

UGDYMAS KŪNO KULTŪRA

Sportas

Education
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Lietuvos
kūno kultūros akademija

Lithuanian Academy
of Physical Education

2
2011



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Žurnalas „Ugdymas. Kūno kultūra. Sportas“ leidžiamas nuo 1968 m. (ankstesnis pavadinimas — mokslo darbai „Kūno kultūra“)

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LITHUANIAN ACADEMY OF PHYSICAL EDUCATION EDUCATION • PHYSICAL TRAINING • SPORT

2 (81) 2011

ISSN 1392–5644

Journal „Education. Physical Training. Sport“ has been published since 1968
(the former title — selected papers „Kūno kultūra“ /Physical Training/)

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The cover has been designed by Gediminas Pempė
Editors V. Jakutienė and Dr. D. Karanauskienė

Published by
LITHUANIAN ACADEMY OF PHYSICAL EDUCATION

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SOME ASPECTS OF NUTRITION AND MODERATE BODY WEIGHT REDUCTION IN LITHUANIAN OLYMPIC SPORT CENTRE FEMALE BASKETBALL PLAYERS

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ABSTRACT

Research background and hypothesis. Many athletes know the benefits of low carbohydrate diets these days, but recently healthcare specialists have paid much attention to high carbohydrate diets and safer methods of losing weight.

Research aim was to investigate Lithuanian Olympic Sport Centre female basketball players' (n = 10) actual and special nutrition and their physical condition.

Research methods. Athletes' food records were analyzed and assessed. We determined plasma triacylglycerol, total cholesterol, LDL cholesterol, HDL cholesterol, glucose. Physical Working Capacity (PWC₁₇₀) test was conducted to determine aerobic fitness before and after moderate weight reduction.

Research results showed that the basketball players received too little carbohydrates, linoleic acid, amino acid methionine and too much fat. Vitamins D, PP, B₁ and folic acid intakes were insufficient. During moderate bodyweight reduction basketball players significantly decreased in their BW (-2.2 ± 0.3 kg, $p < 0.05$), BF (-1.6 ± 0.3 kg, $p < 0.05$) and minerals (-0.1 ± 0.4 kg, $p < 0.05$), but they non-significantly decreased in BP ($p > 0.05$). Furthermore, lipid panels markers (triacylglycerol, total cholesterol, LDL cholesterol, HDL cholesterol) experienced non-significant improvements while glucose levels ($p < 0.05$) and PWC₁₇₀ ($p < 0.05$) resulted in significant decrease following a 12-day hypocaloric diet.

Discussion and conclusions. The results indicate that hypoenergetic moderate weight loss at < 30 kcal · kg⁻¹ · day⁻¹, < 5 g · kg⁻¹ · day⁻¹ carbohydrate is not recommended for athletes as it can affect aerobic fitness.

Keywords: nutrition, female basketball, bodyweight reduction.

INTRODUCTION

In the aspect of duration, body mass reduction can be short-term, lasting for 24–72 hours, moderate, lasting for 72 hours – two weeks, and gradual, lasting from several weeks to several months (Wilmore, 2000). However, it should be noted that most athletes and coaches prefer short-term body mass reduction and not the one which lasts longer. In both cases the aim is the same – to reduce the body mass and to preserve the lean

body mass and physical working capacity as much as possible. This concerns female basketball players from the Lithuanian Olympic Sport Center as well because it is very important to them to reduce their fat body mass for better physical, technical and tactical fitness, as those parameters become slower at the age of 15–17 years, and sometimes they even become worse (Balčiūnas et al., 2009).

Thus, safe body mass reduction is of great importance. In this case the best diet is the one rich in carbohydrates and low in energy value, because the opposite can negatively affect athletes' working capacity indices and even damage their health. However, preparing individual diets for athletes, scientific evaluation of their actual nutrition as well as their physical development need to be evaluated first and only then specialists can recommend moderate diets rich in carbohydrates and low in energy value. In this case it is even more important to evaluate the impact of low energy value diet on the aerobic working capacity, body mass and some biochemical indices of blood of female basketball players. **The aim of the research** was to investigate and evaluate actual nutrition of Lithuanian Olympic Sport Centre female basketball players and the impact of moderate diets low in energy value on their body mass, body components, aerobic working capacity and some biochemical indices of their blood.

RESEARCH METHODS

Aiming at investigating and evaluating actual nutrition of female basketball players and the impact of moderately lasting reduction of their body mass on the changes in their body components, aerobic working capacity and some biochemical indices of their blood (research algorithm, Figure 1), we studied Lithuanian Olympic Sport Centre female basketball players ($n = 10$) aged 16.2 ± 0.4 years for 15 days.

The analysis of athletes' actual nutrition applied a survey method lasting 24 hours, three days in succession. After that individual food rationing for 12 days was introduced allowing the energy value of 1845 ± 76 kcal (27.2 ± 0.9 kcal / kg of the body mass), and carbohydrates, proteins and fats as

well as their energy values were respectively 4.4 ± 0.2 g / kg ($64.8 \pm 1.1\%$), 1.0 ± 0.0 g / kg ($14.0 \pm 0.0\%$) and 0.6 ± 0.0 g / kg ($20.8 \pm 1.1\%$) (Table 2). To ensure the substantial amount of vitamins and minerals in female basketball players' food in the period of body mass reduction their actual nutrition was supplemented adding food supplement "Vitamax" (one capsule a day).

We calculated the chemical composition and energy value of female basketball players' food rations using the tables of chemical composition of food products (Sučilienė, Abaravičius, 2002). The measures of body mass components (body mass, lean body mass, muscle mass, fat body mass, general body fluids, intracellular and extracellular body fluids, amounts of proteins and minerals in the body) were taken using BIA tetra-polar electrodes and measuring body resistivity with 8–12 tangent electrodes at different frequencies of the signal: 5, 50 and 250 kHz. We calculated the index of muscle mass and fat body mass (MFMI). Basketball players' fat body mass, the index of muscle mass and fat body mass (MFMI) and body mass index (BMI) were estimated using certain scales (Skernevičius et al., 2004).

Basketball players' blood samples for biochemical testing were taken from the vein in the morning before meals. The tests were performed using hematological analyzer "Micros 60" in the certified laboratory in Vilnius Sports Medicine Center. We established the concentration of plasma triacylglycerol, total cholesterol, LDL cholesterol, HDL cholesterol, and glucose. Low density lipoprotein cholesterol concentration was calculated applying Friedwald equation ($HTL\ Ch + TG / 2.181$) when the amount of TG did not exceed 4.54 mmol / l. Physical (Aerobic) Working Capacity was evaluated applying (PWC_{170}) test (Skernevičius et al., 2004).

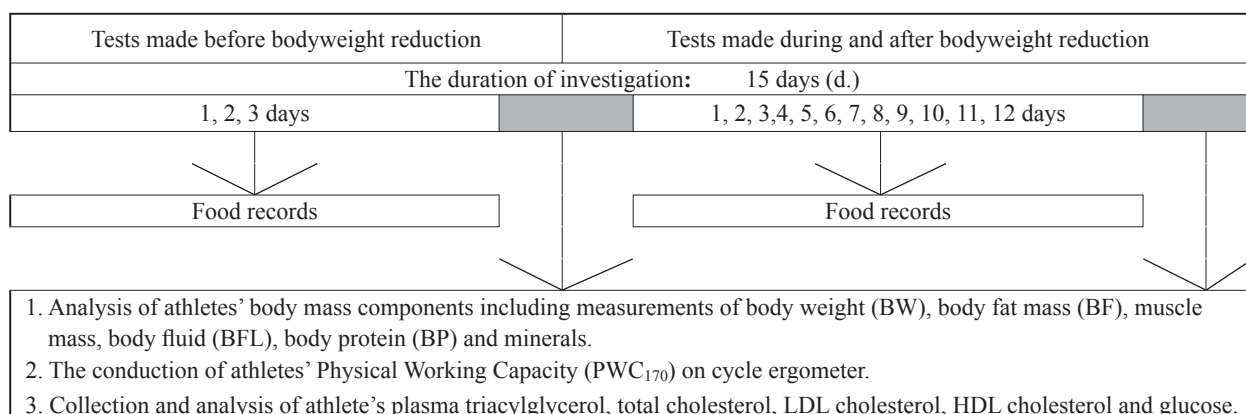


Figure 1. Sequence of tests

Statistical data processing was performed using SPSS v. 15 program package. We applied the following methods of mathematical statistics: calculation of arithmetic means, dispersion of data according to standard deviation (SD), statistical correlations using Pearson's correlation coefficient (r) and coefficient of determination (R^2), and differences using Student's paired samples t-test. Statistical significance of mean differences was evaluated with a confidence interval of 95 percent, when the significance level was set at $p \leq 0.05$.

RESEARCH RESULTS

The study on female basketball players' nutrition (Table 1) revealed that energy received from food, i. e. 40.0 ± 8.4 kcal / kg of body mass was sufficient, however, the main nutrients providing energy – carbohydrates and fats – were not balanced in their food rations. If the amount of carbohydrates received from food in 24 hours was 5.0 ± 0.4 g / kg of body mass, which makes only $50.3 \pm 1.9\%$ from the overall energy value, it was too low and it did not reach the recommended amount – $7-8$ g / kg of the body mass, the amount of fats was 1.6 ± 0.2 g / kg of the body mass on average, and it exceeded the recommended amount

making up $34.7 \pm 1.5\%$ and thus made a rather high proportion of the energy value from fats.

We established that the qualitative composition of the athletes' food rations did not match the recommendations because female basketball players consumed too much saturated fatty acids and too little polyunsaturated linolenic fatty acids with their food. The 14.7% energy value of saturated fatty acids exceeded the recommended amount of 10%, and the inadequate amount of linolenic fatty acid which is not synthesized in the human body can be proved by the inadequate ratio of linoleic and linolenic acids 1 : 1.8, while the recommended ratio is 1 : 5. Besides the athletes consumed a greater amount of cholesterol with food – 0.9 ± 0.2 mg, while the recommended norm is 0.5 mg.

The amount of proteins in the nutrition of female basketball players was efficient – 1.5 ± 0.2 g / kg of the body mass, and the percent of the energy value of proteins – $15 \pm 0.5\%$ – corresponds to the recommended norms: from 12 to 15%. On the other hand, athletes' diets lacked amino acid methionine (Table 3). The lack is confirmed by the inadequate ratio of three amino acids – tryptophan, methionine and lizine, which is 1 : 1.5 : 4.6, and the recommended ratio is 1 : 3 : 4.

Body mass components	Before bodyweight reduction ¹	After bodyweight reduction ²	Mean difference, g ^{1/2}	95% CI	p value
Body weight, kg	70.6 ± 4.6	68.4 ± 4.8	2.2 ± 0.3	(1.2; 3.2)	0.003*
Lean body mass, kg	50.9 ± 2.6	50.4 ± 2.7	0.6 ± 0.1	(0.2; 0.9)	0.012*
Lean body mass, %	72.5 ± 1.1	74.0 ± 1.4	-1.5 ± 0.5	(-2.8; -0.2)	0.031*
Muscle mass, kg	46.9 ± 2.4	46.4 ± 2.4	0.4 ± 0.1	(0.1; 0.8)	0.022*
Muscle mass, %	66.6 ± 1.1	68.2 ± 1.4	-1.6 ± 0.4	(-2.7; -0.4)	0.019*
Body fluid, kg	36.7 ± 1.9	36.2 ± 1.9	0.4 ± 0.1	(0.2; 0.7)	0.010*
Body fluid, %	52.1 ± 0.8	53.2 ± 1.0	-1.1 ± 0.3	(-1.9; -0.3)	0.016*
Intracellular fluid, kg	23.9 ± 1.3	23.6 ± 1.3	0.3 ± 0.1	(0.1; 0.6)	0.025*
Extracellular fluid, kg	12.8 ± 0.6	12.7 ± 0.6	0.1 ± 0.2	(-0.3; 0.5)	0.546
Body protein, kg	10.2 ± 0.5	10.2 ± 0.5	0.0 ± 0.0	(-0.1; 0.1)	0.621
Body protein, %	14.5 ± 0.3	15.0 ± 0.4	-0.4 ± 0.1	(-0.8; -0.1)	0.027*
Body minerals, kg	4.1 ± 0.3	3.9 ± 0.3	0.1 ± 0.0	(0.1; 0.2)	0.004*
Body minerals, %	5.8 ± 0.0	5.8 ± 0.0	0.0 ± 0.0	(-0.1; 0.0)	0.374
Fat mass, kg	19.7 ± 2.0	18.0 ± 2.2	1.6 ± 0.3	(0.7; 2.6)	0.010*
Fat mass, %	27.6 ± 1.1	26.0 ± 1.4	1.6 ± 0.4	(0.4; 2.7)	0.018*
BMI, kg / m ²	23.1 ± 0.9	22.4 ± 1.0	0.7 ± 0.1	(0.4; 1.1)	0.004*
Muscle / fat mass index	2.4 ± 0.2	2.6 ± 0.2	-0.2 ± 0.1	(-0.4; 0.0)	0.028*

Table 1. Body mass components of athletes (mean ± SD)

Note. 95% CI – 95% confidence interval of the difference; * – $p \leq 0.05$ significant differences among groups; ¹ – Group 1, ² – Group 2, BMI – body mass index.

Table 2. Amino acids in athletes' food rations (mean \pm SD)

Amino acids, g \cdot day ⁻¹	Before bodyweight reduction ¹	During bodyweight reduction ²	Mean difference (g) ^{1/2}	95% CI	p value	Recommendation
Essential	38.5 \pm 3.1	22.7 \pm 1.1	15.8 \pm 3.7	(5.4; 26.2)	0.013*	–
Valine	5.8 \pm 0.5	3.4 \pm 0.2	2.5 \pm 0.6	(0.7; 4.2)	0.016*	3–4
Izoleucine	4.7 \pm 0.4	2.9 \pm 0.1	1.8 \pm 0.4	(0.6; 3.0)	0.014*	3–4
Leucine	8.3 \pm 0.7	5.0 \pm 0.2	3.3 \pm 0.8	(1.0; 5.6)	0.016*	4–6
Lysine	7.0 \pm 0.6	4.1 \pm 0.2	3.0 \pm 0.7	(0.1; 4.9)	0.014*	3–5
Methionine	2.3 \pm 0.2	1.4 \pm 0.1	0.9 \pm 0.2	(0.3; 1.6)	0.017*	2–4
Treonine	4.0 \pm 0.3	2.3 \pm 0.1	1.7 \pm 0.3	(0.7; 2.6)	0.009*	2–3
Tryptophan	1.5 \pm 0.1	0.7 \pm 0.0	0.7 \pm 0.1	(0.3; 1.1)	0.008*	1
Phenylalanine	4.8 \pm 0.4	2.9 \pm 0.1	1.9 \pm 0.4	(0.7; 3.2)	0.013*	2–4
Non-essential, g	65.8 \pm 4.9	42.5 \pm 1.7	23.3 \pm 5.8	(7.1; 39.5)	0.016*	–
Arginine	5.0 \pm 0.3	3.1 \pm 0.2	1.9 \pm 0.4	(0.7; 3.1)	0.012*	5–6
Histidine	3.3 \pm 0.3	1.6 \pm 0.1	1.7 \pm 0.4	(0.6; 2.7)	0.01*	1,5–2
Tyrosine	4.0 \pm 0.3	2.3 \pm 0.1	1.7 \pm 0.4	(0.6; 2.9)	0.013*	3–4

Note. 95% CI – 95% confidence interval of the difference; * – $p \leq 0.05$ significant differences among groups; ¹ – Group 1, ² – Group 2.

Table 3. Energy and macronutrients intake of athletes' (mean \pm SD)

Energy value and macronutrients	Before bodyweight reduction ¹	During bodyweight reduction ²	Mean difference (g) ^{1/2}	95% CI	p value
Protein, g \cdot kg ⁻¹ \cdot day ⁻¹	1.5 \pm 0.2	1.0 \pm 0.0	0.5 \pm 0.2	(0.1; 1.0)	0.024*
Fat, g \cdot kg ⁻¹ \cdot day ⁻¹	1.6 \pm 0.2	0.6 \pm 0.0	0.9 \pm 0.2	(0.4; 1.4)	0.008*
Cholesterol, mg \cdot day ⁻¹	0.9 \pm 0.2	0.1 \pm 0.1	0.8 \pm 0.2	(0.3; 1.4)	0.015*
Saturated fatty acids, g \cdot day ⁻¹	45.5 \pm 4.8	16.4 \pm 1.3	29.1 \pm 5.0	(15.3; 43)	0.004*
Polisaturated fatty acids, g \cdot day ⁻¹	17.2 \pm 1.5	7.1 \pm 0.8	10.1 \pm 2.1	(4.2; 16)	0.009*
Linolic acid, g \cdot day ⁻¹	15.4 \pm 1.4	6.2 \pm 0.8	9.2 \pm 2.0	(3.6; 14.9)	0.010*
Linoleic acid, g \cdot day ⁻¹	1.3 \pm 0.2	0.1 \pm 0.1	1.2 \pm 0.2	(0.5; 1.8)	0.007*
Carbohydrate, g \cdot kg ⁻¹ \cdot day ⁻¹	5.0 \pm 0.4	4.4 \pm 0.2	0.6 \pm 0.4	(-0.4; 1.6)	0.190
Dietary fiber, g \cdot day ⁻¹	31.8 \pm 3.0	25.9 \pm 1.4	5.9 \pm 3.6	(-4.2; 16)	0.180
Energy intake, ccal \cdot day ⁻¹	2781 \pm 210	1845 \pm 76	936 \pm 226	(307; 1564)	0.014*
Energy intake, g \cdot kg ⁻¹ \cdot day ⁻¹	40.0 \pm 3.8	27.2 \pm 0.9	12.8 \pm 3.4	(3.3; 22.3)	0.020*
Providing percentage (%) of total energy intake from:					
Carbohydrate, %	50.3 \pm 1.9	64.8 \pm 1.1	-14.6 \pm 1.9	(-19.9; -9.2)	0.002*
Protein, %	15.0 \pm 0.5	14.0 \pm 0.0	1.0 \pm 0.5	(-0.5; 2.5)	0.13
Fat, %	34.7 \pm 1.5	20.8 \pm 1.1	13.9 \pm 1.4	(10; 17.9)	0.001*

Note: 95% CI – 95% confidence interval of the difference; * – $p \leq 0.05$ significant differences among groups; ¹ – Group 1, ² – Group 2.

Athletes' diets lacked vitamins D, PP, B₁, and folic acid. The amount of vitamin D was 3.5 \pm 0.7 μ g (and the recommended norm is 5 μ g); B₁ – 1.4 \pm 0.1 mg (the recommended norm is 2 mg); PP-21.3 \pm 0.9 mg (the recommended norm is 22 mg); folic acid – 247.5 \pm 16.3 μ g (the recommended norm is 300 μ g). The amounts of minerals in athletes' nutrition are close to the recommended norms (Figures 2 and 3).

Having evaluated some indices of female basketball players' physical state in the laboratory tests (Table 2) we established that their muscle mass, which was 66.7 \pm 1.1% of the whole body mass on average, fit into the recommended limits: from 64 to 80%, and the muscle mass of both arms and legs did not differ. Athletes' BMI was 23.1 \pm 0.9 kg / m², and it is evaluated as adequate (from 19 kg / m² to 24 kg / m²), their MFMI – as

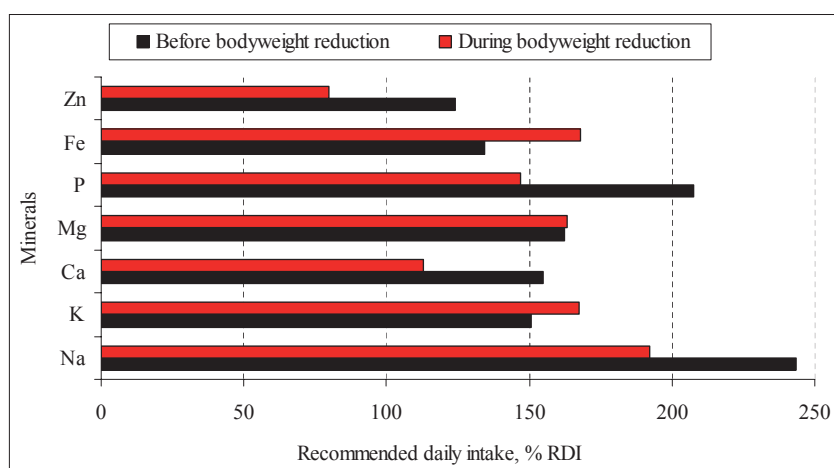


Figure 2. Mineral intake of athletes

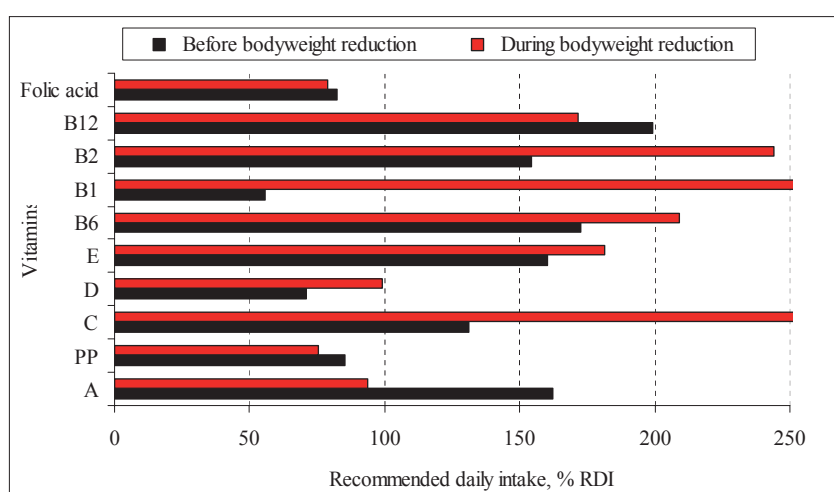


Figure 3. Vitamin intake of athletes

too low 2.4 ± 0.2 (from 1.9 to 2.8) because their fat body mass, which was $27.6 \pm 1.1\%$ of the whole body mass on average, is slightly too high, but it is evaluated as acceptable (from 25 to 29%). Thus, aiming at achieving better technical and tactical fitness, and consequently better results, Lithuanian Olympic Sport Centre female basketball players reduced their body fat and increased their MFMI. For this purpose they received individual food rations with reduced energy values (Table 2). As the food rations before the moderate body mass reduction program lacked vitamins B₁, D, PP and folic acid, their food rations were supplemented by “Vitamax” food supplement capsules, and the amounts of vitamins and minerals during the body mass reduction program were close to the recommended norms (Figures 2 and 3).

During the moderate body mass reduction period, female athletes' overall body mass decreased statistically significantly – 2.2 ± 0.3 kg ($p = 0.003$), their lean body mass – 0.6 ± 0.1 kg ($p = 0.012$), muscle mass – 0.4 ± 0.1 kg ($p = 0.022$), general body fluids – 0.4 ± 0.1 kg ($p = 0.01$), intracellular fluids – 0.3 ± 0.1 kg ($p = 0.025$), amount of minerals – 0.1 ± 0.01 g ($p = 0.004$),

however, the amount of proteins remained unaltered ($p = 0.621$) (Table 1). MFMI increased from 2.4 ± 0.2 to 2.6 ± 0.2 ($p = 0.028$), thus we suggest that when the lean body mass decreases at the expense of fluids, the loss of body fat mass – 1.6 ± 0.3 kg ($p = 0.010$) – was useful to basketball players aiming at increasing the ratio between muscle mass and fat mass.

After evaluating the influence of reduced energy value nutrition on the changes in athletes' body fat mass, we established that the reduction of body fat mass was mostly linked to the reduced energy value of athletes' food rations and the lower amount of fats ($r = 0.8$ and $r = 0.7$), as well as lower amount of carbohydrates ($r = 0.6$).

The indices of fat metabolism in athletes' blood (Ch, MTL Ch, DTL Ch, TG) did not differ statistically significantly before and after the reduced energy value nutrition of moderate duration. Ch concentration before and after the reduced energy value nutrition was between 3.7 ± 0.6 mmol / l and 3.5 ± 0.4 mmol / l ($p = 0.19$), MTL Ch – from 1.9 ± 0.5 mmol / l and 1.8 ± 0.3 mmol / l ($p = 0.4$), DTL Ch – 1.2 ± 0.3 mmol / l and 1.1 ± 0.1 mmol / l ($p = 0.62$), TG – 1.2 ± 0.3

mmol / l and 1.1 ± 0.3 mmol / l ($p = 0.68$). However, there was statistically significant reduction in Glu concentration in blood (from 5.04 ± 0.18 mmol / l to 4.6 ± 0.16 mmol / l ($p = 0.02$)). Reduced Glu concentration was linked to lower energy value in food ($r = 0.9$) and lower amount of carbohydrates ($r = 0.9$).

After evaluating the difference in PWC_{170} indices before and after the moderate body mass reduction, we established that PWC_{170} indices before and after the moderate body mass reduction statistically significantly decreased from 1245 ± 150 kgm / min (18 ± 1.3 kgm / min / kg) to 1035 ± 205 kgm / min (15 ± 0.6 kgm / min / kg) ($p = 0.01$). We established statistically significant relationship between reduced Glu concentration in blood and reduced PWC_{170} ($R^2 = 0.49$).

