ACTA
UNIVERSITATIS PALACKIANAE OLOMUCENSIS
GYMNICA

Vol. 36
No. 1

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Electronic form available on address: http://www.gymnica.upol.cz
Elektronická podoba (časopisu) je k dispozici na adrese: http://www.gymnica.upol.cz

ISBN 80-244-1398-1
ISSN 1212-1185

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The authors take response for contents and correctness of their texts.
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CORRELATION BETWEEN SPORT ACTIVITY AND DRUG-TAKING AMONG 14 YEAR-OLD PRIMARY SCHOOL MALE AND FEMALE PUPILS IN SLOVENIA

Mateja Videmšek, Maruša Skubic*, Damir Karpljuk, Jože Štihec

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** Independent researcher*

Submitted in September, 2005

The aim of this research was to establish whether there is a correlation between sport activity and drug-taking among 14 year old pupils. This research is based on a questionnaire of 38 variables and the probability relations among the variables have been tested by the chi-square.

Analysis has shown that 80% of male and 85% of female pupils practice sport in their leisure time. On average, they practice sport 2 to 3 times a week. The majority of male pupils practice sport competitively (39%), while female pupils primarily practice not officially organized recreational sports (48%). As for smoking, 4% of the male and 12% of the female pupils smoke, the majority of the male pupils had their first cigarette at the age of 13, female pupils at the age of 12. Regarding alcohol use, 90% of the male and 94% of the female pupils had tried an alcohol beverage, which means a majority of pupils between ages 10 and 13. As far as drugs are concerned, 18% of the male and 26% of the female pupils tried drugs. The prevailing types of drug-taking are vapor inhaling, pills and marijuana. The majority of pupils said they had tried smoking, drinking alcohol and taking illicit drugs out of curiosity. Parents mainly encourage their children to practice sport. The majority of pupils think that sport and smoking do not go together, they are of the opinion that sport activities are those activities that could discourage drug-taking.

We have ascertained that is no statistically significant correlation between sport activities and taking drugs both legal and illicit drugs. However, a statistically characteristic correlation has been ascertained with regard to drinking alcohol in the case of male pupils (beer and wine) and inhaling vapors in the case of female pupils. Differences would be probably more evident at a later time – the transition from primary to secondary school. To discourage young people from drug-taking, both legal and illicit, they should be offered more activities so that they can spend their free time in a reasonable and qualitative way.

Keywords: Sport activity, drug-taking, pupils.

INTRODUCTION

Like elsewhere in the world, drugs in Slovenia are more and more widespread and so is their usage. It cannot be said how far the usage of legal and illicit drugs will go since there hardly is a limit or it cannot be set. Numerous arguments and discussions within the expert as well as lay circles cannot give an answer to the question as to where the drug abuse, leading so many especially young people to intoxication, will stop and end. Many experts talk about the "drug addict obsession" seizing the entire world and sphere – the poor as well as the rich, from North to South, East and West. There is hardly any intact place left on this planet, where drugs would not find their way (Berčič, Tušak, & Karpljuk, 2003).

The widespread state of tobacco smoking, taking drugs and drinking alcohol in Slovenia could easily be compared to the state in other relatively developed countries. The number of young people who experiment and are addicted to drugs is bigger from day to day. The main characteristics of these problems are increasing health, social and legal problems as a result of drug-taking, especially heroin and lately ecstasy and cocaine. The number of addicts and their relatives seeking help and joining in various forms of medical treatment is growing (Turk, 2002). There is a highly increased number of young adults seeking help in educational institutions and other institutions for young adults with behavioral disturbances. In the past, drug abuse was associated only with the so-called risk groups of young people. According to the number of young people who try or take drugs, it is evident, that experimental drug-taking is more and more making its way to younger and younger people, since the average age of first attempts is decreasing (Kastelic & Mikulan, 1999).

Family is the one agent informing children about the standards of a wide socio-cultural environment, helping them to build the system of values, which are being passed on from generations as educational messages.

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Family is the one agent informing children about the standards of a wide socio-cultural environment, helping them to build the system of values, which are being passed on from generations as educational messages.

All that happened in the family in early childhood and adolescence, is "indelibly" part of the adolescent's personality and closely related to his/her behavior in the period of adolescence, often also in maturity. Family is the fundamental and most important micro social environment, where a child is growing to be mature and is gaining first experiences in life. Family is where the child's physical and motor development starts, its intellectual emotional and social "potentials" which later on can positively or negatively reveal the child's attitude towards drugs (Kogovšek, 1999). Studies have shown that a family has a balanced combination of love and educational discipline, which acts preventively. An adolescent needs the feeling of being loved even though positive socialization also requires limitations. It is important that parents and children communicate – the communication must be sincere, and parents should find a suitable moment to talk to their children about drugs as well.

The majority of people who take drugs start taking them in the most vulnerable period of growing up – adolescence. This is the period when the majority of young people go to school and do many things, not being certain if they will ever do them again later. The period from starting school to adolescence is getting shorter and shorter. Perhaps it is this rapid growing-up, which often passes them by, the reason why young people cannot plan their spare time and are often bored, are displeased with themselves and do not respect themselves – all of which can perhaps lead to a desire to have fun in a different, more dangerous way. Adolescence is also considering the meaning of life and searching for one's own self (Zaletel-Kragelj, 2004). The age 13 to 14 is the period when adolescents usually start experimenting with drugs. The coeval or group pressure is high – those who take drugs are prone to encourage members of the group to do the same. The influence of parents is getting weaker. Adolescents disagree with them in many things, they are reluctant to obey parents' authority and keep secrets. It is also the period of numerous changes in physical appearance, adolescents are highly occupied with themselves and are worried about their appearance. The expectations from their parents and the community are growing, therefore, adolescents often lack confidence and self-confidence (Tomori, 2003).

The most widespread drugs among adolescents are still alcohol and tobacco. The results of a research project by the European bureau of WHO, which included 162.000 young people (aged between 11 and 15) from 35 countries have shown, that 23.2% of girls and 22.5% of boys aged 15 have declared themselves to be regular smokers. These results rank Slovenia fourth (Drole, 2004). Between 1995–2003, the percentage of young people who start smoking at the age of 11 or earlier markedly increased. Almost one third of those who in 2003 stated they have smoked, smoked their first cigarette when they were 11 or younger. Boys start smoking earlier than girls. The most critical years for girls to start smoking are the ages between 13 and 15 (Stergar, 2004).

Research shows that young people very well know how smoking affects health, however, the latent period (mostly ages between 25 and 30) when serious health problems may occur is too far away for them (Lampret, 2004). Despite that, health problems may occur already in young people. The CDC (Centers of Disease Control and Prevention) data indicates that the lung capacity of young people who smoke is lower than of those who do not smoke. Smoking namely interrupts the lungs' growth. Early signs of cardiovascular diseases appear quite quickly in young people. Smoking weakens a person's physical shape so the endurance and motor abilities of young people are lower. The resting heartbeat rate of young smokers compared to non-smokers is faster by 2 to 3 beats per minute. Young smokers suffer from shortness of breath three times more often. They are eight times more likely to smoke marijuana, twenty-two times more likely to take cocaine and three times more likely to drink alcohol (Stergar, 2000).

Alcohol is a drug causing 57.000 adolescents in Europe to die in car accidents every year. In Slovenia, driving under the influence of alcohol causes every third car accident with a death toll. To decrease these numbers, all of us must strive to decrease the consumption of alcohol, primarily among adolescents. We should be aware that the consumption of alcohol among adults influences the attitude of adolescents towards alcohol and other drugs (Rogl, 1995).

Drug addicts are rarely found among groups of people who reject drugs for their special interests and goals (Videmšek, Karpljuk, & Debeljak, 2000). Undoubtedly, sport activities represent an important factor in preventing drug-taking. Most people begin taking drugs in their youth and become addicted easily. Therefore, it is important to offer young people a number of various healthy activities, among which sports activities undoubtedly belong (Shapiro, 1994). Appropriate sport activities can most efficiently restrain drug-taking attempts, where on the other hand, wandering and strolling around with friends can only accelerate the progress of this bad habit. A healthy life style represents a very important aspect in education, which begins at home and continues in kindergarten and school and finally extends into a form of self-education. The problem of drug-taking among young people should not be solved as a sole problem, but rather in the scope of caring for young people in general (Primic-Žakelj, 2002).

The aim of this research was to analyze sport activities among pupils, determine their attitude towards drugs and ascertain whether there is a correlation be-

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The aim of this research was to analyze sport activities among pupils, determine their attitude towards drugs and ascertain whether there is a correlation be-

tween sport activity and drug-taking. We were interested in finding out if those young children who are more active in sports less frequently take legal or illicit drugs.

METHODS

Sample of subjects

The sample of subjects studied here includes 14 year old 8th grade pupils – 163 male and 177 female pupils. The study includes pupils from 9 different primary schools in Slovenia.

Sample of variables

This research is based on a questionnaire of 38 questions on sport and drugs, adapted for 14 year old pupils.

The questionnaire includes the following questions:

- Sex.
- Last year's school report.
- Are your parents divorced?
- Are you active in sports in your spare time?
- How often do you practice sport?
- What kind of sport activity do you do?
- Are your parents active in sport?
- Which sport do you do in your spare time?
- Do your parents encourage you to be active in sports?
- How do you mostly spend your spare time?
- Do you smoke?
- How old were you when you had your first cigarette?
- How many cigarettes a day do you smoke?
- If you smoke, how long have you been smoke regularly? / How long do you usually smoke at a time?
- Do your parents smoke?
- Do the friends you spend your spare time with smoke?
- What were the reasons you tried smoking?
- Do you think sport and smoking go together?
- Where do you most often smoke?
- Do your parents know you smoke?
- Have you ever tried alcohol beverages?
- Have you ever had these alcohol beverages?
- How often do you drink these beverages?
- How old were you when you first tried alcohol?
- Do your parents drink alcohol beverages?
- How often do your parents drink alcohol?
- What were the reasons you tried alcohol?
- Who offered you alcohol?
- Where do you most often drink alcohol?
- Can you have fun without alcohol?
- Do you know anyone who takes illicit drugs, such as cannabis, marijuana, hashish, ecstasy, amphetamines, heroin, cocaine, LSD...?
- Have you ever tried any of the following drugs?
- How old were you when you first tried one of the illicit drugs?
- Why did you try one of the illicit drugs?
- Where do you most often take illicit drugs?
- Are you familiar with how drugs are harmful?
- Do you think sport activity can decrease drug-taking?
- What is, in your opinion, the most important reason young people start taking drugs?
- Which activities do you think would turn young people away from taking drugs?
- Do you think Slovenia does not have enough places for young people to have fun?

Procedures

The data has been processed by SPSS software (Statistical Package for the Social Sciences). Frequency and Contingency tables have been generated with the help of FREQUENCY and CROSSTABS sub-programs. The probability relations among the variables have been tested by the Chi-square.

RESULTS

The results have shown that 80% of male and 85% of female pupils practice sport in their spare time (Fig. 1). The majority practice sport 2 to 3 times a week (36% of male and 55% of female pupils). The majority of male pupils practice sport competitively (39%), the next sport activity is recreational sport, which is not officially organized. Almost one half of female pupils practice such recreational sports (Fig. 2). Male pupils primarily do basketball and football, while female pupils do dance, roller skating and taking walks.

With male pupils, almost one half, with female pupils a bit over one third of parents are *not* active in sport. There is about one third of parents, where both parents are active in sport. This research does *not* show that pupils whose parents are *not* active would statistically characteristically be less active in sport. Despite the fact that so many parents are not active in sport, it is encouraging that the majority of parents encourage their children to do sport.

This research indicates that most male pupils (37%) spend their spare time practicing sport or meeting friends. A little over one half of female pupils in the first place spend their spare time meeting friends and in the second place practice sport. Adolescence is the time when children push their parents away while their

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With male pupils, almost one half, with female pupils a bit over one third of parents are *not* active in sport. There is about one third of parents, where both parents are active in sport. This research does *not* show that pupils whose parents are *not* active would statistically characteristically be less active in sport. Despite the fact that so many parents are not active in sport, it is encouraging that the majority of parents encourage their children to do sport.

This research indicates that most male pupils (37%) spend their spare time practicing sport or meeting friends. A little over one half of female pupils in the first place spend their spare time meeting friends and in the second place practice sport. Adolescence is the time when children push their parents away while their

friends are becoming more and more important. Despite that, it is encouraging that so many young people devote their spare time to sport.

Even though the results of WHO show that in Slovenia 23% of boys and girls at the age of 15 smoke (Drole, 2005), this research indicates that in primary schools, the percentage is much lower – 4% of male and 12% of female students smoke. We must emphasize though that the selected sample of subjects studied here is *not* a representative one for Slovenia and that children are one year younger. A similar research project studying children of the same age (Videmšek, Karpljuk, Štihec, & Debeljak, 2003) has shown, though, that 11.5% of the students smoke. These results are quite similar to those of nearly 20 years ago, where Debeljak and Kalan (1987) established that 9% of boys and 14% of girls aged 14 smoked.

A little over one half of the pupils questioned never tried smoking. The majority of male pupils had their first cigarette at the age of 13, females at the age of 12. The results have shown that there is no statistically characteristic difference between the frequency of sport activity and smoking. We cannot state that those who smoke are not that often active in sport. The majority of those who smoke, smoke on special occasions only and the time they have been smoking ranges form 1 to 6 months to two and more years. The primary reason why children start smoking is curiosity. Children want to know how a person feels when smoking. At the same time, they want to be liked, or do not want to be an exception among others. The coeval pressure is high in this period and it can influence the "smoking" habits of adolescents. With over one half of male and female pupils, none of their friends they spend time with smoke. With a little less than one half, some of their friends smoke.

There is a little over one half of the questioned children's parents who do not smoke, and 10% where both parents smoke. Whether parents smoke or not, does not however influence the frequency of male and female pupils' sport activity. The majority is of the opinion that sport and smoking do not go together.

According to the ESPAD survey, which collects data on alcohol and other drugs among 15 to 16 year old students in 35 European high schools, the number one drug is still alcohol. Over 90% of 15 to 16 year old students have tried alcohol (Lorenčič, 2004). The results of this research show that 98% of male and 94% of female 14 year old pupils have tried alcohol. They mostly drink alcohol once a month or less frequently, and first tried it between the age of 10 and 13. The main reason they have first tried alcohol is curiosity and it is the children's parents who offered alcohol to the majority of pupils questioned. Of parents, 3/4 male and 4/5 female parents drink alcohol. The majority of the questioned pupils state they can have fun without alcohol.

The ESPAD survey shows that as many as 29% of the students have tried illicit drugs and 7% students are regular users (Lorenčič, 2004). The results of this research show that 18% of male and 26% of female pupils have tried drugs. The prevailing types of drug-taking are vapor inhaling, pills (e. g. sedatives) and cannabis (marijuana, hashish). The majority of pupils tried drugs at the age of 13 (8% of male and 16% of female pupils). Those who have tried drugs, say they first tried it for the same reason as cigarettes and alcohol – curiosity. The majority of pupils say they are familiar how drugs are harmful.

The answer to the question "What is in your opinion the most important reason young people start taking drugs?" almost one half answered it was the curiosity. The second most frequent answer was a desire to be accepted or approved by the coevals. The other answers were curiosity and an attempt to overcome emotional distress, depression, and anxiety.

Half of the pupils questioned are of the opinion that sport activities are those that would turn young people away from taking drugs, next would be the promotion of parties with no drugs and alcohol (Fig. 3).

Over 2/3 of male and 4/5 of female pupils think that there are not enough places for young people to have fun. In the future, we should make some changes to have such places for children and adolescents where they could gather and spend their spare time in a reasonable way.

We have ascertained that there is no statistically significant correlation between sport activities and taking legal and illicit drugs. However, a statistically characteristic correlation has been ascertained between sport activities and drinking beer and wine with male pupils, and inhaling vapors with female pupils. All the questions were related to trying and *not* regular usage of legal and illicit drugs.

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Fig. 1
Are you active in sports in your spare time?

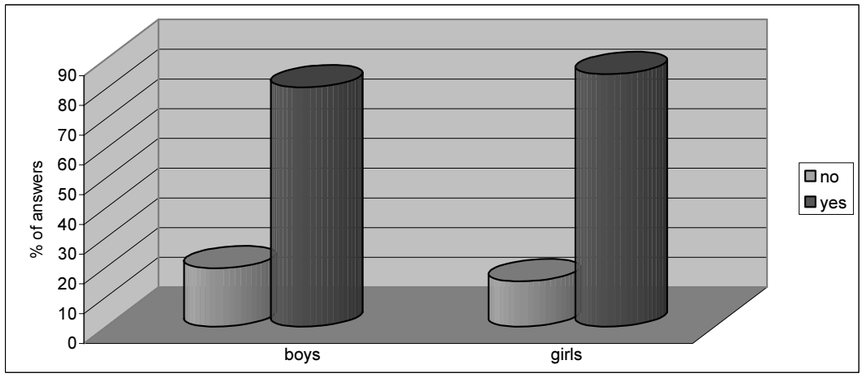


Fig. 2
What kind of sport do you do?

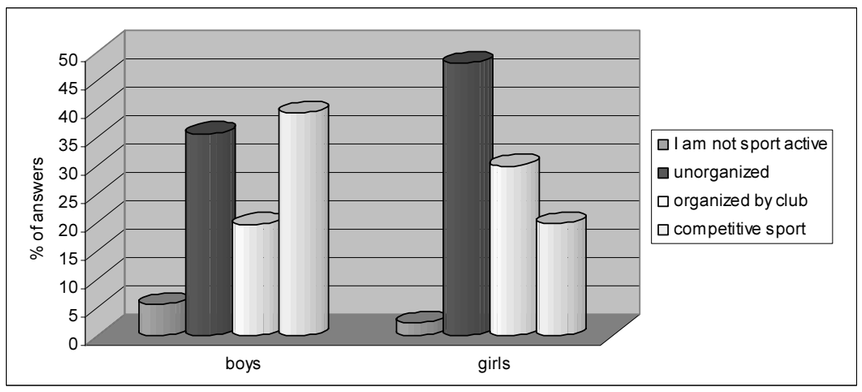
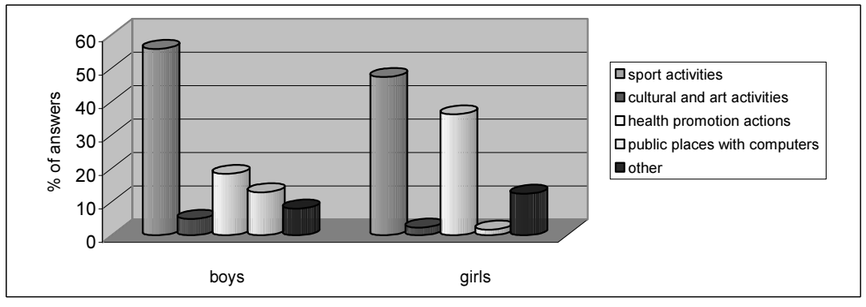


Fig. 3
Which activities you think would turn young people away from taking drugs?



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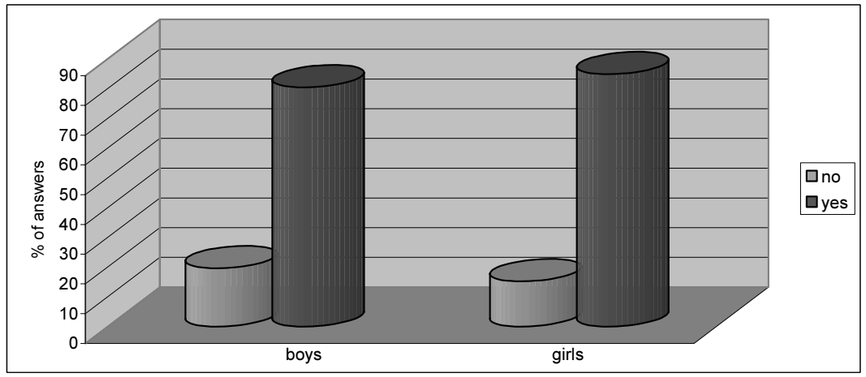

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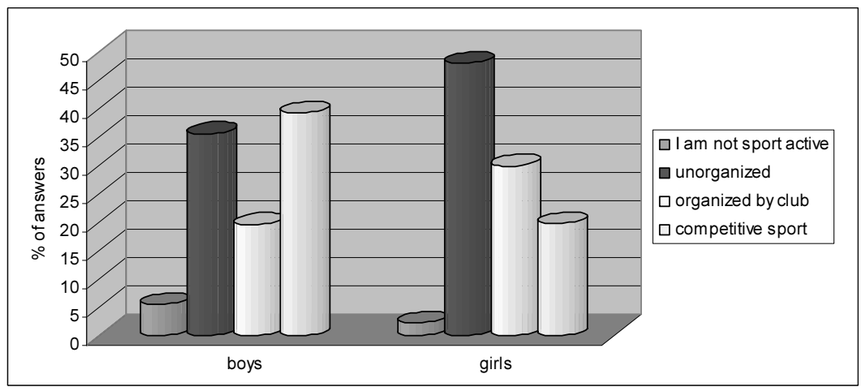

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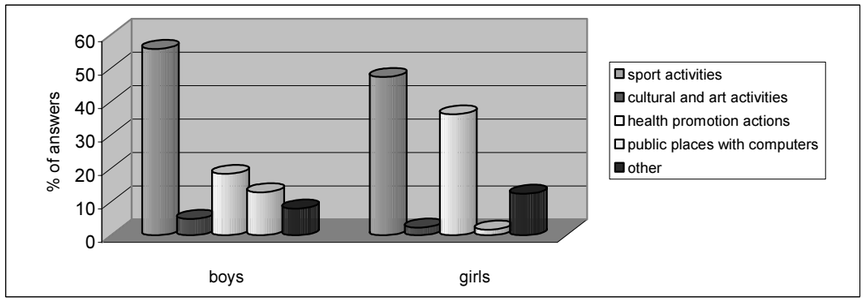

DISCUSSION

The fact is that the problem of drug-taking cannot be entirely solved, but it could be reduced. The questionnaire was focused on 14 year old pupils who still visit the primary school. According to their age, quite a large number of primary school pupils smoke, drink alcohol or take drugs. The number will probably increase when these children get to a secondary school. In order to move in a positive direction, we need to be more active within the families, schools and local communities. Parents are those who raise their children from the start and pass their behavior patterns on to them. It is scientifically proven that children whose parents smoke, drink alcohol and take illicit drugs rather reach for such substances than not. In addition, passive smoking for example increases the possibility for children to get asthma and other chronic lung diseases, and even healthy children will, as adults, have a decreased lung capacity. Lung capacity measurements of young athletes taken at medical examinations have shown an average lower result with those athletes who come from a smoking environment (Kopriva, 2002).

If parents are active in sport and have their children involved in sports as well, children will accept sport as part of their everyday life and spare time. Parents are also responsible to openly talk to and inform children about the drug-taking problem. A permissive attitude towards smoking and alcohol in a family, where in addition some of the parents smoke and drink too much alcohol, more likely causes children to start smoking or taking any other drugs. Experts recommend (Stergar, 2004) parents to start talking about smoking, drinking alcohol and taking drugs to their children when they are 5 or 6 years old, since many children have their first cigarette and an alcoholic drink very early. By then, they should be appropriately familiarized with drugs being unacceptable and harmful. Parents should tell their children how to turn down a cigarette and alcohol if offered and yet remain a "hero". They should talk about commercials, publicity, the "true" messages, and wrong beliefs about drugs among young people (relaxation, body weight control, less harmful light cigarettes, mature appearance, better digestion...). Their educational attempts will certainly be more successful if their behavior will support what they are saying (Ivelja, 2004).

Also school plays an important part, after all, children spend a lot of their time there. It is important that the school is outward oriented, accepting encouragements from the environment and tries to respond to changes life brings inside and outside of the institution. With the support from the local community, schools should offer a lot of activities for children to expand their knowledge, abilities and skills and thus enable children to spend their spare time in a quality way, also during school holidays and vacation (summer, winter breaks). It is important that we become aware that the problem of drug-taking is increasing, along with which the age of drug-takers is decreasing. We need to act precautionarily – have activities and promotions to inform children about the positive effects of sport activities on one hand, and danger and consequences of drug-taking on the other hand.

"Sport without drugs" should become a rule and a part of the moral of all who practice sport. A lot of attention is devoted to achieving better physical shape, with which the problem of drug-taking is also related. Besides, young people can massively be motivated and convinced to join sport. Most convincing are also medical reasons and particularly the reasons pertaining to one's general appearance (Lampret, 2004). There is probably no boy who would not want to be liked by others or himself by the way he looks like. Tall figure, broad shoulders, large chest – this is the image almost every young boy dreams about. Scientists have however proved that drug-taking in the early ages impedes physical development and growth. It has been proved that individuals who started smoking early have smaller lung volumes than non-smokers. The effects of smoking and drinking alcohol are thus just the opposite of what young people would like to achieve. The behavior of young girls is even less understandable when they want to prove their equality to boys having a cigarette in their mouths and holding a glass of an alcoholic drink (Pečjak & Mohorko, 1995). Abusing their own health, having stinky clothes and hair, bad breath – all of these are the characteristics men least expect from an attractive young woman. Everybody fighting against smoking and drug-taking should take advantage of these facts (Videmšek, Karpljuk, Štihec, & Debeljak, 2003).

The fight against drugs continues and is seeking new methods that would enable a more healthy way of life among young people. Schools are nowadays participating in various projects with which young people are being motivated to promote sport and not drugs. Joining in this fight are also medical and other institutions pertaining to preventive and curative treatments (Kopriva, 2002). PE teachers should get involved more as well. In cooperation with parents, they could well use sport to restrain drug-taking and build upon a relationship towards sport activities. Deprecation, prevention, and prohibition of smoking among young people are undoubtedly means that can help reduce these bad habits. Despite that we are of the opinion that young people will be turned away from smoking by means of planning a quality way of life. People who are adequately occupied most likely fulfill their needs by taking part in appropriate activities and in this way do not feel the need for any kind of substitutes (Sullivan, 2004).

One of the most important factors influencing the decrease of drug-taking habits is providing appropriate and adequate activities for young people in their spare

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DISCUSSION

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time. It is the spare time that should be properly conducted and planned. Spare time should be fulfilled with activities that would fully engage each young individual. And sport activities should certainly find their place among them.

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KORELACE MEZI SPORTOVNÍ ČINNOSTÍ A UŽÍVÁNÍM NÁVYKOVÝCH LÁTEK U 14LETÝCH ŽÁKŮ A ŽÁKYŇ ZÁKLADNÍCH ŠKOL VE SLOVINSKU

(Souhrn anglického textu)

Cílem tohoto průzkumu bylo zjistit, zda u 14letých žáků existuje korelace mezi sportovní aktivitou a užíváním návykových látek. Tento průzkum je založen na dotazníku s 38 proměnnými, přičemž pravděpodobnostní vztahy mezi proměnnými byly testovány pomocí chí-kvadrát testu.

Analýza ukázala, že ve svém volném čase se sportu věnuje 80 % chlapců a 85 % dívek. Sportu se věnují většinou dvakrát až třikrát týdně. Většina chlapců se věnuje sportu závodně (39 %), zatímco dívky se věnují především rekreačním pohybovým aktivitám (48 %). Pokud jde o kouření, ke kuřákům patří 4 % procenta chlapců a 12 % dívek. Většina chlapců začala kouřit ve věku 13 let, dívky ve věku 12 let. 90 % chlapců a 94 % dívek již nějaký alkoholický nápoj vyzkoušelo – jde tedy o většinu žáků ve věku od 10 do 13 let. Pokud jde o užívání drog, vyzkoušelo je 18 % chlapců a 26 % dívek. Nejčastějšími typy drog jsou inhalace, pilulky a marihuana. Většina žáků prohlásila, že kouření, pití alkoholu a užívání nelegálních návykových látek vyzkoušela ze zvědavosti. Rodiče většinou podporují děti v provozování sportu. Většina žáků se domnívá, že sport a kouření spolu nejde dohromady. Domnívají se, že sportovní aktivity jsou činnosti, které by od užívání návykových látek mohly odrazovat.

Zjistili jsme, že mezi sportovními aktivitami a užíváním legálních i nelegálních návykových látek není statisticky významná korelace. Statisticky významná korelace

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KORELACE MEZI SPORTOVNÍ ČINNOSTÍ A UŽÍVÁNÍM NÁVYKOVÝCH LÁTEK U 14LETÝCH ŽÁKŮ A ŽÁKYŇ ZÁKLADNÍCH ŠKOL VE SLOVINSKU

(Souhrn anglického textu)

Cílem tohoto průzkumu bylo zjistit, zda u 14letých žáků existuje korelace mezi sportovní aktivitou a užíváním návykových látek. Tento průzkum je založen na dotazníku s 38 proměnnými, přičemž pravděpodobnostní vztahy mezi proměnnými byly testovány pomocí chí-kvadrát testu.

Analýza ukázala, že ve svém volném čase se sportu věnuje 80 % chlapců a 85 % dívek. Sportu se věnují většinou dvakrát až třikrát týdně. Většina chlapců se věnuje sportu závodně (39 %), zatímco dívky se věnují především rekreačním pohybovým aktivitám (48 %). Pokud jde o kouření, ke kuřákům patří 4 % procenta chlapců a 12 % dívek. Většina chlapců začala kouřit ve věku 13 let, dívky ve věku 12 let. 90 % chlapců a 94 % dívek již nějaký alkoholický nápoj vyzkoušelo – jde tedy o většinu žáků ve věku od 10 do 13 let. Pokud jde o užívání drog, vyzkoušelo je 18 % chlapců a 26 % dívek. Nejčastějšími typy drog jsou inhalace, pilulky a marihuana. Většina žáků prohlásila, že kouření, pití alkoholu a užívání nelegálních návykových látek vyzkoušela ze zvědavosti. Rodiče většinou podporují děti v provozování sportu. Většina žáků se domnívá, že sport a kouření spolu nejde dohromady. Domnívají se, že sportovní aktivity jsou činnosti, které by od užívání návykových látek mohly odrazovat.

Zjistili jsme, že mezi sportovními aktivitami a užíváním legálních i nelegálních návykových látek není statisticky významná korelace. Statisticky významná korelace

však byla zjištěna u pití alkoholu v případě chlapců (pivo a víno) a inhalace látek v případě dívek. Rozdíly by zřejmě mohly být výraznější v pozdějším věku – při přechodu mezi základní a střední školou. Mladé lidi by bylo možno od užívání legálních i nelegálních návykových látek odradit nabídkou většího množství aktivit, které by jim umožňovaly trávit volný čas přiměřenějším a kvalitnějším způsobem.

Klíčová slova: sportovní aktivita, užívání návykových látek, žáci.

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First-line publications

Videmšek, M., Videmšek, P., Štihec, J., & Karpljuk, D. (2004). Sport activity and eating habits of 14 year old male and female pupils. *Kinesiologia Slovenica, 10(2)*, 65–77.

