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LITHUANIAN OLYMPIC BASKETBALL PLAYERS' NUTRITION DURING THE TRAINING MEZZO-CYCLES DESIGNED FOR STRENGTH TRAINING

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ABSTRACT

Research background and hypothesis. Unbalanced nutritional status, incorrect qualitative and quantitative content of nutritional and bioactive substances (nutrition value) for athletes in strength and speed sports can have a negative impact on acid-base homeostasis and physical working performance. Hypothesis – there is a dietary acid-base balance in the Lithuanian Olympic basketball team players' food rations.

Research aim was to assess dietary acid-base balance in Lithuanian high-performance basketball players during the training mezzo-cycles designed for strength training.

Research methods. In the general preparation period, Lithuanian Olympic Team basketball players (n = 52), aged 18.0 ± 1.9 years, training 197.9 ± 58.7 min a day, 6 days a week on average, were tested. Body composition analysis of athletes was performed using bioelectrical impedance analysis (BIA) method. Applying the survey method we investigated and assessed the nutritional status of basketball players, possible effect of their dietary intake on potential renal acid load (PRAL) and net endogenous acid production (NEAP).

Research results. The dietary PRAL of more than half (67.3%) of subjects was positive (8.5 ± 49.0 mEq/day). Basketball players' protein intake was positively related to dietary PRAL ($r = 0.408$, $p = 0.003$). Protein intake of 20.5% of male basketball players on average was 2.6 ± 0.7 g/kg body weight, and their dietary PRAL was 75.5 ± 22.8 mEq/day, NEAP – 128.5 ± 23.7 mEq/day.

Discussion and conclusions. If high-protein diet (protein intake meets 1.8–2.0 g/kg BW) is followed, basketball players' nutritional habits should be changed. Athletes are recommended to consume significantly more fresh fruits and vegetables and/or enrich the normal diet by sodium bicarbonate and/or beta-alanine dietary supplements.

Keywords: basketball, acid-base balance, renal acid overload.

INTRODUCTION

The maintenance of homeostasis plays a key role in health and sports performance. As such, tissue and blood pH levels, once perturbed, must be returned to normal ranges. Basal metabolism generates organic acids while intensive exercise can cause transient increases of the acid load (Robergs et al., 2004). For the elimination of a proton surplus,

the body has several buffering systems with a crucial role for the lungs and kidneys. One component that influences acid-base balance in the human body is the composition of the diet. Researchers found a strong relation between the composition of the diet and the urine pH, and introduced the estimated “potential renal acid load” (PRAL) of food items (expressed

in milli-equivalents (mEq) H⁺ per 100 g) (Remer, 2001). Fruits and vegetables have a negative PRAL which means that they potentially contribute in buffering hydrogen ions. Foods with high protein and phosphorus content such as meat and cheese have a positive PRAL, and hence potentially increase hydrogen ion production.

The estimated diet-dependent net endogenous acid production (NEAP) can be calculated as the sum of organic anions from the basal metabolism and the PRAL of all consumed food items (Frassetto et al., 2007). It has been suggested that the long-term net acid excretion should not exceed 100–120 mEq/day since this may result in a maximal renal stimulation of acid, decreasing the plasma bicarbonate availability (Remer et al., 2003; Remer, Manz, 2003).

Basketball is a team sport where athletes perform high-intensity physical loads of moderate or long duration with recurrent low-intensity intervals of rest. Basketball players are strength-power athletes. Strength-power parameters are the main predictors of sprinting performance and resistance-based activity. Sprinting is a short burst of activity of high intensity relying primarily on alactic and lactic anaerobic energy systems and in case of repeated sprint exercise, aerobic metabolism also becomes involved (Berg et al., 2010). Especially during longer sprints or when rest periods between repetitions are too short to allow complete recovery, sprint athletes have to deal with high amounts of protons causing metabolic acidosis (Robergs et al., 2004).

Thus basketball players' unbalanced nutritional status, incorrect qualitative and quantitative content of nutritional and bioactive substances (nutrition value) can have a negative impact on acid-base homeostasis, anaerobic fitness parameters and slow down the adaptation to exercise training. In Lithuania there are no scientifically valid data on the impact of elite basketball players' nutrition on the body acid-base homeostasis. Optimization recommendations for players' nutrition have not been established though they would help improve the preparation of athletes for national and international championships. **Research aim** was to assess dietary acid-base balance in Lithuanian high-performance basketball players.

RESEARCH METHODS

Participants. In the general preparation period of 2011–2012, Lithuanian Olympic Team basketball players (n = 52), included into the lists of athletes

approved by the orders of the Department of Physical Education and Sport, were included in the research. The mean age of the research participants was 18.0 ± 1.9 years; their training status was 6.8 ± 2.5 years. Athletes trained 6 days a week on average. The duration of one training session was 117.1 ± 15.3 min, and the duration of one-day training was 197.9 ± 58.7 min. The research sample consisted of 75% of men and 25% of women. In addition, athletes were engaged in weight-training aiming at muscular hypertrophy and strength.

Anthropometric measures. The height of basketball players was measured using the electronic scales at the Lithuanian Sports Medicine Centre. Body composition analysis of athletes was performed at the Lithuanian Olympic Sports Centre using Body Composition Analyser X-SCAN using bioelectrical impedance analysis (BIA) method (American College of Sports Medicine, 2009) applied in research with athletes. We also established athletes' body weight (BW, kg), fat-free mass (FFM, kg and %) and body fat (BF, kg and %), as well as body mass index (BMI) (*The World Health Report*, 2002) and muscle and fat mass index (MFMI) (Skernevičius et al., 2004).

Physical activity level. To estimate total energy expenditure, basal metabolic rate we used Harris-Benedict equation (Harris, Benedict, 1919). To estimate exercise energy expenditure, we used metabolic equivalent records over a 24-hour period (Ainsworth et al., 2011). 24-hour records of physical activity were collected on the same day participants recorded their dietary intakes to estimate physical activity level during a period of active training.

Dietary intake. Nutritional status of athletes in the Lithuanian Olympic Team was assessed after 24-hour food recall. We recorded the data for each athlete's consumed food and dishes. Dietary recall was investigated using special Atlas of Foodstuffs and Dishes sizes. In accordance with tables of food composition, we calculated the chemical composition of athletes' diet (Sučilienė, Abaravičius, 2002). We estimated athletes' carbohydrate, protein, dietary fat, phosphorus, calcium, potassium and magnesium intakes. Macronutrient intake was assessed according to the recommendations provided in research literature (*American College of Sports Medicine*, 2009; Burke, 2010; Kreider et al., 2010). Compliance of mineral intake with RDI was assessed referring to recommended daily intake norms approved in Lithuania (*Rekomenduojamos paros maistinių medžiagų ir energijos normos*, 1999).

PRAL and the diets. The following formula was used to estimate the net endogenous acid production (NEAP) (Remer, Manz, 1995):

Estimated NEAP (mEq/day) = ¹PRAL (mEq/day) + ²OA (mEq/day); whereby PRAL denotes estimated dietary potential renal acid load and OA denotes estimated urinary organic anions, with the 2 components it is calculated as follows:

PRAL (mEq/day) = (0.49 × protein (g/day)) + (0.037 × phosphorus (mg/day)) – (0.021 × potassium (mg/day)) – (0.026 × magnesium (mg/day)) – (0.013 × calcium (mg/day)) (2)

OA (mEq/day) = individual body surface area³ × 41/1.73.

Body surface area was calculated according to the formula proposed by D. Du Bois and E. F. Du Bois (Du Bois, D., Du Bois, E. F., 1916):

Individual Body surface area (m²) = 0.007184 × (height (cm))^{0.725} × weight (kg)^{0.425}.

Data analysis. Statistical data analysis was carried out using the SPSS (Statistical Package for Social Sciences) v. 15.0. Data analysis was carried out using conventional methods of descriptive statistics: calculation of arithmetic means, standard

deviations (SD). Student's t-test was used for the comparison of means between two independent groups of respondents. Hypothesis was verified using the level of significance of $\alpha = 0.05$. The significance level was set at $p < 0.05$. Some calculations were made using Pearson's correlation coefficient (r).

RESEARCH RESULTS

Body composition analysis of athletes in the Lithuanian Olympic team (height, BW, FFM, FM, MM, BMI and MFMI) is given in Table 1. Regardless of gender, basketball players' BMI ranges within the normal range, but the male basketball players' BW (kg and %, $p < 0.0001$), FFM (kg and %, $p < 0.0001$), MM (kg and %; $p < 0.0001$) are higher than those of female basketball players. In addition, the male basketball players' MFMI (4.5 ± 1.3) (estimated as the average) at a higher level conforms to the requirements for elite athletes compared to the female basketball players' MFMI which is too low (2.9 ± 0.4) (seen as too small). This is attributed to the purposefully increased MM in men basketball players.

Table 1. Sports experience and anthropometric data of Lithuanian Olympic team basketball players (n = 52)

Sports experience, height and body mass components	Total (n = 52)	Male ¹ (n = 39)	Female ² (n = 13)	t-test ^{1/2}	
	Mean ± SD			t	p
Sports experience, yr	9.01 ± 3.3	9.2 ± 3.3	6.8 ± 2.5	1.234	0.225
Workouts per week, no.	6.0 ± 0.8	6.0 ± 0.8	5.7 ± 0.6	0.779	0.44
Workouts per day, no.	1.6 ± 0.5	1.6 ± 0.5	2.0 ± 3	-4.873	< 0.0001
Average training time per day, min	117.1 ± 15.3	118.5 ± 14.6	100.0 ± 17.3	2.094	0.043
Total training time per day, min	197.9 ± 58.7	205.4 ± 65.7	175.4 ± 16.6	2.613	0.012
Age, yr	18.0 ± 1.9	18.6 ± 1.8	16.1 ± 0.5	8.115	< 0.0001
Height, cm	192.7 ± 11.6	197.6 ± 8.0	177.8 ± 7.0	7.93	< 0.0001
BW, kg	81.7 ± 11.7	85.7 ± 9.9	69.5 ± 8.0	5.357	< 0.0001
FFM, kg	65.8 ± 9.7	70.3 ± 5.8	52.1 ± 4.7	10.245	< 0.0001
FFM, %	80.5 ± 4.4	82.3 ± 3.3	75.2 ± 2.8	6.855	< 0.0001
MM, kg	61.0 ± 9.0	65.3 ± 5.2	48.1 ± 4.3	10.687	< 0.0001
MM, %	74.7 ± 4.4	76.5 ± 3.3	69.4 ± 2.7	6.932	< 0.0001
FM, kg	16.0 ± 4.3	15.5 ± 4.5	17.4 ± 3.7	1.376	0.175
FM, %	19.5 ± 4.4	17.7 ± 3.3	24.8 ± 2.8	-6.847	< 0.0001
PM, kg	13.8 ± 2.2	14.8 ± 1.3	10.6 ± 0.9	10.793	< 0.0001
PM, %	16.8 ± 1.2	17.3 ± 0.9	15.3 ± 0.7	7.451	< 0.0001
M, kg	4.7 ± 0.7	5.0 ± 0.6	4.0 ± 0.4	5.787	< 0.0001
M, %	5.8 ± 0.1	5.8 ± 0.1	5.8 ± 0.1	1.306	0.198
BMI, kg/m ²	21.9 ± 1.9	22.0 ± 1.9	21.8 ± 1.6	0.233	0.825
MFMI	4.1 ± 1.3	4.5 ± 1.3	2.9 ± 0.4	7.103	< 0.0001

Note. Values are expressed as mean ± SD; BW – Body Weight; FFM – Fat-free Mass; MM – Muscle Mass; FM – fat Mass; PM – Protein Mass; M – Body Minerals; BMI – Body Mass Index; MFMI – Muscle and Fat mass Index. Significant differences set by independent samples Student's t-test among groups: ¹– Group 1, ²– Group 2.

Table 2. Dietary intake of Lithuanian Olympic team basketball players (n = 52)

Nutrition profile	Male (n = 39) ¹	Female (n = 13) ²	Recommended for:		t-test ^{1/2}	
	Mean ± SD		Male	Female	t	p
EI, kcal	4521.2 ± 1341.7	2854.5 ± 428.1	EER = 5073.3 ± 855.9	EER = 3685.85 ± 308.6	6.790	< 0,0001
EI, kcal/kg BW	52.9 ± 14.8	41.6 ± 8.4	EER = 59.2 ± 7.2	EER = 53.3 ± 2.9	3.365	0,002
CHO, g/kg BW	6.0 ± 1.9	5.4 ± 1.3	7-10		0.925	0.359
CHO, %	44.8 ± 5.4	52.0 ± 5.1	> 55		-4.239	< 0.0001
PRO, g/kg BW	1.9 ± 0.6	1.5 ± 0.3	1.4–2.0		2.270	0.028
FAT, %	40.7 ± 5.2	33.5 ± 4.2	20–30		4.581	< 0.0001
K, mg	6926.8 ± 2755.1	4012.8 ± 742.5	2500		5.980	< 0.0001
Ca, mg	1434.5 ± 612.8	1447.8 ± 484	1000		-0.071	0.944
Mg, mg	698.9 ± 324.7	472.6 ± 82.2	300		3.987	< 0.0001
P, mg	2524.8 ± 784.7	1830.1 ± 403.5	900		3.046	0.004
Ca/P ratio	0.6 ± 0.2	0.8 ± 0.1	0.75		-4.177	< 0.0001
PRAL, mEq	8.5 ± 49.0	15.0 ± 17.8	0		-0.711	0.481
NEAP, mEq	60.5 ± 49.6	59.2 ± 19.3	< 100		0.140	0.889

Note. Values are expressed as mean ± SD; EI – Energy Intake; EER – Estimated Energy Requirement; BW – Body Weight; PRO – Protein; CHO – Carbohydrate; FAT – Fat; Ca – Calcium; P – Phosphorus; Mg – Magnesium; K – Potassium; RDI – Recommended Daily Intake; PRAL – Potential Renal Acid Load; NEAP – Net Endogenous Acid Production. Significant differences set by independent samples Student's t-test among groups: ¹– Group 1, ²– Group 2.

Dietary intake. The analysis of the nutritional status of basketball players showed that 24-hour energy intake (EI) of both male and female basketball players (respectively, 52.9 ± 14.8 kcal/kg BW and 41.6 ± 14.8 kcal/kg BW) was lower than the estimated energy requirements (EER)) (Table 2).

The evaluation of macronutrient intake for the players showed that regardless of gender, players' carbohydrate intake was less than recommended. Men basketball players' average dietary intake of carbohydrates (6.0 ± 1.9 g/kg BW) did not differ from women players' carbohydrate intake (5.4 ± 1.9 g/kg BW) (p < 0.0001) and it did not match the recommended intake (7.0–10 g/kg BW). Average protein intake in male and female basketball players' food rations, respectively 1.9 ± 0.6 g / kg BW and 1.5 ± 0.3 g/kg BW, met the recommended norms (1.4–2.0 g/kg BW), but men basketball players' protein intake was higher than that of women (p = 0.028).

In the research we found that basketball players consumed more fat than it was recommended. This is confirmed by the energy supply rate (40.7 ± 5.2% of daily calories come from fat) in basketball players' diets, which exceeded the recommended norms. Meanwhile, the share of fat supply for energy intake in women basketball players' rations (33.5 ± 4.2% of daily calories come from fat) was significantly lower than that in men basketball

players' rations (p < 0.0001), and slightly higher than the recommended (20–30%).

The analysis of the mineral status of athletes' diets (Table 2) showed that basketball players' phosphorus intake was higher than recommended, as well as the intake of base-forming dietary *minerals* such as potassium, magnesium, calcium. Contrary to women's diets, calcium and phosphorus intake in men basketball players' diets was unbalanced (p < 0.0001). This was confirmed by the calcium and phosphorus ratio (Ca/P, 0.6 ± 0.2) men basketball players' food rations that did not reach the recommended intake of 0.75, which was determined by excess dietary intake of phosphorus. However, the optimal Ca/P (0.8 ± 0.1) was characteristic of women basketball players' diets.

Acid-base balance and diets. The assessment of Lithuanian Olympic team dietary PRAL showed that the dietary PRAL of more than half (67.3%) basketball players was positive. Dietary PRAL of male basketball players (8.5 ± 49.0 mEq/day) did not differ from the one of female basketball players (15.0 ± 17.8 mEq/day) and was positive (p = 0.841) (Table 2).

Analysing the links between PRAL and nutrition value of basketball players' diets we found that greater protein intake was linked to positive dietary PRAL (r = 0.408, p = 0.003) (Figure).

Aiming at establishing if the chemical composition of athletes' dietary intake was proper for the maintenance of acid-base homeostasis, we evaluated the effect of nutrition on the body NEAP. For athletes it is important that long-term net acid excretion should not exceed 100 mEq/day since this may result in a maximal renal stimulation of acid, decreasing the plasma bicarbonate availability)

(Remer et al., 2003; Remer, Manz, 2003). Though our male basketball players' average NEAP (60.5 ± 49.6 mEq/day) did not differ from that of female basketball players (59.2 ± 19.3 mEq/day) ($p = 0.889$) (Table 2), NEAP of as many as 20.5% of Lithuanian Olympic team men basketball players was higher than 100 mEq/day and on average it was 128.5 ± 23.7 mEq/day (Table 3).

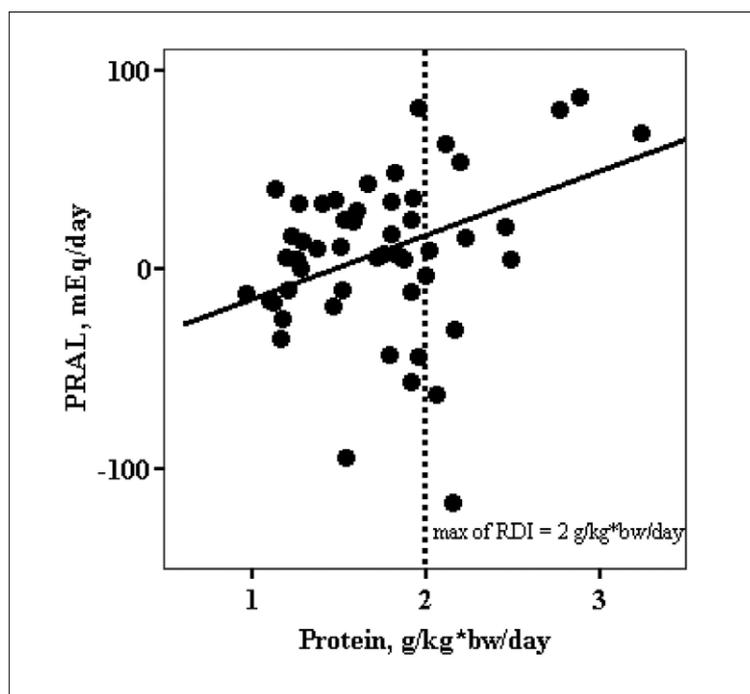


Figure. Relationship between PRAL (mEq/day) and dietary protein intake (g/kg body weight/day)

Note. RDI – Recommended Daily Intake; PRAL – Potential Renal Acid Load. Pearson's correlation coefficient $r = 0.408$, $p = 0.003$.

Table 3. Daily intakes of protein and selected micronutrients and estimated potential renal acid load (PRAL) in Lithuanian Olympic team basketball players (by the net endogenous acid production (NEAP) groups)

Nutrition profile	NEAP < 100, mEq ¹		NEAP > 100, mEq ²		t-test ^{1/2}	
	Minimum–Maximum	Mean ± SD	Minimum–Maximum	Mean ± SD	t	p
PRO, g/kg BW	1.0–2.5	1.6 ± 0.4	1.8–3.7	2.6 ± 0.7	-5.631	< 0.0001
PRO, % RDI	48.9–124.8	82.1 ± 34.6	91.5–183.3	129.4 ± 33.0	-3.935	0.004
P, mg	1188.8–5247.9	2232.0 ± 761.5	2502.1–3543.9	3006.4 ± 389.9	-2.794	0.007
P, % RDI	99.1–583.1	210.2 ± 19.2	208.5–393.8	294.0 ± 67.9	-2.496	0.016
K, mg	2570.8–17411.7	6235.3 ± 2928.0	4521.8–7902.3	5994.8 ± 1122.2	0.228	0.821
K, % RDI	102.8–696.5	249.4 ± 117.1	180.9–316.1	239.8 ± 44.9	0.228	0.821
Ca, mg	680.6–3964.5	1425.8 ± 576.7	1012.2–2903.6	1504.0 ± 625.7	-0.349	0.729
Ca, % RDI	69.4–396.5	165.5 ± 108	113.7–290.4	167.2 ± 63.2	-0.07	0.945
Mg, mg	310.8–2111.8	638.8 ± 323.6	514.0–792.7	661.5 ± 107.4	-0.195	0.846
Mg, % RDI	77.7–703.9	194.0 ± 90.2	128.5–264.2	194.2 ± 49.3	0.364	0.995
PRAL (mEq)	-116.9–42.8	-1.8 ± 34.6	48.7–121.1	75.5 ± 22.8	-6.054	< 0.0001
NEAP (mEq)	-59.3–97.1	47.8 ± 34.1	104.2–173.5	128.5 ± 23.7	-5.68	< 0.0001

Note. Values are expressed as mean ± SD, minimum and maximum values; BW – Body Weight; PRO – Protein; Ca – Calcium; P – Phosphorus; Mg – Magnesium; K – Potassium; PRAL – Potential Renal Acid Load; RDI – Recommended Daily Intake; NEAP – Net Endogenous Acid Production. Significant differences set by independent samples Student's t-test among groups: ¹ – Group 1, ² – Group 2.

As we see in Table 3, men basketball players' (NEAP > 100 mEq/day) protein intake (2.6 ± 0.7 g/kg body mass) exceeded the recommended intake 1.3 times, and phosphorus intake (3006.4 ± 289.9 mg) – 3 times. For athletes with NEAP > 100 mEq/day, protein and phosphorus intakes were statistically significantly higher compared to protein and phosphorus intakes of those athletes whose NEAP < 100 mEq/day ($p < 0.0001$ and $p = 0.007$). It should be noted that too high NEAP in the body can be found when the protein intake is 1.8 g/kg body mass.

When the diet is high in protein, lower dietary PRAL and lower NEAP can be ensured by adequate intake levels of minerals, such as potassium, calcium and magnesium. Research findings showed that for athletes with NEAP > 100 mEq/day, potassium intake (5994.8 ± 1122.2 mg), calcium intake (1504.0 ± 625.7 mg) and magnesium intake (661.5 ± 107.4) exceeded RDI 1.7–2.5 times. However, potassium, calcium and magnesium intakes of basketball players with NEAP > 100 mEq/day did not differ statistically significantly from those of players with NEAP < 100 mEq/day ($p = 0.821$, $p = 0.729$, $p = 0.995$) (Table 3).

DISCUSSION

Daily physical performance in the training zone of high intensity determines stress of buffering systems. Research has shown that even moderate physical exercise causes metabolic changes that affect acid-base homeostasis in skeletal muscles and other tissues (Lindinger, 1995). Meanwhile, due to the effect of high-intensity training, blood pH can drop from 7.4 to 7.1 per 1 min, which is felt as very fast muscle fatigue, resulting in a decrease of anaerobic fitness (Robergs et al., 2004).

When training is extremely intense, high-protein and low-carbohydrate diet can result in metabolic acidosis and have negative influence on performance (Robergs et al., 2004). Much attention is paid to protein intake. A diet high in protein significantly reduces dietary PRAL and increases NEAP in the body. Long-term NEAP of 100–120 mEq/day and more conditions maximal renal stimulation of acid, and the decrease of the plasma bicarbonate availability correlates with a long-term net acid excretion ion (100–120 mEq/day) (Remer et al., 2003; Remer, Manz, 2003). Carbohydrate intake of four investigated athletes did not reach the recommended minimum, and protein intake depended on basketball players'

gender. The average protein intake of female basketball players was 1.5 ± 0.3 g/kg body mass. Significantly higher protein intake was typical of male basketball players who enhanced muscle hypertrophy. We established that protein intake of 20.5% of Lithuanian elite basketball players was higher than 1.8–2.0 g/kg body mass, and their NEAP was found to be above the proposed cut off 100 mEq/day, suggesting that the buffering systems of the body would be stressed to the proposed limit) (Remer, 2001; Remer et al., 2003; Remer, Manz, 2003). In this case metabolic acidosis could be normalized changing dietary habits (ensuring low dietary PRAL) (Pizzorno et al., 2010) or using specific dietary supplements (Derave, 2011). Research has established that higher consumption of fruit and vegetables increases potassium and magnesium intake leading to increased production of base in the body (Tucker et al., 1999). Aiming at increasing buffering capacity and improving high-intensity anaerobic capacity, Lithuanian Olympic team basketball players are recommended the intake of buffering agents, such as sodium bicarbonate: 0.18–0.30 g/kg BW of sodium bicarbonate intake help to maintain higher blood pH and thus improve aerobic capacity indices during high-intensity training (McNaughton et al., 1999; Requena et al., 2005). While training bicarbonate supplementation possibly delays intracellular acidification or the body is supplied with the additional amount of bicarbonate, thereby increasing the buffering capacity (Lindh et al., 2008; Derave, 2011). Besides, aiming at improving performance when training is extremely intense, Lithuanian basketball players are recommended 4–10 week dietary beta-alanine supplementation, respectively 1.5–6.0 g a day (Baguet et al., 2010; Derave, 2011). Increasing carnosine levels in skeletal muscles, beta-alanine acts as an intracellular buffer. Carnosine helps muscle cells to remove protons, which are further affected by the circulating buffers (such as bicarbonate) in the extracellular fluids and thus acidosis is staved off and rapid muscle fatigue is avoided (Baguet et al., 2010; Sweeney et al., 2010).

Summing up, high-protein diet, e. g. high intakes of meat, cheese, eggs and other food products, in Lithuanian elite male basketball players is recommended to be changed by high-protein diets full of fruit and vegetables to reduce dietary PRAL and NEAP in the body. Basketball players, overcoming strenuous exercise, are recommended supplementing the regular diets by sodium

bicarbonate and beta-alanine dietary supplements in relevant doses. Supplementation of food rations with buffering agents (e. g. bicarbonates) causes ergogenic effect, improves performance, but it cannot replace conventional foods reducing PRAL. For this reason, further research is needed to assess the impact of the higher intake of fresh fruit and vegetables on physical performance parameters for basketball players in the course of their training.

CONCLUSIONS AND PERSPECTIVES

1. Nutrition of Lithuanian Olympic basketball teams does not meet the requirements: basketball players' diet is too high in dietary fat and is too

low in carbohydrates. One in five (20.5%) male basketball players uses high-protein diet (protein intake exceeds 1.8–2.0 g/kg BW), which conditions dietary acid-base misbalance and excessive net endogenous acid production in the body.

2. If high-protein diet (protein intake meets 1.8–2.0 g/kg BW) is taken, basketball players' nutritional habits should be changed. Aiming at ensuring dietary acid-base balance and maximal muscular adaptations in response to anaerobic training, basketball players should use higher levels (two or more times exceeding RDI) of minerals, potassium, calcium and magnesium. Athletes are recommended to consume significantly more fresh fruits and vegetables and/or enrich the normal diet by sodium bicarbonate and beta-alanine dietary supplements.

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LIETUVOS OLIMPINĖS PAMAINOS KREPŠININKŲ MITYBA TRENIRUOTĖS MEZOCIKLU TAIKANT PADIDINTUS KRŪVIUS JĖGAI UGDYTI

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Jėgą ir greitumą ugdančių sportininkų netinkama maisto raciono maistinių ir biologiškai aktyvių medžiagų sudėtis gali neigiamai paveikti rūgščių ir šarmų pusiausvyros homeostazę ir fizinio darbingumo rodiklius. Hipotezė – rūgštinės ir šarminės medžiagos Lietuvos olimpinės pamainos krepšininkų maisto racione tinkamai subalansuotos.

Tikslas – įvertinti Lietuvos olimpinės pamainos krepšininkų maisto raciono rūgštinių ir šarminių medžiagų sudėtį ir jų galimą poveikį sportininkų inkstų apkrovai rūgštimis.

Metodai. Parengiamuoju varžybų laikotarpiu ištirti kasdien po 197.9 ± 58.7 min šešias dienas per savaitę besitreniruojantys 18.0 ± 1.9 metų amžiaus 52 Lietuvos didelio meistriškumo krepšininkai. Panaudojus *BIA tetra* poliarinį elektrodų metodą įvertinta krepšininkų kūno sandara. Pritaikius apklausos metodą ištirta krepšininkų faktinė mityba, įvertintas maisto raciono galimas poveikis inkstų apkrovai rūgštimis (PRAL) ir nustatyta bendra organinių rūgščių gamyba organizme (NEAP).

Rezultatai. 67.3% krepšininkų maisto raciono PRAL (8.5 ± 49.0 mekv./dieną) yra teigiamas. Krepšininkų suvartojamas baltymų kiekis teigiamai koreliuoja su maisto raciono PRAL ($r = 0.408$, $p = 0.003$). 20.5% krepšininkų vyrų vidutiniškai suvartoja 2.6 ± 0.7 g/kg kūno masės baltymų, jų maisto raciono PRAL sudaro 75.5 ± 22.8 mekv./dieną, NEAP – 128.5 ± 23.7 mekv./dieną.

Aptarimas ir išvados. Taikant padidinto baltymų kiekio (1.8–2.0 g/kg kūno masės) mitybą krepšininkų mitybos įpročiai turi būti keičiami. Krepšininkams rekomenduojama suvartoti daug didesnę šviežių vaisių ir daržovių kiekį ir/arba įprastinę mitybą papildyti natrio bikarbonato ir/arba betaalanino maisto papildais.

Raktažodžiai: krepšinis, rūgščių ir šarmų pusiausvyra, galima inkstų apkrova rūgštimis.

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COMPARATIVE STUDY ON SELF-ASSESSMENT OF TEACHING COMPETENCIES OF PE STUDENT TEACHERS FROM POLAND AND KOSOVO

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ABSTRACT

Research backgrounds and hypothesis. This study investigates the student teachers' preparation for the practical school placement in Poland and Kosovo. Considering the two countries with different academic backgrounds there might be reasonable differences in the state of students' preparation to work practice. While other research concentrates on teachers' supervision during practical placement the literature review carried out for this paper illustrates that teaching practicum, which has been a focal point of many academic discussions, has been relatively little researched, especially from the students' perspective of the process. Understanding the differences regarding various academic systems may bring some more light into the search for the most effective ways of preparing student teachers for the school practical placement.

Research aim. The purpose of the study was to analyse the student teachers' assessments of their actual teaching competencies in order to further prepare a Cooperating PE Teachers Programme (COPET) at both universities. A sample of 154 second year Bachelor undergraduates in Poznań and 128 students from Pristina and respectively 109 from Master students from Poznań, and 45 from Master students of the international post-graduate programme in Physical Education and Sport in Kosovo were surveyed.

Research method. Quantitative data were collected via the Pre-Service PE Teachers Self-Assessment Questionnaire including 25-items concerning three areas: organizational, didactic and pedagogical. A multivariate analysis of variance showed the differences between students from Poznań and Pristina.