DISCUSSION

In the last decade athletes' nutrition has not changed: elite athletes' diets lack carbohydrates, the amount of fat is too high, and the amount of proteins is efficient (Baranauskas et al., 2007, 2009; Pečiukonienė et al., 2007, 2009; Stukas et al., 2009). Lithuanian Olympic Sport Centre female basketball players are no exception. Their food rations have too much saturated fat acids, linoleic cat acids, but they lack carbohydrates, indispensable amino acid methionine and linolenic fat acid, and the amount of proteins is sufficient. Besides, our research participants' nutrition lacked vitamins D, B₁ and folic acid, but the indices of minerals compared to the nutrition of elite athletes were closer to the recommended norms.

Our research results proved that during the moderate body mass reduction diets rich in carbohydrates, lacking fats and cholesterol and having low energy values were efficient in reducing athletes' fat body mass, and they did not affect the indices of fat metabolism in female basketball players' blood. Our findings confirmed the findings of other researchers (Hortobagyi et al., 2004; Kersick, 2009; Stukas et al., 2009) who found that peculiarities of athletes' nutrition did not significantly affect fat metabolism in blood, and those changes were due to physical activities and genetic factors, but not the amount of cholesterol in food (Bui et al., 2010).

Reduction of body fat mass of female basketball players more depended on the energy values of their food rations than on the balance of the main nutrients in their food. Lower amount of

carbohydrates than recommended (4.4 ± 0.2 g / k of body mass) negatively influenced concentration of glucoses in blood and aerobic working capacity, but it was sufficient for the maintenance of normal concentration of glucoses and hormone insulin in blood. This amount was enough for the supplies of glycogen to remain only partly reduced. Consequently, the amount of proteins in food rations of basketball female players, which was 1.0 ± 0.0 g / kg of body mass on average, was able to meet their needs. This was confirmed by statistically significant difference found in the amount of proteins in athletes' organisms before and after body mass reduction. On the other hand, athletes' body mass was reduced at the expense of fluids, and the losses were 0.4 ± 0.1 kg: with the reduced amounts of glycogen athletes lose water as well.

So, the 12-day period of female basketball players' body mass reduction is not optimal when the energy value of food is reduced by 936 ± 226 kcal on average compared to the usual values because it can negatively impact aerobic working capacity, only if 4 days before the competitions, aiming at increasing the amount of endogenous glycogen in muscles and improving the indices of aerobic working capacity the athletes increased the energy value of their food by 30% and the amount of carbohydrates – to 8 g / kg of body mass a day (Tarnopolsky et al., 2001) because otherwise, under the conditions of longer and more intensive training, their supplies of carbohydrates would run out more, and if they were not regained with food, their bodies could suffer from the increased amount of hormone cortisol and reduced concentration of testosterone (Vaszquez, Adibi, 1992; Remer, 2001), metabolic acidosis and reduced lean body mass (Gougeon-Reyburn et al., 1991; Layman et al., 2005; Mero et al., 2010) could be observed as well as indices of aerobic and anaerobic working capacity.

CONCLUSIONS AND PERSPECTIVES

The main nutrients of food rations of Lithuanian Olympic Sport Centre female basketball players are not balanced. The misbalance is mainly conditioned by the reduced amount of carbohydrates and too much fat in athletes' food. Vitamins D, PP, B₁ and folic acid in food do not reach the recommended norms for the day, though the amounts of minerals are close to the recommended norms.

Low energy value nutrition of moderate duration, when the energy value of food is lower by 1000 kcal than the regular one, and the percentages of energy values from carbohydrates, proteins and fats are respectively 65, 14 and 21%, is efficient in increasing the ratio of athletes' muscle mass and fat mass ($p < 0.05$), but it negatively affects glucose concentration in blood as well as aerobic capacity ($p < 0.05$).

Basketball players' nutrition with little fat and low in energy value for a very short time affects fat metabolism in athletes' organisms: the fat body mass reduces ($p < 0.05$), but it does not affect the concentration of general cholesterol ($p > 0.05$), low density lipoprotein cholesterol ($p > 0.05$), high density lipoprotein cholesterol ($p > 0.05$) and triacylglycerol ($p > 0.05$) in blood plasma.

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KAI KURIE LIETUVOS OLIMPINIO SPORTO CENTRO KREPŠININKIŲ MITYBOS IR KŪNO MASĖS MAŽINIMO YPATUMAI

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Didelio meistriškumo sportininkai, norėdami sumažinti kūno masę, dažnai praktikuoja sumažintos energinės vertės labai nedaug angliavandenių turinčią mitybą. Visgi specialistai pastebi, kad itin svarbu nustatyti, kokią įtaką daro saugesnė vidutinės trukmės daug angliavandenių turinti sumažintos energinės vertės mityba sportininkų kūno masei ir fiziniam darbingumui.

Tikslas: ištirti ir įvertinti Lietuvos olimpinio sporto centro krepšininkų ($n = 10$) faktinę mitybą ir vidutinės trukmės sumažintos energinės vertės mitybos daromą įtaką kūno masei ir jos komponentams, aerobiniam darbingumui bei kai kuriems kraujo biocheminiams rodikliams.

Metodai. Tikslui pasiekti prieš sumažintos energinės vertės mitybą ir jos metu ištirta sportininkų faktinė mityba. Prieš mažinant kūno masę ir po to įvertinti kai kurie fizinio išsivystymo rodikliai, kraujo riebalų apykaitos rodiklių (bendrojo cholesterolio, mažo ir didelio tankio lipoproteinų cholesterolio, triacilglicerolių) bei gliukozės koncentracija. Aerobinis darbingumas nustatytas atlikus PWC₁₇₀ testą.

Rezultatai. Krepšininkų maisto racionuose pagrindinės maistinės medžiagos nesubalansuotos, nes angliavandenių, linoleno riebalų rūgšties, nepakeičiamos aminorūgšties metionino, vitaminų D, PP, B₁, folio rūgšties kiekiai nesiekia rekomenduojamų, o riebalų kiekis, priešingai, – rekomenduojamą viršija. Kūno masės mažinimo metu krepšininkų kūno masė, riebalų masė, organizmo mineralinių medžiagų kiekiai sumažėjo atitinkamai $2,2 \pm 0,3$ kg ($p < 0,05$), $1,6 \pm 0,3$ kg ($p < 0,05$), $0,1 \pm 0,4$ kg ($p < 0,05$), tačiau nekito jų organizmo baltymų kiekis ($p > 0,05$).

Aptarimas ir išvados. Norint nepabloginti fizinio darbingumo rodiklių, vidutinės trukmės sumažintos energinės vertės mityba, kurios energinė vertė sudaro mažiau kaip 30 kcal / kg kūno masės, o angliavandenių kiekis joje – mažiau kaip < 5 g / kg kūno masės per dieną, sportininkams yra nerekomenduojama.

Raktažodžiai: mityba, moterų krepšinis, kūno masės mažinimas.

Gauta 2011 m. kovo 17 d.
Received on March 17, 2011

Priimta 2011 m. birželio 16 d.
Accepted on June 16, 2011

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INFLUENCE OF SHORT-TERM FASTING ON THE CHANGES IN WOMEN'S CARDIOVASCULAR FUNCTIONAL PARAMETERS

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ABSTRACT

Research background and hypothesis. Recently, cardiovascular diseases (CVD) have been the major cause of mortality as a result of poor diet, emotional stress and insufficient physical activity. Improvement of dietary habits based on reduction of body weight by short-term or long-term fasting has been observed. While analyzing the effect of fasting, its psychological rather than physiological features are usually emphasized.

Research aim was to assess the impact of daily fasting on the changes in women's cardiovascular functional parameters during physical load.

Research methods. Thirty six women performed exercise test on bicycle ergometer (the load increased each minute by 25 W) before and after 24 hours of fasting. After the 1st exercise test the subjects used only non-energetic liquid. Evaluation of electrocardiogram (ECG) data was performed applying computerized ECG analysis system "Kaunas-Load" (Institute of Cardiology, LUHS). We analyzed systolic blood pressure (S), heart rate (HR) and JT interval at rest and throughout the load.

Research results. After 24 hours of fasting, HR of women at rest and during the first 3 minutes of the load significantly decreased ($p < 0.05$). Duration of the JT interval decreased during both exercise tests. Longer JT interval was obtained at rest and during the first 2 minutes of the load after 24 hours of fasting ($p < 0.05$). S at rest and throughout the load was significantly lower after fasting ($p < 0.05$).

Discussion and conclusions. Functional state evaluation of untrained women after 24 hours of fasting during bicycle ergometry test demonstrated dynamical changes of many cardiovascular function variables: lower HR, increased the JT interval, and decreased S.

Keywords: cardiovascular system, short-term fasting, bicycle ergometer test.

INTRODUCTION

Emotional stress, fatigue, sleep disorders and improper diet are basic factors resulting in ischemic heart disease, angina pectoris, myocardial infarction or stroke (Singh et al., 2001). In order to maintain the body functions, first of all, whatever their reasons (health problems, religion, etc.), people change their dietary habits (Johnson, Leck, 2010). Even 14%

of Americans were fasting for weight reduction or weight control, which contributed to the solution of the obesity problem. However, other medical documents witnessed the data of the consequences of long-term fasting, in particular, those with normal body weight (participants of hunger strike, prisoners of war, victims of famine, etc.) (Johnstone, 2003).

Fasting is defined as a period of having low intake or abstinence from all vital nutrients. During this period, first of all, the changes related to the cardiovascular system (CVS), frequently defined as pathological, occur (Singh et al., 2001; Zhang et al., 2010). Following the meal, during the period of 3–12 hours the body undergoes an „early“ fasting phase, which is called post-absorptive. After this phase, a „real“ fasting phase marked by hypoglycemia and increased glucogenic activity occurs (Varady, Hellerstein, 2007).

Excess of energetic substances also trigger negative consequences, since they accumulate in the body as fats resulting in cardiovascular diseases (CVD) or diseases of other functional systems (Vaisvalavičius et al., 2006).

Homeostasis is maintained not only by well-balanced diet but also by physical activity – two inseparable factors. Improper diet places an additional stress on the body and may limit daily possibilities of physical activity (Vizbaraitė, Petronytė, 2005; Johnson, Leck, 2010). Short-term fasting affects the general body function. Studies demonstrated that due to fasting, sportspeople's aerobic endurance reduces and reaction time increases, and heart rate (HR) as well as lactate level increase during load (Ainslie et al., 2003; Johnson, Leck, 2010).

Our literature review showed that most common fasting was observed when investigating elite athletes. Moreover, the changes of cognitive functions are analysed rather than alterations of the parameters of functional systems (Rampersaud et al., 2005; Johnson, Leck, 2010). There is still a lack of evidence that fasting affects functional capacity of non-sporting individuals. Therefore, it is hypothesized that short-term fasting (24 hours), when an individual has no intake of nutrients and consumes only water, affects the parameters of the cardiovascular system (CVS). When analysing CVS, our studies allow more comprehensive evaluation of adaptation of the human body to physical loads and changes following twenty four hours. Interpretations of the data based on the model of integrated evaluation of human organism as a complex adaptive system proposed by A. Vainoras is widely used in analogous interpretations in Lithuania as well as beyond it (Vainoras et al., 2008).

The aim of the study was to assess the impact of daily fasting on the changes in the cardiovascular functional parameters of women during physical load.

RESEARCH METHODS

The study included 36 women who did not have any health complaints and whose ECG were without any pathological changes. The mean age of participants was 32.03 ± 1.57 years, height – 170 ± 0.14 cm, weight – 71.96 ± 2.56 kg, BMI – 24.71 ± 0.69 kg / m².

The participants performed an increasing every 1 minute (by 25 W) exercise test on a bicycle ergometer before and after 24 hours of fasting. After the first bicycle ergometry test the subjects only used liquid of no energizing value (water). In order to evaluate the functional state of the cardiovascular system we used a computerized electrocardiogram (ECG) analysis system „Kaunas-load“, which was developed at the Institute of Cardiology, LUHS. Both tests were performed from 6 to 8 o'clock in the evening. Synchronously 12 leads of ECG and the arterial blood pressure were recorded during the bicycle ergometry test. The initial load of bicycle ergometry for all participants was 25 W, every minute increased by 25 W up to 150 W. The workload level was evaluated as higher than average, but not maximum. The speed of workload was 60–65 rpm. Every minute arterial blood pressure was measured before the load and during the workload. During the investigations systolic blood pressure (S), heart rate (HR) and JT interval dynamics were estimated.

Student *t* test was used for paired samples to evaluate the confidence level of the data. The differences were valued as statistically significant, if $p < 0.05$. The results are presented as arithmetic mean \pm standard deviation.

RESEARCH RESULTS

When evaluating the changes of regulatory processes of HR, HR changes were analysed. Based on the results of the study, prior to fasting, the relative resting HR of the investigated women was 87.38 ± 2.23 beats / min. During the exercise test HR increased with an increase of workload (by 25 W) and after the development of maximal power (150 W) it reached 145.82 ± 2.73 beats / min. Repeated exercise test after 24 hours of fasting revealed a significantly decreased HR of 81.83 ± 2.20 beats / min at a relatively steady state ($p < 0,05$). The comparison of the data of cycling exercise performed at different levels of intensity showed that statistically significant

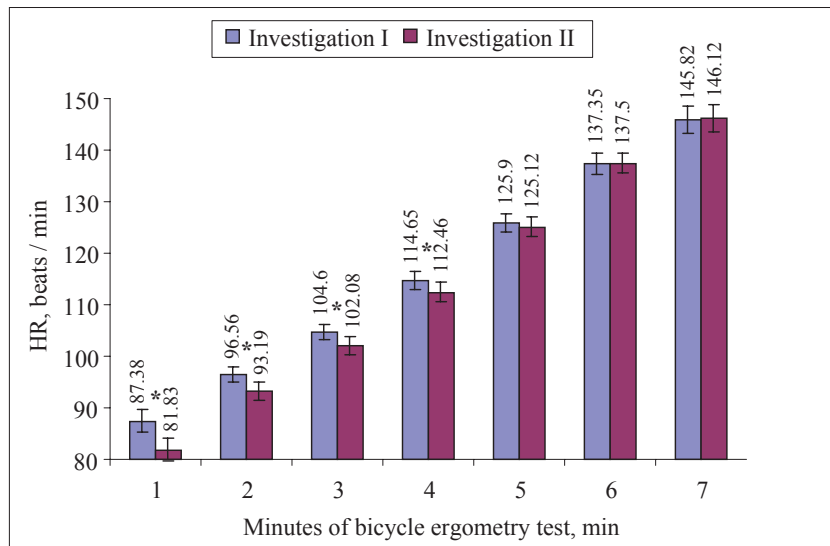


Figure 1. HR changes during investigation I and II

Note. * – $p < 0.05$.

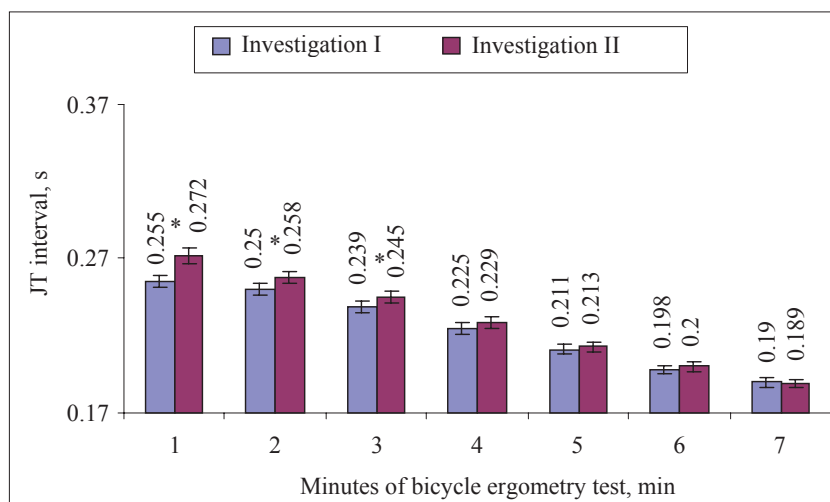


Figure 2. JT interval changes during investigation I and II

Note. * – $p < 0.05$.

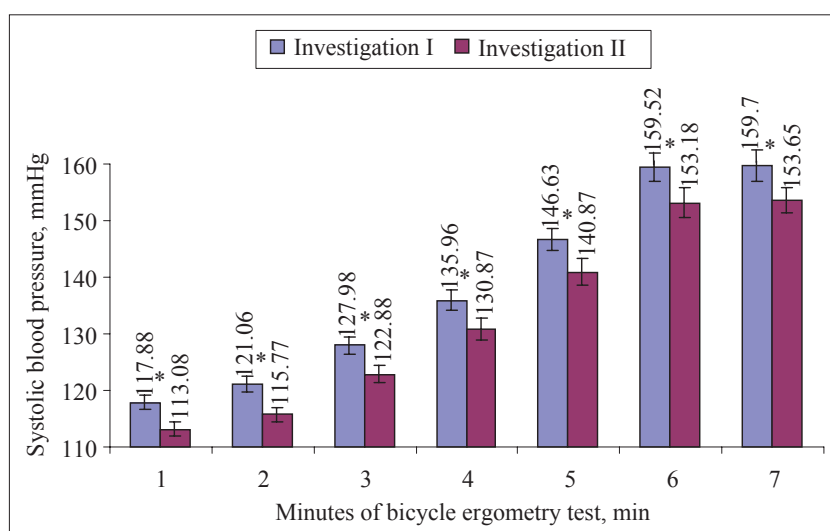


Figure 3. Systolic blood pressure changes during investigation I and II

Note. * – $p < 0.05$.

heart rate variability was recorded at the second (25 W), third (50 W) and fourth (75 W) minutes ($p < 0.05$), while at the fifth (100 W), sixth (125 W) and seventh minutes (150 W) there was a slight difference in the results ($p > 0.05$). After fasting, the maximal recorded HR during exercise test was 146.12 ± 2.58 beats / min (Figure 1).

Analysis of the JT interval, which reflects metabolism changes, demonstrated the shortening of this interval during the cycling exercise test. This apparent trend was observed both during the first test and the repeated test following 24-hour-fasting (Figure 2). However, HR (see Figure 1) and JT interval (see Figure 2)

differences at higher power before and after fasting disappeared.

The comparison of the results of both tests determined that JT duration over the first test (0.255 ± 0.004 s) statistically significantly differed from JT interval that was recorded after fasting 0.272 ± 0.005 s ($p < 0.05$). At the second and third minutes (power corresponds to 25 W and 50 W) the values of the JT interval significantly differed prior to and after fasting ($p < 0.05$). The shortening of the JT interval during the workload ranged from minimal (25 W) to maximal (150 W) level of intensity, however, the tendencies of longer values of the JT interval were recorded following 24-hour fasting.

Evaluation of systolic ABP data that were received during bicycle ergometer prior to fasting and following 24-hour-fasting revealed that the differences were statistically significant during all work load ($p < 0.05$). Before the first investigation the resting systolic blood pressure was 117.88 ± 1.17 mmHg, and after 24-hours of fasting it was 113.08 ± 1.25 mmHg ($p < 0.05$).

Systolic blood pressure increased with an increase in levels of intensity from 25 W to 150 W and reached the maximal value of 159.70 ± 2.68 mmHg before fasting, but after fasting systolic blood pressure of 153.65 ± 2.28 mmHg was determined ($p < 0.05$) (Figure 3).

DISCUSSION

Recently, more attention has been focused on the risk factors that are associated with CVS, which account for the highest rate of mortality (Folta, Nelson, 2010). Therefore, awareness of physical activity and dietary habits that are based on recommendations of cardiologists, are promoted. In order to maintain the optimal or proper body function, an increase of level of physical capacity as well as adaptation to diet in terms of its quality, quantity and frequency are taking place (Singh et al., 2001; Folta, Nelson, 2010). Thus changes in body mass that are linked to health disorders (diabetes, hypertension, dyslipidemia, obesity, etc.) can be controlled (Zhang et al., 2010). Not rarely, short-term or long-term fasting is used to reduce body weight whatever its reasons might be: disease or esthetics. However, the studies that analyse the impact of fasting are more concerned with changes in cognitive processes rather than functional body systems, i. e., more attention is drawn to psychological rather than physiological processes (Rampersaud et al., 2005).

Apparently body weight changes have influence on the activity of the cardiovascular system, thus it is important to analyze adaptation of CVS under changing conditions. HR, which reflects the peculiarities of mobilization function of CVS during exercises, is the most commonly analysed parameter in scientific studies, since its variability is observed from the first seconds of load (Shephard, Balady, 1999). In addition, it is particularly easily and reliably recorded. HR increases with the gradual increase of workload. The increase of HR during load results from alteration of the sympathetic nervous system activity.

Obviously, proportional increase of HR values observed during exercise test were also evident after the day of fasting. Lower HR values at rest and onset of workload showed early CVS response to 24-hour fasting, which may be conditioned upon the tone of the parasympathetic system increases and energetic substrates reduction in blood. Our obtained results confirmed R. B. Singh's et al. (2001) proposition that fasting is also a decisive factor of the resting and the exercising HR variability.

According to the model of intergrated evaluation of human organism as a complex adaptive system it is known that in the evaluation of the human body during workload not only HR shows the state of it. JT interval illustrates the course of ventricular repolarization process, and may be used as a parameter of repolarization duration (Perkiomaki, 2003). Change of JT intervals over work load is linked to variability of myocardium metabolism and correlates (there is a strong and very strong negative correlation) with HR increase (Jarusevičius, 2000). When JT interval shortens to 160 ms, the maximal rate of metabolism in the heart is reached (Poderys et al., 2007). When performing every minute increasing cycling exercise test prior to fasting (investigation I), and after 24-hour-fasting (investigation II) JT interval values recorded after maximal power (150 W) did not shorten to the minimal duration (160 ms) (Hlaing et al., 2005). A comparison of the results of both studies revealed that significant changes in the heart metabolism were determined at rest and during the first two levels of intensity (25 and 50 W) ($p < 0.05$). Thus, duration of ventricular repolarization following 24 hours of fasting significantly increased, and the rates of heart metabolism were slower at lower workloads and this process disappeared at more intensive

workloads, what goes well with the changes in the specificity of the HR dynamics. 24-hour fasting did not lead to myocardial metabolic pathological deviations.

The circulation system adapts to the body needs and provides blood supply to all organs; with blood the body obtains oxygen and nutrients. Thus, when the body adapts to the environmental conditions and increasing intensity of physical activity, regulatory system of the body, which similarly determines alterations of HR, redistributes blood flow in the body. ABP dynamics demonstrates changes occurring in blood vessels, redistributing hemodynamical flows (Evrengul, 2006). Variation in hemodynamics, including an increasing HR and systolic blood pressure shows that regulatory system of the body analogously influences these two indexes, but observed differences between last-mentioned indexes reveals undefined fact that specifics of their management is different. Thus, only an increased parasympathetic tone after fasting could not explain this phenomenon

According to the other studies (Singh et al., 2001), our results also confirmed the statement that even 24-hour fasting also determines significantly decreased systolic ABP, both at rest and during exercise test (bicycle ergometry test). The findings of our study support this claim as recorded values of systolic ABP during all levels of intensity were significantly smaller after fasting ($p < 0.05$). Differently from evaluation of HR or JT interval, values of systolic ABP during maximal load (150 W) were also significantly smaller after fasting ($p < 0.05$).

CONCLUSIONS AND PERSPECTIVES

The analysis of the assessment of the functional state of untrained women after 24 hours of fasting while they were performing a bicycle ergometry test demonstrated the change of dynamics of many variables of the cardiovascular function: A lower heart rate, an increase in the JT interval duration, and a decrease of systolic blood pressure.

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TRUMPALAIKIO BADAVIMO ĮTAKA MOTERŲ ŠKS FUNKCINIŲ RODIKLIŲ KAITAI

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Pastaruoju metu širdies ir kraujagyslių sistemos (ŠKS) ligos yra pagrindinė mirštamumo priežastis, kurią lemia netinkama mityba, stresas, fizinio aktyvumo sumažėjimas. Siekiant teigiamų pokyčių, neretai mažinamas kūno svoris trumpalaikiu arba ilgalaikiu badavimu. Visgi tiriant badavimo poveikį dažniau akcentuojami psichologiniai, o ne fiziologiniai veiksniai.

Tikslas: įvertinti paros badavimo poveikį moterų ŠKS funkcinių rodiklių kaitai fizinio krūvio metu.

Metodai. 36 moterys atliko pakopomis (po 25 W) kas 1 minutę didinamo fizinio krūvio veloergometrinių mėginių prieš badavimą ir praėjus 24 valandoms po jo. Tiriamosios po pirmo veloergometrinio mėginio 24 valandas vartojo tik vandenį. ŠKS funkcinei būklei vertinti buvo naudojama KMU Kardiologijos institute sukurta kompiuterizuota EKG analizės sistema „Kaunas–Krūvis“. Tyrimo metu buvo analizuota sistolinio kraujospūdžio (S), širdies susitraukimų dažnio (ŠSD) ir JT intervalo kaita ramybės sąlygomis, fizinio krūvio metu.

Rezultatai. Po 24 valandų badavimo ŠSD ramybės sąlygomis ir pirmas tris krūvio minutes reikšmingai sumažėjo ($p < 0,05$). JT intervalo trukmė viso fizinio krūvio metu trumpėjo. Užregistruotos ilgesnės JT intervalo reikšmės ramybės metu ir pirmas dvi fizinio krūvio minutes po badavimo ($p < 0,05$). S ramybės sąlygomis ir viso fizinio krūvio metu po paros badavimo reikšmingai sumažėjo ($p < 0,05$).

