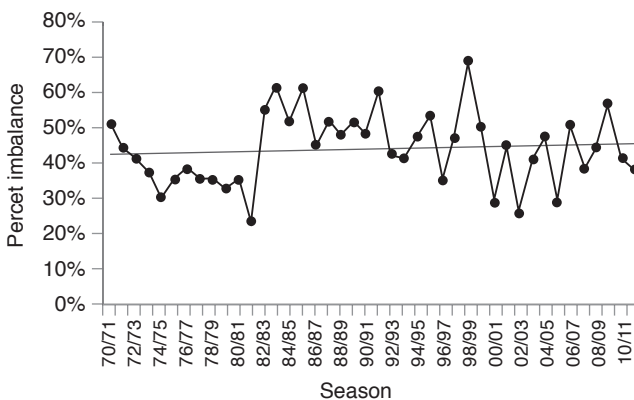


Figure 1. Austrian Bundesliga 1970–2012

This one is the least stable one, with the balance varying between different seasons. However, we can say in general that the competitive balance is improving in the long term. In the season of 2002/03, the second lowest static imbalance level is reached. This year can be considered as the limit between the second and the third period which goes till now. Then, the static balance worsened again in a trend, with some cyclicity.

As we can see from the overall trend, the competitive balance is worsening in the long term, but still staying in average levels below 50% of imbalance. It goes exceptionally above 60% and even not so often above 50%.

Czech Republic

Historically, we can speak of two main periods, because of the existence of two different countries. Czechoslovakia divided in 1993, for then, we include only the Czech league. In the period of 1970 till 1993, the Czechoslovak league was played by 16 teams per year. Altogether, 31 teams played the Czechoslovak league, from which 17 were Czech and 14 Slovak ones. The share of the Slovak teams was slowly diminishing.

After the division of Czechoslovakia, the number of teams was completed by the lower league teams to 16. Now, the Czech Gambrinus liga is played still by 16 teams in 30 rounds. That makes that the maximum static imbalance would correspond to the standard deviation of 0.32 (case of 100% competitive imbalance). Thus, to calculate the percentage for the Czech league, we divided the calculated standard deviation by 0.32 for the whole period. For instance, for Austria, we had to change the number up to the number of the playing teams.

In general, we can say that the Czechoslovak and Czech leagues' competitive balance is quite high but with a worsening trend. It hardly goes above 50% of competitive imbalance. The worsening trend could be visible already in the Czechoslovakia times, when it hardly went even above 40% of competitive imbalance. The variations seem a bit cyclical.

In the 1990s, the competitive imbalance level was quite stable close to 50%, except the season 1998/99, when it was lower. In the following years, the cyclicity comes back, confirming the worsening trend towards 50% of competitive imbalance.

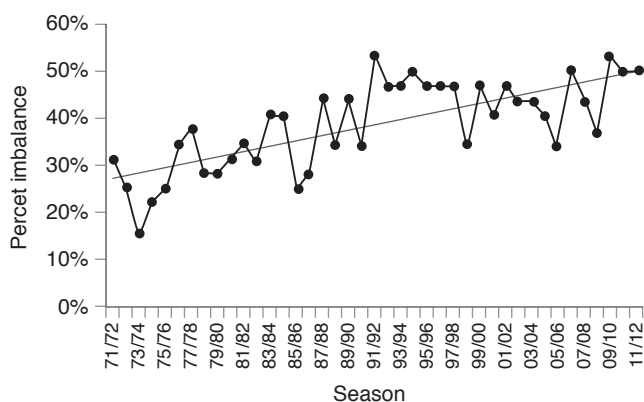


Figure 2. Czech Gambrinus liga 1970–2012

Hungary

Also the Hungarian OTP Liga has sixteen teams nowadays. However, even here, the number of participating teams varied. Between twelve and eighteen teams participated to the league in the 1970 till now period. Of course, that causes that the maximum standard deviation varies between 0.31 and 0.33. Therefore, we had to divide the calculated standard deviation by the respective numbers in order to get the percentage of competitive imbalance.

After the first five years of the studied period of time, the competitive balance was improving till the year 1991/92, down to the levels close to 30% of imbalance. In the last years of this period of time, we can see already some cyclical evolution that increases afterwards.

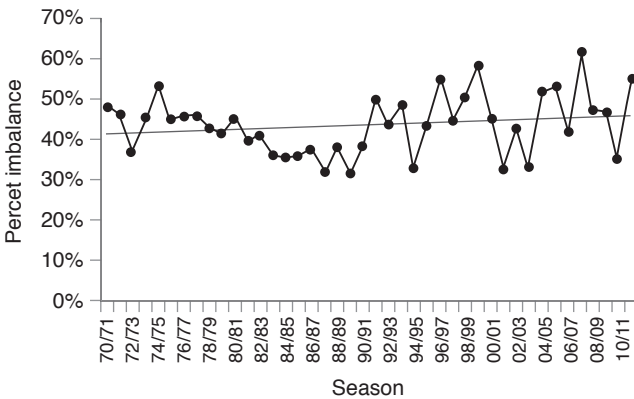


Figure 3. Hungarian OTP Bankliga 1970–2012

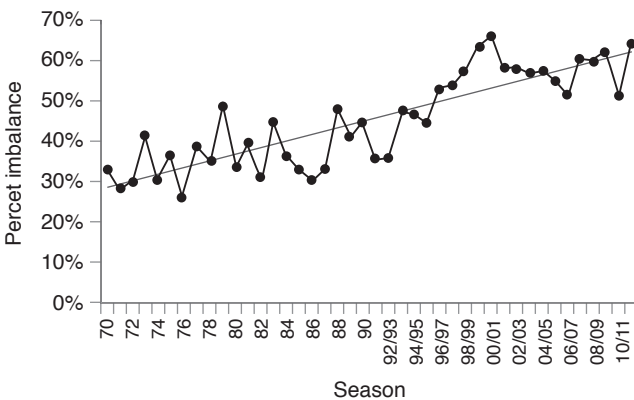


Figure 4. Ukrainian Premier liga 1970–2012

Since then, the competitive imbalance level is varying a lot, with some cyclical evolution. The highest competitive imbalance is reached in the season 2007/08, when it culminates to 60.68%.