Research results. In our own research, the analysis of progression (visible in the difference between Bachelor and Master students) in their self-assessment indicates more critical self-reflection present in the assessments of students in Poznań. This was not common in the self-assessment of the students in Pristina as levels of their self-assessment at the two phases of the PETE programme (Bachelor and Master) were similar.

Discussion and conclusions. Recommendations for further improvements of PETE programmes in both Polish and Kosovan Higher Education Institutions concern the introduction of a COPET programme. Improving teaching practice and professional preparedness of student teachers requires elevating the quality of academic teaching delivered to students throughout their studies. This especially concerns subjects dealing with the teaching of practical and methodological skills. Equally important is the quality of early practical experience.

Keywords: PE practical school placement, student teachers' competencies, self-assessment.

INTRODUCION

Preparing highly qualified physical education teachers has become a critical issue for the legitimization of the subject and its future as part of school curricula alongside other, more academic, subjects. However, an even equipping student teacher with the most essential knowledge, skills, and dispositions (Darling-Hammond, 2001; Johnson, Reiman, 2007) does not appear to be sufficient.

The literature review carried out for this paper illustrates that although teaching practicum has been a focal point of many academic discussions (Hascher et al., 2004; Behets, Vergauwen, 2006; Anderson, 2007; Ayesr, Housner, 2008), there is relatively little research on the student teachers' perspective of the process (Kelly, Tannehill, 2012). Other research has concentrated on teachers' supervision during practical placement widely studied (Shaughnessy, 2004; Tschennen-Moran, Hoy, 2007).

A decisive part of physical education teachers' programmes (PETE) comes through teaching practice, which shapes the beginnings of one's involvement in the teaching profession (Little, 1990; Hiebert et al., 2002; Dunning et al., 2011; Meegan et al., 2013). This is also a decisive moment in the development of teaching efficacy which is determined as much by external sources (supervisors, school climate and school personnel) as by successful or unsuccessful pedagogical experiences (Caires et al., 2012). Successful experiences are characterised by a correlation between mastery of content knowledge and learners' achievements, between the effective use of teaching skills (Leinhardt, Greeno, 1986), and control of pupils' behaviour, and between feedback received and the awareness and thinking processes that teachers experience in the situations of teaching (Graham, 2006; Zach et al., 2012). As such, teaching practice can be a difficult time when there is often an imbalance between what student teachers are taught about teaching and learning at university, and what they observe and how are expected to perform in a school environment.

Teaching practice provides student teachers with an opportunity to gain practical teaching experience by becoming immersed in a school environment. It is during such work experience that the realities of teaching are encountered and student teachers not only develop their pedagogical skills but also become socialized into the teaching profession (Hoy, Woolfolk, 1990; Guyton et al., 1991; Su, 1992; Larson, 2005).

Belton et al. (2010) investigated the impact of a new Cooperating PE Teachers Programme (COPET) from the cooperating teacher's perspective. They found that a more well-defined role allowed the teachers to provide student teachers with an enhanced learning environment during the work placement period. In the subsequent research (Dunning et al. 2011), a majority of student teachers

were found to have reported feeling well prepared and more confident prior to, and during, teaching practice. COPET program is a novelty in PETE study programmes, which was developed at some universities when it became clear that in schools with non-COPET trained cooperating teachers, the experiences of practice were less successful for student teachers. D. Tannehill and D. Zakrajsek (1988) reported that non-trained cooperating teachers' feedback tended to fall outside of lesson assessment guidelines and areas which were of concern to the developing of student teacher's teaching skills. It is worth mentioning that COPET programme did not exist at none of the universities (Poznań and Pristina) examined in our research. Therefore our work can be related to an important discussion about teacher professionalization.

Introducing such COPET programmes requires recognition of the potential strong and weak points in the process of preparation towards work placement. The purpose of this study was to compare physical education student teachers' self-assessment of their levels of overall and specific teaching competencies concerning school practice at different levels of their teacher training in two different backgrounds of Poland and Kosovo. At the University School of Physical Education in Poznań (Poland) programme COPET is being prepared to be introduced and one of the reasons why the University of Pristina (Kosovo) has been chosen for this comparative study was the lack of such a programme and the relatively poor quality of practical school placements in case of PE student teachers. Indeed, this is one of the reasons that the Faculty of Physical Education at the University of Pristina was not granted accreditation recently (*Project Inception Report*, 2012). The EU has funded an International Masters programme at the University of Pristina as part of a wider European Union project (EuropeAid/130886/C/SER/KOS) after the programme of physical education studies run by the University of Pristina failed the accreditation process in 2010 (*Project Inception Report*, 2012).

Poland became a democratic country after the fall of Communism in 1989 and adopted the Bologna system of Higher Education in 1999. In contrast, the case of Kosovan educational system is unique. Because of recent domestic conflict, most educational changes and adjustments have occurred only recently. Although education is a top priority for Kosovo, schools have to deal

with insufficient financial, material and personnel resources. With limited sporting facilities (many of which were destroyed during the periods of the war) and the low quality of physical education teachers' education, the status of PE as a school subject seems vulnerable. For example in Poland almost 70% of schools have a sports hall (NIK, 2010). Furthermore, there have been 2012 additional football complexes built as a part of governmental initiative for the 2012 European Football Championships and 1400 indoor swimming pools will be ready by 2015. The situation with infrastructure in Kosovo is far from satisfactory.

A key priority for the Kosovan Ministry of Education, Science and Technology (MEST, 2004, 2010) is improvement of access to higher education by increasing participation of the 18–25 years age group from 22 to 35% by the year 2015 (*Project Inception Report*, 2012), whereas in Poland it is already at around 50% (*Report OECD*, 2010). There is also a problem with facilities of the Faculty of Sport Science in Pristina, which lacks not only sport gyms halls and swimming pools, but also basic apparatus and equipment. This can be compared to the University of Physical Education in Poznań which owns three full size sports hall, a gymnastics gym, swimming pool, field hockey stadium with artificial grass and a regulation 400 meter track for athletics around it. Furthermore, at the Faculty of Physical Education in Pristina both students and teaching staff lack relevant up-to-date publications or access to international databases and online journals whereas in Poznań students and academics have full access to a very well-equipped modern library providing numerous national and international journals and books.

RESEARCH METHODS

Participants. The study is related to student teachers of the Physical Education Faculty from University School of Physical Education in Poznań, Poland and similar faculty at the University of Pristina, Kosovo. Data was collected from student teachers of both genders at the respective faculties. The subjects, 154 second-year Bachelor undergraduates in Poznań and 128 student teachers from Pristina, completed the questionnaire. This was supplemented by 109 questionnaires from Masters Programme participants from Poznań, and 45 from student teachers of the international post-graduate programme (Master programme) in Physical Education in Kosovo. All data was

anonymous and collected by a trained member of the faculty during one of the classes in the academic year of 2012/2013. The examined subjects were given relevant information on the purpose of the survey.

Research instrument. The idea of the design of the study was based on the research of T. Hascher et al. and P. Moser (2004), who examined student teachers and mentors on preparing, teaching and post-processing lessons after each work placement. Data for the study was collected with the use of the Pre-service PE Teacher Self-Assessment Questionnaire. The questionnaire was developed by M. Bronikowski and A. Kantanista (2013) to examine physical education student teachers' preparation for school practice. In the preparation of that research tool a mixed methodology (open issues, personal interviews with the experts, focus groups and discussions) was used. The panels of experts were approached—59 last year post-graduate student teachers of PETE course, 6 cooperating PE teachers with a minimum of 15 years of teaching experience and 5 university tutors supervising practical school placement were asked to verify the general areas and each of the items. The reliability of the questionnaire was checked on a group of Polish student teachers (test-retest reliability 0.91). The questionnaire was translated into Albanian and before handing it to the student teachers in Kosovo it was cross-checked for the accuracy of translation with several Physical Education experts, members of the Physical Education Faculty from Pristina. The questionnaire consists of 25-items divided into 3 sections reflecting the most essential areas of teachers' preparation, with a Likert scale of 1 (very poor) to 5 (very good) describing the level of self-assessment. These three areas concerned:

1. The *organizational* area of physical education processes included 7 items concerning the following aspects: diagnosing conditions for PE in school, planning daily teaching activities, teacher documentation, all-staff meetings and PE departmental team meetings, organization of school trips.

2. The *didactic* area of the physical education process included 12 items concerning the following aspects: diagnosis of pupils' interests, physical fitness and development, preparing lesson plans, observing other lessons, assisting in the organization of a PE lesson and organization of lessons by oneself, fulfilling national PE curricula standards, teaching 6–9 years old pupils,

organizing sport and dancing lessons, evaluating pupils' efforts, and analysing the effectiveness of own teaching (self-evaluation, critical reflection)

3. The *pedagogical* area of the physical education process included 6 items concerning the following aspects: diagnosis of pupils' behavioural problems, collaborating with teachers of other subjects and with the school pedagogue and school psychologist in solving problems appearing in a class, dealing with conflict situations (aggression, emotional problems), communicating with pupil's parents during school meetings, and providing first aid to pupils in case of emergency.

Statistical analysis. Average scores were calculated for each of the three areas to provide an overall view and for every single of the 25 items to obtain more specific information. Differences between the groups were tested with Friedman's ANOVA and a Wilcoxon signed-rank test. The Mann-Whitney *U* test was employed to determine the significance of differences between groups in each of the 25 items. The level of significance was set at $p < 0.05$. Statistical calculations were performed by using the Statistica 10 software package (StatSoft Inc., Tulsa, OK).

RESEARCH RESULTS

The data in Table 1 presents the mean scores obtained in organizational, didactic and pedagogical areas by PE student teachers from Poland and Kosovo.

Undergraduate Polish student teachers declared the highest preparation for realization of didactic tasks followed by realization of duties concerning pedagogical and organizational aspects. In the opinion of undergraduate Kosovan students they were best prepared for working in pedagogical, followed by didactic and finally organizational areas. There were significant ($p \leq 0.001$) differences between the mean scores among Polish and Kosovan students. Students from Kosovo declared a generally higher preparation in all areas compared to declarations of Polish students ($p \leq 0.001$).

Polish Master Degree student teachers declared the highest level of preparation for realization of didactic tasks, followed by pedagogical and finally organizational aspects and these differences were significant ($p \leq 0.001$). In the opinion of Kosovan Master Degree student teachers, they assessed the best preparation for working in didactic areas,

Table 1. Mean scores and standard deviations of Physical Education students from Poland and Kosovo in organizational, didactic and pedagogical areas

Academic year	Organizational Area Mean/SD	Didactic Area Mean/SD	Pedagogical Area Mean/SD	Friedman's test (χ^2) p value	Wilcoxon signed-rank test
Bachelor Degree level					
Poland (n = 154)	3.02 0.58	3.37 0.57	3.18 0.64	0.000	a ^{***} , b ^{***} , c ^{***}
Kosovo (n = 128)	3.73 0.46	3.90 0.49	4.04 0.54	0.000	a ^{***} , b ^{***} , c ^{***}
Test U Mann-Whitney; p value	0.000	0.000	0.000		
Master Degree level					
Poland (n = 109)	3.51 0.68	4.08 0.49	3.72 0.68	0.000	a ^{***} , b ^{***} , c ^{***}
Kosovo (n = 45)	3.67 1.02	4.18 0.48	4.00 0.70	0.004	a ^{***} , b [*]
Test U Mann-Whitney; p value	0.151	0.412	0.019		
Bachelor vs. Master Degree Poland					
Test U Mann-Whitney; p value	0.000	0.000	0.000		
Bachelor vs. Master Degree Kosovo					
Test U Mann-Whitney; p value	0.675	0.001	0.813		

Note. * – $p \leq 0.05$; ** – $p \leq 0.01$; *** – $p \leq 0.001$. a – significant difference between mean scores achieved in organizational and didactic areas. b – significant difference between mean scores achieved in organizational and pedagogical areas. c – significant difference between mean scores achieved in didactic and pedagogical areas.

which was statistically higher than preparation for organizational tasks ($p \leq 0.001$). The statistical analysis indicated that students from Kosovo declared a higher preparation in the pedagogical area when compared to responses of Polish students ($p \leq 0.05$).

There were no differences in self-assessment between Bachelor and Master Degree Kosovan student teachers in organizational and pedagogical

areas. This can be contrasted to Polish students, where differences were observed in all areas (Table 1).

Bachelor and Master student teachers' responses to all the questions included in organizational, didactic and pedagogical areas are presented in Table 2.

Bachelor Kosovan student teachers assessed their preparation in organizational areas at a higher

Table 2. Mean scores of Physical Education students from Poland and Kosovo in specific aspects of their preparation for teaching practice

Student teacher is prepared to:	Bachelor Degree			Master Degree		
	PL	KOS	p value	PL	KOS	p value
In organizational aspects:						
1. Diagnose conditions for PE in school	2.91	1.78	0.000	3.60	3.88	0.074
2. Analyze PE teacher's teaching documentation (program, trading system)	2.73	3.86	0.000	3.44	3.86	0.009
3. Participate in teaching staff meetings (raising questions, referring topics related to physical education)	2.91	4.35	0.000	3.22	4.31	0.000
4. Participate in PE teachers' meetings concerning professional development	2.93	4.06	0.000	3.11	4.28	0.000
5. Plan a calendar (schedule) of sport events over the school year	3.49	3.92	0.000	3.77	4.06	0.070
6. Organize school trips to interschool competitions (preparation of appropriate documentations)	3.21	4.17	0.000	3.66	3.91	0.154
7. Plan activities for each day of the practice period in school	2.99	3.95	0.000	3.96	3.80	0.962
In didactic aspects:						
1. Diagnose pupils' interests	3.54	3.87	0.013	4.01	4.15	0.314
2. Diagnose pupils' physical fitness and physical development	3.61	4.08	0.000	4.20	4.31	0.329
3. Plan PE lesson (prepare a lesson plan with objectives, learning outcomes)	3.54	3.99	0.000	4.61	3.82	0.000
4. Observe lesson of PE teacher with analysing the aims, learning contents and learning outcomes	3.32	3.71	0.000	4.32	3.88	0.002
5. Assist PE teacher in organizing a PE lesson	3.83	3.65	0.037	4.59	4.28	0.008
6. Organize the PE lesson on their own	3.25	4.06	0.000	4.38	4.37	0.733
7. Fulfill national curricula in PE lessons	3.16	3.78	0.000	3.86	3.42	0.043
8. Organize PE classes for 6 to 9 year olds	3.21	3.39	0.101	4.04	3.93	0.792
9. Organize sport lessons	3.73	4.24	0.000	4.48	4.28	0.393
10. Organize dancing classes in school PE	2.45	4.35	0.000	2.83	3.60	0.001
11. Evaluate pupil's work (give grades)	3.43	3.58	0.125	3.84	4.33	0.000
12. Analyze effectiveness of own teaching process (self-evaluation, critical reflection)	3.36	4.13	0.000	3.96	3.88	0.595
In pedagogical aspects:						
1. Diagnose pupils' personal problems	3.05	4.14	0.000	3.70	4.22	0.000
2. Collaborate with teachers of other subjects in solving problem situations appearing in the class	3.31	4.15	0.000	3.91	4.33	0.009
3. Cooperate with school pedagogue and psychologist (analysing situation of individual pupils)	3.23	4.14	0.000	3.94	4.20	0.066
4. Deal with conflict situations, aggression, vandalism and other behavioural and emotional problems	3.00	4.02	0.000	3.62	4.24	0.000
5. Cooperate with pupil and his/her parents during parents' meetings at school (giving information about a pupil)	3.21	3.75	0.000	3.49	4.57	0.000
6. Provide first medical aid to pupils suffering during PE	3.29	4.02	0.000	3.69	4.26	0.000

level when compared to Polish students ($p \leq 0.001$). However, the particular skills to *diagnose conditions for PE in school* were rated higher by Polish students ($p \leq 0.001$). Preparedness for *participating in teaching staff meetings*, *organizing school trips for interschool competitions* (in the case of Kosovan students) or *planning a calendar of sport events over the school year* and *organizing school trips for interschool competitions* (in case of Polish students) were evaluated quite highly. In contrast, Kosovan students rated their skills in *diagnosing conditions for PE in school*, and Polish students in *analysing PE teacher's teaching documentation*, at low levels.

In most aspects of the didactic area, Bachelor Kosovan student teachers declared better preparation for the realization of different tasks when compared to their Polish peers. Only the ability to *assist PE teachers in organizing a PE lesson* was higher evaluated by Polish student teachers ($p \leq 0.05$). There were no significant differences between the Polish and Kosovan students in the declared level of preparation for *organizing PE classes for 6 to 9 year olds* and *evaluating pupil's work (give grades)*. Mean scores of the specific aspects suggest that in the students' opinion they felt best prepared for *organizing sports lessons* (Polish and Kosovan students), *organizing dancing classes in school PE* (Kosovan students) and *assisting PE teachers in organizing a PE class* (Polish students).

Bachelor Kosovan student teachers rated their preparation in all specific aspects of the pedagogical area at a higher level than their Polish counterparts ($p \leq 0.001$). Mean scores suggest that specific aspects in the pedagogical area (when compared to organizational and didactic areas) were rated higher by Kosovan students. Polish students rated their preparation significantly lower, especially in such aspects as: *dealing with conflict situations*, *aggression*, *vandalism and other behavioural and emotional problems* and *diagnosing pupils' personal problems* (Table 2).

Kosovan Masters student teachers (Table 2) rated their preparation in organizational area higher when compared to Polish students in some specific aspects: *analysing PE teacher's teaching documentation* ($p \leq 0.01$), *participating in teaching staff meetings* ($p \leq 0.001$), and *PE teachers meetings concerning professional development* ($p \leq 0.001$). Preparedness for *participating in teaching staff meeting* and *participating in PE teachers meetings*

concerning professional development (in case of Kosovan students) or *planning a calendar (schedule) of sport events over the school year* (in case of Polish students) were all evaluated highly. In contrast, Kosovan students rated their skills of *planning activities for each day of the practice period in school* at a relatively low level. Likewise, Polish students evaluated *participating in PE teachers meetings concerning professional development* at a low level.

In the didactic area, Polish Masters student teachers rated their preparedness higher than Kosovan student teachers in four specific aspects: *Planning a PE lesson* ($p \leq 0.001$), *observing lessons of another PE teacher with the analysis of the aims*, *learning contents and learning outcomes* ($p \leq 0.01$), *fulfilling national curricula in PE lessons* ($p \leq 0.05$), and *assisting a PE teacher in organizing a PE lesson* ($p \leq 0.01$). However, students' preparedness to *organize dancing classes in school PE* and *evaluate pupil's work (giving grades)* was rated better by Kosovan students ($p \leq 0.001$). Neither group of Master Degree student teacher felt very well-prepared for *organizing dancing classes in school PE*. Additionally, Kosovan Masters student teachers rated their preparation towards *fulfilment of national curriculum in PE* relatively low.

In comparison to Polish peers, Kosovan Masters student teachers rated their preparation in all specific aspects of pedagogical area at a significantly higher level. Mean scores suggest that specific aspects of the pedagogical area (when compared to organizational and didactic areas) are rated by Kosovan students higher. Conversely Polish students rated their preparation significantly lower, especially in such aspects as *cooperating with a pupil and his/her parents during parents' meetings at school (giving information about a pupil)*.

DISCUSSION

Physical education student teachers at the University of Pristina clearly assessed their preparedness for carrying out tasks during practical school placement better than their counterparts from the University School of Physical Education in Poznań. Particularly clear differences were noted at the undergraduate Bachelor level. S. Zach et al. (2012) indicate that the high evaluation of one's self-efficacy during the early years of studying may be an outcome of

student teachers' earlier perceptions about their abilities which led to them choosing this course of study in the first place. In their research the authors found a significant increase in teaching efficacy among pre-service teachers over the three years of a teacher preparation programme. S. Zach et al. (2012), as well as R. Gurvitch and M. W. Metzler (2009), found that the longer the pre-service teachers practice experience, the greater their efficacy. Findings of A. W. Hoy and R. B. Spero (2005) also allow for a cautious assumption that such an increase may continue in the same participants (student teachers) from the beginning of the programme through to graduation.

Generally, in our study, the student teachers' self-assessment of their preparation towards school work placements competencies in didactic area was evaluated higher than in the other two areas. The analysis of progression (visible in the difference between Bachelor and Master student teachers) in their self-assessment indicates more critical self-reflection (Gay, Kirkland, 2003) present in the assessments of students in Poznań. It is not common in the self-assessment of the students in Pristina, as levels of their self-assessment at the two phases of the PETE programme (Bachelor and Master) were similar. Critical self-reflection is a very important component of students' competencies and teaching skills (Patterson et al., 2002), but it is difficult to teach. Apparently, lack of self-critical approach was one of the reasons the faculty of Physical Education at University of Pristina has recently not been granted accreditation (*Project Inception Report*, 2012). The EU also noticed the need to ensure equal opportunities and standards in this respect, hence the financing of project with the aim of improving preparation of teaching staff and the level of training of PE teachers.

It is also worth mentioning the primary differences in social and academic contexts between the two universities. Student teachers in Kosovo do not have the chance to compare their level of teaching competencies against the skills and competencies of student peers abroad. Whereas students of the university in Poznań have a completely different experience in this respect as the number of students travelling abroad as part of the ERASMUS, or other programmes, is almost 150 every year. Also, a difference in the quality of academic staff international experience (participation in international conferences

and projects) could be noted between the two universities. There are also more professors and academic staff with a PhD at the Faculty of Physical Education at University in Poznań than in Pristina (threefold). Obviously, holding a PhD degree or a number of full professorships positions are not direct indicators of a better teaching quality, but in a way describe a level of academic development and experience of the whole faculty.

Differences are also apparent in the access and use of scientific databases. The library of the University in Poznań provides free access to all databases significant for physical education and their use is growing each year not only among the staff, but also among the student teachers. Polish student teachers can also access many websites in their native language, which include teaching and training materials and examples of good educational practices. Quite few projects and websites are run with the substantive supervision of the Ministry of Education and refer directly to the Physical Education Core Curriculum. This type of technical support and background is not in place in Kosovo yet, thus it should not be expected that student teachers in Pristina would have a similar point of reference in self-assessment of their teaching abilities and preparation towards work placement as student teachers in Poznań. As a result there is a high relativity to the self-assessment of student teachers in Kosovo in relation to their teaching abilities, due to isolation from comparisons and assessments functioning in the EU, which may lead to apparently heightened self-assessment. Patterns of their school practice and academic educational standards remain in contrast to the standards expected by institutions and academic accreditation agencies in Europe. Although, the abovementioned information can't be used as an explanation of the findings of our study per se, however, they highlight some of the existing differences.

Our observations of the university teaching practice carried out during the stay at University of Pristina also indicate that the training of physical education teachers is dominated by emulation – a system which teaches by imitating. A set of PE lesson work plans for school practice, prepared by the academic teachers of University of Pristina, is learned by heart, and later carried out by student teachers as part of their teaching routine during the practical placement in schools. Conversely, a

more individual approach in PE teaching prevails in Poland. In the last decade Polish teachers had to re-direct their thinking about teacher-student relations. A typically instrumental, authoritarian, teacher-centred relation ought to be altered into a subjective, student-centred, partner-like relationship (Gardiner, Robinson, 2009).

It is also understandable that the situations described above, as well as different cultural and social backgrounds, and in fact different moments in the social and historical development of the two nations, may have affected the quality of education in both examined universities. But the outcomes of the study could serve as a valuable reference point in further development and PE teacher professionalization.

CONSLUSIONS AND PERSPECTIVES

The study was developed to explore PE student teachers' perspectives during teaching practice and find the potential differences in self-assessment in their professional preparation. The problems of self-assessment are quite evident. It would be helpful to have an external frame for evaluating the competencies, e. g. observation data, assessments by the cooperating teachers. To correlate self-assessment with action in practice could also be an important step to enhance this kind of study in the future. A study based on action research on

the same cohort of student teachers could show its impact on didactic effectiveness to ensure equal learning opportunities for students with adequate feedback and sufficient support during school teaching practice.

Recommendations for further improvements of PETE programmes in both Polish and Kosovan Higher Education Institutions concern the introduction of a COPET programme. Improving teaching practice and professional preparedness of student teachers requires elevating the quality of academic teaching delivered to students throughout their studies. This especially concerns subjects dealing with the teaching of practical and methodological skills. Equally important is the quality of early practical experience. For the best effectiveness of teaching experience, the triad of firstly student teacher, secondly cooperating teachers in schools and thirdly university supervisors during practice, needs to coordinate their work in providing the best professional experience for the students. Therefore programmes like COPET, designed to support the abovementioned triad, seem to be a necessity. Recently, such guidelines have been developed to outline the role of the student teachers, PE teachers and university supervision at the Faculty of Physical Education in Poznan, with daily observation sheets to set and evaluate goals and lesson outcomes. Similar solution should take place in case of the Faculty of Physical Education in Pristina.

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LENKIJOS IR KOSOVO KŪNO KULTŪROS MOKYTOJŲ PRAKTIKANTŲ MOKYMO KOMPETENCIJŲ ĮSIVERTINIMO LYGINAMASIS TYRIMAS

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Šiuo tyrimu analizuojamas studentų būsimų mokytojų parengimas pedagoginei praktikai mokykloje Lenkijoje ir Kosove. Kadangi šios šalys turi skirtingą akademinę sistemą, verta patyrinėti studentų parengimo praktiniam darbui būklę. Kitais tyrimais labiau akcentuojamas dėstytojų vadovavimas praktikai. Mokslinės literatūros analizė, atlikta šio tyrimo metu, rodo, kad mokytojavimo praktika iš tiesų yra mažai tyrinėjama, ypač studentų praktikantų. Supratus akademinį sistemų skirtumus galima būtų veiksmingiau rengti studentus pedagoginei praktikai mokykloje.

Tikslas – išanalizuoti, kaip studentai vertina turimas pedagoginio darbo kompetencijas, ir parengti abiejų universitetų *Kūno kultūros mokytojų bendradarbiavimo programą*. Tiriamieji: pirmos pakopos studentai – 154 iš Poznanės ir 128 iš Prištinos universitetų; antros pakopos studentai – 109 iš Poznanės ir 45 iš Tarptautinės kūno kultūros ir sporto magistrantūros programos iš Kosovo.

Metodai. Kiekybiniai duomenys surinkti naudojant *Kūno kultūros studentų praktikantų įsivertinimo anketą*, kurią sudarė 25 klausimai iš trijų sričių (organizavimo, didaktinės ir pedagoginės). Daugiamatė dispersinė analizė atskleidė skirtumus tarp studentų iš Poznanės ir Prištinos.

Rezultatai. Įsivertinimo progresinė analizė parodė, kad studentai iš Poznanės vertina save kritiškiau. Tai nebūdinga Prištinos universiteto studentams, kadangi abiejų pakopų (bakalauro ir magistro) studentų vertinimai buvo panašūs.

Aptarimas ir išvados. Rekomendacijos, kaip pagerinti kūno kultūros mokytojų pedagoginės praktikos programas tiek Lenkijos, tiek Kosovo aukštojo mokslo sistemoje, bus pateiktos *Kūno kultūros mokytojų bendradarbiavimo programoje*. Pedagoginės praktikos ir mokytojo profesinio parengtumo gerinimas reikalauja tobulinti studijų kokybę visais studijų metais. Tai ypač aktualu praktinių ir metodologinių įgūdžių formavimo modulių programoms. Pedagoginės praktikos kokybė taip pat labai svarbi.

Raktažodžiai: kūno kultūros pedagoginė praktika mokykloje, studentų būsimų mokytojų kompetencijos, įsivertinimas.

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EFFECT OF GENERAL VERSUS SPECIALIZED EXERCISES ON MOVEMENT CONTROL OF LUMBO-PELVIC REGION IN SUBJECTS WITH CHRONIC LOW BACK PAIN

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ABSTRACT

Research background and hypothesis. Low back pain is a huge problem in the world. One of the main reasons why the low back pain problems arise is lumbo-pelvic motor control dysfunction. Specialized exercises are the basis of physical therapy for low back pain patients. Hypothesis: specialized exercises can be more effective for movement control of lumbo-pelvic region in subjects with chronic low back pain.

Research aim was to assess the effect of general versus specialized exercises for movement control of lumbo-pelvic region in subjects with chronic low back pain.

Research methods. The study involved 60 subjects with chronic low back pain, 29 women and 31 men, aged 21.5 years on average. All subjects were submitted to the Low Back Pain Duration and Beacke Habitual Physical Activity Assessment questionnaires (Baecke et al., 1982). Lumbo-pelvic motion control was evaluated by six Hannu Luomajoki movement control tests (Luomajoki et al., 2008). Specialized and general training programs were prescribed and performed under supervision of physical therapist. Video materials expert analysis was used for the evaluation of the study data.

Research results. The results showed that a specialized training program was more effective than general exercises in improving movement control in lumbo-pelvic region for patients with low back pain.

Discussion and conclusions. General exercise training program for general exercise group had no effect for all test results. Specialized exercise training program results showed that lumbo-pelvic movement control improved in five of the six control tests ($p < 0.05$).

Keywords: motor control, physical therapy program, stability, mobility.

INTRODUCTION

Low back pain is an important and increasing problem in modern society (Airaksinen et al., 2006). Sometimes the pain is so intensive that people are forced to stop their daily activity. Due to the deteriorating quality of life the person becomes more irritable and more

vulnerable, experiences psychological and physical stress, feels weakness and fatigue. All these factors affect the musculoskeletal system. The spine and joints are overloaded, strength and muscle flexibility decrease, movement control impairs. M. M. Panjabi (1992) asserts that abnormal

movement control is the result of incomplete spinal stability and it may be cause of micro injuries and low back pain (Figure 1).

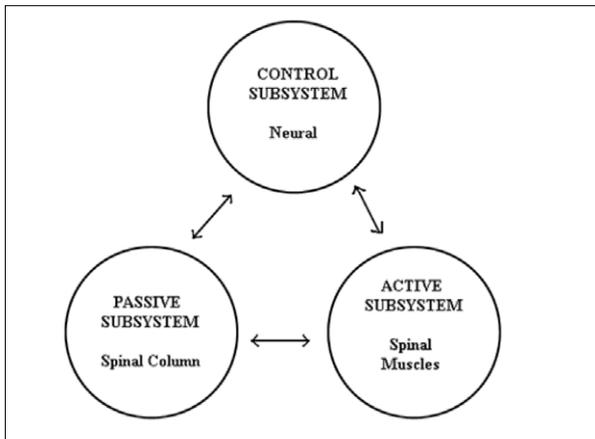


Figure 1. Spinal stability systems (Panjabi, 1992)

Low back pain is the most expensive pain syndrome to society. In all life four of five people felt pain on the planet, one tenth of their back pain became chronic (Sakalauskienė, 2009). This large scale computer-assisted telephone survey was undertaken to explore the prevalence, severity, treatment and impact of chronic pain in 15 European countries and Israel. In-depth interviews with 4839 respondents with chronic pain (about 300 per country) showed that 66% of them had moderate pain, 34% of them had severe pain, 46% of them suffered from constant pain, and 54% of the respondents had intermittent pain. Chronic pain is a major health care problem in Europe that needs to be taken more seriously (Breivik et al., 2006). Movement impairment syndromes are important for physical therapists when we consider that the detection of faulty movement or kinesiopathology is a key competence of physical therapy. Physical therapy improves, restores or supports the movement function (Kriščiūnas et al., 2008). There are two low back pain treatment trends – one of them is to improve movement control and the other is an application of specialized training programs (Macedo et al., 2008). In order to restore the patients function we have to pay more attention to spinal stability and the quality of movement control. Physical therapists must observe not only the primary or final movement phases, but also they have to focus on all movement in general. Research shows that low back pain should be treated with the understanding of teaching and emphasis on how to correctly perform the movement and how to strengthen the lumbo-pelvic stability muscles

(Hodges, 1999; Haxby et al., 2005; Cairns, 2006; Loumajoki, Moseley, 2011). Maladaptive movement control can also occur with hypo mobility (Cook et al., 2006). Decreased physical activity may be the cause of low back pain (Van Dijken et al., 2008).