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EXUS BETWEEN MANIFEST MOTOR INDICATORS AND FLUID INTELLIGENCE IN PREPUBERTAL BOYS

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Submitted in October, 2005

The purpose of this study was to investigate the correlation between manifest motor indicators and the fluid intelligence of boys. The sample comprised 550 boys aged 10 to 14. A battery of 26 tests was used for measuring motor performance. Intelligence testing was implemented with the test TN-20. A multiple regression analysis indicated that association between motor variables and fluid intelligence exists. The closest connection was the one between fluid intelligence and motor tasks which demand the coordination of movement in rhythm and the speed of movement. The associations between motor performance and fluid intelligence were age dependent: in 12 year old boys the connection between motor variables and fluid intelligence is the highest, followed by 14 year old boys, where it is a little lower; the connection is the lowest in 10 year old boys. The results suggest that developmental changes have a significant influence on the relations between motor performance and fluid intelligence.

Keywords: Motor performance, physical fitness, fluid intelligence, connection, boys.

INTRODUCTION

Motor abilities are shown in interaction with other psychosomatic dimensions, so they can be correctly interpreted only on the basis of knowledge about such connections. A better understanding of the principles of human development requires the study of motor dimensions and their relations with other psychosomatic dimensions, since in the course of development changes occur in the individual dimensions as well as in the relations between them. A more detailed analysis of the connections between motor dimensions and intelligence is reasonable for children and adolescents who are in the phase of dynamic development. The age period between 10 and 14 is characterised by great variability and instability of several human dimensions as well as relations among them, which results in the instability of development processes (Gallahue & Ozmun, 1998).

Some studies have analysed connections between various motor variables and intelligence (Carretta & Ree, 1997; Mejovšek, 1977; Mohan & Bhatia, 1989; Momirović & Horga, 1982; Momirović, Hošek, & Gredelj, 1987; Planinšec, 2002; Planinšec & Pišot, 2003; Tirre & Raouf, 1998). These studies have proved the existence of two important factors which are significant for the connection between motor performance and intelligence. In cases where the motor task does not include problem situations, the connection is dependent on the speed of the information flow in the nervous system, while in cases where the motor task is complex on the information level, the nexus is dependent on the intellectual activity used in solving the motor problem situations. There are interesting conclusions that the correlation coefficients among tests for measuring the motor coordination are almost equally significant as compared with the correlation coefficients of these tests with intelligence tests (Momirović et al., 1987). However, the ability of motor coordination is not simply one of the manifestations of general intellectual ability, but a result of several abilities (Tirre & Raouf, 1998). Carretta and Ree (1997) have established that the nexus between high-order cognitive factors and psychomotor factors are higher than between low order factors. Nijenhuis and Van de Flier (2002) established that perceptual-motor ability tests overlap with the general intelligence factor. The interdependence of motor abilities and the intellectual skills of children has been studied by Bonifacci (2004). According to motor efficiency she divided children into groups with low, average and above average motor abilities. She concludes that there are important differences in the abilities of visual-motor integration between the low-average and above-average group while there were no differences among children concerning their perceptual skills.

Only a few studies up to now have treated the development changes of relations between motor performance and intelligence (Cole & Harris, 1992; Eggert & Shuck, 1978; Thomas & Chissom, 1972; Zimmer, 1981). Their studies show a positive correlation between motor performance and intelligence. It is medium high

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in the pre-school period and decreases in older children, with the ability of the coordination of movement having the strongest connection with intelligence. Cole and Harris (1992) have established that the relations between the intelligence quotient and the motor quotient are unstable, as they change significantly with age.

The above mentioned studies show significant differences with regard to the samples of participants, the selection of tests and the methods of data processing, which makes the comparison among them rather difficult. In comparison with the above mentioned research, our research mainly uses different motor and intelligence tests.

The main aim of this study is to analyse the connection between the manifest motor indicators and fluid intelligence of boys aged 10 to 14 years. It intends to establish whether the relations among motor performance and intelligence change with age and which motor variables show the strongest connection with the fluid intelligence in difference age periods.

MATERIALS AND METHODS

Participants

The participants were 550 healthy boys, of whom 195 are aged 10.2 years (SD = 0.32), 160 are aged 12.3 years (SD = 0.29) and 195 are aged 14.3 years (SD = 0.34). The selection of boys for sample was random. The participants come from different parts of Slovenia.

Variables

Motor tests. For the assessment of motor performance a battery of 26 tests (Strel, 1996) was used; eight tests are from Eurofit test battery (1993). The motor tests belong to the following indicators of motor performance: *speed of movement* (hand tapping; hand tapping 25 cycles; foot tapping); *strength* (standing broad jump; put the medicine ball; 60 m run; hand grip; sit-ups 20; sit-ups 30; sit-ups 60; bent arm hang); *agility* (running around three stands; running around two stands with obstacles; running, rolling, crawling); *motor coordination* (drumming with the hands; drumming with the hands and feet; polygon backwards; climbing and descending; match juggling); *flexibility* (forward bow; back arm twist; sit and reach); *balance* (standing on a low beam; flamingo balance); *endurance* (600 m run; endurance shuttle run). The motor tests have been applied on a population of Slovenian children (Kovač & Strel, 2000; Strel, 1996; Šturm, 1980) and are thus appropriate for application on the selected sample. In existing studies, motor tests were of acceptable reliability.

Intelligence test. The assessment of intelligence was carried out with the test TN-20 (Pogačnik, 1994). The test is intended for measuring fluid intelligence, i. e. for the testing of the general neurophysiological capacity of the central nervous system for information processing. It is non-verbal and culture free. The test consists of 45 tasks, which increase in difficulty. Since there is a 20 minute time limit for the test, it can be labeled as a speed test. The test has satisfactory measurement characteristics and is thus appropriate for application on the selected sample (Pogačnik, 1994). Pogačnik (1995) determines a high correlation of this test with other tests for the assessment of intelligence.

Procedure

The measurements of motor abilities and intelligence were always carried out before noon in especially prepared areas. Each participant completed all the tests in two hours. The measurements were carried out by qualified experts. First, the participants performed an intelligence test followed by measurements of motor performance. All participants were well informed about the course of measurements and they received precise instructions for each task before performing it. The whole course of testing was coordinated and supervised by the measurements leader while a special leader was responsible for the motor and psychological complex of the measurements. Children and their parents agreed to participate in this research. Written consent was obtained from the children's parents.

Analyses

The data were processed with the program SPSS 12.0, separately for each age group. The relations between motor variables and fluid intelligence were estimated with multiple regression analysis. The system of predictors was represented by the manifest motor variables, while the criterion was represented by the result of the intelligence test.

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RESULTS

The results of the regression analysis in 10 year olds show (TABLE 1) that there is no significant correlation between the entire system of motor variables and fluid intelligence on the level of $p < .05$, with the multiple correlation coefficient (R), as an indicator of the connection of the predictors with the criterion, being .35, which means that 12% of the common variance between motor and intelligence variables is explained. Of the individual motor variables, a significant coefficient of β on the level $p < .05$ belongs to drumming with the hands (.22).

TABLE 1
Summary of regression analysis for 10 years old boys

Motor Dimension and Variable	r	Part – r	β	p
Speed of movement				
Hand tapping	.09	.03	.05	.64
Hand tapping 25 cycles	–.06	.03	.06	.60
Foot tapping	.08	.05	.07	.46
Strength				
Standing broad jump	–.00	–.03	–.05	.65
Put the medicine ball	.02	.02	.03	.72
60 m run	–.03	–.02	–.03	.77
Bent arm hang	–.02	–.01	–.01	.88
Hand grip	.04	.06	.06	.40
Sit-ups 60	–.03	–.08	–.12	.23
Sit-ups 20	.05	.10	.38	.17
Sit-ups 30	.05	–.07	–.28	.32
Agility				
Running around two stands with obstacle	–.01	.01	.02	.84
Running, rolling, crawling	–.06	–.01	–.02	.82
Running around three stands	.07	.14	.21	.06
Coordination of movement				
Drumming with the hands	.23	.18	.22	.01
Drumming with the hands and feet	.11	.02	.02	.80
Match juggling	.02	.00	.00	.96
Polygon backwards	–.04	–.00	–.01	.94
Climbing and descending	–.03	–.02	–.04	.71
Flexibility				
Back arm twist	.06	.05	.06	.45
Forward bow	–.01	–.01	–.02	.89
Sit and reach	–.01	–.00	–.00	.98
Balance				
Standing on a low beam	.04	–.01	–.01	.88
Flamingo balance	–.04	–.05	–.06	.46
Endurance				
600 m run	–.01	.05	.07	.49
Endurance shuttle run	.21	.09	.15	.06
R = .35	R^2 = .12	p = .62		

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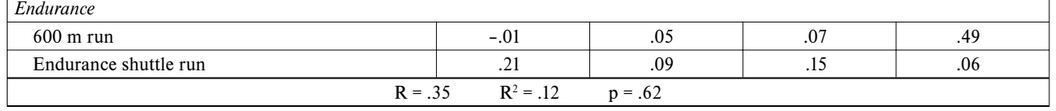

TABLE 2 shows the results for 12 year old boys. The multiple correlation coefficient (R) had an expected value of (.50), which means that there is 25% common variance between motor variables and fluid intelligence. The coefficient R is significant at the level of $p < .05$. The most important motor variable which has a significant coefficient of β at the level of $p < .05$ is hand tapping, 25 cycles (.26).

TABLE 2
Summary of regression analysis for 12 years old boys

Motor Dimension and Variable	r	Part – r	β	p
Speed of movement				
Hand tapping	–.03	–.10	–.15	.16
Hand tapping 25 cycles	–.19	–.17	–.26	.02
Foot tapping	.01	.13	.18	.07
Strength				
Standing broad jump	.07	-.06	–.10	.42
Put the medicine ball	.04	–.01	–.02	.83
60 m run	–.07	.02	.04	.73
Bent arm hang	.15	.07	.09	.33
Hand grip	.12	.07	.09	.31
Sit-ups 60	.09	.00	.00	.97
Sit-ups 20	.09	–.07	–.30	.32
Sit-ups 30	.10	.06	.27	.36
Agility				
Running around two stands with obstacle	–.06	.06	.10	.38
Running, rolling, crawling	–.15	–.03	–.04	.68
Running around three stands	–.01	.07	.12	.29
Coordination of movement				
Drumming with the hands	.22	.05	.07	.50
Drumming with the hands and feet	.18	.10	.13	.18
Match juggling	.09	.04	.05	.57
Polygon backwards	–.15	–.08	–.13	.29
Climbing and descending	–.13	–.02	–.03	.75
Flexibility				
Back arm twist	–.21	–.12	–.16	.09
Forward bow	.24	.07	.16	.32
Sit and reach	.17	–.01	–.03	.84
Balance				
Standing on a low beam	.18	.04	.05	.56
Flamingo balance	.00	.07	.09	.30
Endurance				
600 m run	–.13	–.02	–.03	.79
Endurance shuttle run	.21	.09	.15	.21
R = .50	R^2 = .25	p = .03		

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TABLE 2 shows the results for 12 year old boys. The multiple correlation coefficient (R) had an expected value of (.50), which means that there is 25% common variance between motor variables and fluid intelligence. The coefficient R is significant at the level of $p < .05$. The most important motor variable which has a significant coefficient of β at the level of $p < .05$ is hand tapping, 25 cycles (.26).

TABLE 2
Summary of regression analysis for 12 years old boys

Motor Dimension and Variable	r	Part – r	β	p
Speed of movement				
Hand tapping	–.03	–.10	–.15	.16
Hand tapping 25 cycles	–.19	–.17	–.26	.02
Foot tapping	.01	.13	.18	.07
Strength				
Standing broad jump	.07	-.06	–.10	.42
Put the medicine ball	.04	–.01	–.02	.83
60 m run	–.07	.02	.04	.73
Bent arm hang	.15	.07	.09	.33
Hand grip	.12	.07	.09	.31
Sit-ups 60	.09	.00	.00	.97
Sit-ups 20	.09	–.07	–.30	.32
Sit-ups 30	.10	.06	.27	.36
Agility				
Running around two stands with obstacle	–.06	.06	.10	.38
Running, rolling, crawling	–.15	–.03	–.04	.68
Running around three stands	–.01	.07	.12	.29
Coordination of movement				
Drumming with the hands	.22	.05	.07	.50
Drumming with the hands and feet	.18	.10	.13	.18
Match juggling	.09	.04	.05	.57
Polygon backwards	–.15	–.08	–.13	.29
Climbing and descending	–.13	–.02	–.03	.75
Flexibility				
Back arm twist	–.21	–.12	–.16	.09
Forward bow	.24	.07	.16	.32
Sit and reach	.17	–.01	–.03	.84
Balance				
Standing on a low beam	.18	.04	.05	.56
Flamingo balance	.00	.07	.09	.30
Endurance				
600 m run	–.13	–.02	–.03	.79
Endurance shuttle run	.21	.09	.15	.21
R = .50	R^2 = .25	p = .03		

The results of the regression analysis for 14 year olds show (TABLE 3) that there is a significant correlation between the entire system of motor variables and fluid intelligence on the level of $p < .05$, with the multiple correlation coefficient (R) being quite high (.45), which means that 20% of the common variance between motor variables and intelligence is explained. The motor variables which have a significant coefficient of β at the level of $p < .05$ are the following: running around three stands (.26), foot tapping (.20), drumming with the hands (.17), bent arm hang (.17) and back arm twist (.15).

TABLE 3
Summary of regression analysis for 14 years old boys

Motor Dimension and Variable	r	Part – r	β	p
Speed of movement				
Hand tapping	.03	–.04	–.06	.51
Hand tapping 25 cycles	–.04	.00	–.00	.99
Foot tapping	.08	.16	.20	.02
Strength				
Standing broad jump	.07	.08	.14	.24
Put the medicine ball	–.02	.04	.06	.51
60 m run	.01	.08	.12	.24
Bent arm hang	.13	.14	.17	.03
Hand grip	–.06	–.05	–.07	.42
Sit-ups 60	–.03	–.06	–.07	.38
Sit-ups 20	.07	–.02	–.04	.73
Sit-ups 30	.13	.06	.13	.31
Agility				
Running around two stands with obstacle	–.08	.03	.04	.66
Running, rolling, crawling	–.02	.02	.02	.75
Running around three stands	–.16	–.16	–.26	.01
Coordination of movement				
Drumming with the hands	.19	.13	.17	.04
Drumming with the hands and feet	.11	.03	.04	.62
Match juggling	.17	.09	.10	.17
polygon backwards	.01	.12	.19	.07
Climbing and descending	–.10	–.07	–.10	.28
Flexibility				
Back arm twist	–.17	–.14	–.16	.04
Forward bow	–.02	–.02	–.06	.68
Sit and reach	–.02	–.02	–.06	.69
Balance				
Standing on a low beam	.01	–.12	–.15	.07
Flamingo balance	–.09	–.04	–.06	.50
Endurance				
600 m run	.06	–.05	–.07	.89
Endurance shuttle run	.21	.09	.15	.21
R = .45	R^2 = .20	p = .02		

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Sit and reach	–.02	–.02	–.06	.69
Balance				
Standing on a low beam	.01	–.12	–.15	.07
Flamingo balance	–.09	–.04	–.06	.50
Endurance				
600 m run	.06	–.05	–.07	.89
Endurance shuttle run	.21	.09	.15	.21
R = .45	R^2 = .20	p = .02		

DISCUSSION

We can say that the obtained results are partly consistent with expectations and with results of the previous studies. The results show that there are positive and significant associations between motor and intellectual variables, but there are some differences among all age groups. In 12 year old boys the connection between motor variables and intelligence is the highest, followed by 14 year old boys, where it is a little lower; the connection is not significant and it is the lowest in 10 year old boys. The nexus between motor performance and fluid intelligence is the result of various factors.

The most important motor dimension which shows the strongest connection with the intellectual variable is the coordination of movement in rhythm. Motor tasks involving the coordination of movement in rhythm (variable drumming with the hands) consist of simple movements. However, these are integrated into a rhythmical whole in an unusual way, which makes them complex mostly on the information level. Such movements are abstract and not carried out in everyday situations. The ability of motor coordination is influenced by different cognitive processes which include visuo-processing, visuo-spatial processing and working memory, very important is also the processing speed (Tirre & Raouf, 1998). Planinšec (2002) also states that the speed of information processing plays a very important role in the fast realization of coordination-demanding motor tasks. This speed of information processing is important for the efficiency of intellectual processes (Vernon & Mori, 1992). Pogačnik (1994) suggests that this holds true for the intelligence test TN-20 as well. Bestawros, Langevin, Lalonde and Botez-Marquard (1999) conclude that there is a relationship between measurements of the speed of information processes and the solving of problem situations, which implies a possibility of a common neuro-biological bases for the speed of processing information and human realization functions. The speed of processing information plays an important role in structuring, regulation and motor control, especially when motor tasks are performed at maximum speed.

The nexus between the speed of movement (variables of hand tapping for 25 cycles and foot tapping) and intelligence has already been confirmed (Mohan & Bhatia, 1989; Planinšec, 2002). This connection was explained with a faster and more efficient central nervous system or nerve conduction velocity. It is a fact that speed of movements does not require intelligence. Some researchers have already established that the nerve conduction velocity is correlated with intelligence and speed of movement (Reed & Jensen, 1991; Vernon & Mori, 1989). The speed of neural transmission is important for the speed of information processing, which has a significant influence on the level of intelligence (Bestawros et al., 1999; Vernon & Mori, 1992). The intelligence tests is characterised by time limitation, therefore intellectual speed contributes significantly to the result (Pogačnik, 1994). All this proves the existence of the connection between the speed of movement with the result of the intelligence test.

Fluid intelligence is also connected with variable running around three stands. Motor tasks which are characterised by the quick changing of the direction of movement are complex (Jurimae & Saar, 1998; Planinšec, 2001). Informational complex movement tasks require the successful processing of information, and this also requires intellectual activity (Planinšec, 2002; Tirre & Raouf, 1998).

Contrary to expectation, flexibility (variable back arm twist) falling under the category of motor variables is significantly connected with fluid intelligence, which has already been confirmed (Momirović & Horga, 1982). It was also surprising that there is a significant connection between intelligence and the functional strength (variable bent arm hang), which has also been proved by other researchers (Kovač & Strel, 2000). The implementation of tasks involving flexibility and functional strength certainly does not require intelligence.

CONCLUSION

It has been confirmed that developmental changes have significant associations with the closeness of the nexus between manifest motor indicators and fluid intelligence. The findings of Cole and Harris (1992) regarding relations between motor and intellectual abilities, which seem to be developmentally unstable, can be confirmed. Direction of the relationship between motor abilities and intelligence remains unclear. Therefore it would be advisable to investigate the causal link between motor and intellectual dimensions and to find out which factors influence the relationship. We suggest additional studies for the future where a broader children's age range would be discussed. This might help to gain a better insight into the influence of developmental factors on the relations between motor and intellectual dimensions.

Acknowledgement

The collection of data was carried out within the framework of the longitudinal study with the title *An analysis of the development trends of motor abilities and morphological characteristics and their relations to the psychological and sociological dimensions of Slovenian children and youth*. The author would like to thank Janko Strel, Ph.D., for his help.

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VZTAH MEZI ZJEVNÝMI MOTORICKÝMI UKAZATELI A FLUIDNÍ INTELIGENCÍ U PREPUBERTÁLNÍCH CHLAPCŮ

(Souhrn anglického textu)

Cílem studie bylo zkoumat korelaci mezi zjevnými motorickými ukazateli a fluidní inteligenci u chlapců. Vzorek zahrnoval 550 chlapců ve věku od 10 do 14 let. Pro měření motorického výkonu byla použita baterie 26 testů. Testování inteligence bylo prováděno pomocí testu TN-20. Vícenásobná regresní analýza prokázala existence korelace mezi motorickými proměnnými a fluidní inteligencí. Nejužší korelaci bylo možno pozorovat mezi fluidní inteligencí a motorickými úkoly vyžadujícími pohybovou koordinaci rytmu s rychlostí pohybu. Korelaci mezi motorickým výkonem a fluidní inteligencí záviselo na věku. U 12letých chlapců je vztah mezi motorickými proměnnými a fluidní inteligencí nej-

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vyšší. Následují 14letí chlapci, nejnižší závislost je pak u 10letých chlapců. Výsledky naznačují, že vývojové změny mají významný vliv na vztahy mezi motorickým výkonem a fluidní inteligencí.

Klíčová slova: motorická výkonnost, tělesná zdatnost, fluidní inteligence, korelace, chlapci.

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vyšší. Následují 14letí chlapci, nejnižší závislost je pak u 10letých chlapců. Výsledky naznačují, že vývojové změny mají významný vliv na vztahy mezi motorickým výkonem a fluidní inteligencí.

Klíčová slova: motorická výkonnost, tělesná zdatnost, fluidní inteligence, korelace, chlapci.

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Education and previous work experience

Doctor's degree on Faculty of Sport, University of Ljubljana. Works as an Associate Professor at the Faculty of Education, University of Maribor and at the Institute of Kinesiological Research, University of Primorska. His research interest is related to the motor behavior, health related physical activity and physical self-concept of children and adolescents.

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AMERICAN ADAPTED PHYSICAL EDUCATION IN THE FIRST HALF OF THE 20th CENTURY

Martin Kudláček

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Submitted in May, 2005

Adapted physical education in the U. S. has evolved from medical, corrective gymnastics. The original influence of Swedish gymnastics was passed on to American Universities via Hartwig Nissen (1855–1924), Nils Posse (1862–1895) and William Skarstrom (1896–1951). The first American leaders of corrective gymnastics were Lillian Curtis Drew and Louisa Lippitt. The corrective approach was the philosophy of physical education for students with special needs from the 1920 till the 1950. Leaders of APE in that era were Charles Lowman (1879–1977), George Stafford (1894–1968) and Josephine Rathbone (1899–1989). They very closely cooperated with physical therapists. A great number of World War II veterans influenced the major changes in sport for people with disabilities. World War II significantly changed the approach to physical activities for people with disabilities, which led to the separation of corrective physical therapy and adapted physical education in 1952.

Keywords: Adapted physical education, history, corrective physical education, USA.

INTRODUCTION

Corrective physical education evolved from the Swedish system of medical gymnastics. The leaders who directly influenced American corrective gymnastics were Nissen, Posse and Skarstrom. They all wrote influential books on medical gymnastics and led courses in early medical gymnastics. World War I changed the situation in corrective education, because of a growing number of people who were injured and needed physical rehabilitation. Most major adapted physical education textbooks (Jansma & French, 1994; Seaman & DePauw, 1982; Sherrill, 1988; Sherrill, 1993) agree that World War I instigated the growth of corrective physical education. Sherrill (1988) states that training in physical therapy consisted of a degree from schools of physical education or nursing and an approximately 9 month long course in massage, therapeutic exercise, hydrotherapy and electrotherapy. However, at that time, preparation of teachers of physical education shifted from medical to educational. Students of physical education were still required to take courses in corrective gymnastics as part of their university training.

CORRECTIVE PHYSICAL EDUCATION (1920's - 1950's)

The era from 1930 to 1952 is called the Era of Professional Preparation in Corrective Physical Education. During this time there was a growing gap between physical education and physical therapy. The term corrective physical education appeared as the name of 2 major textbooks in 1928. Both books were written by influential leaders, Charles Lowman and George Stafford. Winnick (1990) cites Sherrill's description of corrective physical education in that era.

Assignment to physical education was based upon a thorough medical examination by a physician who determined whether a student should participate in the regular or corrective program. Corrective classes were comprised primarily of limited, restricted, or modified activities related to health, posture, or fitness problems. In many schools students were excused from physical education. In others, the physical educator typically taught several sections of regular physical education each day. Leaders in corrective physical education continued to have strong backgrounds in medicine and/or physical therapy. Persons preparing to be physical education teachers generally completed one university course in corrective physical education.

World War II had also tremendous impact on the development of adapted physical education. Many war veterans claimed that their disabilities could not be corrected and therefore the term corrective was not appropriate. The post war era is also significant in sport for people with disabilities in America as well as in Europe.

William Skarstrom (1869–1951)

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Skarstrom was one of the early leaders of Swedish medical gymnastics in America, which later led to the

development of corrective physical education. Skarstrom was mentored by Amy Morris Homans, taught at the Boston Normal School of Gymnastics (1899–1903), at Teacher's College, Columbia University (1903–1912), and Wellesley College from 1912 on. Many women leaders were influenced by Skarstrom. Among them were Senda Berenson of Smith College and Josephine Rathbone of Teacher's College, Columbia University. They were applying Swedish gymnastic concepts through their carriers (Sherrill & DePauw, 1997). Skarstrom as well as Nissen wrote influential books on Swedish gymnastics. One of his best is Gymnastic Kinesiology (1913).

Lilian Curtis Drew

Unfortunately there is not much information on Lilian Curtis Drew in adapted physical education textbooks. She was the director of the department of corrective gymnastics at the Teachers College of Columbia University (Sherrill & DePauw, 1997). The symposium of preventive and corrective physical education was dedicated to the memory of Lilian Curtis Drew. Therefore there is some evidence of her influence on the development of corrective physical education. In her book Individual gymnastics: A handbook of corrective and remedial gymnastics (1926, p. 18), Drew defined medical gymnastics as: "...exercises based on anatomical and physiological principles, performed by the individual alone or with assistance, for prevention or arrest, the cure or correction of some definite functional or organic disability or deformity". Its objectives were the improvement of the general condition, the increase of flexibility, strengthening muscles and readjustment of muscle control.

Drew (1926) is critical of the term corrective, because of its stigma and tendency to cause morbidity and self consciousness. She also stressed the importance of being sensitive in emphasizing the fact of a student's abnormal condition. Drew (1926) said: "While it is essential, to some extent, to direct attention to definite purposes, it must be done carefully, and the interest aroused in such ways as to create an atmosphere in which individual is conscious merely of being a pupil working with an instructor toward a purposeful goal, rather then being a patient or a case who is receiving treatment." According to Drew, teachers should bring students joy and enthusiasm, and teachers also need to have tact and adaptability.

George Stafford (1894–1968)

Stafford was both a physical therapist and a specialist in corrective physical education. He became interested in those areas through service in the World War I Army reconstruction department (Sherrill, 1988; Sherrill & DePauw, 1997). He received his BPE degree in 1917 at Springfield YMCA College and his doctoral degree in 1937 at New York University. He practiced physiotherapy in Boston from 1919 to 1923 and from 1923 he worked at the University of Illinois as Supervisor of Corrective Physical Education. Stafford and Tappan (1927, p. 5) define corrective exercises: "The aim of corrective exercises is to relieve certain conditions such as painful arches, constipation, ptosis, cardiac weakness, digestive disorders, neurasthenia, general debility, postural defects, malnutrition, paralysis (infantile and spastic), etc." Stafford also understood the psychological importance of exercise when he claimed that persons with disabilities should not look at themselves as invalids, but as normal individuals with bodily defects. He believed that sport and exercise can help to achieve this goal (Stafford & Tappan, 1927). Stafford (1943, p. 127) also specified the requirements for successful teaching. He believed that teachers must have the desire to help others, good physique and cheerful disposition, knowledge of human nature, patience, vision, enthusiasm, sincerity, optimism, mental alertness, tact and adaptability. They also need equipment and to be resourceful in solving the individual problems of students. His 2 major textbooks were Preventive and corrective Physical Education (1927) and Sports for the handicapped (1947). Sherrill and DePauw state that leadership of the University of Illinois in the wheelchair sports movement can be traced to Stafford, who was influential in moving corrective physical education from being medical to being educational and recreational.

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Rathbone learned medical gymnastics from Skarstrom at Wellesey College (Sherrill & DePauw, 1997) and was also taught by physician Frank B. Granger from the Boston City Hospital (Sherrill, 1988). Rathbone taught at the Normal School in New Britain, Connecticut at Wellesley College (1925–1930) and at the Teacher's College of Columbia University (1930–1960), where she influenced a number of adapted physical education leaders. Sherrill and DePauw (1997) state that Rathbone's Corrective Physical Education (1934) lasted through seven editions and influenced more professionals than any other text.

Rathbone (1934, p. 3) defines correction as a field that is: "...as wide as any one cares to make it. It can not be satisfied with a few exercises for strengthening specific muscles, nor with a method of standing in perfect balance. It must consider the health problems of the child, so as to help him to develop as normally as possible; and it must consider the hazards of the athlete, so as to protect him from injury or strain... It must consider the body at different stages in its development, and must call upon every possible physiological and psychological aid to normal bodily development."

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Rathbone's requirements for a good teacher were: knowledge of anatomy, physiology, biomechanics and psychology; and appreciation of the intellectual, social, and cultural functions of general education. She also stated that a sense of humor and a sense of proper values are necessary for all good teachers of corrective physical education. In her text of 1934, Rathbone showed the understanding of the social and psychological importance of physical education for students with disabilities. She stated that many teachers fail to realize that students with disabilities might have a passionate interest in physical education and leisure time recreation. Rathbone also stressed that children with disabilities need joy: "Joy from inward health, joy from a kindly environment, joy from achievement, joy from watching their conditions improve, joy from association with other people, or joy from doing for other people." Rathbone believed that the community should be responsible for integrating all individuals with disabilities, apart from those that are dangerous to society.

Symposium of Preventive and Corrective Physical Education

The 1931 volume of The Journal of Health and Physical Education is partially devoted to the state of corrective physical education. In 5 issues of the given journal the Committee of the American Physical Education Association reports on the state, conditions, objectives and applications of corrective physical education. Among 6 members of committee are two of the above mentioned leaders, Charles Lowman and George Stafford. The symposium was dedicated to the memory of Lilian Curtis Drew, who died in 1930. The committee (1931a) stressed the importance of appropriate physical activities in physical education, claiming that each activity must be adjusted to the individual's physical needs; and that equality of abilities between individuals and groups who compete must exist to protect health and promote social development. The freedom to choose both the time and the type of exercise should encourage responsibility in each student. In part II (1931b, p. 23), the committee specifies the objectives of corrective physical education, which were to be:

1. to correct existing defects,
2. to reduce handicapping conditions,
3. to restore and maintain organic vigor and skeletal skill to the end of benefit and joy in the various safe sports',
4. to learn to adapt one's self to one's physical condition and to life conditions in and out of school,
5. to constantly maintain habits of work, rest and play conducive to one's best health interests.

They addressed motivation (1931b), organization and administration (1931c), games and recreation (1931c), limitations of corrective work (1931d) and included a bibliography (1931d). At the end of the symposium, the committee argues about terminology and supports the use of a new term: individual physical education. They also set 11 principles of effective corrective programs. They urged teachers to get familiar with individual diagnosis and to try to bring up the right mental attitude of all individuals toward improvement. Recreational skills and activities were recognized and the need for leisure time physical activities was supported.