As we can see from the graph, the overall trend is increasing. That means that the level of competitive balance is worsening for the overall of the studied period of time.

Ukraine

Also for Ukraine, we have to observe two different countries/leagues. In 1991, the division of the Soviet Union makes that the Ukrainian teams stop their participation in the Soviet Vysshaya Liga. In 1992, a new Ukrainian Premier Liha is created, with teams originated from three divisions.

The league is played by 16 teams again. Apart of the first year of the new Ukrainian league, there are practically only two winners. Till 2013, Dynamo Kyiv was the champion thirteen times, while Shakhtar Donetsk seven times.

Till 1996, we can speak of relatively cyclical competitive balance of the Soviet and Ukrainian leagues, with a slow worsening. However, the competitive imbalance remains below 50%. On the contrary, since the season 1996/1997, the competitive imbalance remains above 50% and it gets even close to 70%. The highest level is just above 66% for the season 2000/2001. There is a visible upward trend of competitive imbalance percentage, which means worsening of the competitive balance level, as well as for the period 1996/97 till now and for the overall history of the Soviet and Ukrainian leagues.

DISCUSSION

Austria and Hungary are the most balanced in the long term of the studied four leagues, at a similar level. Austria is slightly more balanced. Both show also a very stable evolution.

The Czech league was very balanced in the times of the Czechoslovak one, mostly in the communist times. The overall evolution made that nowadays, it became from the most balanced the second most unbalanced league of the group.

The Ukrainian league was also very balanced in the time of the USSR. That means more that the USSR league was very balanced. Nowadays, the Ukrainian league is the least balanced of the whole studied group.

In general, we can conclude that the competitive balance is worsening in these smaller leagues. However, we can divide the group into two sub-groups: The Austrian and Hungarian leagues remain quite stable and more balanced, while the Czech and the Ukrainian ones belonged to more balanced leagues in the communist times and nowadays, they are less balanced.

ACKNOWLEDGEMENTS

The article was written in the framework of the scientific branch development programme UK FTVS n. 39 Social-Sciences Aspects of Human Movement Studies.

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VYROVNANOST SOUTĚŽE V RAKOUSKÉ, ČESKÉ, MAĎARSKÉ A UKRAJINSKÉ FOTBALOVÉ LIZE

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SOUHRN

Studie se zabývá měřením a vyhodnocením statické vyrovnanosti soutěže čtyř vybraných národních fotbalových lig. Těmito ligami (alfabeticky řazeno) jsou česká, maďarská, rakouská a ukrajinská liga. Statická vyrovnanost vypovídá o tom, jak se od sebe lišily týmy v ligových tabulkách každého ročníku. Je stanovena pomocí výpočtu směrodatných odchylek v procentech výher.

Výsledky této práce ukazují za pomoci grafů vývoj statické vyrovnanosti vybraných soutěží za posledních čtyřicet dva let. Určí vývojový trend tohoto fenoménu. Z vybraných soutěží vykazuje česká liga nejvyšší statickou vyrovnanost. Přesto jsou dnes rakouská a maďarská liga krátkodobě vyrovnanějšími. Naopak ukrajinská liga je nejméně vyrovnaná. U všech studovaných soutěží lze zaznamenat viditelný pokles vyrovnanosti soutěže. Tento trend se však ve skupině liší.

Klíčová slova: vyrovnanost soutěže, statická vyrovnanost soutěže, fotbalová liga, rakouská liga, česká liga, maďarská liga, ukrajinská liga

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ANALYSIS OF PHYSICAL EDUCATION STUDENTS' EMOTIONAL STABILITY AND REACTABILITY

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ABSTRACT

This paper will aim to show the possible association between emotional stability and reaction time variability of Physical Education students. It can be stated that our study confirmed our suppositions which were based on works that have focused on similar topics. Our research sample showed the expected characteristics: primarily lower neuroticism values and higher extraversion when compared to the non-sporting population. Emotional stability which was reflected in the neuroticism dimension in EPQ-R (Eysenck Personality Questionnaire) was shown to be connected with variability of the reaction time in the test of reactability to selected visual stimulus, disregarding the reaction rate. The effect of extraversion is partly reflected by the tendency of the sanguine temperament type to react in a balanced manner (i.e. with low reaction time variability) during the reactability test. Due to the relatively low number of other temperament types in our sample, it is not possible to draw any conclusions in this regard.

Keywords: neuroticism, reaction time variability, EPQ-R

INTRODUCTION

Reactability is especially important in sports, as the sportsman's quick and correct reaction has a positive influence on their performance (Lehnert, 1994). Students of Physical Education often actively participate in sports. Our study attempts to show the possible connection between Physical Education students' reactability and their emotional stability.

The basic part of every human motoric activity is composed of several processes, each with three stages:

- a) Problem identification – reception of information from the surroundings.
- b) Choice of response – decision, which action should be undertaken.
- c) Programming of response – the system of the motoric activity itself is organized.

These three stages are accumulated in the reaction time (RT), which may either be simple or selective (the response is selected out of a certain number of alternatives). It is

assumed that the test of selective reaction time to visual stimuli is the one that corresponds most with the complex processing of stimuli necessary in most sports (especially games). According to Stejskal (1998), stable reactivity (for repeated reactions) is very closely connected with perception of space-time constituents of movement, and with attention and concentration. This leads to the question of whether stable reactivity is associated with an emotionally stable personality.