H. Luomajoki et al. (2007) examined ten movement control tests for the back. For the intraobserver reliability, five tests out of ten showed an excellent reliability. In our research we examined the specialized training program impacts on movement control. This diagnostic test cannot be translated into diagnostic action but adds to our biological insight into mechanisms of disease and may serve later research into treatment as well as diagnosis (Sackett, Haynes, 2002).

RESEARCH METHODS

The research was accomplished in Lithuanian University of Health Sciences, Institute of Sport. We got a licence from Kaunas Regional Biomedical Research Ethics Committee (Be-FMR(M)-82).

The study involved 60 subjects with chronic low back pain: 31 men and 29 women, aged 21.5 years on average, their body mass index was 22.5 kg/m² and the subjects had to have experienced low back pain at some point in their life.

All subjects were submitted to the Low Back Pain Duration Questionnaire (a. Have you ever had low back pain? b. Have you had low back pain in the period of one year? c. Have you had low back pain in the period of three months? d. Do you have low back pain today? For each question the possible answers were as follows: a. No pain b. Mild pain c. Moderate pain d. Severe pain e. Worst pain possible) and Baecke Habitual Physical Activity Questionnaire (Baecke et al., 1982). Lumbo-pelvic movement control was evaluated by six functional movement control tests established by Hannu Luomajoki (Loumajoki et al., 2007) (Figure 2).

Video materials expert analysis was used for the evaluation of the study data. According to the answers in the questionnaires and the primary investigation, 30 people with inadequate lumbo-pelvic movement control were selected for further research. Patients were divided randomly into specialized exercise (n = 15) and general exercise (n = 15) groups (Table 1).

Specialized and general exercise training programs were applied twice a week, one hour, a total of 10 workouts (Table 2). In the general exercise group three subjects did not complete the program.

After the training cycle diagnostic test was repeated. The obtained data were statistically processed and compared. The study lasted for four months. The results showed that a specialized exercise training program was more effective in improving movement control.

Statistical analysis. This study used *SPSS 20.0 for Windows* program for statistical analysis.

The statistical significance was estimated at the probability ($p < \text{value}$) level lower than 0.05 ($p < 0.05$). Mann Whitney and Wilcoxon tests were used for non-normal distribution of data. For independent sample χ^2 criterion was applied. In order to compare the data, the mean (\bar{x}) and standard error of the mean estimate (SEM) were calculated. Qualitative variables are presented as percentage.

Test	Correct	Not correct
Test 1. "Waiters bow": Flexion of the hips in upright standing without movement (flexion) of the low back	Forward bending of the hips without movement of the low back (50-70° Flexion hips). 	Angle hip Flexion without low back movement less than 50° or Flexion occurring in the low back. 
Test 2. Pelvic tilt Dorsal tilt of pelvis actively in upright standing.	Actively in upright standing; keeping thoracic spine in neutral, lumbar spine moves towards Flexion. 	Pelvis does not tilt or low back moves towards Extension or compensatory Flexion in thoracic spine. 
Test 3. One leg stance: From normal standing to one leg stance: measurement of lateral movement of the belly button. (Position: feet one third of trochanter distance apart).	The distance of the transfer is symmetrical right and left. Not more than 2 cm difference between sides. 	Lateral transfer of belly button more than 10 cm. Difference between sides more than 2 cm. 
Test 4. Sitting knee extension. Upright sitting with neutral lumbar lordosis; extension of the knee without movement (flexion) of low back	Upright sitting with neutral lumbar lordosis; extension of the knee without movement of low back (30-50° Extension of the knee is normal). 	Low back is moving in flexion. Patient is not aware of the movement of the back. 

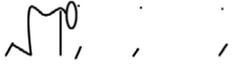
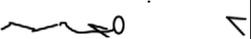
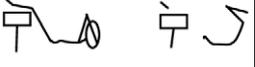
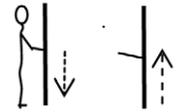
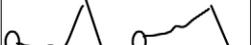
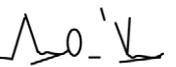
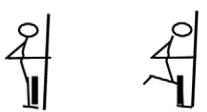
<p>Test 5. Quadruped position. Transfer of the pelvis backwards and forwards (“rocking”) keeping low back in neutral. Starting position 90° hip flexion.</p>	<p>120° of hip flexion without movement of the low back by transferring pelvis backwards.</p> 	<p>Hip flexion causes flexion in the lumbar spine (typically the patient not aware of this).</p> 
	<p>Rocking forwards to 60° hip flexion without movement of the low back.</p> 	<p>Hip movement leads to extension of the low back</p> 
<p>Test 6. Prone lying active knee flexion</p>	<p>Active knee flexion at least 90° without movement of the low back and pelvis.</p> 	<p>By the knee flexion low back does not stay neutral maintained but moves in extension or rotation</p> 

Figure 2. Movement control tests by Hannu Luomajoki (Luomajoki et al., 2008): 1) “Waiters bow”; 2) “Pelvic tilt”; 3) “One leg stance”; 4) “Sitting knee extension”; 5) “Quadruped position”; 6) “Prone lying active knee flexion”

Table 1. Characteristics of the study population

Characteristics	Specialized exercise group, m ± SEM	General exercise group, m ± SEM
Subjects, n	15	15
Men	4	5
Women	11	10
Age, years	20.87 ± 0.2	21.83 ± 0.3
Height, cm	172.87 ± 2.3	172.47 ± 1.6
Weight, kg	65.07 ± 3.2	67.73 ± 3.0
BMI, kg/m ²	21.1 ± 0.7	22.3 ± 0.7
Level of physical activity (from low (3 points) to high (15 points)) (Beacke habitual physical activity assessment questionnaire)	7.2 ± 1.7	7.2 ± 0.2
There was no statistically significant difference between groups.		

Table 2. Summary of specialized and general training programs

Training programs	Specialized exercise training program	General exercise training program
Duration	10 sessions (twice a week, one hour)	
Amount of exercise	5	
Repetitions of exercise	3 sets of 10 times (3X10)	
Muscle groups	Back, abdominal, legs, arms, chest	
Differences between groups	Priority operating sequence schema: finding, sensing and maintaining (stabilizing) physiological spine curves: neutral alignment in most cases and working alignment in crunches	We used B. Anderson and B. Peatl training instructions (Anderson, Peatl, 1996)
Exercise: Monday program		
The main accents of specialized exercise training program: 1. Warm up	Cycling on veloergometer	Cycling on veloergometer
2. Finding and sensing physiological spine curves neutral alignment		
3. Finding, sensing and regaining physiological spine curves (neutral alignment) "sitting tall" after bending forward and backward		
4. Maintaining (stabilizing) physiological spine curves (neutral alignment) in alternative knee rising		
5. Finding, sensing and maintaining (stabilize) physiological spine curves (neutral alignment) in squatting rolling fit ball		
Exercise: Thursday program		
1. Warm up	Cycling on veloergometer	Cycling on veloergometer
Maintaining (stabilizing) physiological spine curves (neutral alignment) in rising hand, straightening leg and alternative hand and leg simultaneously		
Finding, sensing and regaining physiological spine curves (neutral alignment) "sitting tall" after bending forward and backward		
Sense working spine alignment for optimal load distributing		
Maintaining (stabilizing) physiological spine curves (neutral alignment) in squatting with simultaneously hands rising		

RESEARCH RESULTS

The “Waiters bow” test is presented in Figure 3. Statistically significant difference was found in the specialized exercise training group before and after training (before the training program 100% of subjects failed the test, after training 73.3% of the patients passed the test). Statistically significant difference was also observed between the results of the specialized and general exercise training groups after training programs.

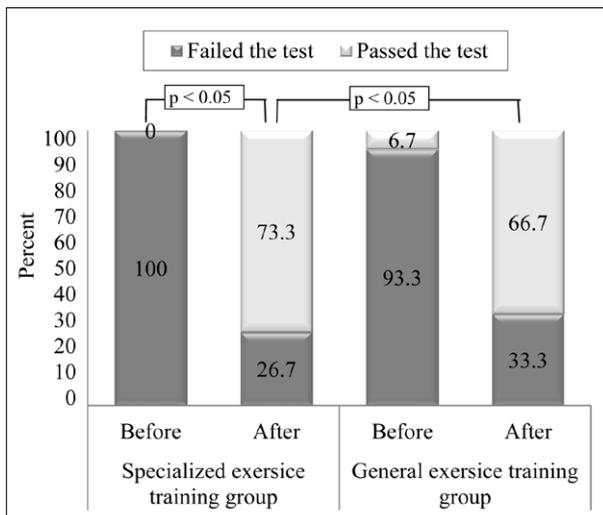


Figure 3. “Waiters bow”

The “Pelvic tilt” test is presented in Figure 4. Statistically significant difference was established in the specialized exercise training group before and after training (before training program 66.7% of subjects failed the test, after training 80% of subjects passed the test). Significant differences were observed after the training program in

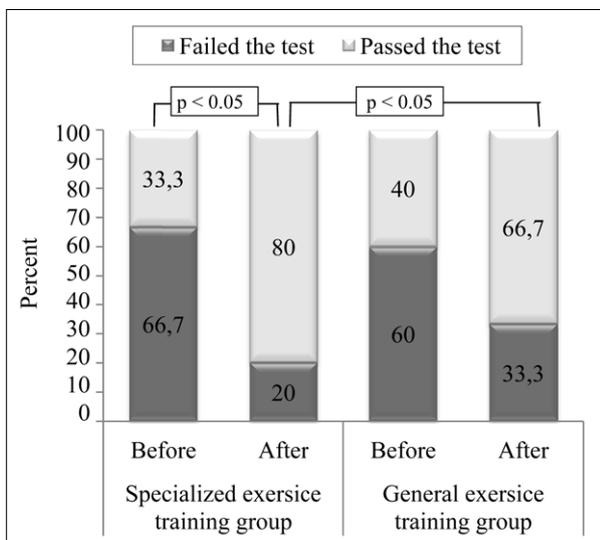


Figure 4. “Pelvic tilt”

specialized exercise group between subjects who passed (80%) and failed (20%) the test. Statistically significant difference was also found between the results in the specialized and general exercise training groups after training programs.

The “One leg stance” test is presented in Figure 5. The results did not improve in both groups.

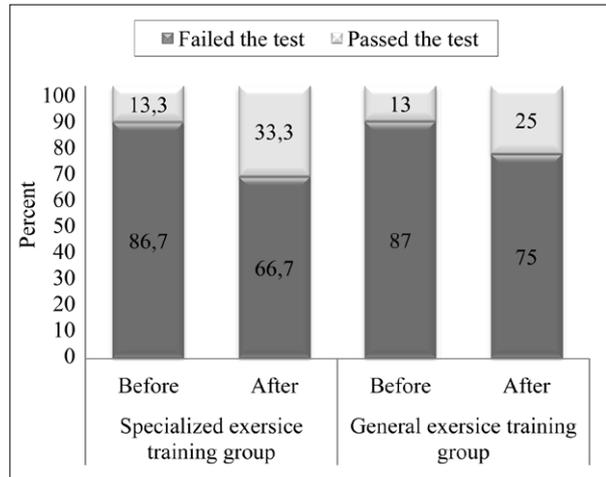


Figure 5. “One leg stance” test

The “Sitting knee extension” test is presented in Figure 6. There was statistically significant difference observed in the specialized exercise training group before and after training (before training program 86.7% of subjects failed the test, after training 93.3% of subjects passed the test). Significant differences were established before the training program in specialized exercise training group between the results of subjects who passed (13.3%) and failed (86.7) test and after training program in specialized exercise group between the results of subjects who passed (93.3%) and failed (6.7%) the test. Statistically significant difference

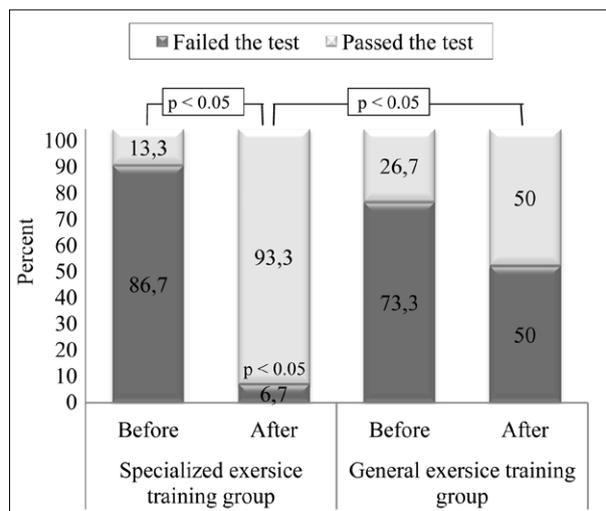


Figure 6. Sitting knee extension

was also found between the results in the specialized and general exercise training groups after training programs.

The “Quadruped position” test is presented in Figure 7. There was statistically significant difference observed in the specialized exercise training group before and after training (before training program 66.7% of subjects failed the test, after training 93.3% of subjects passed the test). Significant differences were established after the training program in specialized exercise group between the results of subjects who passed (93.3%) and failed (6.7%) the test. Statistically significant difference was also found between the results in the specialized and general exercise training groups after training programs.

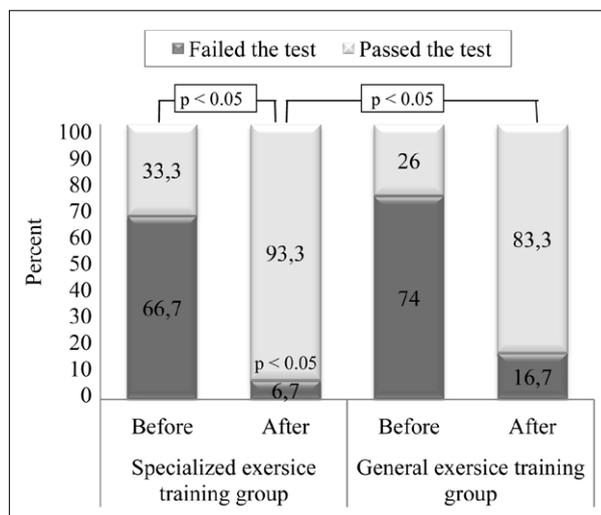


Figure 7. “Quadruped position”

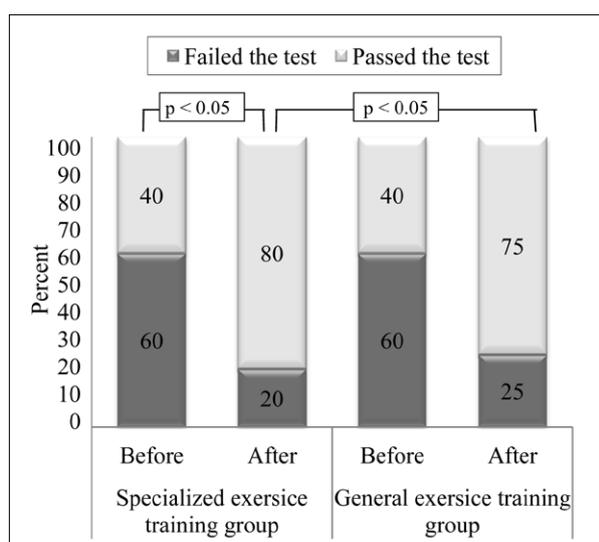


Figure 8. Prone lying active knee flexion test

The “Prone lying active knee flexion” test is presented in Figure 8. There was statistically

significant difference observed in the specialized exercise training group before and after training (before training program 60% of subjects failed the test, after training 80% of subjects passed the test). Statistically significant difference was also found between the results in the specialized and general exercise training groups after training programs.

DISCUSSION

Our study demonstrated a clear difference between general and specialized exercise programs for patients with low back pain regarding their ability to actively control the movements of the lumbo-pelvic region. Lumbo-pelvic movement control assessment is a relatively new concept. In our studies the biggest effect on lumbo-pelvic region movement control was shown in the subjects who performed specialized exercises.

There are already studies carried out to assess the reliability of these tests. H. Luomajoki et al. (2007) used ten lumbo-pelvic movement control tests for subjects who complained of low back pain. In that study six tests showed good reliability. H. Luomajoki et al. (2010) studied 38 people complaining of non-specific low back pain and those with lumbo-pelvic movement control dysfunction. For subjects lumbo-pelvic movement control function was assessed in six movement control tests and a specialized exercise program. All subjects had nine workouts. The results showed that lumbo-pelvic movement control function significantly improved, pain and the level of disability decreased. The same results we obtained in our study measuring the quality of movement control of lumbo-pelvic region. Only in the “One Leg Stance” test, we did not get statistically significant results. However, we found a similar study performed on side to side weight bearing which demonstrated a significant difference between patients with low back pain and healthy controls (Childs et al., 2003).

P. O’Sullivan (2005) developed a classification system of LBP. The first distinction is between centrally evoked and peripherally evoked LBP. The centrally evoked pain is associated with psychological factors, such as fear avoidance, catastrophizing or depressive mood (approximately 30% of LBP patients). The peripherally evoked LBP is mechanically caused and includes movement

impairment and movement control impairment (each approximately 30%). Patients with movement impairment have a painful restriction of movement. Patients with movement control impairment have complaints in certain positions, such as sitting, standing or in twisted positions. Movement control impairment is direction specific, either provoked by flexion, extension, rotation or multidirectional movements.

V. Lehtola (2012) and H. Luomajoki (2011) said that it was enough to change the movement patterns and decrease disability. Large reviews conclude that there is strong evidence for the effectiveness of exercise as a treatment for LBP (van Tulder et al., 2000; Hayden et al., 2005; Airaksinen et al., 2006).

Benefits of specific exercises were demonstrated in subgroups of patients with LBP. Specific stabilizing and movement control exercises are more effective than general exercises in postpartum women with pelvic instability (Stuge et al., 2004) and patients with spondylolisthesis (O'Sullivan et al., 1997). There is evidence to indicate that patients with movement control deficits are an important subgroup of LBP and that they may benefit from specific exercises (Maluf et al., 2000; O'Sullivan, 2000; Comerford, Mottram, 2001, 2001 a).

In our study we tried to review the physical activity questionnaire, lumbo-pelvic movement control assessment and training programs in the impact assessment. Analysing research literature we did not find studies of all these aspects in complex. We found information only on the

individual tests which we tried to analyse and compare.

CONCLUSIONS AND PERSPECTIVES

Movement control of lumbo-pelvic region improved after ten physical therapy sessions with specialized exercises for people with chronic low back pain ($p < 0.05$). Five of six functional tests were performed with better quality after the treatment. General exercises had no effect on movement control of lumbo-pelvic region in people with chronic low back pain. So we can state that specialized exercises were more effective for the movement control of lumbo-pelvic region and should be used in physical therapy practice for people with chronic low back pain. Functional tests of H. Luomajoki (Luomajoki et al., 2007) are recommended as a good and reliable tool for the assessment movement control of lumbo-pelvic region for low back pain patients.

Practical recommendation. During the exercise the patient should be accompanied by an active participant in shaping the visual exercise. To achieve this goal the necessary conditions are:

- Motivation.
- Teaching to pay attention to and prioritise: “nesting, stability and movement quality”.
- Creating a complex of daily individual exercises and teaching to do them correctly.

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BENDRŲJŲ IR SPECIALIŲJŲ FIZINIŲ PRATIMŲ PROGRAMOS POVEIKIS JUOSMENS-DUBENS SRITIES JUDESIŲ VALDYMUI

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SANTRAUKA

Tyrimo pagrindas ir hipotezė. Nugaros apatinės dalies skausmas yra viena aktualiausių problemų visame pasaulyje. Dažniausia nugaros skausmo priežastis – juosmens-dubens judesių valdymo sutrikimas. Specialieji pratimai yra svarbiausi gydant nugaros skausmą. Hipotezė: specialiosios treniruotės programa yra veiksmingesnė lavinant žmonių, jaučiančių lėtinį nugaros skausmą, juosmens-dubens srities judesių valdymą.

Tikslas – palyginti specialiosios ir bendrojo lavinimo treniruotės programos poveikį žmonių, jautusių lėtinį nugaros apatinės dalies skausmą, juosmens-dubens srities judesių valdymui.

Metodai. Buvo tiriama 60 asmenų, jautusių nespecifinį nugaros apatinės dalies skausmą. Tiriamieji – 31 vyras ir 29 moterys, vidutinis amžius – 21,5 m. Visiems buvo taikomas nugaros apatinės dalies skausmo ir *Baecke* fizinio aktyvumo klausimynai. Juosmens-dubens srities judesių valdymas vertinamas šešiais testais pagal Hannu Luomajoki. Taikyta specialioji ir bendrojo lavinimo treniruotės programa priziūrint kineziterapeutams. Norint tiksliau surinkti duomenis panaudota vaizdo filmavimo kamera.

Rezultatai. Paskaičius ir įvertinus specialiosios treniruotės programos rezultatus galima teigti, kad ši programa labiau paveikė judesių valdymą.

Aptarimas ir išvados. Po bendrojo lavinimo treniruotės programos ciklo kontrolinės grupės vertinimo testų rezultatai nepakito ($p > 0,05$). Po specialiosios treniruotės programos ciklo tiriamosios grupės penkių testų iš šešių rezultatai pagerėjo.

Raktažodžiai: judesių valdymas, kineziterapijos programa, stabilumas, mobilumas.

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INFLUENCE OF PASSIVE FOOT FLECTION MOVEMENTS APPLIED AFTER EXERTION ISOMETRIC WORKOUTS ON MUSCULAR BLOOD FLOW

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ABSTRACT

Research background and hypothesis. Blood flow intensity plays an important role in the recovery after exercising.

Research aim was to compare the effect of passive rest and passive foot movement on calf muscle blood flow applying dosed static physical loads.

Research methods. Eighteen adult males were divided into two sub-groups. Participants of the study performed two isometric 30-s workouts at 75% of MVC with 20 minutes interval for the recovery between the workouts. During the first stage one sub-group performed workout and a passive recovery was applied while the subjects of the second sub-group performed passive foot flexion movements. During the second stage the form of recovery was changed. Arterial blood flow intensity was registered during venous occlusion plethysmography and passive foot flexion movements were performed by special mechanical equipment.

Research results. The results obtained during the study showed that maximal increase of blood flow registered at 21 second after the workout was (52.0 ± 2.9 ml/min/100 ml), while the application of passive movements before the workout decreased the blood flow intensity (45.0 ± 2.6 ml/min/100 ml). It was significantly ($p < 0.05$) lower compared to passive rest.

Discussion and conclusions. These effects can be explained by reduced venous filling and increased venous vascular reserve capacity in the calves. The results obtained during this research allow concluding that passive foot flexion manoeuvre applied before the isometric workload faster decreases the blood flow intensity during the recovery.

Keywords: arterial blood flow recovery, isometric physical workout, passive foot movement, passive rest.

INTRODUCTION

Working capacity and recovery of athlete's body after exhausting physical loads are affected by many factors, such as systemic and muscular blood flow characteristics. Various regulatory mechanisms and their interaction lead to the final result – the intensity of blood flow. With increased training workloads and contest activities, athlete recovery has probably become the main object of investigation. Fatigue levels in the process of sports training are one of the factors that determine the performance of exercise and the body adaptation to physical load. It is the recovery

period, when the most significant adaptive changes occur, which are the basis for long-term adaptation.

Muscle blood flow changes directly affect the intensity of oxidative metabolic processes (Friedmann et al., 2007) suggesting that the intensification of muscle blood flow can increase the rate of tissue respiration, reduce fatigability and improve muscle working capacity. When looking for an advanced solution to this problem, researchers propose a variety of blood flow activation effects applying additional recovery measures. Extra mechanical impact on blood vessels is one of the

self-regulatory phenomena causing vasodilator response (Boutcher, Y. N., Boutcher, S. H., 2005). The problem of the relationship between muscle blood flow and working capacity is still relevant and not fully understood (Hughson et al., 1996).

Local work carried out to failure lasts longer at a good functional state. Applying recovery exercises after the physical load, physical working capacity significantly improves for non-activated muscles during exercise compared to passive rest (Fujita et al., 2009). After physical work there are great changes in muscle blood flow. To assess the recovery measures (effect of passive rest and passive foot movement on calf muscle blood flow) we applied a functional test – static physical load of dosed duration.

Research aim was to compare the effect of passive rest and passive foot movement on calf muscle blood flow applying dosed static physical loads.

RESEARCH METHODS

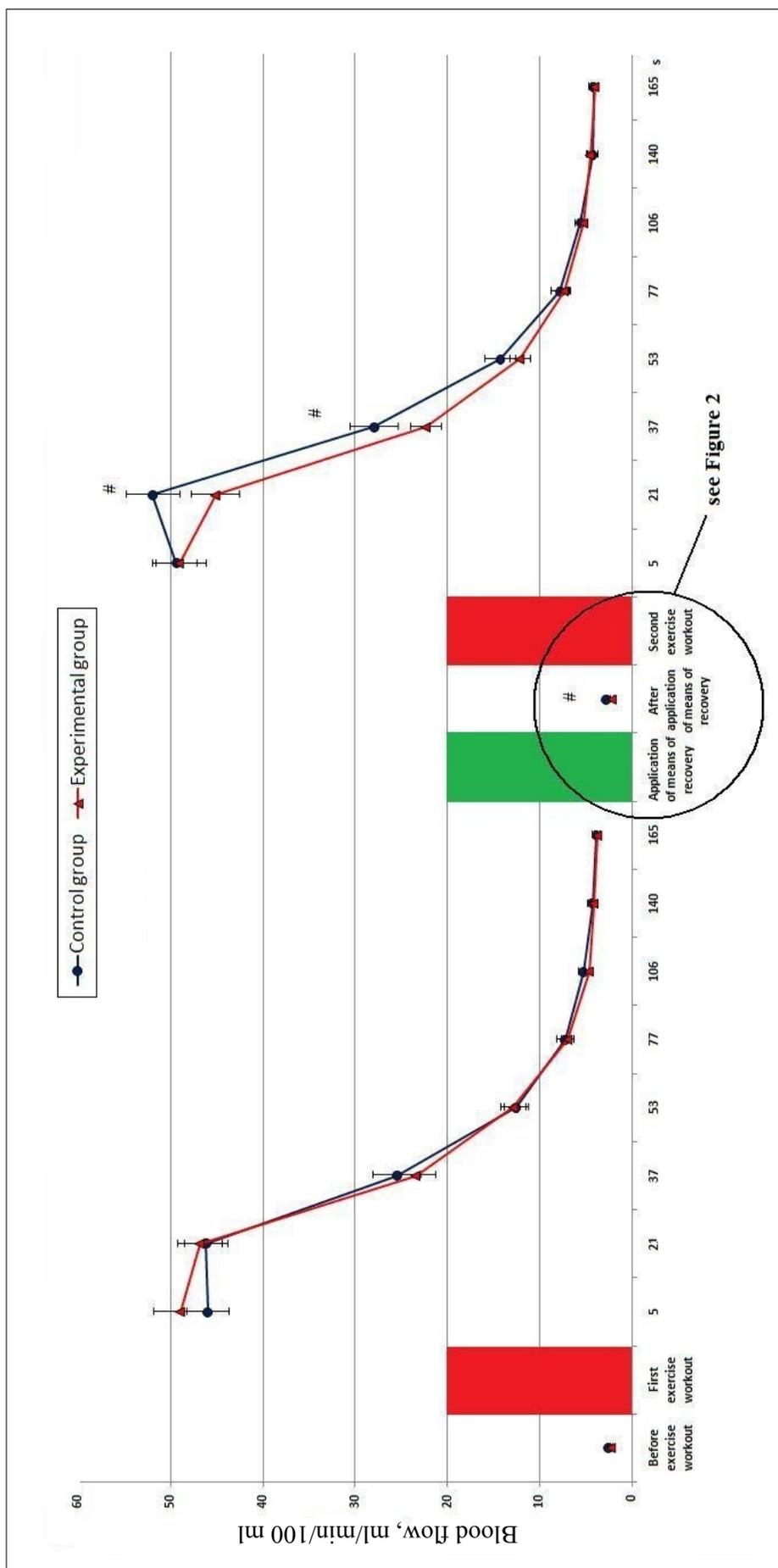
Research participants were 18 persons adapted to endurance physical loads. Their age was 20.3 ± 2.1 years, height 178 ± 4.2 cm, body mass 71.2 ± 3.5 kg. Two studies were carried out using different recovery means (passive rest, passive foot movement). All subjects were assigned to two groups, 9 persons in each group: control and experimental, where recovery measures were administered in a certain order in each group. The control group had passive rest for 20 min between the two physical loads, and the experimental group – passive rest for 5 min and passive foot movements for 15 min. Physical working capacity is the greatest when the passive foot movements last for 15 min. After three days the recovery measures applied to groups were interchanged – the control group received 5 min passive rest and 15 min passive foot movements, while the experimental group – 20 min passive rest. Such interchanging is necessary in order to avoid training and adaptation effect for subjects under the experimental conditions. In each study, after 20 min of adaptation, the calf muscle blood flow was recorded using venous occlusion plethysmograph while the subject was in a sitting position. We determined maximal voluntary contraction force of foot flexors, and two 30 s static physical workloads of 75% of the maximum voluntary contraction force were performed. The maximal voluntary contraction force (MVC) was determined using the dynamometric device. The

maximal voluntary contraction force value was recorded three times and the highest value was taken for analysis. We captured the subjects' joints of the working knee at the 90° angle and the ankle – at the 70° angle. Maximal muscle endurance (MME) was determined by pressing the foot on the operating plate with 75% of the maximal voluntary contraction force. The subjects had to perform a 30 s static physical load by pressing the plate and maintaining the same amount of force. Passive foot flexion was performed using a mechanical device. The feet were attached to the pedals which were moved by the electric motor. The angle of pedal movement and the range of motion of flexion and extension were 35° , and the frequency was 30 movements per minute.

Statistical analysis. The difference between the groups was considered to be reliable with Student's *t* test statistical significance set at $p < 0.05$. Before the test of means, equality of dispersion was checked up. The data are expressed as means \pm standard error. These calculations were performed using statistical functions of the *SPSS Statistics 17.0*.