Aptarimas ir išvados. Vertinant nesportuojančių moterų funkcinę būklę po paros badavimo, daugelis ŠKS funkcinių rodiklių buvo pakitę: užregistruotas mažesnis ŠSD, pailgėjęs JT intervalas ir sumažėjęs S.

Raktažodžiai: širdies ir kraujagyslių sistema, trumpalaikis badavimas, veloergometrinis mėginys.

Gauta 2010 m. spalio 26 d.
Received on October 26, 2010

Priimta 2011 m. kovo 17 d.
Accepted on March 17, 2011

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PRECONDITIONS OF YOUNG LEARNERS' HUMANISTIC EDUCATION DURING PHYSICAL EDUCATION LESSONS

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ABSTRACT

Research background and hypothesis. Favourable conditions for children's humanistic education will occur after the implementation of the programme of junior schoolchildren's humanistic education in physical education lessons.

Research aim was to analyze the background for junior schoolchildren's humanistic education theoretically and to determine the tendencies of changes in the relationship between schoolchildren and teachers in physical education lessons.

Research methods. Literature review and questionnaire survey.

Research results. After the implementation of humanistic education program for junior schoolchildren in physical education lessons, their behavior became more humanistic, their relationship with classmates and teachers improved. Our findings coincided with those of the other authors. Junior schoolchildren's relationship particularly lack sensitivity. The findings of Group E have shown that children of that age group can already understand moral concepts and base their behavior on them. The experimental program had an effect not only on the behavior of children in Group E, but also on their teachers' behavior, which became more humanistic.

Discussion and conclusions. Junior schoolchildren's education in a humanistic, safe and functional environment which fosters sincere relationship changed the relationship between pupils and teachers, so it can be assumed that the experimental program has proved to be successful in pedagogical practice. The study shows the changes of behavior of Group E teachers who participated in the educational experiment.

Keywords: humanistic education, physical education lesson, relationship among junior schoolchildren.

INTRODUCTION

All the world feels the recession of values, therefore, it is necessary to develop children's humanism from the moment they start school. According to A. Gumuliauskienė (2001), the most important age for developing person's humanistic values is young school age, as it is the period of intensive development of child's personality, their self-awareness, and relations with themselves and the world (Pileckaitė-Markovienė, 2005). D. Augienė (2002) points out

that social knowledge at this age is related to the understanding of friendship and the development of the contemplations of ethics; a more purposeful ambition for self-help – situational self-control and correction of one's behaviour – is noticed. Today's school faces the requirement to organise the educational process by creating humanistic relationship based on humanistic values; the main purpose of the education of a young generation is, according to V. Rajeckas (2001), the development

of a well-rounded, democratic and humanistic personality with high national consciousness. Humanism (lat. *humanus*) is understood as a positive attitude towards a person, the object of love and respect; human life is the highest value; the core value of a well-rounded and mature person is communication based on humanistic relation (Bitinas, 2004), which is the base of spirituality and honesty (Bakutyte, 2001).

Humanistic education helps learners understand their needs, acquire inner freedom and develop responsibility, try to adapt humanistic values as their own values, form positive self-evaluation, encourage consciousness and activity of behaviour (Cibulskaitė, 2000), and join cognitive and emotional elements of teaching. A person who is thrilled with the joy of pure emotional experience feels and experiences values as the objects of conscientious behavior (Stančienė, 2005), and experiencing a certain feeling, one is able to determine what is more or less valuable (Martišauskienė, 2001). If people strictly follow the code of morals, when they break it, they feel guilty, and if people doubt some values, they need to decide either to choose some of them or not, and the values which always get the priority are called the essential personal values (Ursery, 2005), which are already the essence of a personality and have a motivational function in everyday life.

However, according to E. Armavičiūtė (2004), there is a clear gap between what learners know about proper behaviour and their real behaviours. Therefore, the ability to make decisions takes an important place in the process of internalisation of learners' ethical values, when students have to express their thoughts about many ethical issues or ethical principles, to choose one or the other manner of behaviour, and to distinguish the good from the evil (Vasiliauskas, 2005). In the opinion of B. Bitinas (2004), teaching, ethical education encourages students to behave in a humanistic way, however, solid humanistic forms of behaviour can be developed only through practice. Therefore, it is necessary to develop not only ethical attitudes, beliefs, feelings, ideals, but also behaviour, as behaviour is an important index of one's social values (Ališauskienė, 2005). According to L. Jovaiša (2001), children's humanistic behaviour and their social competences can be developed in humanistic relations between teachers and learners. Observing students' activities during Physical Education lessons teachers have to react instantly to inappropriate behaviour of their students,

analyse and discuss it with all classmates (Knudson, Morrison, 2002; Schmidt, Wrisberg, 2004). During Physical Education lessons children should be taught appropriate behaviour directly (Eldar, Ayvazo, 2009) by providing them not only with theoretical ideas which reflect humanistic behaviour, but also they should be shown how to adapt them to real situations (Bitinas, 2004). According to M. Jonilionė (2008), it is possible to observe children's efforts to solve problems, which bother them, and to stick to certain behaviour rules at play, but a teacher should notice if children do not hurt others while solving their problems. D. Hellison (1995) points out the necessity of the teacher's applied strategies, which help to impart values to children by changing the rules of a game, modelling different situations, thus children's behaviours are observed and corrected (Morris, Stiehl, 1999). When children behave in a humanistic way during Physical Education lessons, the teacher should emphasise such behaviour by praising them, thus encouraging other children to praise their peers, behave honestly, stick to the rules of a game and help to create a safe environment (Sullivan, 2006).

The relevance of humanistic education is reflected in many studies by foreign and Lithuanian scientists. The problems of humanistic education are observed in different levels and aspects, however, there is no research which examines the problem of young learners' humanistic education during Physical Education lessons. This fact does not allow forming a whole view of the status of humanism during Physical Education lessons among children of this age group. After starting school, primary school learners face difficulties of socialisation (Augienė, 2002) as children often lack consideration and openness (Bakutyte, 1998). Children encounter their peers' intolerance and inability to tackle conflicts during Physical Education lessons, and the increase in children's aggression is becoming a topical problem for the society (Rupšienė, Plačienienė, 2002). Therefore, it is necessary to humanise the educational process. In order to solve the problem of young learners' humanisation during Physical Education lessons, it is necessary to reorganise physical education making it more humanistic, therefore, it is important to discuss the preconditions of young learners' humanistic education theoretically and to determine changes in relations between children and teachers during Physical Education lessons.

Hypothesis. The realisation of our created humanistic programme of Physical Education

lessons for young learners encouraging their relations based on sensitivity, openness, dignity and responsibility and expressing them in their humanistic behaviour will create favourable conditions for children's humanistic education.

Research object. Young learners' humanistic education during Physical Education lessons.

Research aim was to discuss the preconditions of young learners' humanistic education theoretically and to determine the tendencies in the changes of relations between children and teachers during Physical Education lessons.

Research aims:

1. To discuss the presumptions of young learners' humanistic education during Physical Education lessons theoretically.
2. To determine the change of relations among children and teachers during Physical Education lessons.

RESEARCH METHODS

Philosophical, pedagogical, and psychological literature was studied, the preconditions of humanistic education during Physical Education lessons were discussed. Anonymous questionnaires were given to young learners at the beginning and the end of the educational experiment with the aim to research children and teachers' relationship and the tendencies of their changes during Physical Education lessons. The questionnaires consisted of 21 multiple choice questions. Computer programme *SPSS 10.0* processed the research data. The correlational analysis of the data was conducted, the differences and the reliability and validity of the research data were determined.

Research organisation. The educational experiment was carried out in two Klaipeda schools in 2006–2007. Group E children were educated according to General Programmes and Educational Standarts of Lithuania's General School (2003) and integrated our created programme of young learners' humanistic education during Physical Education lessons. Group C children were educated during Physical Education lessons only according to General Programmes and Educational Standarts of Lithuania's General School (2003). The research used a random sample, but both Group E and C were homogeneous: 81 children from Group E and 82 children from Group C participated in the first research of the educational experiment, relatively 80 children from Group E and 80 children from Group C – in the second research. Our created

programme ensured that the children were educated in humanistic, safe and functional educational environment, emphasising the value of every child as a personality. Humanistic values were imparted to children during Physical Education lessons, they were taught to communicate and collaborate. Apart from traditionally accepted knowledge of the subject, a system of positive attitudes towards different areas of knowledge was formed, and the humanistic values, were imparted by the teacher to the children in the main part of a Physical Education lesson by observing and correcting children's relationship and behaviour and in the final part of a lesson by discussing the results of the lesson.

RESEARCH RESULTS

Our created programme ensured that during the experiment the children were educated in humanistic, safe and functional educational environment; the relationship among children and teachers and its changes were researched. The second research determined that the number of Group E children who always tried to cheer their classmates ($Z = -3.68$; $p < 0.001$) increased. Even 23.6% of Group E children and 12.0% of Group C always tried to cheer up their classmates when they were sad, which allows to state that the children from Group E became more considerate towards their classmates trying to cheer their classmates more often, than the children from Group C. There was a significant increase in the number of the children from Group E who often and always consoled their classmates ($Z = -6.248$; $p < 0.001$). As many as 22.5% of children from Group E and 3.6% from Group C always consoled their classmates during Physical Education lessons when they failed to perform a task or activity, which means that the children in Group E became more considerate towards their classmates in a year as they consoled their classmates more often than the children from Group C. A statistically significant difference ($Z = -7.293$; $p < 0.001$) between the results of Groups E and C in consoling their classmates was determined. The number of children from Group E who never helped their classmates dramatically decreased, and more children appeared who always helped their classmates. Thus, 21.2% of Group E and 2.4% of Group C children always helped their classmates when they failed to perform a task or activity; a statistically significant difference ($Z = -7.197$; $p < 0.001$) between the results of Groups E and C was determined. The children from Group E

became more considerate towards their classmates in a year, helping their classmates more often when they failed to perform a task or activity than the children from Group C ($Z = -6.423$; $p < 0.001$). Children always want to be noticed and accepted the way they are by their peers, and, if there are no possibilities to meet these needs; they feel unsafe, which makes them act impulsively and hastily. All this decreases learning motivation and socialisation and causes behaviour problems even in primary classes. There was a significant increase in the number of the children from Group E who never hurt or offended their classmates during Physical Education lessons ($Z = -4.818$; $p < 0.001$). Even 72.5% of children from Group E and 61.4% of the children from Group C never hurt or offended their classmates during Physical Education lessons when they failed to perform a task or activity, which allows to state that the children from group E became more tolerant and considerate towards their classmates than the children in Group C; a statistically significant difference ($Z = -2.033$; $p < 0.05$) between the results of Groups E and C was determined. It suggests that children from Group E became more humanistic and tolerant to their classmates in a year than the children from Group C as they did not hurt their classmates because of their failures.

In a year the number of the children from Group E who always shared their joy and sorrow during Physical Education lessons with their classmates increased ($Z = -3.651$; $p < 0.05$). As many as 32.5% of the children from Group E and 26.5% from Group C thought that their classmates always shared their joy and sorrow with them. Other classmates were more open and shared their feelings more often with children from Group E than Group C. A statistically significant difference of the results between children in Groups E and C was determined ($Z = -2.39$; $p < 0.05$). We found that 73.8% of the children from Group E and 68.70% from Group C never cheated or lied to their classmates during Physical Education lessons. Children in Group E were more honest while socialising with their classmates, they did not cheat or lie, shared their feelings and experiences with others, got on well with their classmates and behaved humanistically more often than the children from Group C. There was a significant increase in the number of children from Group E who always praised their classmates for their achievements during Physical Education lessons ($Z = -5.3$; $p < 0.001$). We saw that 22.5%

of the children from Group E and 8.4% from Group C always praised their classmates for their achievements, which means that children in Group E became more considerate and attentive to their classmates in a year, praising them more often than the children from Group C. A statistically significant difference of the results between Groups E and C was determined ($Z = -5.64$; $p < 0.001$). However, the number of the children in Group C who always praised their classmates for their achievements during Physical Education lessons decreased ($Z = -2.7$; $p < 0.05$). As many as 28.8% of the children from Group E and 30.1% from Group C never boasted during Physical Education lessons, and 63.8% of the children from Group E and 67.5% from Group C never reminded their classmates of their previous failures.

The number of the children from Group E who claimed that their teacher always listened to their opinion increased in a year ($Z = -3.359$; $p < 0.001$), and 43.8% of the children from Group E and 28.9% from Group C said that teachers always listened to their opinions during Physical Education lessons, which might mean that the teachers of Group E tried to listen to the opinions of their students more often than the teachers in Group C ($Z = -3.237$; $p < 0.001$). While listening to their students' opinion, teachers taught the children to be more understanding and tolerant and thus developed their humanism. The analysis the results of Group C showed, however, that the number of cases when teachers always listened to their students' opinions decreased significantly ($p = 0.000$). In the opinion of children from Group E, there were significantly more teachers who always noticed their students' bad mood and comforted them ($Z = -4.903$; $p < 0.001$). Even 33.8% of teachers in Group E and 21.7% of group C always noticed their students' bad mood and comforted them. It may mean that the teachers of Group E noticed their students' bad mood and comforted them more often than the teachers of Group C ($Z = -3.189$; $p < 0.001$).

There was a significant growth in the number of teachers of Group E who often or always consoled their students in case of failure ($Z = -4.771$; $p < 0.001$): 33.8% of children from Group E and 19.3% from Group C thought that their teachers always consoled their students when they failed to perform a task or activity. This fact allows presuming that teachers in Group E consoled their students more often during Physical Education lessons than teachers in Group C ($Z = -4.025$;

$p < 0.001$). However, discussing the results of Group C, it appeared that the number of teachers who always comforted their students in case of failure decreased ($Z = -2.448$; $p < 0.05$). On the other hand, in the opinion of children from Group E, the number of teachers who always helped their students in case of failure increased ($Z = -5.025$; $p < 0.001$), as 47.5% of children in Group E and 26.5% in Group C thought that teachers always helped their students in case of failure during Physical education lessons, which means that teachers in Group E helped their students more often when they failed than teachers in Group C ($Z = -4.626$; $p < 0.001$). Analysing the research results of the children from Group C, it appeared that the number of teachers who always helped their students in case of failure decreased ($Z = -2.316$; $p < 0.05$). The children from Group E claimed that the number of teachers who never shared their mood with their students decreased, but the number of those who always shared their mood with their students slightly increased ($Z = -3.93$; $p < 0.001$), as 21.3% of the teachers of Group E and 12.0% of Group C always shared their mood with their students during Physical Education lessons. This means that teachers in Group E were more open and sincere with their students than Group C teachers ($Z = -4.445$; $p < 0.001$). However, analysing the research data of Group C, we found that the number of teachers who never shared their mood with their students increased during the second research ($Z = -1.978$; $p < 0.05$).

The children in Group E thought that the number of teachers who always praised their students for their achievements during Physical Education lessons increased significantly ($Z = -2.761$; $p < 0.01$). Children said that 46.3% of the teachers of Group E and 31.3% of Group C always praised their students for their achievements during Physical Education lessons, which means that teachers in Group E became even more considerate to their students in a year by praising them more often for their achievements than teachers in Group C ($Z = -3.37$; $p < 0.001$). We found that 82.5% of children in Group E and 74.7% in Group C thought that teachers never reminded their students of their previous failures, 20.0% of children from Group E and 43.4% of Group C thought that teachers never allowed their children to choose their sport activities, which might mean that teachers of Group E were more considerate and attentive to their students by listening to them more often and allowing them to choose

their sport activities themselves than teachers of Group C ($Z = -3.619$; $p < 0.001$). In a year the number of teachers of Group E who never made their students do what they did not want during Physical Education lessons significantly increased ($Z = -2.85$; $p < 0.01$), they were more considerate to their students than Group C teachers.

DISCUSSION

After the implementation of young learners' humanistic education programme during Physical Education lessons, children's behaviour became more humanistic, their relationship with their friends and teachers improved. At the end of the experiment children in Group E tried to listen to, conform, console, cheer and help their classmates more often, they more frequently shared their joy and sorrow, praised others for their achievements in Physical Education lessons than children in Group C, who were less considerate to their classmates. Our research results conform to R. Bakutytė's (2001) research data that young learners' relationship especially lack consideration. The research showed that other classmates were more open with the children from Group E, sharing their joy and sorrow with them because children in Group E did not lie and cheat, did not remind their classmates of their previous failures. The behaviour among the children in Group C, however, changed little in a year. The relations of children in Group C still lacked consideration and understanding. The results obtained from Group C correspond to the ones by R. Ališauskienė (2005), D. Augienė (2002) as it is difficult for primary school learners to listen to their friends, comfort, sympathise and help them. E. Martišauskienė (2001), N. Cibulskaitė (2000) research data show that the relationship of both younger and older adolescents are not considerate enough, and, according to V. Aramavičiūtė (2004), adolescents do not fully understand the meaning and essence of some ethical values, for this reason, they worry too little about them and do not try to realise them in practice.

Even though the children from Group E were provided with theoretical knowledge about humanistic values and humanistic behaviour during the educational experiment, there were some children in Group E, as in many cases in Group C, whose behaviour had not changed after a year. Our results correspond with the opinion of Lithuanian and foreign scientists (Bakutytė, 1998; Nunner-Winkler, Sodian, 1988)

that children of that age and their feelings are based on hedonistic selfishness, thus they are not able to understand fully the essence of ethical concepts as they are too complicated for children, and children's understanding is limited by too little life experience; as well as with T. Malti and M. Keller's (2009) opinion that the behaviour of primary school learners is adversely related to the knowledge of ethical concepts, therefore, children's aggression can be related to the lack of ethical knowledge (Stams et al., 2006). On the other hand, according to J. Smetana and M. Killen (2008) and our research results of Group E children, the children of this age are already capable of understanding ethical concepts and they ground their behaviour on them. A lot of other scientists (Krettenauer et al., 2008; Malti et al., 2009) think that moral decisions and expression of emotions can be related to personal behaviour.

Our created experimental programme of humanistic education, applied during the educational experiment, influenced not only the behaviour of children in Group E, but also of their teachers. They became more humanistic and tried to listen to their students' opinion, notice children's bad mood, comfort, console and help them when they failed to perform a task or activity, and to praise them for their achievements during Physical Education lessons more often than Group C teachers. Our research results corresponded with R. Bakutyte (1998), R. Vitkauskas (2004) research data that Group E teachers were most attentive to their students, helped them when necessary and

admitted their own mistakes. The majority of Group E educators tried to follow the direction of humanistic education, which encourages children's self-actualisation, and humanistic relationship with their students was based on respect and trust, which could encourage the development of children's social skills and their humanistic behaviour during Physical Education lessons.

CONCLUSIONS AND PERSPECTIVES

When young learners are educated in humanistic, safe and functional environment, which enshrines sincere relationship between teachers and children, students' relationship with their classmates and teachers becomes more humanistic, which allows assuming that the application of the experimental programme in pedagogical practice has served the purpose.

At the end of the experiment children in Group E helped, comforted their classmates during Physical Education lessons when they failed to perform a task or activity more often than children in Group C. Thus we suggest that imparting knowledge about humanistic values to children in Group E during Physical Education lessons, helping students to feel and experience these values, and choose humanistic behaviour based on them, changed their behaviour into more humanistic one.

The research showed that the behavior of Group E teachers, who participated in the experiment, became more humanistic as well.

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JAUNESNIOJO MOKYKLINIO AMŽIAUS VAIKŲ HUMANIŠKUMO UGDYMO KŪNO KULTŪROS PAMOKOSE PRIELAIDOS

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Pedagoginėje praktikoje realizuojant mūsų parengtą jaunesniojo mokyklinio amžiaus vaikų humaniško ugdymo(-si) kūno kultūros pamokose programą, kūno kultūros pamokose kuriant jautrumu, atvirumu, orumu ir atsakingumu pagrįstus jaunesniojo mokyklinio amžiaus vaikų tarpusavio santykius, susidarys palankios sąlygos vaikų humaniško ugdymui.

Tikslas: teoriškai aptarti jaunesniojo mokyklinio amžiaus vaikų humaniško ugdymo prielaidas bei nustatyti vaikų ir mokytojų tarpusavio santykių kaitos tendencijas kūno kultūros pamokose.

Metodai. Literatūros apžvalga ir anketinė apklausa.

Rezultatai. Įgyvendinus jaunesniojo mokyklinio amžiaus vaikų humaniško ugdymo(-si) kūno kultūros pamokose programą, vaikų elgesys tapo humaniškesnis, pagerėjo jų santykiai su klasės draugais ir mokytojais. Mūsų tyrimo rezultatai sutapo su kitų autorių gautaisiais – jaunesniojo mokyklinio amžiaus vaikų tarpusavio santykiuose ypač stinga jautrumo. Visgi mūsų tyrimo rezultatai E grupėje parodė, kad šio amžiaus vaikai jau gali suprasti dorovines sąvokas ir jomis grįsti savo elgesį. Eksperimentinė programa turėjo įtakos ne tik E grupės vaikų, bet ir jų mokytojų elgesiui, kuris tapo humaniškesnis.

Aptarimas ir išvados. Jaunesniojo mokyklinio amžiaus vaikams ugdantis humaniškoje, saugioje ir funkcionalioje aplinkoje, kurioje buvo puoselėjami nuoširdūs vaikų ir mokytojų tarpusavio santykiai, pasikeitė ugdytinių santykiai su klasės vaikais ir mokytojais humaniško linkme. Taigi galima daryti prielaidą, kad eksperimentinės programos taikymas pedagoginėje praktikoje pasiteisino. Tyrimo metu buvo nustatyti ir E grupės vaikų mokytojų, dalyvavusių ugdymajame eksperimente, elgesio pokyčiai su savo klasės auklėtiniais humaniško linkme.

Raktažodžiai: humaniško ugdymas, kūno kultūros pamoka, jaunesniojo mokyklinio amžiaus vaikų tarpusavio santykiai.

Gauta 2011 m. kovo 15 d.
Received on March 15, 2011

Priimta 2011 m. birželio 16 d.
Accepted on June 16, 2011

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RELATIONSHIPS BETWEEN SPORT, WORK AND LEISURE-TIME PHYSICAL ACTIVITY AMONG LITHUANIAN UNIVERSITY STUDENTS

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ABSTRACT

Research background and hypothesis. Other than sport physical activity which occurs in occupational, leisure and domestic sectors is often overlooked, meanwhile it also affects health. Previous research revealed that energy expenditure in occupational, domestic and leisure-time domains may influence energy expenditure in sports or exercising domain. University students are understudied population in this area. We expected that lower work and leisure-time activity among university students would be associated with their higher sports related activity.

Research aim was to examine relationships between sport, work and leisure-time activities in a sample of university students.

Research methods. The final sample consisted of 867 students from four Lithuanian universities, 195 (22.5%) were males, their age ranged from 18 to 22 years. Baecke Questionnaire of Habitual Activity (Baecke et al., 1982) was used to assess work, leisure-time and sport physical activity.

Research results. Male students scored significantly higher than female in work and sport activity ($p < 0.0001$), but not in leisure-time activity ($p = 0.61$). Males and females who were more active in their occupational domain were also twice more active in sports-related activities (OR = 2.22 [95% CI 1.25–3.93] and OR = 2.14 [95% CI, 1.50–3.04] respectively). Females who were more active in leisure-time domain were almost twice more active in sports-related activities (OR = 1.65 [95% CI 1.22–2.21]) as well.

Discussion and conclusions. Analysis of the relationships between sports, work and leisure-time physical activities did not confirm our expectation. The results of the current study revealed that lower physical activity in occupational or leisure-time domains did not determine higher sports related physical activity. Sports-related activity and physical activity in other domains can coexist together in the population of students and possibly depends on variables which influence them all. In further research, the broader set of variables influencing university students' habitual physical activity should be taken into account.

Keywords: habitual physical activity, physical activity domains, occupation of university students.

INTRODUCTION

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure above the resting level (WHO, 2011). Regular physical activity is one of the most important factors in health promotion. It not only improves mood, but also is definitely beneficial to physical health

(WHO, 2011). Adequate physical activity reduces risk of cardiovascular disease, diabetes and even certain forms of cancer, helps control weight and improves mental health. Participation in physical activities helps to make friends and feel part of the community (Castillo, Garcia-Molina, 2009) as increased physical activity is associated with

higher levels of social support and self-efficacy (Maglione, Hayman, 2009; Shuval et al., 2009). On the contrary, physical inactivity is associated with many chronic diseases and obesity (Baba et al., 2006) and is among the 10 leading causes of mortality and morbidity around the world (WHO, 2002).

Assuming that years while studying make a great impact on the young people consciousness, this is an opportune time point for implementation and fixing ideas about healthy lifestyle. Besides, students are supposed to be an educated part of the society and are expected in the future to spread ideas and be an example for certain groups in society. Data about students' physical activity is important in assessing their health status, predicting the changes and trends of public health development, planning health promotion and disease prevention strategies.

Up to now, many studies revealed that physical inactivity is a serious health problem among university students. A cross-sectional survey in 23 countries identified that the prevalence of inactivity in leisure time varied, averaging 23 percent in North-Western Europe and the United States, 30 percent in Central and Eastern Europe, 39 percent in Mediterranean countries, 42 percent in Pacific Asian countries, and 44 percent in developing countries (Haase et al., 2004). Moreover, another study reported that, for example, in Canada 65 percent of students were insufficiently physically active (Irwin, 2007).

Understanding of physical activity is sometimes associated with sport and exercising, but physical activity and exercising actually, reflect different things. Physical activity is a broader concept than physical exercise; it is a complex and multidimensional exposure variable and includes several domains – occupational, domestic and leisure (Ono et al., 2007; Jankauskiene, 2008).