Physical Education in special classes

Herbert W. Grigson was the Supervisor of Physical and Health Education in the Philadelphia Public Schools. In the 1931 volume of the Journal of Health and Physical Education he wrote four articles about physical education in special education classes in public schools. In the beginning he explains the establishment of special education as a relatively new division in public schools, which was organized in Philadelphia schools in 1898. Grigson (1931a, p. 3) starts his article with the explanation of the need for segregated special education:

"So the backward pupil gradually became a part of an entirely different social group. His ostracism irked him, and all sorts of emotional outbursts, seemingly without cause, occurred. There were not enough pupils of this sort in any one grade school to form a homogeneous group even if the school had segregated them, so the pupil remained in school... School was a place he hated because it attempted to make him do what was impossible for him to accomplish, and he lived only for dismissal time each day."

Grigson provided numbers of students with disabilities divided into categories. His categories were: deafness, nutritional difficulties, tubercular condition, orthopaedic needs, sight saving needs, difficulties with orthogenic backwardness, orthogenic disciplinary problems, cases of restoration and cardiac patients. He provided general information about students' specific needs in physical education for each of his categories. His second article (Grigson, 1931b) is devoted to the education of students with behavioral problems. His article The physical education program in orthogenic, backward and disciplinary classes provides examples of exercises, games and their modifications, and is supplemented with many photographs from school settings. His description of games continues in the fourth article from November 1931. In his last article Grigson (1931d) focuses on behavior management and the roles of habit, activity and interest. Finally he concludes his series of articles with information about instructional needs in special education classes and the program of health education. From the series of Grigson articles it is clear that special education was, at the beginning of

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the 20th century, an emerging discipline, which needed help with developing its physical education programs. Very interesting is the reasoning for segregation of students with disabilities from regular schools.

Physical Education in Residential Facilities

The first physical education scholar to write about residential facilities for students with disabilities was a Canadian, R. Tait McKenzie, who devoted the entire chapter of his book Exercise in Education and Medicine to the "Physical Education of the Blind and the Deaf-Mute" (Sherrill, 1988; Sherrill & DePauw, 1997). One of his chapters was focused on "Mental and Moral Defectives". In his work he was truly a pioneer. Sherrill (1988, p. 29) states "R. Tait McKenzie was one of the first physical educators to be influenced by special education, he was almost 50 years ahead of the times".

The first residential school for children with hearing impairments was founded in 1817 by the Minister Thomas Hopkins Gallaudet (Sherrill, 1993; Sherrill & DePauw, 1997). Gallaudet was later honored by the deaf community in 1856, when its first college was named Gallaudet College. This school is located in Washington, DC and has a long history of excellent physical education and sport (Sherrill, 1993; Sherrill & DePauw, 1997).

One item of information about early adapted physical education comes from Sherrill (1988), who briefly describes the founding of early special educational residential facilities and states that the only records on adapted physical activities from the 1900's are by Dr. Charles Buell. Winnick (1990) also devotes attention to Samuel Gridley Howe and his contribution to adapted physical education for students with visual impairments. In the U. S. A., three schools for the blind were founded between 1830 and 1833, in Boston, New York and Philadelphia. Buell (1966) cites Howe's school report in which it is mentioned that physical exercise plays an important role in developing and maintaining the health of all students. Howe used to take his students swimming in the sea, he did bowling and also had them participate in gymnastics. Buell (1966) states that most early physical education was organized by German Turners. At the end of the 19th century, schools for students with visual impairments were engaged in both German and Swedish gymnastics. The schools were influenced by the playground movement. The leading person of that time was Sir Francis Campbell, whose aim was to discover and arrange outdoor games suitable for students with visual impairments. Buell (1966, p. 22) cites Campbell: "The education of the blind, whether literary, musical or technical, will not be crowned with practical success unless based upon a thorough system of physical education."

THE CHANGE FROM CORRECTIVE TO ADAPTED PHYSICAL EDUCATION

1952 – The Conflict between Corrective and Adapted Physical Education

The return of war veterans influenced greatly the change of corrective physical education to adapted physical education (Daniels & Davies, 1954; Stafford, 1947). Sherrill (1993) explains that war veterans pointed out that amputations and spinal cord injuries could not be corrected. They also started sport programs for use in rehabilitation centers. Experience with Army reconditioning and Air Forces rehabilitation programs led in 1946 to the establishment of the AAHPER committee to study the needs of individuals with disabilities (Sherrill & DePauw, 1997). This committee was established by the Therapeutic Section of AAHPER. In 1952 this committee issued the first official definition of adapted physical education. Sherrill (1993, p. 19) cites Committee on Adapted Physical Education: "Adapted physical education is a diversified program of developmental activities, games, sports, and rhythms suited to the interests, capacities, and limitations of students with disabilities who may not safely or successfully engage in unrestricted participation in the vigorous activities of the general physical education program".

Members of the committee represented 3 different philosophical views of adapted physical education. Arthur Daniels (Ohio State University), M. Harrison Clarke (Springfield College), and C. Morgan (Army Medical Corps; part-time at George Washington University) all had background in regular physical education, but were strongly influenced by the World War II veterans. Josephine Rathbone (Teacher's College, Columbia) and Catherine Worthington (Standford University) were corrective and physical therapy specialists. Finally George Stafford (University of Illinois) strongly advocated the change from corrective to adapted sport (Sherrill & DePauw, 1997). "...the formal program of corrective physical education lacks the satisfaction of the drives and interests of the students which are satisfied by adapted sports" (Stafford, 1947, p. 32). Stafford also claimed that persons with disabilities do not want activities modified to allow for their disabilities, but they want activities which are adapted for their remaining abilities.

In 1952 a decision was made that moved the focus from corrective to adapted physical education. This philosophy was unacceptable to the American Physical Therapy Association, which had, up to 1952, closely cooperated with AAHPER's therapeutic section, and after the shift to the adapted philosophy decided to end their close cooperation. One of the other major factors was the dynamic growth of physical therapy caused by

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the 20th century, an emerging discipline, which needed help with developing its physical education programs. Very interesting is the reasoning for segregation of students with disabilities from regular schools.

Physical Education in Residential Facilities

The first physical education scholar to write about residential facilities for students with disabilities was a Canadian, R. Tait McKenzie, who devoted the entire chapter of his book Exercise in Education and Medicine to the "Physical Education of the Blind and the Deaf-Mute" (Sherrill, 1988; Sherrill & DePauw, 1997). One of his chapters was focused on "Mental and Moral Defectives". In his work he was truly a pioneer. Sherrill (1988, p. 29) states "R. Tait McKenzie was one of the first physical educators to be influenced by special education, he was almost 50 years ahead of the times".

The first residential school for children with hearing impairments was founded in 1817 by the Minister Thomas Hopkins Gallaudet (Sherrill, 1993; Sherrill & DePauw, 1997). Gallaudet was later honored by the deaf community in 1856, when its first college was named Gallaudet College. This school is located in Washington, DC and has a long history of excellent physical education and sport (Sherrill, 1993; Sherrill & DePauw, 1997).

One item of information about early adapted physical education comes from Sherrill (1988), who briefly describes the founding of early special educational residential facilities and states that the only records on adapted physical activities from the 1900's are by Dr. Charles Buell. Winnick (1990) also devotes attention to Samuel Gridley Howe and his contribution to adapted physical education for students with visual impairments. In the U. S. A., three schools for the blind were founded between 1830 and 1833, in Boston, New York and Philadelphia. Buell (1966) cites Howe's school report in which it is mentioned that physical exercise plays an important role in developing and maintaining the health of all students. Howe used to take his students swimming in the sea, he did bowling and also had them participate in gymnastics. Buell (1966) states that most early physical education was organized by German Turners. At the end of the 19th century, schools for students with visual impairments were engaged in both German and Swedish gymnastics. The schools were influenced by the playground movement. The leading person of that time was Sir Francis Campbell, whose aim was to discover and arrange outdoor games suitable for students with visual impairments. Buell (1966, p. 22) cites Campbell: "The education of the blind, whether literary, musical or technical, will not be crowned with practical success unless based upon a thorough system of physical education."

THE CHANGE FROM CORRECTIVE TO ADAPTED PHYSICAL EDUCATION

1952 – The Conflict between Corrective and Adapted Physical Education

The return of war veterans influenced greatly the change of corrective physical education to adapted physical education (Daniels & Davies, 1954; Stafford, 1947). Sherrill (1993) explains that war veterans pointed out that amputations and spinal cord injuries could not be corrected. They also started sport programs for use in rehabilitation centers. Experience with Army reconditioning and Air Forces rehabilitation programs led in 1946 to the establishment of the AAHPER committee to study the needs of individuals with disabilities (Sherrill & DePauw, 1997). This committee was established by the Therapeutic Section of AAHPER. In 1952 this committee issued the first official definition of adapted physical education. Sherrill (1993, p. 19) cites Committee on Adapted Physical Education: "Adapted physical education is a diversified program of developmental activities, games, sports, and rhythms suited to the interests, capacities, and limitations of students with disabilities who may not safely or successfully engage in unrestricted participation in the vigorous activities of the general physical education program".

Members of the committee represented 3 different philosophical views of adapted physical education. Arthur Daniels (Ohio State University), M. Harrison Clarke (Springfield College), and C. Morgan (Army Medical Corps; part-time at George Washington University) all had background in regular physical education, but were strongly influenced by the World War II veterans. Josephine Rathbone (Teacher's College, Columbia) and Catherine Worthington (Standford University) were corrective and physical therapy specialists. Finally George Stafford (University of Illinois) strongly advocated the change from corrective to adapted sport (Sherrill & DePauw, 1997). "...the formal program of corrective physical education lacks the satisfaction of the drives and interests of the students which are satisfied by adapted sports" (Stafford, 1947, p. 32). Stafford also claimed that persons with disabilities do not want activities modified to allow for their disabilities, but they want activities which are adapted for their remaining abilities.

In 1952 a decision was made that moved the focus from corrective to adapted physical education. This philosophy was unacceptable to the American Physical Therapy Association, which had, up to 1952, closely cooperated with AAHPER's therapeutic section, and after the shift to the adapted philosophy decided to end their close cooperation. One of the other major factors was the dynamic growth of physical therapy caused by

the 1944 poliomyelitis epidemic and the reconditioning needs of war veterans.

The "New Adapted Physical Education"

Arthur Daniels (1906–1966) was the first to entitle his textbook Adapted Physical Education (1954). He taught at the University of Illinois from 1934 to 1942, at The Ohio State University from 1945 to 1957 and at Indiana University from 1957 till his retirement. His book Adapted Physical Education (1964), which is co-authored by Evelyn Daniels, is divided into 3 parts. In the first part they define the problem, discussing historical, cultural and societal values. The second part is devoted to physical education in relation to specific disabilities and the third part focuses on organizational and administrational areas. In their new definition of the aim of adapted physical education we can compare the philosophy before and after 1952: "In adapted physical education the effort is made to help the student take his place in the social and economic world as a citizen who is respected for his personal qualities and capabilities. He is given an opportunity for the fullest development of his physical, social, and economic potentialities in an environment that is friendly and informal... Under these conditions he learns how he can earn his place as a member of a social group, not trading on his disability, but utilizing his ability" (Daniels & Davies, 1965).

Hollis Fait (1918–1984) was the first textbook author to include a chapter on mental retardation and learning disabilities (Sherrill & DePauw, 1997). Fait taught at the University of Connecticut and was involved with the nearby Mansfield State Training School. The interesting fact is that Fait changed the title of his textbook from Adapted Physical Education (1960) to Special Physical Education (1966), because of his belief in the close relationship to special education (Sherrill & DePauw, 1997). His definition of adapted physical education is very close to Daniel's definition (Fait, 1960, p. 9): "The modern adapted physical education program is based on the premise that the handicapped individual wants to be an accepted and active participant in the normal community and that he should be given every educational opportunity to develop his potential so that he may become a well-adjusted, contributing member of society."

CONCLUSION

In the first half of the 20th century in America we can say that the evolution of adapted physical education as a discipline took place. At first APE was influenced by the Swedish system of medical gymnastics, which led to the development of corrective gymnastics, represented by Drew, Lowman and/or Stafford. Both World War I and World War II played a crucial role in the development of the discipline. Experience with rehabilitation and the needs of war veterans led in the 1920's to a growing number of corrective physical education programs. It was World War II and its veterans, who challenged the structure and name of corrective physical education by saying that amputation and spinal cord injuries can not be corrected. The year 1952 was the milestone for adapted physical education's focusing more on the abilities of people with disabilities than on correcting their disabilities. Since then on we can draw a distinct line between adapted physical education and physical therapy.

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APLIKOVANÁ TĚLESNÁ VÝCHOVA V USA V PRVNÍ POLOVINĚ 20. STOLETÍ
(Souhrn anglického textu)

Aplikovaná tělesná výchova se v USA vyvinula z léčebné, zdravotní tělesné výchovy. Původní vliv švédské léčebné tělesné výchovy na americké vysoké školy mají „na svědomí“ Hartwig Nissen (1855–1924), Nils Posse (1862–1895) a William Skarstrom (1896–1951). Mezi první americké průkopníky zdravotní tělesné výchovy patřily Lilian Curtis Drew a Louisa Lipin. Korektivní přístup zdravotní tělesné výchovy byl dominantní v období 1920–1950. Vůdčími osobnostmi té doby byli Charles Kosman (1879–1977), George Stafford (1894–1968) a Josephina Rathbone (1899–1989). Tito odborníci v té době velmi úzce spolupracovali s fyzioterapeuty. Velký počet veteránů z druhé světové války způsobil významné změny v přístupu k pohybovým aktivitám osob se zdravotním postižením. Toto později vedlo k oddělení korektivní fyzioterapie od aplikované tělesné výchovy v roce 1952.

Klíčová slova: aplikovaná tělesná výchova, historie, zdravotní tělesná výchova, USA.

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THE EFFECTS OF INDIVIDUALLY DESIGNED PROGRAMS OF PHYSICAL TRAINING BASED ON US ARMY STANDARDS ON MOTOR ABILITIES OF SLOVENE ARMED FORCES PERSONNEL

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Submitted in May, 2005

Adequate physical readiness is a significant aspect of universal armed forces readiness and an integral part of military support. The aim of this research was to ascertain the effect of a training program, based on individually adapted intensity levels, on motor abilities of the Slovene armed forces (SV) personnel. The sample of subjects included 34 members of SV (16 in the experimental group – ES, and 18 in the control group – KS), aged between 35 and 40. Results have been processed by the SPSS 8.0 for Windows program. Data processing was carried out in several phases. First, the basic statistical characteristics and the distribution of individual variables have been determined, the measures of central tendency and the measures of dispersion have been calculated and a method for the analysis of variance with 5% risk has been used. The results have shown that a characteristic enhancement of certain motor abilities of the sample studied can be improved by means of training process economisation and individually adapted training intensity levels. Statistically significant differences between the experimental and control groups were found in measurements of body fat (KG), push-ups (SK), curl-ups (DT), a 3200 meter run (T3200M) and the morning heart beat frequency (FSUs). Although the research sample was small, these studies, at least in theory support the need for future research in these areas, as our evidence strongly suggests the effectiveness of individually designed training protocols on the physical readiness of Slovenian armed personnel.

Keywords: Motor readiness, physical training plan, NATO.

INTRODUCTION

The contemporary way of life has many negative consequences and is marking the way of life of the Slovene people as well, where the Slovene armed forces (SV) is no exception. Despite the fact that physical training in SV is well rounded legally, formally and theoretically, SV is facing the negative influences of our contemporary way of life, too (Tkavc, 1999). The rate of motor and locomotor injuries and cardiovascular disorders is rapidly increasing among SV personnel; due to insufficient exercising, many are facing an increased body weight (Karpljuk, D., Žitko, Rožman, Suhadolnik, & Karpljuk, K., 2001) causing health disorders, etc. These factors significantly affect the combat readiness of SV soldiers and SV as a whole. The motor efficiency of an individual soldier and of a unit – a principle element of combat readiness – is more and more important in readiness programs of every contemporary army (Picarielo, 2000; Jaenen, 2000). As the way of life is changing significantly, the abilities of an individual as well as the abilities of an entire society are changing along with it. Sport plays a more and more important role in developing and maintaining the motor efficiency of a contemporary individual (Karpljuk, 1999). Sport within the Slovene armed forces is and will remain an instrument for the achievement and maintenaince of the adequate motor efficiency of all personnel, as well as one of the principle requirements for the appropriate combat readiness of each individual (Tkavc, 1999). In the Slovene armed forces' fundamental foundations, sport is defined to include physical training, physical education, sport for all profiles, assessment of motor abilities, sports education, sports competitions within SV, international sports competitions, participating in competitions of sport associations and clubs, sport readiness programs of individual soldiers and units, commanders and teams, analytic and research activities, and public relations activities pertaining to informing the public about sport and athletes in the Slovene armed forces (Tkavc, 1999). Sport programs must meet the requirements of a lifestyle and above all suppress the negative consequences the army way of life brings (Jaenen, 2000). Full time SV personnel undergo regular physical training, which represents fundamental physical (motor) readiness for an individual, to most efficiently meet combat requirements or military duties (Tkavc, 1999). Military duties are often carried out under extreme physical and mental conditions, requiring

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excellent motor abilities. Individuals are often facing problems related to their own health state (overweight and accompanying health factors, stressful situations on a daily basis, motor apparatus and cardiovascular disorders, etc.). All of the previously mentioned factors have negative consequences and affect the daily military duties of commanders, military equipment duty personnel, officers managing contemporary weapons, etc. (Karpljuk et al., 2001).

Adequate physical readiness is a significant aspect of universal armed forces readiness and an integral part of military support (Jaenen, 2000). Despite an increase in number and enhanced military equipment, mechanization, means of transport, etc., a number of combat operations still depend on physically well prepared soldiers (Jaenen, 2000; Karpljuk et al., 2001). For example, Canadian armed forces personnel (Jaenen, 2000) must be physically prepared to successfully carry out military operations in a geographically and climatologically diverse landscape. All profiles, from officers to soldiers undergo the process of a highly well rounded physical readiness program. Their physical readiness is evaluated through various assessments based on the Human Rights Act (Jaenen, 2000), which the personnel is informed upon joining the Canadian armed forces.

US army personnel start their physical training program the first day upon entering the forces, and the program lasts until the end of an individual's military career. The sporty way of life in the US army is not an exception but rather a general activity of all the employees. The assessment of physical efficiency is based on the Annual physical training test (also used by some NATO members), and is comprised of push-ups, curl-ups and a 3200 meter (2 mile) run (Picarielo, 2000; Karpljuk et al., 2001). Picarielo (2000) stresses that the physical efficiency readiness is based on endurance, strength, and agility as well as on developing mental abilities, cohesiveness within a group and factors related to combat situations.

In the Slovene armed forces, physical readiness assessment based on American standards has been practiced since 1996. The assessment, even though it seems like a simple evaluation comprised of three tests (push-ups, curl-ups and a 3200 meter run), may be quite a strenuous task. As an encouraging thought to achieving a good assessment result, Tkavc (1999) says that individuals who regularly take care of their health by exercising, and who are occasionally in sports, will not have great difficulties with the assessment or will achieve relatively good results.

The doctrine of the US land forces has been presented in detail by Grizold (Grizold & Ferfila, 2000), stating that the changes applied to the doctrine of the US land forces enable an efficient employment of US armed forces wherever in the world it is needed in a rather short period of time, that requires the support of excellent logistics, which in the US army is the case, and physically well prepared soldiers, which, as stated by Picarielo (2000), is not a disturbing factor.

Liu (2000) exposed the importance of sport in the armed forces. He has analyzed the differences of the two notions, "military sport" and "sport in the military". Military sport is defined as a specific type of sport, where the training process is based upon combat readiness representing a baseground of the Chinese national strategy of defense system, and upon readiness for war or war-like conditions. Sport activities include different types of shooting with combat weapons, parachuting, military pentathlon, etc., all activities directly related to assessment of the soldiers' combat capacities. On the other hand, sport in the military primarily includes the most common types of sport like football, athletics, basketball, handball, cycling, etc., that is the types of sport characteristic for ordinary, civilian society. Liu (2000) emphasized that these sport activities in the context of armed forces do have certain specifics; at the same time the options are open as to an individual sport soldiers can have in addition to the military sport activities.

Tkavc (1999) defines sport in SV as an entity, and thus takes up the same point of view as Zechner. Based on definitions by Liu (2000) – military sport and sport in the military and according to the purpose of sport in SV, her definitions could be related as follows. Military sport is a regular sport activity and assessment of motor abilities, while sport in the military represents any other sport activities ranging from sport for all to sports competitions. Despite different points of view and definitions it is obvious that there is a universal notion of sport and that the principle goal of sport in the military is adequate physical readiness of soldiers to successfully attend to their regular and combat duties (Tkavc, 1999).

According to the climatic conditions in Africa (especially in SAR), Mashiane (2000) pointed out key factors that must be considered (heat, moisture, dehydration and hydration, thermoregulation, clothing, footwear,...) in order for soldiers to successfully perform their duties. In some countries like Zimbabwe (Mudambo, 2000), they are facing additional problems of physical training and its health influences on soldiers with health disorders, for example AIDS. They have studied the positive and the negative influences of physical training on health, performance on duty and allocation of duties that HIV positive soldiers could still successfully manage. According to specific conditions in Africa, Mudambo (1996) studied the effects of the negative energetic ratio of military personnel in "survival" training in hot weather conditions. The author stresses that in order to prepare soldiers for possible war conditions, the training process should include as many factors as pos-

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sible (climatic, health related...) which soldiers would face in war conditions.

Bonev (2000) has introduced a systematic definition of the above mentioned physical training factors – a common term for "physical education" in the military. The author provided a basic model of sport training that should comprise the following elements: sport training as a part of regular armed forces personnel duties – 2 to 3 hours weekly; morning exercises – 30 minutes; elements of sport for all profiles (90 minutes) to be carried out off-duty; physical training aimed at enhancing combat readiness. Particular elements of training, explicitly emphasized, are athletics, marching various distances, movements with acceleration and changes of direction, sport gymnastics (floor, gymnastics, permitted apparatus adjustments), running, swimming, alpine and cross-country skiing, rowing, combat sports, etc.

We are of the opinion that taking up appropriate approaches and having adequate professional knowledge in the field of sports and related fields, can positively influence and enhance motor readiness of SV personnel, and decrease a number of negative consequences of a contemporary way of life. According to contemporary course of events and the demands of the leading world armed forces, SV sport should go beyond the character of being a promotional, occasional and motivational factor. Sport activities should actively be integrated into the working and living sphere of every (healthy) individual of the SV armed forces. A handful of athletes employed at SV, who participate at national and beyond competitions are by no means indicators of the actual state, being regular army, commissioned officers, non-commissioned officers, civil SV or MORS personnel, or the contractual reserve army, which should in the future change their current foundations. It is necessary to emphasize that any kind of training will have a more significant effect, if it is adapted to an individual (Bonev, 2000), his/her motor abilities, motivation and expectations.

The aim of this research is to ascertain the effects of a three-month long, individually adapted training program carried out three times a week on the development of some functional, motor and morphological dimensions with SV regular and reserve officers.

GOALS

The goal of this research was to find out the differences in results of selected functional, motor and morphological variables, tested with SV regular and reserve officers – differences between the initial and final measurements of the experimental and the control group.

METHODS

The training program of the experimental group (ES) was adapted to individuals. The program was based on running endurance, agility, coordination, speed and strength. The control group (KS) performed regular sport activities, in the same extent as before the research (fitness, running, cycling, and games). The initial assessment was carried out prior to experimental program initiation, based on which, the subjects were grouped into two equivalent groups according to the 3200 meter run results. All measurements were done at the Ljubljana athletic stadium and were carried out according to the instructions of the US armed forces standards (Karpljuk et al., 2001). Each group was given instructions on the training program for the following three months. The final assessment was carried out in the same manner as the initial one.

Sample of subjects

The research is based on studying 34 members of the SV, 16 in the experimental and 18 in the control group.

Sample of variables

Three sets of variables were defined according to the subject and the goals of this study, and according to the hypotheses set forth.

Functional variables

FSUm	heart beat frequency, morning, resting	beats/min

Motor variables

SK	push-ups (2 min)	number of repetitions
DT	curl-ups (2 min)	number of repetitions
T3200M	3200 meter run	seconds

Morphologic variables

ATV	height	mm*
ATM	weight	kg
AKGN	body fat	mm
AOS	femur volume	cm

* Note that body height was used solely for the calculation of body mass index (ITM) and was not taken into account as a variable during the statistical workout, as we were not expecting any changes in body height in response to the prescribed training program. One should consider height as a constant and regular anthropometric parameter. As the prescribed training program was described in order to change functional and motor abilities of individuals involved, height would not be an appropriate variable, as it does not fit the desired model of the study.

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DATA PROCESSING METHODS

Results have been processed by the SPSS 8.0 for Windows program. Data processing was carried out in several phases. First, the basic statistical characteristics and the distribution of individual variables have been determined, the measures of central tendency and the measures of dispersion have been calculated. The analysis of variance with a 5% risk has been used to calculate differences between the experimental and the control group (initial and final measurements).

RESULTS

Three sets of variables were defined according to the subject and the goals of this study: morphological (body height – ATV, body fat at upper arm – AKGN, femur volume – AOS), functional (heart beat frequency, morning at rest – FSUm) and motor (push-ups, 2 min – SK, curl-ups, 2 min – DT, 3200 meter run – T3200M). TABLE 1 shows the results of the above mentioned variables, indicating the ES and KS differences between initial and final measurements of all tests. Statistically significant differences between ES and KS were found in measurements of body fat (KG), push-ups (SK), curl-ups (DT), a 3200 meter run (T3200M) and the morning heart beat frequency (FSUs).

TABLE 1
Differences between the initial (1) and final (2) measurements of ES and KS with tests: ATM1–ATM2, AKG1–AKG2, AOS1–AOS2, SK1–SK2, DT1–DT2, T320M1–T3200M2 in FSUm1–FSUm2

Var	Group	Number	Min	Max	Mean	SD	SE	P
ATM1	ES	*16*	70.00	93.00	78.25	7.55	2.18	0.776
	KS	*18*	69.00	88.00	79.00	5.39	1.49	
ATM2	ES	*16*	68.00	89.00	75.17	6.91	1.99	0.187
	KS	*18*	69.00	87.00	78.38	4.81	1.33	
AKG1	ES	*16*	10.60	16.80	13.68	2.28	0.66	0.904
	KS	*18*	9.80	15.40	13.58	1.73	0.48	
AKG2	ES	*16*	8.80	13.40	11.42	1.49	0.43	**0.010**
	KS	*18*	10.00	15.20	13.17	1.64	0.45	
AOS1	ES	*16*	49.00	65.00	55.83	5.27	1.52	0.289
	KS	*18*	50.00	65.00	57.77	3.54	0.98	
AOS2	ES	*16*	48.00	65.00	55.17	5.06	1.46	0.150
	KS	*18*	49.00	66.00	57.77	3.61	1.00	
SK1	ES	*16*	31.00	77.00	57.58	12.72	3.67	0.451
	KS	*18*	37.00	80.00	53.69	12.63	3.50	
SK2	ES	*16*	49.00	88.00	67.17	12.52	3.61	**0.032**
	KS	*18*	44.00	81.00	56.08	11.71	3.25	
DT1	ES	*16*	29.00	92.00	65.92	20.59	5.94	0.225
	KS	*18*	36.00	90.00	56.77	16.00	4.44	
DT2	ES	*16*	55.00	94.00	82.17	12.16	3.51	**0.001**
	KS	*18*	41.00	98.00	59.77	16.34	4.53	
T3200M1	ES	*16*	726.00	1033.00	878.42	97.48	28.14	0.816
	KS	*18*	735.00	1024.00	869.46	92.87	25.76	
T3200M2	ES	*16*	547.00	912.00	774.00	104.79	30.25	**0.042**
	KS	*18*	724.00	984.00	857.15	88.03	24.41	
FSUm1	ES	*16*	48.00	62.00	53.75	4.20	1.21	0.870
	KS	*18*	45.00	63.00	53.46	4.47	1.24	
FSUm2	ES	*16*	46.00	61.00	50.42	2.61	0.75	**0.016**
	KS	*18*	45.00	63.00	54.23	4.39	1.22	

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Three sets of variables were defined according to the subject and the goals of this study: morphological (body height – ATV, body fat at upper arm – AKGN, femur volume – AOS), functional (heart beat frequency, morning at rest – FSUm) and motor (push-ups, 2 min – SK, curl-ups, 2 min – DT, 3200 meter run – T3200M). TABLE 1 shows the results of the above mentioned variables, indicating the ES and KS differences between initial and final measurements of all tests. Statistically significant differences between ES and KS were found in measurements of body fat (KG), push-ups (SK), curl-ups (DT), a 3200 meter run (T3200M) and the morning heart beat frequency (FSUs).

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Fig. 1
Physical training program of experimental group

	Week 1
Day	Program
Friday	***ASSESSMENT***
Monday	15 min light run (intensity 60% ± 4 beats/min) Gymnastic exercises, strength exercises run-out – 5 to 8 minutes.
Wednesday	15 min light run (intensity 60% ± 4 beats/min) Gymnastic exercises, 8 × 60 meters intensification, education on running, run-out 5 minutes.
Friday	20 min light run (intensity 60% ± 4 beats/min) Gymnastic exercises, education on running, strength exercises, run-out 5 minutes.

	Week 2
Day	Program
Monday	Fartlek: light run 6 to 10 minutes, could be combined with walking; gymnastic exercises; steady warm – up run 5 to 8 minutes; walking 2 minutes; intensifications (3 to 5 × 60 meters); interval runs – 6 × 60 to 80 meters, rest – walking 2 minutes; sprint 3 × 30 meters, in between 2 minutes light run; walking 2 minutes; fast run 2 minutes; walking 3 minutes; light run 10 minutes.
Wednesday	15 min light run Gymnastic exercises; 4 × 40 meters intensifications, 400 meters walking at max pace, run-out 5 to 8 minutes. *Note: Calculation 120% of achieved result; max. =* ***e.g. 90 seconds;*** *120% = 108 seconds.*
Friday	25 to 30 min light run switching pace – optional (intensity of running ranges from 60 to 90% ± 4 beats/min) Gymnastic exercises, 6 × 80 meters intensification, strength exercises, light stretching.

	Week 3
Day	Program
Monday	15 min light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, 4 × 50 meters intensification, 4–6 × 400 meters at pace 120% – 108 seconds, rest 3 minutes, run-out 10 minutes, light stretching.
Wednesday	5 min light run Gymnastic exercises, 20 min run (intensity of running 80% ± 4 beats/min), education on running, strength exercises, 5 × 40 meters intensification.
Friday	15 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, 4 × 80 meters intensification, 1000 meters maximum pace, run-out 5 to 8 minutes, *Note: Calculation 110% of achieved result, max. = e.g. 300 seconds (5 minutes), 110% = 330 seconds (5 min 30 sec).*

	Week 4
Day	Program
Monday	20 min light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, strength exercises, 10 × 100 meters intensification, education on running, run-out 10 minutes.
Wednesday	15 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, 5 minutes lively run, 5 minutes walking (intensity of running 90% ± 4 beats/min), 3 minutes lively run, 3 minutes walking (intensity of running 90% ± 4 beats/min), 1 minute high speed run, 3 minutes walking (intensity of running 90% ± 4 beats/min), 3 minutes lively run, 3 minute walking (intensity of running 90% ± 4 beats/min), 2 minutes lively – fast run, 3 minutes walking (intensity of running 90% ± 4 beats/min), run-out 5 minutes.
Friday	5 minutes light run Gymnastic exercises, 30 to 40 minutes light run, strength exercises, light stretching.