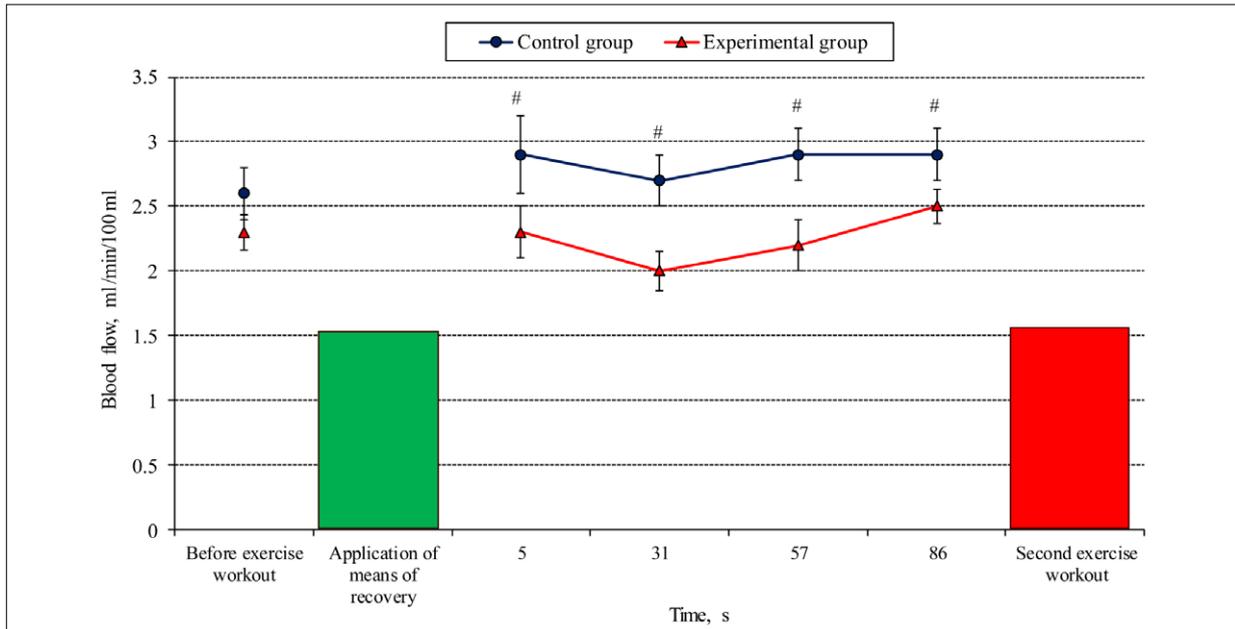
RESEARCH RESULTS

In the control group, the arterial blood volume before the first dosed static physical load was 2.6 ± 0.2 ml/min/100 ml, and immediately after the load it increased to 46.0 ± 2.3 ml/min/100 ml, at the 21st s it was 46.2 ± 2.3 ml/min/100 ml. At the thirty-seventh and fifty-third second we observed a significant decrease in the blood flow, respectively to 25.5 ± 2.6 ml/min/100 ml, 12.6 ± 1.3 ml/min/100 ml. Arterial blood flow at the one hundred sixty-ninth second was still significantly greater than the initial value (Figure 1). In the experimental group, the arterial blood volume before the first dosed static load was 2.3 ± 0.14 ml/min/100 ml, and immediately after the exercise it increased to 49.0 ± 2.9 ml/min/100 ml, at the 21st second – to 46.9 ± 2.4 ml/min/100 ml (Figure 1). At the thirty-seventh and fifty-third second a considerable blood loss was observed, respectively to 23.5 ± 2.2 ml/min/100 ml, 12.9 ± 1.3 ml/min/100 ml. Arterial blood flow at the one hundred sixty-ninth second was still significantly higher than the initial value. After passive rest, the intensity of calf muscle arterial blood flow in the control group before the second physical load was significantly higher than that in the group with passive foot movements (Figure 2).



Note. Values are means ± SE. # – Significantly different from the value between groups ($p \leq 0.05$).

Figure 1. Arterial blood flow in the calf muscle after exercise workouts and after applying means of recovery (the passive rest and passive foot movement)



Note. Values are means \pm SE. # – Significantly different from the value between groups ($p \leq 0.05$).

Figure 2. Arterial blood flow in the calf muscle after applying means of recovery (the passive rest and passive foot movement)

The results obtained during the study showed that maximal increase of blood flow at 21 second after the workout was registered (52.0 ± 2.9 ml/min/100 ml), while the application of passive movement before the workout decreased the blood flow intensity (45.0 ± 2.6 ml/min/100 ml). This was significantly ($p < 0.05$) lower compared to passive rest. The same tendency of lower blood flow intensity was observed in the measurements up to 40 seconds after workouts.

After the second working hyperaemia (the twenty-first second), the largest difference in blood flow intensity was observed applying the passive rest – 5.8 ± 1.7 ml/min/100 ml, and the application of the passive foot movements resulted in 0.9 ± 2.4 ml/min/100 ml ($p < 0.05$). Passive foot flexion before the second static load reduces the maximum intensity of blood flow. The lower values of the highest blood flow can be explained by the fact that passive foot flexion decreased blood filling in venous vessels and increased calf venous vascular reserve volume. After the increase in venous reserve volume, peak blood flow after working hyperaemia decreased because the increase in maximal blood flow was limited by the increased rate of venous emptying.

DISCUSSION

R. M. Enoca and D. G. Stuart (1992) showed that the results are limited to the fatigue task performed because the relative contribution of

the different mechanisms to fatigue is highly task dependent. The fatigue task (to sustain 75% of MVC for 30 s) combined characteristics (high force level, relatively short duration) allowing a rapid muscle recovery (Petrofsky, 1981; Petrofsky, Philips 1981). During a high force level contraction, the consumption of short-term energy supplies in anaerobic muscle fiber (type II) and the hypoxia (blood flow occlusion) of aerobic muscle fibres (type I) led to a rapid decline of muscle force (fatigue) (Lariviere et al., 2003). However, this occurs without significantly increasing the negative effects of some hypothesis concerning muscular fatigue factors associated with a low force-level contraction to fatigue that take longer to restore (Fitts, Balog, 1996).

Static physical workloads of different intensity are applied in sports practice. Static endurance is an indicator of working capacity which depends on the person's maximal effort. When the subjects perform each physical load as a percentage of MVC, the experimenter ensures equal conditions for all subjects taking into account individual differences (Роженблат, 1975). V. V. Rozenblat (Роженблат, 1975) argues that static muscle endurance in physical loads at 50 or 75% of MVC is independent physiological functional test showing the functionality of the movement mechanism. In determining the static endurance, it is necessary to use static physical load of increased intensity. V. V. Rozenblat (Роженблат, 1975) recommends that it is appropriate to use physical workloads of

75% MVC until complete fatigue. Static endurance of 75% MVC as a test determining fatigue has several advantages: 1) fatigue occurs very quickly, 2) significant changes in the intensity of blood flow occur in the working muscles. Our previous study results showed that maximal muscle endurance (MME) of right foot flexors of athletes adapted to speed-strength physical loads was 58.9 s, and that of athletes adapted to endurance physical loads – 70.6 s. Other researchers' findings showed that maximal muscle endurance (MME) of persons not engaged in sports was 54.0 s. The chosen duration of dosed physical load was 30 seconds because it was about a half of the maximum endurance time (van Dieen et al., 1998). The intensity of the blood flow in the working muscle after static physical workloads depends on the intensity of the load performed.

After the working hyperaemia, the maximum values of arterial blood were not immediately after the physical load, but at the twenty-first second and later. The forces compressing blood vessels disappear immediately after exercise when the muscles are relaxed. It would seem that at this time the blood pressure should fully stretch the blood vessels. Why is the blood flow the largest not immediately after physical load, but after some time? What keeps fast stretching of blood vessels, if not of all of them, but at least some of them? The data of H. V. Sparks (1964) and R. T. Grant (1930) suggest what hinders this contraction of the blood vessels which are exposed to high compression during muscle contraction. H. V. Sparks showed that the part of the artery which is exposed to a fast stretch shrinks. Even more interesting and very important is the research by R. T. Grant. He observed that chronically denervated arterioles of a rabbit responded to a slight touch by localized dilatation, but their response to a strong compression resulted in a localized shrinkage. Later, intense slowly developing dilatation

occurred. Why the blood flow is the largest not immediately after the physical load, but after some time, can be explained on the basis of H. V. Sparks (1964) and R. T. Grant's work which suggests that during the load arterial blood vessels are strongly compressed, so it takes time for half-empty arterial blood vessels to fill up with blood. When they fill up with blood, the maximum values of arterial blood flow are reached.

The last question for discussion is about the duration or rest intervals between testing procedures. According to the measurements theory (Crocker, Algina, 1986), the reliability of the measurement can be increased by taking the average of multiple tests. However, in the specific case of fatigue tests, the reliability is affected not only by the random error across tests but also by the systematic error associated with the lack of recovery from the preceding fatigue tests. One way to attenuate the effect of this systematic error is to increase the rest period between tests. Studies in which repeated back muscle fatiguing contractions were performed and where a complete recovery between the tests was assumed used varying rest interval ranging between 10 and 15 min (Kondraske et al., 1987; Roy et al., 1989) and 20 min (Macarez, 1976). The rest intervals appear to be in agreement obtained with handgrip fatiguing contractions (Petrofsky, 1981). Consequently the purpose of the present study was the evaluated rest interval 20 min after performing a short fatiguing contraction.

CONCLUSIONS AND PERSPECTIVES

The results obtained during this research allow concluding that passive foot flexion manoeuvre applied before the isometric workload decreases the blood flow intensity during the recovery.

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PASYVAUS PĖDŲ LANKSTYMO POVEIKIS BLAUZDOS RAUMENŲ KRAUJOTAKAI PO IZOMETRINIŲ FIZINIŲ KRŪVIŲ

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Kraujotakos intensyvumas po fizinių krūvių yra svarbus veiksnys atsigavimo metu. Šio tyrimo uždavinys išsiaiškinti, kaip pasyvus pėdų lankstymas po izometrinių fizinių krūvių veikia raumenų kraujotaką.

Tikslas – nustatyti pasyvaus poilsio ir pasyvaus pėdų lankstymo poveikį blauzdos raumenų kraujotakai taikant dozuotus statinius krūvius.

Metodai. Buvo tiriama 18 asmenų, adaptuotų išvermės fiziniams krūviams. Atlikti du tyrimai taikant skirtingas atsigavimo priemones (pasyvų poilsį, pasyvų pėdų lankstymą). Visi tiriamieji suskirstyti po devynis į dvi grupes (kontrolinę ir eksperimentinę), kurioms atsigavimo priemonės buvo skiriamos tam tikra tvarka. Kiekvieno tyrimo metu po 20 minučių adaptacijos blauzdos raumenų kraujotaka buvo registruojama veniniu okliuziniu pletizmografu tiriamajam sėdint. Buvo nustatoma pėdos lenkiamųjų raumenų maksimalioji valinga jėga ir atliekami du 75% maksimaliosios valingos jėgos 30 s trukmės statiniai fiziniai krūviai.

Rezultatai. Kraujotaka labiausiai padidėjo po krūvio dvidešimt pirmą sekundę ir siekė $52,0 \pm 2,9$ ml/min/100 ml taikant pasyvų poilsį, o pasyviai lankstant pėdas – $45,0 \pm 2,6$ ml/min/100 ml ($p < 0,05$). Trisdešimt septintą ir penkiasdešimt trečią sekundę pastebėtas didelis kraujotakos sumažėjimas – atitinkamai $25,5 \pm 2,6$ ml/min/100 ml ir $12,6 \pm 1,3$ ml/min/100 ml.

Aptarimas ir išvados. Darbo metu tiriamųjų arterinės kraujagyslės buvo stipriai suspaustos, todėl reikėjo laiko joms užsipildyti krauju. Kai jos prisipildo, pasiekiamos didžiausios arterinės kraujotakos reikšmės. Rezultatai parodė, kad pasyvus pėdų lankstymas, taikytas prieš izometrinių fizinių krūvių, sumažina kraujotakos intensyvumą atsigavimo metu.

Raktažodžiai: arterinės kraujotakos atsigavimas, izometrinis fizinis krūvis, pasyvus pėdų lankstymas, pasyvus poilsis.

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PECULIARITIES OF AEROBIC DEVELOPMENT IN KAYAK ROWERS PREPARING FOR 1000 M EVENT

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ABSTRACT

Research background and hypothesis. Lithuanian scientific publications mostly deal with kayak rowers' preparation for 200 and 500 m events, while 1000 m event is hardly analyzed yet.

Research aim was to project scientifically based program of kayak rowers' preparation for 1000 m event, which is to develop aerobic capacity in different mezo-cycles, and to evaluate its efficiency.

Research methods. Preparation of kayak doubles crew members was investigated; the athletes were the 5th place winners of 2013 World Cup II event. The carried out training load for aerobic capacity development was divided into 5 zones of intensity. During training sessions, computer program Garmin Connect measured the distance and speed of a boat, as well as athletes' heart rate (HR). Athletes' aerobic capacity at critical intensity level (CIL) and anaerobic threshold (ANT) was established using gas analyser 'Oxycon Mobile'.

Research results. As the research showed, the kayak rowers in mezo-cycles of both preparatory and competition periods carried out very little training load in the fifth zone of intensity. Considerable is also the fact that during competition period, in mezo-cycle, the total number of kilometres decreased from 218 to 158 km.

Discussion and conclusions. The research demonstrated that training workloads in the first and the second zones for elite kayak rowers preparing for 1000 m event in the first mezo-cycle of competitive period were diminished comparing to the workload carried out in the preparatory period, while the amount of workload in the fourth zone was considerably increased. Adaptation of the two elite athletes to applied training loads is different, although they were following the same program. Due to this fact, the training process of those athletes is recommended to be given more individual approach, though they are rowing one boat.

Keywords: kayak rowing, preparatory and competitive periods, training mezo-cycles, aerobic capacity.

INTRODUCTION

The stage of contemporary kayak rowing training evolution bears characteristic feature of active search for and introduction of still more effective means and methods, which are to increase the efficiency of pedagogical impact. As a matter of fact, constant progress in sport results may only occur alongside stable increase in body functional systems capacity and physical working capacity; the latter can be attained in the process of planning and carrying-out preparation of kayak rowers (Skernevičius et al., 2003). Kayak

rowing sport is classified as event requiring mixed anaerobic alactic energy production, as well as great aerobic capacity and endurance; such reactions of energy production prevail in 1000 m event when athletes overcome it in 3.00 up to 4.00 min and make 81.8% of energy production (Astrand, 2001). Slow twitch, enduring muscle fibres with their inner intense aerobic processes are active participants in muscle work (Wilmore et al., 2008). In 1000 m event, good sport results are being achieved by athletes possessing relative maximal oxygen uptake

70 ml/min/kg (Kahl, 1998); due to this fact the significance and time allocation to aerobic capacity development for kayak rowers preparing for this event becomes obvious.

Lithuanian scientific publications mostly deal with kayak rowers' preparation for 200 m and 500 m events (Rudzinskas et al., 1997, 2000, 2001; Skernevičius et al., 1998, 2002, 2003, 2004; Balčiūnas, 2009, 2010), as in those events achievements of Lithuanian kayak rowers in international competitions are rather distinguished; however, preparation of Lithuanian kayak rowers for 1000 m event is hardly investigated and sports achievements of the athletes are not so much significant.

It becomes relevant to perform deeper scientific investigations on theoretical basis of Lithuanian elite kayak rowers' preparation, as well as content and methods of this preparation in developing aerobic capacity, altogether providing accuracy on the efficiency of the methods. Scientific problem appears on projecting a scientifically based kayak rowers' preparation for 1000 m event program and testing its efficiency.

The aim of the work was to project scientifically based program for kayak rowers' preparation for 1000 m event, which would develop

aerobic capacity in different mezzo-cycles, and to provide evaluation of its efficiency.

RESEARCH METHODS

The research was carried out in the first year of four-year Olympic cycle, during the last mezzo-cycle of the preparatory period, as well as in the first mezzo-cycle of the competitive period, respectively in 2013 February 26–March 17, and April 22–May 16.

The investigation dealt with kayak doubles crew members' preparation; the athletes were the 5th place winners in 2013 World Cup II event competitions, thus attaining the best 1000 m event Lithuanian kayak rowing result ever. The carried out training load for aerobic development was brought into 5 zones of intensity:

- first zone – working intensity under aerobic threshold (AT), HR – 140 ± 10 b/pm, blood lactate concentration – up to 2 mmol/l;
- second zone – working intensity – HR – 155 ± 5 b/pm, blood lactate concentration – 2.1–3 mmol/l;
- third zone – working intensity – HR – 165 ± 5 b/pm, blood lactate concentration – 3.1–5 mmol/l;

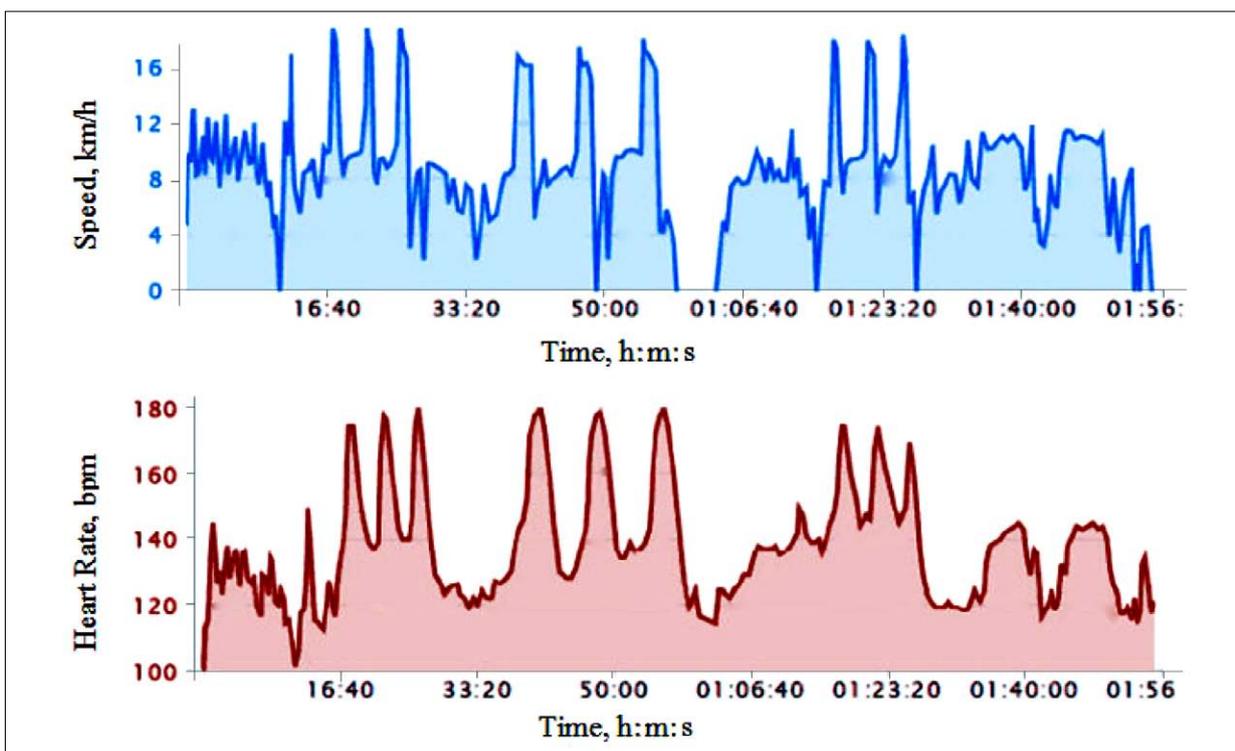


Figure. Distance, overcome by kayak rower R. N., and the change of boat pace and pulse rate in one training session

- fourth zone – working intensity – HR – 175 ± 5 b/pm, blood lactate concentration – 5.1–8 mmol/l;
- fifth zone – working intensity – HR – 180–185 b/pm, blood lactate concentration – 8.1 mmol/l and higher.

During the training sessions, computer program Garmin Connect, Forerunner 910 XT was employed to measure the distance and speed of a boat, as well as the athletes' pulse rate (PR) (Figure). Capillary blood sample used to be taken, establishing La concentration. In each of the practices, in micro-cycle and mezzo-cycle, time for training load carried out in different intensity zones, and distance (km) used to be measured. Gas analyser 'Oxycon Mobile' was used to set out the indices of lung ventilation (LV), heart rate (HR), maximal oxygen uptake (VO_{2max}), oxygen pulse (OP), working capacity (W), working efficiency at the limits of critical intensity (CIL) and anaerobic threshold (ANT). After the experienced load at CIL, blood lactate concentration used to be measured. The protocol of aerobic capacity indices had been compiled following the reference of J. Skernevicius et al. (2004).

Our elaborated training program underwent discussion by athletes, coaches and scientists; it hardly experienced any changes within the process of athletes' preparation.

RESEARCH RESULTS

The first mezzo-cycle of competitive period for our investigated kayak rowers possessed four micro-cycles. The first micro-cycle was aimed at supercompensation, during which athletes' physical and functional body condition investigations were performed. In this microcycle, water rowing consisted of 33.8 km; 43.2% of them were performed at the first zone intensity, and the fourth zone of intensity embraced the least amount of the training load – only 10.2% (Table 1). In the second micro-cycle – the one of great aerobic and glycolytic training load, workload was considerably less in the second zone, but the increase happened in the third zone – up to 23.5% from total workload; training workload also used to be carried out in the fourth and fifth zones and reached 10.8%. The third micro-cycle of special workload was specific in its decreased workload in the first and the second zones, and increased in

the third zone – up to 33.3%, while in the fourth zone it was up to 23.7%. The fourth competitive micro-cycle included participation in the second World Cup event, with three rowing in preliminary rounds, semi-finals and finals, winning the fifth place and reaching the best time ever in Lithuanian kayak double – 3 min 12.63 s. In this micro-cycle, only 19.2 km were rowed, the greatest workload carried out in the first zone – which made 39.2% of total work; a lot of work was performed in the third zone – 26.6%, and 19.4% was allocated to the work in the fourth zone.

Comparison of the on-water rowing work amount in this mezzo-cycle with the special on-water rowing mezzo-cycle in preparatory period (Table 1) shows the change of work intensity in competitive mezzo-cycle with decreased per cent of workload amount in the first and the second zones, as well as an increase of it in the third and the fourth zones – respectively up to 26.2 and 16.1%. The research showed rather little workload, carried out by the kayak rowers in the fifth zone of intensity both in preparatory and competitive mezzo-cycles. It should be noted that the total amount of rowed kilometres in competitive period was considerably less – it decreased from 218.7 km in preparatory period mezzo-cycle to 158.1 km.

Research on aerobic capacity, performed using gas analyser prior to special mezzo-cycle in preparatory period (testing I) and after it (testing II), as well as after the competitive mezzo-cycle in competitive period (testing III), in two days after participation in the World Cup events showed that the majority of aerobic capacity indices of both athletes used to considerably increase during the preparatory period mezzo-cycle, although changes difficult to explain had occurred (Table 2). Lung ventilation for the athlete R. N. at critical intensity level had increased by 10 l/min, and for A. O. it had decreased by 21 l/min. Very similar change of this index was observed also at anaerobic threshold limit. Pulse rate for both athletes at CIL used to increase significantly. Very great oxygen pulse changes were observed for the investigated R. N. (from 26.3 to 31.9 ml/b), for A. O. these changes were less. Working capacity for both of the athletes used to increase respectively by 40 W and 60 W, work efficiency index used to decrease insignificantly. VO_{2max} for the investigated R. N. had increased from 56.1 to 67.5 ml/min/kg, and for A. O. – from 61.2 to 73.4 ml/min/kg.

Table 1. Characteristics of kayak rower R. N. in on-water rowing work in the preparation and competitive mezzo-cycle of February 26–May 16, 2013

Indices	1 st zone	2 nd zone	3 rd zone	4 th zone	5 th zone
Total in 1st mezzo-cycle (February 26–March 17)					
Hours	09:11:24	04:00:00	02:46:25	02:04:11	00:14:52
Total 218.7 km	101.6	49.2	35.2	28.7	4.0
Percentage	46.5	22.5	16.1	13.1	1.8
Total in 2nd mezzo-cycle (April 22–May 16)					
Hours	05:31:11	02:19:23	02:11:40	01:56:57	00:00:00
Total 158.1 km	61.5	29.0	41.4	25.5	0.7
Percentage	38.9	18.3	26.2	16.1	0.5
First micro-cycle of 2nd mezzo-cycle					
Hours	01:16:14	00:47:06	00:26:17	00:15:51	00:00:00
Total 33.8 km	14.6	10.0	5.8	3.4	0.00
Percentage	43.2	29.6	17.0	10.2	0
Second micro-cycle of 2nd mezzo-cycle					
Hours	01:55:42	00:39:17	00:50:03	00:25:11	00:02:24
Total 45.2 km	21.6	8.1	10.6	4.2	0.7
Percentage	47.7	18.0	23.5	9.2	1.6
Third micro-cycle of 2nd mezzo-cycle					
Hours	01:43:03	00:40:54	01:34:15	01:00:45	00:00:00
Total 59.9 km	17.8	8.0	19.9	14.2	0
Percentage	29.7	13.3	33.3	23.7	0
Fourth micro-cycle of 2nd mezzo-cycle					
Hours	00:36:12	00:12:06	00:21:05	00:15:10	00:00:00
Total 19.2 km	7.5	2.8	5.1	3.8	0
Percentage	39.2	14.8	26.6	19.4	0

Note. R. N. aerobic threshold (AerT) – HR-150 b/pm, anaerobic threshold (ANT) – HR-166 b/pm, critical intensity limit, VO₂max – HR-184 b/pm, La – 11.9 mmol/l.

Table 2. Change in kayak rowers' aerobic capacity indices at critical intensity and anaerobic threshold limits during preparatory and competitive mezzo-cycles

Testing	Athletes	Critical intensity limit							Anaerobic threshold limit							La, mmol/l
		LV, l/min	HR, b/pm	VO ₂ max, l/min	VO ₂ max, ml/min/kg	OP, ml/b	W	O ₂ , lW/ml	LV, l/min	HR, b/pm	VO ₂ , l/min	VO ₂ , ml/min/kg	OP, ml/b	W	O ₂ , lW/ml	
I	R. N.	168	184	4.8	56.1	26.3	280	17.3	108	166	3.9	45.8	23.7	210	18.6	11.9
	A. O.	156	198	5.0	61.2	25.4	240	20.9	116	180	4.2	51.5	22.9	180	23.4	7.2
II	R. N.	178	180	5.7	67.5	31.9	320	17.9	126	167	4.5	52.5	26.7	240	18.6	12.2
	A. O.	135	200	5.2	64.7	26.2	280	18.7	94	190	4.2	50.7	21.8	200	20.8	12.3
III	R. N.	174	181	5.7	66.7	31.7	320	17.9	146	170	5.1	58.7	29.7	260	19.4	12.6
	A. O.	147	191	6.0	73.4	31.5	300	20.0	106	179	4.8	58.7	26.9	240	20.0	8.1

At anaerobic threshold limit, HR indices of the both athletes were rather different. In this zone of intensity, HR for the athlete R. N. was 166–170 b/pm, and for A. O. – 179–190 b/pm; working capacity of the first athlete had increased from 210 to 260 W, for the second – from 180 to 240 W. Oxygen uptake at anaerobic threshold used to increase significantly – from 45.8 to 58.7 ml/min/kg, for the athlete A. O. – from 51.5 to 58.7 ml/min/kg.

Investigations on aerobic capacity, performed after competitive mezzo-cycle showed different adaptation of the athletes to applied training loads: for the rower R. N. oxygen uptake and working capacity at anaerobic threshold used to increase considerably, and almost no changes were observed for the indices at critical intensity limit, whereas for A. O. considerable increase was established in VO_{2max} and working capacity indices at CIL. For both athletes, working efficiency at critical intensity and anaerobic threshold was almost constant.

DISCUSSION

Training load which is being carried out in preparing athletes is divided into different zones of intensity basing on various indices; the majority of the scientists (Платонов, 2004; Wilmore, Costill, Kenney, 2008; Issurin, 2008; Bompa, 2009; Skernevicius et al., 2011) explain such division into zones for the sports with prevailing aerobic capacity due to biochemical processes in muscles. Nevertheless, there are no existing standards for establishment of such zones due to diversity of sports and events, requiring different energy resources; different are physical, physiological and biochemical phenomena of the athletes as well (Astrand, 2001; Karoblis, 2005; Skurvydas, 2009). Our compiled zones of work intensity based on specific athletes' research data may experience slight changes during the training process, altogether with the change in ANT and CIL indices. Our investigation showed decreased amount of rowed kilometres in competitive mezzo-cycle when workload amount was decreased in the first and the second zones, and it was increased in the third zone (approaching ANT intensity); work in this zone increases blood lactate concentration up to 3.1–5.0 mmol/l. According to B. H. Платонов (2004), V. Issurin (2008), T. Bompa (2009), the work in this zone improves the function of cardiorespiratory systems without

great acidity effect on the body. Intense oxidation processes occur in muscles (Astrand et al., 2003). Workload of our investigated kayak rowers in the fourth zone (when O_2 consumption approaches maximal and lactate concentration increases up to 8 mmol/l) was of little difference between preparatory and competitive mezzo-cycles. Sport theorists (Hoffman, 2002; Karoblis, 2005; Jeukendrup, Gleeson, 2010; Skernevicius et al., 2011) recommend approaching work intensity to competitive level during practices when preparing for the main competitions in competitive period. Thus, Lithuanian elite kayak rowers, preparing for 1000 m event in World Championship, should increase workload in the fourth zone and include more work performed in the fifth zone in their preparation program; the work intensity in this zone equals to work at CIL when O_2 consumption approaches maximum.

Rowing 1000 m distance takes from 3 to 4 min; such work causes reaching CIL and VO_{2max} with great acidity effect on body (Astrand, 2001; Wilmore et al., 2008). To achieve kayak rowers' physical adaptation for such a work, it appears necessary to carry out workload in the fifth zone during training sessions. Analysis of the intensity and volume of our investigated athletes' training sessions in competitive mezzo-cycle shows that very little workload used to be carried out in the fifth zone while preparing for the first competitions of the season (World Cup event).

Investigations on aerobic capacity demonstrated different adaptation of kayak rowers to applied training load: for R. N., aerobic capacity at ANT used to increase considerably, while for A. O. greater increase was established in VO_{2max} . Such change in the indices highlight different body adaptation trends of the athletes, which should lead to more individualized preparation process – regardless the fact that the athletes row one boat.

CONCLUSIONS AND PERSPECTIVES

1. Elite kayak rowers, preparing for 1000 m event, carried out less workload in the first and the second zones during the first competitive mezzo-cycle comparing it to that of preparatory period; the first competitive mezzo-cycle also included an increased workload in the fourth zone, while very little work was performed in the fifth zone.

2. Preparing for the main competitions of the season, it is purposeful to carry out more work in the fifth zone, as the intensity of the work is close to the competitive.

3. Following the same program, two elite athletes undergo different adaptation to applied training loads. Their preparation is recommended to be more individualized even rowing one boat.

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BAIDARININKŲ, BESIRENGIANČIŲ 1000 M NUOTOLIUI, AEROBINIO UGDYMO YPATUMAI

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Baidarininkams irkluojant 1000 m, 81,8% energijos pagaminama aerobinių reakcijų būdu. Gerų rezultatų pasiekia tie šio nuotolio sportininkai, kurių santykinis maksimalusis deguonies suvartojimas pasiekia 70 ml/min/kg.

Lietuvoje spausdinamose mokslo publikacijose daugiau nagrinėjamas baidarininkų rengimas 200 ir 500 m nuotoliams, o Lietuvos baidarininkų rengimasis irkluoti 1000 m beveik netyrinėtas.

