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Sincere congratulations!



to Antonin Rychtecky,

member of editorial board of the journal “Education. Physical Training. Sport”, professor in Charles University of Prague, on the 60-year anniversary.



to Gintautas Stasiulevičius,

associated professor at the Department of Sports Games, Lithuanian Academy of Physical Education on the 70-year anniversary!

*We wish our celebrants good health, success, happy and creative year.
Let Your achievements and future plans be the source of unspent energy and joy.
Let Your work always be meaningful, purpose — ever achievable!*

Editorial Board

LITHUANIAN ACADEMY OF PHYSICAL EDUCATION

In front of you there is a new issue of our journal “*Education. Physical Training. Sport*” and this issue has a special purpose to introduce the readers from other countries with the scientific researches and their results of the Lithuanian Academy of Physical Education (LAPE). By this we would like to invite sports scientists from other countries to join us and become the authors and co-authors of scientific papers printed in this journal. It is important to all of us because sports science as an interdisciplinary science integrates knowledge, and from the practical aspect, a sports scientist will be increasingly integrated into interdisciplinary teams working with other professionals. There is no doubt that our cooperation will create better conditions for practical applications of sports science’s knowledge by promoting integration and further development.

Many countries have specialized universities, but their function are the same as classical ones. Lithuania is not an exception. The origin of the LAPE began when the Higher Courses of Physical Education (HCPE) were set up in 1934 offering a higher education degree. The HCPE were founded with the idea to conciliate such subjects as body exercises and military training so that the graduates would be able to teach these two subjects in gymnasiums. The HCPE were closed in 1938 and their role was taken by the Department of Physical Education established in Vytautas Magnus University. As an independent institution — the Lithuanian Institute of Physical Education (LIPE) was founded in 1945 and the Institute was renamed into the Academy in 1999. Since its foundation the LAPE has trained over 9000 teachers of physical education, highly-skilled sports coaches, specialists in physiotherapy, health education, adapted physical education and sport as well as in tourism and sports management. A great number of the LAPE graduates have become champions and prize-winners of the Olympic Games, world and European championships.

From its very beginning the LAPE remains the only higher education institution in the field of physical education and sport in Lithuania. The Lithuanian Academy of Physical Education is a university-type higher education institution where more than 2600 students are enrolled. The teaching staff includes 172 lecturers among whom there are 14 Professors, 68 Associate Professors, 49 Assistants, 41 working for Doctor’s degree. The Academy has 3 faculties, 14 departments and 5 research laboratories or centres.

Students willing to extend their knowledge are offered doctoral studies continuing for 4 years. In 1997 the Lithuanian Government ratified new scientific classification and thus Sports Science received accreditation. During the last five years 31 doctoral dissertation was defended. At present there are 38 doctoral students.

Sports science represents a system of scientific research, teaching and practice to which knowledge from other disciplines is integrated. It is the purpose and function of sports science to investigate questions, which have been identified as questions on scientific basis. Finally, found solutions have to be applied in order to explain, control and, if necessary, change practice of sport. The LAPE’s scientists conduct joint research projects with foreign scientists from Belgium, Denmark, Norway, Sweden, Poland, Germany, Spain, the UK and the USA. Laboratories and research centres work on the development of new scientific methodologies and their application in sports practice. The new frontier is in the development of solutions based on the integrating Sciences of Complex Systems, Non-Linear, Dynamic and Self-Organizing Systems, Chaos Theory and Synergetics.

Five research laboratories and centres are functioning at the Academy at present:

- **Human Motorics** — motorika@lkka.lt
- **Elite Athletes** — srvl@lkka.lt
- **Social Problems in Physical Education and Sports** — spl@lkka.lt
- **Kinesiology** — kineziologija@lkka.lt
- **Research Centre for Assessment of Human Physical Abilities** — zfgtc@lkka.lt

The research origin is cooperative. The science development is performed by the knowledge accumulation from different sources and it is the mostly evident in sports science. The best results are achieved when researchers with different interests and with different knowledge can work together and exchange data and ideas. The possibilities for cooperation in the solution of various sports science’s problems are numerous and research scope is very wide.

By this special issue of journal we would like to invite sports scientists from other countries to join us and become partners in the performance of joint research projects, be the authors and co-authors of scientific papers printed in this journal.

Associate Editor-in-Chief Professor Jonas Poderys

PHYSIOLOGICAL RESPONSES DURING COMPETITIVE SPORTS AEROBICS EXERCISE

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ABSTRACT

The aim of this study was to characterize heart rate (HR), oxygen uptake and pulmonary ventilation during competitive aerobic gymnastics routine in a group of elite women athletes. The subjects were Lithuanian aerobic women gymnasts, members of national team (21.6, 4.4) years old). All subjects performed a maximal incremental treadmill test in the laboratory and competitive aerobic gymnastics exercises in group category. Heart rate was continuously recorded using the heart rate measurement equipment Polar ACCUREX-Plus. During the incremental treadmill test HR deflection point and other parameters of aerobic capacity were determined from the relationship of HR to running speed. During the aerobic gymnastics routine pulmonary gas exchange parameters and heart rate were continuously measured using the telemetric equipment Cortex 3B. The changes of HR, minute ventilation and oxygen uptake were analyzed by adopting monoexponential function.

The results showed that HR values during the competitive aerobic gymnastics routine were higher than HR break point which is near the lactate accumulation threshold (reaching 95.2 (4.2)% of maximal HR). Oxygen uptake during competitive routine reached 81.3 (5.8)% of maximal oxygen uptake. Rather high blood lactate accumulation (7.50 mmol / l) at the third minute after exercise show the high intensity of exercise. These results allows us to consider that aerobic gymnastics is a sport with high cardiorespiratory and metabolic demands, in which aerobic and anaerobic sources are intensely activated.

Keywords: *aerobic gymnastics, aerobic capacity, pulmonary gas exchange, lactate, heart rate deflection point.*

INTRODUCTION

Aerobic gymnastics became a member of the gymnastics family, and thus of the International Gymnastics Federation in 1994. This new kind of sport increased in popularity after 1st Sport Aerobics World Championship, which was held in Paris, in 1995. The competition in aerobic gymnastics includes the routine lasting on average 1 min 45 s. It is a sport with the unique structure of the routine, with a different degree of difficulty elements, complex movements patterns and steps in linking to music. All the time a participant must move in time following the beat of music and musical phrases, it

means — without any phase of rest. All movements, including difficulty elements, must be performed with correct posture and with body alignment (neutral alignment without hyperextension of joints).

The physiological responses of aerobic gymnastics exercise have not yet been widely studied. Only one short study has been published describing physiological characteristics of aerobic gymnasts and physiological responses during competitive routine (Rodriguez et al., 1998). Currently measurements of pulmonary gas exchange and heart rate can be continuously

obtained using telemetric systems (Schulz et al., 1997; Maiolo et al., 2003) and metabolic profile based on the measurement of the blood lactate concentration and oxygen consumption pre, during and post different kinds of acyclic activities can be established (Guidetti et al., 2000; Beneke et al., 2004). As a member of gymnastics family aerobic gymnastics in some aspects can be comparable with other kinds of gymnastics sport. Several studies have been published describing the characteristics of rhythmic gymnasts (Case et al., 1980; Gionet et al., 1986; Alexander, 1991) and energy requirement of ball routine in rhythmic gymnastics (Guidetti et al., 2000).

The aim of this study was to characterize heart rate (HR), oxygen uptake and pulmonary ventilation during competitive aerobic gymnastics routine in a group of elite women athletes.

METHODS

Subjects. 9 Lithuanian aerobic women gymnasts participated in this study. Age and physical characteristics of gymnasts are presented in Table 1. All subjects were members of national team and they were tested during their competitive period before the World Championship.

All athletes' participation in the study was requested through their coaches. The informed consent was obtained from all participants. The study was approved by Regional Ethics Committee for biomedical research.

Experimental procedure. All subjects underwent two testing sessions. Both testing sessions were performed one week apart. All athletes were asked not to train vigorously on the eve before both testings. During the first session (treadmill test) the parameters of VO_2 max, HR deflection point were estimated. In the second session (aerobic gymnastics routine) pulmonary gas exchanges parameters, heart rate and blood lactate concentration were measured.

First test session. All subjects performed a maximal incremental treadmill test in the

laboratory. Before the test each athlete performed a 5 min. warm up, which consisted of walking, easy running and stretching exercises. The treadmill test consisted of each minute increasing running. Starting workload was 6.2 km / h, each minute running speed increased by 0.7 km / h. All gymnasts were encouraged to continue as long as they were able to maintain speed of running. Heart rate was continuously recorded using the heart rate measurement equipment *Polar ACCUREX-Plus*. The HR deflection point and other parameters of aerobic capacity were determined from the relationship of HR to running speed.

Second testing session. Over one week, the athletes performed competitive aerobic gymnastics exercises in group category. During the routine pulmonary gas exchange parameters and heart rate were continuously measured using the telemetric equipment *Cortex 3B*. The changes of HR, minute ventilation and oxygen uptake were analyzed by adopting monoexponential function. The heart rate was recorded continuously every 5 s using the *Polar* heart rate monitor.

The length of routine was 1 min 46 s. The aerobics gymnastics exercises must be performed under artistic, execution and difficulty criterions. The main artistic criterions are: choreography, sports specific content, musicality and expression, execution criterions — technical execution of all movements including difficulty elements. The main difficulty criterion is the performance of one minimum element (maximum 12 elements are allowed) from each group of element pool (A — dynamic strength, B — static strength, C — jumps, D — flexibility). Each difficulty element is evaluated under the level of difficulty. The subjects performed the routine that consisted of 12 elements with difficulty value of 4.0 points (*Federation Internationale de Gymnastique*, 2002).

Before, during and 10 min after the routine pulmonary gas exchange parameters and HR were continuously measured using the telemetric equipment *Cortex 3B*. Capillary blood samples were obtained before the routine and at the end of, the third and 18th mins of recovery and analysed for blood lactate concentration (Kulis et al., 1988).

Data analysis. During a maximal incremental treadmill test HR deflection point and VO_2 parameters of aerobic capacity were determined from the relationship of HR to running speed.

Table 1. Anthropometric characteristics and age of aerobic gymnasts (mean (SD))

Age, years	21.6 (4.4)
Height, cm	154 (5.0)
Body mass, kg	55.1 (6.2)

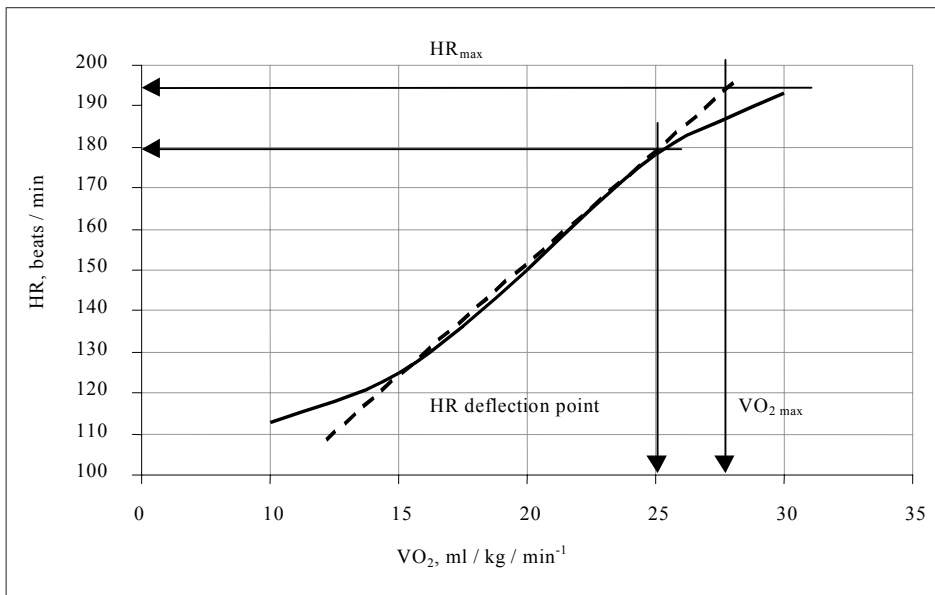


Fig. 1. Relationship of heart rate to running speed in one subject

During the competitive aerobics gymnastics routine the changes of HR, minute ventilation and oxygen uptake were analyzed by adopting monoexponential function.

Statistical analysis. Means' values, standard deviations and correlation were calculated.

RESULTS

Maximal responses during the incremental test on the treadmill are presented in Table 2. Sports aerobics athletes have a moderate maximal aerobic power. The competitive aerobic gymnastics routine are characterized by very intense cardiorespiratory demands, attaining

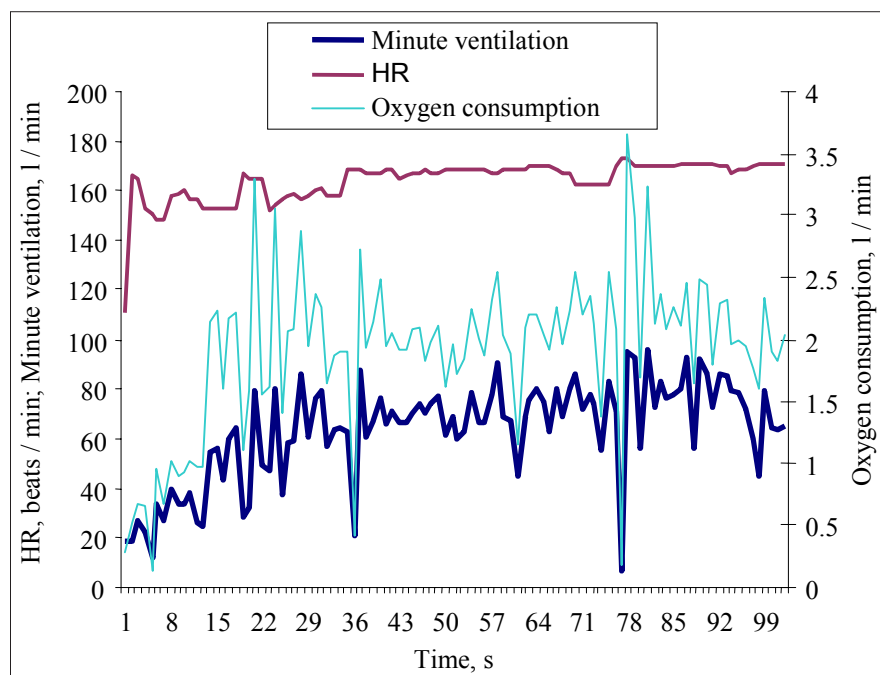
HR _{max} , beats / min ⁻¹	193.3 (7.7)
HR deflection point, km / h ⁻¹	10.9 (0.8)
HR at deflection point, beats / min ⁻¹	171.1 (5.9)
Maximal aerobic speed, km / h ⁻¹	13.31 (0.87)
VO _{2 max} , l / min ⁻¹	2.78 (0.38)
VO _{2 max} , ml / kg / min ⁻¹	50.38 (1.51)

Table 2. Maximal responses in aerobic gymnasts during an incremental treadmill test (mean (SD))

HR asymptote, beats / min ⁻¹	182.1 (7.5)
HR time constant, s	16.5 (5.6)
Minute ventilation asymptote, l / min ⁻¹	82.4 (17.8)
Minute ventilation time constant, s	49.4 (17.7)
VO ₂ asymptote, l / min ⁻¹	2.34 (0.22)
VO ₂ time constant, s	30.9 (15.7)
[Lactate] at 3 rd min after exercise, mmol / l	7.50 (2.09)
[Lactate] at 18 th min after exercise, mmol / l	4.99 (2.30)

Table 3. Cardiorespiratory values during a competitive aerobic gymnastics routine (mean (SD))

Fig. 2. Heart rate, minute ventilation and oxygen consumption during competitive gymnastics aerobic routine in one subject



average maximal values 81.3 (5.8)% of maximal oxygen uptake and reaching 95.2 (4.2)% of maximal HR and overstepping the HR break point which is near the lactate accumulation threshold (Table 2, Fig. 1). A high correlation was observed between VO_2 max determined in the laboratory and VO_2 measured during the routine ($r = 0.872$; $p < 0.05$).

DISCUSSION

The aerobic capacity and physiological responses during competitive routine in well trained aerobic gymnasts were analyzed. Also, the correlation between all parameters mentioned above was assessed.

Maximal responses during treadmill test in Spanish athletes have been published (Rodriguez et al., 1998). HR_{max} in their study was similar. Absolute VO_2 peak data were higher in F. A. Rodriguez's et al. (1998) study in comparison with our calculated data. Spanish gymnasts were of elite international level while ours only of moderate one. This also might be due to different body composition. Our gymnasts were taller and heavier than Spanish ones. In addition, Spanish athletes seem to have higher anaerobic capacity since they achieved higher blood lactate concentration after competitive routine.

Anaerobic thresholds had not been previously evaluated in aerobic gymnasts, but they were evaluated in rhythmic gymnasts (Baldari, Guidetti, 2001). In the present study we did

measure only HR deflection point which is related to blood lactate accumulation threshold.

Only maximal values of physiological variables during competitive routine were presented in the Spanish study (Rodriguez et al., 1998), so all variables in there study were higher in comparison with our asymptotic values. The single and trios were tested in the Spanish study and it is known that this kind of aerobic gymnastics is more intensive. This might be the reason of higher lactate concentration in F. A. Rodriguez's et al. (1998) study.

In this study HR during the quasi-steady state of competitive exercise was higher than at HR deflection point. This may be associated with rather high blood lactate levels (7.50 at the 3rd min after exercise). The marked activation of the cardiorespiratory system may be associated with the involvement of whole body muscles during aerobics exercise. Aerobics can be considered as continuous exercise involving different types of contraction by different muscle groups. The specific training of aerobic gymnastics appears to yield a fitness structure with relatively more developed aerobic and anaerobic alactic capacities and less developed anaerobic lactatic capacity.

CONCLUSIONS

Competitive aerobic gymnastics exercise can be considered as a sport with high cardiorespiratory and metabolic demands, in which aerobic and anaerobic sources are intensely activated.

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PHYSICAL WORK CAPACITY OF YOUNG GRECO-ROMAN WRESTLERS ON THE BACKGROUND OF THEIR SOMATIC DEVELOPMENT

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ABSTRACT

On the basis of studies of 210 Greco-Roman wrestlers aged 11—18 the impact of training loads and sports selection in the above sports event upon physical development and general work capacity of young athletes have been determined.

Besides, age dynamics of changes of the major somatic indices (body length and mass) as well as physical work capacity at the stage of initial and basic sports preparation has been determined.

The studies have resulted in the determination of specific for Greco-Roman wrestlers changes in the examined indices and development of evaluation scale of general physical work capacity.

On the basis of findings we may conclude that Greco-Roman wrestling has a positive influence on developing body. In most cases mean values of examined somatic indices exceed those of children not engaged in sports as well as children practising other sports events. This sports event may be considered as a good means stimulating physical development of children and youth.

The age of 11—15 has turned to be the period of the greatest structural and functional changes in their ontogenesis. During this period the greatest rate of development is peculiar for body mass and height (11—12 years — mass 16%, length 6%; 14—15 years — mass 25%, length 6%), whereas development of work capacity occurs evenly. Along with relative stabilization of the rate of body mass and height development beginning from the age of 16 high rate of work capacity development is observed.

Keywords: Greco-Roman wrestling, somatic development, performance abilities.

INTRODUCTION

In the process of an athlete's preparation for competitions and achievement of high sports level of crucial importance is the information about his body responses to the given training loads and their modifications which allow achievement of maximum results. Training of Greco-Roman wrestlers has an impact upon all motor qualities, increases strength, endurance, speed, flexibility and agility.

Under the influence of physical loads morphological and functional changes occur in organs and systems of the body, central and intrasystem regulation determining the level of body's resistance and its adaptation improves (Płatonov, 1990; Jagiello, 2000 a). Along with improvement of technical and tactical mastery as

well as mental stability significant increase of physical work capacity is observed (Astrand, 1986, 1992). That is why, one should pay special attention to the character of changes in general work capacity determining not only the level of one's potential but the health level of an athlete above all. This is especially important during the period of biological development (Laskowski, Czerwiński, 1997; Jagiello, 2000 b).

Our studies have been based upon suggestion that changes in general work capacity and somatic development of youth engaged in Greco-Roman wrestling may be significantly differentiated as compared to both the youth not engaged in regular sports training and athletes of different sports events.

The main cognitive objective of the work consists in solving the following question: is the linear increase of general physical work capacity of young wrestlers characteristic in the long-term aspect, or are there periodic oscillations which could be linked with somatic development determined by ontogenesis dynamics?

The objective on the whole has been to design estimation scale for general work capacity of young Greco-Roman wrestlers on the basis of obtained empirical data.

MATERIAL AND METHODS

Measurement of general work capacity. Although the most widely used means of work capacity level determination is the method of measurement of oxygen threshold, due to some difficulties of organizational and methodical character during maximum work of athletes (especially children) we were to use fast and simple method — modification of Harvard Step-Test (Wołkow, 1997). It allows fast diagnostics of even great number of athletes without any intervention into training process.

The load in this test consisted in ascending a step during 5 min. During the test the subjects ascended gymnastic bench (30 cm height) at a pace of 30 ascents per minute.

Before the test the subjects were acquainted with the techniques of its execution. Before the work resting heart rate (HR) was measured in a sitting position (during 30 s).

After testing the subjects had a rest in sitting position. Beginning from the second minute of rest HR was measured three times (in 30 s intervals): from 60 to 90 s, from 120 to 150 s, and from 180 to 210 s. Results of measurements were put into protocol. HR was also measured just after the load.

Results of testing are represented in conventional units in the form of index of Harvard Step-Test (IHST). Its value has been determined according to the formula:

$$\text{IHST} = \frac{t \cdot 100}{(f1 + f2 + f3) \cdot 2},$$

when:

t — real time of work in s;

(f1 + f2 + f3) — sum of HR in the first 30 s of each minute (beginning from the second);

number 100 necessary to represent IHST in complete units;

number 2 — to re-count sum of HR per minute.

Anthropometric measurements. Body length was measured from the highest point on the head (vertex) as the upper limit to the level of platform of balance as the lower limit. Measurement was conducted in vertical axis of the body.

Balance was used to measure body mass. During measurements the subjects were in shorts only. Studies were conducted in accordance with generally applied procedures (Drozdowski, 1984).

Statistical methods. Standard statistical methods were used. Microsoft Excel XP programme was used for data processing. The following indices were determined: arithmetical mean (\bar{x}), standard deviation (S_x), coefficient of variation (V), standard mean error (m) as well as coefficient of correlation (r).

Age dynamics was determined on the basis of annual increases according to the formula:

$$T = \frac{100 (P_2 - P_1)}{0.5 (P_1 + P_2)} \%,$$

when:

P_1 — initial result;

P_2 — final result;

T — value of increase.

Standardization criteria. During arrangement of standard values of general work capacity measured by Index of Harvard Step-Test ranges based upon standard deviation of arithmetical mean have been used (Ferguson, Takane, 1997). The following levels of evaluation have been utilized:

1. Very high — $> \bar{x} + 1 S_x$,
2. High — from $\bar{x} + 0.5 S_x$ to $+ 1 S_x$,
3. Moderate — from $\bar{x} + 0.5 S_x$ to $\bar{x} - 0.5 S_x$,
4. Low — from $\bar{x} - 0.5 S_x$ to $\bar{x} - 1 S_x$,
5. Very low — $< \bar{x} - 1 S_x$.

210 skilled Greco-Roman wrestlers representing two provinces of Poland: Mazovetsky (“Legia Warszawa” “Budowlanka Radom”, “SMS Radom”, “Orzel Wierzbica”, “WLKS Siedlce” and Ljublin (“Orleta Lukow”, “AGROS Zamosc”, Grezowia Grezowka”, “UKS Trzebieszow”) took part in the studies. Age of subjects was in the range of 11—18 years. They have been training for 1—8 years.

Most of wrestlers were at the age of 14 ($n = 52$). Body mass of subjects has ranged from 25 to 95 kg, whereas body length — from 125 to

190 cm. All subjects obtained the written consent of a physician for participation in the studies.

RESULTS

Changes of wrestlers' general work capacity. Results of physical studies are presented in Fig. 1.

Mean values of resting HR are rather high (except for athletes aged 18) and change with age. The highest values of HR have been observed in wrestlers aged 14 and 15. The above may be due to the so-called pre-start response — excitation of central nervous system before expected work (Matwiejew, Jagiełło, 1997).

High level of HR just after the load as well as

during the 1, 2, and 3 min of the recovery has been characterized by significant variability. The highest level of HR just after the load has been revealed in athletes aged 16 and 14, whereas the lowest — in those aged 13 and 17. HR indices during the recovery period decrease with age which is indicative of adaptation capacity development in response to physical loads.

Age dynamics of IHST is presented in Table 2. Constant index increase is observed with age up to 18 years. From 11 to 16 years annual index increase constitutes 1.2—3.2%. After the age of 16 rapid increase of index is observed which constitutes 7.8 and 10.1% at the age of 16—17 and 17—18, respectively. The highest value is

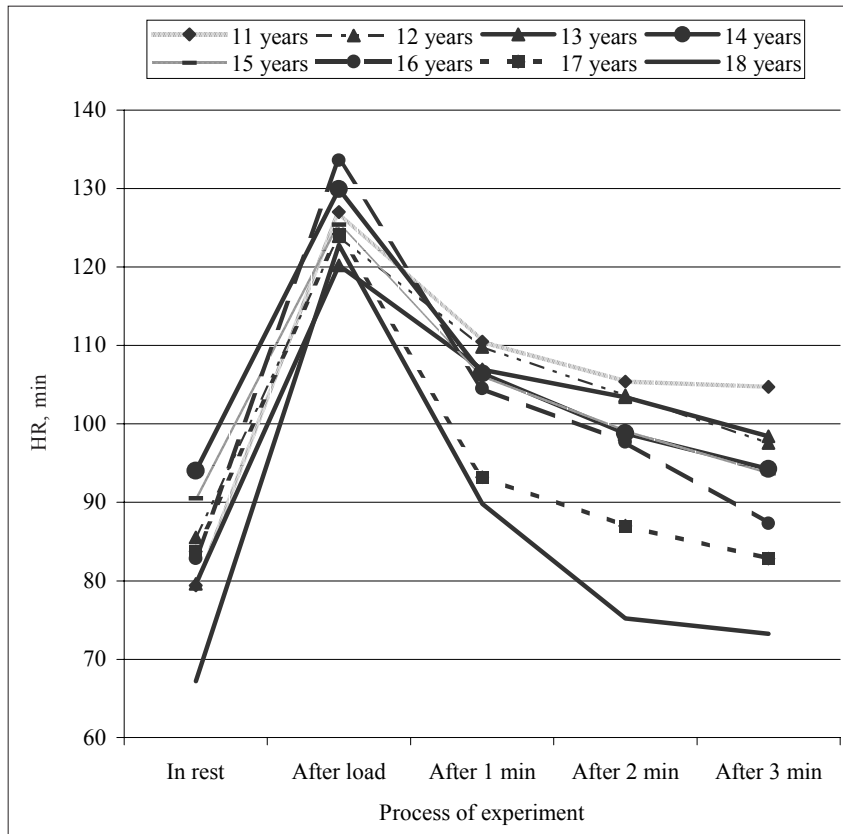


Fig. 1. Cardiovascular system response to the load of Harvard Step-Test in Greco-Roman wrestlers

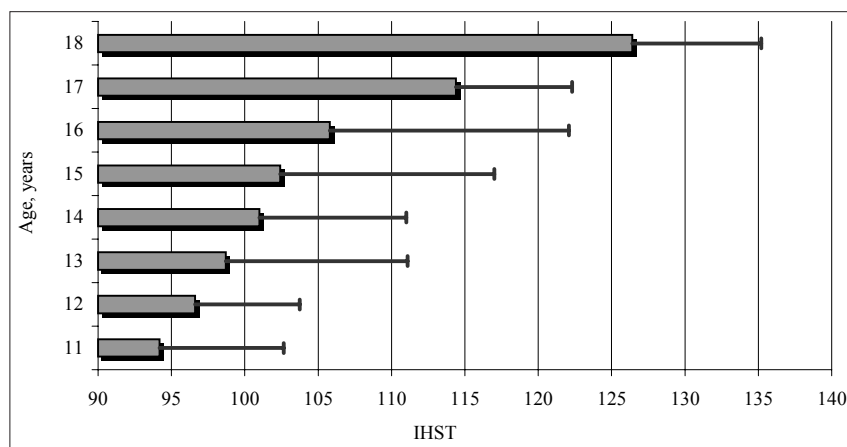


Fig. 2. Age dynamics of general work capacity of Greco-Roman wrestlers (expressed by Index of Harvard Step-Test (IHST))

observed at the age of 18 — 126.4 CU.

