Guide for Authors

Authors are encouraged to submit high quality, original works which have not appeared, nor are under consideration in other journals. Contributors are invited to submit their manuscripts electronically to e-mail: cejsm@gmail.com. Central European Journal of Sport Sciences and Medicine considers for publication manuscripts in the categories of Original Research, Review Article and Short Communication. The manuscripts should be in one of the following sub-disciplines: exercise physiology and biology, sports nutrition, sports science, biomechanics, coaching and training, sports medicine, sports injury and rehabilitation, physical activity and health, public health, physical education and health promotion as well as methodology of sport and history of physical culture and sport. Manuscripts with an interdisciplinary perspective with specific applications to sport and exercise and its interaction with health will also be considered.

Papers are published only in English.

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The manuscript must be word-processed, double-spaced throughout, with a 2.5 cm margin all around, with no ‘headers and footers’ (other than page numbers), and without footnotes unless these are absolutely necessary. Use Arial, size twelve (12) point font.

All experimental work in which humans are participants must conform to the laws of the country in which the work took place. The manuscript should contain a statement to the effect that the work reported has been approved by a local ethics committee or review board.

The statements about ethics approval or sources of data should be made at the beginning of the methods section.

Manuscripts should be compiled in the following order: title page; abstract; keywords; main text; acknowledgments; references; list of table(s) caption(s) and figure(s) legend(s) (on individual page at the end of the manuscript). The table(s) and figure(s) have to be uploaded as separated file(s). The main text can be arranged under headings such as Introduction, Methods, Results, Discussion and Conclusion if this is appropriate. Number the pages consecutively, beginning with the title page as page 1 and ending with the Figure pages. 6,000 word count limit (including title, abstract, acknowledgements, and references).

Title page

Include the following information on the first page of the manuscript: the full title, a running title of no more than 75 characters and spaces. List all authors by first name, all initials and family name. List departmental affiliations of each author affiliated with institutions where the study described was carried out. Connect authors to departments using numbers superscripts. Contributions of the author and each co-author considering the following categories: A – Study Design; B – Data Collection; C – Statistical Analysis; D – Manuscript Preparation; E – Funds Collection. No names of co-authors will be published unless their contributions are indicated. Connect authors to contributions using alphabetic superscripts.

Provide the name, full address and e-mail address of the corresponding author to whom communications, proofs and requests for reprints should be sent. Provide up to five keywords for indexing purposes.

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References

References should be cited in the text by author and year of publication e.g. (Cięszczyk 2009). In case there are more than one author: reference with two authors should be cited as Nowak and Kowalski (2008) or (Nowak and Kowalski 2008); when citing a reference with three authors or more use Nowak et al. (2010) or (Nowak et al. 2010). All references must be alphabetized by surname of first author and numbered at the end of the article.

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IMPACT OF NINE MONTH HEALTH TRAINING AND A SINGLE EXERCISE ON CHANGES IN GHRELIN, LEPTIN AND FREE FATTY ACIDS LEVELS IN WOMEN’S BLOOD

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Abstract. The aim of the research was to assess changes in ghrelin, leptin and free fatty acids (FFA) levels in women’s blood after training. The research was carried out in women aged 45.55 ±11.33 years and with the BMI of 26.49 ±4.49. Health training at 50–66% VO2max took place twice a week for 9 months. In the baseline phase and in the 3rd, 6th and 9th month of the training, body mass and composition were measured, cardiorespiratory fitness was checked after a 10-minute exercise test on a cycloergometer, and fasting levels of ghrelin, leptin and FFA in the serum were assayed and 15 minutes after the exercise test. Body mass was reduced in the 6th month of the training. Fasting ghrelin level increased because of training, leptin and FFA decreased. After single 10-minute exercises performed every 3 months level of ghrelin and FFA increased while leptin decreased. An increase in ghrelin level in the blood after the single exercise can be the result of negative energy expenditure. An increase in fasting ghrelin level after training can be one of the adaptive physiological mechanisms connected with energy saving. A mechanism that is switched on as a result of a long-lasting stimulus that leads to energy losses, reduction in body mass and a decrease in leptin level in the blood.