Tikslas – suprojektuoti moksliai pagrįstą baidarininkų rengimą irkluoti 1000 m nuotolį programą, kuri ugdytų aerobinį pajėgumą atskirais mezociklais ir įvertinti jos veiksmingumą.

Metodai. Tirti dvivietės baidarės įgulos nariai, kurie 2013 metų sezono Pasaulio taurės II etapo varžybose iškovojo 5-ą vietą ir pasiekė visų laikų geriausią Lietuvos baidarininkų 1000 m nuotolio rezultatą. Atliktas fizinis krūvis, ugdantis aerobinį pajėgumą, suskirstytas į penkias intensyvumo zonas. Pratybų metu kompiuterine sistema *Garmin Connect* buvo fiksuojamas nakties įveikiamas atstumas, jos greitis, sportininkų pulso dažnis (PD). Dujų analizatoriumi „Oxycon Mobile“ nustatytas sportininkų aerobinis pajėgumas ties kritinio intensyvumo (KIR) ir anaerobinio slenksčio (ASR) riba.

Rezultatai. Baidarininkai tiek parengiamojo, tiek varžybų laikotarpio mezociklais penktoje intensyvumo zonoje dirbo labai mažai. Pažymėtina ir tai, kad varžybų laikotarpio mezociklu bendras nuirkluočių kilometrų kiekis buvo daug mažesnis. Jis sumažėjo nuo 218,7 km, įveiktų parengiamojo laikotarpio mezociklu, iki 158,1 km.

Aptarimas ir išvados. Didelio meistriškumo baidarininkų, besirengiančių startuoti 1000 m nuotolyje, pirmuoju varžybų mezociklu buvo sumažinta darbo apimtis pirmoje ir antroje zonoje, lyginant su parengiamuoju laikotarpiu atlikto darbo apimtimi, ir smarkiai padidintas krūvis ketvirtoje zonoje. Du elitinio meistriškumo sportininkai, treniruodamiesi pagal vieną programą, skirtingai adaptuojasi prie taikomų fizinių krūvių. Rekomenduotina daugiau individualizuoti jų rengimąsi, nors sportininkai startuoja vienoje valtyje.

Raktažodžiai: baidarių irklavimas, parengiamasis ir varžybų laikotarpiai, treniruotės mezociklai, aerobinis pajėgumas.

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SPORT PERFORMANCE PROFILE IN MEN'S EUROPEAN MODERN HANDBALL: DISCRIMINANT ANALYSIS BETWEEN WINNERS AND LOSERS

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ABSTRACT

Research background and hypothesis. Europeans have won Olympic and world gold medals since modern indoor men's handball became an international sport (1938) and an Olympic sport (1972) (www.ihf.com). Nevertheless, no research has been carried out in order to find out the tendencies in European modern men's handball.

Research aim of this study was to illustrate discriminant indicators of sport performance between winners and losers in European men's modern handball match activities.

Research methods. Data sets were gathered from the European Handball Federation (EHF) website (<http://www.eurohandball.com>) covering the five European Men's Handball Championships (EMHC): 2002, 2004, 2006, 2008 and 2010 ($n = 239$ matches). Each match was classified as successful and non-successful for each team, and then the number of analysed matches doubled to 478. We examined 28 variables of sport performance, but only 15 key indicators where significant discriminant between winners and losers at least in one EMHC was shown.

Research results. Winners scored more goals ($p < 0.01$, $p < 0.001$), were better in total attack ($p < 0.001$) and positional attack ($p < 0.01$, $p < 0.001$), performed more efficiently in shooting total ($p < 0.001$) and shooting from long distance ($p < 0.01$, $p < 0.05$), and goalkeepers saved more throws ($p < 0.05$, $p < 0.001$).

Discussion and conclusions. Winning and losing teams played in the same pattern ($p > 0.05$). In many cases the separate match-play was determined by using temporal model of playing style. The phenomenon is that teams scored more goals in the second half than in the first one despite the fact that players' activities decreased in the second half. Sport performance profile in European modern handball can generate a useful database.

Keywords: sports games, performance analysis, elite athletes.

INTRODUCTION

Europeans have won Olympic and world gold medals since modern indoor men's handball became an international sport (1938) and an Olympic sport (1972) (www.ihf.com). Whilst European men were leaders in world handball, they did not compete in continental championships until the European Handball Federation (EHF) was founded (1991). European championships (EC) have been organised every two years since 1994. In the beginning of the EC (1994–2000), 12 teams competed in the final stage. However, the rapid popularity of the game convinced the EHF to enlarge the number of teams to 16 in 2002

(www.eurohandball.com). This fact determined the need to carry out a sport performance analysis of European men's modern handball.

Sport performance requires an athlete to integrate many factors (Smith, 2003). Evaluation is an essential component because it provides the coach with a means of establishing norms from the model. Moreover, the development of a database is a crucial element. If the database is large enough to formulate predictive models as an aid to the analysis of sports, it will, subsequently, enhance future training and performance (Hughes, Bartlett, 2002; Hughes, Franks, 2006).

The main method of objectifying the process in sports games is the use of notational analysis. One of the main purposes of notation is statistical compilation (Franks, 2006). Notational analysis can be used to determine the key indicators of performance (Taylor et al., 2007). Full and objective interpretation of the data from the analysis of a performance and comparison of data are vital (Hughes, Franks, 2006). The existence of structure in sport competition is implicated in the widespread practice of using the information gathered from a past contest to prepare for a future contest (McGarry et al., 2002). If a large number of players are observed, mean values yield important information about activity and fitness profiles and how these might vary with different team configurations. Fitness profiling can generate a useful database (Reilly et al., 2000). Performance indicators should relate to successful performance or outcome. Analysts and coaches use performance indicators to assess the performance of an individual, a team or elements of a team, using in a comparative way, with opponents, other athletes or peer groups of athletes or teams, but often they are used in isolation as a measure of the performance of a team or individual alone. Notational analysts have focused on general match indicators (Hughes, Barlett, 2002; James et al., 2005).

Typically, indicators of team performance are provided from the comparison of winning and losing teams (Jones et al., 2004). There are different aspects of performance profiles, assessing, for example, positive and negative aspects of attacking and defensive play (Ortega et al., 2009). However, comparing winning and losing indicators may result in a potential loss of any meaningful information due to each team possessing different styles of play and diverse performance profiles (Taylor et al., 2005). Some studies (Jones et al., 2004) considered the winning and losing performances of a single team and found a number of significant statistical differences. Nevertheless, studies comparing successful teams have been popular as they can identify the reasons why certain individuals or teams dominate a particular sport (Hughes, Franks, 2006). In order to enable a full and objective interpretation of the data from the analysis of a performance, it is necessary to compare the collected data with the aggregated data of a peer group of teams, or individuals, which compete at an appropriate standard (Hughes, Barlett, 2002).

Any quantitative analysis must be logically structured of the game itself, defining the possible actions and the possible outcomes (Hughes, Franks, 2006 a). The research related to identifying the efficiency indicators in a game, which have the power to discriminate between winning and losing teams, was conducted in sports such as basketball (Mendes, Janeira, 2001), but not in handball. Feedback is a concept that originated in control theory for close-loop systems designed to keep homeostasis or equilibrium around a reference value a priori set. Feedback may change the attitude of players in their thinking about and analysis of personal performance (Franks, 2006).

The increasing demand for ever higher top-level achievements in sport in general (Hughes, Bartlett, 2002), including handball, has meant greater interest and research into the factors which influence performance and sporting achievements (Gómez et al., 2008). Discriminant analysis between elite and non-elite players reveals that height, running speed and agility are important parameters for talent identification in youth handball (Mohamed et al., 2009).

Handball is a complex sport whereby performance can be analysed and presented in a variety of ways. Variables of sport performance in handball are obtained from the trained staff of observers, who follow all matches of the Olympics and World Championships (IHF), and in the European Championships (EHF). Match statistics are given directly after the match in digital version and can be seen on the websites of the IHF (www.ihf-info.com) or the EHF (www.eurohandball.com). Trend analysis after the end of each EC is provided by the EHF handball experts (Mocsai, 2002; Sevim, Taborsky, 2004; Pollany, 2006, 2010; Hergeirsson, 2008). Performance and success in team handball depend on many factors, and efficacy models are different with each team and almost each match. Analysis of women's handball WC'2003 results showed that the performance of the teams in each group might be described by different performance factors (Ohnjec et al., 2008).

Y. Sevim and M. Bilge (2004) analysed sport performance in Athens OG, EC'2004 and WC'2005 men's handball. For the analysis, they selected variables of attacks, goal throws and goalkeeper. The authors concluded that handball was now being played quickly and dynamically, with attractive and fast individual and group combinations. Goalkeepers were also seen as crucial for winning

a game. F. Taborsky (2008) suggested that attacks and shooting efficiency, mistakes were the key indicators for winning at the Beijing OG men and women tournament, but not goalkeepers' efficacy in the men's game.

M. Wiemeyer (2008) analysed the difference between winners and losers in the EC 2002–2006. They suggested that some variables might be specific to one or two championships and thus considered as 'short-term fashion' in the development of handball tactics. They concluded that in the EC'2000 variables of defensive tactics dominated, whereas offensive tactics were more important in the EC'2002 and 2004, and steals in the EC'2006.

It is unclear how European men's modern handball has developed over the last decade in general. A review article by G. Ziv and R. Lidor (2009) indicated that longitudinal studies were lacking in handball research.

The aim of this study was to use a combination of notational analysis and historical records to illustrate discriminate indicators of sport performance between winners and losers in European men's modern handball match activities in the last decade.

We hypothesized that winners played more dynamic handball, used greater ratio of counterattacks, and played more efficiently in this pattern.

RESEARCH METHODS

The data sets gathered from the EHF website (<http://www.eurohandball.com>) cover the five European Men's Handball Championships (EMHC) held in 2002 (Sweden), 2004 (Slovenia), 2006 (Switzerland), 2008 (Norway) and 2010 (Austria). The same number of 16 teams, and the same competition system, except the number of matches played for the ranking, were used in the years 2002–2010 of the EMHC. Both mentioned factors determined selection of the particularly EMHC for the analysis. We used data from all 239 matches (Table 1). Ethics approval was not required as the data sets are publically available at the EHF website (<http://eurohandball.com./activitiesnew/analysis>). No interventions were required for data gathering.

Data collection. The indices of each match of sport performance were analysed using 'Match Team Statistics' from the EHF site (<http://eurohandball.com./activitiesnew/analysis>). According to the EMHC regulations, winners of a match are awarded 2 points, 1 point for a draw, and losers get 0 points. Each match was classified as successful (won match and draw – for both teams) and non-successful for each team. Then, the number of analysed matches doubled to 478.

Sport performance indicators. Sport performance indicators were determined by the given match statistics on the EHF website. Later

Table 1. Number of matches, players and competition system design of the EMHC in 2002–2010

European Men's Championships	2002	2004	2006	2008	2010	Total
Matches analysed, n	50	48	47	47	47	239
Champions	Sweden	Germany	France	Denmark	France	
Competition system, matches played and maximum points earned by one team						
Places 1–4	8 matches – maximum 16 points					
Placement matches	Places 7–12	Places 5–8	Places 5–6	Places 5–6	Places 5–6	
	7 matches – maximum 14 points					
Non-holding of placement matches	Places 9–12	Places 7–12	Places 7–12	Places 7–12	Places 7–12	
Places 13 to 16	6 matches – maximum 12 points					
	3 matches – maximum 6 points					
Winners & Losers						
Matches won + (draw*2)	43+(7*2) = 57	41+(7*2) = 55	44+(3*2) = 50	43+(4*2) = 51	40+(7*2) = 54	267
Matches lost	43	41	44	43	40	211
Cases analysed	100	96	94	94	94	478

circumstance was limitation factor to choose key indicators of sport performance: goals, attacks, shots, goalkeeper's playing efficacy, positive actions (steals, 7 metres throw earned, shots blocked) and negative actions (2 minutes suspension, turnovers). For the purpose of determining the features of playing style (ratio of positional and counterattacks) we used the formula:

$$R_p = (P / A) * 100,$$

where R_p is the ratio of positional attacks, P is the number of positional attacks and A is the number of total attacks. Rest percentage ratio of attacks were considered as the counterattacks ($R_c = 100 - R_p$). The ratio of individual and team counterattacks from overall counterattacks, goals from positions and durations and goalkeeper's playing efficacy were calculated similar to attacks.

Data analysis. A discriminant analysis was employed to identify a subset of game-related statistics that discriminated between winning and losing teams in each of the five EMHC. In the final discriminant model were included the variables with significant inequality of group means (the Wilks' Lambda Statistic) and with highest absolute values of the correlation coefficient between discriminating variables and standardised canonical discriminant functions. The indicators of champions, teams of 1–4, 5–12 and 13–16, were compared across EMHC'2002–2010, using a general linear model analysis of variance (ANOVA), with Tukey Post Hoc test using PASW 18.0 statistical package. The ANOVA was evaluated as significant when there was a < 5% chance of making a type I error ($p < 0.05$).

RESEARCH RESULTS

Game-related statistics that discriminate between winners and losers. The results allowed discrimination between winning and losing team performances through the following game-related statistics. In all events, i. e. EMHC'2002–EMHC'2010, the discriminant models are as a whole significant; Wilks' lambda is significant at the level below 0.001, the canonical correlation, where the squared canonical correlation is the per cent of variation in the dependent discriminated by the independents in discriminant analysis, and is in the range 0.943–0.999. The Box's M test validates the homogeneity of covariance matrices between

groups and the discriminant function obtained correctly classified 100% of the cases.

We analysed 28 variables of sport performance, but only 15 key indicators with significant discriminant between winners and losers at least in one EMHC. This is presented in Table 2. Winners were better ($p < 0.05$, $p < 0.01$, $p < 0.001$) than losers in 6 indicators throughout EMHC'2002–2010. Winners scored more goals ($p < 0.01$, $p < 0.001$), were better in *total attacks* ($p < 0.001$) and *positional attacks* ($p < 0.01$, $p < 0.001$), performed more efficiently in *shooting total* ($p < 0.001$) and shooting from *long distance* ($p < 0.01$, $p < 0.05$), and *goalkeepers saved* more throws ($p < 0.05$, $p < 0.001$).

Attack structure and efficacy. Besides the data presented in Table 2, we analysed the ratio of positional and counter-attacks, the efficacy of the latter and the efficacy of individual counter-attacks and team counter-attacks. No statistically significant differences were found in the mentioned indices except individual counter-attacks at the EMHC'2010 ($p < 0.05$). Winners played more efficiently in the majority especially at the EMHC'2002 ($p < 0.01$), 2004 ($p < 0.05$), 2006, 2008 ($p < 0.001$), but more efficiently in the minority at the EMHC'2010 ($p < 0.05$, $p < 0.01$, $p < 0.001$).

Shots. We analysed shots efficiency and goalkeeper's playing efficiency total as well as from long distance, 6 metres, 7 metres, wing positions and counter-attacks. Winners performed total shots better throughout EMHC'2002–2010 ($p < 0.001$), and from long distance ($p < 0.01$, $p < 0.001$). Wing players of winning teams performed better than the players of losing teams at the EMHC'2004 ($p < 0.01$); from 6 metres at the EMHC'2002, 2004 ($p < 0.05$); and 7 metres penalties at the EMHC'2004, 2006 ($p < 0.001$, $p < 0.01$ respectively).

Goalkeepers of winning teams saved throws better: in total throughout EMHC'2002–2010 more than goalkeepers from losing teams ($p < 0.05$, $p < 0.001$), and shots from long distances ($p < 0.05$, $p < 0.01$), except EMHC'2002.

Positive and negative indices. We analysed three positive (earned 7 metres penalties, steals, blocked shots) and two negative (turnovers, 2 minute penalties) actions. Winning teams were better than losing teams in blocked shots at the EMHC'2002–2008 ($p < 0.05$, $p < 0.01$, $p < 0.001$), except the last, EMHC'2010. Winners did not exceed losers in the other mentioned positive or negative indices throughout the analysed EMHC'2002–2010.

Table 2. Sport performance indicators of winners and losers in EMHC (mean \pm s)

Sport performance indicators	2002		2004		2006		2008		2010	
	Winners	Losers	Winners	Losers	Winners	Losers	Winners	Losers	Winners	Losers
Goals scored	28.7 \pm 2.6	23.7 \pm 1.9***	29.5 \pm 1.9	25.0 \pm 1.4***	32.3 \pm 2.6	26.9 \pm 2.6***	30.2 \pm 2.8	25.4 \pm 4.1***	30.8 \pm 2.7	26.6 \pm 3.7**
Goals missed	24.7 \pm 3.8	28.9 \pm 1.7***	25.7 \pm 1.5	28.0 \pm 2.1**	28.1 \pm 2.4	31.6 \pm 2.5***	25.9 \pm 1.5	29.8 \pm 4.1**		
Attacks efficiency, %	53.2 \pm 3.5	44.0 \pm 3.3***	52.1 \pm 1.9	44.9 \pm 1.9***	54.8 \pm 4.2	46.6 \pm 4.4***	51.9 \pm 2.1	43.0 \pm 5.8***	54.2 \pm 4.1	46.6 \pm 4.2***
Efficiency of positional attacks	50.9 \pm 4.3	43.1 \pm 4.2***	50.5 \pm 2.3	42.9 \pm 2.8***	52.4 \pm 4.9	42.8 \pm 5.6***	48.8 \pm 4.9	42.6 \pm 6.8**	52.3 \pm 4.2	43.8 \pm 3.6***
Efficiency of individual counter-attacks									77.5 \pm 31.5	45.3 \pm 40.5*
Number of players	66.2 \pm 16.1	51.6 \pm 13.3**	57.3 \pm 5.3	51.9 \pm 5.0*	65.2 \pm 11.3	51.6 \pm 8.3***	66.9 \pm 10.9	48.6 \pm 12.8***		
Efficiency of shots, %									47.6 \pm 12.5	35.1 \pm 14.1*
Total	58.8 \pm 4.5	48.3 \pm 5.8***	58.3 \pm 4.5	48.5 \pm 3.2***	60.3 \pm 3.3	51.9 \pm 5.9***	59.4 \pm 2.2	49.2 \pm 6.4***	59.7 \pm 4.1	53.3 \pm 4.1***
Long distance	43.4 \pm 7.8	33.7 \pm 7.2**	43.3 \pm 1.9	28.8 \pm 3.5***	45.9 \pm 7.2	36.5 \pm 7.1***	44.2 \pm 6.1	36.4 \pm 8.5**	44.1 \pm 5.3	37.6 \pm 6.9**
Wings			55.5 \pm 8.7	46.7 \pm 4.2**						
6 m	68.8 \pm 7.9	58.6 \pm 14.4*	69.2 \pm 12.4	78.5 \pm 7.9*						
7 m			75.2 \pm 11.0	59.9 \pm 6.1***	78.5 \pm 14.5	63.3 \pm 15.2**				
Total	37.3 \pm 5.5	29.9 \pm 4.6***	36.1 \pm 2.3	32.6 \pm 5.0*	35.7 \pm 4.3	28.4 \pm 3.9***	36.1 \pm 62.7	29.8 \pm 4.3***	33.6 \pm 4.1	29.4 \pm 4.9*
Long distance	49.7 \pm 7.4	38.3 \pm 9.7**			44.0 \pm 8.7	37.9 \pm 7.9*	48.4 \pm 5.7	39.5 \pm 8.4**	45.4 \pm 5.3	38.9 \pm 8.3*
Blocked shots	4.2 \pm 2.7	3.1 \pm 1.7*	5.1 \pm 1.1	2.5 \pm 1.1***	3.9 \pm 1.4	2.4 \pm 1.1**	3.7 \pm 1.6	2.6 \pm 1.1*		

Note: Data presented as means of means.

* – $p < 0.05$; ** – $p < 0.01$; *** – $p < 0.001$ between winners and losers of the same championship.

Dynamics of handball. Controversy results between indices of *attacks* by one team and goals scored by both teams per match were found (Figure 1). Despite variation of attacks and goals scored during EMHC'2002–2010, teams performed more attacks across all EMHC'2004–2006–2008–2010 compared to EMHC'2002 (53.6 ± 4.6). Attacks increased until the EMHC'2004 (59.1 ± 4.6 attacks), and to the EMHC'2006 (59.0 ± 4.2) ($p < 0.001$, $OP = 1.000$). Then, the number of attacks decreased at the EMHC'2008 (57.0 ± 5.5), but was still more than in 2002 ($p < 0.001$, $OP = 1.000$). In the last, EMHC'2010 (55.2 ± 9.1), attacks decreased, but were still 1.6 attacks more than in the EMHC'2002.

Goals scored by both teams per match increased across all EMHC ($p = 0.000001$, $OP =$

0.999) compared to EMHC'2002. Teams scored more goals until the EMHC'2006 (59.0 ± 6.2) – similar to increasing attacks. Furthermore, the number of goals scored by both teams decreased in the EMHC'2008 (55.8 ± 6.2) and increased again in the EMHC'2010 (56.5 ± 9.6).

Teams scored more goals in the second half than in the first (Figure 2) in all EMHC (EMHC'2002 – 27.2 ± 4.5 and 24.8 ± 4.1 , $p < 0.01$; EMHC'2004 – 30.2 ± 4.4 and 28.1 ± 3.7 , $p < 0.02$; EMHC'2006 – 30.2 ± 4.4 and 28.8 ± 4.0 , $p < 0.05$; EMHC'2008 – 28.1 ± 4.7 and 27.7 ± 4.3 , $p > 0.05$, respectively), but not in the EMHC'2010 (28.3 ± 7.8 and 28.2 ± 5.1 , $p > 0.05$ respectively). Difference between goals scored and goals missed slightly fluctuated from 4.3 to 4.9 goals during the last decade.

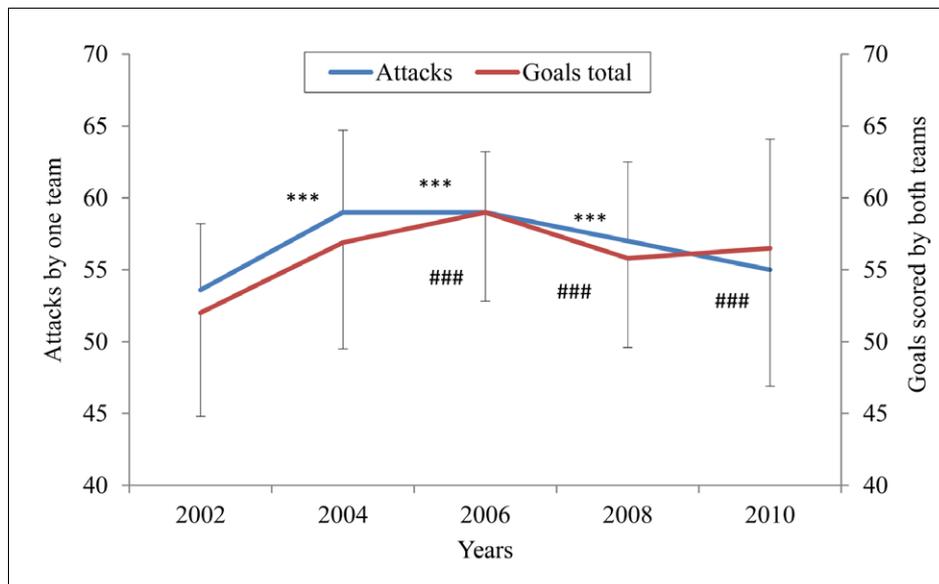


Figure 1. Attacks, goals scored in the years 2002–2010 of the EMHC (mean ± s)

Note. *** – $p < 0.001$ number of attacks compared to the EMHC'2002.
– $p < 0.001$ goals scored by both teams compared to the EMHC'2002.

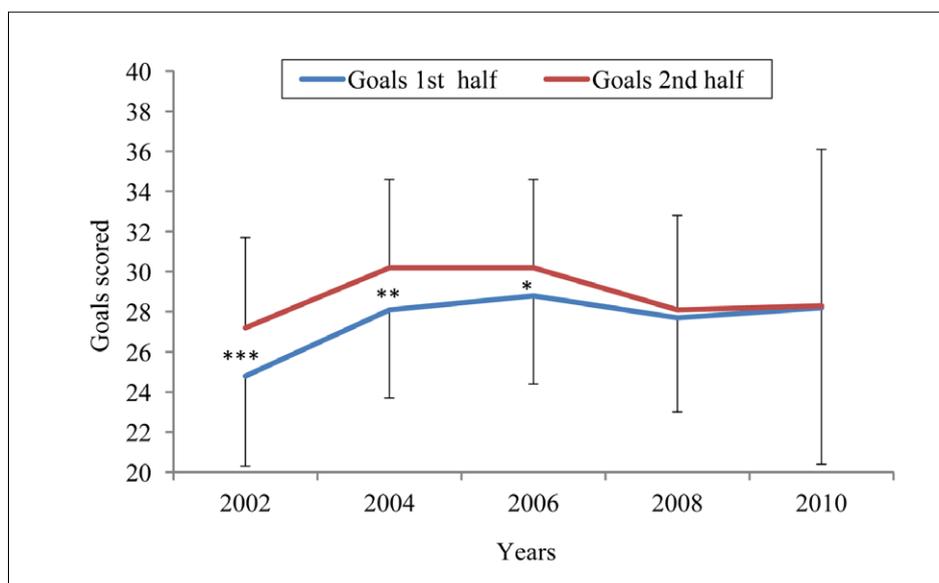


Figure 2. Goals scored in the halves in the years 2002–2010 of the EMHC (mean ± s)

Note: * – $p < 0.05$, ** – $p < 0.01$, *** – $p < 0.001$ between halves.

DISCUSSION

Pattern of European modern handball.

Attacks and goals. Changes in handball match activities are defined by the number of attacks and goals scored per match (Mocsai, 2002; Skarbalius, 2002, 2006, 2010; Sevim, Taborsky, 2004; Polany, 2006, 2010; Hergeirsson, 2008; Taborsky, 2008). Europeans performed the same numbers of attacks in the EMHC'2002–2010 as the teams in the last three Olympic Games handball tournaments. Teams performed 38.8 ± 5.9 attacks at Munich OG and $32.3, s = 9.7$ goals were scored per match only by both teams (Skarbalius, 2002, 2010). During four decades between the years 1972–2008 Olympic handball (OH) became more dynamic (Skarbalius, 2002, 2010): number of attacks increased ($p < 0.001$) by 17.2 attacks (Beijing OG, 56 ± 4.4) and goals scored by both teams increased ($p < 0.001$) by 22.3 goals (Beijing OG, 54.6 ± 6.9), but this was still 2.1 goals less compared to the EMHC'2010. Later findings suggest that the competitive level of European teams was higher in EMHC than that of the teams at the modern OG. However, no significant differences were found in attacks efficacy between OH at Beijing OG ($48.7 \pm 7.4\%$) and the EMHC'2010 ($48.3 \pm 7.3\%$). The fact that 50% of the matches at the EMHC'2010 were as close as 2 or less goal difference in the final score (Pollany, 2010) is evidence of equal ability (Mocsai, 2002; Pori et al., 2008). Our results are in line with general research on this subject and allow for the proposition that individual skills of European handball players are better and team actions in offence and defence are more balanced than OH. That said, there is no information on how playing faster or slower affects game performance. The activity profiles can also vary from game to game (Quarrie, Hopkins, 2007) depending on the strength of the opposition, the fitness of players, the consequences of previous games and a myriad of other factors (Drust et al., 2007).

Types of attacks. Empirical research investigating performance analysis in handball has been limited to studies exploring, for example, the patterns of team play. To date, there has been no performance analysis of elite men's handball, assessing team performance via the evaluation of team playing pattern indicators. Winning and losing teams in the EMHC'2002–2010 played in the same pattern ($p > 0.05$) because the ratio of positional attacks as well as counterattacks varied

slightly. The ratio of positional attacks for winners varied between 84.5–90.9% from total attacks, and between 86.4–90.4% for losing teams. The same ratio of positional attacks was found at the Beijing OG'2008 ($86.6 \pm 6.9\%$), but less as in the beginning of OH (Munich OG'1972 – $91.4 \pm 5.7\%$) (Skarbalius, 2002, 2010). The phenomenon of EMHC'2002–2010 is that winners exceed ($p < 0.01, p < 0.001$) losers throughout all the championships in efficacy of positional attacks, but moderate value of efficacy of positional attacks of European handball and the last three at the OH is the same (44–46%). Whilst these changes (Pyne et al., 2004) appear small in size (less than 1%), they have a substantial effect on the outcome of competition (Trewin et al., 2004).

Team counterattack is a considerable feature of modern handball (Sevim, Taborsky, 2004; Pollany, 2006, 2010; Hergeirsson, 2008). No significant difference of efficacy of team counterattacks were found in the EMHC'2002–2010 between winners and losers: i. e. they varied between 63–75% for winners and 59–66% for losers. Efficiency of individual attacks varied between 56.8–83.9% for winners and 45–82.3% for losers, but there was no significant difference between winners and losers, except EMHC'2010. This suggests that, within the international matches, individual events were more often part of larger temporal patterns and that more consistency in temporal structure exists within international matches (Borrie et al., 2002).

Majority. According to handball rules, players are allowed to play tough game and so they need to have excellent fitness. Players who commit fouls are punished by suspension of 2 minutes. Then opponents have superiority in terms of number. Winners and losers at the EMHC'2002–2010 performed the same 2 minutes faults (8–10 minutes per match), but winners played more efficiently than losers ($p < 0.05, p < 0.01, p < 0.001$) at the EMHC'2002–2008. The phenomenon is that winners performed losers better ($p < 0.05$) at the EMHC'2010 in minority. The latter findings are in line with OH where the teams who achieved higher placing performed more vigorous and aggressive actions, did not take risks and made more rules violations, but most frequently won the match (Skarbalius, 2002, 2010).

Goals after halftime. In the men's tournament the scores became closer in the second half, but the gap widened in women's handball (Pollany, 2010). Whilst the two standards of competition place similar physical and game-specific skill demands

on players during matches, variations do exist within a match between the two playing standards (Sirotic et al., 2009). Contrary findings have been obtained of match activities in rugby (Sirotic et al., 2009) and football (Reilly, 2005). Handball teams at the EMHC'2002–2006 ($p < 0.05$, $p < 0.01$, $p < 0.001$) scored more goals in the second half than in the first. These findings allow consideration of the excellent fitness of European handball players. However, controversy results have been shown at the EMHC'2006, where Scandinavian teams tend to be stronger offensively in the second half, but French teams perform less effectively (Pollany, 2006). Success at the EMHC'2010 was based upon the first half performance (Pollany, 2010).

Individual indices. *Shots* as the main action for scoring goals have a variety of attention in research (Bayios et al., 2001; Gorostiaga et al., 2005; Marques et al., 2007; van der Tillaar, Ettema, 2007; Wagner, Müller, 2008). The phenomenon of modern European men's handball is that the winners at EMHC'2002–2010 exceed ($p < 0.001$) the losers in total shooting performance and long distance ($p < 0.01$, $p < 0.001$) indicators. Winners performed shots better from 6 m at the EMHC'2002, 2004 ($p < 0.05$), and from 7 m penalties at the EMHC'2004, 2006 ($p < 0.01$, $p < 0.001$). Shots efficacy varied between 53–57% ($p > 0.05$) throughout EMHC'2002–2010, whilst OH during four decades increased by 18.3% ($p < 0.001$). The efficacy of shots at the EMHC were similar to the last three (Skarbalius, 2002, 2010) OG (2000 – $50.6 \pm 15.2\%$; 2004 – $54.0 \pm 19.2\%$; 2008 – $55.3 \pm 9.0\%$). Handball expert L. Mocsai (2002) asserted that defensive play was the result of the decline in the shot efficiency of the attacking teams at the EMHC'2002, but it didn't prove on the basis of handball sport performance indicators.