An international study, which reviewed and analyzed the prevalence of university students' participation in physical activity at the level necessary to acquire health benefits, revealed that female students were less active than male students (Irwin, 2004). Results of some other cross-cultural studies are in accordance with the previous research (Seo et al., 2009).

According to K. R. Evenson and colleagues (2003), physical activity that occurs in the occupational and domestic sectors is often overlooked (Evenson et al., 2003). While it has

an important effect on body weight (Monda et al., 2008), cardio-vascular disease in later life (Wang et al., 2010) and self-rated health (Parkes, 2006). A large number of research examining physical activity has largely focused on sports and physical exercise rather than other sources of energy expenditure, such as occupational or work activity and leisure-time activity. Thus the actual data about habitual physical activity could be incomplete.

Results of some previous research about relationships of sports, work and other than sports leisure-time activities are contradicting. Research in the USA shows, that the level of work and leisure-time activity may negatively influence energy expenditure in sports and exercising domain (Evenson et al., 2003). On the contrary, the study in Australia revealed that white-collar employees were less likely to engage in sufficient physical activity and more likely in occupational sitting than blue-collar employees (Duncan et al., 2010). Meantime, a study in the USA with racial or ethnic minorities and study in Brazil showed that occupational and housework physical activity were not related to participation in physical exercise in leisure (Marquez et al., 2010; Rombaldi et al., 2010). So, the research of the relationship of various types of physical activity is still important. Particularly university students are understudied population in this area. While their prime occupation, i. e. studying, is supposed to be associated with sitting and this fact is not positively related to their health (Duncan et al., 2010). The **aim** of the study was to examine relationships between sport, work and leisure-time activities in a sample of university students. We hypothesize that lower work and leisure-time activity of university students would be associated with their higher sports-related activity.

RESEARCH METHODS

Participants. The initial sample of participants included 1036 of university students. 169 students failed to complete questionnaires correctly. The final sample consisted of 867 students from four Lithuanian universities, 195 (22.5%) were males and 672 (77.7%) females, who ranged in age from 18 to 22 years. Lithuanian University of Health Sciences (LUHS) was represented by 421 student, studying medicine, odontology, pharmacy and public health. There were 235 students from

the Lithuanian Academy of Physical Education (LAPE), Faculties of Sports Biomedicine and Sports Education participated in this study, and 101 students were from the Lithuanian Music and Theatre Academy (LMTA). These students were studying music and music performance-related sciences. Finally, 110 students were from Mykolas Romeris University (MRU), studying social sciences.

Instruments. *Baecke Questionnaire of Habitual Activity* (Baecke et al., 1982) proved to have high reliability and accurate assessment of heavy intensity activity as well as light intensity activities. Additionally it fits for both men and women (Richardson et al., 1995). It was proved by research that the Baecke Questionnaire of Habitual Activity can provide valid data about physical activity (Philippaerts et al., 1999). The questionnaire consisted of 16 items, classified into three scales: work, sports, and leisure-time activity, which measure self-assessed activity referring the past 12 months. The first scale, *work activity*, consists of eight questions reflecting the occupation-related physical activity. All occupations in this questionnaire are classified into three groups based on physical activity levels and each group assigned a corresponding score (1-st item). The 2–8 items assess individual work-related physical activity. As the population in target was university students, work activity was considered as activity while studying. The second scale, *sport activity*, reflects the casual sports-related physical activity. Taking into account that different sports related to different amount of energy expenditure, two out of four items estimate that. The third scale, *leisure-time activity*, also consists of four items. Non sport-related activity, such as watching television, riding a bike, walking to and from work, which also utilized certain

amount of energy, is included into leisure-time activity scale.

Demographic information included age and gender.

Statistical analysis. Students' sample was divided into two groups depending on the means of the sport, work as well as leisure-time activity indexes. More and less physically active groups were obtained. Binary logistic regression analysis was used to assess the relationship between sport, work as well as leisure-time activity and university variable. Students from LUHS were considered as a reference group. Gender as a control variable was included into the equation. Descriptive statistics was used to calculate means and standard deviations (SD).

Gender differences of habitual physical activity were determined by a Mann-Whitney test for nonparametric data. Percentage distribution of exercising, occupational sitting, sitting at a computer or watching TV were calculated using χ^2 statistic.

Finally, binary logistic regression analysis was used to assess the relationships between sport, work and leisure-time physical activity. Predictive value of work and leisure-time activity variables for greater sport activity index were evaluated.

RESEARCH RESULTS

Differences of habitual physical activity between universities. First, prevalence of sport, work and leisure-time physical activity between universities was compared. Results of binary logistic regression analysis (Table 1), adjusted for gender, showed that students from LAPE and MRU were more likely to be classified as more physically active in sports (OR = 3.52

Table 1. Logistic regression models of habitual physical activity prevalence between universities showing adjustment for gender odds ratios (with 95% confidence intervals)

University	Sport activity		Work activity		Leisure-time activity	
	Mean SD	OR (CI 95%)	Mean SD	OR (CI 95%)	Mean SD	OR (CI 95%)
LUHS	2.62 ± 0.48	Ref.	2.12 ± 0.41	Ref.	3.17 ± 0.54	Ref.
LAPE	2.99 ± 0.66	3.52 (2.49–4.98) **	2.34 ± 0.54	1.61 (1.16–2.24) **	2.96 ± 0.58	0.60 (0.43–0.84) *
LMTA	2.75 ± 0.60	1.54 (0.96–2.44)	2.51 ± 0.52	2.97 (1.86–4.74) **	3.44 ± 0.58	2.13 (1.33–3.39) *
MRU	2.95 ± 0.44	3.37 (2.18–5.22) **	2.02 ± 0.46	1.32 (0.86–2.01)	3.07 ± 0.47	0.70 (0.46–1.07)

Note. * – $p < 0.05$; ** – $p < 0.0001$.

Variable	Male OR (CI 95%)	Female OR (CI 95%)
Work activity	2.22 (1.25–3.93) **	2.14 (1.50–3.04) **
Leisure-time activity	0.96 (0.58–1.59)	1.65 (1.22–2.21) **

Table 2. Logistic regression models showing relationships of sport, work and leisure-time physical activity in male and female university students (odds ratios with 95% confidence intervals)

Note. ** – $p < 0.0001$.

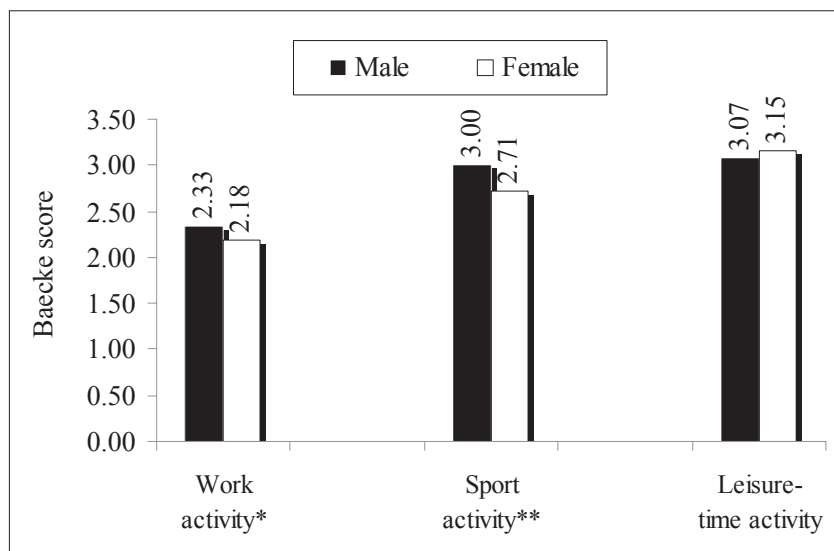


Figure. Habitual physical activity indexes in male and female students

Note. * – $p < 0.05$; ** – $p < 0.0001$.

[95% CI 2.49–4.98] and 3.37 [95% CI 2.18–5.22] respectively; $\chi^2 = 103.21$; $df = 4$; $p < 0.001$) as compared to LUHS students. Students from LAPE and LMTA were more active at work (OR = 1.61 [95% CI 1.16–2.24]; and 2.97 [95% CI 1.86–4.74] respectively; $\chi^2 = 35.22$; $df = 4$; $p < 0.001$); and also students from LMTA were more likely to be active in other than sports leisure-time activity (OR = 2.13 [95% CI 1.33–3.39]) as compared to LUHS students. But LAPE students had lower odds to be active in leisure than LUHS students (OR = 0.60 [95% CI 0.43–0.84]); model's $\chi^2 = 31.62$; $df = 4$; $p < 0.001$.

Gender differences of habitual physical activity. Further, we evaluated and compared occupational sitting between genders. Results showed that 79.5 percent ($n = 155$) of male and 85.4 percent ($n = 574$) of female students agreed that their occupation was always or very often related with sitting. Only 8.2 ($n = 16$) and 7.4 percent ($n = 50$) of male and female students reported that their sitting was not habitual or was just rarely related to their work. Reported occupational sitting between males and females did not differ ($\chi^2 = 6.53$; $df = 4$; $p = 0.16$).

Only one (0.5 percent) male student and 1 percent ($n = 7$) of female students reported that they sat at the computer or watched TV always, 20 ($n = 39$) and 23.1 percent ($n = 155$) respectively agreed that they did that often, 36.4

($n = 71$) and 36.5 percent ($n = 245$) respectively – sometimes, 38.5 ($n = 75$) and 33.3 ($n = 224$) respectively – rarely, and small percent – 4.6 ($n = 9$) and 6.1 ($n = 41$) respectively declared that they never sat at computer or watched TV in leisure time. Results distributed in a similar way between male and female students ($\chi^2 = 2.82$; $df = 4$; $p = 0.59$).

χ^2 statistic revealed that 92.3 percent ($n = 180$) of male and 61.3 percent ($n = 412$) of female students reported that they exercised or played sports in leisure time. Obviously, more male than female students exercised ($\chi^2 = 67.06$; $df = 1$; $p < 0.0001$).

The Mann-Whitney test was applied to assess the differences of work activity, sport activity and leisure-time activity indexes between male and female students. The test results revealed (Figure 1) that males scored significantly higher than female students on work and sport activity (Mann-Whitney $U = 55376$; $p = 0.001$ and Mann-Whitney $U = 46402$; $p < 0.0001$ respectively). Leisure-time activity index didn't differ between the groups (Mann-Whitney $U = 59811$; $p = 0.61$).

Relationships between sport, work and leisure-time physical activity. Results of binary logistic regression analysis in the male group of students (Table 2) indicated that only work activity was associated with sport activity. The greater

the work activity index, the higher the odds of being classified as more physically active in sports (OR = 2.22 [95% CI 1.25–3.93]; $\chi^2 = 8.11$; $df = 2$; $p = 0.02$).

Logistic regression analysis in female group of students revealed (Table 2) that both greater work and leisure-time activity indexes were associated with greater sport activity (OR = 2.14 [95% CI, 1.50–3.04] and 1.65 [95% CI 1.22–2.21] respectively; $\chi^2 = 32.27$; $df = 2$; $p < 0.001$).

DISCUSSION

By the current research we tried to identify the impact of occupational and leisure-time activities for students' participating in sports activities. It was proposed that lower work and leisure-time activity of university students would be associated with their higher sports related activity. Analysis of the predicting factors of higher sports-related activity did not confirm our expectations. The results of the current study revealed that lower physical activity in occupational or leisure-time domains did not determine higher sports related physical activity. On the contrary, male and female students who were more active in their occupational area, were also twice more active in sports-related activities. Higher leisure-time activity was associated with higher sports related activity in females, but it was associated in males. P. C. Rouse and S. J. H. Biddle (2010) revealed in their research that leisure-time activities related to sedentary technology, which includes TV watching and computer gaming, was associated with higher physical activity in male, but not female students, but this relation was slight. So, the authors concluded that these slight relationships suggest that technological sedentary behaviours and physical activity do not compete significantly for time and can coexist as part of a student's lifestyle (Rouse, Biddle, 2010). But research in older population produces different results. Our results contradict to the results obtained in the USA and Brasil, where authors did not find any relationship between work and sports activities in working age adults (Marquez et al., 2010; Rombaldi et al., 2010). But K. R. Evenson and colleagues (2003) revealed that those middle-aged adults with the highest occupational activity had lower participation in any sports than those with lower occupational activity across gender groups.

The results of the current study also provide important evidence that occupation of most students is predominantly related with sitting. Though, that is not surprising, because the main occupation of students is supposed to be studying, which is in turn associated with sitting. In the study in England, P. C. Rouse and S. J. H. Biddle (2010) also revealed that studying was the predominant sedentary activity among students followed by the sedentary technology (Rouse, Biddle, 2010). But in our study only one fifth of students, both males and females, sat at the computer or watched TV in their leisure-time. Furthermore, nine out of ten male students and more than a half of female students reported exercising or participating in sports regularly. Significantly more male than female students are physically active. The latter finding was expected and was already confirmed in Lithuania (Puišienė et al., 2008) as well as in many other countries (Irwin, 2004; Seo et al., 2009).

There is a lack of research about physical activity differences between universities in Lithuania. Our study add some evidence revealing that students form LAPE were more active at sports than other students who participated in this study. Also they were among the most active ones at work. The results obtained are not surprising because physical activity is an integrated part of studies at LAPE.

CONCLUSIONS AND PERSPECTIVES

So, on the basis of the current research we can conclude that students, especially females, if they were physically active, they were active in all domains of life, and vice versa. We suggest that sports-related activity and physical activity in other domains can coexist together in the population of students and possibly depend on variables which were not studied in this research and which influence all of them. In further research, the broader set of variables, possibly predicting university students' habitual physical activity, should be taken into account.

Acknowledgments. The authors would like to thank Assoc. Prof. E. Puišienė, Assoc. Prof. R. Baublienė and doctoral student J. Čepelionienė for their assistance in organizing the survey.

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LIETUVOS AUKŠTŲJŲ MOKYKLŲ STUDENTŲ FIZINIO AKTYVUMO SPORTUOJANT, DIRBANT IR LAISVALAIKIU SĄSAJOS

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Su sportu nesusijęs fizinis aktyvumas dirbant, laisvalaikiu ir buityje dažnai yra nepakankamai įvertinamas kaip sveikatą veikiantis veiksnys. Kita vertus, ankstesni tyrimai atskleidė, kad energija, išseikvota dirbant ir laisvalaikiu, siejasi su energijos išseikvojimu sportuojant ir mankštinantis. Visgi studentai yra ypač mažai šiuo atžvilgiu analizuota grupė. Tikėjomės, kad mažesnis fizinis aktyvumas dirbant ir laisvalaikiu siesis su didesniu aktyvumu sportuojant.

Tikslas: nustatyti aukštųjų mokyklų studentų fizinio aktyvumo sportuojant, dirbant ir laisvalaikiu sąsajas.

Metodai. Galutinę tyrimo imtį sudarė 867 Lietuvos aukštųjų mokyklų studentai, 195 (22,5%) iš jų buvo vyrai. Amžiaus ribos – 18–22 metai. *Baecke* kasdienio fizinio aktyvumo klausimynas (*Baecke Questionnaire of Habitual Activity* – Baecke et al., 1982) buvo naudojamas įvertinant fizinį aktyvumą studentams sportuojant, dirbant ir laisvalaikiu.

Rezultatai. Vaikinų fizinis aktyvumas dirbant ir sportuojant buvo didesnis nei merginų ($p < 0,0001$), bet aktyvumas laisvalaikiu vaikinų ir merginų grupėse nesiskyrė ($p = 0,61$). Vaikinai, kaip ir merginos, kurių aktyvumas dirbant buvo didesnis, du kartus dažniau buvo aktyvūs sportuodami nei tie studentai, kurių aktyvumas dirbant buvo mažesnis (šansų santykis (ŠS) = 2,22 [95% PI 1,25–3,93] ir ŠS = 2,14 [95% PI, 1,50–3,04] atitinkamai). Merginų, kurių aktyvumas laisvalaikiu buvo didesnis, beveik du kartus dažniau buvo aktyvios ir sportuodamos nei tos merginos, kurių aktyvumas laisvalaikiu buvo mažesnis (ŠS = 1,65 [95% PI 1,22–2,21]).

Aptarimas ir išvados. Fizinio aktyvumo sportuojant, dirbant ir laisvalaikiu sąsajų analizė nepatvirtino mūsų prielaidų. Šio tyrimo rezultatai leidžia teigti, kad mažesnis fizinis aktyvumas dirbant ir laisvalaikiu nelemia didesnio fizinio aktyvumo sportuojant tikimybės. Taigi fizinis aktyvumas sportuojant ir aktyvumas kitose gyvenimo srityse dera tarpusavyje ir, tikėtina, priklauso nuo neįtrauktų į šį tyrimą veiksnių, kurie gali veikti visas šias sritis kartu. Tolesnių tyrimų metu norint iširti didesnę studentų kasdienį fizinį aktyvumą lemiančius veiksnius, reikėtų apimti platesnį šių veiksnių spektrą.

Raktažodžiai: kasdienis fizinis aktyvumas, fizinio aktyvumo sritys, universiteto studentų veikla.

Gauta 2011 m. balandžio 20 d.
Received on April 20, 2011

Priimta 2011 m. birželio 16 d.
Accepted on June 16, 2011

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EVALUATION OF CARDIOVASCULAR SYSTEM REACTIONS WHEN DIFFERENT MUSCLE GROUPS ARE ACTIVATED

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ABSTRACT

Research background and hypothesis. In our study, the dynamics of working muscle oxygen saturation of participants in the final stages of provocative bicycle ergometer test was different. According to this, we hypothesized, that different central and peripheral reaction of cardiovascular system would dominate during local and regional exercises, too.

Research aim was to evaluate central and peripheral reaction of cardiovascular system when different muscle groups are activated.

Research methods. Twenty seven healthy men (age 32 ± 1.8 years, body mass index 25.3 ± 0.6 kg / m²) participated in the study. All participants performed provocative bicycle ergometer test, electrocardiogram and oxygen saturation were registered. The participants performed three exercises activating different muscle groups: calf, forearm and back extension.

Research results. Variation of heart rate and oxygen saturation values highlighted the difference between arm and leg training exercises. However, the load for arms and legs was individualised, both Groups A and B were different according to the dynamics of heart rate and oxygen saturation indices.

Heart rate reaction to the physical load for the back muscles was unusual - heart rate decreased during the first seconds of the back load. Oxygen saturation was lower in resting back muscles compared to those of resting arm and leg muscles ($p < 0.05$).

Discussion and conclusions. The analysis of heart rate and oxygen saturation values has revealed that each functional muscle group of the human organism contains not only general but also individual activating features both integrating regulatory systems and forming a certain activation of metabolism in working muscles.

Keywords: heart rate, oxygen saturation, variation of indices.

INTRODUCTION

The main function of skeletal muscle is to perform mechanical work at the expense of potential chemical energy, usually for postural support and movements. However, skeletal muscle does not act alone. Important communication and coadaptation at the whole organism level must take place to optimize muscle

function. For example, the rate of oxygen and extramuscular fuel supply must be closely matched to muscle demand (Storey, 2004).

Efficiency of muscles is greatly influenced by their supply of blood (Poderys et al., 1998). The intensity of blood circulation of muscles is controlled by combining the changes of heart

function and general peripheral resistance (Lash, 1996).

Near-infrared Spectroscopy (NIRS) is becoming a widely used instrument for measuring tissue O₂ status (Ferrari et al., 2004). Oxygen saturation measure shows how much oxygen the blood carries as a percentage of the maximum it could carry. M. Beekvelt et al. have shown that NIRS is able to discriminate between the resting and exercising states of the muscles (Beekvelt et al., 2001).

A lot of studies were done to examine the oxygenation levels of the vastus lateralis muscle during incremental work test. All these studies demonstrate a decrease in StO₂ that occurred gradually in proportion to the increasing work rate (Belardinelli et al., 1995; Bhambhani et al., 2001). In our study, the dynamics of oxygen saturation of some participants was slightly unusual – StO₂ increase in the final stages of provocative bicycle ergometer test. According to the dynamics of oxygen saturation in the final stages of bicycle ergometer test, the participants were divided into two groups: Group A – with the increase of StO₂ in the final stages of the workload and Group B – with the decrease of StO₂ in all stages of the workload. We hypothesized, that different StO₂ dynamics and heart rate in A and B group would dominate during local and regional exercises as well.

The aim of the work was to evaluate central (heart rate) and peripheral (oxygen saturation) reaction of cardiovascular system when different muscle groups were activated.

RESEARCH METHODS

Twenty seven men (age 32 ± 1.8 years, body mass index 25.3 ± 0.6 kg / m²) participated in the study. All of them were apparently healthy without any history of chronic disease. Subjects did not

smoke, nor did they take any medications. None of them had previously participated in regular exercise training.

The evaluation of the heart rate was based on the electrocardiogram analysis system „Kauņas–load“, created at the Institute of Cardiology of the Lithuanian University of Health Sciences. Synchronous 12 lead Electrocardiogram was registered and analyzed during the exercise and the first four minutes of recovery.

The variation of oxygen saturation (StO₂) in the muscles during the workload and after it was estimated by the non-invasive Near-infrared Spectroscopy Method (NIRS) with the application of a photo sensor (*Hutchinson Technology, Hutchinson, Minnesota USA*). A photo sensor was placed on the main group of muscles performing a movement.

All participants performed provocative bicycle ergometer test, ECG and oxygen saturation were registered. According to the dynamics of oxygen saturation in the final stages of bicycle ergometer test, the participants were divided into two groups: Group A – with the increase of StO₂ in the final stages of the workload (n = 15) and Group B – with the decrease of StO₂ in all stages of the workload (n = 12).

The present work deals with the analysis of the heart rate (HR) and StO₂ indices of the participants who performed three exercises activating different muscle groups. The exercises consisted of calf, forearm and back extension.

The protocols of calf and forearm extension exercises (Figure 1) were analogous: the participants underwent a capacity estimation test for the functional group of the muscles participating in the exercise. An individual weight, which constituted 50 percent of the maximum, was chosen for the test. Then the participants performed three local workloads. The movement

Figure 1. Protocol of calf and forearm extension exercises

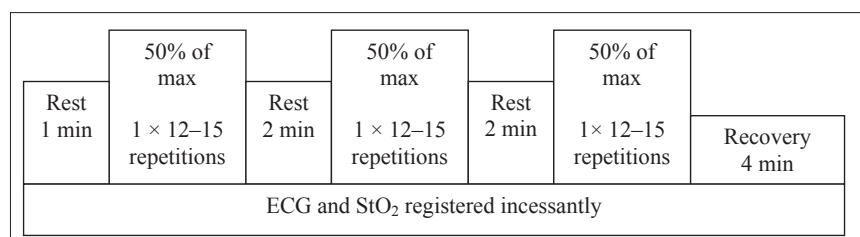
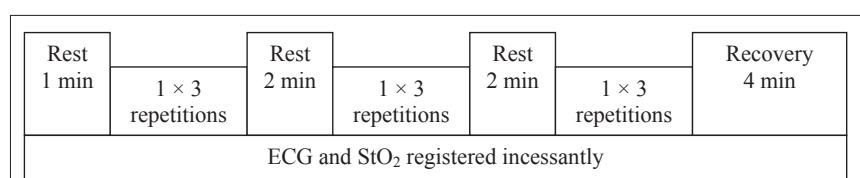


Figure 2. Protocol of back extension exercise



performing extension took 2 seconds and returning to the initial position – 2–3 seconds, the number of repetitions was 12–15, the number of sets was 3. Resting intervals between sets were 2 minutes. ECG and oxygen saturation were incessantly registered 1 minute before the workload, during it, after each workload in resting position and four minutes after the exercise. Each workload was divided into 2 stages, rest – in 4, recovery – in 4. We calculated means and SD.

For the back muscle training, the participants performed three trunk extension exercises leaning on thighs on an exercise machine. Making a move, the participants performed trunk extension – 10 seconds and returned to the initial position – 20–25 seconds. Rest intervals between workloads were 2 minutes in a standing position. ECG was registered 1 minute before the exercise, during the workload and at rest. The variation of oxygen saturation was incessantly registered in the back muscle (*m. erector spinae*). After the final load ECG and StO₂ were further registered for the first four minutes in the standing position (Figure 2). Each workload was divided into 3 stages, rest – in 4, recovery – in 4. We calculated means and SD.

The data of the study were processed with the help of *SPSS* statistical package. The following statistical criteria were applied: *Wilcoxon* criterion, was applied for dependent samples, when analysing a statistically significant difference between the indices registered at different periods of exercises and performed by the same group of participants; *Mann-Whitney* criterion was applied for independent samples, when analysing a statistically significant difference between the indices of different groups of the participants. The difference was considered statistically significant when $p < 0.05$ (95% of confidence intervals).