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Physical training program of experimental group

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Friday	***ASSESSMENT***
Monday	15 min light run (intensity 60% ± 4 beats/min) Gymnastic exercises, strength exercises run-out – 5 to 8 minutes.
Wednesday	15 min light run (intensity 60% ± 4 beats/min) Gymnastic exercises, 8 × 60 meters intensification, education on running, run-out 5 minutes.
Friday	20 min light run (intensity 60% ± 4 beats/min) Gymnastic exercises, education on running, strength exercises, run-out 5 minutes.

	Week 2
Day	Program
Monday	Fartlek: light run 6 to 10 minutes, could be combined with walking; gymnastic exercises; steady warm – up run 5 to 8 minutes; walking 2 minutes; intensifications (3 to 5 × 60 meters); interval runs – 6 × 60 to 80 meters, rest – walking 2 minutes; sprint 3 × 30 meters, in between 2 minutes light run; walking 2 minutes; fast run 2 minutes; walking 3 minutes; light run 10 minutes.
Wednesday	15 min light run Gymnastic exercises; 4 × 40 meters intensifications, 400 meters walking at max pace, run-out 5 to 8 minutes. *Note: Calculation 120% of achieved result; max. =* ***e.g. 90 seconds;*** *120% = 108 seconds.*
Friday	25 to 30 min light run switching pace – optional (intensity of running ranges from 60 to 90% ± 4 beats/min) Gymnastic exercises, 6 × 80 meters intensification, strength exercises, light stretching.

	Week 3
Day	Program
Monday	15 min light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, 4 × 50 meters intensification, 4–6 × 400 meters at pace 120% – 108 seconds, rest 3 minutes, run-out 10 minutes, light stretching.
Wednesday	5 min light run Gymnastic exercises, 20 min run (intensity of running 80% ± 4 beats/min), education on running, strength exercises, 5 × 40 meters intensification.
Friday	15 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, 4 × 80 meters intensification, 1000 meters maximum pace, run-out 5 to 8 minutes, *Note: Calculation 110% of achieved result, max. = e.g. 300 seconds (5 minutes), 110% = 330 seconds (5 min 30 sec).*

	Week 4
Day	Program
Monday	20 min light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, strength exercises, 10 × 100 meters intensification, education on running, run-out 10 minutes.
Wednesday	15 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, 5 minutes lively run, 5 minutes walking (intensity of running 90% ± 4 beats/min), 3 minutes lively run, 3 minutes walking (intensity of running 90% ± 4 beats/min), 1 minute high speed run, 3 minutes walking (intensity of running 90% ± 4 beats/min), 3 minutes lively run, 3 minute walking (intensity of running 90% ± 4 beats/min), 2 minutes lively – fast run, 3 minutes walking (intensity of running 90% ± 4 beats/min), run-out 5 minutes.
Friday	5 minutes light run Gymnastic exercises, 30 to 40 minutes light run, strength exercises, light stretching.

	Week 5
Day	Program
Monday	Fartlek: light run 10 minutes; gymnastic exercises; steady warm-up run – 3 minutes; walking – 2 minutes; intensifications (3 to 5 × 50 meters); faster run – 1, 2 and 3 minutes, in between rest periods – walking 2 minutes; 1 minute high speed run (maximum pace); walking 2 minutes; 1 minute high speed run (maximum pace); walking 2 minutes; 2 intensifications at distances from 30 to 40 meters; light run 10 minutes.
Wednesday	15 minutes light run Gymnastic exercises, 4 × 90 seconds fast run, in between 3 minutes walking, run-out 10 to 15 minutes.
Friday	5 minutes light run Gymnastic exercises, 35 to 45 minutes light run (intensity of running 75% ± 4 beats/min), 4 × 60 meters intensification.

	Week 6
Day	Program
Monday	15 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, 3 × 60 meters intensifications, 1000 meters for 5 minutes, rest 6 minutes; 600 meters for 2 minutes and 50 sec., rest 6 minutes; 400 meters for 100 seconds, rest 6 minutes; 300 meters at maximum pace, rest 6 minutes; 600 meters at maximum pace, rest 6 minutes; run-out 5 to 8 minutes.
Wednesday	10 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises; 20 minutes light run (intensity of running 70% ± 4 beats/min); strength exercises; light stretching.
Friday	10 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises; 10 × 100 meters intensifications; run-out 10 minutes.

	Week 7
Day	Program
Monday	5 minutes light run gymnastic exercises; 30 to 45 minutes light run (intensity of running 75% ± 4 beats/min), education on running; 4 × 60 meters intensifications.
Wednesday	10 minutes light run Gymnastic exercises; 4 × 40 meters intensifications; 10 × 400 meters for 100 seconds, rest 3 minutes; run-out 5 to 8 minutes.
Friday	25 to 30 minutes light run (intensity of running 65% ± 4 beats/min) Gymnastic exercises; strength exercises; light stretching.

	Week 8
Day	Program
Monday	10 minutes light run gymnastic exercises; 4 × 80 meters intensifications; 2000 meters at maximum pace, rest 5 minutes (intensity of running 100%); 1200 meters at maximum pace, rest 5 minutes (intensity of running 100%); run-out 5 minutes.
Wednesday	20 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises; strength exercises; light stretching.
Friday	10 minutes light run Gymnastic exercises; 6 × 80 meters intensifications; 10 × 200 meters for 45 seconds, rest 2 minutes; run-out 10 minutes.

	Week 9
Day	Program
Monday	***ASSESMENT***

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	Week 5
Day	Program
Monday	Fartlek: light run 10 minutes; gymnastic exercises; steady warm-up run – 3 minutes; walking – 2 minutes; intensifications (3 to 5 × 50 meters); faster run – 1, 2 and 3 minutes, in between rest periods – walking 2 minutes; 1 minute high speed run (maximum pace); walking 2 minutes; 1 minute high speed run (maximum pace); walking 2 minutes; 2 intensifications at distances from 30 to 40 meters; light run 10 minutes.
Wednesday	15 minutes light run Gymnastic exercises, 4 × 90 seconds fast run, in between 3 minutes walking, run-out 10 to 15 minutes.
Friday	5 minutes light run Gymnastic exercises, 35 to 45 minutes light run (intensity of running 75% ± 4 beats/min), 4 × 60 meters intensification.

	Week 6
Day	Program
Monday	15 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises, 3 × 60 meters intensifications, 1000 meters for 5 minutes, rest 6 minutes; 600 meters for 2 minutes and 50 sec., rest 6 minutes; 400 meters for 100 seconds, rest 6 minutes; 300 meters at maximum pace, rest 6 minutes; 600 meters at maximum pace, rest 6 minutes; run-out 5 to 8 minutes.
Wednesday	10 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises; 20 minutes light run (intensity of running 70% ± 4 beats/min); strength exercises; light stretching.
Friday	10 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises; 10 × 100 meters intensifications; run-out 10 minutes.

	Week 7
Day	Program
Monday	5 minutes light run gymnastic exercises; 30 to 45 minutes light run (intensity of running 75% ± 4 beats/min), education on running; 4 × 60 meters intensifications.
Wednesday	10 minutes light run Gymnastic exercises; 4 × 40 meters intensifications; 10 × 400 meters for 100 seconds, rest 3 minutes; run-out 5 to 8 minutes.
Friday	25 to 30 minutes light run (intensity of running 65% ± 4 beats/min) Gymnastic exercises; strength exercises; light stretching.

	Week 8
Day	Program
Monday	10 minutes light run gymnastic exercises; 4 × 80 meters intensifications; 2000 meters at maximum pace, rest 5 minutes (intensity of running 100%); 1200 meters at maximum pace, rest 5 minutes (intensity of running 100%); run-out 5 minutes.
Wednesday	20 minutes light run (intensity of running 60% ± 4 beats/min) Gymnastic exercises; strength exercises; light stretching.
Friday	10 minutes light run Gymnastic exercises; 6 × 80 meters intensifications; 10 × 200 meters for 45 seconds, rest 2 minutes; run-out 10 minutes.

	Week 9
Day	Program
Monday	***ASSESMENT***

CONCLUSION

Differences between ES and KS in body fat measurements were 2 mm (TABLE 1) and were statistically characteristic (P = 0.010). There were differences in body weight (ATM) – of approximately 3 kg, however, these differences were not statistically significant. The subjects have maintained a relatively active way of life even prior to this study. This experiment was by no means aimed at changing their existing way of living, including their nutrition habits. Prior to the study, the subjects were given the instructions that their nutrition should remain the same. There were differences in KG at final measurements, suggesting that the kind of activities they were involved in, could have had an indirect, positive effect on the individual's health state. In the armed forces, increased body weight (overweight) and the accompanying circumstances are no exception.

There were no statistically characteristic differences between the groups with the AOS (femur volume) variable. A more detailed inspection of the results presented in TABLE 1 however shows that the femur volume in the ES has slightly decreased. Similar results, where the AOS has decreased, can be observed in the study (Bevc, 2002), a preliminary study to this one. It is assumed that exercising has indirectly influenced a decrease in body weight, body fat and ITM (body mass index). The ITM values for the ES group were 23.63 – final measurements (initial measurements 24.61; p = .000), while for the KS the ITM values were 24.03 – final measurements (initial measurements 24.21; p = 0.221).These results indicate that in the ES group, statistically significant differences in the ITM variable occurred at the end of the research.

When training for the assessment of motor abilities, it is encouraging to examine the results of ES enhancements and the statistically significant differences of all three motor variables (DT, SK, T3200M) as presented in TABLE 1. Even before the program, some preliminary studies have been carried out (Karpljuk et al., 2001; Karpljuk, Videmšek, Cecic-Erpic, Žitko, Štihec, & Kondrič, 2001; Bevc, 2002), as well as studies confirming that economisation of the training process and individually adapted intensity of training characteristically help to enhance certain motor abilities (Karpljuk, 1999). It is assumed that economisation of the training process is required in order to achieve a general level of SV personnel's motor readiness. At the same time, it is a prerequisite for fundamental physical fitness abilities and the development of those motor abilities, required to fulfill the work and duties of all profiles in the Slovene armed forces. The latter will inevitably become an important factor these days, when Slovenia has been invited to become a NATO member.

The final aspect of this study, with which we wanted to confirm the physical training efficiency of the SV personnel, was monitoring the morning heart beat frequency (Ušaj, 1996). While examining the early effects of exercising (Karpljuk, 1999), the FSUm represented a variable whose positive results indicated that the ES training program was appropriate and that the heart beat frequency while resting decreased within the range predicted by many researchers (Willmore & Costill, 1994). Also in the course of the research, no increase of the morning heart beat frequency in the ES group was detected. Based on this, we have concluded that the training process does not cause any forms of fatigue – the indicator of which could be an increased heart beat frequency while resting (Willmore & Costill, 1994).

This study is one of the rare ones in the Slovene armed forces which would systematically and professionally examine the aspects of training for the assessment of motor abilities, following US military standards. Up until now, training for the assessment has in many cases been a matter of the last month or even the last week before the assessment. This approach is inappropriate for many reasons, here mentioning primarily the one closely related to the health state of the SV personnel, which is further related to their physical readiness. The campaign excursus mentioned earlier, treating an assessment as an "adventure" into the unknown may lead tragic consequences. Physical training of the SV personnel, including the reserve (now a professional reserve), should be continued all year round or throughout one military career, which in the leading NATO member countries represents a clearly understood integrated part of their duties. This point of view in the SV has not been put to practice yet (except for some professional athletes, recreational athletes and some conscious individuals), despite numerous attempts and the legal and formal ground.

It is assumed that the results of this research will contribute to theoretical findings in the field of endurance training in the SV, to examining other armed forces, particularly of the NATO member countries. We hope that these findings will be used as a baseground for similar studies that may follow – and, as it is most common in other countries, to a closer interaction and complementation of military, civil scientific and professional spheres.

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CONCLUSION

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ÚČINKY INDIVIDUÁLNĚ NAVRŽENÝCH PROGRAMŮ TĚLESNÉ PŘÍPRAVY ZALOŽENÝCH NA NORMÁCH AMERICKÉ ARMÁDY NA MOTORICKÉ SCHOPNOSTI ZAMĚSTNANCŮ SLOVINSKÝCH OZBROJENÝCH SIL

(Souhrn anglického textu)

Přiměřená fyzická zdatnost je významným aspektem obecné připravenosti ozbrojených sil a nedílnou součástí armádní podpory. Cílem tohoto průzkumu bylo zjistit účinky výcvikového programu, založeného na individuálně přizpůsobené míře intenzity, na motorické schopnosti zaměstnanců slovinských ozbrojených sil (SV). Vzorek zahrnoval 34 členů SV (16 zařazených do experimentální skupiny – ES a 18 do kontrolní skupiny – KS) ve věku od 35 do 40 let. Výsledky byly zpracovány pomocí programu SPSS 8.0 pro Windows. Zpracování výsledků bylo prováděno v několika etapách. Nejprve byly stanoveny základní statistické charakteristiky a distribuce individuálních proměnných, byla vypočtena míra střední tendence a stupeň disperze, byla použita metoda pro analýzu s rizikem odchylky 5 %. Výsledky prokázaly, že charakteristického zvýšení úrovně určitých motorických schopností sledovaného souboru lze dosáhnout pomocí ekonomizace výcvikového postupu a individuálně přizpůsobené intenzity výcviku. Statisticky významné rozdíly mezi experimentální a kontrolní skupinou byly zjištěny při měření tělesného tuku (KG), kliků (SK), hrudních předklonů v lehu pokrčmo, běhu na 3200 metrů (T3200M) a klidové srdeční frekvence (FSUs). Přestože byl zkoumaný vzorek malý, tyto studie alespoň teoreticky potvrzují potřebu dalšího výzkumu v této oblasti, protože naše důkazy výrazně naznačují účinnost individuálně navržených výcvikových protokolů na tělesnou připravenost zaměstnanců slovinských ozbrojených sil.

Klíčová slova: motorická připravenost, plán tělesného výcviku, NATO.

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(Souhrn anglického textu)
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Klíčová slova: motorická připravenost, plán tělesného výcviku, NATO.

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2D MINIPLATFORM FOR MEASURING FORCE AT A COMPUTER KEY BUTTON

Luiz Carlos Gertz, Milton Antônio Zaro, Jefferson Fagundes Loss*

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** Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil*

Submitted in April, 2005

By the usage of computers, both at work and home, health problems due to typing started appear, mostly by the individual's posture, upper limbs repetitive movements, forces, etc. Several studies for understanding the causes for these health problems have been carried out since the early 90's. The main objective of this work is the development of a force platform to measure the finger's applied force at the keyboard during computer typing. This platform will be used in Biomechanics and Motor Control applications. It was designed and built in order to measure vertical force Fz (z direction), horizontal force Fx (x direction) and transversal force Fy (y direction) and the moment applied in the horizontal (and longitudinal) axis Mx (x direction). Resistance strain gauges were used as sensors bonded in cantilever beams. These sensors are connected to a Wheatstone full bridge, in order to measure, independently Fx, Fy and Mx. To developing the conception adopted, the force platform was evaluated and tested by a numerical model (finite elements technique). The data acquisition system is composed by (a) a computer, to acquire and further processing the collected information by (b) an A/D converter, (c) a signal conditioner and (d) the software SAD 2.0. The static calibration of the force platform presented linearity within the range of 3%. Dynamic tests showed that the platform has a fundamental frequency higher than 2300 Hz, and consequently permits its use for analysis of the applied forces during typing.

Keywords: Biomechanics, motor control, dynamometry, force platform, keyboard, typing.

INTRODUCTION

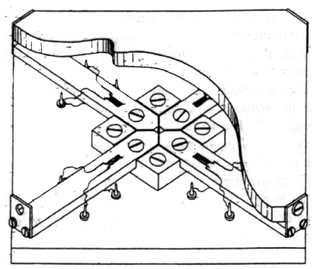
The first measurements of the force applied by fingers at a computer key button was carried out by Armstrong (1994) and Rempel (1994a). These authors developed two measuring systems: (a) one with two load cells connected to the lower part of the keyboard, and (b) another one with a piezoelectric sensor under the keycap. These two systems were used in several experiments to study the force applied to the computer keys. Some remarkable experiments were developed by Rempel (1994b, 1997, 1999), Serina (1997) and Smutz (1994). In all these studies, the systems were restricted to the measurement of force in a single axis (vertical). Today, force platforms (which measure forces and force moments at three axes) are being produced to analyze either human and animal body movements.

The objective of this work is to develop a force platform that measures the force applied by the fingers on the surface of a computer key button during typing. This platform measures the force in two axes: y (transversal to the keyboard) and z (vertical), and the moment in one axis, x (longitudinal to the keyboard). With this data it is possible, in a bidimensional analysis, to determine the magnitude of the resulting force vector applied on the key button, its angle in relation to the keyboard's transversal axis (y axis) and the position of the force vector at the key in relation to the x axis.

THEORETICAL FUNDAMENTS

In 1964, Petersen built a force platform to work with small animals. It was composed by 4 cross-shaped cantilever beams, with edges fixed at the superior base (contact surface), and its center fixed at the inferior base (Fig. 1). This equipment reads the same value of force regardless the surface region where the force is applied.

Fig. 1
Petersen (1964)



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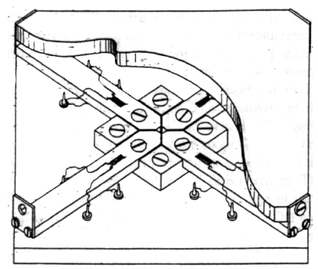


In 1987, Lywood developed a force platform that measures force at three orthogonal axes. The structure is similar to that constructed and reported by Petersen's (cross-shaped), in which it was measured the vertical force. However, two other sets of four beams were added in order to measure the two force components in horizontal position.

Based on Lywood's project, Roesler used a similar structure and developed, in 1997 a platform that measures forces and force moments in three axes. This platform is waterproof, in order to be used in researches related to activities carried out in swimming pools (hydrogymnastics).

PROJECTING THE FORCE PLATFORM

The small dimensions involved in the making of this force platform and the limitations related to the size of the sensors (resistance strain gages) determined the unfeasibility of tridimentional analysis. The chosen option was a system which is capable of a bidimentional analysis at the transversal position (sagittal plane). Therefore, the measurement of one of the force components and one of the moments was disregarded. This analysis needs the force measurement at z, Fz direction, and at y, Fy direction and the x, Mx moment. By determining the force at z, Fz, and the force moment at x, Mx direction, it is possible to determine the force vector position in relation of y axis, Dy, since $Dy = \frac{M_X}{F_Z}$ and that Fy does not cause force moment at x axis.

To measure these three components, it is necessary to have three independent Wheatstone bridge circuits, which means twelve sensors, a number considered too high to fit in the available space.

The force platform boards were built in two parts: (a) the upper part, with elastic elements (boards), where the sensors that measure force at z, Fz direction and moment at x, Mx direction would be placed, and (b) the lower part, composed by the elastic elements (boards) where the sensors that measure force at y, Fy direction would be placed.

The upper part is formed by a structure with a "H" shape. This format enabled a very interesting solution for measuring Fz and Mx. At a force platform used to study human gait, the sensors that measure force can be fixed at the same side of the sensors that measure the force moment; the beams are wide enough for that purpose. However, the width of the beams in this project is determined by the sensor's width, which allows only one sensor to be fixed at each side of the platform.

The lower part is formed by four cantilever beams; the force is applied at the upper edges.

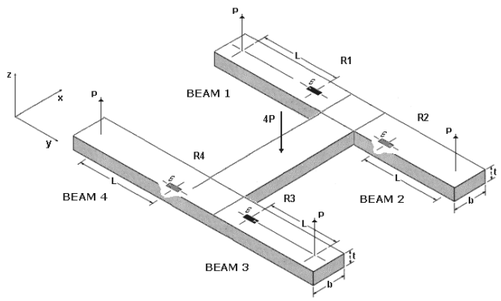
HOW THE FORCE PLATFORM WORKS

This force platform works similarly to a table where every leg is substituted by a spring. When a load is applied to the center of the table, each spring suffers equal deflection; however, if the load is exentrical to the center of the table, a bigger strain will be induced at the nearest spring. Regardless the position in which the force is applied, the average strain in the four "springs" (cantilever beams) will be the same.

The same principle should be applied to the "H" format structure in order to allow the measured force to be the same, regardless the point of application of this force at the surface of the key button. As the force platform circuit is mounted in a full bridge type, the bridge's unbalance will be similar to the case where the force is applied at the center of the key. Therefore, if the applied force by the finger is displaced from the center of the key button, the reading of this component will not suffer any distortion, since the force platform was developed to compensate variations in positioning of the applied load. The same will happen with force moments.

Fig. 2 shows a drawing that illustrates the force platform structure conceived to measure the force applied at z, Fz axis, and the force moment at x, Mx axis. This structure has two sensors attached at the upper part, on cantilever beams 1 and 3, plus other two at the lower part of beams 2 and 4.

Fig. 2
Force platform upper part



DIMENSIONING THE FORCE PLATFORM

The small surface dimensions of a computer key button, 12 mm × 14 mm and, comparatively, the large dimensions of the sensor used, 2 mm × 5 mm, do not allow many options about the dimensions of the structure. The complete set should have dimensions close to the conventional key button and the width of the cantilever

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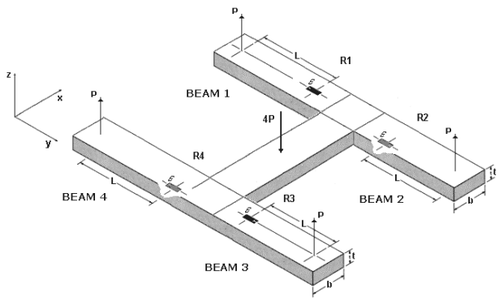

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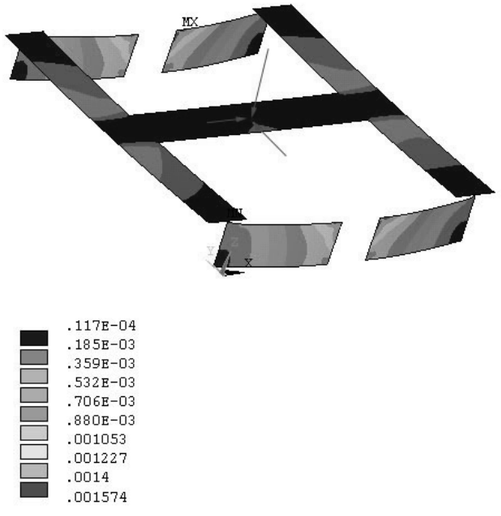
beam can not be less than the sensor's, that is, 2 mm, and length over 5 mm.

Thus, the upper part of the extensometric transducer is composed by 4 "H" – shaped cantilever beams, 2.0 mm wide, 6.0 mm long, 0.4 mm thick each, total length of 14 mm between the anchors at the lower part, and 15.0 mm wide. This geometry allows the sensors' to be set like two complete Wheatstone bridges circuits, one to read the force at z, Fz axis, and the other to read force moment at x, Mx axis.

The lower part is also formed by four cantilever beams, which are 5.5 mm long, 2.0 mm wide and 0.2 mm thick, with four sensors connected in a full bridge type circuit, in order to read force at y, Fy direction.

To illustrate a typical responde of a H cantilever beam structure subjected to a force, Fig. 3 presents the strains calculated using the Finite Elements theory when forces are applied at three directions simultaneously, one at x direction, Fx = 2N, another at y direction, Fy = 2N and the third at x direction, Fz = –3N.

Fig. 3
Force applied, Fx = 2N, Fy = 2N and Fz = –3 N; strain analysis using von Misse's method



BUILDING THE FORCE PLATFORM

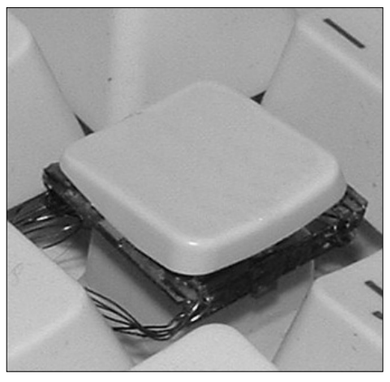
To produce the elastic elements, the force platform, it was built on 304 stainless steel (210 × 109 N/m^2). Young modulus, 2.8 × 108 N/m^2 of tensile strength, poison coefficient 0.28, density of 7.9 Kg/m^3 (Sandivik, 1994). The choice was due to the high resistance to oxidation, mechanical high resistance and to be adequate for work with electroerosion process.

The extensometric sensors used at the force platform are Kyowa's, KFG-1-120-C1-23N15C2 model, with a grid of 1 mm. It used the MB35 glue – (Micromeasurements) to fix the sensors at the beams' surfaces.

The base of a key button was prepared in order to fix sensors at its inferior structure. The two sets with two serial cantilever beams were attached at the center of the base. The "H-shaped" upper structure was attached at the cantilever beams edges of the lower structure. The contact surface of the force platform was built using a computer key button, which was attached at the center of the "H-shaped" structure.

The connection between the upper and the lower structures should be round so that it could only transmit force to the lower beams. However, it is not mechanically possible to produce such part with the required dimensions. Since the beams deformation is irrelevant, the option was to unite these parts with a small amount of glue, so that the stiffness of the union would be significantly less than the stiffness of the metal parts. Cyanacrilate glue was used because it glues fast and it is apropriate to unite metals (Fig. 4).

Fig. 4
Platform lower view



CALIBRATING THE FORCE PLATFORM

Statistic calibration

In order to calibrate statically the force platform, a structure has been set to apply Fz, Fy and Mx loads independently in each of the directions. Therefore, when a load is applied in one direction, there can not be any other component in another direction (as suggested by Gola, 1980; Hall, 1996), avoiding "mechanical coupling".

The signal generated by the force platform was amplified by a signal conditioner and sent to an A/D converter. Usually, the input signal of the Wheatstone

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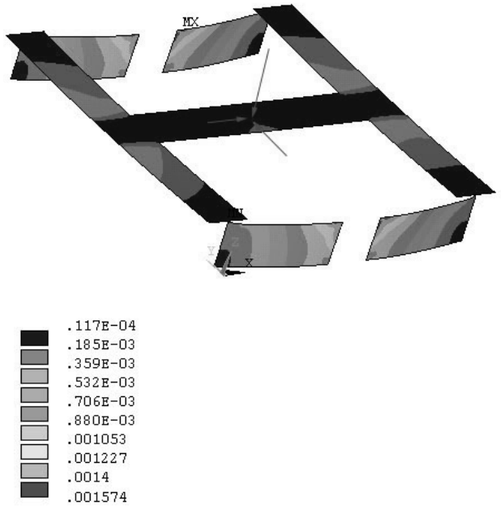

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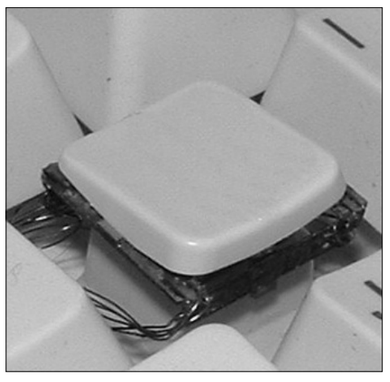

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The signal generated by the force platform was amplified by a signal conditioner and sent to an A/D converter. Usually, the input signal of the Wheatstone

bridge circuit of the load cells is 4V or 10V. However, due to the beams' tiny structure, the best option was to 2V, since the objective was to avoid overheating of the structure.

The calibration was made by applying force using dead weights. According to Gola (1980), if the dynamic analysis shows that the force platform is light and stiff enough, and if the vibration modes are sufficiently high compared to the vibration modes of the applied forces during measurement, the static calibration is valid.

Several data aquisition sets where conducted at one direction with the load applied in order to verify mechanical coupling, repetitivity and linearity. The results presented are the mean of three values each of a series of different measurements.

SAD32 software was used for signal analysis; it was used the mathematical function called Mobile Weighted Mean, with a cut-off frequency of 0.45 Hz. The sampling rate chosen was 10 points per second.

When a force of 0.53 N was applied towards z axis, in several points of the load cell surface, the maximum error range was less than 4%. At the central position of the surface of the force platform the error range was less than 2%. Force readings towards y, Fy direction were almost zero. The system's sensitivity at z axis, force Fz, was 0.0063 N, with R2 = 0.9998.

The force moment variation at x, Mx direction, caused by the applied force towards z, Fz, was zero.

To an 1N force applied towards z direction, the maximum force registered at Fy was inferior than 0.001 N, a considerably low value if compared to the values registered during typing, which almost reached 0.4 N. Taking this value as a reference, it can be stated that Fz force generates mechanical coupling at Fy of 0.25% from the maximum value registered when typing at normal speed.

The calibration curve of the applied force towards y, Fy direction, displayed a correlation coefficient R2 = 0.994. The calibration curve at the moment at x, Mx direction, displayed a correlation coefficient R2 = 0.9991.

When a moment is applied towards x, Mx direction, not exceeding 0.0070 Nm, which is approximately the maximum value mean registered during typing, the highest value registered by force at z, Fz direction, is 0.032 N. Considering that the force at z, Fz direction, reached maximum values close to 1.6 N during typing, it is appropriate to say that the mechanical coupling that Mx causes at Fy is less than 2%.

Concerning to the force at y, Fy direction, the highest value found was 0.0022N. Considering that Fy registers maximum values close to 0.4 N, it can be assumed that the mechanical coupling caused by Mx at Fy force component measurements during typing is less than 5.5%.

Dynamic calibration

For the dynamic calibration, it was used a Thüringer Industriewerk Bauestein vibratory table set. 5000/300, a 2250AMI-10 Endveco piezoceramic accelerometer (0.3 grams' mass), Brüel & Kjaer cables, a 2034 dual channel signal analyzer Brüel & Kjaer, 9.93 mV/g sensitivity and a 102 Endveco signal amplifier and conditioner.

The accelerometer was fixed at the surface of the force platform, which was attached at the vibrating table. The range of vibration chosen was from 0 to 6.4 kHz, with the accelerometer also fixed at the vibrating table, and the output signals were sent to the signal analyzer.

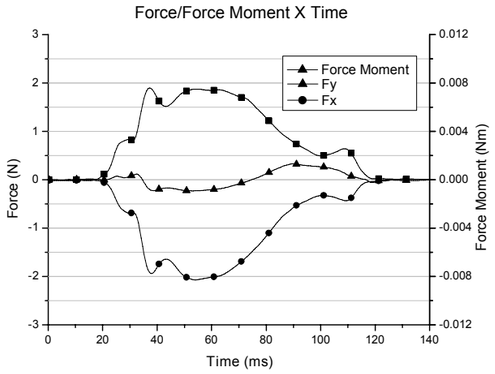
The dynamic calibration showed that the first fundamental mode of the force platform is superior to 2300 Hz. This result allows the equipment to be used safely in order to analyze events where the frequency does not exceed 750 Hz.