Temperament reflects the characteristic features of the emotional personality of an individual and includes their perceptiveness of emotional stimulation, their usual strength and rate of response, the quality of their persisting mood, and all unusual mood fluctuations and intensities (Allport, 1961). H. J. Eysenck sees temperament as a more or less stable and prevalent system of affective behaviour. He represented it using a system of coordinates comprised of two bipolar dimensions – introversion–extraversion and stability–lability – that form four quadrants, each according to one temperament type. In our study, the term “emotionally stable” is used to describe those persons that have achieved low values in the neuroticism dimension (and are therefore considerably close to the stability pole).

PURPOSE

The purpose of this paper is to point out the possible association between emotional stability and reaction time variability. Precisely speaking, it is expected that the temperament type of the tested person, especially their neuroticism dimension value – i.e. their lability or stability, is associated with the variability of reaction time to a visual stimulus in the reactivity test.

METHODS

Participants: The research sample consisted of 149 probands (57 women, 92 men) between 19 and 21 years of age. All the probands were Physical Education students in the first year of KTVS PF UJEP. The sample was therefore comprised on the basis of voluntariness and availability (Hendl, 2004). It is presumed that the sample will be sufficiently balanced as it consists of students who have successfully passed the entrance exams, both theoretical and practical, to the Physical Education Teacher programme.

Procedures: The probands were given an EPQ-R questionnaire and afterwards were individually tested on their reactivity to selected visual stimulus.

Measures: Emotional stability was identified based on neuroticism levels, one of the EPQ-R dimensions. This dimension is identified by 12 items from the shortened (with 48 items altogether) and revised version of the standardized dichotomously scored questionnaire. The questionnaire was administered to the group of probands in written form before noon in a classroom and the instructions of the creator of the test were followed. The reactivity testing took place individually afterwards, also before noon in a well-known room (the changing room). The software (created by the Psychosoft company) was installed on the laptop that was used during the tests. The administered colour-based form

of the test assembles colour matrices from the 8 available colours. The stimulus consists of a matrix of 4×4 colours. The given task is to decide as fast as possible whether the matrix contains 3 of the same colours. The computer measures the reaction time and correctness. The reaction time was measured in a series of 50 impulses for the selected visual stimulus. After discriminatory processing of the stimulus in the brain centres, the proband reacted by touching the right (meaning they saw three fields of the same colour) or left (meaning no three fields of the colour can be seen on the screen) button using the right or left hand. Each respondent had 10 trial attempts for practice before beginning the actual test. All the respondents were given verbal instructions, without any emphasis given on reaction speed or correctness.

RESULTS

Three categories of reaction time variability [VARKOEF-TERT] were defined according to the tertiles: low, medium and high variability. The tested persons were divided by the end values (rough score of the neuroticism scale) in the EPQ-R test [NEUR-KAT]. They are marked in the table (n. 1) as stable (low neuroticism) and labile (high neuroticism).

The resulting contingency (Table 1) shows that at a significance level lower than 0.05 ($p = 0.038$) the reaction time variability type is connected with the stability or lability of the tested person.

Table 1. NEUR-KAT * VARKOEF-TERT

			VARKOEF-TERT			Total
			Low	Medium	High	
NEUR-KAT	Stable	Count %	38 41.3%	25 27.2%	29 31.5%	92 100%
		Adjusted Residual	2.5	-1.5	-1.1	
	Labile	Count %	12 21.1%	22 38.6%	23 40.4%	57 100%
		Adjusted Residual	-2.5	1.5	1.1	
	Total	Count %	50 33.6%	47 31.5%	52 34.9%	149 100%

$$\chi^2 = 6.54; p = 0.038$$

By looking at the table (n. 1) it is possible to ascertain that the more stable individuals often tend to show lower reaction time variability in the reactivity test (first tertile) and contrarily, labile individuals often show wider dispersion (variability) of the reaction times. Those with lower reaction time variability react significantly less (adjusted residual = -2.5).

On the basis of this data we have attempted a better description of the level of connection between temperament and reaction time variability in our research sample by performing this additional analysis:

According to the classic above mentioned coordinate system which consists of two bipolar dimensions – neuroticism and extraversion [NEUR-EXTR] – forming four quadrants, each for one temperament type, we have transformed the rough score obtained using the scales in the EPQ-R test into the following categories:

- Phlegmatic – low neuroticism, low extraversion
- Sanguine – low neuroticism, high extraversion
- Melancholic – high neuroticism, low extraversion
- Choleric – high neuroticism, high extraversion

The criterion for low neuroticism was a value under 5, for high extraversion it was a value over 8 on a 12 point scale.

The following contingency table shows the association between temperament type and categorized variability of reaction time in the reactivity test ($\chi^2 = 15.3$; $p = 0.018$).

Table 2. NEUR-EXTR * VARKOEF-TERT

			VARKOEF-TERT			Total
			Low	Medium	High	
NEUR-EXTR	Phlegmatic	Count	10	5	15	30
		%	33.3%	16.7%	50.0%	100.0%
		Adjusted Residual	0	-2.0	1.9	
	Sanguine	Count	28	20	14	62
		%	45.2%	32.3%	22.6%	100.0%
		Adjusted Residual	2.5	0.2	-2.7	
	Melancholic	Count	7	17	14	38
		%	18.4%	44.7%	36.8%	100.0%
		Adjusted Residual	-2.3	2.0	0.3	
	Choleric	Count	5	5	9	19
		%	26.3%	26.3%	47.4%	100.0%
		Adjusted Residual	-0.7	-0.5	1.2	
Total		Count	50	47	52	149
		%	33.6%	31.5%	34.9%	100.0%

$\chi^2 = 15.3$; $p = 0.018$

The table (n. 2) presented above also shows, due to the higher values of adjusted residuals, that in our sample sanguine individuals (i.e. persons with low neuroticism value and high extraversion) have above all others displayed significantly higher tendency for reactions with lower reaction time variability (adjusted residual = 2.5) and considerably

lower tendency to react in an unstable manner, or with higher reaction time variability (adjusted residual = -2.7) in our reactivity test.