RESEARCH RESULTS

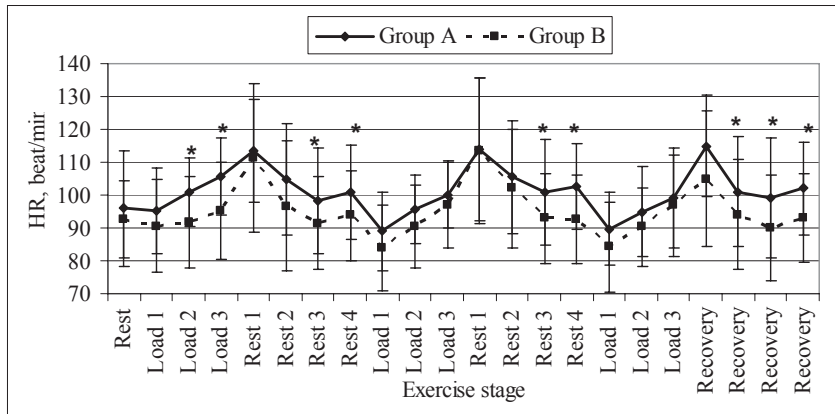
The analysis of variation of HR while performing repeated exercises for leg and arm muscle training revealed differences between Group A (StO₂ increased) and Group B (StO₂ decreased) (Table). Statistically significant HR was in rest and recovery stages of exercise for leg muscles, and in all stages performing physical task by arms (Table) it was higher in Group A than that

Exercise stages	Leg exercise		Arm exercise	
	Group A	Group B	Group A	Group B
Rest	84 ± 8 ●□	76 ± 6 ●■	97 ± 8 ○□	91 ± 11 ○■
Load stage 1	95 ± 8 □	97 ± 9	108 ± 10 ○□	99 ± 10 ○
Load stage 2	109 ± 10 □	110 ± 5	118 ± 11 ○□	108 ± 11 ○
Rest stage 1	95 ± 7 ●□	86 ± 6 ●■	107 ± 11 ○□	98 ± 8 ○■
Rest stage 2	90 ± 10 ●□	81 ± 7 ●■	104 ± 12 ○□	94 ± 11 ○■
Rest stage 3	87 ± 8 ●□	78 ± 9 ●■	101 ± 10 ○□	92 ± 9 ○■
Rest stage 4	85 ± 12 ●□	79 ± 9 ●■	102 ± 12 ○□	91 ± 10 ○■
Load stage 1	105 ± 9 □	102 ± 10	111 ± 8 ○□	104 ± 9 ○
Load stage 2	113 ± 9 □	114 ± 10	125 ± 15 ○□	114 ± 12 ○
Rest stage 1	96 ± 11 □	91 ± 9 ■	111 ± 10 ○□	100 ± 9 ○■
Rest stage 2	93 ± 10 ●□	82 ± 6 ●■	105 ± 6 ○□	96 ± 8 ○■
Rest stage 3	90 ± 10 ●□	79 ± 9 ●■	104 ± 8 ○□	92 ± 9 ○■
Rest stage 4	89 ± 9 ●□	80 ± 10 ●■	103 ± 10 ○□	94 ± 9 ■
Load stage 1	105 ± 12 □	106 ± 11	113 ± 11 ○□	108 ± 10 ○
Load stage 2	116 ± 11 □	117 ± 11	127 ± 13 ○□	119 ± 11 ○
1-min recovery	96 ± 13 ●□	88 ± 10 ●■	110 ± 12 ○□	100 ± 12 ○■
2-min recovery	88 ± 11 ●□	79 ± 10 ●■	105 ± 12 ○□	95 ± 14 ○■
3-min recovery	91 ± 9 ●□	77 ± 10 ●■	105 ± 11 ○□	93 ± 12 ○■
4-min recovery	89 ± 9 ●□	78 ± 9 ●■	104 ± 9 ○□	95 ± 11 ○■

Table. Variation of HR (beats per minute) performing repeated exercises for arm and leg muscle training

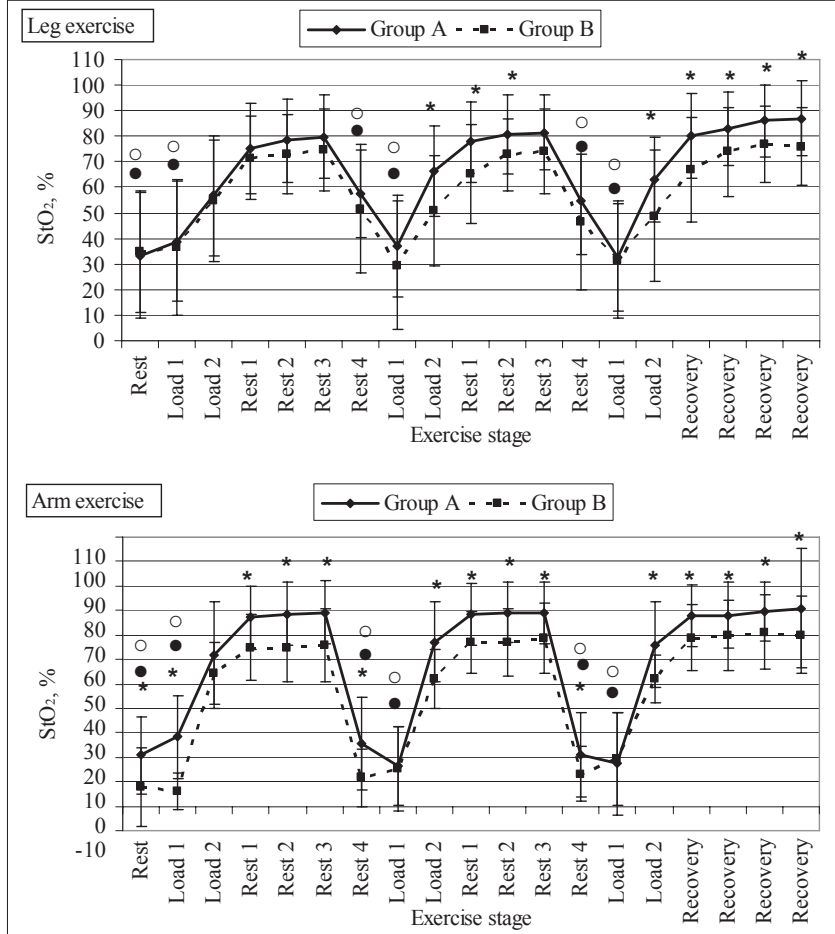
Note. ● – $p < 0.05$ comparing HR values of Group A to those of Group B during leg exercise; ○ – $p < 0.05$ comparing HR values of Group A to those of Group B during arm exercise; □ – $p < 0.05$ comparing HR values of leg exercise with arm exercise in Group A; ■ – $p < 0.05$ comparing HR values of leg exercise with arm exercise in Group B.

Figure 3. Variation of HR while performing repeated exercises for back muscle training



Note. * – p < 0.05 comparing HR values of Group A to those of Group B in the same stage of workload.

Figure 4. Dynamics of StO₂ indices while performing repeated exercises for arm and leg muscle training



Note. * – p < 0.05 comparing StO₂ values of Group A to those of Group B in the same stage of workload. ● – p < 0.05 comparing StO₂ values of leg exercise to those of arm exercise in Group A. ○ – p < 0.05 comparing StO₂ values of leg exercise to those of arm exercise in Group B.

in Group B. During arm exercise HR was higher than during leg exercises in Group A in all exercise stages (p < 0.05), while in Group B significant differences of HR values between arm and leg exercise were only in rest and recovery stages.

The variation of HR shows the effect of load summation in both groups performing exercise for leg and arm muscles (Table). The average of HR was statistically lower at the beginning of the first exercise load (performing leg exercise: in Group A the sum of two load stages was 102 ± 9 beats / min, in Group B – 103 ± 7 beats / min; the corresponding values performing arm exercise: in Group A – 113 ± 11 beats / min, in Group B – 104 ± 11 beats / min)

than during the third one (performing leg exercise: in Group A the sum of two load stages was 110 ± 12 beats / min, in Group B – 112 ± 11 beats / min; the corresponding values performing arm exercise: in Group A – 120 ± 13 beats / min, in Group B – 114 ± 12 beats / min).

Figure 3 shows that HR decreased during the load for back muscles. It is different than in leg and arm exercises. Repeated exercises for back muscle training also resulted in the effect of load summation. However, in reverse to arm and leg exercises, HR decreased in both groups during the back muscle exercises, but statistically significant difference was found in Group A comparing the

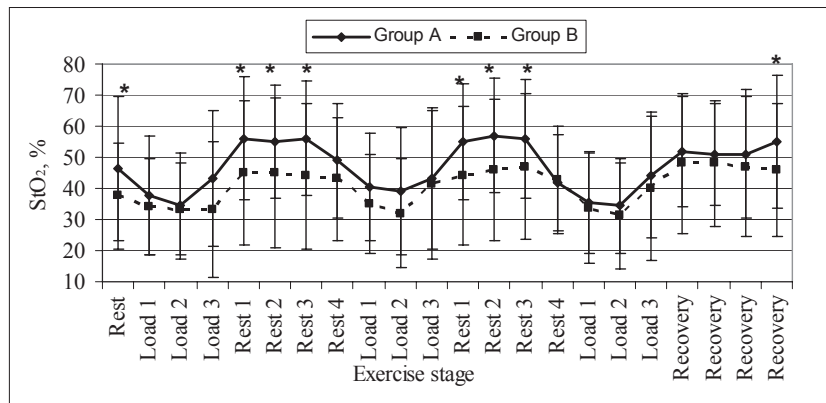


Figure 5. The dynamics of StO₂ indices while performing repeated exercises for back

Note. * – $p < 0.05$ comparing StO₂ values of Group A to those of Group B in the same stage of workload.

first and the third exercise loads (the sum of three stages of the first exercise load was 101 ± 12 beats / min and during the third load – 95 ± 13 beats / min).

Statistically significantly lower oxygen saturation was observed in Group B during almost the whole exercise of arm training (Figure 4). The same difference occurred during the exercises of leg training with higher values in Group A, but statistically significant StO₂ values were found only in some rest Stages and all recovery stages.

Statistically higher StO₂ values were found during physical task for legs compared to those in arms in the last measurement at rest (during leg exercise the values of Group A were 33, 57, 54% and Group B – 35, 52, 46%; corresponding arm exercise values of Group A were 21, 26, 21% and Group B – 8, 12, 13%) and in the first stages of the load (during leg exercise the values of Group A were 39, 37, 33% and Group B – 37, 29, 32%; corresponding arm exercise values of Group A were 28, 17, 17% and Group B – 6, 15, 20%).

General variations in oxygen saturation during the exercise for back muscle training (Figure 5) produced about the same changes as it was found in other studies (Ozyener, 2002; Carlson, Pernow, 2008) – oxygen saturation decreased during the workload and increased during the recovery period. The tendency of smaller amount of oxygen saturation during the back exercise was determined in Group B (statistically significant difference was found not during the whole workload).

DISCUSSION

Different StO₂ dynamics of participants in the final stages of the provocative bicycle ergometry test showed different relation of activated muscles and central function of the heart. The decrease of oxygen saturation during the workload shows a specific synergetic relation of skeleton muscles

to the central function of the heart myocardium which maintains hemodynamics (Adams et al., 1993). Meanwhile, an increasing amount of oxygen in muscle tissue is related to the vasodilatation of peripheral vessels and is considered as a compensatory mechanism of increasing functional ischemic phenomena in myocardium (Poderys et al., 2000; Po kaitis, 2008).

Differences between Groups A and B dominated during local and regional exercises too. Analysing the dynamics of HR values, a tendency of higher values in Group A compared to Group B was noticed.

Comparing the dynamics of HR values during local exercises when different muscle groups were activated, we noticed that HR of Group A was significantly higher during arm exercises than during leg exercises in all stages. However, HR values of Group B were statistically significantly different in rest and recovery stages, but similar in load stages performing both exercises. This reveals that the subjects of Group B had a better (or different) coordination between peripheral and central circulation.

During the first seconds of the back load, HR decreased. Such dynamics of HR is difficult to compare with typical reaction to physical load for other muscle group. This could be explained by the fact that the exercise for back muscles mostly involves trunk extensors (*m. erector spinae* – antigravity muscles) which are adapted to perform static physical load (Jorgensen, Nicolaisen, 1986).

However, the load for arms and legs was individualised, both Groups A and B were different according to the dynamics of HR and StO₂ indices. This indicates that the performance of the exercises of global and local character results in the different functioning of the regulation mechanisms of central and peripheral blood flow.

In the first stage of loads, oxygen saturation was lower for arm exercise, than in the same stage of

the leg load in both groups ($p < 0.05$). In the second stage of load O_2 saturation increased and this could be related to higher activation of respiratory system. J. A. I. Calbet et al. (2004) demonstrated lower O_2 extraction in the arms than in the legs during skiing on a treadmill with different techniques: diagonal stride (combined arm and leg exercise), double poling (predominantly arm exercise), and leg skiing (predominantly leg exercise). They attributed the observed differences in maximal arm and leg O_2 extraction to higher heterogeneity in blood flow distribution, shorter mean transit time, smaller diffusing area, and larger diffusing distance in arms than in legs (Calbet, 2004).

It is interesting to note that oxygen saturation began to decrease already before the load. Such reaction could be explained as precocious metabolic reaction and reflects the stage before the start (Skernevičius, 1997).

Oxygen saturation was lower in resting back muscles compared to resting arm and leg muscles ($p < 0.05$). But StO_2 values statistically more decreased in the arms, then in the back muscle in the first load stages (during arm exercise in Group A, the values were 28, 17, 17%, and during back exercise – 38, 40, 36%; in Group B during arm exercise – 6, 15, 20%, and during back

exercise – 34, 35, 34%). Our results are supported by R. V. Maikala and Y. N. Bhambhani (2007) who studied tissue heterogeneity in peripheral circulatory responses from two muscle groups (brachial biceps and lumbar muscles) and reported that oxygen supply and demands were regulated by muscle location and muscle fibre characteristics.

CONCLUSIONS AND PERSPECTIVES

The analysis of HR and oxygen saturation indices has revealed that each functional muscle group of the human organism contains not only general but also individual activating features both integrating regulatory systems and forming a certain activation of metabolism in working/functioning muscles. The evaluation of the variation of HR during local and regional workloads indicated the different impact of regulatory systems to activated muscles. Oxygen saturation was lower in the resting back muscles compared to arm and leg muscles but it was higher during the first stages of workloads.

The calculation of the dynamics and absolute values of the variation of indices revealed differences between the chosen groups during different physical tasks.

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ŠIRDIES IR KRAUJAGYSLIŲ SISTEMOS REAKCIJOS ANALIZĖ AKTYVUOJANT SKIRTINGAS RAUMENŲ GRUPES

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Atliekant provokacinį pakopomis didinamą fizinį krūvį, dirbančio raumens deguonies išsotinimo kaita paskutiniaisiais krūvio etapais buvo skirtinga. Darome prielaidą, kad šis skirtumas gali lemti nevienodas centrinės bei periferinės kraujotakos reakcijas dirbant rankų, kojų ir nugaros raumenims.

Tikslas: įvertinti centrinės ir periferinės širdies ir kraujagyslių sistemos reakcijas aktyvuojant skirtingas raumenų grupes.

Metodai. Ištirti 27 sąlygiškai sveiki vyrai (amžius $32 \pm 1,8$ m., KMI $25,3 \pm 0,6$ kg / m²). Visi tiriamieji atliko pakopomis kas minutę didinamą provokacinį fizinį krūvį veloergometru. Jo metu buvo registruojama elektrokardiograma ir vertinamas deguonies išsotinimas neinvaziniu artimosios infraraudonosios spektroskopijos būdu. Tiriamieji suskirstyti į dvi grupes pagal deguonies išsotinimą paskutiniaisiais veloergometriniu krūvio etapais: A grupė – deguonies išsotinimas didėjo paskutiniaisiais veloergometriniu krūvio etapais; B grupė – deguonies išsotinimas mažėjo visais krūvio etapais. Jie tiesė blauzdą, dilbį ir nugarą.

Rezultatai. Širdies susitraukimų dažnio ir deguonies išsotinimo rodiklių kaita parodė skirtumus tarp rankomis ir kojomis atliekamo pratimo. Nors krūvis rankoms ir kojoms buvo individualizuotas, A ir B grupės širdies susitraukimų dažnio ir deguonies išsotinimo rodiklių kaita skyrėsi.

Kiek neįprasta širdies susitraukimų dažnio reakcija taikant fizinį krūvį nugaros raumenims – širdies susitraukimų dažnis pirmomis krūvio sekundėmis sumažėdavo, bet ne padidėdavo. Ramybės sąlygomis užregistruotas deguonies išsotinimas nugaros raumenyse buvo mažesnis nei rankų ir kojų ($p < 0.05$).

Aptarimas ir išvados. Širdies susitraukimų dažnio ir deguonies išsotinimo rodiklių kitimas aktyvuojant skirtingas raumenų grupes parodė, kad kiekviena funkcinė raumenų grupė žmogaus organizme turi ne tik bendrųjų, bet ir savųjų aktyvavimo ypatybių, tiek išitraukiant reguliacinėms sistemoms, tiek formuojant tam tikrą metabolizmo aktyvavimą dirbančiuose raumenyse.

Raktažodžiai: širdies susitraukimų dažnis, deguonies išsotinimas, rodiklių kitimas.

Gauta 2011 m. kovo 10 d.
Received on March 10, 2011

Priimta 2011 m. birželio 16 d.
Accepted on June 16, 2011

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KNEE MUSCLE TORQUE AND H:Q RATIO CHANGES BEFORE ACL SURGERY AND AFTER REHABILITATION

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ABSTRACT

Research background and hypothesis. Anterior cruciate ligament (ACL) of the knee joint is often quite a fragile structure of the knee. After the rupture of ACL neuromuscular control worsens and sensorimotor system breaks down (Risberg et al., 2007), muscle activation is poor and muscle strength decreases (Croce, Miller, 2006). Some authors have reported greater strength loss in *quadriceps femoris* than in *hamstring femoris* muscle (Busch-Joseph et al., 2001; Neeter et al., 2006), therefore we hypothesized that strength loss in knee extensors may affect *hamstring/quadriceps* torque (H:Q) ratio.

Research aim of this study was to investigate knee extensors and flexors isometric and dynamic torque and H:Q ratio alterations before ACL surgery and after rehabilitation.

Research methods. Ten volunteers with ACL ruptured knee were tested before surgery and after rehabilitation. Isokinetic dynamometer was used for this testing. Maximal isometric torque was performed during flexion and extension at 90°, 60° knee angles. Dynamic torque was performed at 30, 180, 300°/s angular velocities.

Research results. Results of this study show that after rehabilitation isometric and dynamic torque of the involved leg decreased. Isometric flexion and extension torque of the uninjured leg was greater than that of the injured leg, but after rehabilitation the extension torque of the injured leg was lower than that before surgery.

Discussion and conclusions. Before ACL surgery and after rehabilitation *quadriceps femoris* muscle torque of the uninjured leg was more affected than *hamstring femoris* muscle torque. After rehabilitation H:Q ratio of the injured leg was not dependent on angular velocity and knee joint angle.

Keywords: maximal voluntary torque, muscle balance, muscle contraction.

INTRODUCTION

Anterior cruciate ligament (ACL) of the knee joint is often quite a fragile structure of the knee. After the rupture of ACL neuromuscular control worsens and sensorimotor system breaks down (Risberg et al., 2007), muscle activation is poor and muscle strength decreases (Croce, Miller, 2006). The ratio of maximal isokinetic hamstring muscle strength relative to

maximal isokinetic quadriceps muscle strength (H:Q ratio) is a parameter commonly used to describe the muscle strength properties about the knee joint (Aagaard et al., 1998). Normal H:Q ratio for healthy people is 0.5–0.8 (Holcomb et al., 2007). The H:Q ratio is greater at the highest velocity (0.8 ± 0.1 at 360°/s) compared to the lowest angular velocity (0.47 ± 0.2 at 30°/s)

(Hewett et al., 2008). If H:Q ratio is closer to 1, the hamstring muscles are stronger and knee joint is more stable (Aagaard et al., 1998). Isokinetic and isometric different muscle group testing is applied to assess muscle strength recovery, and this enables us to know the H:Q ratio between healthy and unhealthy leg muscles (Rosene et al., 2001) and then decide whether the patient is able to return to sport (Keays et al., 2000).

To our knowledge, there is no detailed study which compare knee extensors and flexors isometric and dynamic torque and the H:Q ratio in one study after ACL rupture and how these parameters change after 3 months of rehabilitation. Some authors have reported greater strength loss in *quadriceps femoris* than in *hamstring femoris* muscle (Busch-Joseph et al., 2001; Neeter et al., 2006), therefore we hypothesized that strength loss in knee extensors may affect H:Q ratio. Therefore, the aim of this study was to investigate knee extensors and flexors isometric and dynamic torque and H:Q ratio alterations before ACL surgery and after rehabilitation.

RESEARCH METHODS

The study was accomplished in accordance with the principles of the Declaration of Helsinki, concerning the ethics of experimenting with humans. Ten untrained males with left leg ACL rupture took part in this study (their mean age was 28.4 ± 7.1 years, height – 179.8 ± 8.5 cm, weight – 76.0 ± 14.0 kg.). The inclusion into the research criteria were as follows: 1) during the surgery not more severe than grade I cartilage violation was observed; 2) the other knee joint was not damaged; 3) the subjects were not older than 35 years; 4) three or fewer months had passed from ACL injury to surgery. The exclusion criteria were as follows: 1) previously they had had knee injury or had undergone surgery; 2) they had osteoarthritis or posterior cruciate ligament rupture; 3) had II–IV grade knee cartilage damage.

Isokinetic dynamometer (*Biodex Medical System 3, Shirley, New York, USA*) was used for the measurements applied.

Isometric maximal voluntary contraction (MVC) torque measurement. MVC torque was measured isometrically when the leg was fixed at the knee joint at 90° and 60° degrees and the subjects were asked to increase maximal flexion and extension torque and to hold it for 5 s. The procedure was repeated 3 times, there was 1 min

rest between repetitions and the highest torque was used for calculation. The participants were encouraged to reach maximal torque and they were able to see their achieved torque on the screen.

Dynamic muscle torque measurement. Concentric isokinetic torque for extension and flexion (injured and uninjured legs) was measured using a isokinetic dynamometer at randomly ordered 3 angular velocities: 30, 180, and $300^\circ/\text{s}$. We asked the subjects to flex and extend their knees as fast as they could. There was 1 min rest between the tests at different velocities.

H:Q ratio. Concentric and isometric H:Q strength ratio is calculated by dividing maximal concentric knee flexor (hamstring) moment by the maximal concentric knee extensor (quadriceps) moment obtained at a given joint angular velocity (Aagaard et al., 1998).

Rehabilitation programme. Rehabilitation started 2 weeks after surgery: physiotherapy, massage, electrical stimulation (16 times, 3 times per week). After 16 procedures the treatment was continued in the gym. During the physiotherapy procedure (45 min) the range of motion, strength, balance and coordination exercises were applied. During the electrotherapy procedure (30 min) we applied electrostimulation (*Neuro Trac, Sports XL, Hampshire, UK*), at the intensity of 20 Hz, exercises in the gym and swimming pool (30 min), and a range of motion and strength exercises. To reduce pain, the patients were recommended to apply freezing compresses at the knee joint.

Organization of the research. The subjects performed warm-up exercises which consisted of 5 minutes of veloergometric exercise at the intensity that corresponded to the heart rate (HR) of 130–150 beats / min (about 70% of maximum HR). HR was measured using a Polar HR recorder (*Polar Electro*). After 5 min interval we measured maximal voluntary leg flexion and extension (at 90° , 60° of the knee joint) torque and dynamic muscle torque at 30, 180, and $300^\circ/\text{s}$ velocities. The testing was carried out 2 times: 1) before ACL surgery; 2) 3 months after rehabilitation.

Statistical analysis. The research data were processed using *Microsoft Excel 2007* program mathematical statistical analysis. The data are reported as group mean values \pm standard deviations. The mean peak torque and the H:Q ratio were compared between groups using a Student's *t* test. The level for statistical significance was set to an alpha level of $p < 0.05$.

RESEARCH RESULTS

After rehabilitation we found statistically significant differences ($p < 0.05$) between injured and uninjured legs, when the leg at the knee joint was flexed 60 and 90 degrees (Table 1). After rehabilitation MVC torque of the injured and uninjured legs flexion decreased at 60° and 90° knee angles, but we did not find any significant difference.

Extension MVC torque significantly ($p < 0.05$) differed between the ruptured and the unruptured leg before surgery and after rehabilitation when the leg at the knee joint was flexed at 60° and 90° (Table 2). After rehabilitation the MVC torque

at 60° and 90° of the ruptured leg significantly ($p < 0.05$) decreased.

The injured leg flexion torque (Table 3) was statistically significantly lower than that of the uninjured leg at all speeds before surgery and after rehabilitation. After rehabilitation the injured leg flexion torque at 180°/s was significantly lower than that before surgery.

The injured leg flexion torque (Table 4) was significantly less than that of the uninjured leg at all speeds before surgery and after rehabilitation, except for the 300°/s speed after rehabilitation, where we did not find statistically significant difference ($p > 0.05$) between the injured and the uninjured legs.

Table 1. MVC torque of flexion of injured and uninjured legs before surgery and after rehabilitation

Place	Time		Before surgery		After rehabilitation	
	Knee joint angle		60°	90°	60°	90°
Injured leg, N·m	124.72 ± 23.58	73.58 ± 14.72	98.56 ± 39.17*	68.32 ± 32.1*		
Uninjured leg, N·m	136.42 ± 46.45	91.98 ± 40.22	125.64 ± 37.98	99.66 ± 33.84		

Note. * – $p < 0.05$ between injured and uninjured legs.

Table 2. MVC torque of extension of injured and uninjured legs before surgery and after rehabilitation

Place	Time		Before surgery		After rehabilitation	
	Knee joint angle		60°	90°	60°	90°
Injured leg, N·m	273.24 ± 58.87*#	235.94 ± 41.09*#	223.26 ± 28.01*	166.42 ± 44.27*		
Uninjured leg, N·m	347.52 ± 69.7	347.82 ± 130.15	328.34 ± 69.19	328.08 ± 117.39		

Note. * – $p < 0.05$ between injured and uninjured legs; # – $p < 0.05$ difference before surgery and after rehabilitation.