MEASUREMENTS

The desks used for typing can be adjusted to the keyboard's height, in order to achieve a comfortably position according to the anthropometric characteristics of each typist. However, these tables are not rigid enough for simulations. For that matter, a 0.70 m high masonry table has been specially made for mechanical measuments, where the keyboard with the force platform (H-shaped) has been placed. Fig. 5 shows the force components in three different time moments during typing.

Fig. 5
Force components on key button's surface

● Fz ▲ Fy ■ Mx



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When a force of 0.53 N was applied towards z axis, in several points of the load cell surface, the maximum error range was less than 4%. At the central position of the surface of the force platform the error range was less than 2%. Force readings towards y, Fy direction were almost zero. The system's sensitivity at z axis, force Fz, was 0.0063 N, with R2 = 0.9998.

The force moment variation at x, Mx direction, caused by the applied force towards z, Fz, was zero.

To an 1N force applied towards z direction, the maximum force registered at Fy was inferior than 0.001 N, a considerably low value if compared to the values registered during typing, which almost reached 0.4 N. Taking this value as a reference, it can be stated that Fz force generates mechanical coupling at Fy of 0.25% from the maximum value registered when typing at normal speed.

The calibration curve of the applied force towards y, Fy direction, displayed a correlation coefficient R2 = 0.994. The calibration curve at the moment at x, Mx direction, displayed a correlation coefficient R2 = 0.9991.

When a moment is applied towards x, Mx direction, not exceeding 0.0070 Nm, which is approximately the maximum value mean registered during typing, the highest value registered by force at z, Fz direction, is 0.032 N. Considering that the force at z, Fz direction, reached maximum values close to 1.6 N during typing, it is appropriate to say that the mechanical coupling that Mx causes at Fy is less than 2%.

Concerning to the force at y, Fy direction, the highest value found was 0.0022N. Considering that Fy registers maximum values close to 0.4 N, it can be assumed that the mechanical coupling caused by Mx at Fy force component measurements during typing is less than 5.5%.

Dynamic calibration

For the dynamic calibration, it was used a Thüringer Industriewerk Bauestein vibratory table set. 5000/300, a 2250AMI-10 Endveco piezoceramic accelerometer (0.3 grams' mass), Brüel & Kjaer cables, a 2034 dual channel signal analyzer Brüel & Kjaer, 9.93 mV/g sensitivity and a 102 Endveco signal amplifier and conditioner.

The accelerometer was fixed at the surface of the force platform, which was attached at the vibrating table. The range of vibration chosen was from 0 to 6.4 kHz, with the accelerometer also fixed at the vibrating table, and the output signals were sent to the signal analyzer.

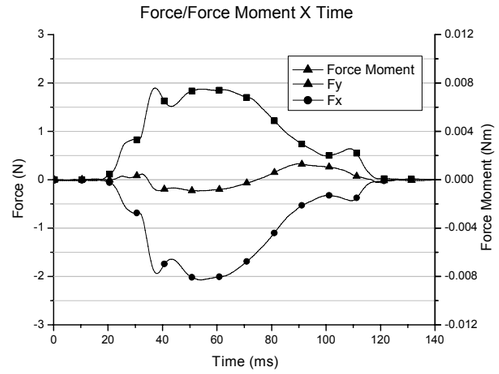
The dynamic calibration showed that the first fundamental mode of the force platform is superior to 2300 Hz. This result allows the equipment to be used safely in order to analyze events where the frequency does not exceed 750 Hz.

MEASUREMENTS

The desks used for typing can be adjusted to the keyboard's height, in order to achieve a comfortably position according to the anthropometric characteristics of each typist. However, these tables are not rigid enough for simulations. For that matter, a 0.70 m high masonry table has been specially made for mechanical measuments, where the keyboard with the force platform (H-shaped) has been placed. Fig. 5 shows the force components in three different time moments during typing.

Fig. 5
Force components on key button's surface

● Fz ▲ Fy ■ Mx

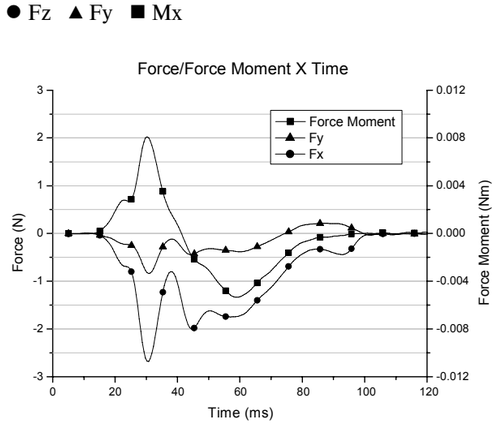


A representative model of the force components refering to three different moments during key button fingering can be seen in Fig. 6. It can be noticed that the pressure center on the surface of the force platform is initially placed at the furthest half from the typist's body. However, when the key button reaches its course end, the pressure center changes position, moving over the surface to the nearest half from the typist's body.

Maybe this fact can be explained because: (a) first, the finger movement on the surface of the key button and (b) second, because the pressure center of the fingertip's contact area changes position as the applied force increases.

Initially, the pressure center is at the center of the finger's contact area on the surface, when only skin tissues are being pressed; however, when the applied force increases, the pressure center moves to the edge of the finger, due to fingertip bone load (distal phalanx tuberosity).

Fig. 6
Force components on key button's surface



Analyzing the results, one can assume that the force platform developed for this experiment displays accurate characterization of the applied force on the surface of computer key buttons.

In 1994, at the presentation of his innovative load cell, Rempel (a) stated that, at that point, there was not solid information on load force during typing, so it was useful to develop mathematical models with experimental data to be used in the analysis of upper limbs (hands and fingers), as it has been proposed by Chao (1976).

Later, more complex models were created by Leijnse (1995, 1996 and 1997) and Biggs (1999). The information generated by the load cell developed in this work is more adequate to supply these models with experimental data. Also, moving the key button to a 90 angle, it is possible to measure force at the keyboard's longitudinal axis.

CONCLUSIONS

The force platform produced in this work displayed enough sensitivity, sampling rate, repetition, mechanical uncoupling and precision, in order to measure two force components (and one force moment) of the applied force at the surface of a key button during typing with great accuracy.

The force at y, Fy direction, denotes significantly representative level. By determining that, it is possible to observe important aspects concerning the key button triggering characteristics from a typist. This force must not be taken for granted, as well as x, Fx direction force.

It has not been found any better equipment to describe the characteristics of the applied force at a key button than the one presented in this work.

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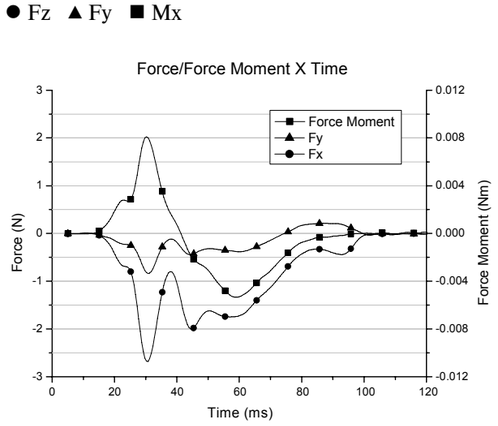

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2D MINIPLATFORMA PRO MĚŘENÍ SÍLY VYVÍJENÉ NA KLÁVESNICI POČÍTAČE

(Souhrn anglického textu)

V souvislosti s používáním počítačů v zaměstnání i doma se začínají objevovat zdravotní problémy související se psaním na počítači, způsobené většinou držením těla jednotlivce, opakovanými pohyby horních končetin, jimi vyvíjenou silou atd. Od začátku 90. let 20. století již bylo provedeno několik studií s cílem pochopit příčiny těchto zdravotních problémů. Hlavním cílem této práce je vytvoření silové platformy pro měření síly vyvíjené prstem na klávesnici při psaní na počítači. Tato platforma bude využívána v aplikacích biomechaniky a motorické kontroly. Byla vyvinuta a vyrobena za účelem měření vertikální síly Fz (směr z), horizontální síly Fx (směr x), transversální síly Fy (směr y) a momentu aplikovaného v horizontální (a podélné) ose Mx (směr x). Jako senzory byly použity odporové tenzometry umístěné na konzolovém nosníku. Tyto senzory jsou za účelem nezávislého měření Fx, Fy a Mx připojeny na plný Wheatstonův můstek. Pro účely rozvoje byla silová platforma vyhodnocována a testována pomocí numerického modelu (metodou konečných prvků). Systém získávání dat se skládá z (a) počítače pro sběr a další zpracování informací získaných pomocí (b) měniče proudu, (c) zařízení upravujícího signál a (d) softwaru SAD 2.0. Statická kalibrace silové platformy vykazovala lineárnost v rozmezí 3 %. Dynamické zkoušky prokázaly, že platforma má základní frekvenci vyšší než 2300 Hz a že tudíž může být použita pro analýzu sil vyvinutých při psaní.

Klíčová slova: biomechanika, motorická kontrola, dynamometrie, silová platforma, klávesnice, psaní na počítači.

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Mechanics for Engineers disciplines, Internal Combustion Engines, Evolution of Automobile and Mechanical Automotive Systems (brake, suspension and direct systems).

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PROFILES OF INTENSITY LOADS IN PHYSICAL EDUCATION CLASSES IN POLAND

Michał Bronikowski

University School of Physical Education, Poznań, Poland

Submitted in May, 2005

The aim of the research was to compare the health-related effectiveness of various types of physical education lessons on the cardio-respiratory system. The research was carried out in the years 2002 and 2003 in two junior high schools in Poznań. There were four types of classes examined: outdoor athletics, volleyball, basketball and fun games, each type lasting 45 minutes. Heart rates of two randomly selected pupils aged 15–16 were recorded during class, with the use of Polar heart rate monitors. According to the findings of a cross-national study, Polish youth do not have enough *moderate-to-vigorous* activity on a daily basis (Cabak & Woynarowska, 2004). In our research the most effective in stimulating cardio-respiratory fitness appeared to be outdoor athletics classes in boys and girls, and basketball in boys. Our data support the earlier findings of other studies (Stratton, 1997; Fairclough & Stratton, 2005).

Keywords: Intensity loads, cardio-respiratory fitness, physical education, youth.

INTRODUCTION

Physical activity remains one of the fundamental stimuli for the biological, psychosocial and motor development of young children. A sedentary life style and, generally, physical inactivity have been identified in numerous studies as causes of diseases collectively called the metabolic syndrome. Various studies have proven a connection between the level of activity and body fat (Hill, 1999; Owens, 1999; Moore, 2003; Boreham, 2001) as well as the incidence of heart diseases, metabolic problems, and type II diabetes (Ball, 2003; Janz, 2002; Kozieł et al., 2000, also see review of evidence in Vuori, 2004). Especially the problem of obesity in younger age categories appears to be growing in most of the industrialized countries, including Poland.

The quantity and quality of exercise influence the morphological (body composition, metabolism, oxygen uptake and consumption), somatic (body mass and height) and neurological (co-ordination, reaction time) characteristics of individuals. Recent studies have concerned relations between physical activity and motor and cardiovascular fitness, fatness, body mass, BMI and other body components in certain developmental stages, but with no educational interventions (Boreham, 2001; Eliakim, 2002; Barkey, 2003; Chromiński, 1985; Raczek, 1997; Gołąb, 2002). Earlier studies concerned mainly the effectiveness of exercise on reducing body fat mass (Boileau, 1985; Ilyes, 1992; Mulder, 1983), alongside the effectiveness of medical treatment and special diet in obesity (Gately, 2000; Eliakim, 2002; Kasprzak et al., 2000).

A reduced level of physical activity negatively influences motor fitness (Corbin, 1996; Mota, 2002; Przewęda & Trześnowski, 1996; Przewęda & Dobosz, 2003; Raczek, 1986). In their research Magiera et al. (2002) observed a very low level of cardio-respiratory fitness among Polish pupils. Osiński (1988) found a relation between poorer results in motor abilities and pubescence and secular trends in body mass and height. A similar association was found by Gołąb et al. (2002).

At the same time, insufficient intensity of physical education classes in school appears to affect obesity. Research projects in Poland (Woynarowska, 1982; Raczek, 1986; Perkowski, 1995, 1998; Pańczyk, 1998, 1999; Bronikowski, 2004), and in other countries (Burton, 1996; Stratton, 1997; Boreham, 2001) have indicated this growing problem.

Stratton (1997) found in his study of British public school children aged 9–15 that almost 80% of the lesson time does not meet the National public health service criteria of using 50% of total PE lesson time by carrying out exercises with a heart rate intensity of HR ≥ 150 b/min. He also indicated that the amount of time spent in sufficient moderate-to-vigorous physical activity (MVPA) had been increasing until the pupils' age of 11–12, and then was systematically decreasing to 10% of lesson time with the required intensity among 15 years old children. As a possible explanation of this fact Stratton suggested problems connected with changing of schools at the age of 12. The worsening results may be connected with negative changes in the quality of lessons provided in later years of education. Burton (1996) established that during physical education lessons the average heart rate for 9–13 years old American pupils was 142 beats per minute, and 45% of lesson time failed to achieve this level. Children from French

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Submitted in May, 2005

The aim of the research was to compare the health-related effectiveness of various types of physical education lessons on the cardio-respiratory system. The research was carried out in the years 2002 and 2003 in two junior high schools in Poznań. There were four types of classes examined: outdoor athletics, volleyball, basketball and fun games, each type lasting 45 minutes. Heart rates of two randomly selected pupils aged 15–16 were recorded during class, with the use of Polar heart rate monitors. According to the findings of a cross-national study, Polish youth do not have enough *moderate-to-vigorous* activity on a daily basis (Cabak & Woynarowska, 2004). In our research the most effective in stimulating cardio-respiratory fitness appeared to be outdoor athletics classes in boys and girls, and basketball in boys. Our data support the earlier findings of other studies (Stratton, 1997; Fairclough & Stratton, 2005).

Keywords: Intensity loads, cardio-respiratory fitness, physical education, youth.

INTRODUCTION

Physical activity remains one of the fundamental stimuli for the biological, psychosocial and motor development of young children. A sedentary life style and, generally, physical inactivity have been identified in numerous studies as causes of diseases collectively called the metabolic syndrome. Various studies have proven a connection between the level of activity and body fat (Hill, 1999; Owens, 1999; Moore, 2003; Boreham, 2001) as well as the incidence of heart diseases, metabolic problems, and type II diabetes (Ball, 2003; Janz, 2002; Kozieł et al., 2000, also see review of evidence in Vuori, 2004). Especially the problem of obesity in younger age categories appears to be growing in most of the industrialized countries, including Poland.

The quantity and quality of exercise influence the morphological (body composition, metabolism, oxygen uptake and consumption), somatic (body mass and height) and neurological (co-ordination, reaction time) characteristics of individuals. Recent studies have concerned relations between physical activity and motor and cardiovascular fitness, fatness, body mass, BMI and other body components in certain developmental stages, but with no educational interventions (Boreham, 2001; Eliakim, 2002; Barkey, 2003; Chromiński, 1985; Raczek, 1997; Gołąb, 2002). Earlier studies concerned mainly the effectiveness of exercise on reducing body fat mass (Boileau, 1985; Ilyes, 1992; Mulder, 1983), alongside the effectiveness of medical treatment and special diet in obesity (Gately, 2000; Eliakim, 2002; Kasprzak et al., 2000).

A reduced level of physical activity negatively influences motor fitness (Corbin, 1996; Mota, 2002; Przewęda & Trześnowski, 1996; Przewęda & Dobosz, 2003; Raczek, 1986). In their research Magiera et al. (2002) observed a very low level of cardio-respiratory fitness among Polish pupils. Osiński (1988) found a relation between poorer results in motor abilities and pubescence and secular trends in body mass and height. A similar association was found by Gołąb et al. (2002).

At the same time, insufficient intensity of physical education classes in school appears to affect obesity. Research projects in Poland (Woynarowska, 1982; Raczek, 1986; Perkowski, 1995, 1998; Pańczyk, 1998, 1999; Bronikowski, 2004), and in other countries (Burton, 1996; Stratton, 1997; Boreham, 2001) have indicated this growing problem.

Stratton (1997) found in his study of British public school children aged 9–15 that almost 80% of the lesson time does not meet the National public health service criteria of using 50% of total PE lesson time by carrying out exercises with a heart rate intensity of HR ≥ 150 b/min. He also indicated that the amount of time spent in sufficient moderate-to-vigorous physical activity (MVPA) had been increasing until the pupils' age of 11–12, and then was systematically decreasing to 10% of lesson time with the required intensity among 15 years old children. As a possible explanation of this fact Stratton suggested problems connected with changing of schools at the age of 12. The worsening results may be connected with negative changes in the quality of lessons provided in later years of education. Burton (1996) established that during physical education lessons the average heart rate for 9–13 years old American pupils was 142 beats per minute, and 45% of lesson time failed to achieve this level. Children from French

schools, according to research conducted by Baquet et al. (2002), exercised with an intensity lower then 50% HR max for almost 40% of lesson time. For only 25% of the total lesson time did they exercise with an intensity of over the level of 60% HR max, and 10% of the time with an intensity of above the 75% HR max.

Studies conducted in Poland do not produce a dramatic image, but certainly some questions and concerns may arise. Perkowski (1998) found that the average HR during physical education lessons in Poland was 149 b/min within 38% of the activity time with an intensity of between 140–170 b/min (*moderate-to-vigorous* activity). Pańczyk (1998, 1999) reports the average HR of 159 b/min for outdoor physical education classes, while in indoor classes the average HR was 142 b/min. In our own research the average HR during the indoor classes was estimated at the level of 138 b/min for 13 years old boys, and at the level of 145 b/min for girls (Bronikowski, 2004). The majority of physical education classes do not provide physiological support for developing physical fitness, especially cardio-respiratory fitness and endurance. According to Stratton (1997), Pańczyk (1999), Perkowski (1998), Raczek (1986), Osiński (2001) only exercising with and above *moderate-to-vigorous* (over 140 b/min) and *vigorous* (over 160 b/min) physical activity can have a positive effect on cardio-respiratory fitness and support proper biological development.

The aim of the paper was to assess the levels of intensity of workloads using heart rate telemetry during various types of physical education classes in Polish schools. For the purpose of the work, the total exercising time of the class was divided into 5 pre-determined zones of intensity. The analysis of intensity represented by a curve was also presented.

MATERIAL AND METHOD

The subjects of this study were 14 boys and 12 girls randomly selected from two classes of 15–16 years old pupils from two junior high schools in Poznań and were part of a larger study project carried out in order to assess the cardio-respiratory effectiveness of physical education lessons. This study was supported by Polish scientific committee grant no PO5D 04623.

Body mass and height were measured using standard anthropometric methods and are presented in TABLE 1.

The heart rate was measured with Polar sport-testers S 601i. Monitoring devices were worn during each lesson for its entire duration by two subjects. Later the collected data was downloaded for statistical and graphic analysis. To establish the significance of differences between boys participating in the lessons, a one-way ANOVA analysis was carried out. The same procedure was adopted separately for girls who participated together in one lesson. The level of significance was established at $p < 0.05$. From this data the percentage of lesson time, mean values and time allocation of intensity in five pre-determined heart-rate zones were calculated, following Swaim and Edwards (2002) who established five zones of intensity accordingly to % Max HR and fuel usage. Those zones were adopted in the study:

1) 50–60% Max HR (under 119 b/min);
   fuel usage: 10% carbohydrates, 50–75% fat, 5% protein, app. 5 calories per minute;
2) 61–70% Max HR (120–139 b/min);
   fuel usage: 10% carbohydrates, 50–75% fat, 5% protein, app. 5–8 calories per minute;
3) 71–80% Max HR (140–159 b/min);
   fuel usage: 60% carbohydrates, 35% fat, 5% protein, app. 8–10 calories per minute;
4) 81–90% Max HR (160–179 b/min);
   fuel usage: up to 80% carbohydrates, 15–45% fat, 5% fat, app. 10–15 calories per minute;
5) 91–100% Max HR (180 b/min and above);
   fuel usage: 90% carbohydrates, 5% protein, 5% fat, app. 15–20 calories per minute.

To establish the maximal heart rate for this age category we used the Ball State University formula, where the HR max for females = 209 – (0.7)(age), gave approximately 198 b/min for girls; and for males HR max = 214 – (0.8)(age), gave approximately 202 b/min for boys (Swaim & Edwards, 2002).

TABLE 1
Characteristics of the sample group (mean ± SD)

Characteristics	Boys (N = 14)			Girls (N = 12)		
	Min	Mean	Max	Min	Mean	Max
Body mass [kg]	55.0	61.6	75.0	43.0	54.4	64.0
Body height [cm]	168	176	186	156	166	174

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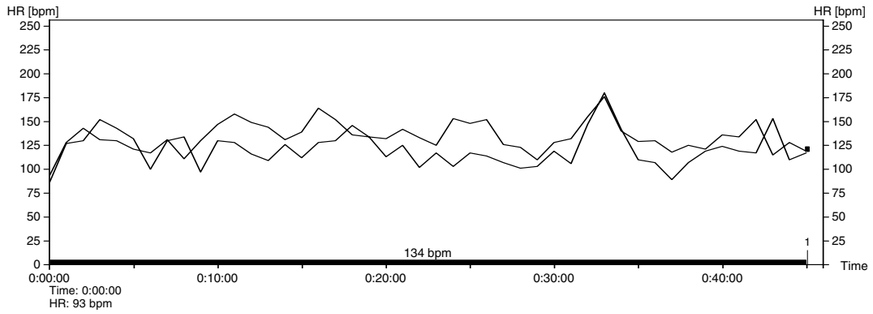
RESULTS

Monitoring of heart rates showed there were differences in exercising time in five zones of intensity in various types of physical education lessons. Fig. 1a below shows average heart rate curves; Fig. 1b shows a time allocation in five zones of intensity in all types of physical education lessons monitored.

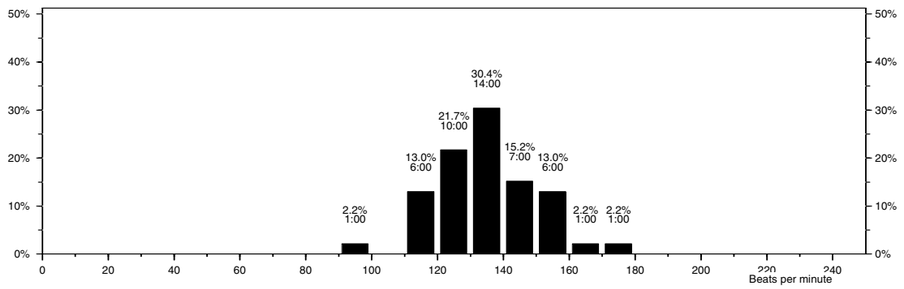
Fig. 1a
Average heart rate curve during a lesson of fun plays in 16 years old girls ($p < 0.001$)



No	Exercise	Date	Cursor HR	Heart rate	Duration	Note
1.	2003-05-26 09:53	2003-05-26	86	121 / 180	0:45:07.5	
2.	2003-05-26 09:53	2003-05-26	93	134 / 176	0:45:03.6	
3.						
4.						
5.						

Fig. 1a illustrates an average heart rate (HR) in a lesson of simple fun plays and games in girls. The average heart rate was 134 b/min, reaching its peak 176 b/min at around the 30–35th minute of the lesson. Fig. 1a presents ups and downs in the curve indicating resting breaks between consecutive plays, usually used by a teacher for explanation of rules and fibula of a play. There were no significant differences in the intensity levels between two girls wearing sport-testers ($p < 0.001$) during the same lessons.

Fig. 1b
The percentage of lesson time spent with varying intensity during a class of fun games in 16 years old girls (%)



2003-05-26 134 bpm

Person	Michał	Date		Heart rate average	176 bpm		
Exercise	2003-05-26 09:53	Time	0:45:03.6	Heart rate max			
Sport	Running	Duration			0:	)0	(0:45:00.0)
Note				Selection			

Fig. 1b shows that during the monitored lesson of fun plays girls exercise 52% of the total lesson time with the intensity of zone II (120–139 b/min). Exercising time spent in zone IV (140–159 b/min) was almost 4.5%, and no exercising time of zone V of maximal intensity was noticed. Altogether the amount of time above the level of 140 b/min (recommended as stimulating cardio-respiratory functions) was almost 32.5%, which was nearly 15 minutes (Fig. 1b). During the lesson of fun plays the 16 years old girls burnt 385 kcal/45min (±60) on the average.

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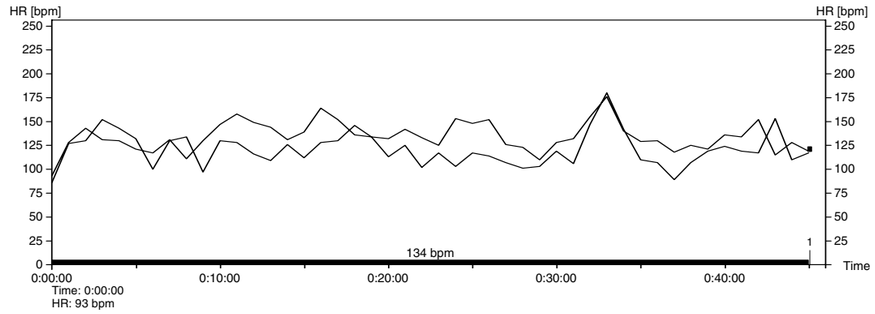

No	Exercise	Date	Cursor HR	Heart rate	Duration	Note
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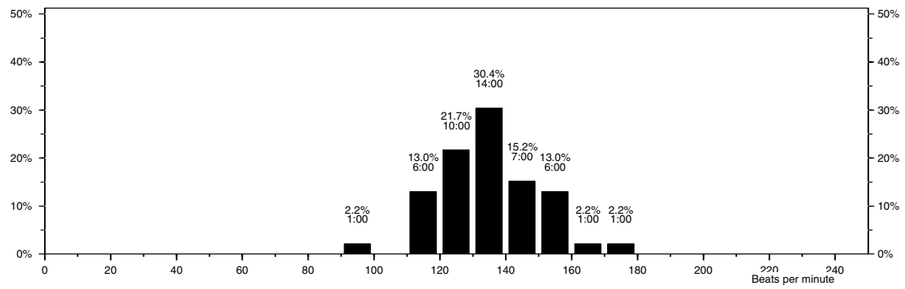
Fig. 1b
The percentage of lesson time spent with varying intensity during a class of fun games in 16 years old girls (%)



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Person	Michał	Date		Heart rate average	176 bpm		
Exercise	2003-05-26 09:53	Time	0:45:03.6	Heart rate max			
Sport	Running	Duration			0:	)0	(0:45:00.0)
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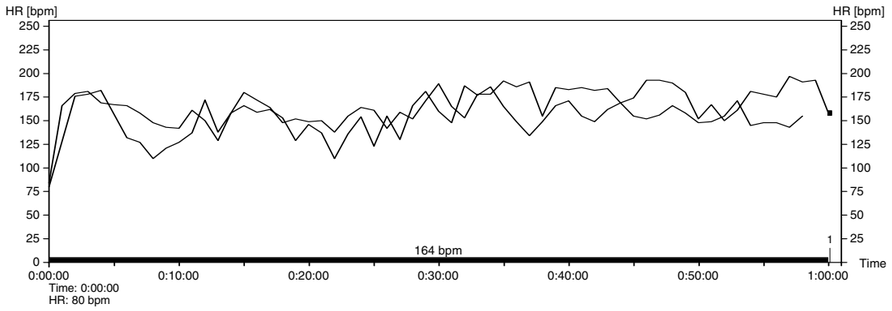
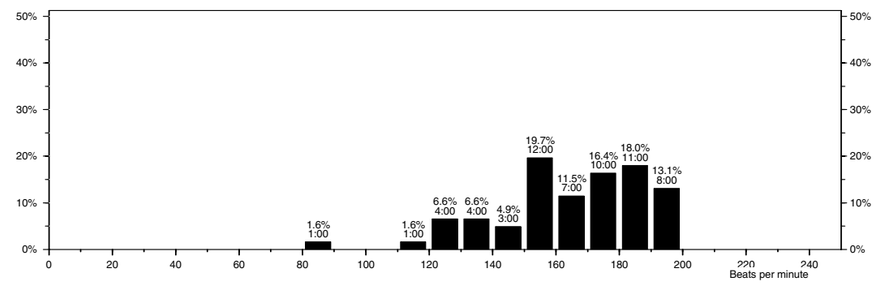
Fig. 2a
Average heart rate curve during an outdoor track and field lesson in 16 years old girls (p = 0.012)



No	Exercise	Date	Cursor HR	Heart rate	Duration	Note
1.	2003-05-21 13:04	2003-05-21	84	154 / 187	0:58:48.2	
2.	2003-05-21 13:03	2003-05-21	80	164 / 197	1:00:06.8	
3.						
4.						
5.						

Fig. 2a presents an intensity curve of an outdoor track and field lesson in 16 years old girls. The average heart rate was 164 b/min. In the first part of the lesson (up to the 5th minute) a steep line up in the intensity curve reaching the value of 175 b/min was due to the introduction of a physical activity called "tugs of war". The response of the cardio-respiratory system (steep curving intensity line) indicates that such a workload was too demanding for this part of the lesson and therefore should not have been introduced, at least not at such an early stage of the warm up. The measured heart rate reached its highest value of 197 b/min between the 30th and 40th minutes of the lesson, which is in accordance with the theoretical assumptions of physical education lessons.

Fig. 2b
The percentage of lesson time spent with varying intensity during a lesson of outdoor track and field athletics in 16 years old girls (%)



Person	Michal	Date	2003-05-21	Heart rate average	164 bpm		
Exercise	2003-05-21 13:03	Time	13:03:07	Heart rate max	197 bpm		
Sport	Running	Duration	1:00:06.8				
Note				Selection	0:00:00 - 1:00:00 (1:00:00.0)		

The examined 16 years old girls exercised with the intensity of zone III (140–159 b/min) for about 25% of the total lesson time. They spent 27% of the total lesson time exercising in zone IV (160–179 b/min) and 31% in zone V (over 180 b/min). Altogether they exercised with an intensity suited to supporting cardio-respiratory fitness (over 140 b/min) for 83% of the lesson time. Preparation for such intensive exercise took 17% of the total time, with only 3.5% of the total time in zone I (under 119 b/min; Fig. 2b). The caloric cost of the outdoor track and field lesson in 16 years old girls was almost 470 kcal/45min ±105.