Standard requirements of general work capacity of young wrestlers. Arrangement of standard values of general work capacity (expressed by Harvard Index) has been based on standard deviation from arithmetical mean (Ferguson, Takane, 1997) for three age groups: 11—13, 14—16 and 17—18 years.

Taking the above into consideration an estimation scale allowing relatively objective diagnostics of the state of body of young wrestlers has been elaborated (Table).

Objective estimation of general work capacity of young wrestlers should assist in determination of the reserve for further individual development and achievement of high level of sports mastery. Besides, it plays an important role in selection of the most efficient means and methods of training process.

Dynamics of somatic development. Body length is a stable quality; only the long-term impact of a definite factor can significantly influence changes of this quality in individual development. Obtained data of anthropometric measurements (body length and mass) indicate a natural biological development of young wrestlers. Fig. 3 illustrates age dynamics of body length.

Progressive dynamic increase of index is observed until the age of 16, afterwards it stabilizes. Maximum annual increase is observed at the age of 14—15 (6.2%) and 11—12 (5.7%). During other time intervals an even increase is noted (annual increase constitutes approximately 2—3%).

Body mass is characterized by significant variability. According to the above feature the subjects represent heterogeneous group. The highest annual increase of the above index has been noted at the age of 11—12 (14.2%) and 14—15 (25.4%).

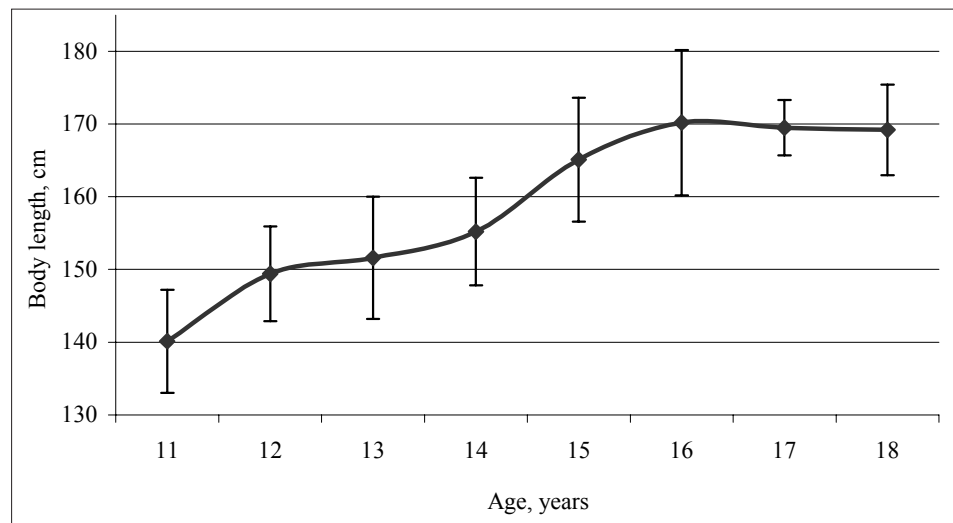
Although in our studies mean values of body mass of athletes aged 13 have been 4.8% lower as compared to those aged 12, there is no reason to say about natural age decrease of body mass. Revealed trend in development of body mass of wrestlers aged 12—13 needs further verification. This result may be influenced by numerous factors, such as selection of subjects, sports event specifics (13-year-old athletes are allowed to participate in competitions; the lowest weight category is that of 29—32 kg).

Roufier’s index changes irregularly with age (Fig. 5). Changes are of expressed wave-like character. It decreases at the age of 11—13,

Table. Estimation of general work capacity of young Greco-Roman wrestlers

Age group \ Levels	11—13 years	14—16 years	17—18 years
Very high	106.7 >	117 >	130.6 >
High	101.6—106.6	110.5—116.9	125.5—130.5
Moderate	91.4—101.5	97.6—110.4	115.3—125.4
Low	86.3—91.3	91.2—97.5	110.2—115.2
Very low	86.2 <	91.1 <	110.1 <

Fig. 3. Age dynamics of body length of Greco-Roman wrestlers (n = 210)



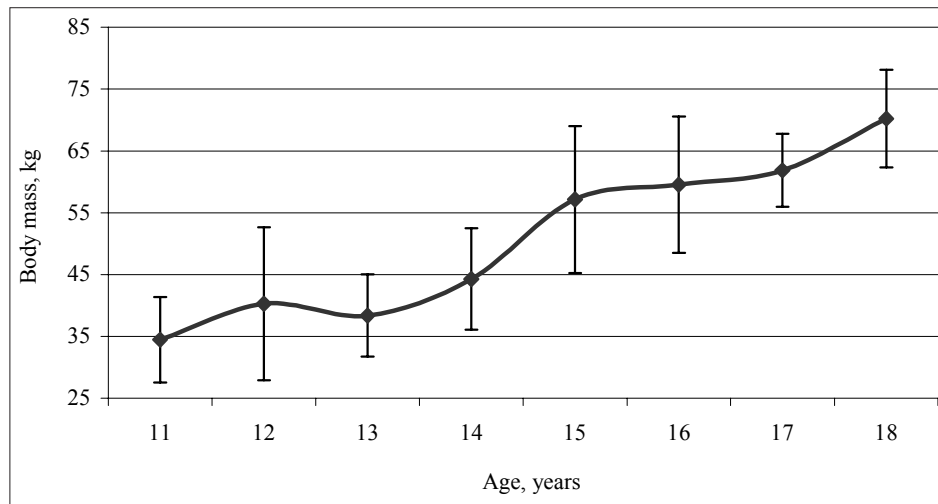


Fig. 4. Age dynamics of body mass of Greco-Roman wrestlers (n = 210)

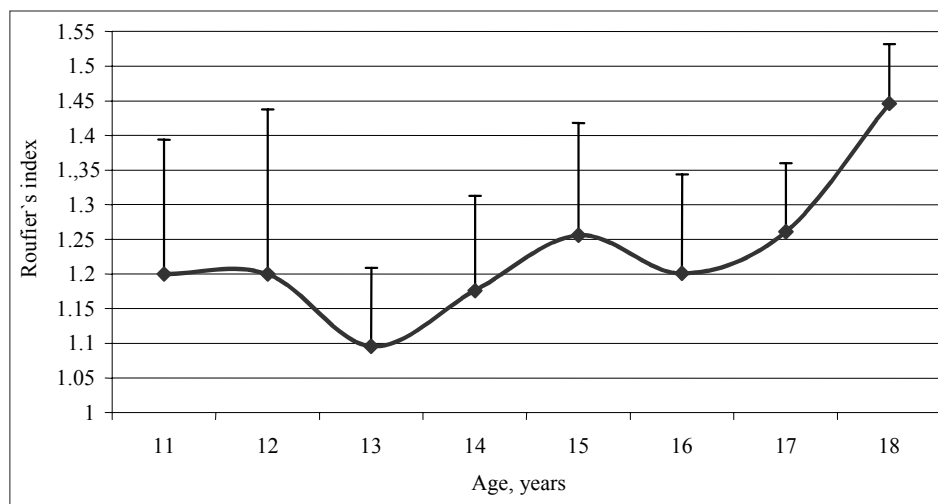


Fig. 5. Age dynamics of body mass of Greco-Roman wrestlers' (n = 210) Roufier's index

whereas at the age of 13—15 the tendency of index increase is observed. At the age of 15—16 another decline is noted whereas beginning from the age of 16 constant increase is observed. Maximum values are attained at the age of 17—18.

Taking into account somatotype classification according to Roufier's index one may state that before 16 years of age young wrestlers have a leptosomatic type of body build whereas beginning from the age of 17 — athletic one. Taking into account the above tendency as well as the fact that coefficient of variation of index significantly decreases with age (19% — at the age of 11 and 5% — at the age of 18), one may assume that long-term training loads have a tremendous influence upon the type of body build of wrestlers.

DISCUSSION

Numerous authors studied general work capacity with utilization of Harvard Step-Test

(Astrand, 1986; Fibak et al., 1993; Wolkow, 1997, Jagiełło, 2000 b; Jagiełło et al., 2002).

Long-term studies of great population of children and youth (Berger et al., 1990) indicate rather high age variations in general work capacity of boys. Studies of other authors (Burdukiewicz et al., 1997) have shown that the lowest values of Harvard's index are observed at the age of 11 which is characterized by relatively great increase in body mass and length. Then above phenomenon has been confirmed by our studies of wrestlers: 11—12 years of age is the period during which one may observe rather significant increase in body mass (15.5%) and body length (5.7%) while the level of Harvard Step-Test remains the lowest.

Studies of the group of judokas (Jagiełło, 2000 b) demonstrate that intensive increase of body length and mass at the age of 11—12 is associated with decreased general work capacity. Despite similarity between judo and Greco-Roman wrestling age dynamics of work capacity

of judokas differs from that of Greco-Roman wrestlers. Beginning from the age of 12—13 the level of work capacity in judokas increases, during the period of 13—15 years it stabilizes, whereas since 15 years of age an even and gradual increase occurs. In Greco-Roman wrestlers a constant and relatively even increase of general work capacity occurs with age and experience.

The results of conducted studies demonstrate that physical loads applied in training process of young Greco-Roman wrestlers have a favorable effect on the development of their functional capacities.

As regards the studies of body length and mass of Polish youth (Trzesniowski, 1990; Asienkiewicz, 1999), we may state that young Greco-Roman wrestlers excel their peers in all age groups both in body mass and length. It should be also outlined that children from eastern regions of Poland significantly excel rural youth (Łaska-Mierzejewska, 1999; Berger et al., 1990).

Comparison of the results of somatic indices of young Greco-Roman wrestlers with standards for Polish children (Trzesniowski, 1990) indicates a positive influence of training means upon physical development of children because at the age of 11—16 they excel their peers not engaged in sports. After the age of 16 a relative stabilization of body length along with simultaneous increase of body mass is observed.

Boys engaged in wrestling are much taller than gymnasts (Karosz, 1993) and slightly (differences are statistically insignificant) shorter and lighter than judokas (Jagiełło, 2000 b). They are significantly shorter than track and field athletes specialized in speed and strength events, such as shot putting, javelin and discus throwing (Migasiewicz, 1999; Pionk, 1997) as well as athletes of sports games such as handball (Lakomy, 1978; Stawiarski, 1989), volleyball (Stefanicki et al., 1994). Children and youth engaged in swimming are taller and lighter than judokas (Piechaczek et al., 2000).

Comparative characteristics of somatic development (body mass and length) are observed in fencers (Polanowski, 1998), footballers (Bednarski, Kuzmin, 1996; Ozimek, Staszkiwicz, 1999) as well as athletes engaged in winter sports events (Gowarzewski, 1978).

Due to the above one may ascertain that Greco-Roman training sessions positively influence developing body of children. The above

is confirmed by numerous studies in the field of sports wrestling (Jęskolski, 1996; Kalina, Jagiełło, 2000 a, 2000 b; Jagiełło et al., 2002).

High heterogeneity of subjects according to indices of body mass is related to this sports event specifics in which there are 7 weight categories (from 55 to 120 kg). Due to the above among elite wrestlers one may encounter athletes representing various somatotypes. Sports wrestling is rich in different technical means allowing to decide the outcome of combat. That is why, each athlete irrespective of his body length and mass can form his own style based upon optimum for him techniques.

High variability of Roufier's index in age aspect of Greco-Roman wrestlers is indicative of significant changeability of somatotypes conditioned by various intensities of maturation processes during this period of development as well as sports event specifics (weight categories, selection requirements, etc.). However, the trend of body build transformation into more athletic type which corresponds to the requirements of sports event is quite obvious (after the age of 16).

Numerous studies demonstrate significant correlations between body mass and the level of general physical work capacity (Szopa et al., 1996). These dependences are manifested above all in boys aged 7—14 and indicate achievements of the better results in tests of work capacity by those persons which are characterized by significant involvement of muscular mass. The above studies also demonstrate relationship between general work capacity and body length (relative to boys aged 7—13) as well as prove a positive impact of body length on the efficiency of utilization of long load.

Our studies have failed to prove the above tendency. Correlation analysis of somatic development indices (body mass and length) has failed to show significant dependence of the above indices upon general physical work capacity of examined wrestlers. Thus, in examined group of wrestlers the result of Harvard sample is not solved by mass, length and type of body build. Potential unfavorable impact of body build on the result is statistically insignificant due to compensation by other factors, such as post-training changes of cardiovascular system.

The above regularity has been confirmed in the works of M. Michałkow et al., (1992) and L. W. Wolkow (1997). They discovered that

Harvard Step-Test is an adequate measure of general work capacity in personal with sufficient physical preparation due to the fact that the type of body build does not influence significantly upon demonstrated result.

CONCLUSIONS

1. Greco-Roman wrestlers are characterized by heterogeneity of physical work capacity level with tendency of progressive increase with age. Revealed differences of work capacity potential indicate that coaches should incorporate the principle of training load individualization according to biological capacities of the body. In the process of development the above differences are of irregular character (calm increase from 11 to 15 years and dynamic — from 15 to 18 years).
2. Statistically significant correlations between age, body height and work capacity level were not observed. Therefore, we may assume that Harvard Step-Test is an adequate measure of work capacity in persons with sufficient preparation because the type of body build does not significantly influence upon the result of sample in this case.
3. On the basis of findings we may conclude that Greco-Roman wrestling has a positive influence on developing body. In most cases mean values of examined somatic indices exceed those of children not engaged in sports as well as children practising other sports events. This sports event may be considered as a good means stimulating physical development of children and youth.
4. The age of 11—15 has turned to be the period of the greatest structural and functional changes in their ontogenesis. During this period the greatest rate of development is peculiar for body mass and height (11—12 years — mass 16%, length 6%; 14—15 years — mass 25%, length 6%), whereas development of work capacity occurs evenly. Along with relative stabilization of the rate of body mass and height development beginning from the age of 16 high rate of work capacity development is observed.
5. High variation of studied features, especially body mass and index (Roufier's) of judokas confirms thesis according to which anthropometric indices do not influence efficiency of competitive activity as it is observed in some sports events, but significantly effect selection of individual techniques.
6. Elaborated scale for estimation of general work capacity should be used for correction of training loads depending on individual peculiarities of work capacity development.
7. Utilized modification of Harvard Step-Test is rather simple and easy to execute test under conditions of training. It allows to execute diagnostics of even great number of athletes within short period of time; amount of load provides its usage practically at all stages of control. Numerous scientific studies as well as practical experience confirm its high diagnostic significance in sports wrestling.

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MANIFESTATION OF SOCIAL IDENTIFICATIONS OF WOULD-BE PHYSICAL EDUCATION AND SPORTS SPECIALISTS

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ABSTRACT

Research deals with the problem what social identifications are characteristic of the higher school students and how they are related to other factors influencing them. Research object was the social identifications of students. Research aim was to characterize the manifestation of social identifications of would-be physical education and sports specialists and to reveal their links with the independent variables of the research. Research participants were 622 1—4th year students of the Lithuanian Academy of Physical Education, the faculties of Sports Education and Sports Technologies. The social identifications of students were measured using M. Hooper (1976) Social Identification Measurement Scale. The factor analysis of social identifications distinguished five factors. Social identifications typical of would-be specialists of physical education and sports were linked to social prestige (wish to have a well-paid job and be respected in the society), family (the roles of husband / wife, father / mother), age (importance of being adult), nationality (importance of being Lithuanian) and political activity (wish to belong to or support a political party). The distinguished social identifications were related to gender (girls compared to boys want more to be adults, but their national identification is weaker), academic achievements (higher achieving students are more identified with family, and it is more important for them to be adults), sports activities (students higher achieving in sports are more identified with their nationality) and other sociodemographic indicators (better-off students want to be adults more, and national identification is more important to those students whose parents are blue-collar workers and farmers compared to the children of white-collar workers).

Keywords: social identifications, higher education, Social Identification Measurement Scale.

INTRODUCTION

Studies at a higher school are critical for the development of students' social identities (*ASHE-ERIC Higher Education Report*, 2002). This can be confirmed by the changes in their self-perception. From the intuitive sense of development which occurs during late adolescence individuals create a sense of self that usually feels more grounded and stable. Answering the question "Who am I?" is paramount to them and requires a substantial amount of reflection and action to try out new behaviors, consider alternative value sets, and

become comfortable with the new roles students both take on and are given.

Assessing those changes students begin to understand the multiple layers of identity they have to manage, develop, and make peace with. As all members of the society students undergo many forces and influences of different cultures. Besides the university environment the development of their social identities can be conditioned by various non-traditional contexts: virtual reality, forms of electronic environment and others. However, it does not mean, that

traditional elements of the development of social identities (family, nation, educational institutions, etc.) do not carry weight. Those particular social categories form the fundamental of the person's social identity.

Thus, it may seem that successful social identification, as P. Heaven (1999) maintains, can provide support to people in the chaotic world and help them make sense of the immense cultural space. Therefore research about the influence of the new (academic) environment on the development of social identifications of young people is critical as it can reveal the peculiarities of the study processes at the institutions of higher education. It is important to note that not much research has been done in the area of social identifications (as constituents of social identity) in connection with the studies in higher education. More research has been addressed to students' academic identity (Osborne, 1997; Howard, 2003; Karanauskienė, Kardelis, 2005) and national identity (Antinienė, 1999, 2002; Ezell et al., 2003; Zevin, 2003; Dolby, 2004). Thus the research question is: what social identifications are characteristic of higher school students and how they are related to other factors influencing them.

In search of answers to those questions two hypotheses were raised:

H 1. Student population in a higher school is diverse not only by their sociodemographic characteristics, but also by distinctive social identifications.

H 2. The most significant social identifications of students are related to their studies and sociodemographic factors.

Research object was the social identifications of students.

Dependent variables of the research were the manifestations of social identifications of students. Students' sociodemographic characteristics, academic achievements and sports activities were chosen as *independent* variables.

Research aim was to characterize the manifestation of social identifications of would-be physical education and sports specialists and to reveal their links with the independent variables of the research.

The analysis of the conception of social identifications and social identity. Due to rapid social changes social identifications of people become even more important. This is

understandable, as knowing how people identify themselves with certain positions in their social life and what values are their priorities in the process of socialization helps us reveal the real life of the society, its groups and various people, and foresee the preconditions and possibilities for making social decisions at different levels of life (Mitrikas, 1995). It is also natural, that social identifications of young people and their research attract more and more attention because the stronger is the identification with a certain social group, the greater is the possibility that the person will take over its behavior standards and values.

A significant part of human social identity is the social roles that are most important to a person at certain period of his / her life (Broom et al., 1992). For example, being a son and a daughter is a very important element of family identification for every boy and girl, as for many other people, however, only being in a social group (family, peer group, local community, nation, etc.) does not guarantee person's social identity. Gender identification, i. e. perceiving oneself as male or female, appears rather early and might be an essential element of person's social identity, but this perception can be more important than other social identifications only at certain periods of life.

The concepts of social identity and social identification are closely interconnected, but they are not identical. Some authors (Gouveia et al., 2002) suggest that social identification emerges when a person admits belonging to a certain social group, and social identity means proximate coalescence with this group. Thus, social identity externalizes subordination of personal needs and interests towards a certain group.

Very often the constructs of social identity and identification converge, most likely they differ from each other conceptually (notionally), and not empirically. The previously mentioned authors suggest that social identification is understood by many scholars as part of social identity, i. e. it depicts the degree the person identifies with certain social groups or categories. On the other hand, person's social identity, which is made from his / her identifications with various social groups, situations and roles, is only a relatively stable condition because situations in human life, especially in young people's life, constantly change, so their social identities are not

permanently fixed. It means that in research social identity must be viewed not as a state, but as a process of its formation (Krukauskienė et al., 2003).

Social identity fluctuates when a person learns new social roles or when the content of his / her present roles changes. On the other hand, social roles depend on the personal attitudes and values, which constitute the content of social identifications (Broom et al., 1992). Before becoming the President of the United States, Landon B. Johnson described himself in the following way: “I am a free man. American, a US senator, and — to keep the right order — a democrat. I am also a liberal, conservative, Texas resident, tax payer, ranch owner, businessman, client, parent, voter, and not as young as I used to be, but not so old as I hope to become, and I am all of them but not in turn” (Broom et al., 1992, 79). Thus, in different social spheres one and the same person can be in different stages and environments of identification, where he / she may have to overcome various crises of life and indefinite situations so characteristic of postmodern epoch (Krukauskienė et al., 2003).

RESEARCH METHODS

Research participants. Research participants were 622 1—4th year students of the Lithuanian Academy of Physical Education, the Faculties of Sports Education and Sports Technologies (366 males and 256 females) (the whole population).

Research methods. Students’ social identifications were measured with a scale composed by M. Hooper (1976). As S. Greene suggests (2002), social identification measurement needs theoretically firm and psychologically grounded instruments. They should team up with the social-psychological conceptions of group identification. The dominant social-psychological theory which helps to understand the relationship between people and their social groups is the social identity theory. According to it social identification is defined as part of individual’s self-concept which derives from his / her knowledge of his / her membership of a social group or groups together with the value and emotional significance attached to that membership (Tajfel, 1981). That is, social identification is based not on the formal, but on the perceived membership in a certain social

category, e. g. not every man or woman appreciates his / her social gender.

The instrument which was applied to measure students’ social identity had to tap identifications with various social groups significant to them. M. Hooper (1976) suggests that the key phrase “think of yourself as” should constitute the core of the measurement procedure. For example, “generally speaking, do you think of yourself as a liberal ...or not belonging to any political party?”. Later on this phrase was incorporated into a verbal format that would tap identifications with a broad range of groups and, at the same time, allow the expression of intensity of identification. For example, “Is it important to you to think of yourself as a [group name placed here]?”:

very important, quite important, somewhat important, I don’t know, not important.

The use of response categories emerged from a number of informal interviews with students.

If we wanted to measure the social identifications of a number of students with a single instrument so that we could systematically examine their relationship with other variables, we needed that subsets of students within a sample of respondents identified with at least some of the same groups. This procedure would reveal social identification *factors*, characteristic of the research participants.

Another important step in the construction of the instrument was the selection of stimulus groups. On the basis of the previous research data (Hooper, 1982; Jones, 1997; *ASHE-ERIC Higher Education Report*, 2002), the following social categories (groups) were distinguished: nationality, gender, age, political activity, social class, family, studies, and work groups. Each social category was incorporated into a question, understandable to research participants. As individual’s social identity consists of negative identifications as well, a number of reference groups were included in the negative format, e. g. “Is it important to you to think of yourself as not being a...?” The choice of social groups and the comprehensibility of questions were checked in the interview with nine students. It allowed including more reference groups into the questionnaire (Table 1).

The internal consistency — Cronbach’s alpha — of the social identification scale was adequate (0.77). It means that the method was valid to measure social identifications. Every

Table 1. Social identifications and reference groups

Social identifications	Reference groups
Age identification	<ul style="list-style-type: none"> • Adult • Not a child • Adolescent
Gender identification	<ul style="list-style-type: none"> • Man / woman
Family identification	<ul style="list-style-type: none"> • Daughter / son • Father / mother (parent) • Husband / wife
Identification with studies	<ul style="list-style-type: none"> • Higher school student • Secondary school graduate • Active participant in students' life
Identification with political activities	<ul style="list-style-type: none"> • Belonging to or supporting a political party • Neither belonging to nor supporting any political party
National identification	<ul style="list-style-type: none"> • Lithuanian • Not a foreigner
Occupational identification	<ul style="list-style-type: none"> • White-collar worker • Blue-collar worker
Other identifications	<ul style="list-style-type: none"> • Well-off • Poor • Middle class • Having a prestigious job • Having a well-paid job • Respected society member

statement was estimated on a five-point scale. The points were calculated so that the highest number (5) showed the most intense characteristics (“very important”). After estimating each statement in points, the mean showing the intensity of each student’s social identification was calculated. Other questionnaire questions were meant to evaluate students’ sociodemographic indicators, academic achievements and environmental variables. Students’ academic achievements were self-reported measures.

Research procedures. Data collection occurred during the Spring Term, March—May, 2004. The survey was conducted following goodwill, legal and ethical principles. All the research participants were informed that the aim of the survey was to establish how people viewed and identified themselves with the given social categories. They were instructed to go through the list of statements and to put a checkmark in the slot on the scale beneath each item that best corresponded to their feelings.

Statistical analysis. The statistical analysis of the research data was performed using program package *SPSS 11.0 for Windows*. The methods of descriptive statistics were used to estimate

numerical characteristics (mean, standard error, etc.) of various indicators. With the help of parametric and non-parametric methods the hypotheses about the equality of the means of test scores, the significance of the correlation coefficients, the compatibility of the sum of scores distribution with the normal distribution, etc., were tested. To test those hypotheses the factor analysis was performed, Chi square criteria were used, Cronbach’s alpha coefficient was calculated. The results were considered statistically significant with the probability level $p < 0.05$ and the reliability of 95 per cent.

RESEARCH RESULTS

The factor analysis of the social identification scale revealed five factors with the eigenvalues of 1.0 or better (Table 2).

Thus, from original diagnostic variables five ultimate scales were obtained. As G. Merkys et al. (2001) suggest, extracted factors reflect the multiplexed statistical relation of variables, which can be interpreted as the internal structure of the diagnosed construct. If the factor analysis exposes a notionally meaningful structure, this fact can be

Factors	Factor loadings
I — social prestige	0.70
• Having a prestigious job	0.80
• Having a well-paid job	0.79
• Respected society member	0.66
• Higher school student	0.52
II — family	0.66
• Husband / wife	0.84
• Father / mother (parent)	0.78
• Son / daughter	0.56
• Man / woman	0.47
III — age	0.83
• Adult	0.84
• Not a child	0.83
IV — nationality	0.60
• Not a foreigner	0.72
• Lithuanian	0.54
V — political activity	0.71
• Belonging to or supporting a political party	0.71
• Neither belonging to nor supporting any political party	0.70

Table 2. Social identifications of would-be physical education and sports specialists

considered as an argument of the validity of the construct and the scale. V. Čekanavičius and G. Murauskas (2002) maintain that the variables of each group are consolidated by a directly indiscernible (latent) factor. The data in Table 2 indicate that the feature uniting the variables of the first factor (factor loading is 0.70) is *social prestige*. The students of this subgroup tend to identify themselves with white-collar workers having prestigious jobs (0.80). It is very important for them to be well-paid (0.79) and be respected in the society (0.66). It should be noted that those are the students who appreciate their studies at a higher school (0.52). That is to say, studying at a higher school is related to the possibility to have a well-paid prestigious job and be respected in the society. It is worth noticing that the evaluation of prestige depends on the respondents' gender. Prestige is more important to female students than to male students (the intensity of the feature 2.70 ± 0.07 and 2.37 ± 0.06 respectively; $\chi^2 = 13.79$; $df = 3$; $p < 0.01$) (df — degrees of freedom). This factor was influenced neither by the students' living place, parental education, nor by their social status. Marital status and perceived material standing were not significant, as well.