Table 3. Isokinetic flexion torque of injured and uninjured legs before surgery and after rehabilitation

Legs	30°/s		180°/s		300°/s	
	Before surgery	After rehabilitation	Before surgery	After rehabilitation	Before surgery	After rehabilitation
Injured leg, N·m	105.8 ± 21.79*	92.02 ± 21.4*	92.98 ± 19.75*#	72.7 ± 17.08*	94.62 ± 14.71*	84.94 ± 14.26*
Uninjured leg, N·m	150.04 ± 25.76	131.8 ± 23.28	123.86 ± 32.71	96.86 ± 16.99	104.2 ± 14.61	98.06 ± 9.72

Note. * – $p < 0.05$ between injured and uninjured legs; # – $p < 0.05$ difference before surgery and after rehabilitation.

Table 4. Isokinetic extension torque of injured and uninjured legs before surgery and after rehabilitation

Legs	30°/s		180°/s		300°/s	
	Before surgery	After rehabilitation	Before surgery	After rehabilitation	Before surgery	After rehabilitation
Injured leg, N·m	219.44 ± 69.44*#	156.8 ± 53.03*	141.7 ± 44.47*	134.48 ± 41.98*	147.8 ± 33.72*	148.6 ± 32.35
Uninjured leg, N·m	298.64 ± 39.7	273.52 ± 59.21	197.36 ± 42.12	182.2 ± 41.32	190.04 ± 38.75	166.66 ± 31.21

Note. * – $p < 0.05$ between injured and uninjured legs; # – $p < 0.05$ difference before surgery and after rehabilitation.

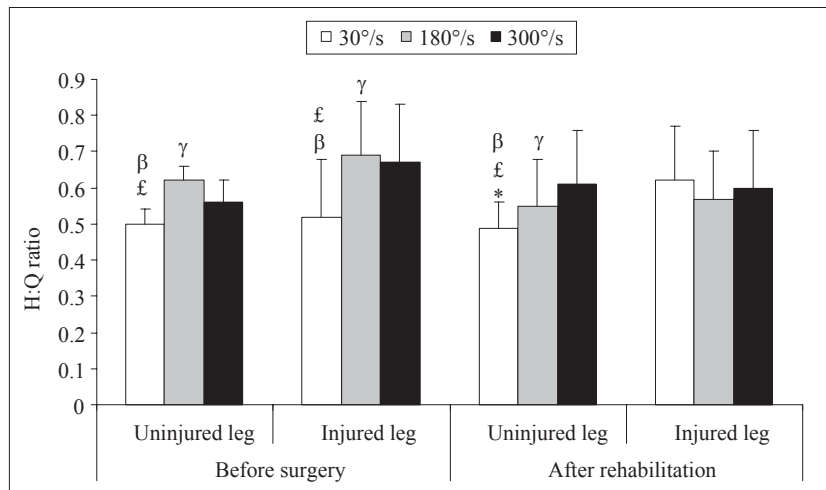


Figure 1. Isokinetic torque H:Q ratio at different angular velocities

Note. * – $p < 0.05$ between injured and uninjured legs; ϵ – $p < 0.05$ between 30 and 180°/s; β – $p < 0.05$ between 30 and 300°/s; γ – $p < 0.05$ between 180 and 300°/s.

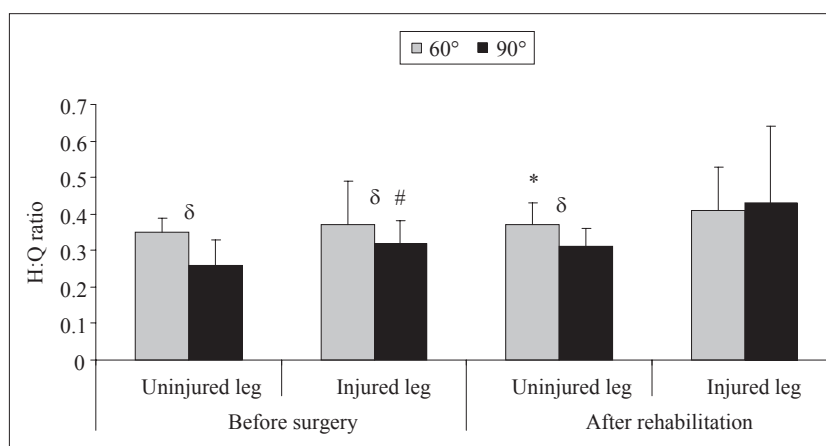


Figure 2. Isometric torque H:Q ratio at different angles

Note. * – $p < 0.05$ between injured and uninjured legs; # – $p < 0.05$ before surgery and after rehabilitation; δ – $p < 0.05$ between 60° and 90°.

After rehabilitation, the uninjured leg H:Q ratio at 30°/s angle speed was significantly lower than that of the injured leg (Figure 1). However, at a different speed we did not find significant differences between the injured and the uninjured legs before surgery and after rehabilitation. Before surgery we found significant differences between the task performance at different speeds (30 / 180, 30 / 300 and 180 / 300°/s) when it was performed with the injured and the uninjured legs. After rehabilitation significant differences were found between all speeds when the task was performed with the uninjured leg, but when the task was performed with the injured leg significant differences were not established.

After rehabilitation, the uninjured leg H:Q ratio at 60° knee angle was significantly lower than that of the injured leg (Figure 2). After rehabilitation the injured leg H:Q ratio at 90° knee angle was significantly higher than that before surgery. But at other knee angles we did not find significant differences between the injured and the uninjured legs before surgery and after rehabilitation. H:Q ratio of the injured and the uninjured legs before surgery and of the

uninjured leg after rehabilitation were dependent on the knee angle, but after rehabilitation the injured leg H:Q ratio was independent on the knee angle.

DISCUSSION

Results of this study show that after rehabilitation isometric and dynamic torque of the involved leg decreased. Isometric flexion and extension torque of the uninjured leg was greater than that of the injured leg, but after rehabilitation the extension torque of the injured leg was lower than that before surgery. After rehabilitation H:Q ratio of the injured leg was not dependent on the angle velocity and the knee joint angle.

Isometric MVC torque. We found that after rehabilitation isometric extension torque of the involved leg decreased. Before surgery and after rehabilitation the extension torque of the involved leg was lower than that of the uninjured leg. After rehabilitation flexion torque was lower in the involved leg than that in the uninjured leg. Therefore we suggest that ACL rupture affects isometric extension torque reduction, but it does

not affect flexion torque. Reflex inhibition of the lower motor neurons, pain, inadequate training, muscle disuse have been shown to cause significant atrophy of type I and type II muscle fibers of the quadriceps and that can lead to quadriceps deficit (Pua et al., 2008).

We found that after rehabilitation the quadriceps and hamstrings muscle torque of the involved leg decreased, but the one of the uninvolved leg did not change. However, we found different results than those of other researchers. T. L. Chmielewski et al. (2004) found, that ACL rupture affected *quadriceps femoris* muscle torque reduction not only in the involved leg but also in the uninvolved leg. The differing reports found in current literature may be partly explained by differences in the rehabilitation programs and the fact that the measurements were done at various points in time. We think that our results differ, because the patients had all three months of rehabilitation, and the uninvolved leg strength restored, and the involved leg strength did not manage to fully recover.

Dynamic torque. Maximal dynamic extension and flexion torque was registered when the angle velocity was the lowest. These findings coincide with the results of many researchers who indicate that the size of the torque is dependent on the joint angle (Aagaard et al., 1998; Croce, Miller, 2006) and angle velocity (Hiemstra et al., 2004). For healthy people the maximum torque of the hamstring muscle is reached at 30 and 180°/s angular velocity, and quadriceps muscle is the strongest at 60°/s angular velocity (Itoh et al., 1992). These data confirm the results of our study claiming that at lower speed flexion and extension torque is the highest. We found that after rehabilitation dynamic torque of the involved leg decreased. A. Clair Gibson et al. (2000) also found that quadriceps and hamstrings peak torque values were significantly decreased in ACL deficient compared to the uninvolved limb. A. Czamara et al. (2011) observed 9% deficit in extensor muscle strength measured under isokinetic conditions of the involved knees compared to the uninvolved knees. Our results led us to conclude that the physiotherapy was of too low intensity and that the period of physiotherapy should be extended for patients.

Dynamic and isometric torque H:Q ratio. We found that after rehabilitation H:Q ratio of

the involved leg was higher than that of the uninvolved leg at 30°/s angular velocity and 60° knee angle. We believe that this is due to the fact that after the rehabilitation the quadriceps muscle torque of the involved leg decreases more than the hamstring muscle torque, thus reducing the torque difference between these muscle groups (i. e. H:Q ratio approaching 1). After rehabilitation H:Q ratio of the involved leg is not dependent on the angle velocity and knee joint angle. Our data do not coincide with the data in M. J. Rosene et al. (2001) study where H:Q ratio is dependent on the angular velocity and joint angle. It is argued that in order to avoid the hamstrings muscle and knee joint injuries, the optimal H:Q ratio should be not less than 0.6. This may change with the velocity in which strength is tested. P. Kannus (1988) found that the rate of this ratio must be calculated individually for all patients, because each patient is different and H:Q ratio is also different.

H. Lund-Hanssen et al. (1996) measured H:Q ratio after ACL surgery and found that H:Q ratio of the injured leg is higher at higher angle velocity (240°/s) compared to the one of the uninjured leg, but at lower angle velocity (60°/s) they did not find significant differences. P. Kannus (1988) also found that H:Q ratio of the injured leg was higher at higher angle velocity (180°/s) compared to the one of the uninjured leg. We found, that at 180°/s angular velocity H:Q ratio reduced more than at 30°/s, and we think that this is due to quadriceps muscle torque reduction and fast muscle fiber atrophy.

We found that concentric torque at different velocities showed that bigger differences between injured and uninjured legs were visible at higher velocity. Lower H:Q ratio between injured and uninjured legs shows that muscle torque is not yet full reached and needs further rehabilitation (Aagaard et al., 1998). We can make a conclusion that H:Q ratio is higher at higher velocity; H:Q ratio after ACL surgery depend on quadriceps muscle torque reduction; the goal of rehabilitation should be the achievement of H:Q ratio of the injured leg equal to the one of the uninjured leg. It is very important to calculate H:Q ratio because it was found that the risk of ACL rupture depended on the H:Q ratio (Devan et al., 2004) and strength imbalances were associated with the risk of injury in sports (Pua et al., 2008).

CONCLUSIONS AND PERSPECTIVES

Before ACL surgery and after rehabilitation *quadriceps femoris* muscle torque of the uninjured leg was more affected than *hamstring femoris*

muscle torque. After rehabilitation H:Q ratio of the injured leg was not dependent on angular velocity and knee joint angle.

Acknowledgements. This study was supported by Research Council of Lithuania (MIP-10346).

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ŠLAUNIES RAUMENŲ JĖGOS MOMENTŲ IR JŲ SANTYKIO POKYTIS PRIEŠ PKR OPERACIJĄ IR PO REABILITACIJOS

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Kelio sąnario priekiniai kryžminiai raiščiai (PKR) – dažnai pažeidžiama kelio sąnario struktūra. Po PKR plyšimo suprastėja neuroraumeninė kontrolė, sutrinka sensomotorinė sistema (Risberg et al., 2007), raumenų aktyvacija ir sumažėja raumenų jėga (Croce, Miller, 2006). Keleto mokslininkų atliktų tyrimų rezultatai parodė: po PKR plyšimo labiau sumažėja keturgalvio šlaunies raumens nei užpakalinių šlaunies raumenų jėga (Busch-Joseph et al., 2001; Neeter et al., 2006). Taigi manytume, kad kelio tiesiamųjų raumenų jėgos sumažėjimas turi įtakos keturgalvio ir užpakalinių šlaunies raumenų santykiui (H:Q).

Tikslas: ištirti kelio tiesiamųjų ir lenkiamųjų raumenų izometrinės bei dinaminės jėgos momento ir H:Q santykio pokyčius prieš PKR operaciją ir po reabilitacijos.

Metodai. Tirta 10 fiziškai aktyvių vyrų, kurių PKR pažeisti. Testavimai atlikti prieš PKR rekonstruojamąją operaciją ir po 3 mėnesių reabilitacijos. Tiriamieji buvo testuojami izokinetiniu dinamometru. Išmatuotas maksimaliosios lenkimo ir tiesimo (esant 90°, 60° kampams) izometrinės kojų raumenų jėgos momentas. Dinaminės jėgos momentas tirtas esant 30, 180, 300°/s kampiniams greičiams.

Rezultatai. Remiantis tyrimo rezultatais galima teigti, kad po reabilitacijos sumažėjo pažeistos kojos izometrinės ir dinaminės jėgos momento dydis. Sveikos kojos izometrinės lenkimo ir tiesimo jėgos momentas buvo didesnis nei pažeistos, tačiau po reabilitacijos pažeistos kojos tiesimo momentas mažesnis nei prieš operaciją.

Aptarimas ir išvados. PKR plyšimas daugiau turėjo įtakos pažeistos nei sveikos kojos keturgalvio raumens jėgos momento sumažėjimui prieš operaciją ir po reabilitacijos nei užpakalinių šlaunies raumenų. Po reabilitacijos pažeistos kojos H:Q santykis nepriklausė nuo greičio ir kelio sąnario kampo.

Raktažodžiai: maksimaliosios jėgos momentas, raumenų pusiausvyra, raumenų susitraukimas.

Gauta 2010 m. lapkričio 18 d.
Received on November 18, 2010

Priimta 2011 m. birželio 16 d.
Accepted on June 16, 2011

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CHANGES IN THE INCIDENCE OF UNDERWEIGHT AND OVERWEIGHT IN CHILDREN AND ADOLESCENTS FROM RURAL AREAS

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ABSTRACT

Research background and hypothesis. Considering the socio-economic transformations affecting the life style of rural families of Eastern Poland, it seemed worthwhile determining changes in the frequency of occurrence of overweight and underweight among girls and boys from this region, as the negative effects of improvements in life conditions include an increase in overweight and obesity, which in some countries takes the form of epidemics.

Research aim was determine changes over time in the frequency of occurrence of underweight and overweight (including obesity) among children and adolescents in Eastern Poland considering social variation.

Research methods. Information was obtained applying a questionnaire survey concerning the educational level of parents and the number of children in the family. The standards recommended by the International Obesity Task Force were used for the evaluation of underweight and overweight including obesity, based on the BMI index.

Research results. During the period of time between 1998 and 2007, an increase was observed in the frequency of occurrence of overweight and obesity, accompanied by a decrease in underweight among boys. In girls, an opposite trend was noted – an increase in the number of underweight girls and a decrease in the frequency of occurrence of overweight and obesity. In addition, social differences were noted concerning BMI values: girls and boys with overweight and obesity most often came from families with lower levels of parental education and a larger number of children in the family.

Conclusions and perspectives. The education of parents and the number of children, in spite of observed social and economic positive changes in Poland, still have an influence on the frequency of occurrence of overweight and obesity in children and the youth of the rural areas.

Keywords: body mass index, time changes, social conditions.

INTRODUCTION

The eastern provinces belong to the poorest regions of Poland and their GDP (Gross Domestic Product) per capita is under 40% of the average GDP of the European Union (GUS, 2007). Most inhabitants of these regions live in rural areas and agriculture is their main source of income. The poor financial condition of most households, along with the difficult situation of employment

and low rates of education, constitute the basic problems faced by these regions of Poland. At the onset of the 21st century, nearly 60% of the rural inhabitants possessed elementary or incomplete elementary education level. Only 13.4% of farmers had a secondary school or university level of agricultural education compared to the national average of 21.4% (Niećko et al., 2001).

For the rural areas of Eastern Poland, entering the European Union clearly meant changes for the better. These areas obtained considerable financial support for development. A gradual increase was also observed with respect to levels of education for the inhabitants of this region; however, this level still remains below the national average (Bański et al., 2010).

The negative effects of these improvements in life conditions include an increase in the frequency of occurrence of overweight and obesity, which has been noted in recent years and in some countries takes the form of epidemics (WHO, 1998). Due to the appearance of a greater variety of high calorie meals and drinks on the market, combined simultaneously with an increase in physical inactivity, a considerable growth in the BMI index among Polish children and adolescents has been noted over the last years (Chrzanowska et al., 2007). On the other hand, in every population there is a group of children and adolescents with a deficiency of body mass. It is usually assumed that the cause of malnutrition is poverty; however, this may also result from the lack of adequate nutritional habits, lack of sufficient care, poor family life, or family pathology (Bennett et al., 2010). Other causes for this phenomenon may include strong social pressure of the media favoring the fashion of slim figures, which consequently leads to volitional nutritional limits among young girls.

Considering the socio-economic transformations affecting the life style of rural families on the verge of the 21st century, it seemed worthwhile to determine changes in the frequency of occurrence of overweight and underweight among girls and boys from this region during the period of time between 1998 and 2007 considering social diversity.

RESEARCH METHODS

Selection of the sample. Research materials were collected in two study series covering the years 1998 and 2007 as part of research project P05D 02314 and statutory studies DS.69. These studies were cross-sectional in character and included girls and boys aged 10 to 18, attending rural elementary, junior, and secondary schools in the Lubelskie Province (Eastern Poland). Schools participating in the study were selected at random from a list of all schools in this area made available by the Local Education Authority.

The schools selected constituted from 1.68 to 2.40% of the total number of schools in the region. The study was planned so as to include all children whose parents expressed consent for their children to participate. Ultimately, the study included data concerning 963 boys and 984 girls in 1998 (approximately 90% of the total number of children from the schools selected), and 800 boys and 639 girls in 2007 (about 75%). The studies were conducted by the authors of the presented report. The study protocol was approved by the Local Bioethical Committee of the University of Physical Education in Warsaw.

Methods. The study started with a survey among parents who provided data concerning, among other things: the date of birth of each child, education level of the mother and the father, and number of children in the family. The children were qualified to specified age categories based on their date of birth and the date of the survey. In both study series (1998 and 2007), measurements of basic somatic traits were performed including the measurements of height and body mass using the Martin technique (Martin, Saller, 1957). Based on these parameters, the BMI index was calculated then. This index was used to establish the incidence of underweight and overweight (including obesity) based on cut off values of BMI for children and adolescents recommended by the International Obesity Task Force (Cole et al., 2000; Cole et al., 2007). This enabled the demonstration of changes in the frequency of occurrence of underweight and overweight (including obesity) in the study series compared. Within the aforementioned groups of underweight and overweight subjects, we calculated the percentage of children from families where the parents had obtained elementary, vocational, secondary, and university levels of education. The statistical significance of the differences between the results obtained over the years examined was assessed by means of the χ^2 test. Similar calculations were performed while analyzing the percentage distribution of the participants in the study according to the number of children in the family (one child, three children, three or more children). All calculations were performed with the use of Statistica 7 (StatSoft® Poland) software.

RESEARCH RESULTS

Underweight and overweight (including obesity) according to gender and age. The

Table 1. Frequency of occurrence of underweight and overweight including obesity in boys during the period of 1998–2007

1998						Age, years	2007						Chi-square test – χ^2
Underweight		Normal BMI value		Overweight and obesity			Underweight		Normal BMI value		Overweight and obesity		
n	%	n	%	n	%		n	%	n	%	n	%	
10	9.6	86	82.7	8	7.7	10	14	15.1	72	77.4	7	7.5	1.36
17	15.3	79	71.2	15	13.5	11	6	5.9	77	76.2	18	17.8	5.31
19	16.1	82	69.5	17	14.4	12	7	9.2	61	96.0	8	10.5	3.00
20	15.7	94	74.0	13	10.2	13	5	3.6	93	66.4	42	30.0	25.10**
12	10.7	95	84.8	5	4.5	14	1	1.4	54	73.0	19	25.7	23.29**
9	12.2	59	79.7	6	8.1	15	8	7.5	81	75.7	18	16.8	3.76
4	3.8	94	90.4	6	5.8	16	1	1.0	79	78.2	21	20.8	12.01**
12	11.4	85	81.0	8	7.6	17	1	1.9	47	87.0	6	11.1	5.70
8	7.4	96	88.9	4	3.7	18	1	1.9	47	87.0	6	11.1	5.39
111	11.5	770	80.0	82	8.5	Total	44	5.5	611	76.4	145	18.1	50.91**

Note. * – statistically significant differences at the level $p < 0.05$; ** – statistically significant differences at the level $p < 0.01$.

Table 2. Frequency of occurrence of underweight and overweight including obesity among girls during the period of 1998–2000

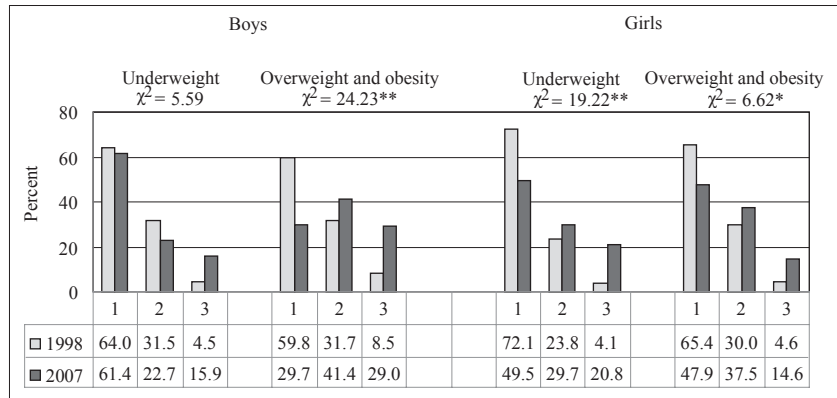
1998						Age, years	2007						Chi-square test – χ^2
Underweight		Normal BMI value		Overweight and obesity			Underweight		Normal BMI value		Overweight and obesity		
n	%	n	%	n	%		n	%	n	%	n	%	
12	12.5	71	74.0	13	13.5	10	11	13.6	55	67.9	15	18.5	0.95
20	18.3	75	68.8	14	12.8	11	8	14.0	36	63.2	13	22.8	2.78
27	24.5	72	65.5	11	10.0	12	2	5.4	33	89.2	2	5.4	9.43**
15	13.4	82	73.2	15	13.4	13	11	15.9	54	78.3	4	5.8	2.89
16	13.8	85	73.3	15	12.9	14	9	12.7	58	81.7	4	5.6	2.96
8	8.8	69	75.8	14	15.4	15	7	9.5	66	89.2	1	1.4	11.83**
4	3.3	98	81.0	19	15.7	16	22	22.9	70	72.9	4	4.2	26.15**
12	9.8	95	77.9	15	12.3	17	13	23.6	40	72.7	2	3.6	8.36*
8	7.5	84	78.5	15	14.0	18	18	18.2	78	78.8	3	3.0	12.59**
122	12.4	731	74.3	131	13.3	Total	101	15.8	490	76.7	48	7.5	15.96**

Note. * – statistically significant differences at the level $p < 0.05$; ** – statistically significant differences at the level $p < 0.01$.

analysis of the frequency of occurrence of underweight and overweight (including obesity) in boys in 1998 showed that the percentage of those underweight was higher than of those overweight and obese. Deviations from normal BMI values were the greatest among boys aged from 11 to 13.

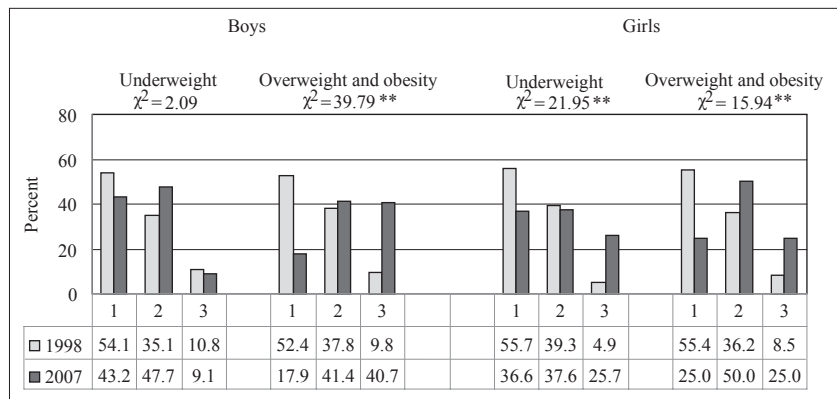
When comparing the above-mentioned data to the studies conducted in 2007, we observed a decrease in the percentage of underweight boys (from 11.5% down to 5.5%). Also, a significant increase was noted in the percentage of overweight and obese boys (from 8.5% up to 18.1%). The changes

Figure 1. Frequency of occurrence of underweight and overweight including obesity according to the education level of the father



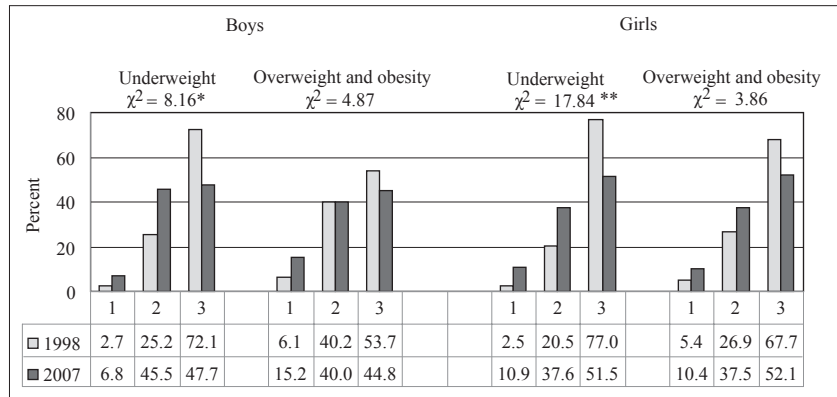
Note. * – statistically significant differences on the level $p < 0.05$; ** – statistically significant differences on the level $p < 0.01$. Education level: 1 – elementary + vocational, 2 – secondary, 3 – university.