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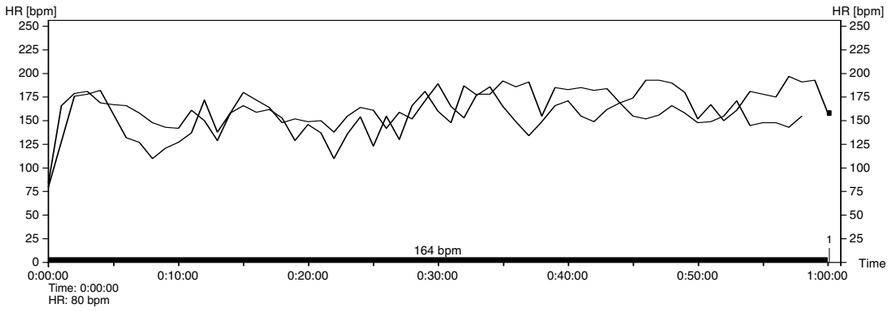
Average heart rate curve during an outdoor track and field lesson in 16 years old girls (p = 0.012)



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2.	2003-05-21 13:03	2003-05-21	80	164 / 197	1:00:06.8	
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Fig. 2b
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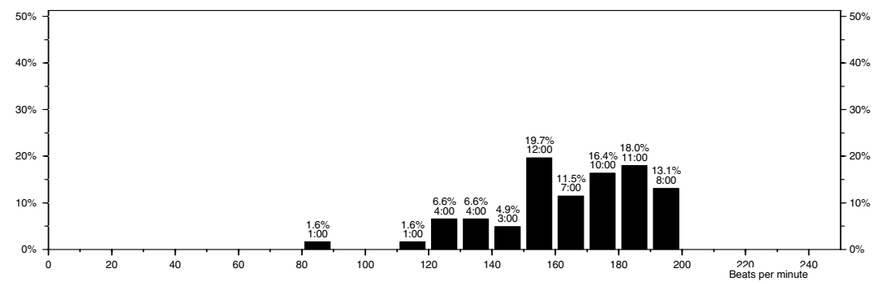

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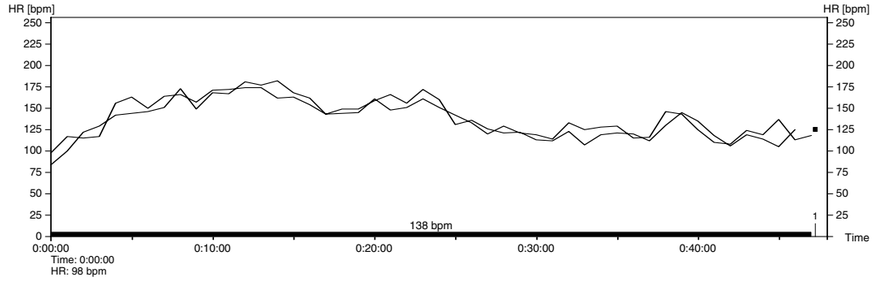
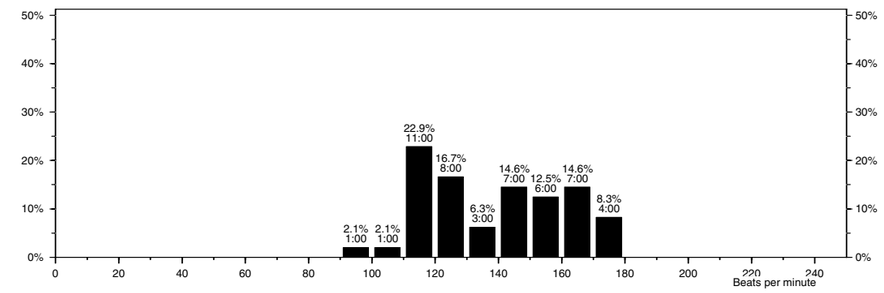
Fig. 3a
Average heart rate curve during a volleyball lesson in 16 years old girls (p = 0.083)



No	Exercise	Date	Cursor HR	Heart rate	Duration	Note
1.	2003-05-19 09:09	2003-05-19	84	137 / 182	0:46:43.4	
2.	2003-05-19 09:08	2003-05-19	98	138 / 174	0:47:16.3	
3.						
4.						
5.						

Fig. 3a shows a volleyball class attended by 16 years old girls. The intensity curve forms a characteristic slope, rising up to the 15th minute of the lesson. It is owing to the properly conducted warm up. Next, it is slowly falling toward the end of the lesson. The average heart rate was 138 b/min, reaching its highest value of 174 b/min in the first part of the lesson. Introduction of new material, connected with sampling and repetition, usually requiring little physical work caused a drop in the intensity level between the 15th and 30th minutes. This is understandable, as learning technical and tactical elements of team games always requires more accuracy and less speed. A game of volleyball introduced in the final part of the lesson did not increase the intensity back to the level of over 140 b/min.

Fig. 3b
The percentage of lesson time spent with varying intensity during a volleyball lesson in 16 years old girls (%)



Person	Michał	Date	2003-05-19	Heart rate average	138 bpm		
Exercise	2003-05-19 19:08	Time	19:08:11	Heart rate max	174 bpm		
Sport	Running	Duration	0:47:16.3				
Note				Selection	0:00:00 - 0:47:00 (0:47:00.0)		

During the volleyball class 16 years old girls practiced with an intensity supporting the development of cardio-respiratory functions (over 140 b/min) for 50% of the lesson time. However, there were no loads in zones IV and V recorded, which may suggest that this type of lesson demands little or no maximal intensity (Fig. 3b). Energy expenditure during the volleyball class equaled 380 kcal/45min (±74).

A similar situation was observed among 16 years old boys during a volleyball lesson. In Fig. 4a the intensity curve is gradually rising up to the value of 169 b/min in the 5th minute, and then systematically falling until the end of the lesson. Both, the shape of the intensity curve and the average heart rate of around 130 b/min proved similarities in the same type of lesson in both genders.

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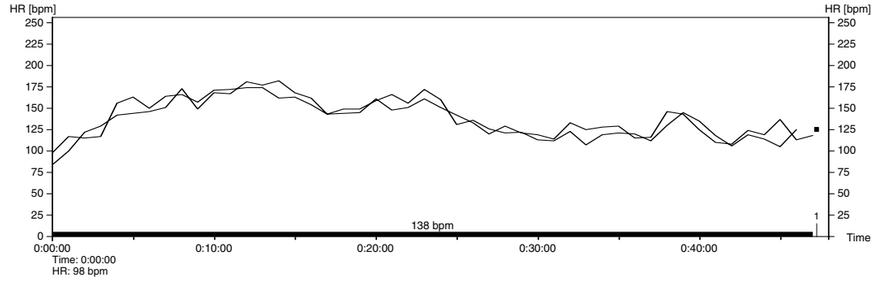

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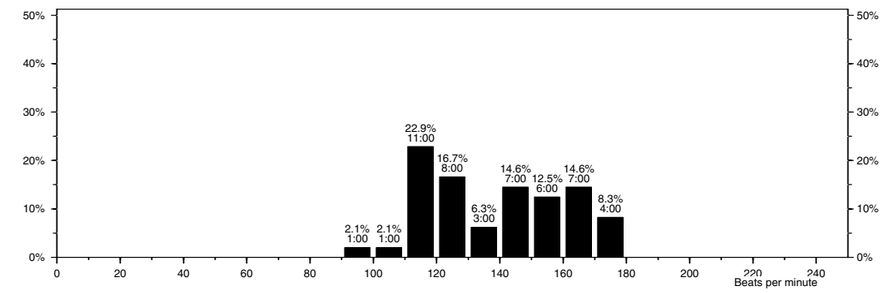

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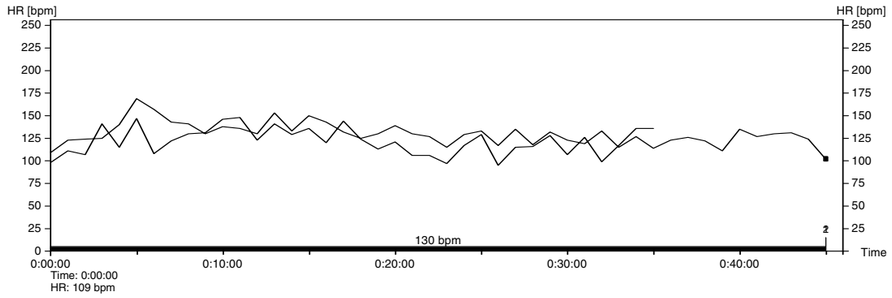
Sport	Running	Duration	0:47:16.3				
Note				Selection	0:00:00 - 0:47:00 (0:47:00.0)		

During the volleyball class 16 years old girls practiced with an intensity supporting the development of cardio-respiratory functions (over 140 b/min) for 50% of the lesson time. However, there were no loads in zones IV and V recorded, which may suggest that this type of lesson demands little or no maximal intensity (Fig. 3b). Energy expenditure during the volleyball class equaled 380 kcal/45min (±74).

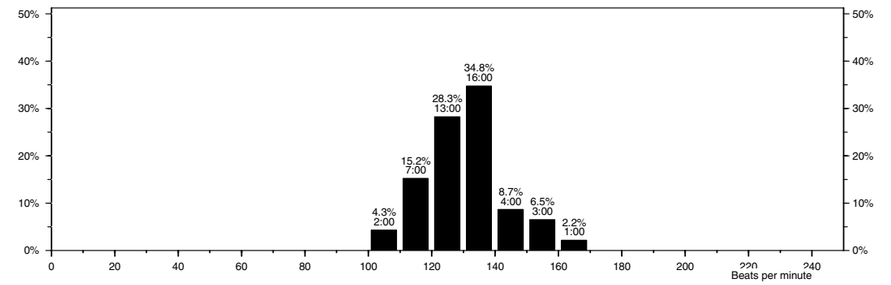
A similar situation was observed among 16 years old boys during a volleyball lesson. In Fig. 4a the intensity curve is gradually rising up to the value of 169 b/min in the 5th minute, and then systematically falling until the end of the lesson. Both, the shape of the intensity curve and the average heart rate of around 130 b/min proved similarities in the same type of lesson in both genders.

Fig. 4a
Average heart rate curve during a volleyball lesson in 16 years old boys (p = 0.013)



No	Exercise	Date	Cursor HR	Heart rate	Duration	Note
1.	2003-05-06 16:25	2003-05-06	98	122 / 148	0:35:00.7	
2.	2003-05-06 16:25	2003-05-06	109	130 / 169	0:45:02.1	
3.						
4.						
5.						

Fig. 4b
The percentage of lesson time spent with varying during a volleyball class in 16 years old boys (%)



Person	Michał	Date	2003-05-06	Heart rate average	130 bpm		
Exercise	2003-05-06 16:25	Time	16:25:10	Heart rate max	169 bpm		
Sport	Running	Duration	0:45:02.1				
Note				Selection	0:00:00 - 0:45:00 (0:45:00.0)		

Fig. 4b shows that during the volleyball lesson the examined boys exercised with an intensity of over 140 b/min for 17% of the total lesson time, but only for one minute in zone IV (160–179 b/min) and not even a minute in zone V. The relatively low intensity influenced a low caloric expenditure, which in boys amounted to 225 kcal/45min (±123). In the case of volleyball lessons conducted with 16 years old pupils of both sexes an explanation of low average heart rates and low energy costs could be provided by an understanding of emotional factors. It is common that during physical education lessons pupils of this age usually spend most of the time sampling and modifying well known tasks. No wonder there is little or none of the emotional arousal normally associated with new, challenging tasks. During monitored lessons it was rather boredom which kept the heart rate running low.

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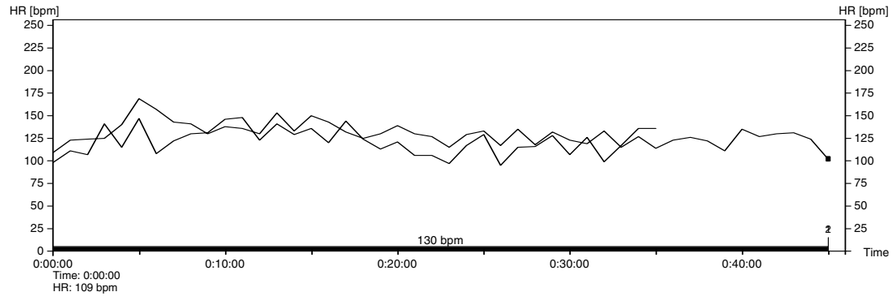
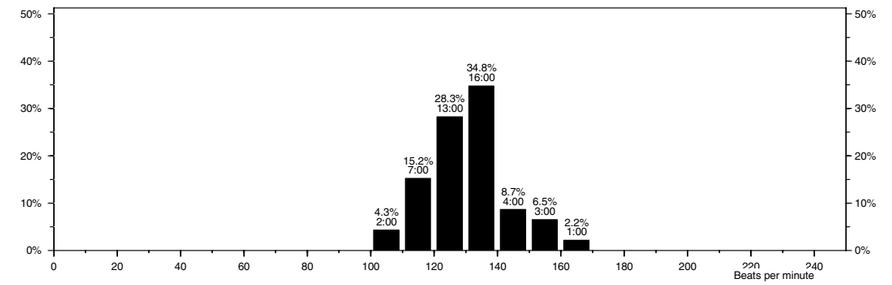
Fig. 4a
Average heart rate curve during a volleyball lesson in 16 years old boys (p = 0.013)



No	Exercise	Date	Cursor HR	Heart rate	Duration	Note
1.	2003-05-06 16:25	2003-05-06	98	122 / 148	0:35:00.7	
2.	2003-05-06 16:25	2003-05-06	109	130 / 169	0:45:02.1	
3.						
4.						
5.						

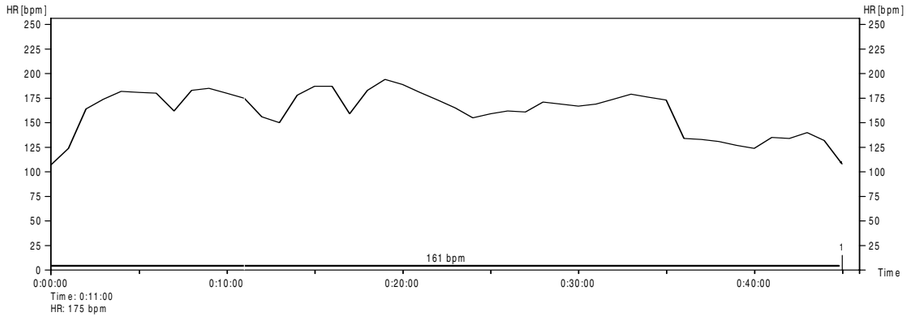
Fig. 4b
The percentage of lesson time spent with varying during a volleyball class in 16 years old boys (%)



Person	Michał	Date	2003-05-06	Heart rate average	130 bpm		
Exercise	2003-05-06 16:25	Time	16:25:10	Heart rate max	169 bpm		
Sport	Running	Duration	0:45:02.1				
Note				Selection	0:00:00 - 0:45:00 (0:45:00.0)		

Fig. 4b shows that during the volleyball lesson the examined boys exercised with an intensity of over 140 b/min for 17% of the total lesson time, but only for one minute in zone IV (160–179 b/min) and not even a minute in zone V. The relatively low intensity influenced a low caloric expenditure, which in boys amounted to 225 kcal/45min (±123). In the case of volleyball lessons conducted with 16 years old pupils of both sexes an explanation of low average heart rates and low energy costs could be provided by an understanding of emotional factors. It is common that during physical education lessons pupils of this age usually spend most of the time sampling and modifying well known tasks. No wonder there is little or none of the emotional arousal normally associated with new, challenging tasks. During monitored lessons it was rather boredom which kept the heart rate running low.

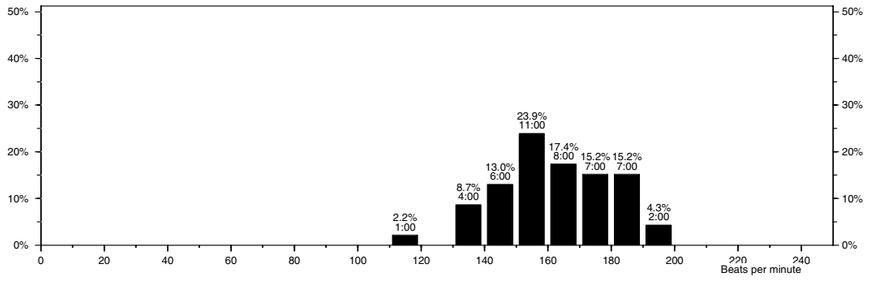
Fig. 5a
Average heart rate curve during an outdoor track and field lesson in 16 years old boys



Person	pupil	Date	2003-05-06	Heart rate average	161 bpm		
Exercise	2003-05-06 11:35	Time	14:10:12	Heart rate max	194 bpm		
Sport	Running	Duration	0:45:02.2				
Note				Selection	0:00:00 - 0:45:00 (0:45:00.0)		

Fig. 5a shows a steep increase of the heart rate curve up to 190 b/min during an outdoor lesson of track and field in 16 years old boys. The increase in the early phase of the lesson is due to the forms of running exercises introduced in the warm-up. In the later part of the lesson the intensity curve forms characteristic ups and downs between 155–185 b/min as a result of the running and resting system of organization of delivering teaching material. The average heart rate recorded during this lesson was 161 b/min.

Fig. 5b
The percentage of lesson time spent with varying intensity during an outdoor track and field class in 16 years old boys (%)



Person	Michał	Date	2003-05-06	Heart rate average	161 bpm		
Exercise	2003-05-06 11:35	Time	11:35:14	Heart rate max	194 bpm		
Sport	Running	Duration	0:45:02.1				
Note				Selection	0:00:00 - 0:45:00 (0:45:00.0)		

Time allocation in five intensity zones during the track and field lesson in boys is shown in Fig. 5b. According to the data the amount of physical activity with a positive effect on cardio-respiratory fitness (zone III and above) in this type of lesson was 89% of the total lesson time, including exercising with a vigorous intensity of 160–179 b/min for 32% and 19.5% with a maximal intensity of over 180 b/min. Interestingly, only for about 10% of the total lesson time did the boys exercise with an intensity of lower than 140 b/min, mostly in the final phase of the lesson. Exercising with the intensity of zones III, IV and V caused fuel usage mainly from carbohydrates, which resulted in the generally high total caloric expenditure during this lesson – 520 kcal/45 min (±63).

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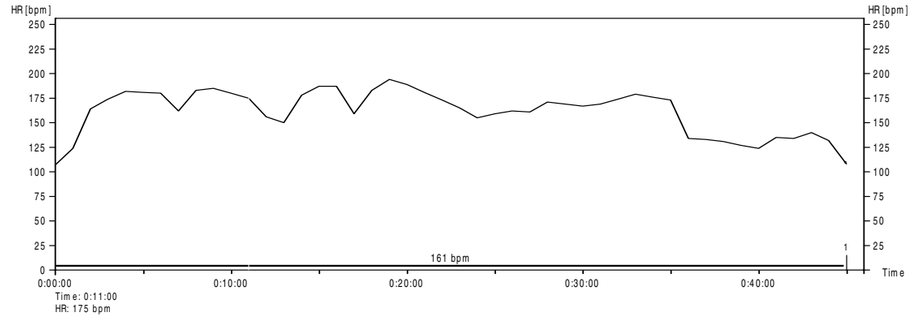
Fig. 5a
Average heart rate curve during an outdoor track and field lesson in 16 years old boys



Person	pupil	Date	2003-05-06	Heart rate average	161 bpm		
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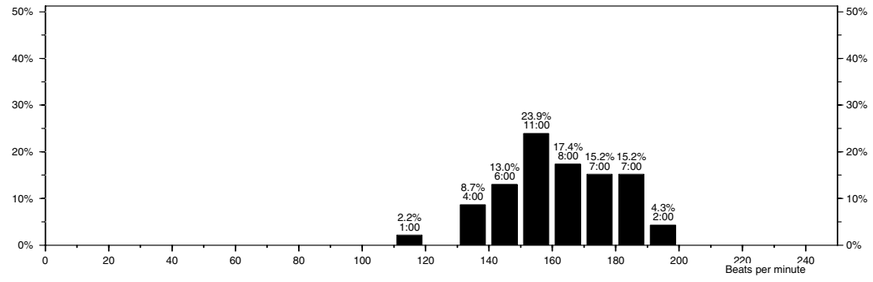
Fig. 5b
The percentage of lesson time spent with varying intensity during an outdoor track and field class in 16 years old boys (%)



Person	Michał	Date	2003-05-06	Heart rate average	161 bpm		
Exercise	2003-05-06 11:35	Time	11:35:14	Heart rate max	194 bpm		
Sport	Running	Duration	0:45:02.1				
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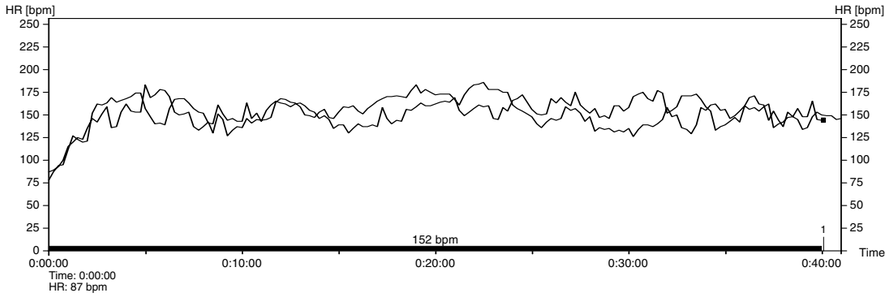
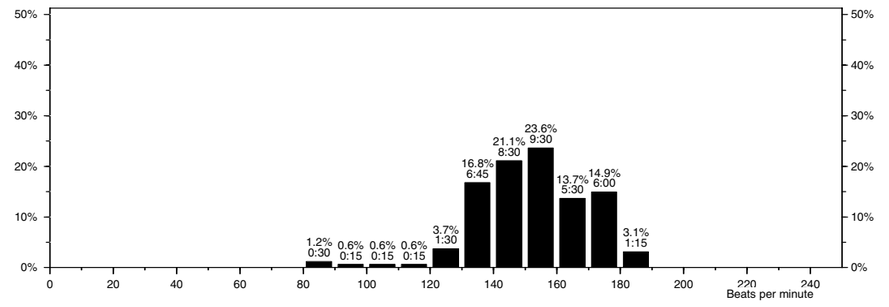
Fig. 6a
Average heart rate curve during a basketball lesson in 16 years old boys (p = 0.909)



No	Exercise	Date	Cursor HR	Heart rate	Duration	Note
1.	2003-04-28 10:04	2003-04-28	78	152 / 177	0:45:43.2	
2.	2003-04-28 10:05	2003-04-28	87	152 / 186	0:40:05.5	
3.						
4.						
5.						

During a basketball lesson the average heart rate in 16 years old boys was established at the level of 152 b/min. Fig. 6a illustrates the intensity curve gradually rising in the first 5 minutes of the lesson, and staying at a reasonably high level for the remaining part of the lesson. Well selected tasks kept the intensity high, especially practicing technical skills with balls in the climax part and a small-sided game in the final part of the lesson helped in achieving such high intensity.

Fig. 6b
The percentage of lesson time spent with varying intensity during a basketball class in 16 years old boys (%)



Person	Michał	Date	2003-04-28	Heart rate average	152 bpm		
Exercise	2003-04-28 10:05	Time	16:38:34	Heart rate max	186 bpm		
Sport		Duration	0:40:05.5				
Note				Selection	0:00:00 - 0:40:00 (0:40:00.0)		

Basketball as an invasion game requires a great deal of position changing and moving, which influences the intensity profile of this activity. The amount of time considered to be sufficient for promoting cardio-respiratory fitness (above 140 b/min) in the examined basketball lesson of 16 years old boys equaled 76.5% of the total lesson time. More than 31% of that time the examined boys practiced with the intensity of zone IV (submaximal intensity) and within zone V (maximal intensity). Preparation for such intensity loads (a warming up phase with an intensity of lower then 140 b/min) lasted for 23.5% of the total lesson time (Fig. 6b). The examined basketball lesson in 16 years old boys caused an energy expenditure at the level of 460 kcal/45min (±88), which is probably related to the type of fuel used in such mixed aerobic and anaerobic activities.

An analysis of differences between the heart rates of pupils participating in the same lesson proved there were no statistically significant differences between the monitored girls during the fun play and games class

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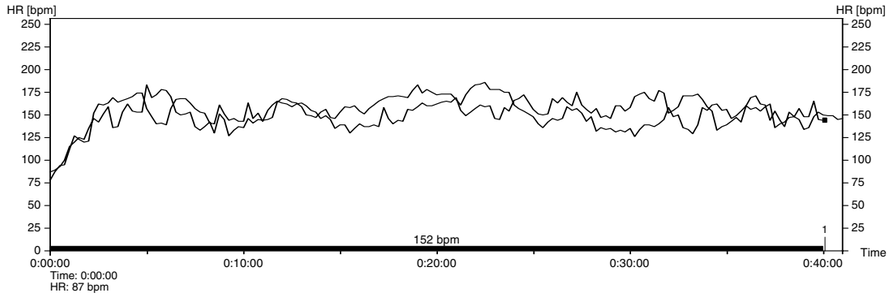
Fig. 6a
Average heart rate curve during a basketball lesson in 16 years old boys (p = 0.909)



No	Exercise	Date	Cursor HR	Heart rate	Duration	Note
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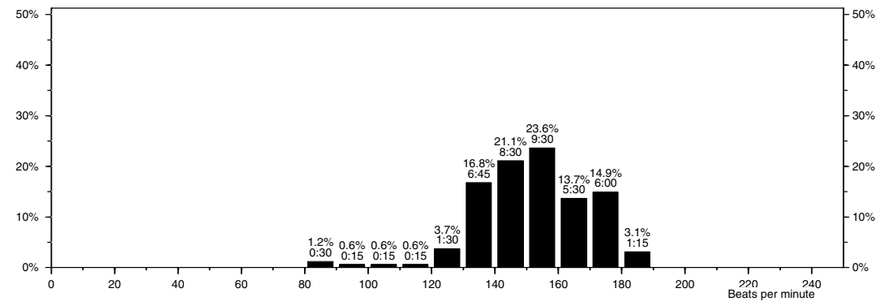
Fig. 6b
The percentage of lesson time spent with varying intensity during a basketball class in 16 years old boys (%)



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($p < 0.01$), outdoor athletics ($p = 0.012$) and volleyball classes $p = 0.083$. As for the boys the analysis showed no differences in volleyball class ($p = 0.013$). In the case of basketball lesson the difference was $p = 0.909$.

DISCUSSION

The study investigated the amount of time spent in five zones of intensity during various types of physical education classes. A study carried out by Bebcakova et al. (2001) in Estonian children showed that in the warm-up part of PE classes almost half of the pupils reached a heart rate higher than 60% of HR max, which was the recommended value. However, it is worth mentioning that the pupils should reach such a level of intensity in the main part of the class (according to methodological guidelines), not in the warm-up phase. Our findings prove that the differences in the heart rates during physical education classes are affected by the sex and the type of activity. Most beneficial for health improvement appeared to be lessons of outdoor track and field in both 15–16 years old girls and boys, with high average heart rates and a great amount of time spent above 140 b/min (specially in zones IV and V). Also in the boys, the basketball class was considered to be sufficiently promoting cardio-respiratory fitness. Quite the opposite, the volleyball classes were recognized as the least effective in stimulating the development of oxygen transportation in both sexes.

Improvements in cardio-respiratory fitness require activities with an intensity sufficient for supporting the delivery of oxygen to the working muscles, with the frequency, duration and level of intensity adequate to the biological development and general motor capacities. According to our findings (supported also in other works: Stratton, 1997; Fairclough & Stratton, 2005; Bronikowski, 2004) invasion games such as basketball, football, handball, floorball and others, including small-sided games (2 vs. 2, 3 vs. 3), are reasonably effective in promoting cardio-respiratory fitness. An explanation may be found in the number of major muscle groups required in such sports due to the translocation (invasion into the opponents' part of the field) and a high level of general motor abilities. On the other hand, school physical education curricula include some activities considered to be insufficient for developing cardio-respiratory fitness (e. g. volleyball and other net games, forms of well-disciplined gymnastics, table tennis), which, however, should not be entirely excluded. They develop other important motor abilities such as flexibility or strength, which do not require great intensity and therefore do not elevate the heart rate so easily. They also develop other goals of physical education, considered to be equally important for life-time commitment to physical activity.

A recent health-related recommendation is concerned with the FIT formula, i. e. exercising at least three days per week (frequency), at the heart rate of 60–90 percent of maximal heart rate or 50 to 85 percent of maximal aerobic power or heart rate reserve (intensity), and for at least 20–60 minutes (time). The most recent guidelines for exercise prescription recommend the minimal threshold of 300 calories per exercise session performed three days a week, or 200 calories per session performed four days a week. However, there is evidence that aerobic benefits can be achieved even with accumulating several shorter bouts of activity throughout the whole day (Corbin, 1996). Strict following of methodological guidelines will improve the organization and intensity of the activity, and this can be easily achieved through appropriate and well-in-advance preparation of school physical education classes.

Lack of sufficient intensity during physical activity may, in the long-term, result in a range of health problems called the metabolic syndrome (for a review of all sorts of possible problems see Vuori, 2004). Health consequences related to obesity in young people concern many risk factors such as cardiovascular (dyslipidemia, elevated systolic and diastolic blood pressure), endocrine risk factors (insulin resistance, abnormal metabolism), life style factors (low fitness, low physical activity level, low movement competence), orthopedic risk factors (accelerated, abnormal growth), psychosocial factors (low self-esteem and socio-economic status). There are also strong indications of carrying obesity from youth into later stages of life (adulthood and elderly) and this is why the problem remains socially important.

CONCLUSIONS

1. There should be more activities supporting cardio-respiratory fitness included in school physical education curricula. The most suitable for health-related fitness seem to be outdoor athletics classes, invasion team games and aerobic dance.
2. It is important to keep a reasonable ratio of high and low intensity activities in school physical education lessons and provide a wide range of activities to give pupils an option to choose the most suitable lifetime activity.
3. Better classroom organization and management will certainly improve the quality and intensity of any lesson, even those considered to be less effective in stimulating aerobic fitness such as volleyball, gymnastics and net team games.

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($p < 0.01$), outdoor athletics ($p = 0.012$) and volleyball classes $p = 0.083$. As for the boys the analysis showed no differences in volleyball class ($p = 0.013$). In the case of basketball lesson the difference was $p = 0.909$.

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PROFILY INTENZIVNÍ ZÁTĚŽE V HODINÁCH TĚLESNÉ VÝCHOVY V POLSKU

(Souhrn anglického textu)

Cílem průzkumu bylo srovnání zdravotní účinnosti různých typů hodin tělesné výchovy na kardio-respirační ústrojí. Průzkum byl prováděn v letech 2002 a 2003 na nižším stupni středních škol v Poznani. Zkoumány byly čtyři typy hodin: atletika, volejbal, basketbal a pohybové hry, přičemž každý typ měl trvání 45 minut. V průběhu hodiny byla u dvou náhodně zvolených 15–16letých žáků měřena srdeční frekvence, a to pomocí monitorů srdeční frekvence Polar. Podle výsledků celonárodního výzkumu nemá polská mládež dostatek každodenní střední až intenzivní aktivity (Cabak & Woynarowska, 2004). V našem průzkumu se hodiny atletiky, v případě chlapců a dívek, a basketbalu, v případě chlapců, jevily jako hodiny nejúčinněji stimulující kardio-respirační zdatnost. Naše údaje potvrzují dřívější výsledky jiných průzkumů (Stratton, 1997; Fairclough & Stratton, 2005).