The unifying feature of the second factor is *family* (factor loading is 0.66). The students of this subgroup mostly appreciate the social role of

husband / wife (feature loading 0.84). It is also important for them to be a parent (0.78) and a son / daughter (0.56). The social gender role identity appears in this factor, as well, but its loading is not high (0.47). The gender differences were not found, i. e. family is equally important to both boys and girls in this population. However, this factor is more significant to married and cohabitant students, compared to single students (respectively 2.86 ± 0.05 and 2.44 ± 0.09 ; $\chi^2 = 22.30$; $df = 9$; $p < 0.01$). Identification with family is more important to students who do not have to pay for their studies (respectively 2.58 ± 0.05 and 2.33 ± 0.09 ; $\chi^2 = 15.67$; $df = 6$; $p < 0.05$) and to those whose grades at the secondary school were very good and excellent compared to students whose grades were good and satisfactory (respectively 2.75 ± 0.12 and 2.48 ± 0.05 ; $\chi^2 = 13.36$; $df = 6$; $p < 0.05$).

The third factor can be characterized as identification with *age*, perception and evaluation of one's own age. The factor loading is rather high — 0.83. Students belonging to this subgroup think it is very important for them to be adults (0.84), and not children (0.83). This attitude is more characteristic of girls compared to boys (2.75 ± 0.07 and 2.34 ± 0.11 ; $\chi^2 = 20.69$; $df = 3$; $p < 0.001$). Being grown-up is more important to students who think they live better than the

majority of people in Lithuania, compared to those who think that they live worse than many Lithuanians (2.64 ± 0.09 and 1.77 ± 0.28 ; $\chi^2 = 20.87$; $df = 9$; $p < 0.05$), and those who do not have to pay for their studies (2.57 ± 0.05 and 2.34 ± 0.09 ; $\chi^2 = 18.52$; $df = 6$; $p < 0.01$). It is interesting to note that students with higher degree of academic identity tend more to consider themselves as grown-ups than those students whose academic identity is lower (2.60 ± 0.06 and 2.38 ± 0.06 ; $\chi^2 = 9.73$; $df = 3$; $p < 0.05$).

The fourth factor is identification with *nationality* (0.60). It is significant for students not to be foreigners (0.73), but to be Lithuanians (0.54). In this case national identification is not as important to girls as it is to boys (2.33 ± 0.07 and 2.61 ± 0.05 ; $\chi^2 = 9.87$; $df = 3$; $p < 0.05$). It is worth noting that the social standing of students' parents can also impact their national identification. Students whose parents are blue-collar workers and farmers are more identified with nationality than the children of white-collar workers (2.68 ± 0.06 and 2.37 ± 0.05 ; $\chi^2 = 31.19$; $df = 18$; $p < 0.05$). It should also be noted that national identification is more significant to students who strive for high sports results compared to students who are contented with compulsory sports classes at the academy (2.63 ± 0.15 and 2.26 ± 0.12 ; $\chi^2 = 20.71$; $df = 6$; $p < 0.01$).

The fifth factor can be called *political activity* (0.71). The students of this subgroup think it is important for them to belong to or to support a certain political party (0.71), not supporting other political forces (0.70). The distinguishing feature of this factor is that it is not related to any other research variable.

DISCUSSION

Research results indicated that students' identifications with social groups and social roles in those groups can be distributed into clearly identifiable subgroups, which constitute the background of their general social identity. Thus, the results suggest that those factor analyzed subgroups reflect the links of a person and the surrounding environment, whereas the investigation of the identification with one social group would not let us reveal such links. Thereby the present research enabled us to distinguish five types of students' social identifications in the

researched population, and those identifications were mostly related to work (learning) and family. This can be confirmed by the research of other authors. M. Hooper (1982) studied social identifications in different populations (lawyers, housewives, scientists, etc.) and found that the most intense social identifications were the same (work and family), while the intensity of other social identifications, such as ethnic, religious and others, was miscellaneous or low. So, we suggest that the factors distinguished in this research could be characteristic of other groups of students, as well. However, M. Hooper (1982) implies that it is advisable to estimate the social identifications of each population at each period of time anew.

It is worth noticing the research data indicating that girls value social prestige in their future work more than boys. This can be explained by the fact that women are more sensitive about that, because in spite of the positive changes in the sphere of gender equality during the last decades there are still differences in the possibilities for men and women to get a better-paid job or be financially motivated, to gain access to the organizational capital and information resources which are necessary for the professional development (Timberlake, 2005). Other authors (Simpson et al., 2005) uphold that men think they need knowledge and skills in their jobs, but women assume it is more important for them to be listened to and their opinion to be taken into account.

It is understandable that after starting studies at a higher school students' identifications with their age mediate. Due to changing living conditions and the nature of studies, the period of coming of age, students start a new stage in their lives — the lives of adults, and for every person the beginning of a new epoch of life is very important. Therefore much research has been carried out with the aim not only to reveal the manifestation of identification of young adults with their age, but also to estimate its role and influence on people's life (McCann et al., 2004). In the context of our study more research is needed to explain why in the population of would be specialists of physical education and sports becoming adults is more important to girls than to boys, and to students with a higher degree of academic identity (usually they learn better and do not have to pay for their studies), as well as to those who think they live better than the majority

of people in Lithuania. Family identification of young people should also interest researchers because family plays a very important role in young people's lives. Other studies provide data about the links between intense family identification and self esteem, psychological well-being (Reitzes, Mutran, 2004), as well as academic achievements and career (Hall, 2003). Those links were traced in our research, too, besides it was noticed that identification with age increased among students having families of their own.

In the context of the academy the fact that stronger national identification is more characteristic of those students who strive for high sports results compared to students who are not actively engaged in sports is of great importance. The relationship between sports and national identification has been studied in other research, as well (Bainer, 2003; Poulton, 2004; Stankovič, 2004), where sports achievements, especially in popular branches of sports, were also associated with increasing pride in one's nation, as well as national identification of sportsmen and fans. Besides, in our research national identification is more typical of boys, because they strive for sports results more than girls, consequently their sports identity is of a higher degree.

Other researchers (Broom et al., 1992), having studied students' identifications for more than three decades, noticed that students' social identifications turned from institutional orientations towards personal orientations. According to their research data, in the fifties and sixties the students identified themselves with familiar social roles, society aims and social group responsibilities. Thus they

described themselves according to their student position, religion or family status. At present students tend to identify themselves according to their feelings and experiences. The data of our research did not confirm those tendencies. The majority of our research participants exposed traditional social identifications, connected with social standing and family.

CONCLUSIONS

1. The present research indicated that social identifications typical of would-be specialists of physical education and sports were linked to social prestige (wish to have a well-paid job and be respected in the society), family (the roles of husband / wife, father / mother), age (importance of being adult), nationality (importance of being Lithuanian) and political activity (wish to belong to or support a political party).
2. The distinguished social identifications were related to gender (girls compared to boys want more to be adults, but their national identification is weaker), academic achievements (higher achieving students are more identified with family, and it is more important for them to be adults), sports activities (students higher achieving in sports are more identified with their nationality) and other sociodemographic indicators (better-off students want to be adults more, and national identification is more important to those students whose parents are blue-collar workers and farmers compared to the children of white-collar workers).

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SPINE'S SAGITTAL PLANE CURVES' COHERENCE WITH ANTHROPOMETRIC PARAMETERS IN SCHOOLCHILDREN

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ABSTRACT

The aim of this study — to identify how anthropometric measurements are connected with spine sagittal curves in schoolchildren.

Anthropometric and sagittal body posture measurements were performed for 405 schoolchildren, age range 10–13 years. Such anthropometric measurements as body height, weight, fat mass and fat free mass were assessed. Degrees of thoracic kyphosis and lumbar lordosis as sagittal profile features were evaluated.

According to the data analysis could be concluded, that coherence between anthropometric parameters and spine's sagittal profile differs according to gender. The number of statistically significant connections between these two parameters' groups was greater in boys. Anthropometric measurements had greater coherence with thoracic kyphosis in comparison with lumbar lordosis. Body weight and fat mass were statistically significantly different according to kyphosis and lordosis values in boys, although fat-free body mass had no significant difference with sagittal curves' expression. Body weight, fat mass and fat-free body mass among girls were associated only with thoracic kyphosis.

Keywords: thoracic kyphosis, lumbar lordosis, height, weight, fat mass.

INTRODUCTION

Asymmetric body posture lately is more and more often diagnosed among adolescents in Lithuania also in other countries. Consequences of this widely spreading health disorder are very important as for physical health and so for social and mental wellbeing. Asymmetric body posture is considered not only one of the most common adolescents' musculoskeletal system disorders (Lindišienė, Murauskienė, 1999; Juškeliene et al., 1996) but also one of the possible signs or reasons of scoliosis

(Nissinen et al., 1993; Hazebroek-Kampschreur et al., 1992; Grivas et al., 2002). Spine sagittal plane curves being too much or not enough in their form expression (according to their expression size) may influence reduced musculoskeletal system functioning. The expression of sagittal curves influences not only spine's frontal plane curves (Mac-Thiong et al., 2003), but also pelvic and lower extremities' posture (Park et al., 2003; Vedantam et al., 1998; Vialle et al., 2005), back pain appearance (Joncas et al., 1996) and other

symptoms. Body posture changes and develops with age and also according to gender and anthropometric parameters. Some researchers (Le Blanc et al., 1995; Farenc et al., 2003) confirmed the influence of morphologic somatotype and body characteristic on body posture. But there is not enough data on how anthropometric measurements affect sagittal plane parameters. And the aim of this article is to reveal the coherence between some anthropometric parameters and spine sagittal alignment among schoolchildren.

MATERIAL AND METHODS

Assessment of schoolchildren's body posture and anthropometric parameters was performed according to standards of medical ethics (Declaration of Helsinki). We assessed 405 schoolchildren (210 girls and 195 boys). Mean age (*mean ± standard error mean*) was 11.6 ± 0.045 years (range 10–13) for boys and 11.48 ± 0.037 years (range 10–12) for girls.

Height of schoolchildren was measured with a steel anthropometer, weight with a weighing machine. Amount of body fat mass was calculated from skinfolds' measurements, performed with Harpenden caliper. Skinfolds' measurements were taken in two points: m. triceps brachii area and subscapular area on the right side of body with 0.2 mm precision. Amount of body fat mass (in percent) was calculated using the T. G. Lohman and M. H. Slaughter's formulae for 6–16 years old children (Heyward, Stolarczyk, 1996).

The curves of spine's sagittal plane were measured with cirtometer — graduated flexible curve that holds position given to it, placing it on the spinous processes of vertebrae. The angles of thoracic kyphosis and lumbar lordosis were calculated.

Schoolchildren were divided into three groups of height, weight, fat mass and fat-free body mass. Medium value we considered value rate of mean $\pm \frac{1}{2}$ standard deviation. Other groups were named as big or small respectively to specific parameter.

Data were analyzed by using *SPSS 10.0 for*

Windows. Student's test was used for statistical differences estimation between groups. Pearson's and Spearman's correlation analysis was used to estimate correlation between anthropometric and sagittal plane measurements. Analysis of variance (ANOVA) was performed for assessing statistical significance of differences. *P* value < 0.05 was considered statistically significant.

RESULTS

The mean values of children's height, weight, fat mass and fat-free body mass are presented in the table.

The height of schoolchildren's had statistically significant difference according to gender. The analysis revealed no significant difference for weight among boys and girls. There was significant difference of body fat mass amount; it was greater in girls ($p < 0.05$). Amount of fat-free mass was greater in girls, but no significant difference was established. Thoracic kyphosis mean value was different between gender groups ($p < 0.05$), although there was no difference in lumbar lordosis. Proportional distribution according to kyphosis expression was similar in boys and girls, but it was different analyzing lumbar lordosis. Boys tended more often have decreased lordosis than girls. Variation of height, amount of body fat mass and lordosis was greater in boys.

The correlation analysis (Pearson's coefficient) revealed no strong significant correlation between anthropometric and sagittal plane measurements in both boys and girls. Significant but weak positive correlation was detected between body weight and thoracic kyphosis ($r = 0.225$, $p = 0.002$) and between body weight and lumbar lordosis ($r = 0.206$, $p = 0.005$) in girls; and body fat mass and lordosis ($r = 0.203$, $p = 0.009$) in boys. The correlation analysis (Spearman's coefficient) revealed additional significant weak correlation between body fat mass and thoracic kyphosis in girls ($r = 0.229$, $p = 0.003$) and in boys ($r = -0.214$, $p = 0.006$).

Parameters	Boys			Girls		
	Parameter's groups					
	Small	Medium	Big	Small	Medium	Big
Height	140.16 ± 0.88	149.65 ± 0.47	155.31 ± 0.73	144.11 ± 0.66	150.52 ± 0.31	156.01 ± 0.41
Weight	31.53 ± 0.64	39.57 ± 0.47	48.03 ± 1.2	31.98 ± 0.48	38.56 ± 0.48	50.89 ± 1.3
Fat mass	10.51 ± 0.27	16.34 ± 0.58	28.04 ± 2.47	13.76 ± 0.39	19.42 ± 0.42	29.61 ± 1.44
Fat-free mass	27.5 ± 0.45	32.13 ± 0.43	36.68 ± 0.42	26.85 ± 0.39	31.1 ± 0.28	36.67 ± 0.65

Table. Mean values (\pm standard error of mean) of schoolchildren's height, weight, fat mass and fat-free mass

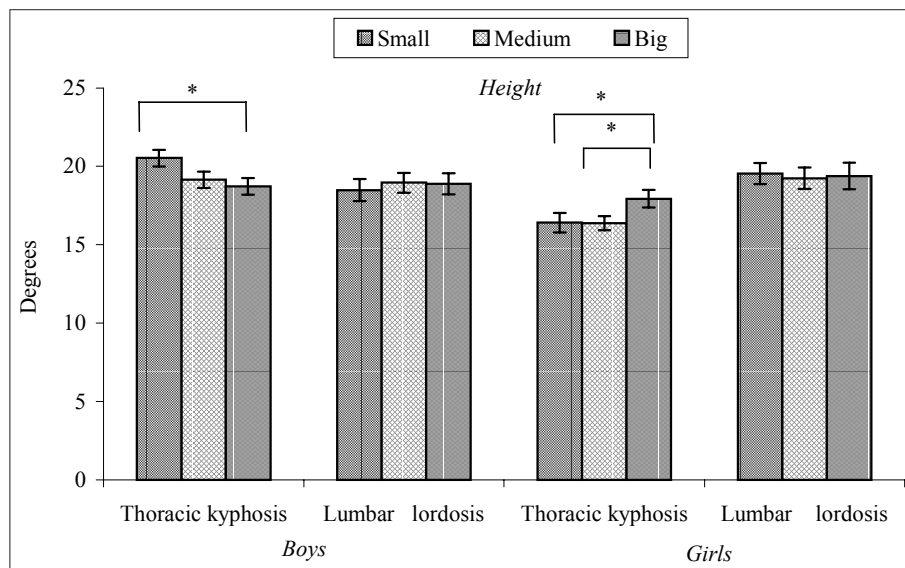


Fig. 1. Degrees of thoracic kyphosis and lumbar lordosis according to height groups among boys and girls

Note. * — $p < 0.05$.

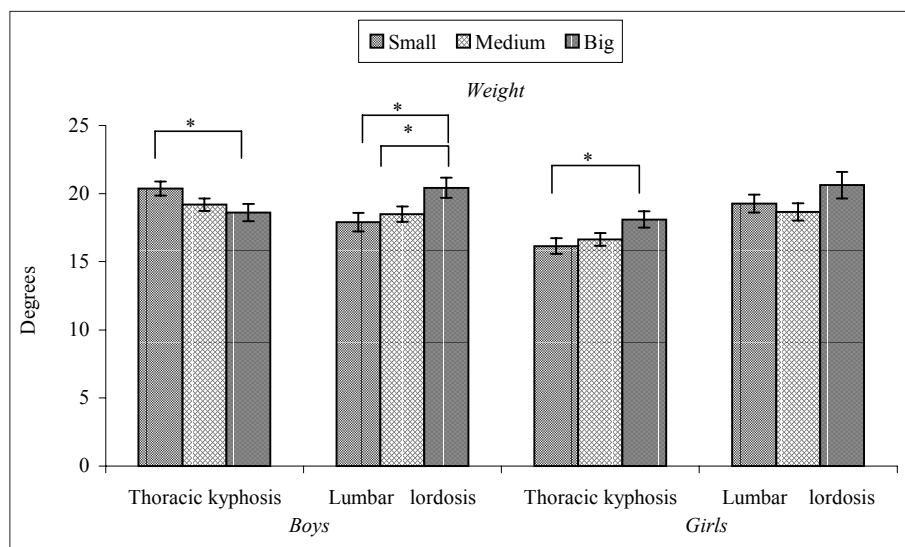


Fig. 2. Degrees of thoracic kyphosis and lumbar lordosis according to weight groups among boys and girls

Note. * — $p < 0.05$.

But there was no correlation between body fat mass amount and lumbar lordosis in boys.

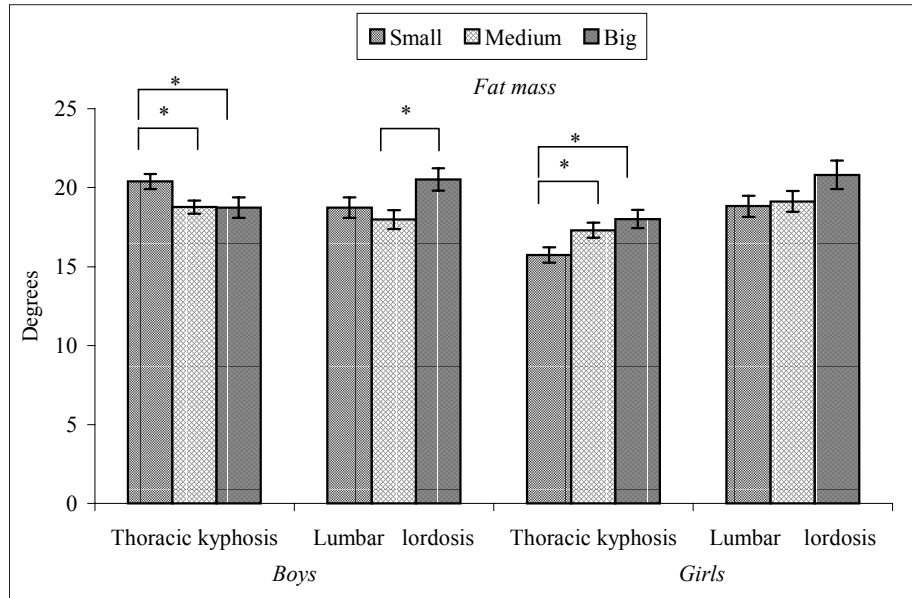
The analysis of variance performed for mean values of kyphosis as calculated by each of height groups yielded significant statistical differences among boys, and showed no significant difference among girls. Mean values of lumbar lordosis calculated by each of height groups had no significant differences also in girls and boys. It was established that thoracic kyphosis of boys with small height was greater than kyphosis of boys with big height. Lordosis of boys with small height was smaller than lordosis of those with big height, but difference wasn't statistically significant (Fig. 1). Kyphosis in girls with big height was more expressed ($p < 0.05$) than in those with medium and small height. Lordosis expression was similar in all height groups among girls.

The analysis of variance performed for the mean values of kyphosis as calculated by each of

weight groups yielded significant statistical differences among boys and girls. Mean values of lordosis have significant difference only among boys. Boys with small weight had greater thoracic kyphosis than those with big weight ($p < 0.05$) and their lordosis was statistically significant smaller (Fig. 2). Boys with big weight had greater lordosis than those with medium and small weight ($p < 0.05$). Kyphosis was greater among girls with big weight.

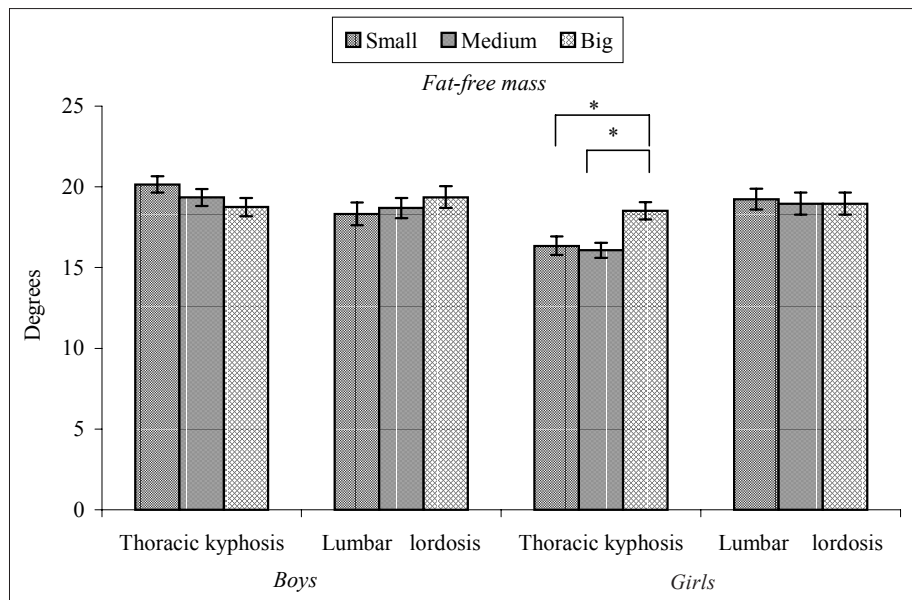
The analysis of variance revealed statistical significant differences among thoracic kyphosis and lumbar lordosis mean values according to amount of fat mass in boys. Among girls statistical significant difference was only in kyphosis mean values. Thoracic kyphosis of boys with small amount of fat mass was greater than kyphosis of boys with medium and big amount of fat mass ($p < 0.05$) (Fig. 3). Boys with big amount of fat mass had greater lordosis than those with medium

Fig. 3. Degrees of thoracic kyphosis and lumbar lordosis according to fat mass groups among boys and girls



Note. * — $p < 0.05$.

Fig. 4. Degrees of thoracic kyphosis and lumbar lordosis according to fat-free body mass groups among boys and girls



Note. * — $p < 0.05$.

fat mass. Girls with small amount of fat mass had minimal kyphosis and lordosis values.

The analysis revealed no significant differences between lordosis mean values and different fat-free body mass groups in both gender groups. Differences were significant only in kyphosis mean values among girls. Girls with bigger fat-free body mass tended to have greater kyphosis values (Fig. 4) than girls with medium and small fat-free body mass ($p < 0.05$).

Although many authors have established correlation between anthropometric and posture parameters (Nissinen et al., 2000; Tambovtseva, Panasiuk, 2000), our research data analysis revealed that among the schoolchildren, who participated in this research, there was no strong statistically significant correlation between

anthropometric and spine's sagittal profile measurements. This could be due to absence of researches of anthropometric data influence on sagittal plane curves, because usually "posture" is used for describing frontal plane alignment. Although data grouping in our research showed some consistent patterns according to the relationship of these parameters.

The relations between anthropometric data and sagittal curves were different according to the participants' gender. This peculiarity could be due to different beginning of growth spurt and posture development among different genders (Nissinen et al., 2000; Tambovtseva, Panasiuk, 2000).

According to our research data, height had no statistically significant influence on lumbar lordosis, but it was connected with thoracic

kyphosis in boys. The analysis of Lithuanian children's morphological features (Tutkuvienė, 1995) also confirmed that the children with bigger or smaller than medium height have greater possibility for scoliosis or kyphosis development. Height was the strongest predictor for the development of trunk abnormalities in both sexes among the children of 11 and 13 years old in The Netherlands (Hazebroek-Kampschreur et al., 1994).

Researchers also emphasize body weight and fat mass influence on posture, especially scoliosis (Allard et al., 2004; Farenc et al., 2003). The data of this research also confirm coherence between weight and fat mass and kyphosis in both sexes. Lumbar lordosis was associated with anthropometric data only in boys.

CONCLUSIONS

1. Coherence between anthropometric parameters and spine's sagittal profile differs according to gender. The number of statistically significant connections between these two parameters' groups was greater in boys.
2. Anthropometric measurements have greater coherence with thoracic kyphosis in comparison with lumbar lordosis.
3. Body weight and fat mass were statistically significantly different according to kyphosis and lordosis values in boys, although fat-free body mass had no significant difference with sagittal curves expression. Body weight, fat mass and fat-free body mass among girls were associated only with thoracic kyphosis.

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ALTERATION OF SPORT PERFORMANCE OF HIGH PERFORMANCE HEPTATHLON ATHLETE OVER OLYMPIC CYCLE

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ABSTRACT

In Lithuania, over the recent years a highly-skilled heptathlon athlete has been developed. She made her international debut in the Sydney Olympic Games in 2000 and took the 12th place. Every year she kept improving her skills and excellently prepared for the XXVIII Olympic Games in Athens where she won a silver medal.

Track-and-field heptathlon requires excellent physical fitness, development of all specific features, as well as good physical fitness for each contest. While planning the process of a heptathlon athlete's training, it is most important to elaborate an optimum structure of an annual cycle with regard to the competition schedule and the individual potential of human adaptation. To be able to control the process, it is necessary to monitor the dynamics of the physical and functional abilities of the athlete in different periods of the annual cycle of training.

The aim of the study was to analyse the dynamics of sports results of the Lithuanian heptathlon athlete A. S. in a four-year Olympic cycle and the dynamics of her physical and functional abilities over this period.

We analyzed the dynamics of the sports results of A. S. over the last five years. Her body composition indices were measured in laboratory, with determining psychomotor response time and movement frequency per 10 s. To determine her physical abilities, we measured her single muscular contraction power (SMCP), anaerobic lactic muscular power (AAMP). A running-track was used to establish the intensity of energetic processes at the anaerobic threshold level, with measuring heart rate (HR), running speed (km / h) and blood lactate concentration. The functional capacity of the circulatory and respiratory systems was assessed by the Roufier index (RI). Anaerobic capacity was measured with a gas analyzer at the critical intensity and anaerobic metabolism limits.

The sports results of A. S. kept improving every year except 2003. In the 2004 Olympic Games she gathered 6435 points and won the second place. In previous years, in separate heptathlon contests the sum total of her points reached 12.7—15.6%, whereas in the 2004 Olympic Games the difference among scores got in separate contests was less. Most points were won in the

100-m hurdling (15.1%) and the least in javelin throwing (13.3%).

Data of laboratory tests showed that the quality of the SMCP and AAMP indices, which are decisive in even five contests of heptathlon, over the four-year Olympic cycle showed a waded dynamics, but attained a high level one month before the Olympic start: her SMCP was 3.22 kgm / s / kg and AAMP 1.72 kgm / s / kg. Also, greatly improved her psychomotor response time, which reached 160 mls, and central nervous system lability (78 movements per 10 s). Her high muscular power was confirmed by performing ten jumps on a running-jumping track, when the difference between the highest and lowest jumps was insignificant and muscular fatigue in a series of jumps was low.

In the final period of the preparation for the Olympic Games under a short-lasting load the muscular power of A. S. reached a high level and allowed her to realize physical and functional abilities.

Keywords: *heptathlon, four-year Olympic cycle, physical abilities, functional capacity, physical and functional abilities.*

INTRODUCTION

In Lithuania, over the recent years a highly skilled heptathlon athlete A. S. has been developed. She made a fine international debut in the Sydney Olympic Games in 2000, where she took the 12th place. In the 2001 World Track-and-Field Championship she took the sixth place, won a bronze medal at the European

Championship of Youth under 23, and in 2002 took the fourth place in the 2002 European Championship. Her performance at the 2003 World Championship in Paris was not successful (the 10th place) (Milašius et al., 2003). In the subsequent year she improved considerably her technique in separate contests, developed her

physical and functional abilities and at the XXVIII Olympic Games in Athens, took the second place.

Track-and-field heptathlon requires excellent physical fitness, development of each single specific physical ability (Комарова, 1985) and fine performance for each contest (Молодцов и др., 1985; Radžiukynas, 1997).