Goalkeepers. Winners differed significantly throughout EMHC'2000–2006: i. e. saves of positional attacks and goals from long distance (Wiemeyer, Heinz, 2008), the average number of shots from 9 m and the wing position in the EMHC'2004, 2006; the number of goalkeeper saves (Pori et al., 2008) remained at the same level (2002 – 31.6%; 2004 – 32.6%; 2006 – 32.0%). T. Hergeirsson (2008) argued that the goalkeepers saved more shots in general and from 6 metres, and there was especially better cooperation between goalkeeper and defence at the EMHC'2008. However, no data was provided for evidence of the latter attitude. M. Taiysir (2008) stated that goalkeepers of Arab

teams (34%), compared to Europeans (44.8%) in the 2007 World Handball Championship, were weaker saving long shots from the backward. He made the assumption that this may be ascribed to the weakness of the defence of Arab teams, which permitted the opposition to shoot freely, compared to the European teams, which had a powerful and effective defensive system (6:0; the German, Polish and Danish teams) and, as a result, gained the top three places. These findings are in line with our research showing that goalkeepers of winning teams exceed losers throughout EMHC'2002–2010 and from long distance in fourth analysed EMHC'2002, 2006, 2008, 2010. We can conclude that both saved indices (total saved shots and long distance) might be used as the key indicators of men's handball sport performance.

Positive and negative actions. Winners did not exceed losers in none of the indices of positive (earned 7 meters penalties, steals, blocked shots) and negative (turnovers, 2 minutes faults) indices throughout EMHC'2002–2010, but they outperformed losers ($p < 0.05$, $p < 0.01$, $p < 0.001$) in blocked shots (moderate 3.1–4.1 blocks) at the fourth EMHC'2002–2008. M. Wiemeyer (2008) suggested that due to the development of the game, in the EMHC'2006 steals became more important and this feature indicated the fast switch from defence to offense, which played a decisive role. Our research did not show that winning teams were superior at stealing the ball and the ratio of counterattacks. On the other hand, M. Wiemeyer (2008) and N. Rogulj (2000) concluded that there were variables specific to one or two championships, which may be considered as 'short-term fashion' in the development of handball tactics. The authors stressed that in the EMHC'2000 variables of defensive tactics dominated the game, whereas offensive tactics were more important in the EMHC'2002 and 2004. Our analysis, based on statistics given on the website of the EHF, does not permit making such a conclusion. A. Borrie with co-authors (2002) suggested that the temporal configuration of play events was due to synchronisation and cooperation between players (including interaction with opponents), their actions and movements, rather than being a simple consequence of the number of data points in a complex performance. L. Nadeau et al. (2008) argued that statistics focused on the end results of various aspects of sport performance. However, it was impossible to determine whether

these statistics reflected the technical aspects of players' performance, tactical aspects, or both. Throughout EMHC'2002–2010 teams on average earned a 7 m penalty 4.3–4.8 times per match, performed steals 3.1–5.1 times and made 11.2–12.5 mistakes. In contrast to our research, F. Taborsky (2008) pointed out that mistakes at the Beijing OG (12.9 mistakes in offence) were the key indicators of sport performance in men's handball.

CONCLUSIONS AND PERSPECTIVES

The aim of this investigation was to determine the key indicators of discrimination between winning and losing teams in European men's handball throughout the last decade. Phenomenon is that no difference was found in playing style (ratio of positional and counterattacks) between winners and losers. Findings indicate that six indicators – goals scored, efficiency of total attacks and positional attacks, efficiency of total shots, from long distance, and shots saved by goalkeepers – are the key indicators of discriminating winners at the EMHC'2002–2010. Five indicators amongst those mentioned (except saved shots by goalkeepers) are characteristic of actions in offence and playing

patterns of team actions. The next three indicators (goals missed, blocked shots, saved long distance shots) among four (the other being efficiency of majority), which discriminate winners from losers at the fourth EMHC in the years 2002–2010, characterise defensive actions and individual fitness of players as having the second level of importance in order to win. Performance indicators such as efficiency of individual attacks, shots from wings and 7 m penalties, and efficiency in minority might be considered as the key indicators of temporal pattern at the EMHC'2002–2010. Detailed quantitative analyses can enhance performance through the improvement of performer feedback. The normative profile of winners identified can help coaches and players to create performance profiles according to team quality (O'Donoghue, 2005; Sampaio et al., 2010). Therefore, handball coaches will benefit from awareness of these results, particularly when designing game strategies and making tactical decisions.

Limitation and future research. The EHF data do not include information about the team actions in the 6–9 metres zone and efficiency in defensive actions, in order to separate team and individual actions. Handball as other sports is a complex game whereby performance can be analysed and presented in a variety of ways.

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EUROPOS VYRŲ RANKINIO ŽAIDIMO POŽYMIAI: LAIMĖTOJŲ IR PRALAIMĖTOJŲ VARŽYBINĖS VEIKLOS SKIRTYBĖS

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Nors Europos vyrų rankinio rinktinės nuolat tampa olimpinių žaidynių ir pasaulio čempionėmis, iki šiol nėra ištirtos europiečių žaidimo tendencijos. Keliama hipotezė, kad šiuolaikinio vyrų rankinio rungtynes laimėjusios Europos šalių rinktinės žaidžia dinamiškiau ir veiksmingiau taiko kontratakas.

Tikslas – nustatyti šiuolaikinio Europos vyrų rankinio čempionatų laimėtojų ir pralaimėtojų varžybinės veiklos skirtumus.

Metodai. Duomenys apie varžybinę veiklą buvo paimti iš Europos rankinio federacijos (EHF) svetainės (<http://www.eurohandball.com>) analizuojant penkis Europos vyrų rankinio čempionatus: 2002, 2004, 2006, 2008 ir 2010 m. (n = 239 rungtynės). Kiekvienos rungtynės buvo traktuojamos kaip sėkmingos ir nesėkmingos atskirai komandai, todėl tiriamų rungtynių skaičius padvigubėjo iki 478. Išnagrinėti 28 varžybinės veiklos rodikliai, tačiau teiktini tik penkiolika, kurių statistinis reikšmingumo lygmuo patikimas.

Rezultatai. Nugalėtojai įmetė daugiau įvarčių ($p < 0,01$; $p < 0,001$), veiksmingiau atakavo ($p < 0,001$) ir taikė pozicinio puolimo veiksmus ($p < 0,01$; $p < 0,001$), veiksmingiau metė į vartus ($p < 0,001$), ypač iš toli ($p < 0,01$; $p < 0,05$), vartininkai atrėmė daugiau metimų ($p < 0,05$; $p < 0,001$).

Aptarimas ir išvados. Laimėtojų ir pralaimėtojų rinktinių žaidimo pobūdis nesiskyrė ($p > 0,05$). Atskirų rungtynių nugalėtojams būdingas tik toms rungtynėms taikytinas žaidimo modelis. Fenomenalu, kad komandos antrą kėlinį pelnė daugiau įvarčių negu pirmą, nors tyrimai rodo žaidėjų veiklos intensyvumo sumažėjimą antro kėlinio metu. Nustatytos Europos šiuolaikinio vyrų rankinio varžybinės veiklos rodiklių reikšmės leis rankinio ekspertams vertinti treniruojamos komandos parengtumą.

Raktažodžiai: sportiniai žaidimai, parengtumo analizė, elito sportininkai.

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ARE THERE ANY DIFFERENCES IN SIMPLE AND RANDOM CHOICE MOTOR TASK PERFORMANCE BETWEEN YOUNG AND MIDDLE-AGED ADULTS?

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ABSTRACT

Research background and hypothesis. Most studies are based on elderly subjects' results, so there is a need to explore if motor performance changes begin in the middle age. We hypothesize that (i) middle-aged subjects use “play it safe” strategy, which depends on the type of tasks (simple vs. random choice); (ii) middle-aged subjects will show higher intra-individual performance variability compared to young adults, furthermore, simple task will show lower performance variability.

Research aim was to establish if there were any movement performance differences during simple and random choice motor task performance between young and middle-aged adults.

Research methods. Middle-aged and young adults performed two speed-accuracy tasks. During simple task participants had to reach the same target which appeared in the same place and during random choice task the target appeared randomly in one of the three different places.

Research results. Data showed that middle-aged group had slower ($p < 0.05$) reaction time and maximal velocity, whereas movement path length was more accurate ($p < 0.05$) than that in the young adult group. Comparing different tasks it was observed that during simple task reaction time was faster ($p < 0.05$) than in the random choice task in both groups. Intra-individual variability of reaction time and maximal velocity was higher ($p < 0.05$) in the middle-aged group, whereas no changes were observed between different tasks.

Discussion and conclusion. Motor performance strategy “play it safe” is already observed for the middle-aged population: they decrease maximal velocity and reaction time in order to make movement more accurate. Additionally, they demonstrate task-independent higher intra-individual variability of reaction time and maximal velocity showing changes in CNS integrity compared to young adults.

Keywords: aging, speed-accuracy tasks, intra-individual variability.

INTRODUCTION

Changes in a number of cognitive and motor tasks are seen as part of the normal aging process in humans. Various neural deficits are related to age including reaction time and attention impairment (Jones et al., 1995; Ward, Frackowiak, 2003; Gorus et al., 2008; Tun, Lachman, 2008), decreased speed of information processing and motor control (Kennedy, Raz, 2005; Gorus et al., 2008; Hueninckx et al., 2008), and increased performance variability (Sosnoff, Newell, 2011; Dykiert et al., 2012). Many of these

studies found linear decrease in functional motor and cognitive performance tasks with increasing age.

Psychomotor performance reflects the time a subject takes to react to stimuli (Botwinick, Thompson, 1996). It can be evaluated as reaction time (Punekar, Kelkar, 2006), which is the duration of the interval between presentation of a stimulus and the participant's response to the stimulus (Der, Deary, 2006). Reaction time emphasizes the special place of speed of processing in aging and

it is a fundamental property of the central nervous system (CNS) (Deary, Der, 2005). Information processing takes longer time and its duration becomes more variable with aging (Deary, Der, 2005; Der, Deary, 2006; Puneekar, Kelkar, 2006). Research studies have indicated a slowing rate of simple and disjunctive reaction (Deary, Der, 2005), and the fact that with increasing age simple as well as choice task performance decreases (Puneekar, Kelkar, 2006; Hueninckx et al., 2008; Lindberg et al., 2009).

Elderly subjects show poorer motor performance skills due to reduced speed, accuracy, and increased movement variability. The decline in motor skills can be due to neuromuscular, biomechanical and cognitive decline (Seidler et al., 2010; Raw et al., 2012). Older adults' movement time is slower compared to that of young adults. Additionally, for young and old adults time increases linearly as difficulty of task increases (Kennedy, Raz, 2005; Hueninckx et al., 2008). Moreover, age-related movement slowing can be complemented by compensatory processes (Raw et al., 2012). J. Trommershäuser and co-authors (2005) suggest that humans can optimize motor strategies. Elderly subjects can slower actions to make getting feedback easier for movement corrections. Increased movement duration allows performing tasks more accurately (Welsh et al., 2007). Referring to age effect on reduced motor planning abilities (de Jong, 2001) and cognitive flexibility (Wecker et al., 2005), our first hypothesis is that middle-aged subject will use "play it safe" strategy to perform movement successfully and that random choice motor task will be affected more than simple task.

Based on a compensation hypothesis, during the functional task, elderly subjects can activate the same brain regions as younger subjects, but to a larger extent. Furthermore, they can activate additional brain areas (Hueninckx et al., 2008). In this way brain overactivation could emerge, which is frequently observed in prefrontal sites (Dolcos et al., 2002; Cabeza et al., 2004; Reuter-Lorenz, Cappell, 2008). In elderly adults, brain overactivation is often found in the opposite brain hemisphere regions compared to young adults (Reuter-Lorenz, Cappell, 2008). Studies showed that brain overactivation of elderly subjects increased opportunity to remember facts or sentences during memory performance tasks (Boyed et al., 2008; Wingfield, Grossman, 2006;

Reuter-Lorenz, Cappell, 2008), and improved motor task performance (Hueninckx et al., 2008). We failed to find any evidence if this compensation model was observed in middle aged subjects. Despite that, it is known that increased variability marks changes of CNS functioning, and age-related higher variability is observed during choice task performance than in the simple task performance (Dykiert et al., 2012). Based on that statement, we pose the second hypothesis that middle-aged subjects will have higher variability compared to young adults, and that random choice task will show higher intra-individual performance variability compared to simple task.

It can be seen that brain may increase function by direct brain activation changes or strategic compensation (Raw et al., 2012). Most studies are based on elderly subjects' results, so there is a need to explore the performance of middle-aged subjects during different tasks, and to identify if age deficits begin in the middle age. It is important to clarify if they use compensatory ("play it safe") strategy or/and brain overactivation in order to keep good motor performance. The aim of this research was to identify if there were differences in simple and random choice movement performance between young and middle-aged adults, and to confirm above mentioned hypothesis, that (i) middle-aged subjects use "play it safe" strategy, which depends on the type of tasks (simple vs. random choice); (ii) middle-aged subjects will show higher intra-individual performance variability compared to young adults, furthermore, simple task will show lower performance variability.

RESEARCH METHODS

Participants. All participants were right-handed. Hand preference was determined with the "Edinburgh Handedness Inventory" (Oldfield, 1971). Seventy six healthy subjects were divided into two groups by age. The first group consisted of 38 middle-aged participants (19 females and 19 males; mean age (SD) 52.4 (4.6) yr, 1.71 (0.8) m height, 80 (11.4) kg mass, BMI 27.2 (2.8)), and the second group consisted of 38 young adults (20 females and 18 males; mean age (SD) 23.6 (2.5) yr, 1.76 (0.9) m height, 73.8 (15.2) kg body mass, BMI 23.4 (3.1)). All subjects were without neurological symptoms and in good physical condition. The study was approved by the local human research ethics committee and conducted in accordance with the Declaration of Helsinki. Besides, all

participants provided informed consent before the experiments.

Standardization of the experimental conditions. The initial subjects' visit involved familiarization with experimental procedures and equipment. Familiarization was performed on the analyser of dynamic parameters of human leg and arm movement (*DPA-1; Patent No. 5251; 2005 08 25*). Subjects were allowed to try two different reaching tasks 3–5 times. The target was a 0.35 cm radius red circle and the start zone was a 0.70 cm radius green circle. The distance from the start zone to the target was 10 cm. During each task the participant was required to position the 0.35 cm radius handle symbol in the start zone (the centre of a 0.70 cm radius green circle) on the computer screen. The program intermittently (every 1–3 s) generated a sound signal and a target in the certain place on the computer screen. The participants were asked and motivated to perform multitask: to react to the target appearing on the computer screen and reach the target as quickly as possible and in the most accurate trajectory. The endpoint of the movement was recorded when the centre of the handle symbol stopped in the circle and stayed there for no less than 0.02 s. After subjects confirmation of the clarity of motor tasks a day later they returned to the laboratory for the experimental procedure.

Before motor task the current level of subjective sleepiness was evaluated using the Stanford Sleepiness Scale (SSS) (Hoddes et al., 1972). The SSS contains seven definitions of different levels of current sleepiness ranging from 1 'feeling active and vital; alert; wide awake' to 7 'almost in reverie; sleep onset soon; lost struggle to remain awake'. The participants had to choose the most appropriate description of their subjective level of sleepiness. Only those participants whose sleepiness level ranged from 1 to 3 were included in the study.

Motor tasks and their measurements. Two speed-accuracy tasks were performed. Motor tasks were performed on the *DPA-1*. The subject's position had been described in previous studies (Zuoza et al., 2009). The distance between the computer screen and the subject's eyes was approximately 70 cm. A handle was given to the participant's right hand, from which the parameters of hand movements at the distal part of the hand were recorded. The sampling rate was 200 Hz. The

handle at the end of the lever was allowed to move only in a horizontal plane. Subjects performed two different goal-directed reaching tasks with dominant hand as fast as possible (Figure). Priority of the tasks was chosen randomly. Subjects had 5 min rest between different tasks. Simple task consisted of 20 goal-directed reaching movements during which participants had to reach the same target which appeared in the same place on the computer screen as fast as possible; and random choice task consisted of 20 reaching movements during which the target appeared randomly in one of the three different places in same distance. The measurement cycle was completed after hitting the target with the circle of the handle symbol. The program registered the reaction time, movement path length, maximal and average velocities.

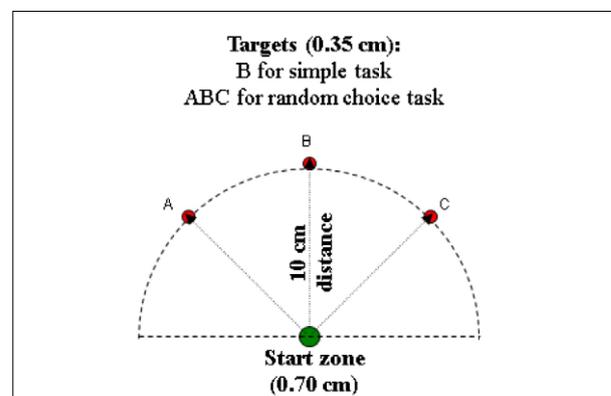


Figure. Illustration of simple and random choice motor tasks

According to P. M. Fitts (1954), a movement task difficulty (ID, the "index of difficulty") can be quantified using information theory metric "bits". Specifically, $ID = \log_2(2A/W)$, where A is the amplitude of movement (10 cm) and W (0.35 cm) is the target width. ID in simple and random choice task was 5.84 bits.

Statistical Analysis. Descriptive data are presented as means \pm standard deviations (SD). The intra-individual variability coefficients of variation (CV) were calculated by applying the following formula: $CV = (\text{Mean}/\text{SD}) \times 100\%$. Normality of data distribution was tested and confirmed by the Kolmogorov–Smirnov test. Statistical analysis consisted of two-way analysis of variance (ANOVA) with the between-subjects factor of age (middle aged, young adults) and the within-subjects factor of condition (simple, random choice). Based on alpha level of 0.05 and sample size ($n = 76$), the statistical power (SP) was calculated.

RESEARCH RESULTS

Age related differences between simple random choice task performances. Table 1 represents average values of simple and random motor task performance for the young and middle-aged groups. In both motor tasks middle-aged group showed slower reaction time ($p < 0.05$; $SP = 1$) and maximal velocity ($p < 0.05$; $SP = 1$), whereas movement path length was shorter ($p < 0.05$; $SP = 0.51$) than in the young adult group.

Comparison of different tasks showed that in both groups reaction time was faster during simple task ($p < 0.01$; $SP = 1$). Maximal velocity and movement path length did not differ. The Age x Task interaction did not reach significance level in all variables.

Age related intra-individual variability differences between simple and random choice task performance. Table 2 represents percentage values of simple and random choice motor task performance intra-individual variability for the young and middle-aged groups. Middle-aged group showed higher variability of reaction time ($p < 0.05$; $SP = 1$) and maximal velocity ($p < 0.05$; $SP = 0.77$) during both tasks compared to young adults group. Variability of movement path length did not differ. Comparison of different tasks showed that there was no significant difference in both age groups. There was not observed any significant interaction effect between Age x Task.

DISCUSSION

The aim of the present study was to investigate the dependence of movement parameters on age (young vs. middle aged) and different task (simple vs. random choice). Firstly, we hypothesised that middle-aged subjects use “play it safe” strategy, which is task dependent. Our study confirmed that middle-aged subjects used this strategy, and that reaction time was faster during simple task. Secondly, we hypothesized that middle-aged subjects would show higher intra-individual performance variability compared to young adults, and that simple task performance would show lower variability compared to random choice task. Our study confirmed that middle-aged subjects showed higher performance intra-individual variability, however, it did not depend on task type.

Compared to young adults, elderly persons can show longer reaction time and decreased velocity, which can be accompanied with shorter path length (Welsh et al., 2007). We confirm that middle-aged subjects used the same strategy for feedback control to correct their programmed actions. They decreased maximal velocity and reaction time in order to make movement more accurate (shorter path length) (Table 1). Additionally, J. Feeney and co-authors (2002) established, that motor performance in the middle-aged subjects was faster and more accurate responding to predictable (simple) than unpredictable (random choice) tasks. It is known

Table 1. Average values of motor task performance between the groups of middle-aged and young adults

Note. MA – middle-aged adults; YA – young adults; * – difference statistically significant at 0.05 level as compared with values between different tasks; § – difference statistically significant at 0.05 level as compared with values between different age groups.

Participants	Simple task			Random choice task		
	Reaction time, s	Maximal velocity, cm/s	Movement path length, cm	Reaction time, s	Maximal velocity, cm/s	Movement path length, mm
YA (n = 38)	0.27*§ ± 0.0	42.45§ ± 15.8	11.18§ ± 0.7	0.32§ ± 0.0	37.33§ ± 14.7	11.31§ ± 1.0
MA (n = 38)	0.32* ± 0.1	27.24 ± 8.7	10.86 ± 0.5	0.36 ± 0.1	26.46 ± 9.1	11.10 ± 0.9

Table 2. Percentage values of motor task performance intra-individual variability between the groups of middle-aged and young adults

Note. MA – middle-aged adults; YA – young adults; § – difference statistically significant at 0.05 level as compared with values between different age groups.

Participants	Simple task			Random choice task		
	Reaction time, %	Maximal velocity, %	Movement path length, %	Reaction time, %	Maximal velocity, %	Movement path length, %
YA (n = 38)	12.78§ ± 4.1	15.00§ ± 4.2	9.03 ± 4.0	12.92§ ± 3.6	16.63§ ± 4.0	9.53 ± 4.3
MA (n = 38)	17.70 ± 5.7	18.80 ± 9.1	8.48 ± 3.7	16.82 ± 6.1	19.63 ± 11.1	9.72 ± 4.8

that the reaction time shows the motor system efficiency to create the motor plan (Gavazzi et al., 2013); therefore our data showed that complicated random choice task required longer reaction time due to more complicated motor planning. We did not observe any differences in movement path length and maximal velocity between tasks. According to our data, we can confirm that middle-aged subjects use “play it safe” strategy, and that reaction time is faster during simple task than in the random choice task.

Movement performance variability serves as a measure for successful goal. It is argued that low variability indicates better performance, whereas high variability indicates poorer performance (Slifkin, Newell, 1998). It is known that aging affects movement performance variability. Additionally, age-related variability is larger in choice compared to simple reaction time tasks (Dykiert et al., 2012). Our data (Table 2) confirmed the data of I. J. Deary and G. Der (2005) which showed that intra-individual variability in reaction time increased steadily from the age of 30 to 60 years. Additionally, D. Dykiert’s and co-authors (2012) meta-analysis and systematic review showed that age effects were larger in choice reaction time tasks than in simple reaction tasks, however, we did not observe any differences between the performance of different tasks in both age groups. Moreover, we observed that during both tasks middle-aged group showed higher variability of maximal velocity. Considering our data, we can confirm our second hypothesis partly because

we did not observe any differences between tasks; meanwhile intra-individual performance variability was higher in the middle-aged subjects. According to M. Wojtowicz and co-authors (2012), who propose that intra-individual variability reflects fairly stable endogenous factors, such as CNS integrity, we can argue about CNS changes due to middle-age. I. J. Sosnoff and K. M. Newell (2011) observed that increased task performance variability of older adults was due to a decreased ability to adapt to the task.

CONCLUSIONS AND PERSPECTIVES

Our findings complement research literature with deeper knowledge about motor performance strategies of young and middle-aged population, suggesting that already in the middle-age, subjects use task-dependent (simple vs. random choice) “play it safe” strategy to perform motor tasks. Additionally, they show task-independent higher intra-individual performance variability compared to young adults during both tasks.

For further studies and deeper knowledge of motor function changes in middle-aged adults it is useful to explore brain activity CNS processes during hand movements. Additionally, it would be useful to analyse physiological motor system changes related with aging, such as decline of muscle strength and mass, loss of spinal motor neurons as well as decreased number of motor units (Lindberg et al., 2009). These changes can influence motor task performance.

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AR JAUNI IR VIDUTINIO AMŽIAUS SUAUGUSIEJI PAPRASTAS BEI SUDĖTINGAS MOTORINES UŽDUOTIS ATLIEKA SKIRTINGAI?

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Dauguma tyrimų yra pagrįsti vyresniojo amžiaus tiriamųjų rezultatais ir trūksta duomenų, ar skiriasi judesių atlikimas vidutinio amžiaus tarpsniu. Manome, kad: (i) vidutinio amžiaus tiriamieji naudoja saugumo strategiją, kuri priklauso nuo užduoties sudėtingumo; bus nustatytas didesnis (ii) vidutinio amžiaus asmenų užduočių atlikimo kaitumas, lyginant su jaunais suaugusiais tiriamaisiais, be to, jų paprastos užduoties atlikimo kaitumas bus mažesnis.

Tikslas – nustatyti, ar jauni ir vidutinio amžiaus suaugusieji paprastas ir sudėtingas motorines užduotis atlieka skirtingai.

Metodai. Vidutinio amžiaus ir jauni suaugusieji atliko dvi greitas ir tikslas užduotis. Paprastos užduoties metu tiriamieji turėjo pasiekti taikinį, kuris atsiradavo toje pačioje vietoje, o atliekant sudėtingą užduotį taikinys atsitiktinai atsiradavo vienoje iš trijų vietų.

Rezultatai. Nustatyta, kad vidutinio amžiaus tiriamųjų reakcijos laikas ir maksimalus greitis buvo mažesnis ($p < 0,05$), o judesio trajektorija tikslesnė ($p < 0,05$) nei jaunų suaugusiųjų. Lyginant skirtingas užduotis nustatyta, kad abiejų amžiaus grupių tiriamųjų paprastos užduoties reakcijos laikas buvo didesnis ($p < 0,05$) nei sudėtingos. Reakcijos laiko ir maksimalio greičio kaitumas buvo didesnis ($p < 0,05$) tarp vidutinio amžiaus asmenų, tuo tarpu skirtingų užduočių atlikimo kaitumas nesiskyrė.

Aptarimas ir išvados. Judesių atlikimo saugumo strategija pastebima jau vidutinio amžiaus tarpsniu: mažinant judesio maksimalų greitį ir reakcijos laiką atliekamas tikslesnis judesys. Be to, tarp vidutinio amžiaus tiriamųjų, nepriklausomai nuo užduoties, pastebėtas didesnis reakcijos laiko ir maksimalio greičio kaitumas, kuris rodo centrinės nervų sistemos pokyčius.

Raktažodžiai: senėjimas, greitos ir tikslios užduotys, kaitumas.

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PECULIARITIES OF STRESSORS EXPERIENCED BY PHYSICAL EDUCATION TEACHERS AT WORK

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ABSTRACT

Research background and hypothesis. The article focuses on assessment of stressors experienced by physical education teachers in their work. As surveyed researchers notice, stress at work can cause a depressive mood, anxiety, tiredness and, eventually, serious illnesses. Under constant and overwhelming stress, a real threat of formation of the burnout syndrome appears. This is a condition of emotional, psychic and physical exhaustion formed under long-lasting unsolved stresses arising in work-related situations. Stress also significantly influences work efficiency, creativity and competitiveness. It is very important to notice that the change of personality features in a teacher experiencing stress or, even worse, the burnout syndrome, leave traces on the other person. Thus, it is necessary to go deeper into this scientific problem: what stressors are characteristic to the work of physical education teachers, what are the correlations with the socio-demographic variables

The aim of the research was to assess work-related stressors of physical education teachers and their relation with socio-demographic variables. Teachers of physical education (n = 118 in comprehensive schools took part in the research.

Research methods applied in the research: the data was collected using questionnaires on work-related stressors and socio-demographic information; the data obtained was processed by applying the parameter statistics, Mann-Whitney (U) criterion was employed as well.

Research results. The research showed that teachers of physical education listed the following as the most important sources of stress at work: abundance of various documents and other “papers”, reforms of the educational system and high responsibility for pupils. Unfavourable work conditions, psychological climate at school, work with groups of pupils of different genders, problems with pupils’ parents almost did not cause stress to teachers of physical education. Younger teachers or those less experienced in pedagogical work felt more stress about high numbers of pupils in a sports hall than their senior or more experienced colleagues did. Senior and more experienced teachers of physical education emphasised that they underwent the following more intensive work-related stressors: high responsibility for others, abundance of various documents and other “papers”, underestimation of physical education teachers’ work. Men were unsatisfied with low salaries, and women indicated that the attitude of teachers in other subjects towards physical education caused dissatisfaction with work. Male teachers’ low salaries and female teachers’ perceived unappreciated attitude towards physical education caused stress to them. Teachers working in cities, towns assessed pupils’ disrespect and high numbers of pupils in forms as a bigger stressor than teachers of physical education in districts. Physical education teachers working in gymnasiums assessed competition inside an educational institution as a stronger stressor rather than educators working in the main or secondary schools.

Discussion and conclusions. In the aspect of work-related stressors of physical education teachers, teachers list abundance of various documents and reforms of the educational system as main sources of stress at work. Negative attitude of other colleagues towards teachers of physical education as well as competition among staff at school, and, on the other hand, negative attitude of pupils towards physical education have been revealed. Analysis of correlations between work-related stressors and socio-demographic variables suggests that younger pedagogues experience higher stress caused by reforms of the educational system and a high amount of pupils in a sport hall during lessons in comparison to their senior colleagues; while senior teachers of physical education emphasise responsibility as a higher work-related stress.

Keywords: physical education, teachers’ stress, burn out.

INTRODUCTION

Presently, the concept of stress is very popular throughout the world and is often used in the life fields related to work and profession. Problems at work are more often related to complaints about health rather than about financial or family problems*.

The issue of stress at work does not leave aside the occupations that are related to education. Many authors (Bulotaitė, Lepeškienė, 2006; Chaplain, 2008; Tonder, Williams, 2009; Brudnik, 2009; Clausen, Petruka, 2009; Ozan, 2009; Bubelienė, 2010) note that the pedagogue's profession belongs to the category of professions attributed with constant tension, increased anxiety, negative emotions, stress which in the Dictionary of Psychology (*Psichologijos žodynas*, 1993) is defined as a human's condition arising from various extreme impacts, i. e. stressors. A stressor is an unfavourable factor causing anxiety, negative emotions, i. e. stress. Dealing with problems of stress in professional activities, definitions dedicated to the labour context appear. Work-related stressors are events of the work-related environment and outside it perceived by employers as making the impact on satisfaction with work, productivity and psychic health (Hammer et al., 2004). The most strongly and painfully perceived stressors for teachers are those occurring in the context of the macro-level (Bubelienė, 2010): continuous reforms of the educational system, decrease in the profession's prestige, too high work load, low salary. The following are the most often listed problems causing stress and other negative feelings to pedagogues: conflicts of teachers' roles, uncertainty about the future, bad relationships with colleagues, schoolchildren as well as disobedient pupils. L. Bulotaitė, V. Lepeškienė (2006) divide teachers' stressors into six categories: changes in the educational system and social plane; conflicts of roles and confusion of roles; bad physical and social conditions for work; problematic pupils; poor professional relationships and collaboration with colleagues; problematic teachers.