DISCUSSION

The results of our study based on a sample of college students of Physical Education confirm our assumption that emotional stability is connected with balance (variability) of reaction times in the reactivity test using selected visual stimuli. Our results have shown that emotionally stable individuals tend to display lower reaction time variability in the reactivity test. Their reaction times were therefore more balanced during the whole test (50 reactions), regardless of their reaction rate. On the other hand, labile individuals tend to show wider dispersion (variability) of reaction times. This finding corresponds with the results of professor Stejskal (1998), who after his long-term research of sportsmen in Prešov determined their reactivity level by a series of measurements of simple or disjunctive reaction times. Stejskal was also convinced that the “reactivity diffusion” (i.e. wider reaction time dispersion) is genetically conditioned. The effect of genetics on reaction rate is not negligible (some authors state it is up to 85%). Nevertheless, many authors argue (Stejskal, 1998; Schweitzer, 2001; Koitka, 2003) that the ability to react can be developed outside the sensitive period as well. The fact that individuals who participated in sports during adolescence develop their reaction abilities more quickly is connected with gaining strength, improvement of technique and an increase in the anaerobic capacity of the organism. Sportsmen who undergo training for coordination and fitness have better performance and quicker reactions (Koitka, 2003).

Reactivity is influenced by many external as well as internal factors, such as activation level, the already mentioned training, stimulants etc. According to the previous research, it is also influenced by intelligence (Deary, 2001; Schweitzer, 2001) and personality type (Lenzeweger, 2001). Brebner (1980) found that extroverts have faster reaction times, as did anxious personality types according to Welford (1980). The results of our study also point to the fact that temperament type (the neuroticism dimension as well as the extraversion dimension, according to Eysenck) can be also connected to the variability of reaction time to selected stimuli. It was proved that sanguine individuals (persons with low neuroticism value and high extraversion) in our sample had a significantly higher tendency to react with lower reaction time variability and considerably lower tendency to react in an unstable manner and therefore with higher reaction time variability. It is assumed that this can be explained by the levels of concentration and attentiveness which are closely connected to emotional stability.

The research of Robinson and Tamir (2005) also yields very interesting results. Their three studies, focused on reactions of college students to selected stimuli, have proven that those students who had neurotic personality types had significantly less balanced reaction times than their more stable counterparts. They state that in their sample the neuroticism values were considerably correlated with the standard deviation of selective reaction time. In our research, the coefficient of variation was used as the measure of reaction time dispersion in the reactivity test. We worked with a sample consisting of students of Physical Education, and therefore of people who actively participate in

sports. Our sample has confirmed the supposition of higher extraversion values in the sporting population, which is in agreement with the relevant works in this field (Knotek, 1971; Vaněk, 1974). The average value of extraversion is 9.56 for women, in contrast with Eysenck's norm 7.6, and 10.15 for men, with Eysenck's norm being 7.42. Similarly, the supposition of lower neuroticism values in comparison with the average population was also confirmed in our experimental sample (Kirkcaldy, 1982; Lemieux, 2003). This has reached the average value of 9.56 points against Eysenck's norm of 7.6 and 10.15 points compared to Eysenck's 7.42. The score of lies and psychoticism was higher with women. However, since the motivation for dissimulation was not generally confirmed, this can be seen as a manifestation of personality – social naivety or conformity to a certain degree. The average reaction in the reactivity test was 3.46 for men, 3.76 for women. The reaction time depended partly on the activation of the probands' attention and partly on their personal preference. There was no emphasis given on the correctness of reaction during the preparatory motivation. The probands also had no immediate feedback on the correctness of their response. The average number of correct reactions was 37.66 for women and 35.09 for men.

To conclude, it can be stated that our study confirmed our suppositions that were based on other works in the field with similar topics. Our research sample showed the expected characteristics, primarily lower neuroticism values and higher extraversion in comparison with the non-sporting population. Emotional stability, which was described in the neuroticism dimension (in EPQ-R), proved to be connected with variability of reaction times in the reactivity test using visual stimuli, regardless of the reaction rate. The effect of extraversion is partly reflected by the above mentioned fact that sanguine temperament types tend to react in a balanced manner (with low reaction time variability) in the reactivity test. Due to the relatively low number of other temperament types in our sample, it is not possible to draw any conclusions in this regard.

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ANALÝZA EMOCIONÁLNÍ STABILITY A REAKTIVITY STUDENTŮ TĚLESNÉ VÝCHOVY

RADKA PEŘINOVÁ

SOUHRN

Tento příspěvek poukazuje na možnou asociaci mezi emocionální stabilitou a časovou variabilitou dob reakcí u studentů tělesné výchovy. Lze konstatovat, že studie potvrdila naše předpoklady vycházející z odborných prací na obdobná témata. Výzkumný soubor vykazoval předpokládané charakteristiky, především nižších hodnot neuroticismu a vyšší extroverze oproti nespportující populaci. Emocionální stabilita vyjádřená pomocí dimenze neuroticismu (v EPQ-R) se ukázala v asociaci s časovou variabilitou dob reakcí v testu reaktivity na výběrový zrakový podnět bez ohledu na rychlost reakce. Vliv extroverze do jisté míry odráží naznačená tendence sangvinického typu temperamentu reagovat vyrovnaně (tedy s nízkou časovou variabilitou dob reakcí) v testu reaktivity. Vzhledem k relativně nízkému početnímu zastoupení ostatních typů temperamentu v našem souboru nelze v tomto ohledu činit zodpovědné závěry.