There are differences in training all-rounders and separate contest performers. Training for each contest takes comparatively little time. The training of heptathlon athletes is an integrated process, which requires bearing in mind that training for a separate contest or developing a separate ability may influence the abilities involved in another contest (Hauptmann, 1994; Radžiukynas ir kt., 2004; Streckis et al., 2005). While planning the training of heptathlon athlete it is most essential to compile the optimal annual cycle of training, in which the contest calendar, the individual possibilities of human adaptation, ability to technique fitness of separate septathlon techniques should be accounted for (Karoblis, 1985; Платонов, 1997).

A sportswoman has to develop individually her abilities in separate contests and the related physical performance. After several years of training it becomes evident that in some contests the indices are lagging behind, although the sum total of points keeps increasing. This lagging behind most often is predetermined by the genetic and functional abilities, long-term adaptation peculiarities (Немцова, 1991; Komi, 1992; Моногаров, 1994; Skurvydas et al., 1998).

Analysis of the long-term dynamics of the improving results of top-class world's all-rounders and their training load has shown that it is necessary to analyze the process of training of top-class heptathlon athlete and her physical and functional abilities over a four-year Olympic preparatory cycle.

At present, there is a shortage of research analyzing the organizational and methodical peculiarities of long-term training and separate training cycles of highly skilled heptathlon athletes, the dynamics of their results in an Olympic cycle and human adaptation to physical loads.

The aim of the current research was to analyze the dynamics of sports results of A. S. over a four year Olympic cycle and the dynamics of her physical and functional abilities reflecting her human adaptation over this period.

METHODS

The contest results, the dynamics of physical and functional parameters of highly skilled Lithuanian heptathlon athlete A. S. were analyzed over a four-year Olympic cycle while preparing for the Athens Olympic Games of 2004 (Raslanas et al., 2001). Extended investigations of the Sports Science Laboratory of Vilnius Pedagogical University were performed seven times: before the Sydney Olympic Games (2000), before the World Track-and-Field Championship (31 July 2001), before the European Championship (5 July 2002), before the World Championship (23 December 2002, 13 August 2003) and before the Athens Olympic Games (4 June 2004, 16 July 2004). Laboratory tests included body composition indices, such as body mass, lung volume (LV), muscle and fat mass and their ratio (MFMI), as well as psychomotor response time (PRT), movement frequency per 10 s. Testing physical abilities involved single muscular contraction power (SMCP), anaerobic alactic muscular power (AAMP). A.S. underwent a ten-jump test on an jump and running meter with measuring the height and power of each jump. The intensity of energetic processes at the anaerobic metabolism threshold, heart rate, running speed (km / h) and lactate level in peripheral blood were assured by using a running-track.

The functional ability of the circulatory and respiratory systems was assessed by the Roufier index (RI), heart rate at rest, response to an orthostatic test, standard physical load and at recovery. A gas analyzer was used to measure aerobic capacity by gradually increasing the load up to the critical intensity level. On reaching the critical intensity and anaerobic metabolism threshold limit, lung ventilation (LV), heart rate (HR), oxygen uptake (VO_{2max}), oxygen pulse (OP), work power (W), work efficiency (oxygen uptake for 1 W of work) were established.

RESULTS

The heptathlon athlete's results kept improving every year. In 2000, at the Olympic Games, A. S. took the 12th place and gathered 6021 points. In 2000, at the World Track-and-Field Championship in Edmonton (Canada) she got 6112 points and took the 6th place. In 2002, at the European Championship, A.S. won the 4th place and collected

Table 1. Sports results' dynamics of highly-skilled heptathlon athlete A. S. in 2000—2004

Event, date, place, number of finishing participants	Results' characteristics	Contests							Total place	Total points
		100 m hurdling, s	High jump, m	Shot put, m	200 m, s	Long jump, m	Javelin throwing, m	800 m, min		
XXVII Olympic Games, Sidney, 23—24 09 2000, 33 participants	Result	14.37	1.78	15.09	25.35	5.97	45.43	2.20.25	12	6021
	Total points in contest	927	953	867	855	840	772	820		
	% in heptathlon	15.4	15.8	14.4	14.2	13.9	12.8	13.6		
	Place in contest	27	8—12	2	19—20	14	8	22		
World Track-and-Field Championship, Edmonton, 04—05 08 2001, 18 participants	Result	14.37	1.79	16.06	25.52	6.00	46.12	2.20.78	6	6112
	Total points in contest	927	966	932	840	850	784	813		
	% in heptathlon	15.2	15.8	15.3	13.7	13.9	12.8	13.3		
	Place in contest	13	5—8	1	11	7	7	10		
European Track-and-Field Championship, Munich, 05—06 07 2002, 24 participants	Result	14.08	1.80	16.72	25.01	6.14	46.72	2.23.38	4	6275
	Total points in contest	967	978	976	886	893	797	778		
	% in heptathlon	15.4	15.6	15.6	14.1	14.2	12.7	12.4		
	Place in contest	16	4—8	1	1	9	7	14		
World Track-and-Field Championship, Paris, 23—24 08 2003, 22 participants	Result	14.44	1.76	16.35	25.76	5.86	47.57	2.18.64	10	6077
	Total points in contest	917	928	952	818	807	813	842		
	% in heptathlon	15.0	15.3	15.7	13.6	13.2	13.4	13.8		
	Place in contest	21	10—18	2	20	16	6	15		
XXVIII Olympic Games, Athens, 20—21 08 2004, 26 participants	Result	14.03	1.76	16.40	24.82	6.30	49.58	1.15.92	2	6435
	Total points in contest	974	928	955	903	943	852	882		
	% in heptathlon	15.1	14.4	14.8	14.0	14.7	13.3	13.7		
	Place in contest	24	14—17	1	16	7	3	14		

Table 2. Characteristics of ten jumps performed by highly-skilled heptathlon athlete A. S. on jump-meter

Indices	Testing date	04 06 2004	16 07 2004
	Total height, cm		414.7
10 jump mean, cm		41.5	39.5
Max. jump, cm		45.1	43.8
Min. jump, cm		39.1	34.2
10 jump power mean, W / kg		41.5	38.7
Push off mean, s		0.197	0.203
Flight mean, s		0.583	0.570

6275 points. In the 2003 World Championship in Paris A.S. failed to improve her result: with her 6077 points she took only the tenth place (Table 1). However, the same year in another contest she covered the A level qualifying result which allowed her participation at the Athens Olympic Games. After a year, at these Games, A.S. reached her personal record (6435 points), took the second place and won a silver medal.

Analysis showed that the contribution of separate contests to the total result was uneven. According to the points collected in 2000—2003,

all the seven contests can be divided into three groups. The first group comprises the 100-m hurdling, high jump and shot put (15.0—15.8% of the total points). The second group includes 200 m and long jump contest (13.7—14.2% of the total points). The third group embraces javelin throwing and 800 m running (12.4 and 13.6%). However, in 2004 this distribution underwent changes. The difference among the points gathered in different contest decreased. The first group included high jump, hurdling, shot put and long jump which furnished 15.1—14.4% of the total heptathlon

Table 3. Dynamics of aerobic capacity indices of highly-skilled heptathlon athlete A. S. in 2000—2003

Indices Testing date	Critical intensity limit							Anaerobic threshold limit							
	LV, l/min	HR, b/min	VO ₂ , l/min	VO ₂ , ml/min/kg	OP, ml/t	W	O ₂ , ml/l W	LV, l/min	HR, b/min	VO ₂ , l/min	VO ₂ , ml/min/kg	OP, ml/t	O ₂ % from VO ₂ max	W	O ₂ , ml/l W
07 06 2000	113.3	186	3.70	47.5	18.0	260	14.2	71.3	160	2.71	34.7	16.9	73.2	220	12.3
05 07 2002*	98.0	172	2.86	35.3	16.6	280	10.2	80.4	158	2.62	32.3	16.2	91.6	250	10.5
13 08 2003	118.2	183	3.14	38.8	17.1	290	10.8	76.8	162	2.44	30.1	14.5	77.0	250	9.76

Note.* — A.S. did not reach critical intensity limit in test performed 5 July 2002.

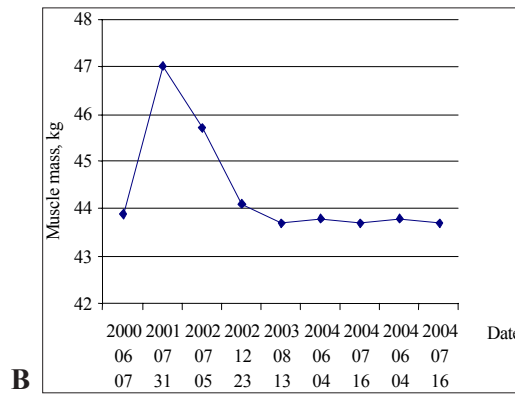
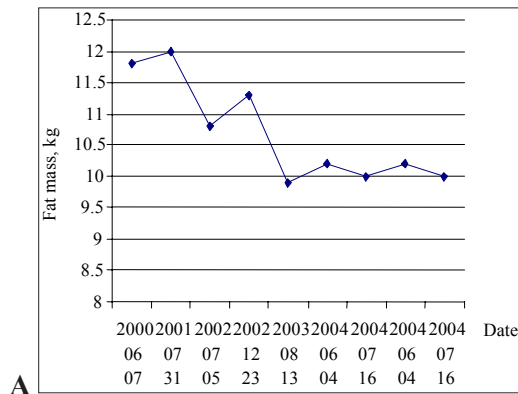


Fig. 1. Dynamics of muscle (A) and fat mass (B) indices of highly-skilled heptathlon athlete A. S. in 2000—2004

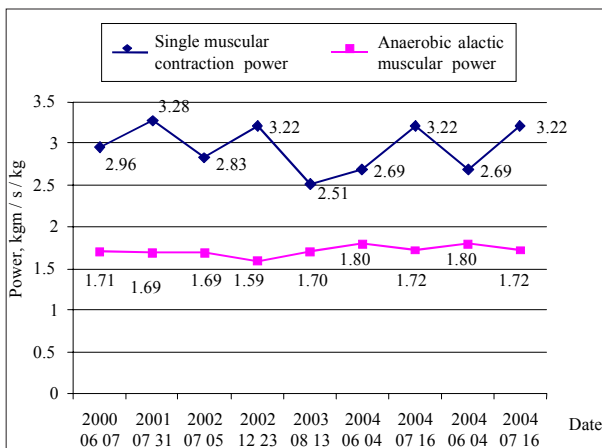


Fig. 2. Dynamics of single muscular contraction power and anaerobic alactic muscular power indices of highly-skilled heptathlon athlete A. S. in 2000—2004

points. The second group comprised 200 m and 800 m running and javelin throwing (14.0—13.3% of the total points) (Table 1).

The results of most contests, except high jump and putting the shot were better than in previous years. In 2004 a particular improvement was shown in javelin throwing, 100-m hurdle-race, 800-m running, long jump, in which A. S. improved her personal results. However, she should increase her anaerobic glycolytic and aerobic capacity, although more time dedicated to developing aerobic capacity may reduce muscular contraction power and speed.

Data of laboratory tests showed an uneven dynamics of the body composition indices of A. S. Her body mass in 2001 reached 85.0 kg, the

muscular and fat mass being also highest. The conclusion was that these body mass indices were too high; therefore A. S. reduced her body mass by next season (Fig. 1).

In many of heptathlon contest, single muscular contraction and anaerobic alactic muscular power indices are of great importance. Even in five heptathlionic contests the quality of these indices is partially decisive for the final result. A.S. developed a rather high SMCP (above 3.00 kgm / s / kg). On the eve of the 2003 World Championship it was too low (2.51 kgm / s / kg). However, a year later, one month before the Olympic Games, it returned to the former level. The AAMP index over the study period was rather stable; however, it should be improved if higher results are desirable (Fig. 2). The PRT was lowest in 2002, reaching 149 mls— a very high index. Before the Olympic Games it reached 160 mls.

In 2004, a ten-jump test was included into the testing program of A. S. It was performed on an SBM-1 jumping and running meter. The test results were obtained 2.5 and 1 months before the Olympic Games. All muscular power indices were higher in June than in July (Table 2).

The intensity of bioenergetic processes at the anaerobic metabolism threshold and critical intensity levels was indicative of the aerobic capacity of A. S. To determine the anaerobic metabolism threshold, the track running speed, PR and blood lactate concentration were measured.

The running speed of A. S. at this limit varied between 7.0 and 11 km / h, and in 2004, 10 months before the Olympic Games, her running speed at the anaerobic metabolism threshold was 7.0 km / h, HR being 165 b / min and blood lactate level — 5.2 mmol / l.

The aerobic capacity of A. S. at the critical intensity level over three years made an insignificant progress. First of all it was related to body mass increase. The highest VO_{2max} (47.5 ml / kg) was fixed in 2000 (Table 3). In 2002, oxygen consumption fell down to 35.3 ml / kg. However, in 2002 the working efficiency of A. S. at critical intensity and anaerobic metabolism threshold limits was rather high, taking 10.2—10.5 ml oxygen per 1 W. The increasing potential of her aerobic abilities at the critical intensity limits is shown also by a high relative oxygen uptake at the anaerobic metabolism threshold (it reached 91.6% of VO_{2max}). In 2003, VO_{2max} increased to 38.8 ml / kg, and at the anaerobic metabolism threshold limit oxygen uptake was 30.1 ml / kg (77% of VO_{2max}). In 2004, her aerobic capacity increased even more, allowing A. S. to improve her result in 800-m running.

DISCUSSION

Heptathlon is one of the most difficult women's track-and-field competitions. Its final result depends on a good performance in all heptathlionic contests. Most authors (Комарова, 1985; Hauptmann, 1994; Моногаров, 1994) claim that heptathlon cannot be regarded as mere sum of separate track-and-field contest results. In the opinion of many authors (Bosco, 1982; Немцова, 1991), results in heptathlon first of all depend on the well developed muscular power under a short-term load. Even five heptathlionic contest require high anaerobic alactic muscular power, one contest requires mixed anaerobic alactic glycolytic capacity, and the last one, 800-m running, requires a high anaerobic glycolytic and aerobic capacity. A.S. has been showing the highest points in three contests — 100-m hurdling, high jump and shot put. Her javelin throwing and 800-m running results have been poorer. At the 2003 World Championship in Paris A. S. performed not too well. The unsatisfactory result was predetermined by a poorer performance in the contests in which she had been showing much

better results (Milašius et al., 2003). At the Athens Olympic Games A. S. managed to improve personal results in three contests and to balance the number of points won in each contest.

Laboratory tests show that A. S.'s body mass, fat in particular, is too high. However, her muscular contraction power under anaerobic alactic energy production is rather high. Her psychophysiological state indices correspond to her muscular power. In P. Komi's opinion (1992), these indices are very important while developing speed and force, as they are a constituent part of agility. As one of the most objective methods of determining muscular power, a maximum strain ten-jump test can be applied, its data show muscular strength endurance. The annual testing of aerobic capacity does not show a pronounced progress in the aerobic capacity of A. S. Her aerobic endurance, which is essential in 800-m running, though improved in 2004, is not yet sufficient.

CONCLUSIONS

1. A. S., the highly skilled heptathlon athlete from Lithuania, is one of the world's best athletes that performed well at the Athens Olympic Games. Over the recent five years her skills have been growing, however, in the 2003 World Championship she failed to improve her result and won the 5th—6th place. Supposedly this was a methodological flaw in the final microcycle of training for the World Championship.
2. In 2002—2003, the heptathlionic contests of A. S. by points were divided into three groups. The first group comprised contests in which A. S. wins more than 15% of all heptathlon points, i. e. 100-m hurdle-race, high jump, putting the shot. The second group included contests that provided 14% of points each 200-m running and high jump. The third group consisted of the two backward contests — javelin throwing and 800-m running, which provided less than 13% each. The future progress of A. S. is most probable in javelin throwing, in which the result greatly depends on rapid muscular contraction and the biomechanics of movement performance. However, in 2004 there became evident a new variant of the contest assessment by points: the

first group comprised the contests in which A. S. wins 14.4—15.1% of points (hurdling, high jump, shot put, long jump), and the second group embraces those providing 13.3—14.0% of points (200-m and 800-m running and javelin throwing).

3. The physical and functional abilities of A. S. over the study period have been clearly increased. Her muscular power under a short-term load is sufficiently high, though in separate years of the Olympic cycle it showed

an uneven dynamics. The physical and functional capacity of A. S. was improving according to researchers' recommendations (while reducing the body mass to increase muscular contraction force, to improve the psychomotor response rate).

Following a certain stabilization of these indices in 2003, after one year they improved again, allowing A. S., even in three contests from seven, to improve her personal results and to show sufficiently high results in other contests.

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MOBILIZATION OF CARDIOVASCULAR FUNCTION AT ONSET OF DOSED AEROBIC AND ALL-OUT ANAEROBIC WORKOUTS

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ABSTRACT

The objective of this study was to compare the peculiarities in the mobilization of cardiovascular function at the onset of an exercise test in dependence on age and the type of adaptation to physical loads. The study's participants were boys of 11, 12, 13 and 14 years old and adults, i. e. 17 voluntary students who were not engaged in sports training and well-trained athletes (all participants were members of various national teams), i. e. 23 athletes in the endurance group, 19 — in the sprint group and 21 — in the combative sports group (box, judo and wrestling). The subjects underwent: 1) Rouflier's test (30 squats per 45 seconds); 2) a 30-second duration maximal vertical jump test. A computerized electrocardiogram (ECG) system "Kaunas-Load" was employed for the 12-lead ECG recording and analysis during the performance of workloads. A computerized program allowed to measure the ratio of JT and RR intervals (JT / RR) and the velocity of adaptation of cardiovascular system to exercise, i.e. the index of velocity of adaptation (V_{Ad}), by calculation the difference between the relative changes of JT and RR intervals as a difference: $V_{Ad} = (Jt_i / JT_0) 100\% - (Rr_i / RR_0) 100\%$. The results obtained during the study allowed to conclude that faster adaptation at the onset of the exercise is rather characteristic for younger persons but the type of the exercise performed during the long term training process plays a significant role in the developing and improving the velocity of adaptation of cardiovascular system. A faster adaptation at the onset of the exercise is a more characteristic feature for the trained athletes in sprint events and combative sports than the representatives of the endurance group or non-athletes. One of the effects of long term adaptation to exercise is a smaller mobilization of cardiovascular system at the onset of the dosed aerobic and all-out anaerobic exercise and the endurance exercise has the most influence on it.

Keywords: cardiovascular system, adaptation, exercise test.

INTRODUCTION

At the onset of an exercise a lot of body systems adapt to the variations of load. Consequently, a number of indices exist for the measurement of response of body functions to workload. In practice, the response to exercise can be evaluated by measuring the changes in the performance of one or another system (Hughson, Tschakovsky, 1999; Hedelin et al., 2000; Porter et al., 2001; Rothe, Gersting, 2002). Recently, more frequent research has been carried out to examine the response of body to exercise as an integral impact on the body (Ahlborg et al., 1996; Ursino, 1998; Biggiero, 2001). The cardiovascular system is one of the

holistic systems of the human body why the reactions of cardiovascular system to the constant-load test or all-out test allow us to assess the functional peculiarities of the body (Vainoras, 2002).

The fast mobilization of body functions at the onset of an exercise is very important in many kinds of sport and there are a lot of situations in competitive sports when this ability is the determinant factor or important element of functional and performance capabilities (Платонов, 2004). On the other hand the effects of an exercise to growing and developing of movement abilities are dependent on the intensity

Indices Subject group	HR, b / min	JT interval, ms	JT / RR	ABP, mmHg
I (11 years)	$\frac{130.8 \pm 3.2^*}{168.6 \pm 4.3^{**}}$	$\frac{214.5 \pm 4.2}{191.0 \pm 4.1}$	$\frac{0.462 \pm 0.01}{0.517 \pm 0.01}$	$\frac{124.5 / 68.4}{133.3 / 61.2}$
II (12 years)	$\frac{129.9 \pm 4.3}{167.4 \pm 5.1}$	$\frac{21.2 \pm 5.1}{184.2 \pm 3.3}$	$\frac{0.455 \pm 0.01}{0.506 \pm 0.02}$	$\frac{125.0 / 68.3}{138.6 / 62.6}$
III (13 years)	$\frac{136.8 \pm 2.7}{175.8 \pm 2.6}$	$\frac{209.6 \pm 3.4}{184.5 \pm 2.6}$	$\frac{0.459 \pm 0.01}{0.516 \pm 0.01}$	$\frac{124.6 / 70.6}{139.3 / 64.8}$
IV (14 years)	$\frac{136.4 \pm 3.0}{174.2 \pm 2.2}$	$\frac{217.2 \pm 3.4}{181.1 \pm 2.4}$	$\frac{0.466 \pm 0.01}{0.520 \pm 0.02}$	$\frac{129.1 / 69.2}{152.8 / 5.8}$
V (Non-athletes)	$\frac{78.3 \pm 2.5}{178.2 \pm 4.7}$	$\frac{268.2 \pm 3.2}{163.1 \pm 4.6}$	$\frac{0.358 \pm 0.01}{0.631 \pm 0.03}$	$\frac{123.2 / 75.6}{198.2 / 31.6}$
VI (Endurance group)	$\frac{66.4 \pm 2.3}{172.4 \pm 1.8}$	$\frac{294.3 \pm 3.3}{161.2 \pm 1.2}$	$\frac{0.343 \pm 0.01}{0.621 \pm 0.02}$	$\frac{121.6 / 78.1}{193.7 / 35.0}$
VII (Sprint group)	$\frac{79.4 \pm 2.6}{178.2 \pm 2.9}$	$\frac{266.5 \pm 3.1}{165.2 \pm 3.4}$	$\frac{0.353 \pm 0.01}{0.633 \pm 0.02}$	$\frac{120.5 / 80.2}{189.4 / 36.6}$
VIII (Combative sports group)	$\frac{72.7 \pm 2.5}{178.4 \pm 2.8}$	$\frac{265.7 \pm 4.0}{162.9 \pm 2.3}$	$\frac{0.351 \pm 0.01}{0.628 \pm 0.03}$	$\frac{122.6 / 35.8}{203.1 / 34.5}$

Table 1. Maximal values of cardiovascular indices registered during workouts

Note. * — upper row — Roufier's test, ** — lower row — a 30-s vertical jump test.

of an exercise, which from the physiological point of view is a level of mobilization of body functions during exercising. The objective of this study was to find out the peculiarities in the mobilization of cardiovascular function at the onset of an exercise test in dependence on age and the type of adaptation to physical loads.

MATERIAL AND METHODS

The study participants were four groups of boys: 11 years old ($n = 22$), 12 years old ($n = 18$), 13 years old ($n = 25$) and 14 years old ($n = 20$) and four adult groups (non-athletes, sprint, endurance and combative sports). The non-sportsman group contained 17 voluntary students who were not engaged in sports training (aged 20.9 ± 1.21 , body mass index — 22.3 ± 0.38). Well-trained athletes fell into three groups (all participants were members of various national teams), i. e. 23 athletes were in the endurance group; 19 — in the sprint group and 21 — in the combative sports group (box, judo and wrestling).

The local ethical committee has approved this study protocol. The subjects underwent: 1) Roufier's test (30 squats per 45 seconds); 2) a

30-second duration maximal vertical jump test.

Arterial blood pressure (ABP) was measured by using Korotkoff's method and a computerized electrocardiogram (ECG) analysis system "Kaunas-Load", developed at the Kaunas Medical University Institute of Cardiology, was employed for the 12-lead ECG recording and analysis. The changes in RR interval or heart rate (HR), JT interval, and in the ratio of intervals JT / RR were analysed. The computerized program allowed us to evaluate the velocity of adaptation of cardiovascular system to exercise, i. e. the index of velocity of adaptation (V_{Ad}), by calculation the difference between the relative changes of JT interval and RR interval as a difference: $V_{Ad} = (Jti / JT0) 100\% - (Rri / RR0) 100\%$. The significance of the difference between parametric and nonparametric values was evaluated by computing criterion t . The difference has been considered statistically reliable, when $p < 0.05$ (95 CI).

RESULTS

Table 1 presents the maximal values of cardiovascular indices registered during the performance of exercise tasks. All values of heart

Table 2. The values in velocity of adaptation (V_{Ad}) of cardiovascular system at onset of Roufier's test (aerobic workout), 30 second all-out test in jumping (anaerobic workout)

Subject group	Exercise test	
	Roufier test	a 30-s vertical jump test
I (11 years)	13.4 ± 1.55	11.9 ± 0.93
II (12 years)	13 ± 1.58	12.7 ± 1.35
III (13 years)	9.3 ± 1.16	10.4 ± 1.1
IV (14 years)	13 ± 0.96	12.7 ± 1.14
V (Non-sportsmen)	21.4 ± 1.33	22.1 ± 1.33
VI (Endurance group)	19.8 ± 1.34	20.6 ± 1.31
VII (Sprint group)	16.3 ± 1.33	16.9 ± 1.32
VIII (Combative sports group)	17.2 ± 1.29	17.8 ± 1.30

rate, JT interval and arterial blood pressure correspond with the data presented in publications of other scientists. As an example, the differences in the reactions of arterial blood pressure between adolescents and adults can be explained by the great elasticity of blood vessels in young age (Shephard, 2001).

The results obtained during the study showed that the velocity of adaptation at the onset of the dosed aerobic and all-out anaerobic exercise depends on age. All groups of the boys have a significantly ($p < 0.05$) faster adaptation than adult groups. The slowest velocity of adaptation has been showed by the adult non-athletes ($21.4 \pm 1.33\%$ — when performing Roufier's test and $22.1 \pm 1.33\%$ — when performing the jumping task. The results presented in Table 1 demonstrate that the velocity of adaptation at the onset of the exercise depends on the residual effects of training but not on the type of exercise-test. The significant differences between values in the velocity of adaptation in response to exercising were not found when three various test protocols were used (Roufier's test, a 30-second duration maximal vertical jump test). The fastest adaptation at the onset of the exercise was in the sprint group ($16.3 \pm 1.33\%$). The values of velocity of adaptation in the endurance group were $19.8 \pm 1.34\%$. The difference between the sprint and endurance groupings was statistically

significant ($p < 0.05$). The velocity of adaptation in the group of non-athletes was the slowest — $21.4 \pm 1.33\%$. Summarizing, the faster adaptation at the onset of the exercise is quite in character for the sprint and combative sports than the endurance or non-athlete contingents.

Figure presents the comparison of the mobilization of cardiovascular function during various exercise tests. The greatest difference among the groups was revealed by a 30-second duration all-out maximal vertical jump test. The greatest values were in the group of non-athletes and the least — in the endurance group. The difference between these contingents was statistically significant ($p < 0.05$). The Roufier's test also revealed the differences between the groups.