Figure 2. Frequency of occurrence of underweight and overweight including obesity according to the education level of the mother



Note. * – statistically significant differences on the level $p < 0.05$; ** – statistically significant differences on the level $p < 0.01$. Education level: 1 – elementary + vocational, 2 – secondary, 3 – university.

Figure 3. Frequency of occurrence of underweight and overweight including obesity according to the number of children in the family



Note. * – statistically significant differences on the level $p < 0.05$; ** – statistically significant differences on the level $p < 0.01$. Number of children: 1 – one child, 2 – two children, 3 – three and more children.

observed in the incidence of underweight and overweight (including obesity) were statistically significant over this period of time (Table 1).

In 1998, a higher percentage of underweight and overweight (including obese) girls was observed in comparison to boys. In addition, it was noted that the percentage of girls who were underweight and overweight (including obese) was similar, amounting to 12.4 and 13.3%, respectively. Underweight girls were most frequently noted in younger age categories, i. e. 10 to 14 years of age. In the subsequent study series (2007), an increase was noted in the incidence of underweight, whereas the percentage of overweight and obese girls decreased nearly twofold. In addition, it was observed that underweight was most typical of girls in the oldest age categories (16 to 18 years

of age). The chi-square test (χ^2) confirmed the presence of statistically significant differences, mainly in the older age categories (Table 2).

Education level of parents. A clear relationship was observed between the incidence of underweight and overweight (including obesity) among the participants and the educational level of their parents. In 1998 the highest percentage of children examined with deviations from normal BMI values was noted in those families where fathers and mothers had elementary or vocational education. For children coming from families with higher levels of parental education, the situation was different. Children from these families constituted the smallest percentage of study subjects in regards to both underweight and overweight (including obesity) subjects.

In 2007, this situation slightly changed – boys with underweight and overweight (including obesity) most often came from families where the parents had secondary education. Girls who had BMI values which were too low or too high came from families where the father had elementary or vocational education while the mother had secondary education. At the same time, compared to data from 1998, an increase was noted in the percentage of children with underweight and overweight (including obesity) whose parents had university education (Figures 1, 2).

Number of children in a family. Figures 5 and 6 present the frequency of occurrence of underweight and overweight (including obesity) in boys and girls according to the number of children in the family. Both underweight and overweight cases (including obesity) were relatively rarely observed in families with a single child. Deviations from normal BMI values were most often found in children coming from families with many children. This situation was noted both in 1998 and 2007. Nevertheless, in 2007 when comparing children coming from families with two, three or more children, differences in the frequency of occurrence of deviations from normal BMI values decreased. Statistically significant differences between the study series analyzed were noted only in the case of underweight boys and girls (Figure 3).

DISCUSSION

The presented results of studies concerning rural children and adolescents from Eastern Poland indicate that the frequency of occurrence of overweight and obesity is increasing on the verge of the 21st century, which is in accord with a worldwide tendency (Frye, Heinrich, 2003; Lobstein et al., 2003). In Poland, this phenomenon has also been observed with varying intensity according to gender, age, and place of residence (Chrzanowska et al., 2007; Zawodniak-Szałapska et al., 2007). Simultaneously, the phenomenon of girls losing weight in early adolescence also occurs (Popławska et al., 2006; Chrzanowska et al., 2007), which was also confirmed by the results of our own studies.

The occurrence of exceedingly low body mass and low fatness among girls after puberty is probably the effect of slimming diets used in order to adjust to the existing fashion of having a slim figure. In general, underweight was found in 12% of boys and 14% of girls in Poland (in half of these

children, this deficiency was to a considerable degree) (Szponar et al., 2003). This problem also occurred among children and adolescents from the studied region. However, a decrease was observed during this time period (1998–2007) in the frequency of occurrence of underweight among boys from this area.

Studies to-date have shown that abnormal body mass, irrespective of genetic determination, is socially and culturally determined (Hardy et al., 2000). In Polish studies, the socio-economic situation of a family is most often determined by two variables, i. e. the level of education of the parents and the number of siblings. These factors can be easily and objectively identified; also, these criteria may be applied when comparing the results of our own studies with the results of other researchers.

The category of parental level of education encompasses a synthetic view concerning the home conditions of a child. Parents with higher levels of education and greater pedagogical awareness may create conditions for their offspring which are more conducive for their development. At the same time, T. Bielicki et al. (2005) suggest that the effects of parental education on a child's development cannot exclusively refer to the relationship between education and income, but are rather the reflection of the management of home finances, which exerts a positive effect on the development and health of a child of better educated parents.

S. Kozieł et al. (2000) observed that children of parents with 'low' categories of education are at higher risk of obesity. However, studies conducted by E. B. Bodzsár (1999) in Hungary showed the opposite relationship: overweight and obesity were most often found in boys and girls whose parents had the highest levels of education. Our studies confirm that during this period (1998–2007), there was indeed a change in the conditioning model in regards to relative body mass and this socio-cultural factor. In 1998, both underweight and overweight children most frequently came from families with the lowest levels of parental education. Nevertheless, in association with the upward tendency of the level of education of the whole of society, the percentage of children from families where the fathers and the mothers possessed secondary or university education increased in 2007. Simultaneously it has been observed that overweight and obese children most

often came from families where the mothers had secondary education.

The second indicator of differences in living conditions between various social groups is the number of children in the family. It is commonly known that the larger the number of children, the lower the income per one family member, which, in effect, qualitatively and quantitatively limits the mode of nutrition, and therefore results in an increase in body mass. High, statistically significant relationships between the size of a family and the level of fatness in British children were observed by E. Duran-Tauleria et al. (1995), as well as in Hungarian children by O. G. Eiben and C. G. Mascie-Taylor (2004). Studies by Polish researchers confirm that an increase in family size is accompanied by a decrease in the frequency of occurrence of overweight and obesity in children (Kozieł et al., 2000). In our studies, an opposite relationship was observed meaning that overweight

and obese children and adolescents most often came from families with many children. A similar situation was noted with respect to underweight children. This is probably associated with the fact that families with three or more children prevail in the rural areas of Eastern Poland. In a family with many children, the parents may not always be able to fully satisfy the basic nutritional needs of a child, which may be reflected by deviations from normal body mass.

CONCLUSION AND PERSPECTIVES

The education of parents and the number of children, in spite of observed social and economic positive changes in Poland, still have an influence on the frequency of occurrence of overweight and obesity in children and the youth of the rural areas.

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Zawodniak-Szałapska, M., Stawerska, R., Lewiński, A.

VAIKŲ IR PAAUGLIŲ ANTSVORIO IR NEPAKANKAMO SVORIO PAPLITIMO KAITA KAIMO VIETOVĖSE

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Vertinant socialinius ir ekonominius pokyčius, keičiančius šeimų gyvenimo būdą Rytų Lenkijoje, verta patyrinėti berniukų ir mergaičių nepakankamo svorio ir antsvorio paplitimą šiame regione: teigiami gyvenimo sąlygų pokyčiai turi ir neigiamų pasekmių – antsvorio ir nutukimo atvejai kai kuriose šalyse jau įgavo epidemijos formą.

Tikslas: nustatyti, kaip kinta Rytų Lenkijos vaikų ir paauglių nepakankamo svorio ir antsvorio (taip pat ir nutukimo) paplitimo dažnumas per tam tikrą laiką, įvertinant ir socialinius pokyčius.

Metodai. Taikant apklausos metodą buvo renkama informacija apie tėvų išsilavinimą ir vaikų skaičių šeimoje. Nepakankamas kūno svoris ir antsvoris buvo įvertintas pagal Tarptautinės kovos su nutukimu darbo grupės parengtas rekomendacijas, kurios remiasi KMI vertinimu.

Rezultatai. Nuo 1998 iki 2007 metų pastebimas berniukų antsvorio ir nutukimo atvejų pagausėjimas, nepakankamo svorio atvejų mažėja. Visiškai priešinga tendencija pastebima tarp mergaičių – pagausėjo nepakankamo svorio atvejų, sumažėjo antsvorio ir nutukimo atvejų. Nustatytos socialinių veiksnių ir KMI indekso reikšmių sąsajos: antsvoris ir nutukimas būdingas tiems berniukams ir mergaitėms, kurių tėvai turi mažesnę išsilavinimą ir kurių šeimose auga daugiau vaikų.

Išvados ir perspektyvos. Nepaisant pastebimų teigiamų socialinių ir ekonominių pokyčių Lenkijoje, tėvų išsilavinimas bei vaikų skaičius šeimoje turi įtakos vaikų ir paauglių antsvorio, nutukimo paplitimui kaimo vietovėse.

Raktažodžiai: kūno masės indeksas, laiko pokyčiai, socialinės sąlygos.

Gauta 2011 m. vasario 23 d.
Received on February 23, 2011

Priimta 2011 m. birželio 16 d.
Accepted on June 16, 2011

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EVALUATION OF NUTRITION HABITS OF ADOLESCENTS IN THE ASPECT OF GENDER AND PHYSICAL ACTIVITY

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ABSTRACT

Research background and hypothesis. Nutrition habits develop with the growth of an individual. During adolescence proper nutrition habits and physical activity are the most important factors influencing health. The quality of life is affected by the peculiarities of behavior and lifestyle in adolescence.

The aim of our study was to determine nutrition habits of adolescents, and then, to make a comparison of eating patterns by gender and the groups of adolescents in different physical activity groups.

Research methods. The study comprised the ninth form students from 16 Kaunas schools (4 gymnasiums, 10 secondary and 2 main schools). The strategy was based on the evaluation of proportions of the different types of schools in Kaunas. The study applied questionnaire survey.

Research results. The analysis revealed that 28.5% of middle-school age students did not have breakfast, there were more girls than boys among them. Boys and students with lower physical activity more frequently had hot meals. Adolescents most commonly had meals four times per day without following nutrition regimen.

Discussion and conclusions. Boys more frequently had breakfast, however, they chose buns, potato chips, and used more fried food for snacks; the same eating patterns were followed by students with lower physical activity. Girls were more likely to have fruit, green vegetables. In most cases, the selection of meals depended on the individual taste; boys more frequently paid attention to prices and nutrition values. Usually adolescents acquired information about proper nutrition from their parents and the internet; girls – more frequently from magazines and the internet.

Keywords: adolescents' knowledge on healthy nutrition, nutrition habits, physical activity.

INTRODUCTION

Nutrition habits and physical activity are the most significant factors influencing health during adolescence. Namely, these factors may reduce the risk of chronic diseases, improve health and work capacity (Boreham, Riddoch, 2001; Grinienė, 2003). Child and adolescent obesity is also a relevant problem in the world, thus the main focus is on the prevention

obesity among young people. Knowledge and lifestyle are becoming important. It is relevant to increase adolescent physical activity and change nutrition habits, reduce the time spent on watching TV and using computer (Perez et al., 2011). The use of appropriate health programs and methods in schools encouraging students to change their lifestyle is relevant (Hardy et al., 2011). Currently,

in the European Union the main concern is about the trends of nutrition and physical activity as well as health enhancement.

Studies show that physical activity and change of nutrition habits provide positive results and are effective means of control of obesity (overweight) (Ezendam et al., 2011).

When compared to boys, girls have healthier diets: they are more likely to have fruit, green vegetables, and less likely – potato chips, fried potatoes, Coke or other sweet drinks, as well as alcoholic beverages, however, they eat sweets and chocolate more frequently (Zaborskis et al., 2006).

Some studies show that more physically active adolescents evaluate their nutrition more positively, thus, their nutrition is healthier (Petronytė, Vizbaraitė, 2005).

The studies performed in Lithuania reveal that although Lithuania belongs to the countries where school-age students spend much time watching TV, eat little fruit, often experience abuse, there are also some positive facts, such as the lowest prevalence of overweight, a small number of adolescents reported drinking Coke and other sweetened carbonated drinks. However, the student population was also marked by unfavorable trends of lifestyle, thus it is necessary to design and implement health programs, which would have a positive influence on student lifestyle (Zaborskis, 2010).

Our hypothesis that nutrition habits and knowledge about nutrition are better (healthier) among girls and those who had a higher level of physical activity than among boys and students with a lower physical activity levels was based on the previously performed studies.

The aim of the study was to determine nutrition habits of adolescents, and to make a comparison of eating patterns by gender and belonging to different physical activity groups.

RESEARCH METHODS

The study was carried out in September and October, 2010.

The subjects. The ninth form students participated in the study from 16 schools in Kaunas (4 gymnasiums, 10 secondary schools and 2 main schools). The sampling strategy was based on the proportions between the different types of schools. Overall 579 questionnaires were disseminated. Not all questionnaires were filled in, thus the data

of 464 questionnaires were used for statistical analysis (girls $n = 236$, boys $n = 228$). The mean age of the subjects (SD) was 14.98 (0.41) years. The youngest participant was 14 years old, the oldest – 17 years old.

The study employed anonymous questionnaire survey; the consent from school as well as students and their parents was obtained.

The questionnaire. The rate of student exercising was determined by a modified Leisure Time Exercise Questionnaire (LTEQ, Godin, Shephard, 1985). Respondents were asked to point out their low, moderate and high intensity of exercising expressed by times per week if the duration of exercises was longer than 15 minutes. These times were compared to metabolic equivalents of 3, 5 and 9, respectively, and later on, the scores of all intensity levels were added together. The LTEQ instructions include the examples of physical activity that were adapted to the Lithuanian adolescent physical activity. Several studies have revealed that LTEQ questionnaire is reliable and valid (Jacobs et al., 1993). The physical activity in the leisure time (not during classes of the sample) had 57 (32.37) scores (MET / wk). The lowest physical activity was given 0 points, the highest – 259 points. Accordingly the subjects were classified into two groups: of lower and higher physical activity.

The questionnaire of nutrition habits was prepared referring to the methodology of the previous studies (Petronytė, Vizbaraitė, 2005). The respondents were asked to report the following: how many times per day they had meals, if they followed nutrition regimen, what kind of products they chose, what influenced their choice, where they acquired information about healthy nutrition.

The results of the study were compared between the groups of girls and boys as well as between the groups of higher and lower physical activity.

Statistical analysis. The data were analyzed using SPSS for *Windows 13.0 (Statistical Package for Social Science 13 for Windows)*. Qualitative determinants were evaluated by chi square criterion. The results were considered statistically significant if $p < 0.05$.

RESEARCH RESULTS

The results of the analysis revealed that 28.5% of students rarely or never had breakfast; there were

Table. Distribution of girls, boys and groups of different physical activity (PA) by nutrition habits

Feature	Girls, %	Boys, %	χ^2	df	p	Higher PA, %	Lower PA, %	χ^2	df	p
Rarely or never have breakfast	7.4	4.5	9.19	3	0.03	7.9	6.4	0.416	1	0.519
Hot breakfast	21.1	28.9	4.64	1	0.03	20.2	28.4	4.247	1	0.039
Consumption of buns as snacks	35.9	56.5	16.16	1	0.001	43.2	53.2	4.637	1	0.031
Consumption of vegetables and fruit as snacks	32.6	22.9	6.61	1	0.01	29.5	26.6	0.495	1	0.482
Meals taken at the same time	14.14	21.8	5.30	1	0.03	18.9	15.7	0.8231	1	0.364
Frequent consumption of fried foods	64.2	76.9	11.03	1	0.001	66.8	76.6	5.47	1	0.02
Consumption of smoked foods	3	9.9	11.24	1	0.001	6.2	5.5	0.092	1	0.762
Frequent consumption of brown bread	40.9	49.3	4.34	1	0.04	41.9	50.6	3.97	1	0.058

more girls than boys, 7.4% and 4.5%, respectively, $\chi^2 = 9.19$; $df = 3$; $p = 0.03$. The responses of lower or higher physical activity groups did not differ significantly (Table).

Hot breakfast was chosen by 24.5% of students, by more boys than girls: 28.9 and 21.1%, respectively, $\chi^2 = 4.64$; $df = 1$; $p = 0.03$. The students of lower physical activity group more frequently had hot breakfast compared to the group of higher physical activity, 20.2 and 28.4%, respectively, $\chi^2 = 4.24$; $df = 1$; $p = 0.039$ (Table).

Only 39.2% of students reported having soup and the second course, 34.4% – most commonly had only the second course. The respondents (13%) pointed out that they had only snacks instead of lunch. About 3.8% of students did not have snacks between meals. Buns as snacks were chosen by 47.5% of respondents; most were boys among them – 56.5 and 35.9%, respectively, $\chi^2 = 16.16$; $df = 1$; $p = 0.0001$. The students with lower physical activity also reported having more frequently buns as snacks, 53.2 and 43.2%, respectively, $\chi^2 = 4.63$; $df = 1$; $p = 0.031$. Vegetables and fruit as the most common snacks were reported by 27.6% of adolescents, more were girls than boys, 32.6 and 22.9%, respectively, $\chi^2 = 6.61$; $df = 1$; $p = 0.01$. Chocolate and potato chips were marked as snacks by 17.3% of students, the responses did not differ by gender, $\chi^2 = 0.05$; $df = 1$; $p = 0.83$. Difference among the students in the groups of different physical activity was not detected (Table).

Barely 17.8% of students reported having their meal at the same time, among them there were more

boys than girls, 21.8 and 14.14%, respectively, $\chi^2 = 5.30$; $df = 1$; $p = 0.03$. The responses did not differ between the groups of different physical activity ($\chi^2 = 0.823$; $df = 1$; $p = 0.364$).

The adolescents responded that they had their meals 3.89 times per day on average. Boys had meals more frequently than girls, 4.14 and 3.67 times per day, respectively, $p = 0.0001$. Frequent intake of food between meals was reported by 41.3% of students. We did not determine the differences by gender and by groups of physical activity.

Almost 69.1% of students pointed out that they most frequently consumed fried foods, there were more boys than girls, 76.9 and 64.2%, respectively, $\chi^2 = 11.03$; $df = 1$; $p = 0.001$. The students of lower physical activity had an intake of fried foods more frequently compared to the students of higher physical activity, 76.6 and 66.8%, respectively, $\chi^2 = 5.47$; $df = 1$; $p = 0.02$ (Table). Boys reported having smoked foods more frequently, 9.9 and 3%, respectively, $\chi^2 = 11.24$; $df = 1$; $p = 0.001$. We did not detect differences in having boiled food by gender. Girls more frequently than boys pointed out that they were having steamed food, 24 and 16.5%, respectively, $\chi^2 = 4.93$; $df = 1$; $p = 0.03$.

The majority of students (68.6%) reported that they had food prepared using oil, but no differences by gender were found. Nevertheless, 30.6% of students reported having butter more frequently, more boys than girls among them, 35.3 and 26.8%, respectively, $\chi^2 = 4.76$; $df = 1$; $p = 0.03$. Differences

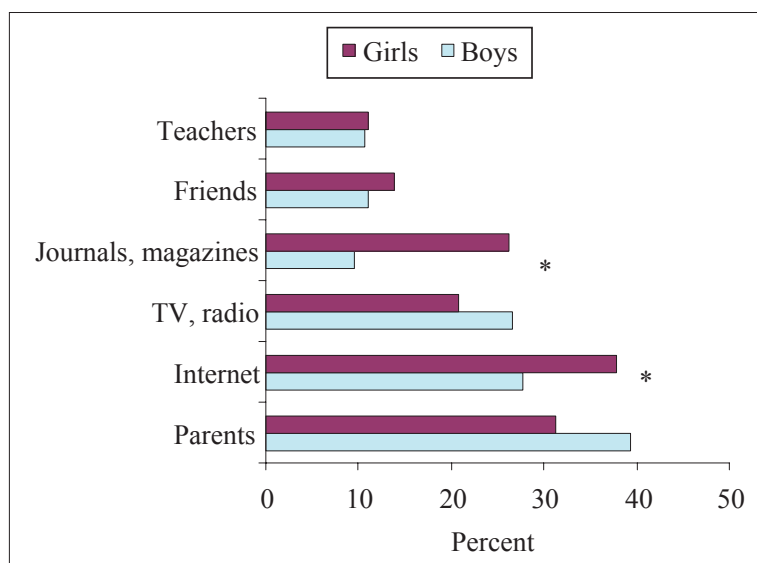


Figure 1. Sources of information about healthy nutrition

Note. * – p < 0.05.

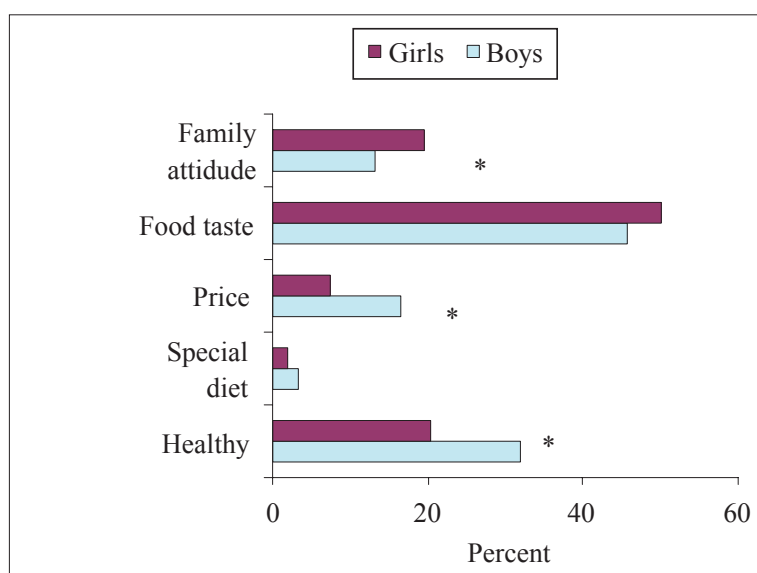


Figure 2. Criteria of respondents for food selection

Note. * – p < 0.05.

between the groups of different physical activity were not determined. Barely 13.6% of students pointed out that they had cracked grain bread, we did not detect any differences by gender. A greater number of respondents (44.2%) pointed out that they more frequently consumed brown bread, there were more boys than girls, 49.3 and 40.9%, respectively, $\chi^2 = 4.34$; $df = 1$; $p = 0.04$. White bread was chosen by 33.9% of students, 23.4% of them reported consuming long loaf more frequently. We did not detect differences by gender and groups of physical activity.

The subjects (34.4%) pointed out that mostly they gained knowledge about nutrition from their parents, internet ranked second (33.1), TV and radio were in the third place followed by magazines (18.3%), then friends (12.5%), and finally, teachers and school staff were only in fifth position (10.9%). More girls found information in the internet, 37.9 and 27.8%, respectively,

$\chi^2 = 6.58$; $df = 1$; $p = 0.01$. As it was expected, more girls reported finding information in magazines 26.2 and 9.6%, respectively, $\chi^2 = 25.9$; $df = 1$; $p = 0.001$ (Figure 1). We did not determine differences between groups of different physical activity.

Every second student (48%) reported that food selection was most commonly based on food taste properties, 25.9% – on nutritional value, 16.5% of students thought that their selection was based on family attitudes, and 11.7% pointed out the price of food. Unexpectedly, nutritional value was more stressed by boys 31.9 and 20.5%, respectively, $\chi^2 = 9.64$; $df = 1$; $p = 0.002$. Girls more frequently admitted that food selection was influenced by the attitudes of their families 19.5 and 13.2%, respectively, $\chi^2 = 4.08$; $df = 1$; $p = 0.04$, while boys more frequently than girls reported that their selection of food was also affected by price 16.5 and 7.4%, respectively, $\chi^2 = 11.39$; $df = 1$;

$p = 0.001$. We did not detect differences between the groups of different physical activity.

When students were asked to mark three main principles of healthy nutrition, they mostly stressed a balanced diet (75.1%), ecological food (58.1%), and a variety of food (56.9%). Moderate in food consumption was marked by 54.3% of students. We did not detect differences by gender and groups of different physical activity.

Only 6.5% of students reported following the requirements of healthy nutrition all the time, while 18.1% of school-age students admitted that they never followed these requirements. We did not find differences by gender or by groups of physical activity. Students (41.1%) responded that they had vegetables every day, only 36.8% ate fruit and berries. Only 51.8% of students had grains (bread, grits, cereals) every day. However, almost 32.2% of students had confectionery every day, 18% of them reported having sweet drinks (lemonade, Coke and others) every day. We did not find differences by gender and groups of physical activity.

DISCUSSION

We wanted to find out the following issues: what were the adolescent nutrition habits, whether they differed among boys and girls and in the groups of different physical activity, which criteria for food selection were chosen by them, which sources of information assisted in the choice of food. The analysis revealed that almost 28.5% of students did not have breakfast, there were more girls than boys. Boys and students of lower physical activity group reported having hot breakfast more frequently ($p < 0.05$). Studies performed by other scientists demonstrated a similar trend, i. e., only approximately 63% of students had breakfast regularly. Hot dinner was selected by 60% of school-age students, intake of fruit every day was pointed out by 65.5%, consumption of vegetables – 30.9% (Vitariusova et al., 2010).

Approximately 13% of the respondents reported that they had snacks instead of lunch, and the most popular snacks were buns (47.5%). More frequently, buns as snacks were selected by boys and students of lower physical activity ($p < 0.05$).