Klíčová slova: neuroticismus, časová variabilita dob reakcí, EPQ-R

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RELATIONSHIP BETWEEN AGE COGNITIVE DECLINE AND PERFORMANCE OF COGNITIVE MOTOR TASKS IN SENIORS

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ABSTRACT

Relationship between the age-related cognitive decline and decline in cognitive processing speed, in a variety of cognitive motor tasks was examined. The sample consisted of 33 well-adjusted older adults (on average 68 years old), recruited from several physical activity programs. The participants performed five cognitive tests selected from the Vienna test system battery. Subsequently, the relationship of their age and the measures of cognitive function was analyzed. It was found that the age of respondents was related only to their performance in complex tasks which included a processing speed component. The participant's performance in simple tasks and in measures unaffected by processing speed was unrelated to age. Results are consistent with the processing speed theory of adult age differences in cognition (Salthouse, 1996). Furthermore, the performance in complex cognitive tasks was influenced by the level of participation in leisure physical activities; this suggests that physically active lifestyle may limit the impact of age on cognitive function.

Keywords: cognitive function, processing speed, aging, Vienna test system, physical activity

INTRODUCTION

As the average age of the world population constantly rises (WHO, 2010), the topic of aging receives ever-growing research attention (e.g. Aldwin, Gilmer, 2013; Cruikshank, 2013; Stepankova, 2012). At present, the main research focus has been, above all, on the factors positively influencing the span of active life and the quality of life in older age (Aldwin, Gilmer, 2013; Netz et al., 2005; Nelson et al., 2007) which have been labeled as “active” or “successful” aging (Rove, Kahn, 1997; Hasmanova Marhankova, 2010). One of the most important criteria of the “successful” aging is the lasting preservation of cognitive functions (Albert et al., 1995; Park, Schwarz, 2012; Stepankova et al., 2012). Cognitive functions such as attention, reaction speed, or memory, significantly determine

self-sufficiency of older people. At the same time, these cognitive functions seem to be significantly impacted by progressing age (Kallus, Schmitt, Benton, 2005; Hoyer, Verhaeghen, 2006).

The processing speed theory of adult age differences in cognition (Salthouse, 1996; 2000) has been one of the most influential theories which attempt to explain the age related cognitive decline. It assumes that the age related decline in cognitive function is determined by a decline in the processing speed of cognitive processes whereas other aspects of cognitive processes remain relatively unaffected by age. On this basis: the theory also supposes that the efficiency of cognitive functions in older age is especially affected by the difficulty of the solved task, its complexity, and time constraints (Salthouse, 1996). As shown for example by Rogers (2012) in a series of experiments with older adults, the age-related decline of performance is especially prominent in complex tasks which demand divided attention, fast reactions, memory input, and in which the respondents have only limited experience. However, these are precisely the tasks which people frequently encounter in their daily lives and an inability to successfully handle these tasks may significantly impair the self-sufficiency of older adults (Ansley et al., 2005; Owsley et al., 1998).

To date several authors researched cognitive function in older adults (Preiss, Lukavsky, Steinova, 2010; Stepankova et al., 2012; Stepankova, Steinova, 2009). We intend to build on their work and examine the impact of aging on performance in cognitive tasks of varying difficulty which would help us to understand the ways in which the processing speed ability influences the cognitive function in older age. We follow up on some of our previous studies in which we focused on motivation to physical activity of older adults (Mudrak, Slepicka, Elavsky, 2011; 2012) and lifestyle factors influencing the quality of life in older adults (Mudrak, Slepicka, Siska, 2011; Mudrak et al., 2011).

The goal of the study is to explore the impact of aging on cognitive function in older adults. Specifically we focus on the relationship of the processing speed of cognitive functions and aging. On the basis of the processing speed theory of adult age differences in cognition (Salthouse, 1996, 2000; Kallus, Schmitt, Benton, 2005) we expect that 1) the processing speed of cognitive functions declines with age, 2) the impact of age is especially prominent in complex tasks performed in stress or within a time limit, 3) the aspects of cognitive function unrelated to processing speed are much less impacted by aging. Furthermore, we expect that 4) the observed impact of age on cognitive function is limited by physically active lifestyle.

METHODOLOGY

Sample

The research sample consisted of 33 seniors aged between 60–92 years; their average age was 68 years. All participants were retired, on average they spent 7.6 years in retirement. Majority of respondents were women (69.7%), 51.6% of participants had high-school education, 45.2% had university education. 33% of participants stated their monthly household income under 10 ths. CZK, 13% of participants stated monthly household

income over 30 ths. CZK. 81.3% of participants mentioned at least moderate health problems and using medication. On the other hand, the participants as a whole represented a group of active and well-functioning older adults. The participants were recruited from various physical activity programs for older adults in which they actively participated. 65.6% of respondents can be regarded as physically active according to the WHO standards (WHO, 2010). They stated that on average they weekly participated in 53 minutes of vigorous physical activity, 201 minutes of moderate physical activity and 301 of light physical activity. Average BMI index was 26.8.

Methods

Vienna test system

Vienna test is a comprehensive battery of electronically administered achievement tests which measure a wide range of cognitive functions, such as attention, working memory capacity, reaction speed spatial abilities and also complex cognitive function and personality characteristics. The tests which measured various aspects of the cognitive processing speed were selected from the Vienna test system: Determination test (DT), Cognitron (COG), Reaction test (RT), Visual pursuit test (LVT), and Visual memory test (VISGED).