DISCUSSION

The fast mobilization of body functions at the onset of an exercise is very important in many kinds of sport and there are a lot of situations in competitive sport when this ability is a decisive factor or important element of functional capability. There are not so many integral methods designed for the assessment of individual peculiarities of mobilization of body functions during exercising. The energy system's approach is fit enough for explanation of matters but it is

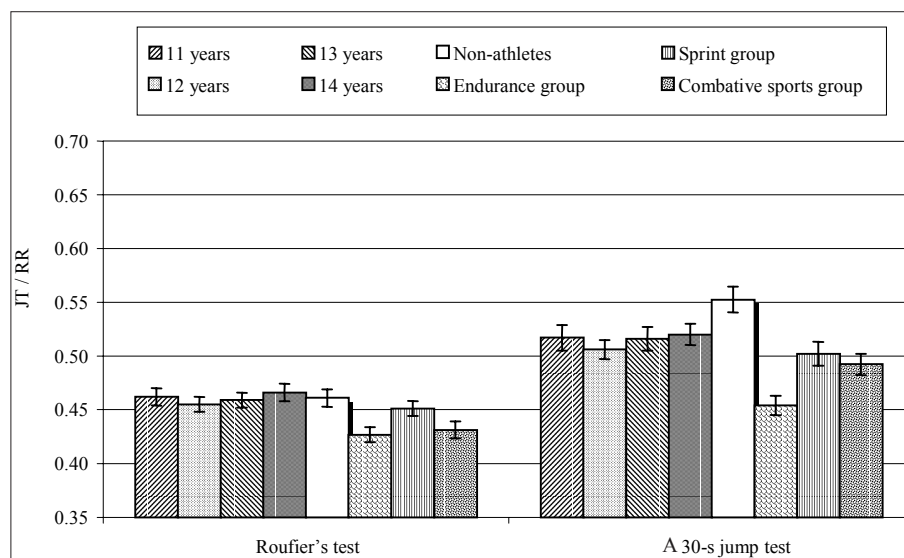


Fig. Mobilization of cardiovascular function during the exercise tests (maximal values in changes of the ratio of JT interval and RR interval (JT / RR))

difficult to use it in practice. On the other hand, given repeated reproduction over the years, these early attempts have led to two common misconceptions in the exercise science and coaching professions (Green, 1995). First, that the energy systems respond to the demands of intense exercise in an almost sequential manner, and secondly, that the aerobic system responds slowly to these energy demands, thereby playing little role in determining performance over short durations. More recent research suggests that energy is derived from each of the energy-producing pathways during almost all exercise activities. The duration of all-out exercise at which equal contributions are derived from the anaerobic and aerobic energy systems occurs is considerably earlier than has traditionally been suggested (Spencer et al., 1996; Gastin, 2001; Green, 1995). We must point out that the last year studies have shown a great importance of complexity in body functioning (Tulpo et al., 2002; Vainoras, 2002). Since the cardiovascular system is one of the constituent parts and a holistic system of the body, therefore, the reactions of cardiovascular system to constant-load tests or all-out tests allows one to assess the functional capabilities and functional peculiarities of the body (Vainoras, 2002).

Concerning the problem of evaluation of the peculiarities in the mobilization of the body functioning during exercising the two factors are important: first, the velocity of adaptation at the onset of an exercise, and second, to what extent the body function was mobilized. The results obtained in this study have shown what a significant role in developing and improving the

velocity of adaptation of cardiovascular system at the onset of the exercise is played by the exercise type or the type of adaptation. The main differences in the content of training between the sprint and endurance groups consist in prevailing the interval methods of training in the sprint group and sustained exercise in endurance events (Платонов, 2004). Sudden changes in intensity in workloads during the fight are the typical characteristics of combative events. Thus, these changes could be a possible explanation of differences in the values of the velocity of adaptation among the endurance and sprint or combative contingents found out during this study.

Individual peculiarities and differences between various groups can be assessed making use of the index of velocity of adaptation (V_{Ad}), which represents the difference between the relative changes of RR and JT intervals of ECG. Our previous studies (Poderys, 2000; Poderys, 2002) have shown that the velocity of adaptation at the onset of the exercise depends rather on the functional state or residual effects of training than on the type of exercise-test. During the study designed to evaluate the changes in the velocity of adaptation in the sprint group significant changes under the influence of concentrated heavy training loads have been found, i. e. $16.3 \pm 1.33\%$ — before the training, $26.2 \pm 1.42\%$ — after two weeks of heavy training, and $20.1 \pm 1.35\%$ — after one week of recovery accordingly (Poderys, 2002). All this allows us to conclude that individual peculiarities and differences between contingents in the velocity of adaptation of cardiovascular system at the onset of the exercise can be evaluated making use of the difference

between the relative changes of RR and JT intervals of ECG. The results obtained during this study showed that faster adaptation at the onset of the exercise is rather characteristic for younger persons but the type of exercise performed during the training process plays a significant role in the developing and improving the velocity of adaptation of cardiovascular system. A faster adaptation at the onset of the exercise is rather characteristic for the sportsmen trained in sprint events and combative sports than the representatives of the endurance group or non-athletes.

The studies designed to assess the individual peculiarities of body functioning during the workloads usually have a task to evaluate to what extent the body function was mobilized during the performance of the task. Absolute values of heart rate during exercising can be used for these purposes. Such methods are practical but not precise for outlining to what extent the mobilization of cardiovascular system occurred (Vainoras, 1996, 2002; Poderys, 2000). A special study performed by V. G. Bochkov in 1986, has shown that the activation of physiological systems could be expressed by normalized values in the ratio of underlying indices of the physiological system. These underlying indices of cardiac function can be the ratio of JT and RR intervals (Vainoras, 1996). The JT interval is not independent of the ventricular depolarisation pattern and can be used as an accurate means of following the duration of ventricular depolarisation (Banker et al., 1997) and its changes interrelate with the changes in the intensity of metabolism (Vainoras, 1996). The results obtained during this study have shown that the ratio JT / RR can be useful for outlining to what extent a cardiovascular function was mobilized. As it was found during the incremental increase in workload (till the inability to continue the task) the ratio in JT / RR has varied very

closely or even coincided as V. G. Bochkov established it in 1986. Accordingly to V. G. Bochkov these biological constants can be expressed mathematically ($1 / e = 0.368$ and $1 - 1 / e = 0.632$). Our previous studies showed that the ratio of JT and RR intervals (JT / RR) of ECG provides the information concerning the dynamics of mobilization of cardiovascular system during the workouts. When performing dosed workloads (Roufier's test — aerobic workout) and during a 30 second all-out test in jumping (anaerobic workout) the changes in the ratio of JT / RR were in dependence on age and on performance abilities (training experience) and functional state. One of the effects of long term adaptation to exercise is a smaller mobilization of cardiovascular system at the onset of the dosed aerobic and all-out anaerobic exercise. The endurance-trained athletes have performed both exercise tasks with smaller changes in the ratio of JT / RR, i. e. with the smallest mobilization of cardiovascular system at the onset of the exercise.

CONCLUSIONS

1. Faster adaptation at the onset of an exercise is a characteristic feature for younger persons but the type of exercise performed during the long-term training process plays a significant role in the developing and improving the velocity of adaptation of cardiovascular system. A faster adaptation at the onset of an exercise is rather characteristic for the trained athletes in sprint events and combative sports than the representatives of endurance group or non-athletes.
2. One of the effects of long term adaptation to exercise is a smaller mobilization of cardiovascular system at the onset of the dosed aerobic and all-out anaerobic exercise and the endurance exercise has the most influence on it.

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PECULIARITIES OF AEROBIC CAPACITY OF MILITARY ACADEMY STUDENTS

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ABSTRACT

The aim of the study was to evaluate the aerobic capacity of the first year students in the Lithuanian Military Academy. 63 first year students (57 men and 6 women) agreed to participate in the study. They performed graded cycling exercise test until voluntary exhaustion. The starting work load was set at 70 W and was increased every minute by 21 W. Pulmonary gas exchange was measured breath-by-breath using the portable telemetric system (Oxycon Mobile, Jaeger). The maximal oxygen uptake (VO_2 max) was determined as the highest VO_2 within 20 s period obtained during increasing cycling test. Maximal cardiorespiratory values at this point were calculated as well. The VO_2 max in military academy cadets was 52.9 (4.6) ml / kg⁻¹ / min⁻¹ (from 42.7 to 63.4). The aerobic capacity in most cadets may be considered as high and very high (80%), and only in one fifth of the subjects — as moderate, applying the normative scale for untrained persons.

Keywords: maximal oxygen uptake, aerobic capacity, cycling ergometry.

INTRODUCTION

Aerobic capacity is defined as the ability to perform long and intensive work by means of dominating aerobic ATP production in working muscles. This capacity is characterized by maximal oxygen consumption (VO_2 max) and anaerobic thresholds as well as work economy and rate of rest to work transitions (Jones, Carter, 2000). VO_2 max is dependent on the maximal rate of aerobic ATP production and oxygen transport capacity by cardiorespiratory system (Astrand, 1952). It is usually determined during graded exercise test by measuring pulmonary gas exchange parameters (Duncan et al., 1997).

The highest values of VO_2 max (above 80 ml / kg⁻¹ / min⁻¹) have been recorded in endurance athletes such as cyclists, distance runners, skiers, rowers and swimmers. The VO_2 max was shown to be lower in other athletes and in untrained subjects reaching only 40 ml / kg⁻¹ / min⁻¹ and 35 ml / kg⁻¹ / min⁻¹ in men and women respectively (Neumann, 1988). The VO_2 max is important not only for athletes but also for moderately active persons because it reflects the general ability of the organism to adapt to physical and even other kinds of activity. Aerobic capacity is known to influence positively the

recovery of muscular power, phosphocreatine and blood lactate disappearing (Tomlin, Wenger, 2001), it is associated with the risk of trauma or illness in soldiers and cadets (Harwood et al., 1999; Knapik et al., 2001). The data about influence of aerobic capacity on heat tolerance (Selkirk, Mc Lellan, 2001), sleep quality (Shapiro et al., 1984), personality characteristics (Jasnoski et al., 1988), stability of reaction time during exercise (Brisswalter et al., 1997) are also available. Since VO_2 max depends on physical activity level, changes under influence of endurance training, it may also reflect the effectiveness of soldiers or cadets physical education programmes (Vogel et al., 1986).

The aim of this study was to evaluate the aerobic capacity in the Lithuanian Military Academy's first year students.

METHODS

Subjects. 63 Lithuanian Military Academy's first year students (57 men and 6 women) agreed to participate in the study. Their age and anthropometric characteristics are presented in Table 1.

Graded exercise test, data collection and VO_2 max determination were the methods of the survey.

All subjects performed a maximal incremental

test on the cycle ergometer Monark 834E. Before the test a 5 min warm up with the intensity of 70 W was performed. The incremental test consisted of each minute increasing cycling with pedalling frequency 70 rpm. Starting workload was 70 W, the increase at each step — 21 W. All subjects were encouraged to continue as long as they were able to maintain the required pedalling frequency. After that the subjects rested for five minutes in the supine position.

Pulmonary gas exchange was measured breath-by-breath using the portable telemetric system (Oxycon Mobile, Jaeger). The flow-volume sensor and the gas analyser (gas mixtures containing 5% CO_2 and 16% O_2 were used) were calibrated using automatic calibration procedures, as provided by Jaeger, before each testing session. Data on gas exchange were averaged over 5 s intervals. Heart rate was recorded simultaneously (Polar S 810, Electro, Finland). The maximal oxygen uptake (VO_2 max) was determined as the highest VO_2 within 20 s period obtained during increasing cycling test (Fig. 1). Maximal cardiorespiratory values at this point were calculated as well.

Capillary blood samples from a finger tip were analysed for lactate concentration with an aid of Exan-G lactate analyser (Kulis et al., 1988). The blood samples were taken after five mins of the supine rest following graded exercise test.

Statistical analysis. The mean values, standard

Academic group	Age, years	Height, cm	Body mass, kg
1 (n = 12)	19.8 (1.2)	182.4 (10.2)	79.0 (11.7)
2 (n = 15)	19.5 (0.5)	184.5 (7.3)	80.2 (9.1)
3 (n = 15)	19.1 (0.4)	181.9 (4.3)	77.3 (7.1)
4 (n = 15)	19.6 (0.6)	180.0 (6.7)	77.1 (5.8)
Women (n = 6)	19.2 (0.8)	167.2 (6.6)	64.0 (4.4)

Table 1. The age and anthropometric characteristics of the subjects in different academic groups and women students, mean (SD)

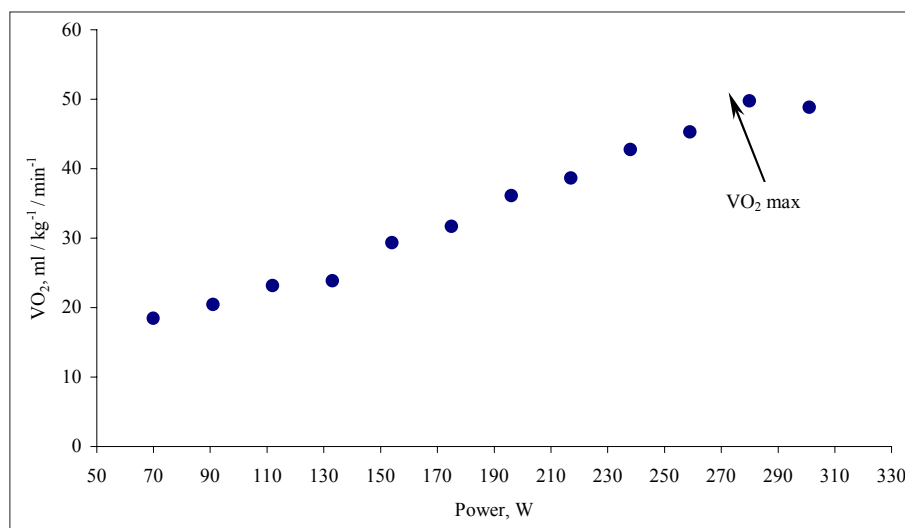


Fig. 1. Determination of VO_2 max. VO_2 max was determined as the highest VO_2 within 20 s period obtained during increasing cycling test

deviations, maximal and minimal values, 95% confidence intervals were calculated. The means were compared using Student's T-test for unpaired data. P values less than 0.05 were considered as statistically significant.

RESULTS

All absolute and relative (expressed as ml per kg of body weight) values of VO_2 max in cadets investigated are presented in Table 2, while the

means of this parameter in different academic groups and in women subjects are shown in Fig. 2. Only in the second group VO_2 max was significantly higher, but in other groups including that of women it was very similar. The distribution of aerobic capacity level according to the scale for untrained persons are presented in Fig. 3. Aerobic capacity in students can be considered as moderate (19.3%), high (42.1%) or very high (38.6%).

Table 2. Maximal values of aerobic capacity and cardiorespiratory parameters in all cadets investigated

Indices	Statistical parameters				
	Mean	Standard deviation	Minimal value	Maximal value	95% confidence interval
VO_2 max, l / min ⁻¹	4.132	0.460	3.202	5.151	0.120
VO_2 max, ml / kg ⁻¹ / min ⁻¹	52.9	4.6	42.7	63.4	1.2
HR max, beats / min ⁻¹	188.1	8.0	170.0	204.0	2.09
VE max, l / min ⁻¹	150.3	23.4	105.0	213.3	6.13
VT max, l	3.171	0.489	2.416	4.113	0.128
BF max, l / min ⁻¹	49.7	8.4	33.7	69.3	2.19
N max, W	327.6	29.6	259.0	385.0	7.75
O ₂ pulse	22.1	2.5	17.7	27.4	0.65
RER max	1.215	0.016	1.073	1.397	0.016
[La] at 5 th min of recovery, mmol / l ⁻¹	6.99	1.80	3.00	10.90	0.47

Note. VO_2 — oxygen consumption, HR — heart rate, VE — minute ventilation, VT — tidal volume, BF — breathing frequency, N — power, O₂ pulse — oxygen pulse, RER — respiratory exchange ratio, [La] — blood lactate concentration.

Fig. 2. The comparison of VO_2 max values (means and SD) among academic and women subjects groups

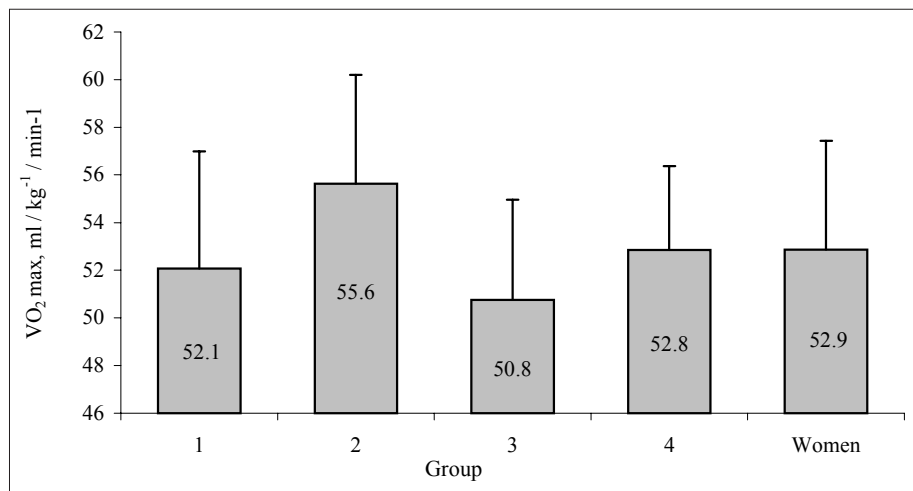
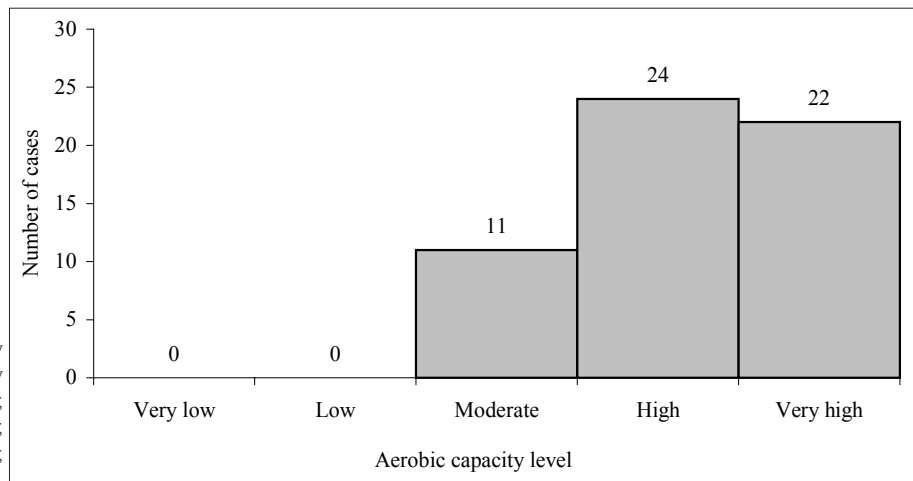


Fig. 3. Distribution of aerobic capacity level in cadets investigated (according to American Heart Association standards)



Note. Margins of aerobic capacity levels: < 33 ml / kg⁻¹ / min⁻¹ — very low; 33—38 ml / kg⁻¹ / min⁻¹ — low; 39—48 ml / kg⁻¹ / min⁻¹ — moderate; 49—54 ml / kg⁻¹ / min⁻¹ — high; > 55 ml / kg⁻¹ / min⁻¹ — very high.

DISCUSSION

In this study the aerobic capacity and maximal cardiorespiratory values of Military Academy's students were determined by means of graded cycle ergometer test. The aerobic capacity in most cadets may be considered as high and very high (80%), and only in one fifth of the subjects — as moderate, applying the normative scale for untrained persons.

The maximal values of heart rate (HR), minute ventilation and respiratory exchange ratio (RER) reached at the end of graded exercise test show the adequate motivation of the subjects and may be an evidence that true maximal aerobic capacity ($\text{VO}_2 \text{ max}$) values were measured in this investigation. The most acceptable criterion that the subject reached his true $\text{VO}_2 \text{ max}$ is the plateau in oxygen consumption and power relationship. This is the case only for 50% of the subjects (Astrand, 1952). We observed plateau only in 35% of the subjects. Therefore the decision about true $\text{VO}_2 \text{ max}$ achievement by the subject is often made according to such indirect criterions as blood lactate concentration which during the first five minutes of recovery should be higher than $8 \text{ mmol} / \text{l}^{-1}$, RER and HR at the end of test which should be higher than 1.1 and 85% of age predicted maximum, respectively (Astrand, 1952; Issekutz et al., 1962). In our case only blood lactate concentration at the fifth min of recovery was lower than $8 \text{ mmol} / \text{l}^{-1}$, but maximal values of RER and HR exceeded required values.

The $\text{VO}_2 \text{ max}$ values measured in our study are similar to those of cadets in other countries. $\text{VO}_2 \text{ max}$ of New Zealand's soldiers was reported to be $50.8 (6.2) \text{ ml} / \text{kg}^{-1} / \text{min}^{-1}$, with interval from 39.8 to $66.0 \text{ ml} / \text{kg}^{-1} / \text{min}^{-1}$ (O'Donnell et al., 1984). The USA army recruits demonstrated such $\text{VO}_2 \text{ max}$ during treadmill exercise test: men — $50.6 (6.2)$; women — $39.7 (5.2)$ (Sharp et al., 2002). So, our Military Academy's female students demonstrated rather higher aerobic capacity. The results of many investigations demonstrate that soldiers and cadets need higher than moderate aerobic capacity level. This may be associated with purposeful training programmes used in many military institutions. As established by the USA investigators, the $\text{VO}_2 \text{ max}$ among the USA army recruits was increased by 5% after the initial basics physical training period (Vogel et al., 1986). Obviously, the possible influence of other

factors on $\text{VO}_2 \text{ max}$ cannot be ignored. For example, $\text{VO}_2 \text{ max}$ is strongly dependent on the genetic factors (Jones, Carter, 2000). This might be the important reason for $\text{VO}_2 \text{ max}$ variation among subjects or academic groups observed in our study.

It is widely accepted that $\text{VO}_2 \text{ max}$ is one of the most important indexes of human physical readiness, especially that of aerobic endurance (Jones, Carter, 2000). There are strong evidences that $\text{VO}_2 \text{ max}$ is limited by maximal cardiac output, blood oxygen carrying capacity and sometimes pulmonary system in the population of healthy people performing dynamic exercise with involvement of large muscle groups (Cerretelli, Di Prampero, 1987; Richardson, Saltin, 1998). What may be the role of $\text{VO}_2 \text{ max}$ for soldiers or cadets? It was established that recovery after intensive exercise is slower among the subjects with low aerobic capacity (Hoffman, 1997). The heat tolerance is higher (Selkirk, McLellan, 2001), the slowdown of reaction during fatigue is less (Brisswalter et al., 1997) and the risk of trauma is lower (Harwood et al., 1999) among persons with higher aerobic capacity level. All the mentioned above factors are closely related to the quality of the soldier or cadet professional activity. So, the testing of aerobic capacity in the military population seems to be important for evaluation of their professional readiness and effectiveness of physical training programs.

CONCLUSIONS

The $\text{VO}_2 \text{ max}$ in Military Academy's cadets is $52.9 (4.6) \text{ ml} / \text{kg}^{-1} / \text{min}^{-1}$ (from 42.7 to 63.4). The aerobic capacity in most cadets may be considered as high and very high (80%), and only in one fifth of the subjects — as moderate, applying the normative scale for untrained persons.

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LOW-FREQUENCY FATIGUE AT DIFFERENT MUSCLE LENGTH FOLLOWING INTERMITTENT ECCENTRIC DROP JUMPS IN 12—14 YEAR-OLD BOYS

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ABSTRACT

Low frequency fatigue (LFF) in 12—14 year-old adolescent boys ($n = 10$) doing 75 eccentric jumps performed every 20 s from a platform 80 cm high was investigated.

Thus the aim of this study was to find out if LFF manifests itself in the muscles of boys aged 12—14 years doing 75 drop jumps performed every 20 s at angles of 90° and 135° from a platform 80 cm high. The results of the research have shown that doing 75 eccentric jumps performed every 20 s calls forth LFF in the muscles of boys that is particularly strong and disappears more slowly at a shorter length of the muscle exercised. Thus, the hypothesis as to the sarcomeric origin of LFF in the muscles of boys and men has been confirmed. Besides, the muscles of men of mature age are more resistant to LFF than those of boys. This fact, as well as a more acute pain brought about in the muscles of boys, indicates that the muscles of boys are less resistant to mechanical damage than those of men of mature age.

It is maintained that as a result of the eccentric exercise performed, some portion of the weak sarcomeres gets torn and then the strong sarcomeres, i.e. the ones that develop contraction force have to work at a shorter muscle length. When muscle contraction length is short the sensitiveness of miofibrillas to Ca^{2+} decreases. It is rather unexpected though that 24 h after the end of the exercise the force developed by electrostimulation at low frequencies (20 Hz) is smaller ($p < 0.05$), as compared to the initial force registered at a shorter muscle length. Since after the exercise there was also a decrease in the force developed at a shorter muscle length in particular, the sarcomeres are believed to have been damaged during eccentric exercise.

Keywords: electrical stimulation, force, age, muscle damage, stretch-shortening exercise.

INTRODUCTION

Doing unaccustomed long-lasting physical exercise, performed in eccentric regime in particular, calls forth muscle fatigue that holds on for 48—72 h and even longer and is frequently accompanied by muscle pain (Jones et al. 1989; Newham et al., 1983).

LFF may be due to a decrease (10—20 Hz) in muscle contraction force (MCF), as well as due to the disintegration of the elastic muscle contraction components (Armstrong et al., 1991; Jones et al., 1989). The sensitiveness of miofibrillas to calcium ions (Ca^{2+}) is believed to depend on the muscle (sarcomeres) length, i. e. the smaller the

amplitude of muscle contraction, the lower sensitiveness to Ca^{2+} (Stephensson, Wendt, 1984). According to the sarcomeric hypothesis, LFF arises due to a partial damage of sarcomeres that manifests itself more markedly during eccentric physical exercise (Friden, Lieber, 1992; Jones, Round, 1997). It is maintained that doing eccentric exercise brings damage to the *weak* sarcomeres in the first place, whereas the *strong* sarcomeres have to contract with a higher amplitude in order for the maximum muscle efforts to be achieved (Jones, Round, 1997). LFF, that arises due to a partial damage of sarcomeres

during eccentric physical exercise, should increase at a shorter muscle length. It is not clear at all, however, how such a type of fatigue manifests itself in 12–14 year-old boys whose muscles, tendons, ligaments and nerves have not fully matured yet (Malina, Bouchard, 1991).

Natural human movements, including various types of jumps, usually combine eccentric and concentric phases of muscle contraction and are referred to as stretch-shortening exercise (Avela et al., 1996). Stretching of the muscle-tendon complex just before the movement affects power generation (Ettema, 1997). It has been demonstrated that height of a vertical jump increases when the subject prestretches muscles by a countermovement, compared to the jump from the static semi-squat position (Häkkinen, Komi, 1983). This could be due to stretch reflex potentiation and utilisation of elastic energy stored in the series of elastic elements during the jump with the countermovement (Häkkinen, Komi, 1983). Stretch loads increase when subjects drop from 80 cm height and perform the so-called drop jump (Avela et al., 1996). Repetitive drop jumps have been used as means of power training in athletes (Bobbert, 1990). However, this type of exercise induces LFF as well (Skurvydas et al., 2000). The LFF is believed to be a major cause of performance deterioration during prolonged isometric exercise of submaximal intensity, but effects of LFF on power generation in brief contractions are less clear (Lucidi, Lehman, 1992; Ratkevičius et al., 1995). The LFF has been mainly studied in adult volunteers, and it is largely unknown how age affects muscle resistance to LFF which appears to be one of the major factors limiting muscle potential to generate force during prolonged repetitive exercise (Ratkevičius et al., 1995). Thus the aim of this study was to find out if LFF manifests itself in the muscles of boys aged 12–14 years doing 75 drop jumps performed every 20 s at angles of 90° and 135° from a platform 80 cm high.

METHODS

Subjects. Nine teenagers boys ($n = 12$) (age = 13.1 ± 0.6 yr, body height = 160.4 ± 7.4 cm, body mass = 46.4 ± 5.9 kg) took part in the study of fatigue in the lower leg muscles after repetitive drop jump exercise. After explanation of procedures, risks and benefits of the study written

informed consent was obtained from the boys' parents and the boys. The boys were recruited from one of the local schools. The boys both participated in classes of physical activity two–three times a week and could be considered as physically active. However, none of the subjects was specializing in any form of sports training.

Isometric torque measurements. The isometric torque of knee extensor muscles was measured in a dynamometer as described previously (Ratkevičius et al., 1995; Skurvydas et al., 2000). The subjects sat upright in the dynamometer chair with both the hip and knee joints positioned at approximately 90–135 degrees of flexion. For a recording of the knee extension torque, force transducer was connected to a lever arm and the pad of the lever arm was placed approximately 3 cm above malleoli. A belt joined to the force measuring device (UGO BASILE 7080 type DY 150, Italy) was placed on the lower third part of the calf of the right leg. The output of the transducer was analogue-to-digital converted (12-bit) at a sampling rate of 1000 Hz and stored on a computer hard disk for later off-line analysis. During the maximal isometric voluntary contraction (MVC), the output from the torque transducer was also displayed on a voltmeter in front of the subjects.