Key words: ghrelin, leptin, free fatty acids, women, health training, single exercise

Introduction

Ghrelin is the orexigenic hormone that regulates processes of hunger and satiety. It stimulates appetite by influencing the hunger centre in the hypothalamus. Its peripheral activity is connected with the control of broadly understood metabolic-energy balance. It intensifies processes leading to hyperglycemia – accelerates...
gluconeogenesis and inhibits glycogenesis. It also stimulates growth hormone secretion (Cummings et al. 2001; Tschöp et al. 2000; Varela et al. 2011).

The most important organ producing ghrelin is the stomach, where enteroendocrine X/A – like cells located mainly in the fundus of the stomach are responsible for its synthesis (Date et al. 2002, Kraemer and Castracane 2007). Ghrelin is also synthesized in other parts of the gastrointestinal tract and outside it, e.g. in adrenal glands, the heart, blood vessels, hypothalamus, pituitary, cerebellum and others (Van der Lely et al. 2004).

Ghrelin has two forms: acylated – which contains n-octanoyl modification of the serine 3 residue and des-acylated without the n-octanoyl form. The particle is modified by the enzyme GOAT (ghrelin O-acyltransferase). Acylation augments the particle’s lipophilicity and facilitates the hormone’s ability to cross the blood-brain barrier and excite specific receptors (Andrews 2011). The biggest concentration of the acylated form is found in the stomach. In the blood, 80–90% of ghrelin circulates as the des-acylated form because the acylated one is quickly captured by the cells with the GHS-R receptor (growth hormone secretagogue receptor) (Toshinai et al. 2006).

Nowadays two subtypes of the receptor are known: GHS-R1a and the GHS-R1b, which belongs to the family of the seven transmembrane G protein-coupled receptors. A cylated ghrelin activates the GHS-R1a in the hypothalamus and releases the growth hormone (Van der Lely et al. 2004). The research showed the presence of the GHS-R receptors in different parts of the central nervous system and in many organs ([Date et al. 2002, Van der Lely et al. 2004, Gnanapavan et al. 2002), which supports the notion of its wide, however not completely explained, biological activity. Ghrelin level in the blood of a grown-up person is not a constant value. It depends, most of all, on nutrition, changes in energy balance, glucose homeostasis and changes in gh secretion. Its secretion is also affected by lifestyle factors such as stress or lack of sleep (Polińska et al. 2011), and is sex-related – it is lower in men than in women. It decreases with age and shows a correlation with testosterone level (Kozakowski et al. 2008). Ghrelin secretion is influenced by the parasympathetic nervous system, by acetylcholine that stimulates the secretion of the hormone (Broglio et al. 2004).

Changes in ghrelin level in the blood dependent on energy balance made us explain the influence of regular physical activity on the hormone’s secretion. Available research in the field does not provide unequivocal information. Some sources show that physical exercise causes a significant increase in circulating ghrelin (Jürime et al. 2007), while in others there is no influence of physical exercise on the hormone’s level (Martins et al. 2007), and still some others report that ghrelin level significantly decreases after exertion (Vestergaard et al. 2007).

Such an ambiguous state of knowledge about the subject made us do the research, the aim of which was to assess ghrelin level in the serum of adult women after 9-month health training and a 10-minute single exercise, which was taken to verify the adaptive progress of training.

**Material and methods**

In our research 75 women, aged 45.55 ±11.33 years, took part. They started the health training to reduce their body mass and to improve their cardiorespiratory fitness. The excluding criteria were diabetes, thyroid diseases, affecting lipid parameters of the blood, irregular participation in control tests, smoking. During the training period the women did not change their old eating habits. Their diet was assessed quantitatively and qualitatively on the basis of the prepared menus. Before training the average consumption of protein was at the level of 0.88 ±0.18g/kg body mass (0.92 ±0.13g/kg after training, , n.s.), of fat at the level of 0.86 ± 0.3g/kg of body mass (0.81 ±0.2g/kg after
training, n.s.), of carbohydrates at the level of 2.75 ±0.64g/kg of body mass (2.95 ±0.48g/kg after training, n.s.) and of fibre at the level of 17.51 ±5.38g/day (21 ±3.20g/day after training, p < 0.05).