Klíčová slova: intenzivní zátěž, kardio-respirační zdatnost, tělesná výchova, mládež.

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First-line publication

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FACTOR ANALYSIS OF ANTHROPOMETRIC CHARACTERISTICS IN YOUNG SWIMMERS AGED 11 AND 12

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Submitted in June, 2005

The aim of this study was to describe the set of somatic characteristics, which significantly discriminate young swimmers. The factor analysis let us reduce the number of somatic traits mostly correlated and to calculate the main structural factors typical for young swimmers. There were 80 pupils (11 and 12 years old) from the primary sport school in Wroclaw recruited for the study. The participants selected for the study had been involved in swimming for 2–3 years. On average their training time was 12 to 18 hours per week. The following parameters were established: body height and weight, upper and lower extremities' length, circumferences of: the thigh, shank, arm, forearm, chest at rest, chest after inspiration, chest after expiration, waist, hips, shoulder width, hips' width, chest width, chest depth, and Rohrer index. All data were normalised at mean and standard deviation to join all children in one group. In order to accomplish the aim of the study, a factor analysis method was employed. Analysis of the results indicated that only some traits, from among all data, are characteristic for young swimmers. They are connected into two somatic factors: the cubic content (including body weight, muscles, trunk and upper and lower extremities' circumferences), vertical dimension (including body height and upper and lower extremities' lengths). Those parameters indicate formation of the body figure typical for swimmers, characterised by specific proportions of the body's weight and height, chest and hips, and usually by longer limbs. Results suggest those somatic parameters characterising young swimmers in the best way. They should be used in a training process' estimation and a check-up of after training changes, as well as sport selection.

Keywords: Young swimmers' morphology, somatic features of young swimmers, factor analysis, swimming sport and body morphology.

INTRODUCTION

Movement is one of the basic symptoms of life. Thus, motion activity has accompanied human beings from their conception. Remaining in a close relationship with motion activity during our life we don't think about its essence. This point of view appears only in special situations, when a specific motion form becomes a desirable value, e. g. during practising sport (Szopa et al., 1996). Monitoring of the influence of an increased movement dose on children's organisms in their progressive development phase justifies multidirectional changes which can occur in the young organism (Benefice et al., 1990; Courteix et al., 1997).

Facts of the biological after-effects of over-training such as ossification of the epiphysis cartilage, hindering the body's growth, are widely known (Ohlen et al., 1989; Stager et al., 1984; Bencke et al., 2002). On the other hand, some people are more susceptible to the disadvantageous influence of training. In the face of this fact, selection is very important (Leone et al., 2002).

Training is a very strong stimulus affecting an organism's status. It must be remembered that during its development, the organism is rebuilt in a direction which will be imposed by physical exercises. Crossing functional adaptation borders can lead to biological equilibrium upset and to developmental irregularities or disproportion.

A child's organism can develop in one direction, e. g. excessive increase in muscle mass at the cost of impairment of traits such as height or organism function. In extreme cases, excessive exploitation of children's biological strength can lead to a change in the rate of sexual maturation.

In sport practice various forms of selection for practising sport occur, such as natural selection, intuitive selection, and guided selection.

All actions connected with children and youth in sport should take into account aspects of biological development. A prognosis of the development of functional abilities should be made on the basis of development parameters depending on training practice. The basis for foresight of development abilities and selection should be stable features (Duche, 1993). Those are features determined by hereditary factors as well as inborn abilities. At the beginning of training the high level of

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these factors determine the achievement of mastery in the future. Height and maximal work capacity (VO_2max) should be mentioned.

The most significant changes resulting from physical activity occur in the body build and in the muscular system (Lowensteyn et al., 1994; Mosaiger et al., 1994; Roemmich & Sinning, 1996; Kozlowski & Nazar, 1996). Sometimes development of muscles takes place at the cost of development of other features, such as body height and its functions.

There are two important elements in the training process: selection at the beginning and supervision during training. Good, proper selection allows us to choose some talented persons with the somatic and functional predisposition to any kind of sport discipline. Good supervision of the morphofunctional development of children decreases the risk of negative changes in their organism. The problem is what kind of somatic and functional traits should be observed. The coach, instructor or medical doctor has very often a dilemma as to which parameters should be chosen. The choice is very often based on intuition. Consequently a group of accidental, strongly correlated parameters are usually chosen. On the other hand, taking into account a wide range of measurements and time-consuming examinations, looking for parameters' models describing typical sport morphology is strongly recommended.

The aim of the work was to describe correlations between somatic parameters, their interactions and identification factors completely characterising the body morphology of young swimmers.

MATERIALS AND METHODS

The research on some morphological traits of school children was done on the population of 80 pupils from a designated primary sport school in Wroclaw.

The research group consisted of 11 year and 12 year old pupils attending the 5th and 6th class of the Primary school number 72 in Wroclaw. The group of boys aged 11 contained children from 10.51 to 11.50 (mean = 11.04, sd = 0.29). The group of boys aged 12 contained children from 11.51 to 12.50 (mean = 12.06, sd = 0.27). Such methodology of qualification into groups relates to girls, too (11 years old: mean = 11.11, sd = 0.22; 12 years old: mean = 12.09, sd = 0.27). All of the pupils under investigation have been members of the swimmer clubs Śląsk and Juvenia in Wroclaw for 2–3 years. The children spend, on average, from 12 to 18 hours a week in the swimming pool.

In our research we employed the following measurements: circumferences, width, length recorded in centimetres (cm), age (years), weight (kg), height (cm) and gender were recorded. Namely, 18 body dimensions were considered, including:

body height,
body weight,
upper extremity length (a-da$_{III}$) – the average of right and left lengths,
lower extremity length (B-sy) – from the pubic symphysis to the base,
thigh (maximum) circumference,
calf (maximum) circumference,
arm (maximum) circumference (biceps circumference, flexed),
forearm (maximum) circumference (extended, palm up),
chest circumference – rest – nipple line in males and just above the breast tissue in females,
chest circumference – inspiration – nipple line in males and just above the breast tissue in females,
chest circumference – expiration – nipple line in males and just above the breast tissue in females,
waist circumference,
hip circumference,
shoulder width – diameter (a-a),
hip width – iliocristal diameter (ic-ic),
chest width – (thl-thl),
chest depth – antero-posterior chest (xi-xi).

Obtained values were used to calculate Rohrer index:

$$\text{Rohrer index} = \frac{\text{body weight (g)}}{(\text{body height})^3} \times 100$$

Body parameters have been measured in accordance with the method of Martin and Saller.

The next statistical analysis of the collected data was carried out. Age groups of the children were connected in order to increase the number of observations, which enabled the use of proper statistical methods. According to principles, data has been normalised with respect to mean and standard deviations for the appropriate age group.

In this way, the influence of age on the diversity of body build was cancelled, which allowed us to join together older and younger children's groups.

This formula was used (Stanisz, 1998):

$$Z = \frac{Xi - \bar{x}}{SD}$$

Z – normalised value; Xi – value of the measured parameter (for the child); $\bar{x}$ – mean value of a given parameter in the age group of the child; SD – standard deviation of parameters according to the age group of the child.

Next, base statistical parameters such as the arithmetic mean, standard deviation, minimal and maximal values of body dimensions were calculated. Also

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these factors determine the achievement of mastery in the future. Height and maximal work capacity (VO_2max) should be mentioned.

The most significant changes resulting from physical activity occur in the body build and in the muscular system (Lowensteyn et al., 1994; Mosaiger et al., 1994; Roemmich & Sinning, 1996; Kozlowski & Nazar, 1996). Sometimes development of muscles takes place at the cost of development of other features, such as body height and its functions.

There are two important elements in the training process: selection at the beginning and supervision during training. Good, proper selection allows us to choose some talented persons with the somatic and functional predisposition to any kind of sport discipline. Good supervision of the morphofunctional development of children decreases the risk of negative changes in their organism. The problem is what kind of somatic and functional traits should be observed. The coach, instructor or medical doctor has very often a dilemma as to which parameters should be chosen. The choice is very often based on intuition. Consequently a group of accidental, strongly correlated parameters are usually chosen. On the other hand, taking into account a wide range of measurements and time-consuming examinations, looking for parameters' models describing typical sport morphology is strongly recommended.

The aim of the work was to describe correlations between somatic parameters, their interactions and identification factors completely characterising the body morphology of young swimmers.

MATERIALS AND METHODS

The research on some morphological traits of school children was done on the population of 80 pupils from a designated primary sport school in Wroclaw.

The research group consisted of 11 year and 12 year old pupils attending the 5th and 6th class of the Primary school number 72 in Wroclaw. The group of boys aged 11 contained children from 10.51 to 11.50 (mean = 11.04, sd = 0.29). The group of boys aged 12 contained children from 11.51 to 12.50 (mean = 12.06, sd = 0.27). Such methodology of qualification into groups relates to girls, too (11 years old: mean = 11.11, sd = 0.22; 12 years old: mean = 12.09, sd = 0.27). All of the pupils under investigation have been members of the swimmer clubs Śląsk and Juvenia in Wroclaw for 2–3 years. The children spend, on average, from 12 to 18 hours a week in the swimming pool.

In our research we employed the following measurements: circumferences, width, length recorded in centimetres (cm), age (years), weight (kg), height (cm) and gender were recorded. Namely, 18 body dimensions were considered, including:

body height,
body weight,
upper extremity length (a-da$_{III}$) – the average of right and left lengths,
lower extremity length (B-sy) – from the pubic symphysis to the base,
thigh (maximum) circumference,
calf (maximum) circumference,
arm (maximum) circumference (biceps circumference, flexed),
forearm (maximum) circumference (extended, palm up),
chest circumference – rest – nipple line in males and just above the breast tissue in females,
chest circumference – inspiration – nipple line in males and just above the breast tissue in females,
chest circumference – expiration – nipple line in males and just above the breast tissue in females,
waist circumference,
hip circumference,
shoulder width – diameter (a-a),
hip width – iliocristal diameter (ic-ic),
chest width – (thl-thl),
chest depth – antero-posterior chest (xi-xi).

Obtained values were used to calculate Rohrer index:

$$\text{Rohrer index} = \frac{\text{body weight (g)}}{(\text{body height})^3} \times 100$$

Body parameters have been measured in accordance with the method of Martin and Saller.

The next statistical analysis of the collected data was carried out. Age groups of the children were connected in order to increase the number of observations, which enabled the use of proper statistical methods. According to principles, data has been normalised with respect to mean and standard deviations for the appropriate age group.

In this way, the influence of age on the diversity of body build was cancelled, which allowed us to join together older and younger children's groups.

This formula was used (Stanisz, 1998):

$$Z = \frac{Xi - \bar{x}}{SD}$$

Z – normalised value; Xi – value of the measured parameter (for the child); $\bar{x}$ – mean value of a given parameter in the age group of the child; SD – standard deviation of parameters according to the age group of the child.

Next, base statistical parameters such as the arithmetic mean, standard deviation, minimal and maximal values of body dimensions were calculated. Also

a simple Pearson correlation between all parameters was calculated. Finally the main somatic factors were calculated based on factor analysis. The factor analysis method applied in this research was used to determine the groups of parameters (factors) characterising the body constitution of young swimmers. We used the main factors method with Varimax rotation. This orthogonal rotation procedure improves the factors' structure. It causes the highest degree of variances of the factors (Stanisz, 1998).

RESULTS

Arithmetic means, standard deviations, minimal and maximal values of absolute and normalised body dimensions are presented in TABLES 1–3.

The factor analysis method was used to reduce the group of data. It's a popular method in anthropology and kinesiology (Ohlen et al., 1989). First we analysed the strength of the correlation between all somatic traits (TABLE 4). The strong links between somatic parameters suggest the rightness of the hypothesis that the set of data is too broad and could be reduced to those describing the morphology of body build parameters. The closest correlation (an over 0.9 coefficient) was observed in all three chest measurements.

In TABLE 5 of self values, variance of each principal component, are presented. Two of the self-values obtained indicate the presence of only two logically and reasonably descriptive morphological builds of swimmers. These values, especially the first principal component, are significant (Ostrowska et al., 2000; Skibinska et al., 1988). The "scree chart" (Fig. 1) proves the rightness of the analysis based only on two of the components mentioned above.

TABLE 1
Absolute values of somatic parameters of the 11 and 12 years old boys

Years	11				12			
Parameter	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Body height	154.55	7.80	141.00	174.00	156.00	7.78	143.00	170.00
Body weight	44.17	8.10	32.00	59.00	43.48	8.47	30.00	63.50
Rohrer index	1.19	0.12	0.97	1.41	1.14	0.13	0.87	1.33
Upper limb (arm) length	68.88	4.59	62.00	80.50	71.93	5.62	66.00	87.00
Lower limb (leg) length	83.50	5.46	74.00	97.50	84.23	4.79	77.00	93.00
Thigh circumference	48.63	4.99	41.00	59.00	46.70	4.40	40.00	56.00
Calf circumference	30.68	2.70	26.00	36.00	30.18	3.32	20.00	34.50
Arm circumference	25.03	2.46	22.00	29.00	24.35	3.17	17.00	30.50
Forearm circumference	22.10	2.13	18.00	26.00	21.93	2.28	17.50	26.50
Chest circumference – rest	74.33	6.15	66.00	86.00	74.45	6.47	63.00	89.00
Chest circumference inspir.	78.85	5.50	72.50	89.00	78.75	6.74	70.00	96.00
Chest circumference expir.	72.55	6.33	64.50	85.00	72.75	6.71	60.00	88.00
Waist circumference	66.70	6.25	55.00	77.00	65.18	5.38	55.50	76.50
Hip circumference	78.93	6.15	69.50	89.00	78.53	5.45	70.00	87.50
Shoulder width	34.58	2.24	31.50	40.00	34.15	3.91	29.00	43.00
Hip width	24.50	2.04	21.00	29.00	24.20	1.78	21.00	28.00
Chest width	24.23	1.93	21.00	28.00	26.03	3.01	22.00	34.00
Chest depth	16.23	2.98	12.00	22.00	16.13	3.86	11.00	24.00

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a simple Pearson correlation between all parameters was calculated. Finally the main somatic factors were calculated based on factor analysis. The factor analysis method applied in this research was used to determine the groups of parameters (factors) characterising the body constitution of young swimmers. We used the main factors method with Varimax rotation. This orthogonal rotation procedure improves the factors' structure. It causes the highest degree of variances of the factors (Stanisz, 1998).

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Body height	154.55	7.80	141.00	174.00	156.00	7.78	143.00	170.00
Body weight	44.17	8.10	32.00	59.00	43.48	8.47	30.00	63.50
Rohrer index	1.19	0.12	0.97	1.41	1.14	0.13	0.87	1.33
Upper limb (arm) length	68.88	4.59	62.00	80.50	71.93	5.62	66.00	87.00
Lower limb (leg) length	83.50	5.46	74.00	97.50	84.23	4.79	77.00	93.00
Thigh circumference	48.63	4.99	41.00	59.00	46.70	4.40	40.00	56.00
Calf circumference	30.68	2.70	26.00	36.00	30.18	3.32	20.00	34.50
Arm circumference	25.03	2.46	22.00	29.00	24.35	3.17	17.00	30.50
Forearm circumference	22.10	2.13	18.00	26.00	21.93	2.28	17.50	26.50
Chest circumference – rest	74.33	6.15	66.00	86.00	74.45	6.47	63.00	89.00
Chest circumference inspir.	78.85	5.50	72.50	89.00	78.75	6.74	70.00	96.00
Chest circumference expir.	72.55	6.33	64.50	85.00	72.75	6.71	60.00	88.00
Waist circumference	66.70	6.25	55.00	77.00	65.18	5.38	55.50	76.50
Hip circumference	78.93	6.15	69.50	89.00	78.53	5.45	70.00	87.50
Shoulder width	34.58	2.24	31.50	40.00	34.15	3.91	29.00	43.00
Hip width	24.50	2.04	21.00	29.00	24.20	1.78	21.00	28.00
Chest width	24.23	1.93	21.00	28.00	26.03	3.01	22.00	34.00
Chest depth	16.23	2.98	12.00	22.00	16.13	3.86	11.00	24.00

TABLE 2
Absolute values of somatic parameters of the 11 and 12 years old girls

Years	11				12			
Parameter	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Body height	151.50	6.17	143.00	165.00	159.45	7.75	147.00	179.00
Body weight	40.61	6.75	29.50	52.00	47.15	8.48	32.00	62.50
Rohrer index	1.16	0.11	1.01	1.41	1.16	0.16	0.92	1.53
Upper limb (arm) length	67.23	3.10	62.00	73.00	71.30	3.93	62.50	78.00
Lower limb (leg) length	80.98	4.37	68.00	88.50	87.00	3.80	78.50	96.00
Thigh circumference	48.38	4.17	42.00	58.00	50.70	5.80	41.50	60.00
Calf circumference	29.75	2.10	26.00	33.50	31.48	3.05	25.50	37.00
Arm circumference	23.15	2.34	19.00	27.50	24.28	2.72	19.50	29.00
Forearm circumference	20.95	1.83	18.00	24.00	21.65	1.89	18.00	25.00
Chest circumference – rest	72.40	3.92	65.00	82.00	73.75	7.07	60.00	84.00
Chest circumference inspir.	75.80	4.07	70.00	84.00	78.28	6.18	67.00	88.00
Chest circumference expir.	70.83	4.56	63.50	84.00	71.55	6.90	59.00	81.00
Waist circumference	62.63	4.72	54.00	73.00	65.53	5.17	57.00	76.50
Hip circumference	77.03	5.27	68.00	88.00	83.85	7.55	72.50	98.00
Shoulder width	33.45	2.44	30.00	38.00	34.90	2.47	31.00	40.00
Hip width	23.25	2.34	20.00	28.00	25.30	2.48	21.00	30.00
Chest width	24.20	1.46	21.00	28.00	25.15	1.79	21.50	28.00
Chest depth	14.65	2.58	12.00	20.00	17.33	3.16	12.00	21.00

TABLE 3
Normalised values of somatic parameters

Parameter	Mean	SD	Min	Max
Body height	0.04	0.93	–1.68	2.30
Body weight	–0.12	0.86	–1.57	1.94
Rohrer index	–0.23	0.77	–2.03	1.27
Upper limb (arm) length	0.31	1.19	–1.59	4.05
Lower limb (leg) length	–0.02	1.01	–1.98	2.69
Thigh circumference	0.01	0.85	–1.36	2.04
Calf circumference	–0.28	0.81	–3.10	1.22
Arm circumference	0.21	0.98	–2.46	2.23
Forearm circumference	0.22	1.03	–1.92	2.35
Chest circumference – rest	0.04	0.82	–1.46	1.96
Chest circumference inspir.	0.03	0.81	–1.14	2.32
Chest circumference expir.	0.05	0.86	–1.63	2.10
Waist circumference	0.04	0.70	–1.28	1.37
Hip circumference	–0.21	0.71	–1.35	1.06
Shoulder width	0.18	1.14	–1.77	3.31
Hip width	0.20	0.81	–1.24	2.20
Chest width	0.08	1.20	–1.78	4.09
Chest depth	–0.38	1.13	–2.09	2.21

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TABLE 2
Absolute values of somatic parameters of the 11 and 12 years old girls

TABLE 3
Normalised values of somatic parameters

TABLE 4
Correlation between all parameters

	Body height	Body weight	Rohrer index	Upper limb length	Lower limb length	Thigh circumf.	Calf circumf.	Arm circumf.	Forearm circumf.	Chest circumf.--rest	Chest circumf. inspirat.	Chest circumf. expirat.	Waist circumf.	Hip circumf.	Shoulder width	Hip width	Chest width
Body weight	0.74																
Rohrer index	-0.03	0.64															
Upper limb (arm) length	0.79	0.61	0.02														
Lower limb (leg) length	0.78	0.51	-0.12	0.74													
Thigh circumf.	0.54	0.74	0.48	0.43	0.40												
Calf circumf.	0.54	0.79	0.55	0.42	0.39	0.69											
Arm circumf.	0.52	0.82	0.63	0.47	0.29	0.80	0.76										
Forearm circumf.	0.52	0.80	0.59	0.52	0.28	0.73	0.72	0.89									
Chest circ.-rest	0.55	0.85	0.62	0.47	0.31	0.75	0.75	0.87	0.80								
Chest circ.-inspir.	0.53	0.81	0.59	0.45	0.30	0.69	0.73	0.80	0.77	0.93							
Chest circ.-expiration	0.56	0.84	0.61	0.46	0.32	0.75	0.75	0.86	0.80	0.99	0.93						
Waist circumf.	0.45	0.80	0.67	0.39	0.27	0.70	0.75	0.85	0.77	0.86	0.83	0.84					
Hip circumf.	0.65	0.85	0.52	0.56	0.51	0.77	0.79	0.80	0.73	0.84	0.80	0.84	0.82				
Shoulder width	0.64	0.70	0.33	0.67	0.50	0.61	0.56	0.69	0.73	0.67	0.64	0.67	0.56	0.66			
Hip width	0.49	0.54	0.25	0.42	0.46	0.53	0.53	0.47	0.45	0.49	0.46	0.49	0.52	0.64	0.52		
Chest width	0.48	0.67	0.44	0.49	0.29	0.55	0.60	0.64	0.62	0.71	0.69	0,69	0.67	0.65	0.61	0.46	
Chest depth	0.29	0.53	0.45	0.19	0.30	0.37	0.53	0.42	0.37	0.52	0.52	0.51	0.53	0.58	0.25	0.33	0.46

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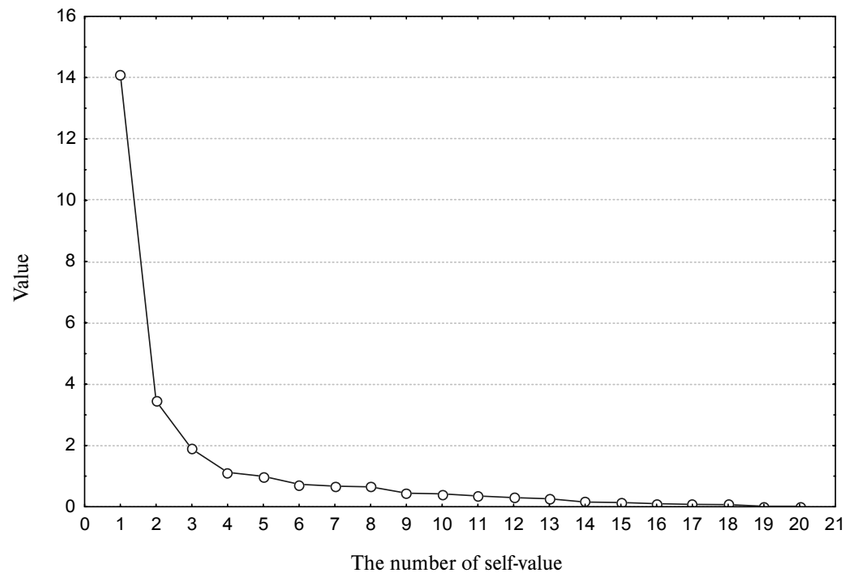
Correlation between all parameters

	Body height	Body weight	Rohrer index	Upper limb length	Lower limb length	Thigh circumf.	Calf circumf.	Arm circumf.	Forearm circumf.	Chest circumf.--rest	Chest circumf. inspirat.	Chest circumf. expirat.	Waist circumf.	Hip circumf.	Shoulder width	Hip width	Chest width
Body weight	0.74																
Rohrer index	-0.03	0.64															
Upper limb (arm) length	0.79	0.61	0.02														
Lower limb (leg) length	0.78	0.51	-0.12	0.74													
Thigh circumf.	0.54	0.74	0.48	0.43	0.40												
Calf circumf.	0.54	0.79	0.55	0.42	0.39	0.69											
Arm circumf.	0.52	0.82	0.63	0.47	0.29	0.80	0.76										
Forearm circumf.	0.52	0.80	0.59	0.52	0.28	0.73	0.72	0.89									
Chest circ.-rest	0.55	0.85	0.62	0.47	0.31	0.75	0.75	0.87	0.80								
Chest circ.-inspir.	0.53	0.81	0.59	0.45	0.30	0.69	0.73	0.80	0.77	0.93							
Chest circ.-expiration	0.56	0.84	0.61	0.46	0.32	0.75	0.75	0.86	0.80	0.99	0.93						
Waist circumf.	0.45	0.80	0.67	0.39	0.27	0.70	0.75	0.85	0.77	0.86	0.83	0.84					
Hip circumf.	0.65	0.85	0.52	0.56	0.51	0.77	0.79	0.80	0.73	0.84	0.80	0.84	0.82				
Shoulder width	0.64	0.70	0.33	0.67	0.50	0.61	0.56	0.69	0.73	0.67	0.64	0.67	0.56	0.66			
Hip width	0.49	0.54	0.25	0.42	0.46	0.53	0.53	0.47	0.45	0.49	0.46	0.49	0.52	0.64	0.52		
Chest width	0.48	0.67	0.44	0.49	0.29	0.55	0.60	0.64	0.62	0.71	0.69	0,69	0.67	0.65	0.61	0.46	
Chest depth	0.29	0.53	0.45	0.19	0.30	0.37	0.53	0.42	0.37	0.52	0.52	0.51	0.53	0.58	0.25	0.33	0.46

TABLE 5
Self-values of the principal components

	Self-values	Percent of the all variance	Cumulated self-values	Cumulated percent
Factor 1	13.24	52.95	13.24	52.95
Factor 2	3.45	13.78	16.68	66.73

Fig. 1
"Scree chart" with values of all factors



The first factor identifies about 53% of variability in the group of analysed parameters. The second factor identifies more variability. Its value was about 67%.

Good representation of the original basic correlation matrix between parameters was shown by remnant correlation (disparity between correlation coefficients in the input matrix and correlation calculated on the base of factors' values).

Disparities mentioned above were not significant thus the swimmer's body built described by two separated components is satisfactory.

In the next step the factor's structure – factors linked with input data – was defined by means of correlation of the parameters given with the factor. Due to the description of factors, factor loads were calculated (correlation of separated factors with original data). First factor loads without system rotation were calculated (before optimalisation – factor loads strength increase). The varimax rotation was applied to factor structure improvement (TABLE 6).

Factor 1 is a combination of: body weight, Rohrer index, circumferences of the calf, forearm, chest, waist and extremities. This factor was called cubic content. It describes body morphology of swimmers better than factor 2 what is proved by previously described values and the percentage of variability explained.

Factor 2 is a combination of three parameters: body height, upper and lower extremity length. All those traits are length parameters indicating vertical values of the entire body. This factor was called vertical dimension. Fig. 2 illustrates factors' structure.

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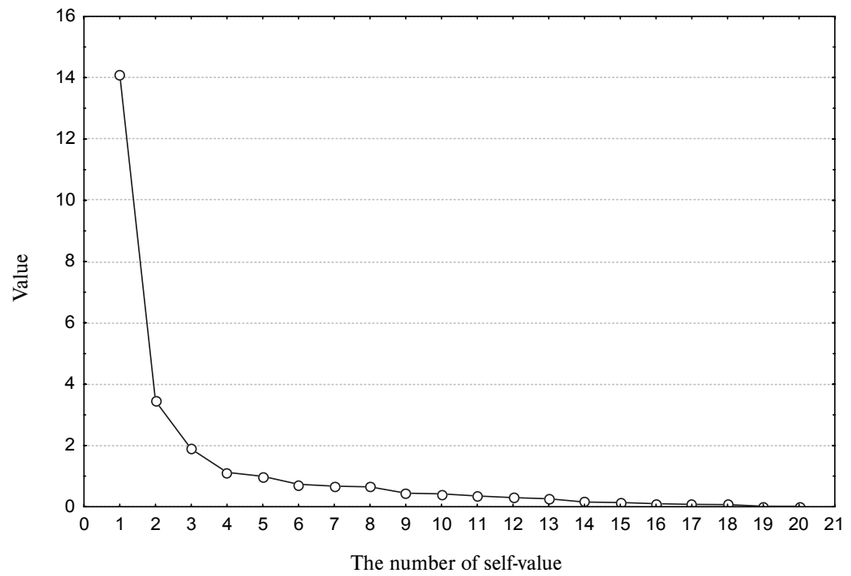

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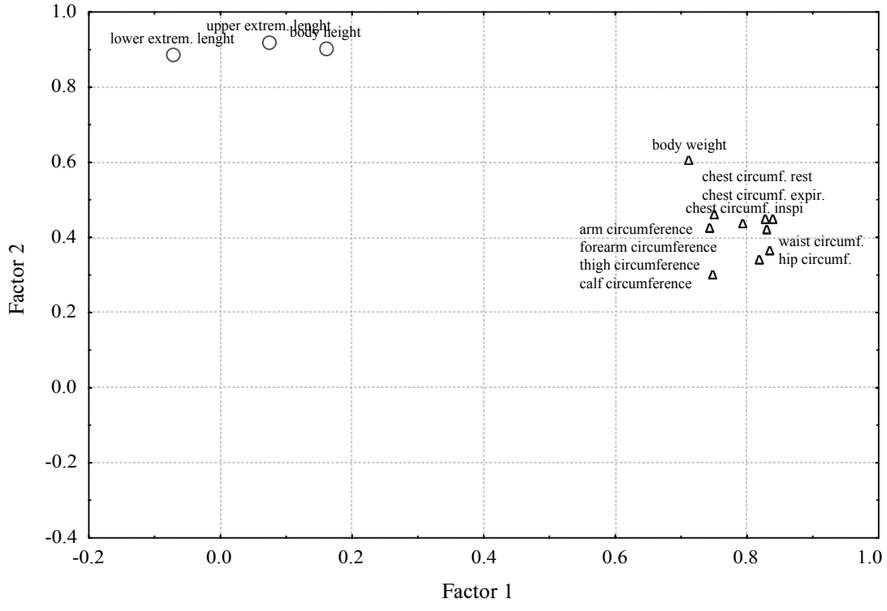
TABLE 6
Factorial load values after Varimax rotation (statistically significant factor loads are bold)

	Factor 1	Factor 2
Body height	0.16	**0.90**
Body weight	**0.71**	0.60
Rohrer index	**0.88**	–0.13
Upper limb (arm) length	0.07	**0.92**
Lower limb (leg) length	–0.07	**0.89**
Thigh circumference	0.67	0.48
Calf circumference	**0.75**	0.42
Arm circumference	**0.83**	0.42
Forearm circumference	**0.75**	0.46
Chest circumference – rest	**0.84**	0.45
Chest circumference inspiration	**0.80**	0.43
Chest circumference expiration	**0.83**	0.45
Waist circumference	**0.84**	0.36
Hip circumference	0.69	0.60
Shoulder width	0.45	0.69
Hip width	0.36	0.55
Chest width	0.59	0.48
Chest depth	0.52	0.24

Fig. 2
Factors' structure after Varimax rotation



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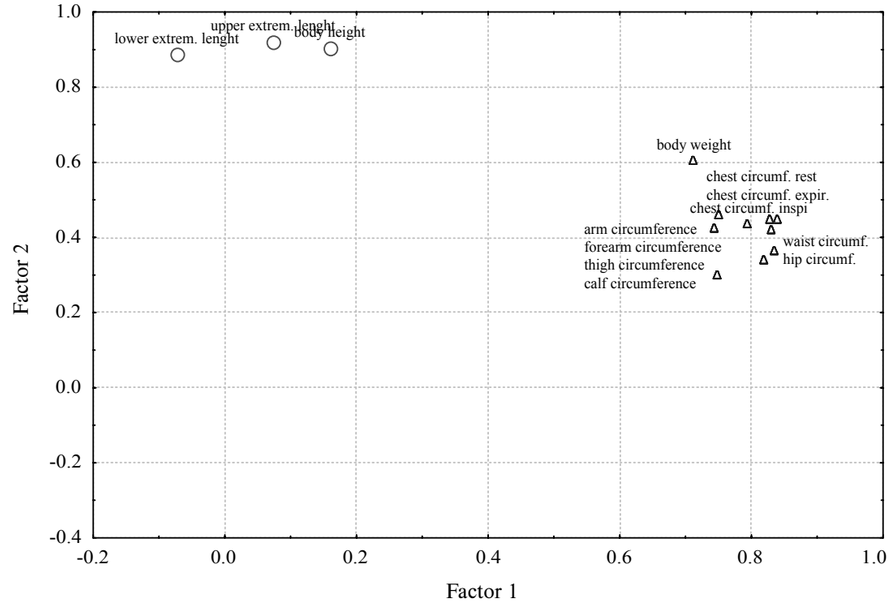
Chest circumference inspiration	**0.80**	0.43
Chest circumference expiration	**0.83**	0.45
Waist circumference	**0.84**	0.36
Hip circumference	0.69	0.60
Shoulder width	0.45	0.69
Hip width	0.36	0.55
Chest width	0.59	0.48
Chest depth	0.52	0.24

Fig. 2
Factors' structure after Varimax rotation



DISCUSSION

Beneficial effects of intense physical activity have been described by lots of authors who emphasise that swimming is a form of a physical activity having a positive influence on the cardiovascular and respiratory systems (Dziedziczak & Witkowski, 1988; Ostrowska et al., 2001). A young body is flexible and susceptible to various stimuli, which exceed the limits of biological tolerance of the body and are inadequate for the level of development of somatic and motor capacities of a child, and may affect the processes of body growth and maturation. Numerous studies carried out on groups of young sportsmen engaged in various sport disciplines (swimming, gymnastics, team games, tennis, etc.) show divergent views concerning the impact of high-performance sports on physical development and the age, when the body becomes mature (Baxter-Jones et al., 1995). It has been proved that among sportsmen, who began training in the pre-puberty period, swimmers show the most rapid development of sex characteristics. It applies to both boys and girls (Malina et al., 1982; Damsgaard et al., 2001). However, the majority of authors report that swimming training does not disturb the puberty period (Courteix et al., 1997) and does not inhibit physical development (Baxter-Jones et al., 1995), including height increase, which, to a large degree, is dependent on the genetic traits inherited from their parents (Malina et al., 1982).