Electrical stimulation. Details of the equipment and procedure for electrical stimulation were essentially the same as previously described (Ratkevičius et al., 1995; Skurvydas et al., 2000). Tolerance of subjects to electrical stimulation was assessed on a separate occasion by testing different patterns of electrical stimulation. All subjects showed good compliance with the procedure when short trains of stimuli were applied at a progressively higher frequency up to 50 Hz. During the subsequent experiment, the electrical stimulation was delivered with surface electrodes, placed over the quadriceps muscle, in 1-s trains of stimuli using the current that induced (at 50 Hz) 52–98% MVC, as measured from the subject on the day of testing. This electrical stimulation of muscles was performed at 1, 10, 15, 20 and 50 Hz stimulation for 1 s at each frequency. During the off-line data analysis, peak torque was evaluated at each frequency. The 1-Hz stimulation produced a single twitch. For the twitch, contraction time (CT) and half-relaxation time (RT 0.5) were measured. The CT was the

time from the start of torque development until the point when the peak torque was reached. The RT 0.5 was the time from the peak torque until the point when torque decreased to a half of the peak torque value.

Drop jumps. Drop jumps were performed as previously described (Skurvydas et al., 2000). Firstly, each subject performed warming-up exercises that consisted of a 5-min running on the spot with an intensity that corresponded to a heart rate of 130–150 beats/min⁻¹; then the subject performed 10 squat-stands and 2 min of rest were allowed. Thereafter, the subject performed 75 drop jumps from a height of 80 cm to an approximately 90° angle in the knees in eccentric mode. One jump was performed every 20 s. The actions of the subjects were discussed with them in advance and they were told that after jump down with a squat the knee joint should be at 90° angle. The subjects always climbed the 80 cm high platform with the left leg while force measurements were performed on the right leg.

Vertical jumps up. The control vertical jumps up with approximately 90° angle in the knees were performed on a standard jump mat (Powertimer Testing System, Newtest, Tampere, Finland). As described by the producer, the Powertimer Testing System calculates jump height according to the time spent in the air (flying time) during the jump (Bosco et al., 1983; Komi and Bosco, 1978; Skurvydas et al., 2000).

Experimental procedure. The indices of muscle contraction and relaxation were registered at angles of 90° and 135° in the following sequence:

1. The power of muscle contraction evoked by a single electrical stimulus (single twitch-P₁), the duration of contraction up to a single twitch and half-relaxation time (RT 0.5) were measured.
2. This electrical stimulation of muscles was performed at 1, 10, 15, 20 and 50 Hz stimulation for 1 s at each frequency. The duration of stimulation was 1 s and rest intervals between stimulation impulses were 5 s.
3. Maximal voluntary force (MVF) of muscle contraction — three trials performed every 3–5 min.
4. After non-intensive warming-up a slow running for 10 min was undertaken (pulse rate

at the end of running had reached about 110–130 beats / min), then followed three control jumps up of performed every 20 s.

5. Jumping exercise consisted of 75 drop jumps performed every 20 s from a platform 80 cm high with a squat up to 90° angle in the knees in the eccentric mode. The platform was mounted leaning on the left leg, i.e. not on the leg muscle function properties of which were being tested.
6. Immediately 3, 30 and 60 min after the exercise all indices of voluntary and involuntary contraction at angles of 90° and 135° were registered repeatedly. The height of standing vertical jump up 1 and 60 min after the exercise was registered too. Fatigue index (FI = index value after exercise / index control value before exercise × 100 per cent) of all index values was calculated. Besides, all indices of voluntary and involuntary contraction at angles of 90° and 135° 12 and 24 h after the exercise were registered repeatedly. Jumping fitness and subjective muscle pain according to a 10-point scale were evaluated too.

Statistics. Descriptive data are presented as means ± SD. The groups of boys were compared with a two-way analyses of variances (ANOVA). Statistical significance of all tests was set at $p < 0.05$. If significant effects were found, *post hoc* testing was performed applying paired t-tests with a Bonferroni correction for multiple comparisons. Statistical significance of all tests was set at $p < 0.05$.

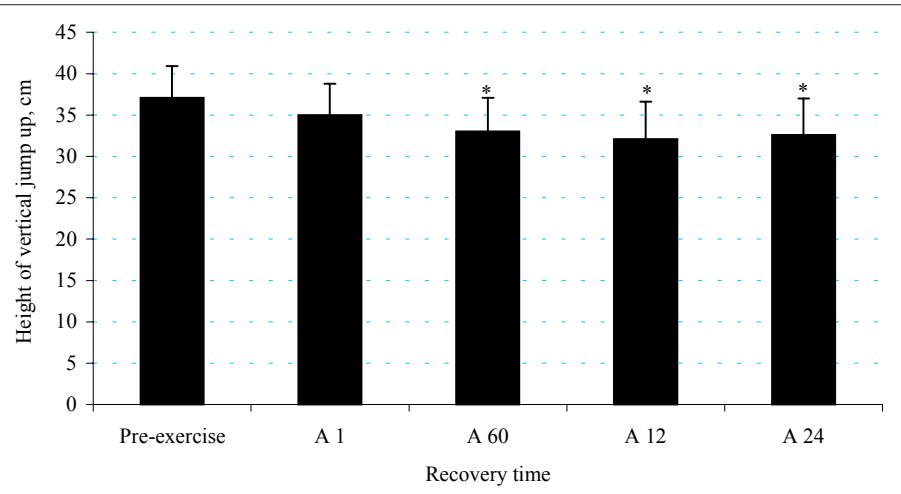
RESULTS

Doing 75 jumps performed every 20 s did not bring about any changes ($p > 0.05$) in the height of vertical jump up that was statistically significantly ($p < 0.05$) different from the initial value but 60 min, 12 and 24 h after the exercise (Fig. 1). The boys felt muscle pain (3.7 ± 1.3 points) 12 h after the exercise, and 24 h after the exercise the boys felt a greater muscle pain (5.4 ± 1.7 points).

There is no correlation between the rate of decrease in the height of vertical jump up immediately after the exercise and muscle pain 12 h (-0.047) and 24 h (-0.051) after the exercise.

The values of the twitch, contraction time (CT) and half-relaxation time (RT 0.5) are presented in Fig. 2 and Fig. 3. There is a statistically significant ($p < 0.05$) difference in

Fig. 1. Mean values in the height of vertical jump up before the exercise, immediately after it 1 (A 1), 60 (A 60) min, 12 (A 12) and 24 (A 24) h after the jumping exercise



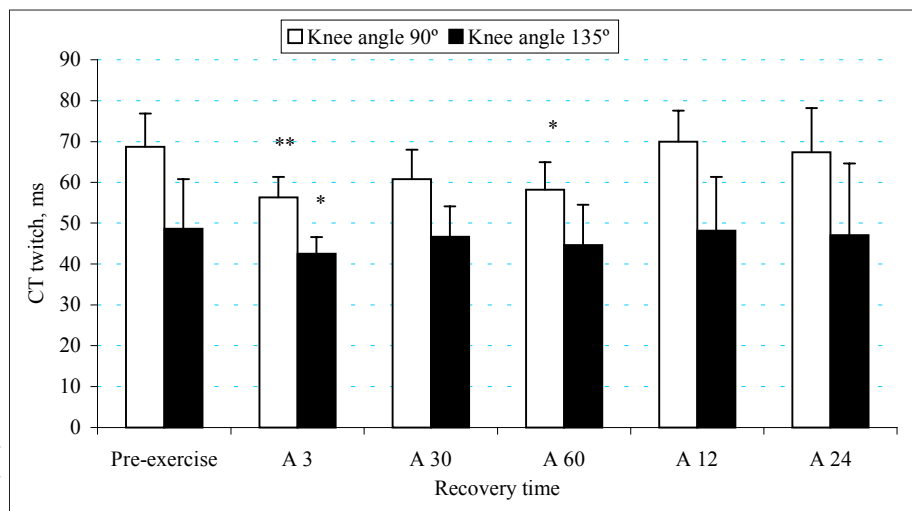
Note. * — there was a statistically significant difference in mean values of the same index immediately after the exercise ($p < 0.01$).

Table 1. General characteristics and torque (in newtons) at different frequencies of electrical stimulation plus maximal voluntary contraction (MVC) in the force generating capacity test (FGCT) before exercise at 90° and 135° angles

Muscle length	Pt, N	P 10, N	P 20, N	P 50, N	P 20 / P 50	MVC, N
90° angle	77.7 ± 26.2	165.9 ± 37.6	295.8 ± 50.0	345.2 ± 50.9	0.85 ± 0.03	500.4 ± 43.8
135° angle	74.5 ± 24.2	137.8 ± 31.7	329.2 ± 67.8	408.6 ± 67.5	0.80 ± 0.06	527.3 ± 51.8
	$p > 0.05$	$p < 0.05$	$p > 0.05$	$p < 0.05$	$p > 0.05$	$p > 0.05$

Note. Pt is twitch peak torque; P 10, P 20 and P 50 stand for peak torques at 1, 10, 20 and 50 Hz of electrical stimulation respectively; MVC is maximal voluntary contraction. Values are means ± SD.

Fig. 2. Mean values of duration of a single twitch muscle contraction time (CT) evoked by a single electrical impulse before the exercise, immediately after it 3 (A 3), 30 (A 30), 60 (A 60) min, 12 (A 12) and 24 (A 24) h after the jumping exercise at angles of 90° and 135°



Note. * — there was a statistically significant difference in mean values of the same index immediately after the exercise ($p < 0.05$); ** — $p < 0.01$.

index values of CT (Fig. 2) and RT 0.5 (Fig. 3) after jumping exercise done at angles of 90° and 135°. There is no statistically significant ($p < 0.05$) difference in index values of CT at the 90° angle 30 min, 12 h and 24 h after the exercise, when compared to the control values. There were similar regularities in the changes of CT values at the 135° angle too (Fig. 2). There were statistically significant differences in index values of RT 0.5 at the 135° angle immediately after the exercise, 30 min and 12 h after the exercise, compared to the initial value ($p < 0.05$) but there was no statistically significant difference 60 min,

24 h after the exercise comparing measurements made with initial values (Fig. 3). There was a statistically significant difference, however, at the 90° angle immediately after the exercise, compared to the initial value ($p < 0.05$) but later the indices returned to their initial values ($p > 0.05$) (Fig. 3).

There was a significant decrease ($p < 0.001$) in the values of Pt, P 10, P 20, and P 50 indices at angles of 90° and 135° after the jumping exercise. Pt, P 10, P 20, and P 50 indices did not return to the initial level 24 h later (Fig. 4 and Fig. 5), except Pt that had recovered ($p > 0.05$) 24 h after

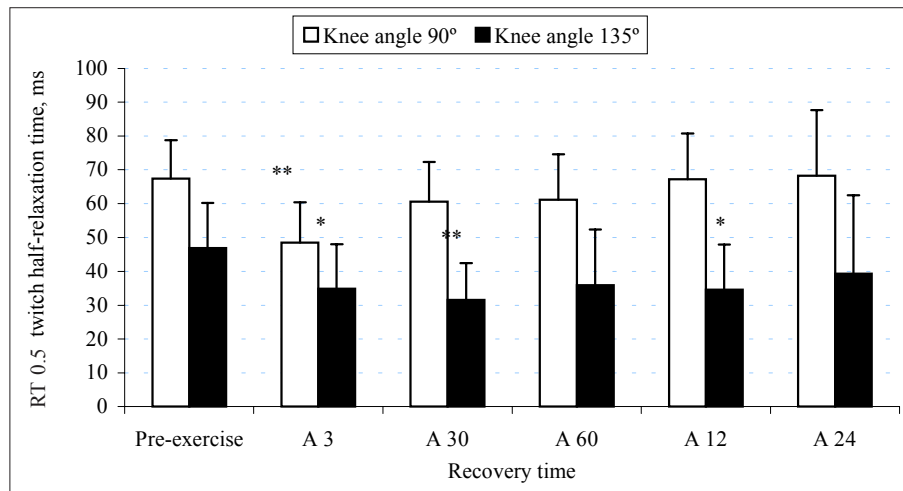


Fig. 3. Mean values of duration of a single muscle half-relaxation time (RT 0.5) evoked by a single electrical impulse before the exercise, immediately after it 3 (A 3), 30 (A 30), 60 (A 60) min, 12 (A 12) and 24 (A 24) h after the jumping exercise at angles of 90° and 135°

Note. * — there was a statistically significant difference in mean values of the same index immediately after the exercise ($p < 0.05$); ** — $p < 0.01$.

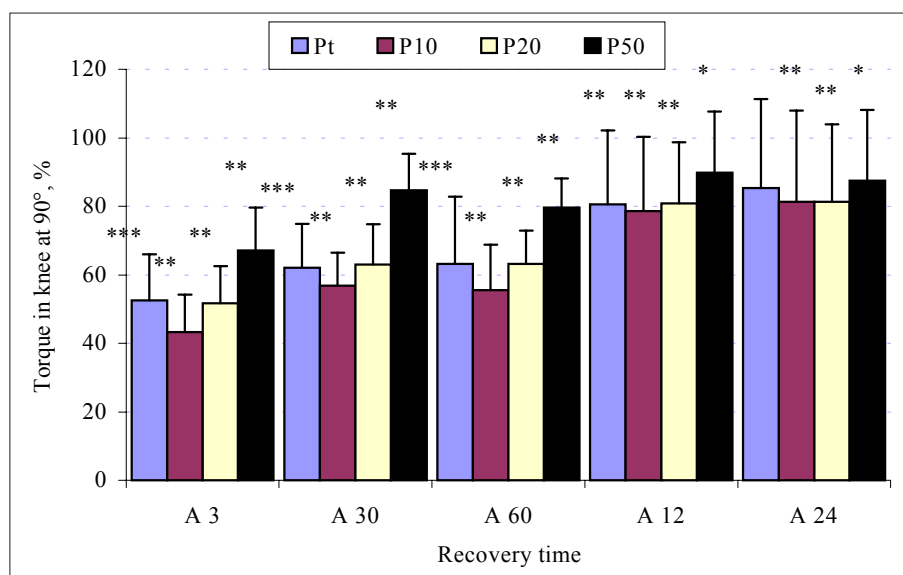


Fig. 4. Mean values of duration of fatigue indices (FI) of muscle involuntary contraction at the angle of 90°. Pt, P 10, P 20 and P 50 index alternation immediately after the exercise 3 (A 3), 30 (A 30), 60 (A 60) min, 12 (A 12) and 24 (A 24) h after the exercise

Note. * — there was a statistically significant difference in mean values of the same index immediately after the exercise ($p < 0.05$); ** — $p < 0.01$; *** — $p < 0.001$.

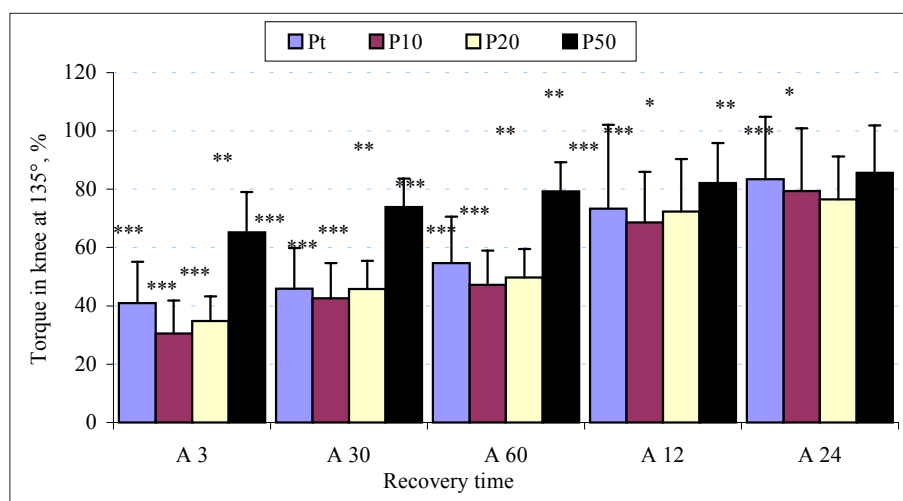


Fig. 5. Mean values of duration of fatigue indices (FI) of muscle involuntary contraction at the angle of 135°. Pt, P 10, P 20 and P 50 index alternation immediately after the exercise 3 (A 3), 30 (A 30), 60 (A 60) min, 12 (A 12) and 24 (A 24) h after the exercise

Note. * — there was a statistically significant difference in mean values of the same index immediately after the exercise ($p < 0.05$); ** — $p < 0.01$; *** — $p < 0.001$.

exercise. There was a statistically significant decrease ($p < 0.001$) in the P 20 / P 50 ratio already 3 min after the exercise both at the 90° angle and 135° angle. This is sure to indicate the presence of LFF (Fig. 6) the indications of which did not disappear, i. e. the indices of the P 20 / P 50 ratio did not reach their initial value even

24 h after the exercise at the angle of 135° but the indices ($p > 0.05$) had recovered at the angle of 90° 24 h after the exercise. It is of interest to note that the repeated eccentric exercise brought about but slight changes in MVF indices (Fig. 7) that did not change statistically significantly ($p > 0.05$) already 3 min after physical exercise, decreased

Fig. 6. Mean values of fatigue indices (FI) of the forces P 20 / P 50 ratio at angles of 90° and 135° immediately after the exercise 3 (A 3), 30 (A 30), 60 (A 60) min, 12 (A 12) and 24 (A 24) h after the exercise

Note. * — there was a statistically significant difference in mean values of the same index immediately after the exercise ($p < 0.05$); ** — $p < 0.01$.

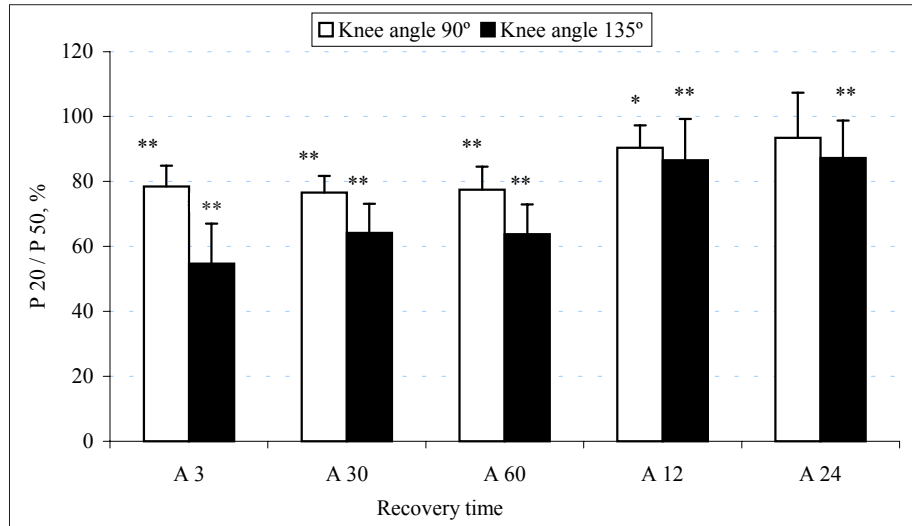
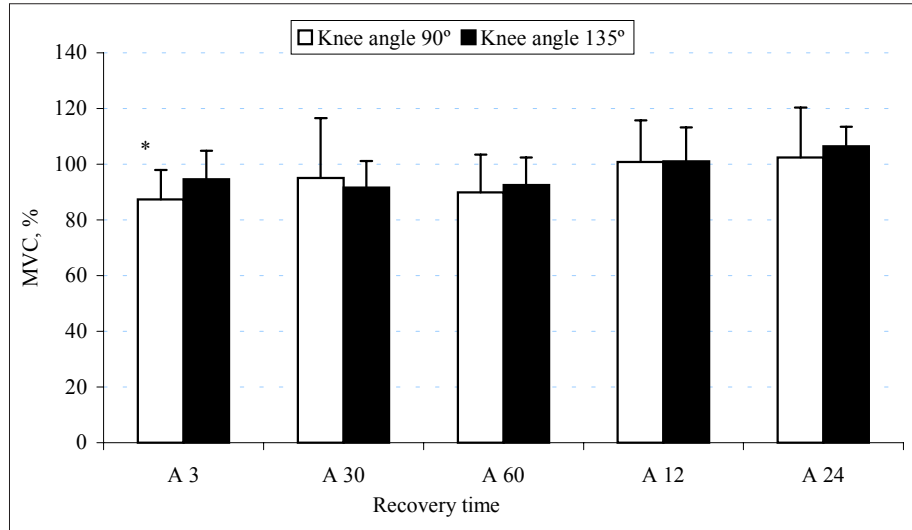


Fig. 7. Mean values of duration of fatigue indices (FI) of muscle voluntary contraction at angles of 90° and 135° immediately after the exercise 3 (A 3), 30 (A 30), 60 (A 60) min, 12 (A 12) and 24 (A 24) h after the exercise

Note. * — there was a statistically significant difference in mean values of the same index immediately after the exercise ($p < 0.05$).



($p < 0.05$) at the angle of 90° and recovered ($p > 0.05$) at the angle of 135°. Later there were no statistically significant changes ($p < 0.05$) in MVF indices at both angles 30 min after physical exercise.

DISCUSSION

On the basis of the results obtained in the process of the research done the main conclusion could be made that doing 75 eccentric jumps performed every 20 s there was a statistically significant decrease in the values of both voluntary and involuntary contraction force and they did not return to their initial values (Fig. 4 and Fig. 5). Still there was a decrease in the values of separate indices. Thus, for example, the slightest changes (about 5.5%) after the exercise had occurred in the height of vertical jump up and MVF at the 90° and 135° angle. There was a 20—

32 per cent decrease in the force (P 50) evoked by high stimulation frequencies at the 90° angle and about 15—35 per cent decrease at the 135° angle accordingly. The greatest decrease (about 45%) was in the force evoked by low stimulation frequencies at the 135° angle (P 10 and P 20) and the same force at the 90° angle had decreased from 20 to 55 per cent. Thus, it could be maintained that it was the so-called low frequency fatigue (LFF) that manifested in the muscles most markedly what is evident from a decrease in the value of the P 20 / P 50 ratio, particularly at a shorter muscle length, i. e. at the 135° angle (Edwards et al., 1977). This corresponds to the results obtained by other scientists and is indicative of the fact that LFF mostly manifests itself doing unaccustomed, eccentric physical exercise in particular. It takes some time for the above-mentioned fatigue to disappear after the exercise and it is frequently accompanied by

muscle pain (Armstrong et al., 1991; Jones et al., 1989).

In the case of our research there could not have been an accumulation of a great number of metabolites (unorganic phosphate, ADF, hydrogen ions, etc.) that decrease muscle contraction force in the muscle, since there was a sufficiently long period of time between the jumps performed for the ATP and PCr (phosphocreatine) to recover (Fitts, 1994). Therefore the reasons for the appearance of muscle fatigue should not be looked for in muscle metabolism. It is believed that doing eccentric physical exercise may give rise to disintegration of sarcomeres and elastic muscle components, as well as proteins connecting the T system with sarcoplasmic reticulum (Armstrong et al., 1991; Jones et al., 1989) what can call forth a decrease not only in the force of myofibrillas but also in the number of Ca ions released from the sarcoplasmic reticulum (Fitts, 1994; Westerblad et al., 1993). This is considered to be the main cause of the rise of LFF. The same cause also forms the basis for the decrease in the force (P 50) evoked by high stimulation frequencies. Since in the case of high stimulation frequencies myofibrillas are saturated by Ca ions more fully a small change in Ca²⁺ concentration changes MCF but slightly (Westerblad et al., 1993).

Performing jumps may cause a decrease in the sensitiveness of reflexes that exert influence on the activity of motor neurons. For example, it has been established that an increased activity of afferents 3 and 4 can inhibit the jumping fitness of athletes. Besides, the sensitiveness of reflexes can also depend on changes in the elastic properties of the muscle during physical exercise. Since jumping fitness also depends on the use of the elastic properties of the muscle (Bosco et al., 1982 a) in the case of our exercise after warming-up of tendons and muscles, muscle elasticity might have been used to a greater extent.

Jumping fitness of boys aged 12—14 years is similar to the results obtained by our earlier research (Skurvydas et al., 1999). Still it is much smaller than that of grown-up athletes and persons not going in for sports (Bosco, Komi, 1979; Bosco et al., 1982 a; Skurvydas et al., 1999). It is of interest to note that the value of the P 20 / P 50 ratio in the case of the boys studied by us is similar to that of grown-up persons not going in for sports (Ratkevicius et al., 1995).

Why is LFF smaller in boys aged 12—14 years than in grown-up persons when doing 75 jumps performed every 20 s? We have not come across any studies testifying to the fact that, for example, doing physical exercises that give rise to LFF would decrease the amount of Ca²⁺ released from the sarcoplasmic reticulum in boys to a greater extent than in the case of grown-up men. Besides, it is not clear at all how such an exercise might cause a damage in the electromechanical connection between the T-system and the sarcoplasmic reticulum in the muscle of boys. It is thought that the duration of a single contraction depends on the number and rate of Ca ions released from the sarcoplasmic reticulum (Cannel, Allen, 1984). Since CT in boys immediately after the exercise comprised 82.7 per cent at the 90° angle and 93.3 per cent at the 135° angle of its control value and, according to the results of our research (Skurvydas et al., 1999), CT in men was about 75 per cent of its control value respectively, we think that in the case of boys a decrease in the number of Ca ions released from the sarcoplasmic reticulum took place. It might be considered, therefore, that our jumping exercise damaged not only the sarcoplasmic reticulum but also its connection with the T system less considerably. It is not likely that there was an essential change in the number of proteins (such as parvalbumin) absorbing Ca ions or in their sensitiveness to Ca ions. The LFF mechanism is not identified with this factor (Westerblad et al., 1993).

It has been established that when doing repeated dynamic exercise of high intensity children distinguish themselves by greater resistance to metabolic fatigue than grown-ups. It has also been established that boys recover sooner than men after intensive exercise of short duration since boys recruit anaerobic glycolysis to a smaller extent compared to men. Therefore acydosis in the muscle of boys manifests itself less considerably than in the case of men (Dotan et al., 2003). Unfortunately, there is still shortage of studies in the differences of fatigue between children and grown-ups when doing physical exercises causing muscle damage (Duarte et al., 1999). Besides, we have not found any data in special literature about the effect of age on the exercise giving rise to metabolic fatigue and muscle damage.

The age of our subjects corresponds to the period of intensive growth of the body during

which the muscles are subjected to both quantitative and qualitative changes (Malina, Bouchard, 1991; Swynghedauw, 1986). It has been established that during post-pubertal period a particularly intensive synthesis of sexual hormones takes place (Malina, Bouchard, 1991) and these hormones exert stronger influence in the synthesis of proteins of muscle fibres of the fast-twitch type (Johnson et al., 1994). There is also another opinion that in the course of body growth no changes in the ratio of muscle fibres of the fast-twitch and slow-twitch types take place (Eriksson et al., 1973; Komi and Bosco, 1978). Besides, it is thought that growth and maturation rates of motor units of different types do not coincide (Bell et al., 1980). Due to an increase in the number of viscous chains of miosin of the fast type the power of muscle contraction increases (Bell et al., 1980; Johnson et al., 1994). For example, the greater the number of muscle fibres of the fast-twitch type in the muscle the higher the jump height of the subjects (Bosco, Komi, 1979). Thus, it might be supposed that in the muscles of

boys aged 12—14 years muscle fibres of the fast-twitch type that possess more elastic components than fibres of the slow-twitch type have not completely matured yet (Eriksson et al., 1973; Malina, Bouchard, 1991). The muscles of boys of this age are known to be more elastic than those of grown-up men (Malina, Bouchard, 1991). All this allows one to suppose that the muscles of boys aged 12—14 years are more resistant to LFF. Besides, boys could have mobilized themselves less when doing the jumping exercise, since it has been established (Belanger, McComas, 1989) that children and adolescents are capable of activating less motor units than grown-ups.