All the subjects were informed about the aim of the research, test procedures and the hazard involved. All the subjects started performing tests after signing a written consent, and the study protocol was approved by the Research Ethics Commission of the University of Physical Education in Wroclaw.

**Health training**

Training sessions were organized twice a week for 9 months. Each exercise unit lasted for 60 minutes. Intensity of the training was at 50–66% VO\(_2\)\(_\text{max}\). It is the intensity typical of a conditioned exercise which enables obtaining energy from fat utilization. Training units were characterized by different efforts undertaken by the subjects. During the first training unit, the method of Total Body Condition was used to build up muscle force, muscle endurance and flexibility of the subjects. In the second one, aerobic capabilities of the body were shaped using mainly the Fat Burning and Low Impact methods. During the training, heart rate was monitored using the Sportest (Polar, Finland).

During the training program, four control tests were carried out. The first one took place before the trainings started, the next ones in the 3rd, 6th and 9th month of the training. Each control test included: anthropological study, a physiological study (single exercise) and biochemical study. The anthropological study involved: measurement of body mass and height, calculation of the BMI value (Body Mass Index), measurement of waist and hip circumference, calculation of the WHR indicator (Waist to Hip Ratio) and measurement of body composition. The assessment of body composition parameters was done by means of spectrometry in near-infrared (Near Infrared Light) using the FUTREX – 6100/XL (Futrex Inc., USA).

A single exercise consisted in a subject performing a 10-minute test on an Excalibur Sport (LODE) cycloergometer at a workload of 100W and a pedaling frequency of 70–80 rpm. During the test, the content of the exhaled air was monitored by a Quark b2 (Cosmed) ergospirometer and respiratory parameters were measured. Among them, the following were registered: the volume of the oxygen consumption (VO\(_2\)), of the CO\(_2\) output (VCO\(_2\)), the respiratory exchange ratio (RER), energy expenditure and the metabolic equivalent of task (MET) were calculated. During the test, changes of the heart rate (HR) were recorded, and the VO\(_2\)\(_\text{max}\) was determined using the Astrand – Ryhming method on the basis of the steady state HR during exercise test.

**Biochemical parameters**

Blood samples for the biochemical analysis were taken from the fasting subjects between 8 and 10 a.m. Then, the subjects performed an exercise test, after which, at the 15th minute of the restitution, their blood was taken again. After the serum was obtained, it was stored at –80°C until the biochemical analysis was carried out.

Levels of ghrelin and leptin in the serum were assayed using the radioimmunoassay (RIA) method and ready-made kits. A Human – Ghrelin – RIA Kit (Diasource Europe, Belgium) was used to assay total ghrelin. The results were expressed as pg/ml. Sensitivity of the method was 40 pg/ml. Intra-assay coefficient of variation (CV) was 5.0% and inter-assay CV was 7.3%. A Human Leptin RIA Kit (Linco Research LTD, USA) was used to assay leptin. The reference range for this method for women is 7.4–11.1 g/L. Sensitivity of the method was 0.5 ng/ml. Inter-assay and intra-assay coefficient of variation was <8.3% and <6.2%, respectively. FFA levels were assayed using the colorimetric method and a NEFA-HR (2) Kit (WAKO Chemicals GmbH, Germany). The reference range for women was 0.1–0.45 mmol/l (2.8–12.7 mg/dl).
Lactate (LA) level was assayed using the colorimetric method and a Lactate Cuvette Test kit (Dr. Lange, Germany). The reference range was 0.6–0.9 mmol/l.

Glucose level was assayed using the colorimetric method, an Olympus AU650 analyzer manufactured by DPC, and a Glucose GOD-POD kit. The reference range was 70–110 mg/dl.