Stress at work can cause a depressive mood, anxiety, tiredness and, eventually, serious illnesses. Under constant and overwhelming stress,

a real threat of formation of the burnout syndrome appears (Maslach et al., 2001; Dirgėlienė, Večkienė, 2009). This is a condition of emotional, psychic and physical exhaustion formed under long-lasting unsolved stresses arising in work-related situations (Maslach et al., 2001). Stress also significantly influences work efficiency, creativity and competitiveness (Bubelienė, 2010). It is very important to note that the change of personality features in a teacher experiencing stress or, even worth, the burnout syndrome, leave traces on the other person (Мерзлякова, 2009).

When talking about teacher's profession and stress, it is necessary to mention that significance of teachers of various specialities in the educational process is assessed differently. L. Kardelienė (2008) states that those taught subjects which are not being examined are lower assessed in the educational system because they are peripheral with regard to school's basic instrumental function. Because of that, the status of teachers who are specialists of non-academic subjects decreases. Research data (Silverman, Subramaniam, 1999; Panczyk, 2005) shows that pupils assess teachers of physical education much lower than educators delivering other subjects.

There are many countries in the world where teachers of physical education are assessed lower than teachers of other specialities, and physical education as a subject is neglected by school administration, teachers of other subjects, pupils, their parents (Hardman, 2008; Krawanski, 2009). N. Fejgin et al. (1995) suppose that specificity of physical education teachers' work is unique and completely differs from performance of other participants of the educational process. First of all, it is related with the learning facilities, quantity and quality of sports equipment and inventory, the environment where lessons of physical education are held (sports hall, stadium, playground etc.). Also, the educational process faces issues of pupils' safety and order during lessons because to control actively moving pupils is more difficult than those calmly sitting in a classroom. In Lithuania there has not been much research of this kind carried out so far (Bagdonas, 2004; Bulotaitė, Lepeškienė 2006; Bubelienė, 2007; Dirgėlienė, Večkienė, 2009; Bubelienė, 2010), and no works dealing with the issues of physical education teachers' stress have been found. Thus, it is necessary to go deeper

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into this **scientific problem**: what stressors are characteristic of the work of physical education teachers, what are their correlations with the socio-demographic variables?

Stressors undergone by physical education teachers in their work are the **research object**.

The research aimed to investigate work-related stressors of physical education teachers and to estimate their correlations with socio-demographic variables.

RESEARCH METHODS

The sample. Teachers of physical education ($n = 118$) from various cities, towns and districts (Kaunas, Šiauliai, Šiauliai District, Tauragė, Pakruojis) of Lithuania took part in the research. Recorded socio-demographic variables are presented in Table 1.

Research methods and organisation.

1. *Questionnaire on work-related stresses* was designed grounding on the recent data of research on teachers' work-related stress carried out by a number of authors (Bagdonas, 2004; Bulotaitė, Lepeškienė 2006; Dirgėlienė, Večkienė, 2009; Bubelienė, 2010). Physical education teachers were presented with 29 aspects of their work and they were asked to assess each of them on a scale from 1 (completely stress-free) to 4 (constantly causes stress). The *internal consistency Cronbach's alpha* was 0.908.
2. *Questionnaire on socio-demographic data.* The following socio-demographic variables were recorded: teacher's gender; age; work

experience at school; work load; pedagogical qualification; geographical location of a school; school type.

To process the research data, methods of statistical analysis were employed. Quantitative research data analysis was carried out by a software package SPSS 16.0 (Statistical Package for Social Sciences). To assess statistical reliability of differences between groups of the research sample, Mann-Whitney (U) criterion was used.

RESEARCH RESULTS

Work-related stressors of physical education teachers. Having assessed the aspects of physical education teachers' work that cause stress, all factors were rated according to the means of answers. The research results are presented in Table 2.

The research results displayed in Table 2 suggest that the following were the major sources of stress, as teachers listed them: "Abundance of various documents and other "papers" and "Reforms of the educational system". The latter aspects of work are not closely related to direct work of a physical education teacher or pedagogical activities. The aspect of teacher's work, "High responsibility for others", is directly related to the specificity of physical education teacher's work. The data of our research also showed that physical education teachers exactly indicated "Negative attitude of colleagues (other teachers) towards physical education" as the factor causing stress at work. Moreover, teachers of physical education underwent negative impact of "Competition at school" as well.

Table 1. Socio-demographic data of the research participants

Age	Under 35 years	Over 35 years	M/SD
	27.1%	72.9%	44.7 ± 8.6
Gender	Male		Female
	58%		42%
Work experience	Under 10 years	Over 10 years	M/SD
	26.3%	73.7%	20.7 ± 9.9
Work load	From 8 to 28 hrs per week		M/SD
			20.5 ± 5.4
Geographical location of a school	City, town school		District school
	65.3%		34.7%
Pedagogical qualification	Teacher	Senior teacher	Teacher methodologist
	7.6%	42.4%	50%
Type of a school	Main school	Secondary school	Gymnasium
	29%	22.9%	38.1%

Note: M/SD is for mean/standard deviation.

Table 2. Physical education teachers' work aspects causing stress

No.	Physical education teachers' work aspects causing stress	Mean assessment
1.	Abundance of various documents and other "papers"	2.93
2.	Reforms of the educational system	2.86
3.	High responsibility for others	2.80
4.	Low, insufficient salary	2.78
5.	Societal attitude towards physical education teacher's work	2.72
6.	Negative attitude of colleagues (teachers of other subjects) towards physical education	2.66
7.	Lack of pupils' motivation for physical education	2.66
8.	Underestimation of physical education teacher's work	2.66
9.	Competition at school	2.57
10.	Disregard of the physical education subject by pupils' parents	2.54
11.	Disrespect from pupils	2.40
12.	High numbers of pupils in classes	2.24
13.	Disregard of the physical education subject by pupils	2.19
14.	Deadlines for performance of tasks, hurry	2.14
15.	High amount of pupils in a sport hall during lessons	2.11
16.	High requirements for a physical education teacher	2.05
17.	Many roles attributed to a physical education teacher (to teach, to educate, to take care)	1.98
18.	Limitations for career development	1.95
19.	Lack of information at school	1.92
20.	Negative attitudes of school administration towards physical education	1.87
21.	Noise at school, in a sport hall	1.85
22.	Negative attitude of pupils towards physical education	1.82
23.	Requirements for development of qualification	1.81
24.	Complex requirements for curricula	1.76
25.	Constant checking, commissions	1.72
26.	Unfavourable work conditions at school	1.66
27.	Work with groups of pupils of different genders	1.57
28.	Psychological climate at school	1.53
29.	Problems with pupils' parents	1.49

Specialists of physical education singled out the following important and intensive work-related stressors: low salary, unfavourable attitude of the society towards physical education teacher's work, lack of pupils' motivation for sports, underestimation of physical education teacher's work by pupils' parents. It is interesting to note that such work aspects as "Unfavourable conditions for work at school", "Negative attitude of pupils towards physical education" were quite lowly assessed by the respondents.

Correlations between work-related stressors and socio-demographic variables. Having analysed research results, it was found out that opinions of the respondents in the aspect of age differed regarding the following work-related

stressors: "Reforms of the educational system", "High responsibility for others", "High numbers of pupils in a sport hall during lessons". Table 3 shows that younger pedagogues, those under the age of 35, experienced higher stress because of reforms of the educational system ($p < 0.0001$) and high numbers of pupils in a sport hall during lessons ($p < 0.05$) than their senior colleagues (at the age over 35). Senior teachers of physical education emphasised that the responsibility for others was a higher work-related stress ($p < 0.05$) to them.

Assessment of physical education teachers' work-related stressors in the aspect of gender (Table 4) revealed that male teachers experienced higher stress because of low salary than women ($p < 0.01$). E. Zak and T. Horowitz (1985) (cited

from Fejgin et al., 1995) stated that the society held the dominating opinion that man's income in the family took "the first" place in a family budget, and woman's income was identified with additional expenses. Meanwhile, female teachers considered a negative attitude of colleagues (other teachers) towards physical education as a greater stressor compared with their male counterparts ($p < 0.01$).

Table 5 suggests that pedagogues working for more than 10 years consider the abundance of various documents and other "papers" a higher stressor than those teachers working up to 10 years ($p < 0.05$). Especially significant difference ($p < 0.001$) was observed in respondents' answers on underestimation of physical education teachers' work. Teachers working for a longer time indicated this aspect as the one causing more stress than their colleagues working for a shorter period than 10 years. The investigation of intensity of work-

related stressors in the aspect of work experience points out that physical education teachers working up to 10 years feel more stress ($p < 0.01$) because of higher numbers of pupils in a sport hall during lessons. Less experienced young teachers are unable to effectively work with big groups of pupils during the lessons.

Research results revealed that physical education teachers working in the city schools and district schools assessed disrespect from pupils and high numbers of pupils in different ways. Pedagogues working in cities, towns, assessed disrespect from pupils ($p < 0.01$) and high numbers of pupils in classes ($p < 0.05$) as a more intensive stressor than physical education specialists working in districts.

It was also found out that the respondents working in gymnasiums assessed competition at school as a stronger stressor than those working in the main or secondary schools ($p < 0.001$).

Table 3. Distribution of the respondents according to the experienced stress in the aspect of age

The research sample	Mann-Whitney U	p	Mean range
<i>Reforms of the educational system</i>			
Teachers under 35 years of age, n = 32	726.000	0.0001	79.81
Teachers over 35 years of age, n = 86			51.94
<i>High responsibility for others</i>			
Teachers under 35 years of age, n = 32	1042.500	0.05	49.08
Teachers over 35 years of age, n = 86			63.38
<i>High numbers of pupils in a sport hall during lessons</i>			
Teachers under 35 years of age, n = 32	1016.000	0.05	70.75
Teachers over 35 years of age, n = 86			55.31

Table 4. Distribution of the respondents according to the experienced stress in the aspect of gender

The research sample	Mann-Whitney U	p	Mean range
<i>Low, insufficient salary</i>			
Male, n = 68	1180.000	0.01	67.14
Female, n = 50			49.11
<i>Negative attitude of colleagues (other teachers) towards physical education</i>			
Male, n = 68	1202.000	0.01	52.18
Female, n = 50			69.46

The research sample	Mann-Whitney U	p	Mean range
<i>Abundance of documents and other "papers"</i>			
Teachers working for under 10 years, n = 31	1002.500	0.05	48.34
Teachers working for over 10 years, n = 87			63.48
<i>Underestimation of physical education teacher's work</i>			
Teachers working for under 10 years, n = 31	864.000	0.001	43.87
Teachers working for over 10 years, n = 87			65.07
<i>High numbers of pupils in a sport hall during lessons</i>			
Teachers working for under 10 years, n = 31	970.500	0.01	71.69
Teachers working for over 10 years, n = 87			55.16

Table 5. Distribution of the respondents according to the undergone stress in the aspect of work experience

DISCUSSION

Dealing with the aspect of **work-related stressors of physical education teachers** we found out that teachers listed abundance of various documents and reforms of the educational system as main sources of stress at work. Similar data has been obtained in other research works by L. Bulotaitė, V. Lepeškienė (2006), C. L. Tonder, C. Williams (2009) involving teachers delivering not only physical education, but also other subjects. However, underlining the specificity of physical education teacher's work, scientists K. Hardman (2008), A. Krawansky (2009), M. Brudnik (2009) point out that physical education teachers must take care of safety of pupils' physical health during lessons. Moreover, our research results revealing negative attitude of other colleagues towards teachers of physical education as well as competition among staff at school echo the survey results obtained by D. Bubelienė (2010) concerning these factors.

In parallel to our findings emphasising unfavourable conditions of work for teachers at school and negative attitude of pupils towards physical education, results of research carried out by foreign scientists, such as J. Mintz (2007), K. Hardman (2008), K. W. Clausen, D. R. Petruka (2009), M. Brudnik (2009), show that exactly these factors cause the biggest dissatisfaction for physical education specialists in their work.

Analysing **correlations between work-related stressors and socio-demographic**

variables we found out that younger pedagogues experienced higher stress caused by reforms of the educational system and high numbers of pupils in a sport hall during lessons in comparison to their senior colleagues; while senior teachers of physical education emphasised responsibility as a higher work-related stress. Similarly, the data of other research works, conducted by C. L. Tonder, C. Williams (2009), J. Mukundan, K. Khandehroo (2010), show that younger specialists of physical education undergo more stress at work than their senior colleagues.

CONCLUSIONS AND PERSPECTIVES

1. These sources of stress as indicated by physical education teachers are the following: abundance of various documents and other "papers", reforms of the educational system and high responsibility for others. Such stressors as unfavourable conditions for work at school, work with groups of pupils of different genders, psychological climate at school, problems with pupils' parents do not cause much stress to specialists of physical education.

2. Younger (at the age under 35) and less experienced teachers (working for less than 10 years) experience more stress because of high numbers of pupils during lessons than their older and more experienced colleagues. Senior teachers

of physical education (at the age over 35) and those working for a longer time (more than 10 years) emphasise the following more intensive work-related stressors: *high responsibility for others, abundance of various documents and other "papers", underestimation of physical education teacher's work.*

3. Low salary causes more stress to male teachers than the female ones. Female teachers feel

tension at work because of other teachers' negative attitude towards physical education.

4. Teachers working in a city or town assess pupils' disrespect and high numbers of pupils in forms as a bigger stressor than teachers working in districts.

5. Physical education teachers working in gymnasiums assess personnel competition at school as a higher stressor than teachers working in the main or secondary schools.

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KŪNO KULTŪROS MOKYTOJŲ DARBE PATIRIAMŲ STRESORIŲ YPATUMAI

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Tyrimu siekta identifikuoti pagrindinius stresorius kūno kultūros mokytojų pedagoginėje veikloje ir išsiaiškinti, kurie iš jų pedagogų suvokiami kaip svarbiausi kasdieniame darbe su mokiniais.

Tikslas – nustatyti kūno kultūros mokytojų darbinis stresorius ir jų sąsajas su sociodemografiniais kintamaisiais.

Metodai. Buvo tiriama 118 kūno kultūros mokytojų, dirbančių bendrojo lavinimo mokyklose. Duomenys rinkti naudojant darbinių stresorių ir sociodemografinį klausimynus. Jie apdoroti taikant parametrinę statistiką ir naudojant *Mann-Whitney (U)* kriterijų.

Rezultatai. Kūno kultūros mokytojai svarbiausiais streso šaltiniais savo darbe įvardija įvairių dokumentų ir kitokių raštų gausą, švietimo sistemos reformas bei didelę atsakomybę už moksleivius. Netinkamos darbo sąlygos, psichologinis klimatas mokykloje, darbas su skirtingos lyties moksleivių grupėmis, problemos su jų tėvais kūno kultūros mokytojams beveik nekelia streso.

Aptarimas ir išvados. Jaunesniems ir mažesni pedagoginio darbo stažą turintiems mokytojams didelės moksleivių skaičius sporto salėje kelia didesnę stresą nei vyresniems ir ilgiau dirbantiems kolegoms. Vyresni ir ilgiau dirbantys kūno kultūros mokytojai pažymėjo, kad jiems stipresnis darbinis stresorius yra didžiulė atsakomybė už kitus, įvairių dokumentų ir kitokių raštų gausa, kūno kultūros mokytojo darbo nevertinimas. Vyrai yra nepatenkinti mažais atlyginimais, o moterys nurodo, kad kitų dalykų mokytojų požiūris į kūno kultūrą kelia nepasitenkinimą darbu. Mokytojams vyrams mažas atlyginimas, o mokytojoms moterims kitų pedagogų požiūris į kūno kultūrą sukelia stresą. Mieste dirbantys kūno kultūros mokytojai moksleivių nepagarbą ir didelį jų skaičių klasėse vertino kaip didesnę stresorių nei dirbantys rajonuose. Gimnazijų kūno kultūros mokytojai konkurenciją mokymo įstaigoje vertina kaip stipresnę stresorių nei pedagogai, dirbantys pagrindinėse ar vidurinėse mokyklose.

Raktažodžiai: kūno kultūra, mokytojų stresas, nuovargis.

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ATHLETES' JUSTIFICATION OF CHEATING IN SPORT: RELATIONSHIP WITH MORAL DISENGAGEMENT IN SPORT AND PERSONAL FACTORS

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ABSTRACT

Research background and hypothesis. The research focus is on university athletes' justification of cheating in sport. We hypothesised that moral disengagement would be more linked to more favourable evaluations of cheating in sports activities among athletes. Secondly it was hypothesised that justification of cheating in sport would be linked to gender and, accordingly, it would not be associated with experience in sport.

Research aim was to reveal the dependence of the athletes' assessment of cheating in their sports activities and moral disengagement in sport considering their personal factors

Research methods. The sample included 338 (246 male and 92 female) athletes recruited from Lithuanian universities. The participants completed the *Justification of Deception in Sport Scale* (Sukys, Nickus, 2010) and the Moral Disengagement in Sport Scale-Short (MDSS-S; Boardley, Kavussanu, 2008).

Research results. The regression analyses showed that gender of athletes was a significant predictor for justification of cheating in sport ($\beta = 0.15$, $p < 0.01$) as male student athletes more justified cheating in sport. Years of involvement in sport were not related with overall justification of cheating in sport. Moral disengagement in sport was a predictor for the overall justification of cheating in sport ($\beta = 0.35$, $p < 0.001$).

Discussion and conclusions. Our study revealed the relationship between moral disengagement in sport and athletes' justification of cheating in sport. Analysing different forms of cheating it was found that moral disengagement in sport was a stronger predictor for the justification of such deceptive actions that are linked to athletes' manipulation of the rules of the sports and manipulation with the results of the sports contest. It was established that male student athletes more justified cheating in sport. Research results did not reveal relationship between overall justifications of cheating by years of involvement in sport. However, the analysis of the justification of different forms of cheating showed that students with less sports experience more justified deceptive actions linked to the manipulation with the results of the sports contest, and, on the contrary, less justified other forms of cheating in sport.

Keywords: sport, justification of cheating in sport, moral disengagement in sport.

INTRODUCTION

Traditionally sport is thought to contribute to social progress, harmony and peace, promote mutual respect and understanding, bring people together and mobilize them for common activities. On the other hand, the attitudes towards sport and its values have been changing in modernizing society (Budreikaitė, Adaškevičienė, 2010). In this way traditional values in sport give way to consumer values (Genys, 2011). It is

therefore not surprising that seeking victory at any cost does not avoid cheating. S. Zaksaitė (2012 a) named cheating in sport as one of black sides of sport which reveals its negative image. Though cheating is unevenly widespread in different sports, certain forms of it are typical of most branches of sport. According to P. G. Mewett (2002) "*cheating, it seems, occurs in all sports. This is not to claim that all sports players cheat, but rather that each sport contains some who cheat*" (p. 292).

Most often cheating is attributed to unfair behaviour when athletes aim to win or gain an advantage over competitors, or during an examination or performing a task (Hsu, 1997). Cheating is an attempt to gain an advantage by violating the shared interpretation of the basic rules (the ethos) of the parties engaged without being caught and held responsible for it. The goal of the cheater is that the advantage gained is not eliminated as compensated for (Loland, 2002, p. 96). It should be noted that cheating is not only violating the rules. As L. Hsu states (1997), breaking rules is not sufficient for cheating, and breaking rules is not necessary for cheating. Research literature also deals with the concept of deception. Deception involves “*making someone believe something that is not true in order to get what you want*” (Hsu, 1997, p. 167). In this sense deception is one of the necessary elements of cheating in sport. Thus, in our work we will use the term *cheating*, and not *deception*.

In research literature the phenomenon of cheating in sport is more analysed in the theoretical aspect (Hsu, 1997; Fraleigh, 2003; Loland, 2005). Legal aspects of cheating in sport have also been researched (Zaksaitė, 2012 b). However, there is a lack of empirical studies and herewith research instruments to investigate cheating in sports activities. Athletes' perception of cheating in their sports activities (Moran et al., 2004), as well as coaches' attitudes towards cheating in sport (Sukys, Nickus, 2010) have been investigated. Some specific forms of cheating have also received researchers' attention, for example, the effect of deception and non-deception penalty kick strategies on goalkeeping performance (Dicker et al., 2011). Though deception in sport manifests in different forms and not necessarily only athletes cheat, in our research we primarily raised the question how this phenomenon was assessed by athletes themselves. On the other hand, researchers try to explain why people get engaged in negative behaviours. Thus, it is relevant to establish not only how athletes evaluate cheating in their sports activities, but also factors determining those evaluations. In recent years studies in negative behaviours of athletes including cheating also deal with moral disengagement in sport context. The theory of A. Bandura (1991) suggests that people are able to violate personal standards without self-sanction through the selective use of eight psychosocial manoeuvres known as *mechanisms*

of moral disengagement. These mechanisms allow individuals to transgress without experiencing negative affect, thereby decreasing constraint on future negative behaviour. Research data suggest that moral disengagement has strong positive relationship with antisocial behaviour towards both teammates and opponents (Boardley, Kavussanu, 2007; 2009). Also it was established that moral disengagement mediated relationship between controlled motivation and antisocial behaviour towards teammates and opponents (Hodge, Lonsdale, 2011). So, we hypothesise that moral disengagement will be more linked with more favourable evaluations of cheating in sports activities among athletes. Research data dealing with athletes' values (Sukys, Jansonienė, 2012), moral disengagement in sport (Boardley, Kavussanu, 2007) indicate differences in the aspect of gender. Respectively, previous research suggests that sports experiences are not associated with antisocial behaviour (Boardley, Kavussanu, 2010) and that sports experiences are not related with moral disengagement in sport (Sukys, Jansonienė, 2012). So, the study evaluated athletes' personal factors and the second hypothesis was that justification of cheating in sport would be linked to gender (male athletes would more justify it) and, accordingly, it would not be associated with experience in sport. In order to verify the hypotheses, our **research aim** was to reveal the dependence of the athletes' assessment of cheating in their sports activities and moral disengagement in sport considering their personal factors.

RESEARCH METHODS

Research participants. The sample included 338 (246 male and 92 female) athletes recruited from Lithuanian universities. The condition of athletes' participation in our research was previous participation in a championship of the country, i. e. we tended to recruit athletes of higher sports mastery levels. For that reason we applied purposive sampling. Among the athletes who participated in this study, 47.6% (n = 161) noted that they were prize-holders in the national championship, 20.4% (n = 69) of them participated in the European Championship and 5.6% (n = 19) – in the World Championship. While analysing the data athletes were divided into two groups by their sports mastery: National level – who participated only in the national championship (n = 259) and International level – who participated

in European or World Championship ($n = 79$). Among the research participants, 63.2% of them played various ball games (basketball, volleyball, handball and football), 10.90% were in track and field events, and 25.9% were in other sports, mainly in individual sports. The average years of involvement in their current sport was 9.33 ($SD = 3.38$). While analyzing the data athletes were divided into three groups based on percentiles of their sport experience: ≥ 7 -year experience ($n = 96$), 8–11 years of sports experience ($n = 140$), and ≤ 12 years of sports experience ($n = 102$).

Measures. The survey-style assessment questionnaire was used in this study and it contained three sections. The first requested the participants' gender, most recent sport, level of sports mastery and years of involvement in that sport. The other sections assessed athletes' justification of cheating in sport and moral disengagement in sport.

The Justification of Deception in Sport Scale (JDSS). While analysing athletes' justification of cheating in sport we used previously applied scale for coaches' (Šukys, Nickus, 2010). The scale consisted of 19 statements describing various cases of cheating. Athletes had to indicate the degree of how such behaviour could be justified from 1 (the behaviour is totally indefensible) to 5 (such behaviour can always be justified). In the study mentioned above, five factors describing different forms of cheating in sport have been identified based on the survey of coaches. Since this study analysed students engaged in sports activities, it was decided to re-check the structure of the scale.

The Moral Disengagement in Sport Scale-Short (MDSS-S; Boardley, Kavussanu, 2008). This eight item scale measured overall construct of moral disengagement in sport. Items were rated on a 7-point scale anchored by strongly disagree (1) and strongly agree (7). Examples of items were "*It is okay for players to lie to officials if it helps their team*", "*Shouting at an opponent is okay as long as it does not end in violent conduct*". Although this scale was a unidimensional measure of sport moral disengagement, it still had items measuring eight of the mechanisms of moral disengagement. However, in this study overall sport moral disengagement was of interest. Alpha coefficient for overall scale was 0.69.

Statistical analysis. First, factor analysis was conducted for Deception in Sport Scale. Then descriptive statistics analyses and internal consistency were examined by conducting

Cronbach's alpha analyses. T-tests and one-way ANOVA were computed to compare group differences. Pearson's correlation analyses were conducted to examine the interrelations between justification of cheating in sport and moral disengagement in sport scales. Multiple regression analyses were performed to test relationships between athletes' justification of cheating in sport, moral disengagement in sport, and personal factors. All statistics was conducted by SPSS 19.0 software.

RESEARCH RESULTS

Analysing the findings of student athletes' justification of cheating in sports activities, first principal components analysis with varimax rotation and Kaiser Normalization were conducted. The factor analysis ($KMO = 0.83$, Bartlett's test of Sphericity was = 1646.00, $p = 0.001$) produced five factors accounting for 56.34% of variance. Items with loadings lower than 0.40 and items with similar loadings on more than one factor must be eliminated to obtain a clear solution and improve the independence of factors (Kahn, 2006). Since there were no such statements, we took into account how many statements the factor included. As two factors consisted of only two statements, the final solution included 15 items. Repeated factor analysis ($KMO = 0.83$, Bartlett's test of Sphericity was = 1338.78, $p = 0.001$) produced three factors explaining 51.99% of variance (Table 1). The first factor indicated behaviours associated with the manipulation with the results of the sports contest (e. g. "*The head of the team settled with the judges about the decisions favourable for the team (or athlete)*"). The second factor was linked with the athlete manipulation of the rules of the sports contest (e. g. "*Athletes hold the opponent by his/ her clothes trying to limit his/ her actions*"). The third factor included behaviours when the athlete provoked the opponent to take certain actions (e. g. "*During the competition athletes try to overbalance the leader of the opposing team psychologically aiming at making him/ her violate the rules*"). Those three factors were entitled as the three forms of deception in sports.

Descriptive statistics and correlations were computed using the entire sample and presented in Table 2. Students engaged in sports mainly justified the third form of cheating. For example, 12.5% of the respondents indicated that such actions when in the contest athletes try to mentally put the

Statements of the scale	Factors		
	Factor 1	Factor 2	Factor 3
Statement 9	0.71		
Statement 10	0.70		
Statement 4	0.66		
Statement 3	0.63		
Statement 7	0.60		
Statement 11	0.59		
Statement 6	0.53		
Statement 16		0.76	
Statement 15		0.71	
Statement 18		0.71	
Statement 19		0.68	
Statement 17		0.67	
Statement 13			0.72
Statement 8			0.71
Statement 14			0.61
Cumulative %	20.79	40.40	51.99

Table 1. Items and factor loading for JDSS (n = 338)

Note. ** – $p < 0.01$. Factor 1 – Manipulation with the results of the sports contest (MRSC). Factor 2 – Athletes' manipulation with the rules of the sports contest (AMRSC). Factor 3 – Provocation against competitors (PAC).

Variables	1	2	3	4	5
1. MRSC	(0.76)				
2. AMRSC	0.27**	(0.78)			
3. PAC	0.12*	0.43**	(0.63)		
4. JDSS	0.71**	0.80**	0.63**	(0.79)	
5. Moral disengagement	0.24**	0.33**	0.17**	0.36**	(0.69)
Mean	1.60	2.49	2.99	2.17	3.46
Standard deviation	0.62	0.84	0.93	0.55	1.09

Table 2. Correlations, reliability estimates, and descriptive statistics for the JDSS and MDSS-S (n = 338)

Note. MRSC – Manipulation with the results of the sports contest, AMRSC – athletes' manipulation with the rules of the sports contest, PAC – Provocation against competitors, JDSS – Justification of deception in sport scale (overall). * – $p < 0.05$, ** – $p < 0.01$. Alpha coefficients are reported on the diagonal.

rival leader out of balance in order to force him/her to violate the rules could always be justified, 20.1% of subjects maintained that such actions could be justified most often. Mean value for moral disengagement in sport shows that athletes more often tend to choose neutral position when evaluating eight statements related with behaviour in sport. Significant correlations were found between all three types of cheating. As it was hypothesized, justification of cheating in sport was related with moral disengagement in sport. Also significant negative correlation was established between years of involvement in sport and the first form ($r = -0.12$, $p < 0.05$), and positive correlation was found with the second ($r = 0.17$, $p < 0.01$) and the third forms of cheating ($r = 0.12$, $p < 0.05$). Significant correlation between athletes' mastery and three forms of cheating was not established.

Next we explored differences by athletes' gender, mastery and years of involvement in sport. The mean scores of males' justification of cheating in sport were significantly higher than those of females on the second factor ($M = 2.60$, $SD = 0.85$ and $M = 2.20$, $SD = 0.76$; $t(336) = -3.94$, $p < 0.01$) and the third factor ($M = 3.06$, $SD = 0.92$ and $M = 2.82$, $SD = 0.94$; $t(336) = -2.09$, $p < 0.05$). Also it was established that the mean scores of males' overall justification of the cheating in sport were significantly higher than those of females ($M = 2.22$, $SD = 0.56$ and $M = 2.04$, $SD = 0.48$; $t(336) = -2.77$, $p < 0.01$). Research results did not reveal statistically significant differences comparing overall moral disengagement in sport by gender. There were no statistically significant differences comparing results by athletes' mastery levels.

ANOVA indicated the differences of years of involvement in sport in dependence on justification of the first form of cheating ($F(2, 336) = 5.00, p < 0.01$). The Turkey test found that the means for ≥ 7 -year involvement in sport, and eight to 11 years of involvement in sport were statistically significantly different from each other ($M = 1.76, SD = 0.72$ and $M = 1.51, SD = 0.50; p < 0.01$), and that there were no other statistically significant differences comparing the mean values between other groups of athletes. ANOVA indicated the differences in the years of involvement in sport on justification of the second form of cheating in sport respectively ($F(2, 336) = 5.51, p < 0.01$). The Turkey test found that the means for ≥ 7 -year involvement in sport and 12 to 20 years of involvement in sport were statistically significantly different from each other ($M = 2.26, SD = 0.82$ and $M = 2.65, SD = 0.84; p < 0.01$), and that there were no other statistically significant differences comparing the mean values between other groups of athletes. Research results did not reveal statistically significant differences comparing overall justification in sport by years of involvement in sport.