Determination test represents a measure which is especially appropriate to the study. It is a complex instrument measuring attention, short-term memory, and reaction speed in tasks which demand fast and accurate responses to changing visual and auditory stimuli. Due to its structure, the test is suitable for examining cognitive changes taking place in older adults because the ability to solve these tasks seems to be vulnerable to the process of aging (Ansley et al., 2005; Rogers, 2012; Salthouse, 1996). During DT, fast-changing visual and acoustic stimuli are presented on the screen to which the participants have to respond quickly and accurately. The test is adaptive, i.e. the speed of the presentation of the stimuli adjusts to participants' performance which makes the subjective difficulty of the tasks always high and, as a result, the respondents always perform under stress (Schuhfried, 2011). DT appears to be a valid instrument discriminating for example between general population and people at risk of driving accident (Neuwirth, 2001). DT was used in previous studies in the research on aging (Kallus, Schmitt, Benton, 2005). *Cognitron* is a test which assesses attention and concentration through comparison of figures with regard to their congruence. The respondent's task is to compare an abstract figure with a model and to decide whether the two are identical. *Reaction Test* measures respondents' reaction time divided into the time of the response to stimuli and the motor time (i.e. the time of the execution of the task). The test is based on presentation of coloured stimuli and/or acoustic signals. The participants are instructed to press the reaction key when specific stimuli are presented and, having pressed the key, to return his/her finger immediately to the rest key. The reaction and motor time are measured in milliseconds. *Visual pursuit test* assesses the aspect of visual orientation performance involved in tracking simple visual elements in a relatively complex environment. The respondents are presented with an array of lines and he or she must as quickly as possible find the end of a specified line. The respondent is required to work in a focused way, ignoring distractions, while being placed under time pressure. The test is well suited to the assessment

of selective visual attention. *Visual memory test* assesses visual memory performance by measuring how respondents receive and replay visual information presented in the form of symbols on a city map. The respondent is instructed to memorize positions of the individual symbols and recall them correctly afterwards. The adaptive presentation ensures that the respondents are only confronted with tasks corresponding to their performance level (Schuhfried, 2011).

Questionnaire battery

Apart from the Vienna tests, the respondents were also presented with a questionnaire battery in which we inquired about their demographic and lifestyle characteristics (especially their physical activity). Participants were asked to provide basic demographic information, such as gender, age, education, income, marital status, height and weight (which were used to compute the body mass index), and details of their health status. Physical activity was assessed by self-report using two different measures, the Leisure Time Exercise Questionnaire (LTEQ; Godin, Shephard, 1985) and the Physical Activity Survey for the Elderly (PASE; Washburn et al., 1993). The LTEQ measures self-reported average weekly amount of PA over the period of the last four weeks at three intensity levels (strenuous, moderate, light) including time spent sitting. LTEQ is considered a valid and reliable instrument for measuring leisure-time PA and has been used previously with older adults (Godin, Shephard, 1985; Kliman, Rhodes, 2008). The PASE records levels of PA in various domains and also types of PA and their perceived intensity as performed in the past week. Compared to LTEQ, it covers broader range of PA focusing also on PA in work and household and was designed specifically for older adults. PASE is considered a valid instrument for measuring PA in older adults (Washburn et al., 1993).

The 12-item questionnaire SF-12 (Ware, Kosinski, Keller, 1996) was used to measure psychological and physical health. This questionnaire focuses on self-evaluation of one's health, perceived health limits, or physical, emotional, and social aspects of one's health. The SF-12 questionnaire provides scores of perceived psychological health (mhs) and physical health (phs). It represents a valid and reliable method of health evaluation frequently used in the research on older adults (Ware, Kosinski, Keller, 1996). Satisfaction with life questionnaire (Swl) (Diener et al., 1985) is the most frequently used instrument measuring global life satisfaction. It represents an instrument with good reliability and validity which is suitable for research on older adults (Diener et al., 1985).

The study

The respondents of the study were approached through various organizations for older adults, such as the Czech Association of Sport for All, the University of the Third Age and a physical activity program taking place at the Faculty of physical education, Charles University in Prague. All respondent were examined by the Vienna test system battery; the total test time was about 45 minutes. Subsequently they filled the questionnaire battery; the return rate of the questionnaires was 100%. The data were processed by SPSS 21.0. We computed the descriptive statistics, and Spearman correlational coefficient between the cognitive and other variables.

RESULTS

Age and demographic descriptors

Of all measured demographic variables, the age of respondents was significantly negatively correlated to household income and physical activity. It means that with growing age the respondents made significantly less money and also participated in less everyday physical activity. Interestingly, it seems that their participation in leisure physical activity was unrelated to age (see Table 1).

Table 1. Age and demographic descriptors

		Education	Household income	bmi	PASE	LTEQ
Age	r	.109	-.385*	-.013	-.366*	-.164
	p	.559	.039	.944	.036	.370

r – correlation coefficient; p – significance level

Considering the relationship of age and the quality of life, a significant relationship between age and the objective measures of health, such as the presence of health problems or the number of health conditions was observed. However, there were no significant relationships between the age and the self-evaluation of psychological (mhs) and physical (phs) health, or the life satisfaction (SWL) of our respondents (see Table 2).

Table 2. Age and health status

		Health problems	Number of conditions	phs	mhs	SWL
Age	r	.383*	.420*	-.189	.089	.054
	p	.030	.023	.292	.624	.766

r – correlation coefficient; p – significance level

Age and cognitive processing speed

Cognitrone presented respondents with relatively easy tasks without extensive complexity or time pressure. In this type of tasks the impact of age was not observed. Only in the most difficult Cognitrone task which was the decline of a picture differing from the model (as opposed to accepting a picture the same as the model), the relationship with age bordered on being significant ($p = .075$) (see Table 3).