**Statistical analyses**

The computer program Statistica PL Stat Soft version 10.0 (Cracow, Poland) was used for statistical analysis. In all tests the statistically significant level was $p < 0.05$. All values are expressed as means ±SD. The following tests were used to analyze the results. Normality of distribution was examined with the Shapiro-Wilk test. If a variable was characterized by normal distribution, for further calculations one-way analysis of variance (ANOVA) was applied and it was preceded by Levene’s test of homogeneity of variance. If the null hypothesis of equal variances was rejected ($p = 0.05$ or less), for further analysis the Duncan’s post-hoc test was used. When a variable did not have a normal distribution, the assessment of differences between the variable’s values in further examinations was made using the non-parametric ANOVA test (the Friedman test), which is equivalent to a one-way repeated measures analysis of variance. When the null hypothesis was rejected, for further analysis, the Wilcoxon’s test as a post-hoc test was used. To assess the statistical dependence of the variables, Spearman’s rank correlation coefficient was calculated.

**Results**

The 9-month training modified the anthropological, physiological and biochemical parameters that the authors measured.

The mean energy expenditure during the single training session was 254.3 kcal. Nine month training led to the reduction in body mass and the BMI of the subjects, even though body mass reduction happened only after 6 months of training. No changes in lean body mass (LBM) were noticed, but total fat mass decreased. Thickness of the skin-fat fold measured on the abdomen was also reduced. Its significant change in relation to the baseline value also took place only in the 6th month of the training. The value of the WHR indicator remained the same because waist and hip circumferences decreased, too (Table 1).

There was a significant improvement in the subjects’ cardiorespiratory fitness, which was seen in a gradual increase in the value of $V\text{O}_2\text{max}$. Maximal oxygen intake increased, as did the anthropological parameters, only in the 6th month of the training (on average by 16%). In the 9th month of the training the value of $V\text{O}_2\text{max}$ was different on average by 25% in relation to the baseline value.

The result of an improvement in cardiorespiratory fitness was seen in the lowering physiological cost of a 10-minute exercise test performed every three months. A decrease in the value of the HR and MET during steady state was observed, there was also a decrease in energy expenditure (EE) during a 10-minute exercise (Table 1). Both the MET and the HR reached their highest values in the first (baseline) and third (6th month) examination and their lowest in the fourth (9th month) examination. Even though cardiorespiratory fitness was improved, physiological and energy cost of exercise tests was reduced, according to ACSM (Garber et al. 2011) physiological cost of work was high in the first 3 examinations. In the 4th one, it decreased to moderate.