CONCLUSIONS

Doing eccentric physical exercises with submaximum intensity (jumping down from a platform 80 cm high) in the muscles of boys there arises low frequency fatigue that remains throughout 24 h and is greater at a short muscle length throughout the time tested.

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THE PECULIARITIES OF MOTIVATION FOR APPLYING FOR MASTER'S LEVEL STUDIES REFERRING TO GENDER, AGE, GRADUATED UNIVERSITY AND ACADEMIC RECORDS

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ABSTRACT

The reform of education system and therefore the reform of higher education system became necessary after Lithuania had become an independent country. Since 1991 we have had a three-level system of higher education (studies of Bachelor, Master and Doctoral degrees). Discussions about learning motivation of adults are not so frequent in higher education didactics. We feel duration of theoretical and empirical research in this field, thus our article is devoted to present a little segment of the long-lasting research about evaluation of changes in structure of students' learning motivation for Master's level studies. The aim of this article is to discuss the motives for enrolment to the Lithuanian Academy of Physical Education (LAPE) Master's studies in 2003, referring to such criteria as graduated university, age, gender and academic records of Bachelor's studies. 253 persons who had officially applied for enrolment to the LAPE and agreed to fill in the questionnaire. In the study the following research methods were applied — questionnaire survey, statistical analysis. Some differences of female and male, older and younger persons were determined investigating peculiarities of motivation for applying for Master's studies at the Lithuanian Academy of Physical Education.

Keywords: *graduate studies, motivation for applying for studies.*

INTRODUCTION

The right to learn and obtain the adequate education is the natural human right. The education system should be organized in such a way, that any person had his individual right to learn, despite his age or living place, as well as choose the learning forms and intensity, according to his skills and possibilities. The education system should be available and enable any person to study “from cradle to grave” (Šeščilienė, 1997). Master's studies, the second stage of higher education, was introduced in Lithuania in 1991, based on the Lithuanian Law of Science and Studies. Later, prestige of Master's degree increased, as training level for Bachelor's

degree didn't satisfy both graduates and the employers.

Efficiency and productivity of any activity, including learning process, depends not only on individual abilities, but on learning motivation and adequate learning and teaching methods as well. Learning motivation and motivation to study is a worldwide education issue (Pear, 2001; Bitinas, 1998). The lecturers during education process usually influence or reform the learning motivation of their students, so they are supposed to know the psychological features of motives and its dynamics. Indication of real motives for learning activities makes students adaptation

process to higher school requirements less complicated, provides more efficiency to lecturer's activities, because it enables to adapt the training process referring to the psychological state of a particular student (Šeščilienė, 2000; Cross, 1988). Students' learning process depends on a variety of factors. Motives for all activities, including learning, are not permanent, they change because of character features, age and socio-cultural environment (Šeščilienė, 2001). Every person usually has several learning motives, and the interrelation among the existing motives is in a permanent change. However, in order to analyse the learning motivation properly, not just a single motive is regarded as an issue, but its relation to other motives is of great significance (Šeščilienė, 2000). There is no use in trying to influence any single motive separately. In fact, learning motivation could be changed by purposefully controlling and influencing the main structural part of motivation in any particular case (Šeščilienė, 2001; Klein, 2002).

Making sense of what an education means to a person and understanding what motivates her / him in learning involve assessing one's preferences and making choices (Carter et al., 2002). Motivation issues were always in the range of view by both theorists and practitioners, but learning motivation in formal or informal education institutions, referring to students, who continue studies after high school, for adults and middle age persons, lacked scientific attention in recent years. Despite solitary instances in the research of postgraduate studies' motivation it is felt the lack of systematic analysis either from theoretical or practical aspects of this phenomenon (Urbonienė, 2004), so pending

scientific problem could be stated by such questions — how graduated university, age, gender and academic records of Bachelor's studies influence motivation for Master's studies.

Textbooks and manuals published in Lithuania were related to the issue just in general terms, meanwhile, some authors (Laužikas, 1974; Poškus, 1988; Rajeckas, 1994; Stulpinas, 1998) conducted famous research in this field. Referring to higher school pedagogics, there are even less research of this kind (Leonavičius, 1997; Minkutė, 1997; Urbonienė, 2004).

The research for enrolment to second study stage and learning motivation on Master's level were carried out at the Lithuanian Academy of Physical Education (LAPE) since 2002 / 2003 school year. The aim of this article is to analyse the motives for enrolment to the LAPE Master's studies in 2003, referring to such criteria as graduated university, age, gender and academic records of Bachelor's studies. Object of the research is motivation for Master's studies.

METHODS

Samples. 253 persons in total who had officially applied for enrolment to the LAPE and agreed to fill in the questionnaire participated in the first research stage (it forms 99.2% of all applicants). The second stage was conducted during the first month of the LAPE Master's studies. In order to get data on motivation changes, the third research stage was carried out after the first study session. This article will refer just to the first stage of the research.

Demographical data of respondents is indicated in Table.

Factor \ Graduated university	LAPE	VPU	ŠU	VDU	VU	KTU	Other	Total
	Number of respondents	225	5	4	3	6	3	
Factor	Academic record of Bachelor's level, points							253
	Up to 7.5	Up to 8	Up to 8.5	Up to 9	Up to 9.5	Up to 10	10	
Number of respondents	13	56	59	66	41	15	3	
Factor	Age, years							253
	21—24	25—30	31—40	41—50	Over 50			
Number of respondents	160	66	18	8	1			
Factor	Gender							253
	Women				Men			
Number of respondents	172				81			

Table. Respondents grouped by various criteria

Note. LAPE — Lithuanian Academy of Physical Education, VPU — Vilnius Pedagogical University, ŠU — Šiauliai University, VU — Vilnius University, KTU — Kaunas Technological University.

Instruments. Research methods comprise questionnaire survey and statistical analysis (data processed by SPSS). Research structure consisted of the three-level questionnaire survey made in 2003. The questionnaire was an original one, formed according to the analysis of literary sources. In designing the questionnaire the researchers referred to such methodological attitudes as M. S. Knowles's (1993) concept of andragogy and concept of interfluent education (Butkienė, Kepalaitė, 1996). The relevance and correctness of the questionnaire was checked by a probationary research (Puidokas, 2002). The questionnaire was formed of the three-question groups: 1) reasons to enrol for second-stage studies in generally (6 propositions); 2) reasons to enrol in Master's level studies exactly at the LAPE (5 propositions); 3) reasons to enrol in a particular study program (8 propositions). The respondents could choose several answers, indicating priorities by corresponding numbers (1 — the main, etc.). This article will refer just to the first two key groups of reasons.

RESULTS

Initially, the research results for reasons to enrol in second stage studies in generally will be provided. The research data indicate, that for the total amount of respondents the following two reasons are the key ones. First, career perspective, which was indicated as the main or very important factor by 177 respondents, or

69.9%, and second — advanced training in particular field, respectively 154, or 59.8% of the students.

Motivation for Master's studies differ just slightly referring to age. Age has no influence for many motives to enrol in Master's level as advanced training in particular field ($\chi^2(4) = 16.80$; $p = 0.157$), influence by friends or acquaintances ($\chi^2(4) = 0.58$; $p = 0.965$), parent's influence ($\chi^2(4) = 3.57$; $p = 0.990$). The reliable difference occurs, indicating the career as a motive for Master's studies ($\chi^2(4) = 22.083$; $p = 0.037$) — the research data confirm, that career is a more important motive for the youngest group of the respondents (21—24 years), because 73.8% indicate this motive as the main or very important (Fig. 1).

Candidates to enrol in Master's studies, both men and women, differ only in one motive of future studies — career ($\chi^2(4) = 20.80$; $p = 0.000$). Data indicated in Fig. 2 confirm, that 14.8% of men and 2.9% of women indicated this motive as the main or very important. Referring to other motives for Master's studies, gender makes no significant difference, advanced training in particular field ($\chi^2(4) = 3.40$; $p = 0.334$), career ($\chi^2(4) = 4.84$; $p = 0.184$), influence by friends or acquaintances ($\chi^2(4) = 0.47$; $p = 0.492$), parent's influence ($\chi^2(4) = 3.21$; $p = 0.361$).

The research results confirm, that motivation to enrol in Master's studies is not influenced by either previous university, where graduates were awarded Bachelor's degree, or academic record

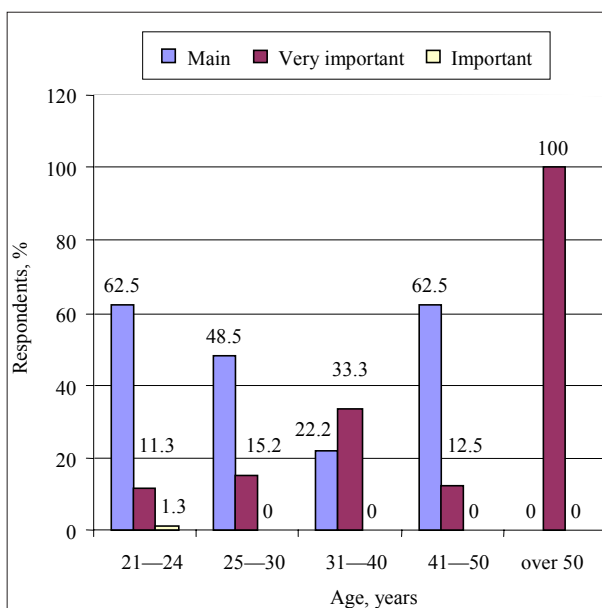


Fig. 1. Career as a motive for respondent groups of various age

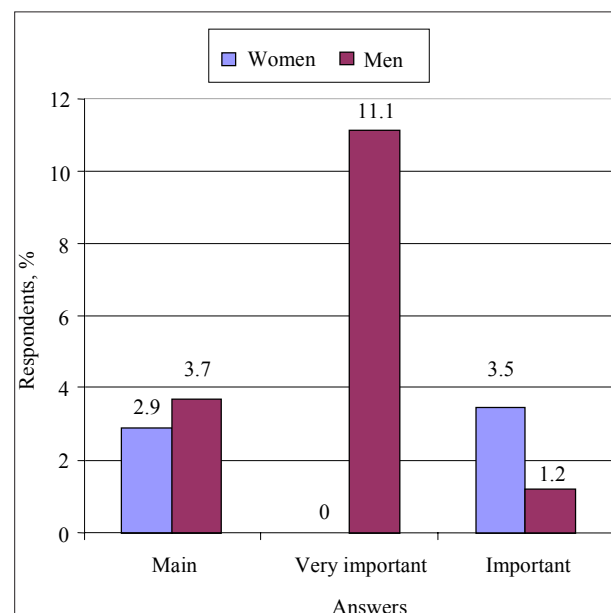


Fig. 2. Career as a study motive referring to gender

of Bachelor's level studies. According to the research graduates from different universities do not differ in such study motives as advanced training in particular field ($\chi^2(4) = 13.864$; $p = 0.738$), future perspective ($\chi^2(4) = 17.992$; $p = 0.456$), career ($\chi^2(4) = 26.297$; $p = 0.093$), influence by friends or acquaintances ($\chi^2(4) = 0.125$; $p = 0.911$), parent's influence ($\chi^2(4) = 0.765$; $p = 0.951$). According to our data respondents with different academic records of Bachelor's level also do not differ in those study motives (advanced training in particular field ($\chi^2(4) = 16.91$; $p = 0.530$), future perspective ($\chi^2(4) = 19.31$; $p = 0.373$), career ($\chi^2(4) = 20.94$; $p = 0.282$), influence by friends or acquaintances ($\chi^2(4) = 5.19$; $p = 0.52$), parent's influence ($\chi^2(4) = 25.39$; $p = 0.114$).

The research data on reasons to enrol in Master's studies in particular in our university indicate two main motives for selection precisely the LAPE. The circumstance that Bachelor's degree was awarded at the LAPE is the main and very important motive for 192 respondents (or 75.9%). The second very important motive for the respondents (respectively 64 or 15.3%) is their enjoying sports activities. According to our research results, age as a motive is of no significance to enrol in Master's studies at the LAPE. The applicants for Master's studies of different gender indicate various reasons, why they chose the LAPE for second study stage. Two motives, like sports ($\chi^2(4) = 10.11$; $p = 0.039$), and advice of competent person ($\chi^2(4) = 12.403$; $p = 0.006$) show the biggest difference between men and women. The first of these motives, like sports, was the main or very important for 19.8% of women and 37% of men. Respectively, 4.8% of men and 11.7% of women indicate "followed advice of competent person" motive as the main and very important. The research of other motives for selection of Master's studies at the LAPE indicate no significant differences referring to gender.

The respondents, graduates from other higher schools, provide various reasons, why they chose Master's studies at the LAPE. Most significant differences are featured by such motives as, graduated Bachelor's studies at the LAPE ($\chi^2(4) = 101.20$; $p = 0.000$), and, followed advice by competent person ($\chi^2(4) = 55.57$; $p = 0.000$). The research results indicate, that 84.8% of the applicants, who graduated from

Bachelor's studies at the LAPE, chose it for Master's studies. The data show that the applicants from different universities (4.4% from LAPE, 20% from Vilnius Pedagogical University, 25% from Šiauliai University, 66.7% from Vilnius University, 33.3% from Kaunas Technological University and 28.6% from other higher schools) find the advice by competent person as the main motive to enrol in Master's studies. However, from our point of view, this data is not pointedly, because the number of the students from other higher schools was comparatively low, making just 11% from the total number of applicants. Actually, the other motives for Master's studies at the LAPE, such as "easier to enrol and study here than other university" ($\chi^2(4) = 16.456$; $p = 0.561$); $\chi^2(4) = 20.427$; $p = 0.905$), "like sports" ($\chi^2(4) = 28.606$; $p = 0.235$), are not influenced by previous studies in other universities.

The analysis of the research data on motives to enrol in Master's studies at the LAPE for Bachelor students with different academic records make no influence for such motives as "easier to enrol in the LAPE than other university" ($\chi^2(4) = 25.25$; $p = 0.118$), "like sports" ($\chi^2(4) = 28.87$; $p = 0.225$), "advice of competent person" ($\chi^2(4) = 21.99$; $p = 0.232$), "easier to study than in other universities" ($\chi^2(4) = 38.37$; $p = 0.140$).

DISCUSSION

V. Kanopienė and D. Tureikytė (2002) have identified that more than 50 percent of the undergraduate students in Vilnius University are motivated for their studies by future motives and intention to have good profession (getting one's living). K. Kardelis and D. Karanauskienė (2003) have found that more than 80 percent of the undergraduate students at the LAPE are motivated for their studies mainly by vision of the future profession. The results of our study confirmed those facts. Our data analysis revealed that applicants emphasize two key motives for enrolment in Master's studies — future perspectives and intention of advanced training in particular field. It seems that either undergraduate or graduate students feel responsibility for future profession and job. Worthy of note that university students conceive of their aspirations. V. Kanopienė and

D. Tureikytė (2002) research reports that about 9 percent of the undergraduate students are influenced for their studies by adults (parents or teachers). Our preliminary analysis indicated no reliable influence for choosing Master's studies by neither adults nor even peers. Probably, this difference was determined by different respondents' age and experience.

The data indicated that mostly applicants would like to choose for their graduate studies the same universities (Is it possible that the familiar system of studies reduces anxiety of application and admission procedures?). It should be noted, that this research could be introduced as a pilot study to find relationship between the peculiarities of motivation for applying for Master's degree studies at the Lithuanian Academy of Physical Education referring to gender, age, graduated university and academic records.

CONCLUSIONS

In summary, the results of the current study indicated that:

- undergraduate applicants emphasize two key motives for enrolment in Master's studies — future perspectives and intention of advanced training in particular field;
- age, gender and academic records of undergraduate studies influence the motives of applying for Master's studies. However, the previous university at which applicants were awarded Bachelor's degree, makes no influence on the issue;
- graduation from Bachelor's degree studies at the LAPE and interest in sports activities are the key motives for respondents to enrol in Master's studies, particularly at the LAPE;
- gender and lower level of Bachelor's academic records make influence for motives to select Master's studies, particularly at the LAPE. On the contrary, age has no such influence.

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FRACTAL DIMENSIONS IN EVALUATION OF HEART FUNCTION PARAMETERS DURING PHYSICAL INVESTIGATIONS

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ABSTRACT

In last two decades the theory of complex systems made big steps in its development. The new methods for integral situations' evaluations were created. Beginning from F. Hausdorff in 1919, the set of fractal dimensions was proposed to evaluate systems' complexity. Now F. Hausdorff's dimension, A. Kolmogorov's integral correlation dimension, information dimension, correlation dimension and many others are widely used. They are used in physics, medicine, biology, astronomy and all other sciences. The question still exists which, when to use and what additional information it will provide. The aim of this work was to explore the behavior of a few well known fractal dimensions during physical investigations of healthy persons, sportsmen and ischemic heart diseased patients with the aim to evaluate the heart function. The studied fractal dimensions can be used for the evaluation of a sportsman's functional state. The endurance-trained sportsman has the highest values of fractal dimensions. Information dimension detects new unstudied information in sport and clinical medicine. It separates out the investigated persons according to gender, disease and physical activity. But information dimension does not depend on age in the investigated groups of asymptomatic persons (men and women).

Keywords: cardiovascular system, functional state, complexity, fractal dimensions.

INTRODUCTION

The idea of complexity must be understood in the context of processes in nature generating systems with more parts and special relations between various kinds of parts. The fractal dimension can be viewed as a relative measure of complexity, or as an index of the scale-dependency of a pattern (Kenkel, Walker, 1996). The fractal dimension could be understood as a summary statistic measure of overall "complexity". The term "fractal" was introduced by B. B. Mandelbrott (1977) to characterize spatial or temporal phenomena that are continuous but not differentiable.

The human body can be evaluated as a complex system (Baranger, 1994) which consists of, at least, three holistic systems, and they were indicated by A. Vesalius in 1548. But, even in today sport and clinical medicine, we can hardly find parameters to evaluate the complexity of human organism. More convenient in medicine are investigations of processes in depth, than the study of systems' relation. The relations between systems in human organism usually are nonlinear and their formalization is quite a difficult task. There is well known fact that human health, harmonic development of human organism strongly depends

on that relations between systems, on the complexity of all organism. Decrease of complexity in human organism leads to disintegration of human organism's functions. The pathology can rise up in any scale it will happen. Evaluating the changes in electrocorticograms with A. Kolmogorov's integral correlation influenced by microwaves (Sidorenko, 2004), have shown decrease of complexity in brain function when the pathogenic influence of microwaves appears.

The aim of this work was to explore the behavior of a few well known fractal dimensions during physical investigations. We evaluated capacity, information and correlation dimensions for the parameters of an integrated health evaluation model (those parameters reflect different human physiological functions). We tried to evaluate the behavior of chosen dimensions in various investigated groups of persons (sportsmen, healthy persons and patients with ischemic heart disease).

MATERIAL AND METHODS

Two investigations were made.

The first investigation. The investigated contingent consisted of three groups: 15 endurance-trained sportsmen, 10 non-athletes and 12 sprint-trained sportsmen. Sportsmen had had their training experience for more than 7 years. All the participants underwent three exercise tests: 1) bicycle ergometry — every one minute stepwise increase in workload; 2) Roufier's test — 30 squats per 45 s; 3) 30 s vertical jump test. The computer system "Kaunas Load" was employed for the registration and analysis of the 12-lead electrocardiogram (ECG). Dynamics of heart rate (HR), and ratio of JT and RR intervals (JT / RR) were investigated. To avoid influence, in calculation, of different range of parameters, the HR and JT / RR were normalized according to their physiological (max-min) scale of changes.

The three widely used fractal dimensions were investigated — F. Hausdorff's, or capacity dimension (CD), information dimension (ID) and correlation dimensions (CoD).

The formula for dimensions' calculations was:

$$D_q = -\lim_{\varepsilon \rightarrow 0} \frac{I_q(\varepsilon)}{\ln \varepsilon},$$

when $q = 0$, we have F. Hausdorff's (capacity) dimension (CD)

$$I_q(\varepsilon) = \ln N_\varepsilon;$$

$q = 1$, we have information dimension (ID)

$$I_q(\varepsilon) = -\sum_{i=1}^{N_\varepsilon} P_i(\varepsilon) \ln P_i(\varepsilon);$$

$q = 2$, we have correlation dimension (CoD)

$$I_q(\varepsilon) = -\ln \sum_{i=1}^{N_\varepsilon} (P_i(\varepsilon))^2;$$

$I_q(\varepsilon)$ — information function;

G — fixed parameter;

ε — square grid box size;

N — the total number of points in the set;

$P_i(\varepsilon)$ — probability that element is normalized, i. e.

$$\sum_{i=1}^{N_\varepsilon} (P_i(\varepsilon)) = 1;$$

N_ε — the number of occupied boxes;

n_i — the number of points counted in the box.

The number of filled boxes is N_ε , calculations were made for fixed ε values. Comparison of means was made for different groups of investigated persons.

The second investigation. The investigated contingent consisted of three groups: sportsmen (159 tests of men, 53 tests of women), asymptomatic persons (113 tests of men, 210 tests of women) and patients with ischemic heart disease (61 tests of men). Asymptomatic persons were divided into 6 groups according to gender (male and female) and age (20—30, 30—40 and 40—50 years old). Groups of investigated persons and the means of their age are given in Table 1 (M stands for the mean of age; SEM stands for standard error of the mean).

The physical load was performed by provocative incremental bicycle ergometry (modified Brooce's protocol). The bicycle ergometry was started with 50 W intensity and the power was increased every minute by 50 W for men and by 25 W for women, and the cycling frequency of 60 cycles per minute was used. The loading was performed till the submaximal heart rate or appearance of clinical symptoms indicating the test. A computerized 12-lead ECG analysis system "Kaunas-Load", developed at the Institute of Cardiology, Kaunas University of Medicine, was used (Vainoras et al., 1999).

We used the model of integral health evaluation (Poderys, 2004), which integrates changes of three functional elements: P — periphery system, R — regulation system (brain), S — supplying system (heart, blood-vessel system) (Fig. 1). Relation between these systems

Table 1. The number and age of investigated groups (M ± SEM)

Group	Number	Age (M ± SEM)
Sportsmen	159	23.56 ± 0.40
Sportswomen	53	24.88 ± 0.65
Men	113	36.05 ± 0.60
20—30	27	28.37 ± 0.56
30—40	55	35.36 ± 0.35
40—50	31	43.97 ± 0.60
Women	210	33.97 ± 0.53
20—30	66	25.17 ± 0.44
30—40	100	35.14 ± 0.28
40—50	44	44.52 ± 0.50
Patients with ischemic heart disease	61	52.44 ± 1.56

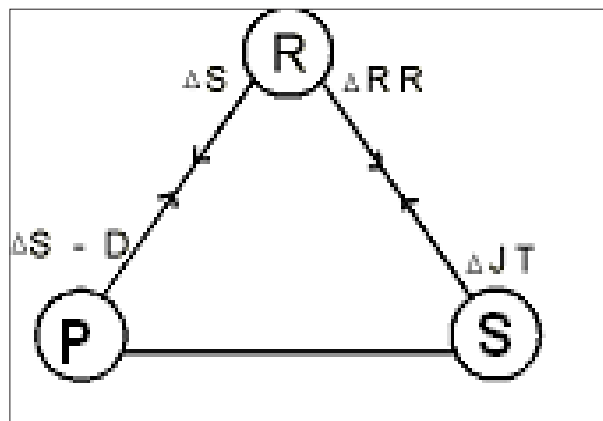


Fig. 1. Integrated model for functional state evaluation

can be specified by several parameters, but we used the simplest and easier calculated ECG and ABP parameters: heart rate (HR), JT interval, systolic (S) and diastolic (D) blood pressure.

Also we studied proportions between

parameters: $\frac{S - D}{S}, \frac{JT}{RR}$, where $RR = 60 / HR$.

Initial data was the discrete values of all discussed parameters at each level of load and during rest.

For calculation of information dimension at first discrete points we interpolated with cubic interpolation spline (Plukas, 2001). Then we calculated function values in step h (h = 0.01). During the research we found out that information dimension depended on particular parameters' values of physiological interval (max-min), so according the interval of possible changes, we normalized the initial data (for example, heart rate can be from 50 to 220 beats per minute, JT interval can be from 0.15 to 0.36 seconds). Then the return map using calculated function values was made. After that, the information dimension for this map was calculated. The algorithm for

calculating information dimension was taken from literature (Internet link).

Consider a square grid (box size ϵ) superimposed on an observed point pattern. Within each occupied grid unit, the number of points n_i is counted. Each count is then expressed as a proportional value:

$$P_i(\epsilon) = \frac{n_i}{N},$$

when N is the total number of points in the set. The "information function" is defined as

$$I \equiv - \sum_{i=1}^N P_i(\epsilon) \ln [P_i(\epsilon)],$$

when N_ϵ is the number of occupied boxes (squares) of size ϵ . $P_i(\epsilon)$ is the natural measure, or probability that element i is populated, normalized so that:

$$\sum_{i=1}^N P_i(\epsilon) = 1$$

The information dimension is then defined as:

$$ID = - \lim_{\epsilon \rightarrow 0} \frac{I}{\ln(\epsilon)} = \lim_{\epsilon \rightarrow 0} \frac{\sum_{i=1}^N P_i(\epsilon) \ln [P_i(\epsilon)]}{\ln(\epsilon)}$$

For the comparison of calculated information dimension, we compared the means of the studied groups. We assumed that the distribution of information dimensions is normal, so we used a two-sample t-test for the significant differences of the means (Čekanavičius, Murauskas, 2001):

$$\begin{cases} H_0 : \mu_X = \mu_Y \\ H_1 : \mu_X \neq \mu_Y \end{cases}$$

RESULTS

Results of the first investigation. The results obtained during the first investigation are presented in Figure 2. Significant differences among the studied groups were found during 30 s jump test for HR in CD (among endurance sportsmen, non-athletes and sprint athletes) and ID calculations (between sportsmen and non-sportsmen). Differences in dimensions for parameter JT / RR were more expressed, especially for Roufier's and 30 s jump tests. Significant differences were between the athlete and non-athlete groups and non-athletes have all the smallest dimensions' values.

For more detailed analysis we chose

Table 2. Means \pm SD of information dimension for investigated men groups

Parameters	Patients with ischemic heart disease	Asymptomatic men of different age	Sportsmen
(S—D) / S	0.48 \pm 0.12	0.65 \pm 0.14	0.77 \pm 0.13
JT / RR	0.54 \pm 0.13	0.62 \pm 0.11	0.64 \pm 0.11
RR	0.56 \pm 0.12	0.61 \pm 0.10	0.68 \pm 0.12
JT	0.56 \pm 0.12	0.62 \pm 0.11	0.67 \pm 0.10
S	0.70 \pm 0.12	0.73 \pm 0.11	0.77 \pm 0.08
S—D	0.55 \pm 0.13	0.65 \pm 0.13	0.81 \pm 0.12

Table 3. Means \pm SD for investigated women groups

Parameters	Asymptomatic women of different age	Sportswomen
(S—D) / S	0.58 \pm 0.14	0.70 \pm 0.15
JT / RR	0.63 \pm 0.12	0.68 \pm 0.11
RR	0.58 \pm 0.09	0.72 \pm 0.12
JT	0.61 \pm 0.11	0.72 \pm 0.09
S	0.61 \pm 0.11	0.71 \pm 0.11
S—D	0.53 \pm 0.14	0.69 \pm 0.15

Table 4. Two-sample t-test for means results for RR interval

Compared groups		t	p
Patients with ischemic heart disease	Asymptomatic men of different age	3.185	0.002
Patients with ischemic heart disease	Sportsmen	6.596	< 0.001
Asymptomatic men of different age	Sportsmen	4.802	< 0.001
Asymptomatic women of different age	Sportswomen	5.905	< 0.001

Table 5. Two-sample t-test for means results for RR interval in different age groups

Compared groups		t	p
Men 20—30	Men 30—40	0.521	0.604
Men 20—30	Men 40—50	0.573	0.569
Men 30—40	Men 40—50	0.502	0.599
Women 20—30	Women 30—40	0.870	0.386
Women 20—30	Women 40—50	1.056	0.295
Women 30—40	Women 40—50	0.529	0.598

information dimension (ID). It shows quite big differences in our studied groups and is sensitive to the person's functional state.