The analysis of selection of foods as snacks by girls showed that their nutrition was healthier. Girls were more likely to consume fruit, green vegetables than boys, and they had less potato

chips, fried potatoes, sweet drinks. Such trends were also determined in previous studies (Zaborskis et al., 2006).

Our subjects reported that they commonly had four meals per day, on average. The previous studies showed that students of similar age, as most Lithuanian residents, pointed out that they had three meals per day, on average (Kadziauskienė et al., 1999; Grabauskas, 2004; Zaborskis, 2005). As most adolescents, our subjects did not follow nutrition regimen. Only 17.8% of students reported having their meals at the same time, among them there were more boys than girls ($p < 0.05$).

Other researchers have also determined that adolescents had nutrition problems, thus it is necessary to change their eating habits. The number of overweight students is slowly increasing, particularly, of those who live in towns. These students more rarely had their meals at home, and more frequently, used confectionery and potato chips (Kukulu et al., 2010). The boys and students with lower physical activity in our study used more foods fried in oil. Therefore, their nutrition is not healthier than that of girls or students of higher physical activity.

Answering the question about oil selection, our subjects reported oil as most common for cooking food (Kadziauskienė et al., 1999; Petronytė, Vizbaraitė, 2005).

There is a lack of healthy grain food in the ration of our students, only few of them pointed out that they ate cracked grain bread or brown bread. Moreover, only 6.5% of students reported following the healthy nutrition requirements. When comparing the results with studies carried out in other countries, few students drank Coke and other sweet drinks, but they did not exclude confectionery from their food ration (Zaborskis, 2005; Strukčinskienė, 2009).

Knowledge and information that may influence adolescents are very important for the development of nutrition habits. It is especially important of the younger age, since some authors associate obesity in the older age with the lack of knowledge (al Riyami et al., 2010). There are interesting results about the sources of information that differed from the previous studies. According to the previous studies, students reported that they received most information from TV and friends, while our students pointed out that they obtained such knowledge from their parents (Petronytė, Vizbaraitė 2005).

Food selection criteria were similar as in the previous studies, however, they differed from the opinion poll of Lithuanian residents, who were more likely to choose foods according to the price (Kadziauskienė et al., 1999; Petronytė, Vizbaraitė 2005). Our subjects most frequently selected food by taste (47.9%), the criterion of nutrition value was important for boys, while for girls it was family attitude ($p < 0.05$). The evaluation of responses to questions about healthy nutrition and the principles of healthy nutrition reveals that there is still a lack of information and knowledge about these issues. The hypothesis that nutrition of girls and school-age students with higher PA is healthier cannot be entirely confirmed on the basis of our studies. Girls selected healthier snacks, however, they did not follow nutrition regimen. No significant differences were found between PA groups. Moreover, we can state that health education programs where adolescents would acquire knowledge about healthy lifestyle in an

popular way, are necessary. This program should last longer until healthy habits have been formed. This is confirmed by other studies (Siega-Riz et al., 2011).

CONCLUSIONS AND PERSPECTIVES

Most often adolescents had their meals four times per day. Boys had breakfast more frequently, however, they selected buns and potato chips as snacks, and they consumed more fried foods, the same pattern was observed in the groups with lower physical activity. Girls were more likely to choose fruit and green vegetables as snacks. Mostly students selected their meals by taste, and boys – more frequently by price and nutrition value. Adolescents most often received information about healthy nutrition from parents and the internet, and girls – from magazines and internet more frequently than boys.

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PAAUGLIŲ MITYBOS ĮPROČIŲ VERTINIMAS LYTIES IR FZINIO AKTYVUMO POŽIŪRIU

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Mitybos įpročiai susiformuoja augant. Tinkami mitybos įpročiai ir fizinis aktyvumas paauglystėje, kai organizmas sparčiai vystosi, yra vieni iš svarbiausių sveikatą lemiančių veiksnių. Nuo paauglystės elgsenos ir gyvenenos ypatumų, požiūrio į sveikatą priklauso vėlesnio gyvenimo kokybė.

Tikslas: nustatyti paauglių mitybos įpročius bei palyginti tarp lyčių ir skirtingo fizinio aktyvumo moksleivių grupių.

Metodai. Buvo tiriami devintų klasių mokiniai iš 16 Kauno miesto mokyklų (4 gimnazijų, 10 vidurinių ir 2 pagrindinių mokyklų). Parenkant tiriamuosius buvo stengiamasi įvertinti proporcijas tarp skirtingo tipo mokyklų Kauno mieste. Tyrimas atliktas naudojant anketinę apklausą.

Rezultatai. Atlikus analizę išsiaiškinta, kad net 28,5% moksleivių nevalgo pusryčių. Tarp jų daugiau mergaičių. Berniukai ir mažesnio fizinio aktyvumo moksleiviai pusryčiams dažniau renkasi šiltą maistą. Paaugliai dažniausiai valgo per parą keturis kartus, bet nesilaiko mitybos režimo.

Išvados ir perspektyvos. Berniukai dažniau valgo pusryčius, o užkandžiaudami renkasi bandeles, traškučius, daugiau vartoja keptų produktų. Taip pat elgiasi ir mažesnio fizinio aktyvumo moksleiviai. Mergaitės užkandžiaudamos linkusios dažniau valgyti vaisių, žalių daržovių. Dauguma moksleivių maistą renkasi pagal skonį, berniukai dažniau pagal kainą ir sveikatingumą. Daugiausia informacijos apie sveiką mitybą paaugliai gauna iš tėvų ir interneto, mergaitės daugiau iš žurnalų ir interneto nei berniukai.

Raktažodžiai: paauglių žinios apie sveiką mitybą, mitybos įpročiai, fizinis aktyvumas.

Gauta 2011 m. Kovo 15 d.
Received on March 15, 2011

Priimta 2011 m. birželio 16 d.
Accepted on June 16, 2011

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THE INFLUENCE OF SHORT-TERM OCCLUSION ON DYNAMICS OF ARTERIAL CIRCULATION IN CALF MUSCLES

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ABSTRACT

Research background and hypothesis. KAATSU training is a method based on workout in a local hypoxic environment. For the justification of its a detailed vascular response to circulatory disturbances is required.

Research aim. The aim of this study was to investigate the peculiarities of reactive hyperaemia depending on the duration of occlusion and preliminary filling with blood of the occluded limb.

Research methods. Arterial blood-flow intensity was measured by vein-occlusion plethysmography after 1, 2, and 3 minutes of occlusions. When the occlusion cuff was quickly inflated with air above 250 mmHg, the amount of blood in vessels was close to the conditions of physiological norm. While the leg was lifted above the heart level for 30 seconds, the amount of blood in the calf decreased. A slow blowing the air into the cuff created a situation when the amount of blood in vessels had increased before the blood-flow was arrested.

Research results. The peak blood-flow in the reactive hyperaemia phase depends on the duration of the occlusion and on the degree of filling with blood of segment under occlusion. The peak blood-flow readings were registered after occlusions conducted when the amount of blood in the limb had decreased before the occlusion and the lowest blood-flow readings was registered after occlusion done with the increased filling of vessels.

Discussion and conclusions. The initial filling of vessels with blood or the degree of tension of endothelial cells of vascular wall is the most significant influence on blood flow activation after short-term occlusions.

Keywords: blood flow arrest, reactive hyperaemia, occlusion plethysmography.

INTRODUCTION

Exercise physiology provides a lot of evidence that muscle working capacity during physical activity is determined by its blood supply (Depairon, Zicot, 1996; Fitzpatrick et al., 1996; Hughson et al., 1996; Smith, Norris, 2002). Changes in muscle blood flow directly influence the intensity of oxidative metabolic

processes in the muscle, and at the same time, they indicate their working capacity (Depairon, Zicot, 1996; Hughson et al., 1996; Poderys, 2000). Thus, it is important to take into account factors influencing blood circulation trying to increase muscle working capacity. For this purpose, a number of methods aimed at increasing muscle

working capacity have been suggested, among them using special regimes of muscle electrostimulation (Kibisha et al., 1992) for the improvement of muscle blood flow, various types of pressure chambers creating a negative pressure in them, which facilitates an increased blood flow into the limbs (Poderys, Trinkunas, 1999; Poderys, 2000). Besides, various combinations of methods for the improvement of muscle working capacity have been proposed showing how these combinations improve muscle capacity more substantially than any other stimulation method taken separately. For example, one of the variants of such combination of stimulation methods is a combination of so called “needle application” and negative pressure (Poderys, 2000).

The KAATSU training is a unique method of muscle training with restricting blood flow which might be applied for various purposes such as to increase of muscle mass, muscular strength or to prevent muscle atrophy (Sundberg et al., 1994; Sato et al., 2004; Credeur et al., 2009). Research on resistance training performed under ischemic conditions on physiological responses could provide important new insights into physiology of strength training. (Tanimoto et al., 2008; Kim et al., 2009). The aim of this study was to find out the peculiarities of reactive hyperaemia depending on the time of the occlusion as well as its character and preliminary filling with blood of the occluded limb blood vessels.

RESEARCH METHODS

Fourteen middle distance runners participated in the investigation. We had three stages of our research trying to achieve our objectives. *The first stage* was the investigation of changes in blood flow intensity after 1, 2, and 3 minutes of occlusion under the conditions of physiological norm, i. e. when the occlusion cuff was quickly inflated with air up to 250–260 mmHg of pressure in it. In this

way, we considered that the amount of blood in the calf blood vessels during the occlusion was close to the conditions of physiological norm; *the second stage* took place after lifting the leg above the heart level and sustaining it in that position for 30 seconds. The amount of blood in the calf decreased by this manoeuvre and after a quick occlusion the leg was let down. The readings of arterial blood circulation after the end of the occlusion was registered in the sitting position; *the third stage* – involved slow blowing the air into the occlusion cuff (5 mmHG / s or slower) and filling of the calf blood vessels with blood before the blood flow is arrested. There is a larger amount of blood in the calf blood vessels than under the conditions of physiological norm.

Arterial blood flow intensity (ml / min / 100 cm³) in the calf was measured by vein-occlusion plethysmography while subject was sitting comfortably. The electroplethysmograph EMPR-01 and Witney type sensors were used.

RESEARCH RESULTS

The research results presented in Tables 1, 2 and Figure indicate that the increase of arterial blood flow in the reactive hyperaemia phase depends on the character and duration of the occlusion and on the degree of filling the calf vessels with blood before the arrest of the blood flow.

The highest readings, i. e. the peak blood flow, were registered after the occlusion conducted when the amount of blood in the limb was decreased before the occlusion and the lowest blood circulation readings were registered after the occlusion, when there was an increased flow of blood into blood vessels. The duration of the occlusion had direct influence on the maximal blood flow figures which were registered immediately after the occlusion. In all cases the highest degree of blood flow intensity was observed after the 3 minutes of occlusions.

Table 1. The values of peak blood flow (ml / min / 100 cm³) in the reactive hyperaemia phase depending on the duration of occlusion and on the degree of filling with blood of the segment

Stages of the experiment	Duration of occlusion		
	1 min	2 min	3 min
I Physiological norm	13.94 ± 0.40	17.04 ± 1.21	19.74 ± 0.59
II Preliminary decreased amount of blood	20.79 ± 1.51	23.18 ± 0.69	25.84 ± 0.48
III Increased amount of blood before occlusion	11.71 ± 0.57	17.05 ± 0.29	18.04 ± 0.38

Stages of the experiment	Time of measurement				
	Before occlusion	After 1–5 s	After 15 s	After 30 s	After 45 s
I Physiological norm	1.63 ± 0.16	13.94 ± 0.40	3.43 ± 0.13	1.88 ± 0.14	1.62 ± 0.11
II Preliminary decreased amount of blood	1.66 ± 0.10	20.79 ± 1.51	5.71 ± 0.37	2.61 ± 0.17	1.90 ± 0.12
III Increased amount of blood before occlusion	1.64 ± 0.10	11.71 ± 0.57	2.78 ± 0.16	1.65 ± 0.10	1.63 ± 0.11

Table 2. The dynamics of the of arterial blood flow ($\text{ml} / \text{min} / 100 \text{ cm}^3$) in the reactive hyperaemia phase after 1-minute occlusions

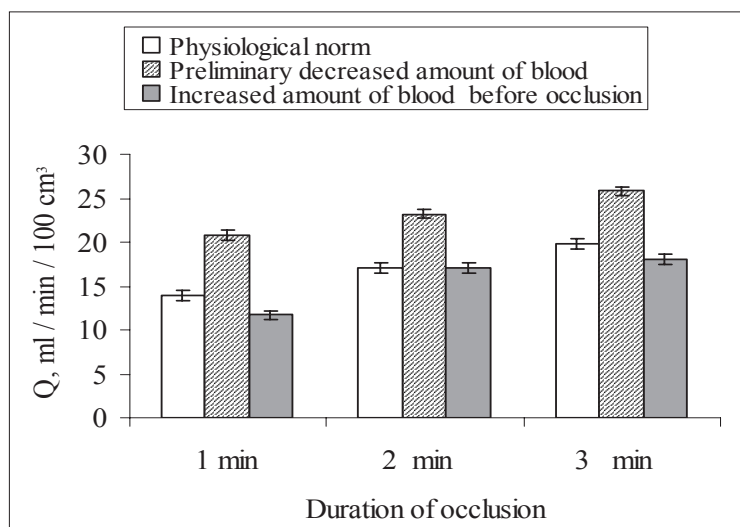


Figure. The values of peak blood flow ($\text{ml} / \text{min} / 100 \text{ cm}^3$) in the reactive hyperaemia phase depending on the duration of occlusion and on the degree of filling with blood of the segment

We tried to find the shortest possible duration of occlusion and conditions under which the highest possible arterial blood flow could be obtained. When the subject was sitting after conducting the occlusion, and there was a preliminary decreased amount of blood in the limb, relatively high level of peak blood flow was registered even after the performance of 1-minute of occlusion. This justified itself in all the subjects without exception. These peak blood flow figures were statistically higher ($p < 0.05$) than the figures obtained after 1-minute occlusions: 1 – in normal conditions, and 2 – when the amount of blood had increased before the occlusion. The intensity of blood flow was decreasing in the exponent-like manner and it fully returned to the preliminary level after 45 or 60 seconds after the end of 1-minute occlusion. The dynamics of the arterial blood flow after 1-minute arrest, are presented in Table 2. For example, after the occlusion conducted when the blood vessel filling with blood decreased, the amount of flowing blood was higher than the preliminary amount in the measurement made after 45 seconds, but in the measurement taken

after 60 seconds, the amount of blood returned to its preliminary level.

DISCUSSION

Regulatory mechanisms of the systemic blood circulation are oriented to sustaining a gradient of pressure, necessary to insure needed blood circulation intensity in organs / working muscles. This happens in the combination of heart work indexes and the changes of total peripheral resistance (Schmidt, Thews, 1989; Ahlborg et al., 1996; Lash, 1996; Tschakovsky et al., 1996). The regulation of local blood circulation is done mostly by changing hydrodynamic resistance of blood vessels, i. e. by changing their diameter (Saltin, 1988; Tschakovsky et al., 1996). As hydrodynamic resistance is oppositely proportional to the blood vessel diameter in the fourth degree, the changes in their diameter are of much greater importance to the intensity of blood circulation in the organs than the changes in the arterial pressure (Schmidt, Thews, 1989).

The research results obtained indicate that increase of the arterial blood circulation in the

reactive hyperaemia phase depends on the character and the duration of occlusion and on the degree of filling with blood of the primary segment under occlusion. Peak blood circulation readings were registered after the occlusion conducted when the amount of blood in the limb had decreased before the occlusion and the lowest blood circulation readings were registered after the occlusion when filling with blood of blood vessels had increased. This shows the importance of myogenic regulatory mechanisms (Sundberg, 1994). The duration of the occlusion did not have direct influence on the maximal blood flow amounts registered right after the end of the occlusion.

One of the goals of this study was to find the shortest possible duration of occlusion and conditions under which the highest possible arterial blood circulation activity could be obtained. In our research we found that when the subject was sitting after conducting the occlusion with a decreased amount of blood in the limb, relatively high indexes of peak blood circulation were registered even after one-minute occlusion. It was true for all the subjects without exception. This means, that having a goal to maximally activate limb muscle blood circulation using occlusion of minimal duration, the optimal decision would be to conduct a one-minute occlusion to a sitting person, after decreasing blood vessel filling at first.

Functional vasodilatation cannot be attributed to the changes in the local concentration of any single metabolic factor (Lash, 1996; Jones, Pole, 2007). Mechanical factors, such as vascular compression and increases in perfusion pressure, also affect vascular resistance and skeletal muscle blood flow. Yet the specific manner in which these mechanical factors interact is not well understood (Jones, Pole, 2007).

Recent determination that arterial vessels upstream from the active tissue and microcirculation, also dilate during reactive hyperaemia and during voluntary muscle contractions has led to the consideration that the vessels are primarily responsible for the

regulation of bulk flow to the tissue (Lin, Duling, 1994; Tschakovsky et al., 1996). Consideration of the interrelations of the factors affecting vasomotor tone may lead to a better understanding of the regulation of muscle blood flow and the mechanisms which may explain the exiting growth and strength adaptations that occur with blood-occlusion training. The explanation lies within the finding that low-oxygen environments increase lactic acids production while the occlusion traps it inside the muscle tissue (Wernbom et al., 2008). Moreover, research suggests that the accumulation of lactic acid in the fast fibres is sensed by local chemical receptors and carried back to the hypothalamus, which ups the rate of growing hormone secretion (Tatsumi et al., 2006). In literature there some others hypothesis concerning the possible triggers of adaptation but all these possible explanations related with the intracellular signalling from blood vessels (Wernbom et al., 2008).

CONCLUSIONS AND PERSPECTIVES

Increase of the arterial blood flow in reactive hyperaemia phase depends on the character and the duration of occlusion and on the degree of filling with blood of the primary segment under occlusion, i. e. on the relaxation or tension of the endothelium of blood-vessels.

The highest readings in the peak blood flow were registered after the occlusion conducted when the amount of blood in the limb had decreased before the occlusion and the lowest blood circulation readings were registered after the occlusion when filling with blood of blood vessels had increased.

It is important to reveal the peculiarities of vascular reactions related to the restriction of blood flow and blood flow arrest on what the resistance training under hypoxic conditions is based. Finding an optimal influence is an important practical and scientific problem.

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TRUMPALAIKĖS OKLIUZIJOS ĮTAKA BLAUZDOS RAUMENŲ ARTERINEI KRAUJOTAKAI

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SANTRAUKA

Tyrimo pagrindimas ir hipotezė. Netradicinių treniravimo metodų ieškoma nuolat. Vienas iš tokių yra KAATSU metodas, vadinamas okliuzine treniruote. Jo pagrindimui būtinas išsamus kraujagyslių reakcijos į kraujotakos sutrikdymus pažinimas.

Tikslas: ištirti blauzdos reaktyvinės hiperemijos ypatumų priklausomumą nuo okliuzinio kraujotakos sutrikdymo trukmės, okliuzijos atlikimo greičio ir kraujagyslių prisipildymo krauju kiekio okliudavimo momentu.

Metodika. Arterinės kraujotakos intensyvumas blauzdoje tiriamajam sėdint buvo matuojamas veninės okliuzinės pletizmografijos metodu. Arterinės kraujotakos kaita tirta esant fiziologinės normos būsenai, t. y. okliuduojama greitu, didesniu nei 250 mmHg, oro pripūtimu į varžtį. Kai tiriamasis 30 s palaikydavo pakeltą koją aukščiau nei širdies lygis ir po greito okliudavimo nuleisdavo žemyn, galūnėje prieš okliudavimą būdavo santykiškai pamažinamas kraujagyslių prisipildymas krauju. Taip pat blauzdos kraujotakos kaita tirta orą į varžtį pučiant lėtai – šitaip kraujotaka sustabdoma blauzdos kraujagyslėse ir santykiškai padidinamas kraujo kiekis.

Rezultatai. Ilgesnės trukmės okliudavimas sukeldavo didesnę kraujotakos suintensyvėjimą nei trumpesni kraujotakos sutrikdymai. Arterinės kraujotakos padidėjimas priklausė ir nuo pradinio kraujagyslių prisipildymo krauju laipsnio. Didžiausios kraujotakos reikšmės užregistruotos tada, kai buvo okliuduojama sumažinus kraujagyslių prisipildymą krauju, mažiausios – kai prieš okliudavimą santykiškai padidinamas kraujo kiekis blauzdos kraujagyslėse. Taigi okliuzijos pobūdis, taip pat ir okliuzijos trukmė yra veiksniai, lemiantys kraujotakos kaitos ypatumus reaktyvinės hiperemijos fazėje.

Aptarimas ir išvados. Reikšmingiausią įtaką kraujotakos suaktyvėjimui reaktyvinės hiperemijos fazėje turi pradinis kraujagyslių sienelės ištempimo laipsnis, tiesiogiai priklausantis nuo kraujagyslėse esančio kraujo kiekio, t. y. kraujagyslės sienelės endotelio ištempimo ar atsipalaidavimo laipsnio.

Raktažodžiai: kraujotakos sutrikdymas, reaktyvinė hiperemija, okliuzinė pletizmografija.

Gauta 2011 m. balandžio 20 d.
Received on April 20, 2011

Priimta 2011 m. birželio 16 d.
Accepted on June 16, 2011

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- 2.3. **Raktažodžiai.** 3–5 informatyvūs žodžiai ar frazės (negali būti nė vieno žodžio, esančio pavadinime).
- 2.4. **Įvadas.** Jame nurodoma tyrimo problema, jos ištirtumo laipsnis, sprendimo naujumo argumentacija (teorinių darbų), pažymimi svarbiausi tos srities mokslo darbai, tyrimo tikslas, objektas ir originali hipotezė.
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- 2.7. **Rezultatų aptarimas.** Aptarimo pradžioje rekomenduojame pateikti pagrindinius originalius straipsnio teiginius (išvadas), kilusius iš tyrimo duomenų. Rezultatų aptarimą būtina struktūrizuoti išskiriant potemes (kiekvieną originalų atrastą teiginį rekomenduojame aptarti atskira poteme). Tyrimo rezultatai ir išvados lyginami su kitų autorių skelbtais duomenimis, įvertinami jų tapatumai ir skirtumai. Ypač svarbu pabrėžti tyrimo duomenų originalumą. Reikia vengti kartoti tuos faktus, kurie pateikti tyrimų rezultatų dalyje.
- 2.8. **Išvados ir perspektyvos.** Išvados turi būti formuluojamos aiškiai ir logiškai, vengiant tuščiažodžiavimo. Išvados turi būti pagrįstos tyrimo rezultatais ir patvirtinti arba paneigti tyrimo hipotezė. Svarbiausias išvadų reikalavimas – jos turi būti pasaulyje originalios. Būtina nurodyti tolesnių tyrimų perspektyvas.
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- 3.2. **Straipsnis turi būti suredaguotas, spausdintas tekstas patikrintas.** Pageidautina, kad autoriai vartotų tik standartinius sutrumpinimus ir simbolius. Nestandartinius galima vartoti tik pateikus jų apibrėžimus toje straipsnio vietoje, kur jie įrašyti pirmą kartą. Visi matavimų rezultatai pateikiami tarptautinės SI vienetų sistemos dydžiais. Straipsnio tekste visi skaičiai iki dešimt imtinai rašomi žodžiais, didesni – arabiškais skaitmenimis.
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Literatūros aprašo pavyzdžiai:

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

Jucevičienė, P. (Red.) (1996). *Lyginamoji edukologija*. Kaunas: Technologija.

Miškinis, K. (1998). *Trenerio etika: vadovėlis Lietuvos aukštųjų mokyklų studentams*. Kaunas: Šviesa.

Ostasevičienė, V. (1998). Ugdymo teorijų istorinė raida. A. Dumčienė ir kt. (Red. kol.), *Ugdymo teorijų raidos bruožai: teminis straipsnių rinkinys* (pp. 100–113). Kaunas: LKKI.

Šveikauskas, Z. (1995). Šuolių technikos pagrindai. J. Armonavičius, A. Buliuolis, V. Butkus ir kt., *Lengvoji atletika: vadovėlis Lietuvos aukštųjų m-klių studentams* (pp. 65–70). Kaunas: Egalda.

Večkienė, N., Žalėnė, I., Žalys, L. (1998). *Ekonominis švietimas – asmenybės ugdymo veiksnys. Asmenybės ugdymo edukologinės ir psichologinės problemos: respublikinės moksl. konferencijos medžiaga* (pp. 159–163). Kaunas: LKKI.

Vitkienė, I. (1998). Kai kurių mikroelementų pokyčiai lengvaatlečių kraujyje fizinio krūvio metu. *Sporto mokslas*, 1 (10), 12–13.

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- 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.
- Deci, E. L., Ryan, R. M. (1991). A motivational approach to self: Integration in personality. In R. Dientsbier (Ed.), *Nebraska Symposium on Motivation: Vol. 38. Perspectives on Motivation* (pp. 237–228). Lincoln: University of Nebraska Press.
- Gibbs, J. T., Huang, L. N. (Eds.). (1991). *Children of Color: Psychological Interventions With Minority Youth*. San Francisco: Jossey–Bass.
- Ratkevičius, A., Skurvydas, A., Lexell, J. (1995). Submaximal exercise-induced impairment of human muscle to develop and maintain force at low frequencies of electrical stimulation. *European Journal of Applied Physiology*, 70, 294–300.
- Town, G. P. (1985). *Science of Triathlon Training and Competition*. Champaign, IL: Human Kinetics.

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Scientific consultant Prof. Dr. Audronė Dumčienė.