The dynamics of changes in biochemical parameters was the following.
Table 1. Values of chosen anthropological and physiological parameters in successive examinations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline</th>
<th>3 month</th>
<th>6 month</th>
<th>9 month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body mass [kg]</td>
<td>72.51 ±12.73</td>
<td>72.06 ±10.09</td>
<td>68.34 ±8.99</td>
<td>65.33 ±9.56</td>
</tr>
<tr>
<td>BMI [kg/m²]</td>
<td>26.49 ±4.49</td>
<td>26.43 ±3.63</td>
<td>25.69 ±3.88</td>
<td>25.50 ±3.66</td>
</tr>
<tr>
<td>FAT [kg]</td>
<td>27.38 ±8.58</td>
<td>26.60 ±6.66</td>
<td>23.08 ±6.72</td>
<td>20.54 ±6.52</td>
</tr>
<tr>
<td>% FAT</td>
<td>37.70 ±5.62</td>
<td>36.91 ±5.25</td>
<td>33.77 ±5.64</td>
<td>31.44 ±5.46</td>
</tr>
<tr>
<td>LBM</td>
<td>45.85 ±4.92</td>
<td>45.46 ±4.72</td>
<td>45.26 ±3.88</td>
<td>44.79 ±3.99</td>
</tr>
<tr>
<td>Abdominal fat fold [mm]</td>
<td>32.15 ±9.95</td>
<td>31.31 ±9.37</td>
<td>27.99 ±8.27</td>
<td>25.50 ±3.66</td>
</tr>
<tr>
<td>Waist circumference [cm]</td>
<td>86.74 ±12.61</td>
<td>84.07 ±9.75</td>
<td>80.46 ±8.20</td>
<td>82.81 ±7.43</td>
</tr>
<tr>
<td>Hip circumference [cm]</td>
<td>106.06 ±9.30</td>
<td>104.30 ±6.59</td>
<td>102.26 ±5.13</td>
<td>103.24 ±5.03</td>
</tr>
<tr>
<td>WHR</td>
<td>0.82 ±0.06</td>
<td>0.81 ±0.06</td>
<td>0.78 ±0.05</td>
<td>0.80 ±0.05</td>
</tr>
<tr>
<td>VO₂max [ml × kg⁻¹ × min⁻¹]</td>
<td>27.04 ±7.94</td>
<td>28.60 ±8.20</td>
<td>31.65 ±9.75</td>
<td>33.49 ±9.41</td>
</tr>
<tr>
<td>HR steady state [bpm]</td>
<td>157.9 ±13.60</td>
<td>152.5 ±13.91</td>
<td>148.8 ±14.83</td>
<td>146.6 ±14.30</td>
</tr>
<tr>
<td>MET steady state [ml × kg⁻¹ × min⁻¹]</td>
<td>6.92 ±0.80</td>
<td>7.19 ±1.34</td>
<td>6.75 ±0.81</td>
<td>6.15 ±1.03</td>
</tr>
<tr>
<td>EE/min [kcal]</td>
<td>8.04 ±1.05</td>
<td>8.62 ±1.60</td>
<td>8.11 ±0.77</td>
<td>7.62 ±0.72</td>
</tr>
<tr>
<td>EE/test [kcal]</td>
<td>90.28 ±20.66</td>
<td>94.24 ±18.16</td>
<td>88.63 ±10.17</td>
<td>74.78 ±12.79</td>
</tr>
<tr>
<td>Test intensity</td>
<td>%VO₂max</td>
<td>85%</td>
<td>87%</td>
<td>72%</td>
</tr>
<tr>
<td></td>
<td>%HRmax</td>
<td>84%</td>
<td>81%</td>
<td>79%</td>
</tr>
</tbody>
</table>

*p < 0.05; *p < 0.01 as compared to the baseline.

Fasting ghrelin level as a result of the research program increased after the 9 months of training by 62.5% on average. An increase in the level of the hormone in the blood was observed already after 3 months of the training (on average by 15%). In the 6th month of the training the increase was 50% in relation to the baseline value (Figure 1).

![Changes in fasting levels of ghrelin and FFA before and after exercise tests, in the baseline, 3rd, 6th and 9th month of health training](image)

Ghrelin level after exercise test in each examination increased in relation to the fasting value measured before the test. In the first (baseline) examination, its concentration after exercise was higher by 93%, in the 2nd one (after
3 months) by 26%, in the 3rd one (after 6 months) ghrelin level after exercise increased by 59%, while in the 4th examination (after 9 months) by 76%.

Fasting leptin level after 9 months of the training decreased by 32% (Figure 1). Lowered fasting level were already noted 3 months after the beginning of the training, on average by 12%, and in the 6th month of the training on average by 18.5% in relation to the baseline value.

The 10-minute exercise test caused a significant reduction in leptin level in the blood. Before the beginning of training (baseline) after a 10-minute test leptin level decreased on average by 26% in relation to the fasting value before the test. In the 3rd month of the training after a 10-minute test leptin level was lower, on average by 21% than before the test, in the 6th months by 20%, and in the 9th month by 30%.

FFA level as a result of training decreased by 31%, on average (Figure 1). A decrease by 31% in relation to the baseline was already noted in the 3rd month of the training. After 6 months FFA level slightly increased but it was still lower than the baseline value (on average by 15%).

The single exercise in each examination led to an increase in FFA level in the subjects' blood. On average by 20% in the baseline, by 26% after 3 months of the training, by 15% after 6 months of the training and by 12% in the 9th month of the training.

Fasting glucose levels did not change significantly within the 9 months of the training, but the exercise test caused a slight increase in glucose level.