Results of the second investigation. In Table 2 and Table 3 the means of information dimension for all parameters (mean \pm standard deviation) are presented:

The means of information dimension of different investigated parameters for all studied groups of men are shown in the diagram form (Fig. 3).

In Figure 2 we can see, that means for all parameters differs — the means of information dimension for patients with ischemic heart disease

are smaller than the means in sportsmen group. For some parameters ($\frac{S-D}{S}, S-D$) we can see even different tendencies compared with other parameters.

The two-sample t-test for the means showed that in most cases the means of information dimension significantly differs ($p < 0.05$) between investigated groups of men, the same for women. For example, for RR interval significant differences you can see in Table 4:

The means of information dimensions don't differ between groups of different age, the same for men and women (Table 5).

Existing difference between the groups with different physical activity and absence of it in the

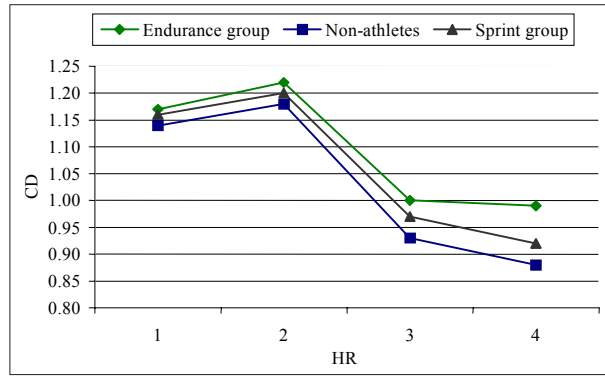


Fig. 2, A. F. Hausdorff's dimension (CD) for heart rate (HR)

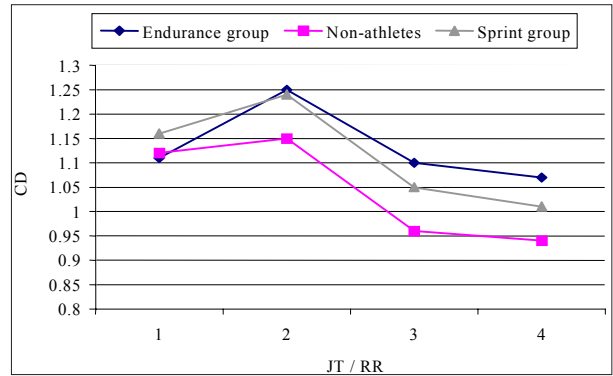


Fig. 2, B. F. Hausdorff's dimension (CD) for heart parameter (JT / RR)

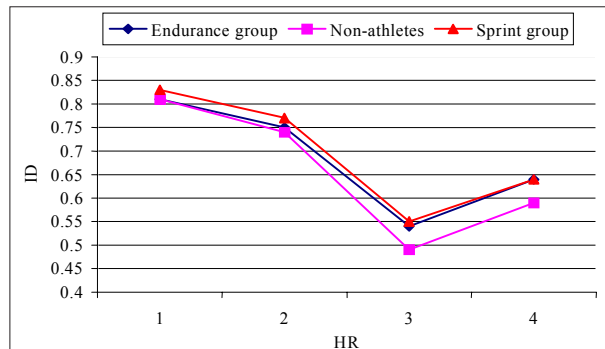


Fig. 2, C. Information dimension (ID) for heart rate (HR)

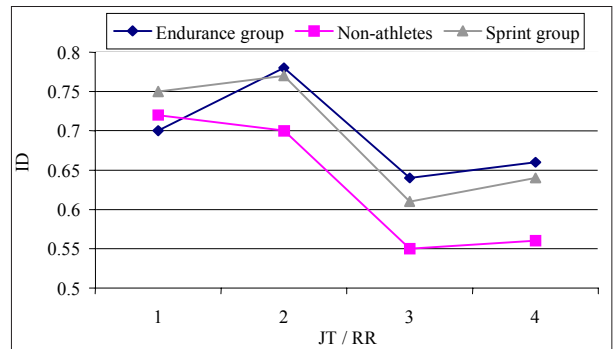


Fig. 2, D. Information dimension (ID) for heart parameter (JT / RR)

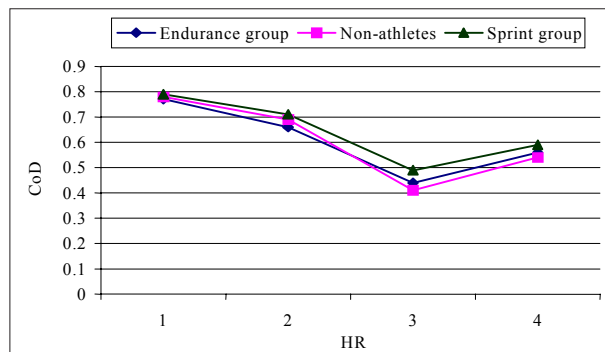


Fig. 2, E. Correlation dimension (CoD) for heart rate (HR)

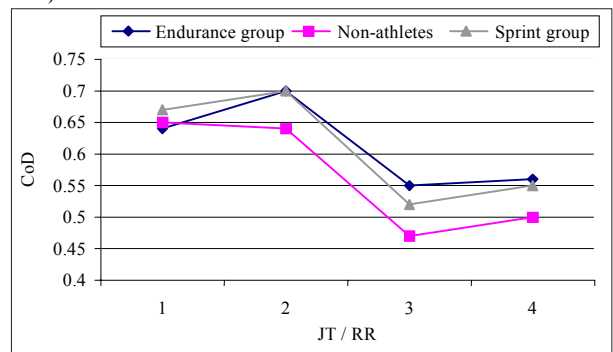


Fig. 2, F. Correlation dimension (CoD) for heart parameter (JT / RR)

Fig. 2. Capacity, information and correlation dimensions for heart rate and heart parameter JT / RR. Number 1 on axis x reflects situation during bicycle ergometry, number 2 — the common, integrated evaluation during Roufier's test and 30 s jumps, number 3 — only Roufier's test and number 4 — only at 30 s jumps. The studied groups are: 1-st, endurance sportsmen, 2-nd, healthy non-athletes, 3-d, and sprint type sportsmen

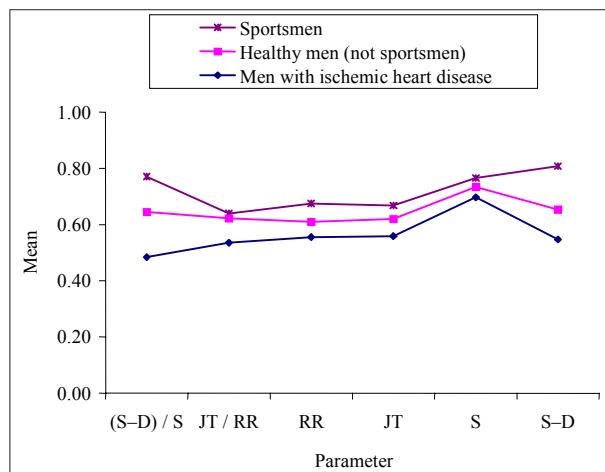


Fig. 3. Mean of Information dimension for studied men groups

groups of different age and gender but with the same physical fitness can point out conclusion, that the studied information dimension could be used as a measure of human functional state or healthiness. It integrates all features of reaction to load — the load and recovery as well.

DISCUSSION

The first investigation has shown that different fractal dimensions express different behavior in evaluation of human organism parameters. The question when and which dimension more effectively could be used is still open. In our study the best results we have from capacity and information dimensions. This fact can reveal that our dimensions being as an integral parameter are related to the form of a curve (function in time) of studied, normalized parameters (this is more typical feature for capacity dimension). It means, that those dimensions can reveal integrated in a curve form information and it could be very important and new information for a person's functionality evaluation. We think, our results from the first study support that opinion.

In the second study the information dimension was studied in details. The calculation for information dimension was made for the normalized parameters which were taken as the parameters of human organism's integral model. It

means that they all must reflect the same level of complexity and Figure 3 can really support this statement. All parameters have about the same value of information dimension, only in the groups with different functional level it differs.

It is interesting that information dimension doesn't differ for different age groups, and the same gender. May be, it could be related to the statement that we can have the same good functional level at all ages if to take care about our health.

The obtained results support our previous opinion that fractal dimensions could be helpful integral parameters to reflect human body as a complex system.

CONCLUSIONS

1. The studied fractal dimensions can be used for the evaluation of a sportsman's functional state. The endurance trained sportsmen have the highest values of fractal dimensions.
2. Information dimension detects new unstudied information in sport and clinical medicine. It separates the investigated persons according to gender, disease and physical activity. But information dimension does not depend on age in the investigated groups of asymptomatic persons (men and women).

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THE PSYCHOSOCIAL ASPECTS OF TEAM SPORTS: THE INDIVIDUAL VERSUS THE TEAM

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ABSTRACT

This text is a part of a longer elaboration concerning the humanistic bases of the theories of team sports. The notion “sports games” refers to team sports, which are most popular in our culture (in Poland): volleyball, basketball, football and handball.

Team sports are a very interesting matter for the observation, how the integrated human teams function. Sport, as a constituent of social life, is liable to the principles and rules, which are similar to the ones we may observe in ambient reality. Willing to explain and describe those phenomena, we should reach for the knowledge from the subject field of social sciences; in this case — concerning the collective behaviours.

In this analysis I took into consideration the opinions about the functioning of human communities — the opinions formulated by G. Le Bon (1996), W. McDougall (1920), S. Freud (2000) and selected conceptions from contemporary American psychology concerning the relations between the individual and the group. In this context I emphasized a reflection about the necessity of proper stimulation, when the development of an individual is concerned, which means the change towards the individualization of training in team sports. The character of this text is strictly theoretical but it is also an attempt to accentuate the importance of the knowledge of a team’s morphology and the relations between an individual and other members of a team for sports practice. This knowledge is a substantial (but usually underrated) element of the trainer’s work.

Keywords: *team sports, collective behaviours, philosophy, psychology of sport, role of trainer, team building.*

INTRODUCTION

Knowledge related to the morphology of a team and also the relations between an individual and other members of a team are really important (but usually underrated) part of the trainers’ “workshop”. Sport, as a constituent of social life, is liable to the principles and rules, which are similar to the ones we may observe in ambient reality. Willing to explain and describe those phenomena, we should reach for the knowledge from the subject field of social sciences; in this case — concerning the collective behaviours.

The main aim of this article is to analyse the opinions about the functioning of human

communities. The opinions formulated by G. Le Bon (1996), W. McDougall (1920), S. Freud (2000) and selected conceptions from contemporary American psychology concerning the relations between the individual and the group. In this context I emphasized a reflection about the necessity of proper stimulation, when the development of an individual is concerned, which means the change towards the individualization of training in team sports. The character of this text is strictly theoretical but it is also an attempt to accentuate the importance of the knowledge of a team’s morphology and the relations between an individual and other members of a team for sports practice.

DISCUSSION

Gustave Le Bon's "psychology of a group". G. Le Bon (1996) — the forerunner of this field of research, which is situated at the boundary of Social Psychology and Sociology, published in 1895 "The Mob Psychology", where he defined the psychology of a community or studying collective behaviours.

There are contradictory views related to the correctness of the notion of "psychology of a group" or "psychology of a community" and this question hasn't been settled yet (Le Bon, 1996). The opponents emphasize that the members of a given community may think alike, feel alike but it's still not enough to jump to conclusion, which would prove the existence of collective psyche. The author presents the features of the mob, which differ it from a set of individuals taking part in it. The G. Le Bon's "mob" has meaning, which is different from a traditional understanding of this conception¹ (Le Bon, 1996). "At the convergence of some circumstances and only in those circumstances the community gains completely new features, different from the ones that the particular individuals, which in this case comprise the mob, have. While being a part of a mob, the consciousness of own individuality dwindles and the feelings and thoughts of everybody have the same direction. The collective soul seems to emerge; it's existence is undoubtedly very short but it has some characteristic features, which are extraordinarily distinct" (Le Bon, 1996). From the one's point of view the affiliation to the mob isn't a beneficial effect due to the fact that "<...> in the collective soul the intellectual features and individuality of a human individual fade. The heterogeneity turns into homogeneity and the unconscious features play the main role here. <...> the mob means accumulation of mediocrity, never intelligence" (Le Bon, 1996).

The basic feature of a human community, which is specified as "psychological mob" (or in other words — organized mob), is "the rule of mental unanimity". According to this rule, the mob shares the same feelings and one main leading idea.

The mob easily undergoes alterations: the thoughts and feelings may often change, e. g. the heroic, revolutionary mob under the influence of

some stimuli may turn into the conservative mob. Moreover, the lack of durability is typical of it. It can't be persistent in pursuing its aim, especially when some obstacles appear. The feelings, which are expressed by the mob are usually exaggerated, extreme, sometimes even supported by detrimental and violent behaviours. The mob doesn't tolerate opinions that are different than its own.

Having mentioned the problem of characteristic of a mob as a whole, G. Le Bon (1996) made also an attempt to present behaviours and psychological processes of the individuals belonging to a mob. Affiliation to a mob gives the feeling of power. "<...> every single individual, even under the influence of the size of a mob only, gains the feeling of invincible power, which lets them express their passions, surely suppressing when they are alone. They will not control themselves because the sense of responsibility, which always curbs them, disappears from their souls; the mob is always anonymous and thus irresponsible" (Le Bon, 1996). This seeming sense of power leads in consequence to desindividualization, which may build the illusion of impunity. The number of individuals who participate in the mob but are able to resist the prevailing atmosphere and suggestion of the rest is slender. The rule says: if you are one of us you have to surrender to the mood of a mob. "The contagion of feelings and act controls the individual so much that one may sacrifice their personal aims to follow the common idea. This feature is against the human nature but everyone is susceptible to performing that way when they become the participants of a mob" — claims G. Le Bon (1996).

Following the moral standards is hindered in a mob as it is changeable and vehement. Nevertheless were there some proves that in parallel to violent and cruel instincts the mob afforded sometimes very elevated moral acts. The history knows the cases of the mobs, which died heroically defending an idea, creeds, etc. There are also some proves for the moral influence of the mob (e. g. during the French Revolution some members of criminal groups gave the money and jewellery, which were taken from their victims to the revolution committees). "Usually the private business is the main factor that makes the individual act whereas in the mob it is really insignificant" — remarks G. Le Bon (1996). The mob may be liable to low instincts or reveal the elevate moral merits. The morality of a mob isn't realized (The mob itself isn't able to reason),

¹ Usually „mob” means a community of accidental individuals, their nationality, gender or religion don't matter as well as the event which gathered them.

however, it has an incredible imagination (e. g. the picturing a great victory, crime, hope, etc., which are very suggestive) that gives the full control of the mob, the power. Every mob has its own leader. His authority is indisputable, he knows how to awaken the faith and be the guide. The soul of a mob isn't directed by the need of freedom but the need of yielding to something or somebody. This need of obedience and affiliation force an individual to surrender and follow anyone who wants to rule. The leader must be distinguished by prestige (personal or acquired).

To recapitulate — a mob doesn't yield any benefits as far as the matter of the individual development is concerned, even more — the individual who becomes a participant of a community goes down the ladder of civilization.

Thesis of G. Le Bon versus team games. Trying to maintain a distance to this thesis (the later research in field of social sciences verified this matter without any problem) we should notice that selected plots G. Le Bon's (1996) conception are related to general meaning of social behaviours. It has been a rich source of references made by many researchers dealing with this issue (Lindsey, 1954; Lindsey, Aronson, 1969; Turner et al., 1957).

It's important for the conducted analysis to emphasize that maintained features are typical for the brief events created as a community of various individuals connected by a momentary interest. In contrary, the sports team is a stable community consisting of different (but properly selected) individuals, who owe the particular abilities and qualifications to perform a task (morphological and psychical features coupled with technical and tactical skills). The main idea which connects the teams members is cooperation and competition with other similar teams. They compete for the victory, which results in prestige, fame and often even money. In contrary to a mob, the team performs consciously and belonging to a group doesn't cause the disindividualization of players. The engagement in action requires also some intellectual work. We meet here (like in every sports games) motion open habits where the main role play cognitive and decisional processes (perception, recognition of a stimulus and selection of reaction). It's possible to react differently for the same stimulus using the system of experiences and operational thinking. The player may follow one out of a few patterns of performing when he faces

the same situation. The game takes place according to a kind of convention and the access to participation is a consent to observe the compulsory norms and regulations (legal, e. g. the rules and moral, e. g. fair play). This we may include that an affiliation to this kind of community influences an individual very positively in contrary to the situation with a mob. The contagion of feelings is worth devoting our attention — we often observe it in the reactions of players (the joy after a well performed action, when they win or the sadness after suffering a defeat, etc.). It is a proof for the fact that the team thinks and feels in the categories of "WE". The joy and enthusiasm of the whole group (not excluding the second team) comprise the "good spirit" of a team.

Aside from the observations that are described above, it seems that in search for the explanation of the functioning of a team we should go towards the conceptions of more stable and better organized communities than G. Le Bon's (1996) "mob".

Community versus Ego. The questions about a "psychological community", the way it gains the power to influence the individual's life so much and about the essence of this psychological change, which is imposed on an individual, were asked by Sigmund Freud (2000), the inventor of psychoanalysis. He treats a human being as a part of a tribe, a nation, a caste, a state, an institution or any other human community, which in particular time and with a particular purpose organizes and makes the community. "This extracting of an individual from their natural context would let assume that the phenomena occurring in these particular conditions are separate symptoms of a social impulse, which can't be compared with anything — herd instinct, group mind — which in other situations isn't revealed (Freud, 2000).

The unification of a level of all "collective people" (Massenindividuen) is a result of abolishing the features, inhibitions characteristic for a particular individual and resignation from their specific propensities. To explain the psychology of a community, he used a conception of libido (derived from the theory of affects). This name defines some " <...> quantitative dimension — it can't be measured — the energy of the impulse, which are connected with what we call love" (Freud, 2000). He made an assumption that emotional connections (more neutral conception) also make a part of the psyche of a mob. The coherence of a mob

is dependent on some power and according to S. Freud (2000) Eros keeps everything in coherent whole. The second premise, which was the basis of his assumptions, was the conviction that if an individual resigns from their individuality in a mob they prefer to be in harmony with the rest than have a conflict, they perform “to the satisfaction of a mob” („ihnen zu liebe”) (Freud, 2000).

When we analyze two artificial communities: a catholic church and an army, he comes to a conclusion of libidinal structure of a community. In his research he took into a consideration, e. g. phenomena of panic in military masses. If the individuality starts to take care only about themselves, it's a proof for the fact that they noticed that the affective bonds, which in their opinion had reduced danger, are broken away — he writes — if an individual has to face the danger alone, they may indeed overrate it.” <...> the fear is a result of looseness of the libidinal structure of a mob and it's an excused reaction for it, not inversely — the fear of danger doesn't slacken and break the libidinal bonds, which exist in a community” (Freud, 2000).

The libidinal bonds are supposed to characterize a community. Therefore, what are the affective attitudes that people adopt towards each other? Probably it's like in A. Schopenhauer's parable about freezing porcupines, nobody likes when others are excessively² (Freud, 2000).

The psychoanalysis proves that every single emotional relationship, which lasts longer (e. g. marriage, friendship, etc.) also contains some shadow of negative feeling, we don't notice it as we suppress it. However, during the process of forming a community and in a community itself, this intolerance disappears until the individuals behave as if they were identical, equal. „The only barrage for a love to oneself may be a love towards the things which are strange and unfamiliar, a love towards objects (Freud, 2000). But is it possible that common business is a sufficient reason to limit narcissism and to tolerate another human being? This tolerance usually lasts for as long as deriving profits from this cooperation with others is possible. However, during this cooperation it

comes to creation of libidinal bonds, which protract durability of this relationship, independently from the profits. In social relations proceeds exactly the same evolution of libido as in the individual. “The libido forces us to meet our basic needs and it chooses the people, who participate in this satisfying as it's first objects” — he writes.

We owe the psychoanalysis the knowledge that there are other mechanisms of emotional bonds — so-called identifications. An identification makes the most primary kind of an emotional bond. It may appear as soon as we have noticed the occurrence of some special common feature in the personality of an individual who is a subject of our sexual impulses. The importance of this feature in interhuman relations prevails as far as the efficiency of identification and creating a new emotional bond is concerned: the empathy (entrance into the spirit, understanding) S. Freud's (2000) libidinal structure of community refers to a special kind of community — with a leader — and it can't gather again the characteristics of an individual due to the excess of “organisation”³.

The theory of libido tells us also about a propensity of all living creatures to associate in greater units. These psychical phenomena are called “herd instinct” by W. Trotter (1916), who describes it as a primary and indivisible feature. An individual feels incomplete when it remains alone (Trotter, 1916).

The quintessence of S. Freud's (2000) opinions includes in conviction that every single individual as a component of many communities is multilaterally bound by identification and that it has its own idea of Ego, which is built according to complicated patterns. Participating in many “collective psyches” (e. g. race, state, nation), an individual may ascend over them — they achieve a bit of independence and originality.

W. McDougall (1920), who is an author of “The Group Mind” (McDougall, 1920), characterizes these communities, which are highly organized. He enumerates five principal conditions, which when fulfilled let raise the psychical life of a mass on a higher level. When we take into consideration interdependencies between players (so distinct from e. g. a team of swimmers or a team of athletic relay racers) we may certainly

² „On a frosty winter day a few porcupines gathered closely to warm each other. Soon afterwards they started to prickle one another so they scurried again. However the need of warmth forced them to gather one more time — then the same unpleasantness met them. They repeatedly went from one extreme to the other to chose the lesser of two evils and finally they found the proper distance, which pleased them all.”

³ The analise of psychoneurosis, which was conducted among the soldiers of German army during the time of World War I, proved that the source of those diseases was internal and embraced the fact that the soldiers were treated badly by the officers, which was a reason of attenuation of the army.

qualify a sport team (organization of team is considered) to this category. These conditions are to prevent arising of negative effects of forming a group (they were signalled by G. Le Bon (1996)):

1. Attainment of a certain degree of continuity in the group's composition (the same people are members for a longer period of time);
2. Forming of a particular notion, which give to an individual an idea of their functions, achievements and requirements made by a group to create an emotional attitude towards the group as a whole;
3. Entrance of a group into relations with other, similar but in a way different creations (during the competition);
4. Possessing it's own traditions, habits and organization of a group, especially the ones which are related to mutual relations of the members;
5. Segmentation of a group, which follows the specialization and diversification of tasks given to an individual.

The fact that problem solving is given to individuals not to a group as a whole prevents a decrease in collective intelligence. This kind of organization of group is characterized by S. Freud (2000) differently. "The task consists in recreating some features of an individual, which were characteristic for them but were destroyed by the process of adjustment to a group. This individual had — beyond a primitive group — their continuity, self consciousness, traditions, habits, particular achievements in work and also a position and they were visibly separate from others, whom they competed with" (Freud, 2000).

If libidinal bonds characterize a community, is deriving a profit from cooperation with others a sufficient reason of their origin in sports teams? Do they always exist and bind the individualities, which make a team, in equal extend? As we know, the positive attitude towards the group as a whole doesn't mean positive feelings to every single member of a team. And what a team is conflicted but still wins, and vice versa, when there is a wonderful atmosphere but no intended results? This state is probably a result of the fact that the occurrence of those bonds isn't a determining factor but only one of the components. It's certain that the bonds easier trainer's work and managing a team. R. B. Maddux (1988) emphasizes that most of the trainers would choose players that cooperate with each other harmoniously, according to rules

that a team with good interhuman relations is more likely to win than a team of conflicted stars. The proverb says: "champion's-team always defeats a team of champions (stars)". In general the team must strive for positive climate. Selection of people, who are able to cooperate well with others is a staple of a success and creating efficient team.

Meeting personal needs (aims) of group's members and achieving maximally high results in one time is a very difficult task. The best players (the most efficacious ones) usually strive for high results and resignation from their own individualities, scarifying it for the team may be also difficult or even impossible (it is very visible at the level of professional teams where deriving profits from games takes place). However, the compromise is possible as the example of Michael Jordan and "Chicago Bulls" shows. "<...> the team won NBA championship scarcely a year after the time of problems, when other players tried to accept the dominating presence of superstar — Michael Jordan, and Michael himself struggled with a problem, how to play with less gifted colleagues from a sports club. That was a great challenge for the trainer — Phil Jackson, who needed to take full advantage of Jordan's talents but also let other players influence results of a game. "<...> if we let Jordan do whatever he wanted, he would probably score 50 or even more points but other players wouldn't be able to play and our system of defence would be predictable, thus the team would play less efficient than it may perform. During a first few months they played in exactly that way. Jordan played as a superstar but the "Bulls" didn't manage to be champions. The team transformed in a champion's-team soon afterwards as Jordan managed to adjust himself to a new role, which consisted in cooperation with team colleagues " (Morris, Summers, 1998).

CONCLUSIONS

Large extent of knowledge about building a team comes from a world of business. T. J. Peters and R. H. Waterman (1994) proved that basic meaning of a success, achieved by the best companies in branch, was grounded on a system of values. "Every perfect company, we examined, was aware of what it represented and treats seriously the values, it prefers. Indeed, we wonder, whether it is possible to create an outstanding company without any special convictions formed on a ground of

positive values” (Morris, Summers, 1998).

The conviction that a team must be more important than an individual is quite common among trainers and it causes that the needs of an individual rarely draw proper attention. Communication usually takes place at the level of group. Trainers often forget that every member of a group wants to have their own, visible contribution to task solving. If we want players to resign from their own ambitions for the sake of a team, we have to talk about it to them. If there's no compromise between a trainer and a player, we can't expect any engagement in realization of a task during a game. *Praising and approbation of individual merits should take place during discussing concrete situations as well as during every day interactions.*

These remarks are directly related to a role of a trainer and a style of working with a team. T. Morris and J. Summers (1998) emphasize that from a moment of selection a team the trainer should strive for maximalization of a team's achievements. This process is very folded and doesn't guarantee that the needs of an individual and the team will always be concurrent. *Team building is a way of creation by thinking to understand, respecting compromises of individuals making the team but first of all it consists in finding a way to develop an individual in frames of structure of efficient team* (Morris, Summers, 1998). Functioning in a team means responsibility and making decisions. We often observe the behaviours of trainers, which prove that the coach doesn't trust his players and at the same time he doesn't regard them as separate individuals. “An

irritated, raving trainer, who doesn't control the situation, shouts at his players but certainly he doesn't do anything to decrease excessively high level of excitation. He can't rate the situation, not to mention an inability to give a reasonable advice” — writes Z. Czajkowski (1996). Also constant advice given to a player by a trainer and other members of a team are very detrimental. Not only do they raise excitement to excessively high level but also kill independence and responsibility “<...>, they retard reactions for the activities of an opponent. <...> the occurrence of this habit is very persistent as well as burning grass, which doesn't raise the level of fertility of a soil but often destroys useful creatures and leads to fires and misery. With gallows humour we may say that excessive exiting of a player and constant advises are equally detrimental and stupid as burning the fields” (Czajkowski, 1996).

The new theories of guidance and managing (human relations management theory), *emphasise the importance of more democratic style of control and of the participation of interested individuals in making decisions.* James Counsilman — a famous trainer and psychologist — claims: “The trainers usually want their contestants to identify with them and it is even better when they all identify with a common aim” (Czajkowski, 1996).

Now, it is only to translate it into the language of sports ordinariness. How to do it? *At first the abhorred yoke of “teamness” must be lifted from the field of sports games. Then there should be a turn to the individualization of a training, which lets the individual be stimulated and developed properly.*

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