The issue of a proper selection of children and youth for high-performance sports training has been studied by many authors (Bartkowiak, 1988; Łaska-Mierzejewska et al., 1985; Piechaczek et al., 1995). The main point here is the age at which the training has begun and defining the criteria, which allow us to confirm the suitability of candidates for a specific sport discipline based on their individual somatic features, motor skills, physical fitness, and other characteristics (Knop, 1996). Somatic features are an important factor conditioning an achievement in sports (Siders et al., 1993) and are one of the elements taken into consideration during the candidate selection process. The method of factor analysis used in our studies allowed, selecting from a large set of somatic features, only two groups of features demonstrating the most significant discriminating power for swimmers (Łaska-Mierzejewska, 1980; Ohlen et al., 1989). Although changing of these parameters may be an effect of training changes, the selection effect cannot be excluded.

In general, the results obtained by many authors show higher values of height and weight of children training (Ostrowska et al., 2001; Courteix et al., 1997; Benefice et al., 1990; Duche et al., 1993). The results of our studies only partially confirmed these observations. Because basic somatic traits are on the basis of two factors. These factors we called vertical dimension and cubic content, suggesting that the most important in swimming sport are length parameters connected with a better range of swimming movements in the pool and cubature (including body weight, muscles and chest circumferences), indirectly informing about vital capacity and circular-respiratory system efficiency.

CONCLUSIONS

1. The method of factor analysis is an efficient tool for characterising somatic parameters among swimmer children.
2. The analysis of 18 somatic parameters allows us to separate two factors of body morphology:
   a) the cubic content (including body weight, muscles, trunk and upper and lower extremities circumferences),
   b) vertical dimension (including body height and upper and lower extremities' lengths).
3. These traits should be used in training process estimation and check-up after training changes, as well as sport selection.

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FAKTOROVÁ ANALÝZA ANTROPOMETRICKÝCH CHARAKTERISTIK U MLADÝCH PLAVCŮ VE VĚKU 11 A 12 LET

(Souhrn anglického textu)

Cílem této práce bylo popsat vybrané somatické charakteristiky typické pro mladé plavce. Faktorová analýza umožnila úměrné snížení somatických ukazatelů a umožnila vypočítat hlavní strukturální faktory typické pro mladé plavce. Do výzkumného souboru bylo zařazeno 80 žáků (11 a 12letých) přijatých ke studiu na základní sportovní škole ve Wroclawi. Sledovaní probandi trénovali po dobu 2–3 let a jejich průměrný tréninkový čas byl 12 až 18 hodin týdně. Byly měřeny následující parametry: tělesná výška a hmotnost, délka horních a dolních končetin, obvod stehen, lýtka, paží, předloktí, hrudníku v klidu, hrudníku po nádechu a po výdechu, obvod pasu a boků, šířka ramen, šířka boků, šířka hrudníku, hloubka hrudníku a Rohrerův index. K dosažení cíle této studie byla použita metoda faktorové analýzy. Analýza výsledků ukázala, že pouze některé zvláštnosti mezi sledovanými parametry jsou pro mladé plavce charakteristické. Jsou spojeny do 2 trsů somatických charakteristik: kubický obsah (zahrnuje tělesnou hmotnost, svalstvo, trup a obvod horních a dolních končetin) a vertikální rozměr (zahrnuje tělesnou výšku a délku horních a dolních končetin). Tyto parametry signalizují formování postavy typické pro plavce, charakteristické specifickými proporcemi tělesné hmotnosti a výšky, hrudníku a boků a obvykle delšími končetinami. Výsledky naznačují, že antropometrické charakteristiky

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lze použít pro optimalizaci tréninkového procesu mladých plavců.

Klíčová slova: morfologie, somatické rysy, faktorová analýza, plavání.

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PERCEPTION OF COLOURS BY MENTALLY-HANDICAPPED PUPILS

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The following article attempts to utilize general knowledge of colours in the sphere of physical culture and applies it to physical education in special schools. It is based on the precondition that education of mentally-handicapped pupils should proceed under conditions evoking pleasurable feelings in them. And such conditions also include colours.

The article presents the results of an examination of colour preference in probands with slight to moderate mental handicaps. The results show that probands with a slight mental handicap tend to be sensitive in relation to colours, even in their abstract form. They prefer blue, respectively green and red, and they have difficulties with perception of black and violet. The favourite colour preference in probands with a more serious mental handicap is more variable than in probands with a slight mental handicap.

Keywords: Colour, physical education, mental handicap, pupil.

INTRODUCTION

During the perception of objective reality that surrounds us the most important thing is the visual analyser with the help of which we receive approximately 84% of all information (Cibulka, 1980; Bohony, 1984). Visually we perceive not only the shape and movement of objects but also colours in all the spectrum. Perception of colours is innate to the human eye. Perception of colours is allowed by the ability of the human eye to distinguish different wave-lengths of light. In colours we perceive nature as well as the products of civilization. Colours influence our mood and state of mind. Some colours provide energy to us, stimulate us, some are repelling. There are pleasant colours and there are irritating colours, and according to C. G. Jung "emotional" individuals react to them strongly (Pleskotová, 1987). There really exists a special relationship between colours and our feelings, as researched by psychology and psychiatry (Veverková, 2002). At the same time psychology researches also the psycho-physical aspects of colour perception and the symbolic value of colours.

Dr. Max Lüscher (Swiss psychologist, born 1923) defined the following basic colours: blue, green, red and yellow. Their combination creates a number of other colours. Interpretation of primary and derived colours appears to be significant for our intentions on the level of presentation of research results allowing eventual comparison with results of other research projects. Lüscher (1990) has determined the following colour perception:

Blue – retards and balances neural processes, sedates skeletal muscles. It develops ease because it reduces blood pressure, pulse and respiratory rate, and the regeneration mechanisms bring energy to the body. This colour presents appurtenance, aims towards empathy and meditative consciousness.

Green – stimulates parasympathetic division and therefore smooth muscles. It develops tension. The physiological condition of the organism is alert to resistance. Preference of this colour denotes the expression of strength and resistance against changes. It is indicative of uniformity of opinion and emphasis on "myself". In relation to emotional content, it is primarily about pride and a sense of power and superiority.

Red – stimulates parasympathetic division and activates skeletal muscles. It represents the physiological condition of the expenditure of energy, accelerates the pulse, increases both blood pressure and the pulse rate. It is related to all forms of vitality and power, its emotional content is desire and passion.

Yellow – relieves and affects both subsystems of nervous system. It expresses undampened expansiveness, develops relaxation, increases blood pressure, as well as pulse and respiratory rate, but this process is unstable. Its emotional content is "volatility full of hope".

If we use another criterion, we can divide the colours into primary: red, yellow, blue; and secondary: orange, green and violet. Tertiary colours are mixtures of primary and secondary – green-blue, etc. Pleskotová (1987) treats the following colours as primary: blue, red, green, yellow, orange, violet, brown, black, white. The fact is that the English Dictionary of Colours (1955) contains

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PERCEPTION OF COLOURS BY MENTALLY-HANDICAPPED PUPILS

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Submitted in October, 2005

The following article attempts to utilize general knowledge of colours in the sphere of physical culture and applies it to physical education in special schools. It is based on the precondition that education of mentally-handicapped pupils should proceed under conditions evoking pleasurable feelings in them. And such conditions also include colours.

The article presents the results of an examination of colour preference in probands with slight to moderate mental handicaps. The results show that probands with a slight mental handicap tend to be sensitive in relation to colours, even in their abstract form. They prefer blue, respectively green and red, and they have difficulties with perception of black and violet. The favourite colour preference in probands with a more serious mental handicap is more variable than in probands with a slight mental handicap.

Keywords: Colour, physical education, mental handicap, pupil.

INTRODUCTION

During the perception of objective reality that surrounds us the most important thing is the visual analyser with the help of which we receive approximately 84% of all information (Cibulka, 1980; Bohony, 1984). Visually we perceive not only the shape and movement of objects but also colours in all the spectrum. Perception of colours is innate to the human eye. Perception of colours is allowed by the ability of the human eye to distinguish different wave-lengths of light. In colours we perceive nature as well as the products of civilization. Colours influence our mood and state of mind. Some colours provide energy to us, stimulate us, some are repelling. There are pleasant colours and there are irritating colours, and according to C. G. Jung "emotional" individuals react to them strongly (Pleskotová, 1987). There really exists a special relationship between colours and our feelings, as researched by psychology and psychiatry (Veverková, 2002). At the same time psychology researches also the psycho-physical aspects of colour perception and the symbolic value of colours.

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7500 separate colours and states their unique definition (http://aitie.scssoft.com/colours/colours.html). This frequency is caused by the fact that colours can be differentiated not only as to their tint (shade) but also value and saturation (Veverková, 2002).

Perhaps the best known classification of colours is from the point of view of their effect on physiological functions (the effect can be proven by measurement) (Pleskotová, 1987). This classifies colours into warm/hot and cool/cold colours.

Warm colours – yellow, orange, red – evoke one's temper and orient it to life and motion. They incite activity, stimulate the function of the vegetative nervous system, and increase blood pressure.

Cool/cold colours – violet, blue, green – are rather sedative, they damp physiological functions.

Colours are significant even in the sphere of physical culture. Based on experience, let us try to outline the characteristics of the function of colours in the sphere of physical culture:

- Colour serves as a group-uniting attribute, which consolidates the consciousness of appurtenance (colour of sports uniforms, etc.).
- Colour has an emphasizing function (lines on the playing-field, colour of the playing-field, referee's outfit, cards and flags, etc.).
- Colour represents tradition (e.g. club colours).
- The colour of sportswear influences the environment as well as the wearers themselves, who lose anonymity and are differentiated from others. For example, during the Olympic Games in Athens (2004) the matches in boxing, Greek-Roman wrestling and free-style wrestling, without a known favourite, were usually won by sportsmen in red sports clothing. Similar results were found by anthropologists also in football games during the World Cup where five teams won more often if they were wearing red uniforms rather than blue or white uniforms (Vinař, 2005).
- Colour has a motivational function. The colour of equipment, requisites, or of the sports area catches or distracts the attention of the gymnast, motivating or dissuading the gymnast from his or her activities. It is obvious that a pleasant, colour-balanced environment tunes one's spirit to pleasant ease.
- Colour carries an aesthetic function as most processes and phenomena realized within physical education, sports and recreation are accompanied by aesthetic aspects (Chlup, 1963; Hohler, 1981). It is possible to mention as an example the choreography of mass appearances with the use of colours of clothing. In some sports disciplines, aesthetic impression is part of the ranking and naturally the factor of colours chosen is important.

In physical education at school the situation is quite different. It looks like the dignity of the educational facilities – schools – excludes sharp colouring of the respective areas and instruments. Typical colours of most old gymnasiums and playgrounds have been brown and grey. According to Lüscher (1990), brown evokes the need for safety and physical comfort, and grey is preferred by persons longing for standing aside, separated from bonds. The above indicates that brown and grey go against sports activities and respective experiences.

However, in recent years there is a tendency towards more colourful choices even in physical education at school. In our opinion, the introduction of diverse colours to gymnasiums is a lawful requirement. But on the other hand, a strict application of the theory of colours to the environment of physical education at school may be fancy but not efficient. This implication holds the more true the more we concentrate on physical education of pupils with mental handicaps. In the case of such pupils, it is predominantly the emotional aspect of their personality that governs their attitudes and behaviour. Experiences with a biological basis in the feeling of pleasure and excitement are very important motivational factors for mentally-handicapped pupils. The above implies that the pupils are captivated by and bear relation to matters evoking in them pleasurable feelings, and vice versa. In the case of mentally-handicapped pupils, there is another important factor at play, the primary controlled conformity (grass is always green, the sky is a symbol of blue, yellow is identified with the sun). Therefore we believe that together with the functionality of colours in the sphere of physical education, also the notions of the pupils should be respected, i.e. which colours they prefer and which they hate.

RESEARCH OBJECTIVE

The research project, the results of which are presented here, was oriented to ascertaining preference of colours in relation to experiences and feelings of pupils with mental handicaps.

We put the following research question:

How do mentally-handicapped pupils perceive particular colours in the environment of physical education?

a) The first research project was carried out in a group of 72 boys with a slight mental handicap, pupils of special schools (13–15 years). The research was carried out using questionnaires administered under the direct supervision of a researcher. Each question had nine possible answers: a range of nine colours differentiated by tint, while keeping approximately the same saturation and value of colour (Fig. 1). The range of colours consisted of the basic range of colours according to Pleskotová (1987).

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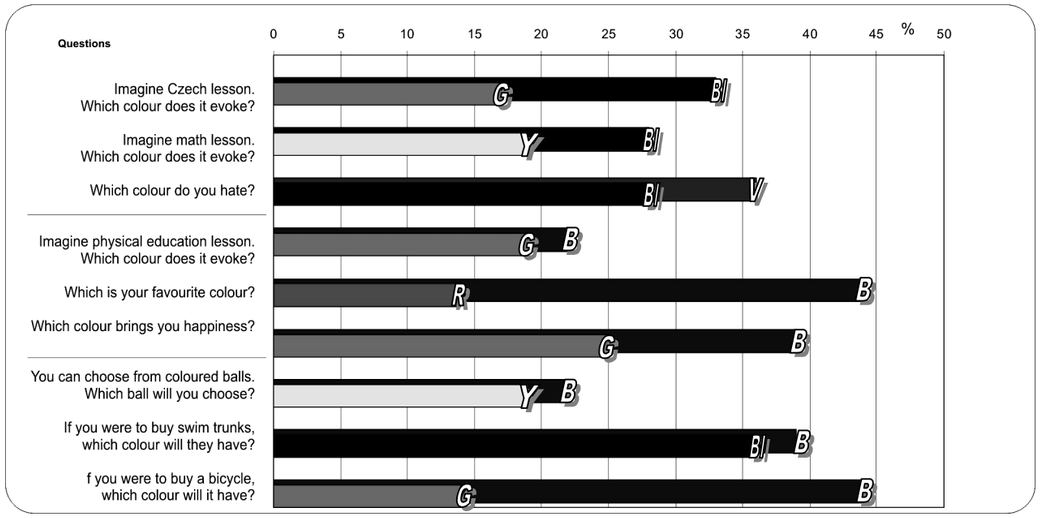
b) The second research project was carried out with the participation of 153 probands, boys with moderate mental handicaps (18–50 years). The research in this group of probands was focused only on ascertaining their preferred colour. The method was as follows: the probands could choose from clothes pins in nine colours of the basic colours range (Pleskotová, 1987). The probands were asked to choose the pin they liked the most. Clothes pins were chosen because the probands know them as a training instrument from the psycho-motoric program. The said method was used because the probands cannot read and write and they do not know the names of the colours.

RESULTS AND ARGUMENTATION

Results and argumentation about the research in probands with a slight mental handicap

We chose answers to nine questions from the questionnaire applied in the first research group. The answers of the probands to the separate questions in percentage formulation are presented in Fig. 1. We present two colours, which were the most frequent in the answers.

Fig. 1
Percentage of answers in probands with a light mental handicap



Legend:
B – blue *Y – yelow*
R – red *V – violet*
G – green *Bl – black*

The first three questions are oriented to ascertaining nonfavoured colours of the probands, based on the expectation that lessons in Czech language and mathematics are not their favourite ones. At the same time the questions are aimed at the sphere of abstract colour perception. The fact that perception of colours in the intact population is influenced by the associations and experiences of each individual, and vice versa, has been proven by several researchers (Wexner, 1954 and Lawler & Lawler, 1965 in Veverková, 2002). Our research implies that pupils with a slight mental handicap perceive colours, even in their abstract form. After expressing a concrete phenomenon known to them, they are able to assign to it emotionally-evoked colour meaning. Mathematics and Czech lessons (Fig. 1) are connected in their minds mostly with the colour black. Pogády (1993) and Šicková-Fabrici (2002) call attention to the fact that black in this context signals problems and sadness. It is therefore very probable that mathematics and Czech language are lessons, in which pupils with a slight mental handicap experience feelings of failure. Generally it is possible to state that the colour black relates to a pro-

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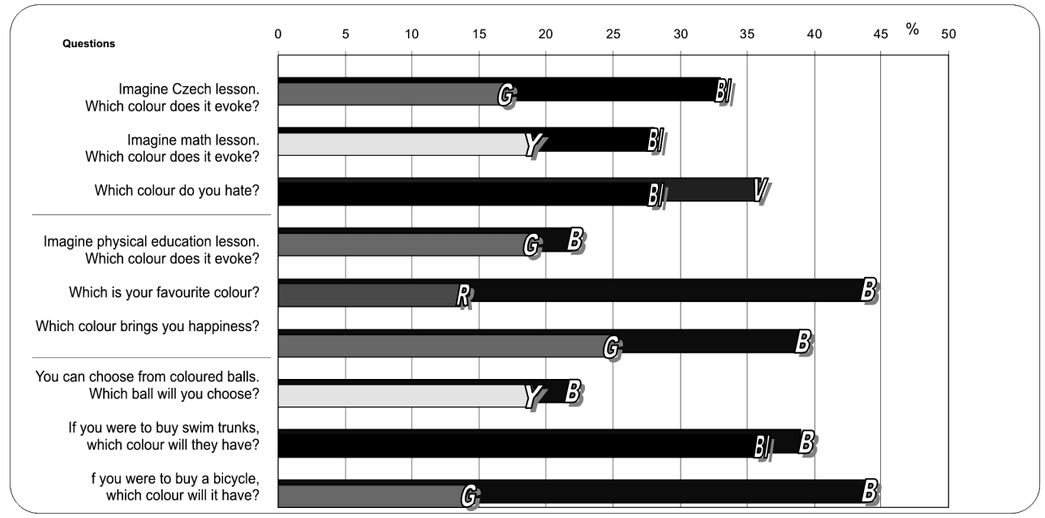

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test against the given conditions, and individuals under the affective influence of the colour black tend to revolt and act in haste. According to the conception of the probands, black evokes darkness, death, "I am afraid", "it brings worse luck", "I can't see in darkness", etc. In connection with mathematics, also the colour yellow is mentioned. This finding is in line with Šicková-Fabrici (2002), stating that yellow is the colour of thinkers and supports one's intellectual capacity. Unfavourable colours are dominated by black and violet. The colour violet is justified by the probands as follows: it is too rich, it is annoying, and it is worn by women. This finding is the absolute opposite of Lüscher's statement (1990) that violet is preferred by mentally and emotionally immature persons.

The next three questions in the questionnaire are aimed at favourite colours, on condition that lessons of physical education belong among students' favourite school subjects. It is evident (Fig. 1) that probands clearly prefer the colour blue. This finding differs from the results of research in boys above 10 years of age of the intact population (Pogády, 1993) where the colour blue ranks fourth in the order of popularity (red, green, yellow and blue). Blue is a colour of peace and harmony but also of cold, feelings of solitude, being in the dumps and distance. If blue is preferred and if it does not indicate the compensatory mechanism within the meaning of peace, then it indicates, according to Lüscher (1990), inner balance or the wish to reach such a condition. Another favourite colour is green. Green is comforting, refreshes mind and soul, and provides strength and resistance against external effects. In Lüscher's test (1990) persons preferring this colour need to attain a feeling of self-esteem by self-assertiveness or acknowledgment by others. It is selected by stubborn and less adaptable persons (Pleskotová, 1987; Puchnarová, 2005). Less than 15% of probands prefer the colour red. Red gives strength to a person, as well as dynamics and an appetite for life. Red is preferred by hyper-active and aggressive children (Šicková-Fabrici, 2002).

The last three questions ascertain the preference of colours by probands in the context of sports instruments and sportswear (Fig. 1). This part is also dominated by the colour blue, most probands wanted a blue ball, a blue swim suit as well as a blue bicycle. According to Puchnarová (2005) blue is preferred by the credulous, complaisant and helpful, it is a valuable source of help in the life of stressed and restless people. Approximately 30% of probands would select a black swim suit. A number of mentally-handicapped pupils cannot swim (Karásková, 2001), and the selection of the colour black can implicitly signal a fear of staying in the water. The possibility of the influence of fashion trends is irrelevant in the probands.

Results and argumentation about the research in probands with a moderate mental handicap

The results of research in the area of preferred colours in the second group of probands with a moderate mental handicap is presented in Fig. 2. It is not possible to state an unambiguous preference of cool or warm colours in this group of probands. The ascertained quantitative representation of colour preference shows higher inter-individual variability than in probands in the first group. In contrast to probands with a slight mental handicap, the individual preference of colours is divided between all colours of the basic range. This huge lack of homogeneity in the preference of colours in the probands is probably the factor complicating innovation activities of physical education teachers in this field. Even if probands from this group prefer blue, even more of them, almost 30%, like red the most. However, we suppose this finding is caused by the fact that red draws the attention of the proband with a moderate mental handicap the most. Red has a shorter wavelength and travels to the human eye faster than blue, for example (Vinař, 2005; Puchnarová, 2005). In pupils with a moderate mental handicap this can be the reason for conformity with objects evoking pleasant feelings (red as an apple, strawberry, etc.).

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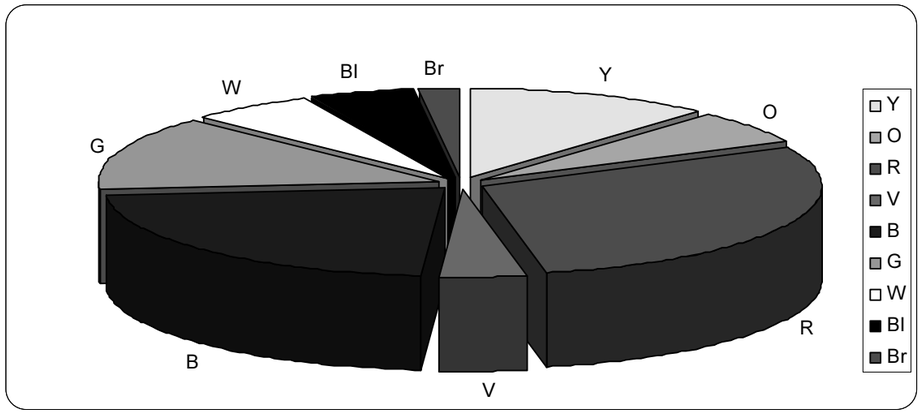
Fig. 2
Favourite colours in probands with medium-heavy mental handicap



Legend:
B - blue colour *O - orange*
R - red *V - violet*
G - green *Bl - black*
Y - yellow *Br - brown*

CONCLUSION

We are aware of the fact that the results of this research cannot be generalized, because of: the low number of probands in the research groups, non-standard experimental conditions, dependence of experiencing the colours on the proband's personality, e. g. if they relate yellow to the sun, they will have pleasant feelings, if they relate this colour to jaundice, they will have unpleasant feelings (Pleskotová, 1987). Therefore we take a critically-confidential approach to the findings, and our opinion is formulated within the meaning of the following tendencies:

- Probands with a slight mental handicap tend to perceive colours sensitively, even in their abstract form.
- It is not possible to state if warm or cool colours are of different importance in mentally-handicapped probands.
- It seems that probands with a slight mental handicap connect the affective content in the context of identical colour similarly to intact population individuals.
- Mentally-handicapped probands prefer most commonly blue, green, and red, and they have difficulty accepting black and violet.
- The preference of favourite colours is more variable in probands with a moderate mental handicap than in probands with a slight mental handicap.

The education of mentally-handicapped pupils should proceed under conditions evoking pleasurable feelings in them. Such conditions also involve colouring. The concept that pupils are primarily captivated by the content of physical education is not true. If we know the preference tendencies in pupils within the sphere of colours, let us try and respect this fact. Its use will support especially pedagogical objectives, not only within physical training but also within the whole educational effort.

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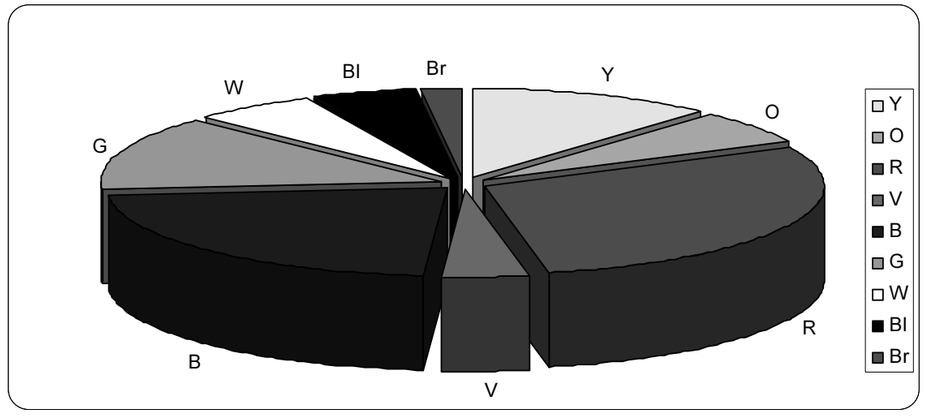

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Y - yellow *Br - brown*

CONCLUSION

We are aware of the fact that the results of this research cannot be generalized, because of: the low number of probands in the research groups, non-standard experimental conditions, dependence of experiencing the colours on the proband's personality, e. g. if they relate yellow to the sun, they will have pleasant feelings, if they relate this colour to jaundice, they will have unpleasant feelings (Pleskotová, 1987). Therefore we take a critically-confidential approach to the findings, and our opinion is formulated within the meaning of the following tendencies:

- Probands with a slight mental handicap tend to perceive colours sensitively, even in their abstract form.
- It is not possible to state if warm or cool colours are of different importance in mentally-handicapped probands.
- It seems that probands with a slight mental handicap connect the affective content in the context of identical colour similarly to intact population individuals.
- Mentally-handicapped probands prefer most commonly blue, green, and red, and they have difficulty accepting black and violet.
- The preference of favourite colours is more variable in probands with a moderate mental handicap than in probands with a slight mental handicap.

The education of mentally-handicapped pupils should proceed under conditions evoking pleasurable feelings in them. Such conditions also involve colouring. The concept that pupils are primarily captivated by the content of physical education is not true. If we know the preference tendencies in pupils within the sphere of colours, let us try and respect this fact. Its use will support especially pedagogical objectives, not only within physical training but also within the whole educational effort.

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VNÍMÁNÍ BAREV ŽÁKEM S MENTÁLNÍM POSTIŽENÍM

(Souhrn anglického textu)

Předložená stať se pokouší o využití obecných poznatků o barvách v oblasti tělesné kultury a aplikuje je na tělesnou výchovu v podmínkách speciálních škol. Vychází z předpokladu, že vzdělávání žáků s mentálním postižením by mělo probíhat za podmínek, které v nich evokují libé pocity. A k těmto podmínkám patří i barevnost.

Jsou prezentovány výsledky šetření preference barev probandy s lehkým a středně těžkým mentálním postižením. Výsledky naznačují, že probandi s lehkým mentálním postižením mají tendenci citlivě vnímat barvy, a to i v abstraktní podobě. Preferují modrou, případně zelenou a červenou barvu a hůře přijímají černou a fialovou. Preference oblíbené barvy je u probandů s těžším mentálním postižením více variabilní než u probandů s lehkým mentálním postižením.

Klíčová slova: barva, tělesná výchova, mentální postižení, žák.

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ACTA
UNIVERSITATIS PALACKIANAE OLOMUCENSIS
GYMNICA

Vol. 36 No. 1

Published by Palacký University, Olomouc 2006

Preparation and arrangement before print: Mgr. Zuzana Hanelová & Iva Tezzelová
Technical Editor and graphic arrangement: Jitka Bednaříková

Electronic form available on address: http://www.gymnica.upol.cz

ISBN 80-244-1398-1
ISSN 1212-1185

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