LA level after exercise tests increased significantly, reaching the level indicating crossing the anaerobic threshold, which suggests that a 10-minute exercise was performed by the energy obtained from anaerobic sources. The assumption was supported by the value of the RER reaching in each examinations the value of more than 1.0 (data not shown).

Discussion

Ghrelin, which was assayed in our research, is a parameter whose fasting level, like the dynamics of post-exercise changes, depends on many factors, including the type of, intensity and duration of exercise, a subject's physical performance, body mass or health (King et al. 2013, Shiiya et al. 2011, Stokes et al. 2010, Erdmann et al. 2007).

In our research we noticed an increase in fasting ghrelin level after 9 months of the training. The increase was already observed in the 3rd month of the training. The training led to a reduction in the subjects' body mass, but it was noted from the 6th month of the training. On the basis of our research, it can be concluded that ghrelin is a sensitive indicator of changes in body mass (Leidy et al. 2004). A similar direction of changes of the hormone after a year’s training in post-menopausal overweight women was observed by Foster-Schubert et al. (2005).

In our research, we also found out that a single, 10-minute exercise in the form of work on a cycloergometer caused an increase in the hormone's level in the blood in all 4 examinations. It proves that an organism that is regularly and for a long time stimulated to physical exercise and to energy expenditure intensifies compensatory mechanisms, connected with energy saving. Thanks to these mechanisms, the organism tries to maintain energy balance by slowing down or inhibiting catabolic processes (Hagobian et al. 2009). One of the mechanisms seems to be an increase in fasting ghrelin level in response to training. It might be thought so, because in our subjects we observed a significant decrease in fasting leptin level in the blood after the training completion and after 10-minute exercises in each control examination.
Leptin acts in opposition to ghrelin. It causes an anorexigenic effect through its auto- and paracrine influences. The central activity location of both the hormones is the hypothalamic arcuate nucleus (ARC), where there are neurons secreting neuropeptide Y (NPY)/agouti-related protein (AgRP) and pro-opiomelanocortin (POMC)/cocaine-and amphetamine-regulated transcript (CART), which are under the regulatory influence of both leptin and ghrelin (Nogueiras et al. 2007, Nogueiras et al. 2008). Contrary to ghrelin, leptin inhibits the neurons secreting NPY/AgRP and stimulates the neurons POMC/CART, which physiologically results in reductions in food intake and an increase in energy expenditure (Rak-Mardyla 2013). As a result of a prolonged increased energy expenditure, there is an increase in secretion of NPY, whose secretion can be increased by ghrelin. An increased level of the hormone in the blood after a 4-week training was observed by Rämon et al. (2012). An increase in NPY level as a result of aerobic exercise was also noted by Broom et al. (Broom et al. 2009). Zajadacz et al. (2009) noticed a significant increase in NPY secretion after a 20-minute exercise at the intensity above the lactate threshold. In the research done by team of Zajadacz (2009), the intensity of work was similar to the intensity observed in our tests.

Ghrelin level increases before meals and it lowers maximally 60–120 minutes after the meal, which proves that ghrelin is secreted in energetically adverse conditions (Tschöp et al. 2001). What is more, an increased secretion of the hormone noted during starvation, in hypoglycemia and in negative energy balance proves that when energy sources are used up, which is a condition typical of physical exercise, among others, ghrelin level increases, both in short-term and long-term (regularly stimulated by training) energy loss. Energy expenditure connected with training in our research was more than 500kcal/week, and in a 10-minute test less than 100kcal. In our opinion, the values were high enough for overweight women to activate compensatory mechanisms.

An increase in ghrelin level in the blood leads to an increase in the RER, which slows down the rate of lipolysis to increase catabolism of carbohydrates (Theander-Carrillo et al. 2006), which might also explain the observed increase in fasting ghrelin level in response to a training cycle and a single exercise. In response to a long-term stimulus, such as training, ghrelin might exert a protective influence on saving energy and slowing lipolysis. In our research, during training session the value of RER was lower than 1.0, at the level indicating the domination of lipids as an energy source, while during exercise tests its value was 1.0, which indicates the dominant role of carbohydrates in exercise energetics. It can be assumed that independently of the type of energy substrates, in exercise of different intensity and duration, an increase in ghrelin level will be an adaptive response.