Table 3. Age and Cognitrone test results

		Average time for "correct hit" (s)	Average time for "correct decline" (s)	"Correct hit" number of responses	"Corect decline" number of responses	Total working time
Age	r	.147	.314	.143	.046	.222
	p	.414	.075	.428	.798	.215

r – correlation coefficient; p – significance level

Reaction test presented respondents also with relatively easy tasks in which the time was measured but the task was not very complex and it did not put respondents under time pressure. In this context, neither the average reaction time, nor the average time of motor reaction was related to age. Only a significant relationship between the age of respondents and the variance in reaction time was observed, i.e. the older the respondents the more their response times fluctuated whereas the reaction times of younger respondents were more consistent (see Table 4).

Table 4. Age and Reaction test results

		Average reaction time	Average time of motor reaction	Reaction time variance	Variance of motoric reaction time
Age	r	.226	-.030	.351*	-.263
	p	.206	.870	.045	.139

r – correlation coefficient; p – significance level

Visual memory test presented respondents with tasks which were especially demanding on the working memory capacity, i.e. an ability to store and retrieve a large number of visual information. However, the task did not require high processing speed as the respondents' response times were measured but not included in the final score. The recorded total working time was more a measure of "cognitive tempo" as a personality characteristic rather than a measure of processing speed as a performance-determining factor. In our sample, this kind of task was unrelated to age (see Table 5).

Table 5. Age and Visual memory test results

		Visual memory performance	Total working time	Total number of items
Age	r	-.084	.152	-.017
	p	.642	.399	.926

r – correlation coefficient; p – significance level

Visual pursuit test was more complex than the previous tests and it also put the respondents under time pressure, as they had to solve the puzzles as fast as possible and the working time was included in their final score. Here, the processing speed was significantly related to the age of respondents with correlational coefficients ranging from $r = .353$ to $.476$. Again, the measure that did not include a processing speed component (i.e. Number of correct answers) did not correlate significantly with age (see Table 6).

Table 6. Age and Visual pursuit test results

		Median time for correct answers (sec)	Number of correct answers	Working time	Raw score based on viewing times
Age	r	.413*	-.085	.476**	-.353*
	p	.017	.639	.005	.044

r – correlation coefficient; p – significance level

Determination test has a very strong processing speed component as the respondents have to react as fast as possible to fast-changing stimuli. The task is very complex; the respondents have to employ both hands (on reaction panel) and legs (on reaction pedals) to respond to various kinds of visual and acoustic information. Also, unlike in the other tests, the failure in earlier tasks negatively affects the performance in latter tasks. Similarly to the Visual pursuit test, the processing speed related measures showed significant correlations with age. We observed significant relationship with median reaction time ($r = .467$), number of stimuli ($r = -.432$), and number of correct answers ($r = -.403$). The number of stimuli and the number of correct answers have also a strong processing speed component because, due to the adaptability of the test, the faster the respondents respond, the more stimuli is presented. On the other hand, the age was not related to the number of incorrect and omitted answers. It means that the older the respondents, the slower they worked, the fewer stimuli they were presented and, as a result, the fewer number of correct answers they scored. However, older respondents did not make more mistakes and not omit more responses than the younger ones (see Table 7).

Table 7. Age and Determination test results

		DT Median reaction time	DT Number of stimuli	DT Correct	DT Incorrect	DT Omitted
Age	r	.467**	-.432*	-.403*	-.066	.140
	p	.007	.013	.022	.720	.444

r – correlation coefficient; p – significance level

Impact of leisure physical activity on cognitive functions

The possible impact of physical activity on the cognitive function in older adults was explored by linear regression models in which the age and participation in physical activity as measured by LTEQ and PASE questionnaires predicted cognitive function measured

by the Determination test. The Determination test captured the age-related changes in cognitive function. It was found that the model significantly predicted both DT median reaction time ($F(3, 27) = 4.005, p = .018, R = .555$, explaining 30.8% of variance DT median reaction time) and the number of correct answers ($F(3, 27) = 5.631, p = 0.004, R = .620$, explaining 31.7% of variance DT number of correct answers). However, in both measures of physical activity, only LTEQ contributed to the models ($\beta = -.296$ in DT median reaction time and $\beta = .275$ in DT number of correct answers) which suggests that only the participation in leisure physical activity (as opposed to overall physical activity measured by PASE) predicted the level of cognitive function in our respondents.

DISCUSSION

Similarly to previous research studies (Ansley et al., 2005; Rogers, 2012; Salthouse, 1996), the present study also shows that age has a significant impact on cognitive function in older adults. As expected, it was found that the age of respondents was significantly related to their ability to perform on various cognitive tasks. Specifically, the age impacted the processing speed component of the cognitive functions. Across all used cognitive tests we consistently observed that most measures related to the processing speed were significantly related to age, whereas measures unrelated to processing speed (i.e. the tasks which did not include the speed of the response into the final score) did not show a significant relationship with age.

It seems that this relationship was strongly dependent on the complexity and difficulty of the task combined with the time pressure. In an easy task with little complexity (as represented by the Cognitrone test) even the measures related to processing speed were not significantly related to age (with the exemption of the most difficult measure which bordered on significant). Similarly in another easy task, the Reaction test, the only measure which was significantly related to age was the reaction time variance. It means that the response times fluctuated significantly more in older respondents, although in general they did not necessarily respond slower than the younger ones. The measures in the Visual memory test did not include the processing speed component at all and, as expected, they did not show a significant relationship with age. That is particularly interesting in relation to the total working time which in this case did not represent a measure of the test performance but more a measure of “cognitive tempo” as a personality characteristic which was unrelated to age.