The regression analyses were performed to examine the effects of personal factors (gender and years of involvement in sport), moral disengagement

in sport on justification of cheating in sport. In each analysis, personal factors of gender, years of involvement in sport, and moral disengagement in sport were included as independent variables while justification of the three forms of cheating and overall cheating – as dependent variables. As we can see in Table 3, gender of athletes was a significant predictor for justification of the second ($\beta = 0.15, p < 0.01$) and the third ($\beta = 0.13, p < 0.05$) forms of cheating. Table 3 shows that years of involvement in sport were negatively related with the justification of the first form of cheating ($\beta = -0.16, p < 0.01$), student athletes with the least sports experience justified this form of cheating most. However, sports experience was positively related with the justification of the second ($\beta = 0.12, p < 0.05$) and the third ($\beta = 0.15, p < 0.01$) forms of cheating. Table 3 shows that moral disengagement in sport was the stronger predictor for justification of the second form of cheating ($\beta = 0.31, p < 0.001$), slightly less but still significant for the first form ($\beta = 0.24, p < 0.001$), and the least significant for the justification of the third form of cheating ($\beta = 0.17, p < 0.01$). Moral disengagement in sport was also a predictor for the overall justification of cheating in sport ($\beta = 0.35, p < 0.001$).

Table 3. Regression analyses predicting justification of cheating in sport (n = 338)

Independent variables	Dependent variable: Manipulation with the results of the sports contest ¹		
	β	SE	t
Gender	0.02	0.08	0.30
Year of involvement in sport	-0.16	0.05	-2.80**
Moral disengagement	0.24	0.03	4.37***
	Dependent variable: Athletes' manipulation with the rules of the sports contest ²		
Gender	0.15	0.10	2.66**
Year of involvement in sport	0.12	0.06	2.14*
Moral disengagement	0.31	0.04	5.82***
	Dependent variable: Provocation against competitors ³		
Gender	0.13	0.12	2.26*
Year of involvement in sport	0.15	0.07	2.49**
Moral disengagement	0.17	0.05	2.91**
	Dependent variable: Overall justification of deception in sports ⁴		
Gender	0.15	0.15	7.96***
Year of involvement in sport	0.02	0.04	0.46
Moral disengagement	0.35	0.03	6.96***

Note. * – $p < 0.05$, ** – $p < 0.01$, *** – $p < 0.001$. 1 – $F = 6.56, p < 0.001$, Adjusted $R^2 = 0.07$. 2 – $F = 16.43, p < 0.001$, Adjusted $R^2 = 0.17$. 3 – $F = 4.93, p < 0.001$, Adjusted $R^2 = 0.05$. 4 – $F = 19.31, p < 0.001$, Adjusted $R^2 = 0.14$.

DISCUSSION

Our research purpose was, first, to examine the relationship between university athletes' justification of cheating and moral disengagement in sport. It was hypothesized that moral disengagement would predict athletes' more positive evaluation of cheating in sport. It should be noted that this hypothesis was based on research where evaluation of cheating had not been directly researched, but the data obtained verified it, i.e. moral disengagement in sport predicted more positive evaluation of cheating in sport. Other studies revealed links between antisocial behaviour and moral disengagement (Boardley, Kavussanu, 2010; Hodge, Lonsdale, 2011) or that athletes used moral disengagement mechanisms to justify their behaviour (Tractlet et al., 2011). Thus, our research complemented previous research proving that moral disengagement predicted more positive justification of cheating in sport.

Analysing the links between moral disengagement and justification of different forms of cheating in sport, we should consider some unexpected results. Our findings showed that athletes most tended to justify deceptive actions associated with the provocation against competitors, they least tended to justify manipulation with the results of the sports contest. We suggest that it is partly logical because the first form of cheating included deceptive actions which could be evaluated as part of contest activities by some of the athletes. Meanwhile, the forms of cheating as using forbidden drugs, betting on the outcome of the sports fight are usually regarded negatively. Incidentally, in the coaches opinion, such cheating cases are not very common in sports (Sukys, Nickus, 2010), but they are quite common in the sports world (Preston, Szymanski, 2003). On the other hand, our research revealed that moral disengagement much more predicted justification of such cheating than provocation against competitors.

The study also sought to determine the relationship between athletes' assessment of cheating in sport and personal factors: gender, sports mastery and sports experience. In the aspect of gender, it should be noted that male athletes more justified cheating in sport. This partly confirmed the findings of other researchers claiming that attitudes of males and females towards antisocial behaviour in sports activities might be different (von Roenn

et al., 2004), or that moral values in sports for female athletes are more important (Sukys, Jansonienė, 2012). However, analysing different form of cheating, it appeared that both males and females equally little justified deceptive actions linked with the manipulation with the results of the sports contest. Thus, the hypothesis that male athletes justified cheating in sports activities more was partly confirmed. At the beginning of the study we also hypothesized that the evaluation of cheating in sports activities would not be linked to athletes' sport experiences. The data obtained did not reveal the links between athletes' sports experience and the evaluation cheating in sport. However, we found differences analysing the evaluation of different forms of cheating. Deceptive actions associated with athletes' manipulation with the rules of the sports contest were more justified by athletes with more experience in sport. However, it was unexpected that deceptive actions linked to manipulation with the results of the sports contest were most justified by athletes with the least experience in sports activities. In conclusion, we can say that the hypothesis associated with sports experience raised at the beginning of the study was partially confirmed. Nevertheless, some recent studies suggested that sports experience positively predicted antisocial behaviour in sport (Sagar et al., 2011). So, the factor of sports experience remains relevant in further studies to clarify athletes' personal behaviour related to deceptive actions. We should also not eliminate sports mastery as an independent factor though our investigation did not reveal links between it and the evaluation of cheating in sport.

CONCLUSION AND PERSPECTIVES

Our study revealed the relationship between moral disengagement in sport and athletes' justification of cheating in sport. Analysing different forms of cheating it was found that moral disengagement in sport was a stronger predictor for the justification of such deceptive actions that are linked to athletes' manipulation of the rules of the sport and manipulation with the results of the sports contest. It was established that male student athletes more justified cheating in sport. Research results did not reveal relationship between overall justifications of cheating by years of involvement in sport. However, the analysis of the justification

of different forms of cheating showed that students with less sports experience more justified deceptive actions linked to the manipulation with the results of the sports contest, and, on the contrary, less justified other forms of cheating in sport.

As there are eight mechanisms of moral disengagement (Bandura, 1991) and different

types of antisocial behaviour associated with the frequency and type of moral disengagement mechanisms (Tractlet et al., 2011), further research should focus on separate moral disengagement mechanisms, not only on the overall scores.

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MORALINIO PATEISINIMO IR SPORTININKŲ ASMENINIŲ VEIKSNIŲ SAŠAJOS SU APGAULĖS SPORTINĖJE VEIKLOJE VERTINIMU

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Tyrimu keliami hipotezė, kad moralinis pateisinimas bus susijęs su sportininkų palankesniu apgaulės sportinėje veikloje vertinimu. Taip pat kelta antra hipotezė, kad apgaulės sportinėje veikloje pateisinimas bus susijęs su lytimi ir atitinkamai nesisies su sportine patirtimi.

Tikslas – išsiaiškinti moralinio pateisinimo ir sportininkų asmeninių veiksmų (lyties, sportinio meistriškumo ir sportinės patirties) sąsajas su apgaulės sportinėje veikloje vertinimu.

Metodai. Tiriamųjų kontingentą sudarė 338 (246 vaikinai ir 92 merginos) sportuojantys studentai, parinkti iš įvairių Lietuvos universitetų. Tiriant studentus naudota Apgaulės sportinėje veikloje vertinimo skalė (Sukys, Nickus, 2010) ir Moralinio pateisinimo sportinėje veikloje trumpoji skalė (MDSS-S; Boardley, Kavussanu, 2008).

Rezultatai. Nustatyta sąsaja tarp sportininkų lyties ir apgaulės sportinėje veikloje vertinimo ($\beta = 0.15$, $p < 0.01$). Tyrimo duomenimis, vaikinai labiau pateisina apgaulę sportinėje veikloje. Sportinė patirtis nėra susijusi su bendru apgaulės sportinėje veikloje vertinimu. Nustatyta sąsaja tarp moralinio pateisinimo ir apgaulės sportinėje veikloje vertinimo ($\beta = 0.35$, $p < 0.001$).

Aptarimas ir išvados. Tyrimas atskleidė sąsajas tarp moralinio pateisinimo ir sportuojančių studentų apgaulės sportinėje veikloje vertinimo. Gilinantis į atskiras apgaulės formas nustatyta, kad moralinio pateisinimo sportinėje veikloje veiksnyms labiausiai prognozuoja tokių apgaulės sportinėje veikloje formų kaip sportininkų manipuliacijos sportinės kovos taisyklėmis ir manipuliacijos sportinės kovos baigtimi pateisinimą. Sportuojantys studentai vyrai labiau pateisina apgaulę sportinėje veikloje. Tyrimas neatskleidė sąsajų tarp sportinės patirties ir bendro apgaulės sportinėje veikloje vertinimo. Visgi gilinantis į skirtingų apgaulės formų vertinimą atskleista, kad mažesnę sportinę patirtį turintys studentai labiau pateisina apgaulingus veiksmus, susijusius su manipuliacijomis sportinės kovos baigtimi, ir mažiau kitas apgaulės formas.

Raktažodžiai: sportinė veikla, apgaulės sportinėje veikloje vertinimas, moralinis pateisinimas.

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PECULIARITIES OF SELECTED SPORT PERFORMANCE IN WOMEN OLYMPIC HANDBALL

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ABSTRACT

Research background and hypothesis. Sport contest model is the main indicator of athletes' sport performance, which allows defining sports trends in general, predicting sports results and also designing directions for training.

Research aim was to determine the alteration of goals (as a key indicator) scored by women in Olympic handball in order to carry out trends of modern women handball.

Research methods. Data sets were gathered from the International Handball Federation (EHF) website (<http://www.ihf-info.com>) covering Olympic Games since Montreal (1976) till London (2012). The data was used from all 248 matches. Statistically significant differences between the independent samples were determined using Student's t-values of the criterion of a 95% significance level.

Research results. In the period of 36 years women's handball has become more dynamic as teams scored 10.2 goals more in London (25.1 ± 4.5) than in Montreal (14.9 ± 7.4). Teams representing the continent of Europe (23.3 ± 4.2) scored 2.2 goals more on average than teams from other continents (21.1 ± 6.1) during the Olympics. Though the mastery of European teams was better than that of others, the South Korean team, representing the Asian continent, is the first in the rating ranks scale.

Discussion and conclusions. Referring to the differences between scored and missed goals by teams which were less compared Montreal and London Olympic Games we suggest that the mastership of women's handball is going up and becoming more equal. The phenomenon of South Korean team has allowed to state that the final results in modern women's handball might be determined not only by the body composition but by other indices of a team or of an individual player's fitness as well.

Keywords: women's elite sport, key indicators in team handball, national analyses.

INTRODUCTION

Permanent monitoring of elite athletes sport performance allows to determine trends in selected sport, to predict sports results, and further directions for training athletes (Skarbalius, 2003, 2006; Reilly, Gilbourne, 2003; Hughes, Franks, 2006; Carling et al., 2009; Rogulj et al., 2011).

J. Jaworski and co-authors (1985) found that more than 300 indicators described only handball actions in defense. The same number of indicators describes the actions in offence (Kotzamanidis et al., 1999). Because of the handball teams and individual player's abundance of activities it is difficult to identify the essential indicators of the game parameters (Czerwinski, 1996; Skarbalius, 2003; Taborsky, 1999). Sport contest model in

handball is mainly characterized by the number of attacks, the effectiveness of attacks, percentage of attacks structure (the number of attacks, counterattacks and positional attacks proportion and its effectiveness), duration of attacks, applied defence and attack systems, shots, saved shots by goalkeepers, blocked shots, lost and stolen balls, turnovers, fault minutes, playing in majority and in minority (Hulka, Belka, 2011; Laffaye, Debanne, 2011). However, the researchers did not mention what were the most important indicators to the success or failure of a team.

Team effectiveness of attacks depends on the individual and team actions (Laffaye, Debanne, 2011). Goals scored by a team are the main indicator

which describes the dynamic change of handball (Taborsky, 1993, 1999; Skarbalius, 2002, 2006).

However, there are no publications related to Olympic women's handball where analysis of goals as an essential indicator of sport performance was made. Determination of the alteration by the main index during nearly four decades in the highest elite level of competition might be presume about the current trends of modern women's handball and evaluate trends of future training programmes.

RESEARCH METHODS

Data sets were gathered from the International Handball Federation (EHF) website (<http://www.ihf-info.com>), covering Olympic Games (OG) since Montreal (1976) till London (2012). The data was used from all 248 matches (Table 1). Statistically significant differences between the independent samples were determined using Student's t-values of the criterion of a 95% significance level. The magnitude between indices of different groups was assessed using standard effect size (ES) analysis procedures (Cohen, 1998; Hopkins, 2002, 2006), previously established scales: < 0.20 = trivial, $0.20-0.59$ = small, $0.60-1.19$ = moderate, $1.20-2.0$ = large, and > 2.0 = very large.

RESEARCH RESULTS

Dynamic alteration of women's Olympic handball. During the 36-year period – 10 Olympic cycles – women's handball dynamics changed (Table 2) and the teams in London (2012) scored on average (25.1 ± 4.5) 10.2 goals more ($p < 0.001$) than at the beginning of the Olympic handball in Montreal Olympics (14.9 ± 7.4). The phenomenon of women's handball is that changes in goals

were performed in polynomial trend-line. Teams performed increasingly more goals in the first two Olympic cycles, than stable trend in the next two Olympic cycles, and followed the same trend later on. It should be noted that even when women's handball match-play time was extended by 10 minutes since Moscow Olympics (1980), handball dynamics was changing slowly: in the second Moscow Olympics (1980) the teams scored just 1.4 goals more compared to Montreal Olympics even though teams had played 60 minutes.

Comparing the score values between the OG, a statistically significant ($p < 0.05$) and the biggest difference of goals 6.2 was between Moscow (16.3 ± 8.5) and Los Angeles (22.8 ± 4.8) Olympics. In Los Angeles Olympics (22.8 ± 4.8) teams scored statistically significant ($p < 0.01$) 7.6 goals more than in the first OG in Montreal (14.9 ± 7.4). Another statistically significant ($p < 0.05$) difference in scored goals (4.7 score) was determined between Barcelona (22.2 ± 4.8) and Sydney (26.7 ± 7.7) OG. Among other Olympics statistically significant changes were also observed (Table 2).

Moderate Effect Size differentiated:

- 1) mean to champions in 1996 OG, 2004 OG, 2008 OG;
- 2) mean to lower places in 1984 OG, 1992 OG;
- 3) lower places to European teams in 1974 OG, 1992 OG, 1994 OG;
- 4) lower places to TOC in 1980 OG;
- 5) champions to higher places in 1984 OG, 2000 OG, 2004 OG;
- 6) champions to lower places in 1980 OG, 2004 OG;
- 7) champions to European teams in 1976 OG, 1990 OG, 2004 OG;
- 8) champions to TOC in 1976 OG, 1996 OG, 2004 OG;

Olympic games	Number of matches
Montreal Olympics in 1976	15
Moscow Olympics in 1980	15
Los Angeles Olympics in 1984	15
Seoul Olympics in 1988	20
Barcelona Olympics in 1992	18
The Atlanta Olympics in 1996	17
Sydney Olympics in 2000	27
Athens Olympics in 2004	32
Beijing Olympics in 2008	42
London Olympics in 2012	38
Total :	248

Table 1. The data samples (IHF-info.com)

Table 2. Goals scored at the Olympic women's handball ($\bar{x} \pm s$)

Olympic games	Average	Champions	Higher places 1–4	Lower places 5–12	European teams	TOC
Montreal Olympics in 1976	14.9 ± 7.4	19 ± 8.2	17.7 ± 7.9	12 ± 5.9*	16.7 ± 6.9	13.2 ± 7.1
Moscow Olympics in 1980	16.3 ± 8.6	19.8 ± 5.8	19.8 ± 7.7	12.7 ± 8.3*	17.7 ± 8.7	9.2 ± 1.9** @ \$ ¥ \$\$
Los Angeles Olympics in 1984	22.5 ± 4.7□ @	28.6 ± 5#*	25.3 ± 4.2□□	19.7 ± 3.6 #□^ & \$	21.7 ± 6 @@	23.4 ± 3.1# ↓ ES = large @@
Seoul Olympics in 1988	21.8 ± 6.6	24 ± 5.4	21.8 ± 5.4	21.9 ± 7.7	22.9 ± 6.2	20.9 ± 6.9
Barcelona Olympics in 1992	22.2 ± 4.8 @	27.2 ± 0.8 ***	24.5 ± 4.2 @@	19.4 ± 3.9□^ & \$	22.6 ± 4.7 @@	21.6 ± 5 @@
The Atlanta Olympics in 1996	25.1 ± 6	29.8 ± 5.4	27.3 ± 5.9	22.2 ± 4.6** @@ ^^	25.6 ± 5.1* ^^^	24.4 ± 6.7
Sydney Olympics in 2000	26.7 ± 7.7	32.8 ± 4.5#	28.6 ± 6.9	25.2 ± 8.1* @@	28.2 ± 7.5	24.5 ± 7.5 @@
Athens Olympics in 2004	26.8 ± 6.2	32 ± 5.5#	28.5 ± 5.9	25.5 ± 5.7*	26.1 ± 6.1	27.8 ± 5.5
Beijing Olympics in 2008	26.9 ± 5.1	31 ± 3.5**	29.6 ± 4.2	25.3 ± 5.1□ @@	28.1 ± 4.9#	25.1 ± 5.1 @@
London Olympics in 2012	25.1 ± 4.5	24.5 ± 3.5	25.7 ± 3.4	24.5 ± 5.3	24.7 ± 4.7	26.4 ± 3.7

Note. * – $p < 0.05$, ** – $p < 0.01$, *** – $p < 0.001$ compared average to champions, higher places to lower places, European teams to TOC.

– $p < 0.05$ compared average to higher places, lower places, European teams and TOC.

□ – $p < 0.05$ compared Olympic Games with the previous Olympic Games.

^^ – $p < 0.01$ compared higher places with lower places.

^ – $p < 0.001$ compared higher places with lower places.

^^^ – $p < 0.05$ compared European teams scored goals with previous Olympic Games.

Effect Size (Hopkins scale): 0.60–1.19 = moderate, 1.20–2.0 = large, and > 2.0 = very large.

↓ – increase compared to previous Olympic Games.

@ – increase compared average to champions, average to TOC (1.20–2.0 = large).

@@ – increase compared champions to higher places, champions to lower places, champions to European teams, champions to TOC (1.20–2.0 = large).

& – increase compared higher places to lower places (1.20–2.0 = large).

¥ – increase compared European teams to TOC (1.20–2.0 = large).

\$ – increase compared champions to lower places, champions to TOC (> 2.0 = very large).

\$\$ – higher places to TOC (> 2.0 = very large).

9) higher places to lower places in 1976 OG, 1980 OG, 1996 OG, 2008 OG;

10) higher places to European teams in 1984 OG;

11) higher places to TOC in 1976 OG, 1992 OG, 2008 OG.

Discriminant analysis between ranking teams

Champions. A team which became champions in all Olympics scored more goals than other teams on average, except for the London Olympics (Table 2). The greatest values of goals were made by Danish national team (32.8 ± 4.2) in the Sydney OG, and the lowest goals were scored by USSR team in the Montreal Olympics (19 ± 8.2) (but the match lasted 50 minutes).

Difference between teams 1–4 and 5–12.

Teams took higher places (Table 2) and scored significantly more goals in Montreal ($p < 0.05$),

Moscow ($p < 0.05$), Los Angeles ($p < 0.001$), Barcelona ($p < 0.001$), Atlanta ($p < 0.01$), Athens ($p < 0.05$) and Beijing ($p < 0.001$) OG. The changes of ranking teams compared to previous OG were adequate in general, but in some cycles it changed differently. Statistically significant difference was found comparing scored goals of teams which took higher places with the previous OG between Moscow (19.8 ± 7.7) and Los Angeles (25.3 ± 4.2) Olympics ($p < 0.05$), and lower places with the previous OG between Moscow (12.7 ± 8.3) and Los Angeles (19.7 ± 3.6) Olympics ($p < 0.01$).

Difference between European and other continental teams. European teams scored more goals than the teams which represented other continents (TOC) in all the Olympics except London, Los Angeles and Athens OG. Nevertheless, Yugoslavia, Denmark and Norway teams became

champions in the above mentioned OG. The trend of scored goals by the European teams increased consistently but slightly waved at the same time. European women teams scored more goals ($p < 0.05$) in Atlanta OG compared to the previous OG in Barcelona.

DISCUSSION

Analysis of goals scored by women's handball teams in the OG during 36 years or 10 Olympic cycles (teams performed 8.8 goals more in London'2012 than in Moscow'1980), allow suggesting that modern Olympic women's handball is as dynamic as (Grünanger, König, 2005) Olympic men's handball (Johansson, 1998; Skarbalius, 2010; Pollany, 2006). On the basis of the fact that the difference between the winners and the losers during 36 years is becoming less (in Montreal was 9.9 goals and in Beijing – 6 goals, and in London only 4.8) allows to discovering another feature of modern Olympic women's handball i.e. that the level of mastership between competitive teams is homogeneous.

Though Olympic champions in all OG scored more goals than the other teams on average (except London OG), it is not allowed to assess and evaluate the fact that the goals scored are the key indicator of sport performance in handball as in sports games (Reilly, 2007; Carling et al., 2009). Indices of goals scored to allow to win, but this key indicator, nevertheless it could be create controversy in order to assess sport performance because of multiply factors influencing sport performance in handball (Pollany, 2006) as well as in other team sports (Hughes, Franks, 2006; Perl, 2002).

Decreasing number of scored goals in the last OG led to a suggestion that team's mastery is converging (Grünanger, König, 2005) and might be considered among other features of modern handball (Povoas et al., 2011). New rules in handball made several Olympic cycles ago allowed increasing attacks (Michalsik et al., 2011), applying more counterattacks, and scoring more goals (Taborsky, 2011). Decreasing goals in latter OG suggested that teams have carried out the solutions and applied team skills in defensive actions vs. counterattacks. On the other hand, playing faster handball requires special training (Hyung-Kyung Chung, 1994; Michalsik et al., 2011). Handball game performance depends on many factors (Oxyzoglou et al., 2008). Players carry out a small period of maximum effort and lower intensity in

the medium actions (Michalsik et al., 2011). In order to keep high intensity during the whole game requires good aerobic and anaerobic fitness of the human (Hasan et al., 2007), so it is very important to create a very good team training strategy. In conclusion, fitness of elite players is on the same level. M. Wiemeyer (2008) concluded that there were variables specific to one or two championships, which may be considered as 'short-term fashion' in the development of handball tactics.

Teams at the Olympic Games. Handball dynamics is described by scored goals in the match (Skarbalius, 2002, 2006; Taborsky, 1993, 1999). Goals scored through positional attacks are more specific to a stronger physical development of handball players, and counter-attacking way is more promoted by weaker physical development handball players. That is why European teams use more positional attacks and other continental teams use counterattacks (Kunst-Germanescu, 1991; Taborsky, 1999). It could be stated that in ranking scale European teams should be in the top scale, but the phenomenon in Olympic women's handball is that no Europeans are in the top.

South Korean phenomenon. The South Korean team from Asia participated in the OG seven times and six times became the prize winner. Korean players are shorter in height and smaller in body mass compared to Europeans. This suggests that handball is a diversity sport and limitation of body composition might be compensated by playing style (Michalsik, 2011) or fitness of players (Oxyzoglou et al., 2008). It could be stated that fast game promoted by South Korean team is adequate to Olympic men's handball and is the essential feature of great success.

Denmark phenomenon. Danish team participated in the OG for four times and three times it became champions. Although handball is very popular in Denmark, Danish team took part in the OG for the first time only 20 years after the Olympic handball started. In addition, it should be noted that although three times in a row they became champions (Atlanta, Sydney and Athens OG), the Danish team did not take part in the Beijing OG. Danish team was already unsuccessful in the last year before the Beijing OG-2006. They took the eleventh place in the European Championship and did not participate in 2007 World Championship. Considering the controversial elite teams participating in the Olympics, it can be assumed that the specific outcome of the game may depend on the rival game and the perturbation

method (Hughes, Frank, 2006), the qualification competition system or the same Olympic event management systems.

The Olympic handball increases much faster than the European or World Championships. Despite the increasing numbers of scored goals per game, more and more goals have been scored in the second half of time. It can be assumed that physical and functional capacity of athletes improved and they were able to play all the matches intensively (Gorostiaga et al., 2005).

CONCLUSION AND PERSPECTIVES

During the 36 years women's handball performing teams reached 10.2 goals more in London

than in Montreal. Assessment indicator of European team skills to achieve goals is superior for teams from TOC. Nevertheless, European national team mastery is better than TOC but Asia represented by South Korean team is the first in rating scale. However, the teams representing Europe at the OG have scored more goals (23.3 ± 4.2) 2.2 than TOC representing teams (21.1 ± 6.1), with the exception of Los Angeles, Athens and London Olympics, where the champions were teams representing Europe. It can be assumed that such dynamic handball game trends were due to elite handball physical fitness, however, to confirm this assumption would require further studies to evaluate the longitudinal change in fitness of players.

Alteration of goals scored during Olympic years might be influenced by social factors such as professionalism since Barcelona OG or boycott in Moscow and Los Angeles OG.

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MOTERŲ OLIMPINIO RANKINIO VARŽYBINĖS VEIKLOS IŠSKIRTINIŲ RODIKLIŲ YPATUMAI

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Varžybinės veiklos rodikliai yra pagrindiniai sportininkų parengtumo kriterijai, leidžiantys numatyti sporto šakos tendencijas, prognozuoti sportinius rezultatus, numatyti sportininkų rengimo kryptis.

Tikslas – nustatyti olimpinio moterų rankinio pelnytų įvarčių, kaip esminio rodiklio, apibūdinančio rankinio žaidimo kaitą, ypatumus ir tendencijas.

Metodai. Taikant matematinės statistikos metodus (aritmetinį vidurkį, standartinį nuokrypį, skirtumo tarp nepriklausomų imčių rodiklių patikimumą, nustatytą Stjudento *t* kriterijumi taikant 95% reikšmingumo lygmenį) buvo analizuojami 1976–2012 metų laikotarpio (9 olimpinių žaidynių, 248 rungtynių) olimpinių žaidynių elito rinktinių įvarčiai. Duomenys paimti iš Tarptautinės rankinio federacijos duomenų bazės (<http://www.ihf-info.com>).

Rezultatai. Olimpinio moterų rankinio žaidimas dinamiškėja: per 36 metų laikotarpį rinktinės įmeta 10,2 įvarčio daugiau (Monrealyje – 14,9 ± 7,4, Londone – 25,1 ± 4,5). Nors Europos žemynui atstovavo daugiausia rinktinių, geriausių rezultatų (pagal reitingą) pasiekė Azijos žemynui atstovavusi Pietų Korėjos rinktinė.

Aptarimas ir išvados. Paskutinėse olimpinėse žaidynėse mažėjantis pelnytų ir praleistų įvarčių skirtumas (Monrealyje – 9,9 įvarčiai, Pekine – 6 įvarčiai, Londone – 4,8) leistų teigti, kad vienodėja rinktinių meistriskumas. Nors europietės, turėdamos didesnio kūno sudėjimo rodiklius, lemiančius rankinio rungtynių baigtį, sėkmingai dalyvavo, Pietų Korėjos rinktinės fenomenas sudaro prielaidas teigti, kad rungtynių baigtį gali lemti dar daug ir kitų žaidimą apibūdinančių veiksnių.

Raktažodžiai: moterų elitinis sportas, rankinio komandos parengtumo kriterijai, žaidimo modelių analizė.

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Literatūros aprašo pavyzdžiai

Gikys, V. (1982). *Vadovas ir kolektyvas*. Vilnius: Žinija.

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INFORMATION TO AUTHORS

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Examples of the correct format are as follows

Bergman, P. G. (1993). Relativity. In *The New Encyclopedia Britannica* (Vol. 26, pp. 501–508). Chicago: Encyclopedia Britannica.

Bjork, R. A. (1989). Retrieval inhibition as an adaptive mechanism in human memory. In H. L. Roediger III, F. I. M. Craik (Eds.), *Varieties of Memory & Consciousness* (pp. 309–330). Hillsdale, N J: Erlbaum.

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Lietuvos sporto universiteto doktorantę **Daivą Majauskienę**, 2013 m. birželio 21 d. Lietuvos sporto universitete apgynusią socialinių mokslų (edukologijos, fizinio lavinimo, judesių mokymo ir sporto) daktaro disertaciją tema „Olimpizmo raiška ir dermė su mokyklos kultūra ir prosocialiu elgesiu“.

Mokslinis vadovas l. e. p. prof. dr. Saulius Šukys.

Moksliniai konsultantai: prof. habil. dr. Povilas Karoblis, doc. dr. Skaistė Laskienė.

We congratulate **Daiva Majauskienė**, the student of doctoral studies at the Lithuanian Sports University, to have defended her thesis “Manifestation of Olympism and its cohesion with school culture and prosocial behaviour” (Social Sciences, Education, Physical Education, Motor Learning, Sport) at the Lithuanian Sports University on June 21, 2013.

Scientific advisor Acting Prof. Dr. Saulius Šukys.

Scientific Consultants: Prof. Dr. Habil. Povilas Karoblis, Assoc. Prof. Dr. Skaistė Laskienė



Lietuvos sporto universiteto doktorantę **Vilmą Jurevičienę**, 2013 m. birželio 28 d. Lietuvos sporto universitete apgynusią biomedicinos mokslų (biologijos) daktaro disertaciją tema „Judesių valdymo atsigavimo dinamika po kelio sąnario priekinio kryžminio raiščio rekonstrukcijos“.

Mokslinis vadovas prof. habil. dr. Albertas Skurvydas.

We congratulate **Vilma Jurevičienė**, the student of doctoral studies at the Lithuanian Sports University, to have defended her thesis “Dynamics of motor control recovery after knee anterior cruciate ligament reconstruction” (Biomedical Sciences, Biology) at the Lithuanian Sports University on June 28, 2013.

Scientific advisor Prof. Dr. Habil. Albertas Skurvydas.



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Mokslinė vadovė doc. dr. Danguolė Satkunskienė.

We congratulate **Raminta Sakalauskaitė**, the student of doctoral studies at the Lithuanian Sports University, to have defended her thesis “The relation between foot arch stability, and mechanical and physiological properties of the foot” (Biomedical Sciences, Biology) at the Lithuanian Sports University on September 13, 2013.

Scientific advisor Assoc. Prof. Dr. Danguolė Satkunskienė.



Lietuvos sporto universiteto doktorantą **Tomą Darbutą**, 2013 m. rugsėjo 20 d. Lietuvos sporto universitete apgynusį biomedicinos mokslų (biologijos) daktaro disertaciją tema „Galvos smegenų infarkto poveikis rankos ir kojos raumenų izometrinų susitraukimų ir judesių tikslumo bei stabilumo valdymui“.

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Moksliniai konsultantai: doc. dr. Vilma Juodžbalienė, dr. Marius Brazaitis.

We congratulate **Tomas Darbutas**, the student of doctoral studies at the Lithuanian Sports University, to have defended his thesis “Stroke effects on accuracy and stability control of isometric contractions and movements of arm and leg muscles” (Biomedical Sciences, Biology) at the Lithuanian Sports University on September 20, 2013.

Scientific advisor Prof. Dr. Habil. Albertas Skurvydas.

Scientific consultants: Assoc. Prof. Dr. Vilma Juodžbalienė, Dr. Marius Brazaitis.