The nature of age-related decline of cognitive function has been best captured by the two remaining tests (Visual pursuit test and Determination test). Both tests were complex, difficult and put the respondents under time pressure which appeared as more challenging for older respondents. Nevertheless, even in these tests the age of respondents was not related to all measures of test performance but only to those which included a processing-speed component. It means that although the older respondents performed generally slower in these tests they did not make more mistakes and did not have more difficulties in solving the tasks.

These findings are consistent with the processing speed theory of adult age differences in cognition (Salthouse, 1996; Kallus, Schmitt, Benton, 2005). Salthouse (1996) explains

the impact of aging on the processing speed of cognitive functions by two mechanisms. The first one is called the limited time mechanism. When an older person performs a complex task, the time to perform later operations is increasingly restricted due to the time demands of the early operations which results in the performance decline. The second mechanism is called the simultaneity mechanism. In older adults, the products of early processing tend to get increasingly lost by the time the later processing is completed and the results of early operations are not available when needed (Salthouse, 1996). These mechanisms take place predominantly in tasks which require processing a large number of cognitive operations. In such case, the later operations are increasingly distorted by the errors made in earlier operations. The Visual pursuit test and the Determination test in which the impact of age has been most prominent represent the prime examples of this kind of a task.

However, although the results of the study show that the age of respondents determines the level of cognitive function by impacting the processing speed ability, we also found that this relationship was mediated by physically active lifestyle, specifically by the participation in leisure physical activity. Also other research studies suggest that the process of aging may be to a large degree determined by the lifestyle factors. For example, the age related decline of cognitive functions can be prevented by cognitive training (Ball et al., 2002; Stepankova et al., 2012). In general, the activity of a person represents a crucial factor in this regard (Newson, Kemps, 2005). Albert et al. (1995) found that vigorous physical activity functions as a preventive measure of the age-related cognitive decline. In a similar fashion, Hultsch et al. (1999) showed that active lifestyle and participation in effortful cognitive activities may mitigate the negative impact of progressing age. Scarmeas and Stern (2003) argued that active lifestyle and the participation in a large number of leisure activities prevents the age-related cognitive decline. Numerous other studies have also shown that the active lifestyle and the participation in leisure physical activity may serve as a protective factor limiting the negative impact of aging on cognitive function (Gelder et al., 2004; Hultsch et al., 1999; Yaffe et al., 2001). Physical health may also play a significant role in the age related cognitive decline (Salthouse, 2000), as well as the psychological health represented by the absence of anxiety and depression (Jorm, 2000; Wetherell et al., 2002). The factors that influence the lifestyle of older people such as their social economic status (Shankar et al., 2010) or activity related beliefs (Albert et al., 1995; Leon, 1995) should be considered. Nevertheless, due to the relatively small scope of our research we were not able to explore all the mediating effect of these variables on the observed relationship between the age of respondents and the processing speed of their cognitive functions. However, it may be assumed that, apart from the participation in leisure physical activity, also other health, environmental and psychological variables have at least some impact on the cognitive aging which should be explored in the continuation of the project.

CONCLUSION

The results of the study confirmed the proposed hypotheses formulated on the basis of the processing speed theory of adult age differences in cognition. We found that the age

related decline of cognitive functions in our respondents may be attributed to the decline in the cognitive processing speed whereas the measures unrelated to the processing speed did not show a significant relationship with age. The age related decline was evident in complex, difficult and time-bound tasks whereas the performance in simple and easy tasks without a time limit remained unaffected by the age of respondents. The age related decline was limited by participation in leisure physical activity which suggests that the concept of “active aging” should be promoted in the population of older adults.

ACKNOWLEDGEMENTS

The article was supported by the research grant of MSMT CR no. MSM 0021620864 and was written in the framework of the scientific branch development programme UK FTVS n. 39 Social-Sciences Aspects of Human Movement Studies.

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STÁRNUTÍ A RYCHLOST ZPRACOVÁNÍ KOGNITIVNÍCH FUNKCÍ

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SOUHRN

V předkládané studii se zabýváme některými aspekty věkem podmíněného úbytku kognitivních funkcí. Konkrétně zkoumáme předpoklady vycházející z teorie rychlosti zpracování (Salthouse, 1996) týkající se toho, že věkem podmíněný pokles kognitivních funkcí je dán především poklesem rychlosti kognitivních procesů, což se projevuje především u komplexních kognitivních úkolů. Vzorek v naší studii se skládal z 33 seniorů a seniorek

(průměrný věk byl 68 let), které jsme oslovili prostřednictvím několika programů pro seniory. Respondenti byli testováni prostřednictvím pěti testů kognitivních funkcí, které jsme vybrali z testové baterie Vienna test systém. Následně jsme analyzovali vztah mezi výsledky testů a věkem respondentů. Zjistili jsme, že věk respondentů souvisel s jejich výkony v testech pouze v komplexních úkolech, které obsahovaly komponenty rychlosti zpracování. Výkon respondentů v jednoduchých úkolech a v úkolech nezávislých na rychlosti zpracování nevykazoval vztah s jejich věkem. Naše zjištění jsou konzistentní s hypotézami vycházejícími z teorie rychlosti zpracování. Dále jsme zjistili, že výkon při řešení komplexních kognitivních úloh byl ovlivněn účastí ve volnočasové pohybové aktivitě, což naznačuje, že aktivní životní styl limituje dopad stárnutí na kognitivní funkce.

Klíčová slova: kognitivní funkce, rychlost zpracování, stárnutí, Vienna test system, pohybová aktivita

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ACTA UNIVERSITATIS CAROLINAE, KINANTHROPOLOGICA
Volume 50, No. 1 – 2014

Cover by Jaroslav Příbramský
Published six monthly by Charles University in Prague,
Karolinum Press, Ovocný trh 3–5, 116 36 Praha 1
<http://www.karolinum.cz>
Prague 2014

Typeset by Karolinum Press
Printed by Karolinum Press

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