The results similar to ours were observed by Jürimäe et al. (2007), who claim that both short maximal anaerobic exercise and aerobic exercise at 50% VO2 max lead to an increase in ghrelin secretion.

In conditions of short-term energy imbalance, when ATP level decreases and AMP increases, AMPK (AMP-activated protein kinase) is activated. It is a very sensitive intracellular energy sensor which protects cells from excessive energy loss and that promotes processes enabling the production of ATP at the cellular level and in the whole organism. It is possible by the activation of catabolic processes that provide energy and the switching off of biosynthetic pathways, through their influence on the hypothalamus, among others (Carling et al. 2008, Hardie et al. 2012).

In the case of lipid metabolism, AMPK inhibits acetyl-CoA carboxylase (ACC) by blocking the synthesis of fatty acids, but activates malonyl-CoA decarboxylase, lowering the level of malonyl-CoA. Thus, it fosters processes of fatty acids oxidation. It is supposed that short-term activity of ghrelin in the hypothalamus through AMPK can inhibit...
the synthesis of fatty acids (Lopez et al. 2008; Lopez et al. 2008a; Lopez et al. 2010; Schneeberger and Claret 2012; Sangiao-Alvarellos et al. 2010).

In our research, we observed a decrease in fasting FFA level in the 3rd month of the research and then stabilization that was maintained till the end of the 9th month of the training. An increase in ghrelin level appearing as a result of a decrease in adipose tissue mass, might have a preventative effect and protect the organism from excessive energy loss and a further loss of body mass. In research carried out on animals, it was proved that a prolonged intracerebroventricular infusion of ghrelin caused a significant increase in the level of mRNA enzymes participating in reactions of fat accumulation, among others, lipoprotein lipase (LPL), ACC, fatty acid synthase (FAS) and stearoyl-CoA desaturase-1 (SCD1), leading to a decrease in the level of mRNA enzyme fostering lipid oxidation – carnitine palmitoyl transferase-1α (CPT-1α). In brown adipose tissue, it also inhibits the expression of the mitochondrial protein connected with thermogenesis – uncoupling protein-1 (UCP-1) (Theander-Carrillo et al. 2006). A significant loss of body mass in patients suffering from anorexia leads to an almost three-fold increase in ghrelin level in the plasma in relation to healthy people (Ariyasu et al. 2001). As mentioned before, the role of ghrelin is to accumulate energy sources, try to maintain positive energy balance, and foster the growth of subcutaneous and visceral adipose tissue. Thus, it seems obvious that a decrease in body mass and in fat mass observed in our subjects causes an increase in ghrelin level in the blood.

Ghrelin released by the stomach activates orexigenic signals. As mentioned before, its central activity mechanism depends on the activation of the pathway CaMKK/AMPK/CPT1/UCP2 (calmodulin- dependent protein kinase/AMP-dependent kinase/carnitine palmitoyl transferase-1/uncoupled protein-2) to maintain the proper level of excitation of the right hypothalamic neurons and of secretion of neuropeptide Y. Tsubone et al. (2005) claim that during prolonged fasting and energy losses ghrelin favours anabolic processes. It stimulates lipogenesis, excites UCP-2 in white adipose tissue and helps change negative energy balance into neutral. Velasquez et al. (2011) suppose that Sirtuin 1/p53 pathway plays an important role in ghrelin’s orexigenic activity.

In our research, we noted a negative correlation between ghrelin level and body mass as well as thickness of skin-fat fold measured on the abdomen. Results similar to ours were obtained by Hansen et al. (Hansen et al. 2002) who noted a mean 12% increase in ghrelin level with a 5% decrease in baseline body mass accompanied by an 8% decrease in total fat mass. A negative correlation between the BMI, total fat mass and the fat mass/lean mass ratio in women was also observed by Makovey et al. (2007). Kelishadi et al. (2008) state that together with a decrease in the value of BMI, there is an increase in the total and des-acylated ghrelin levels, while the level of acylated ghrelin does not change, which might show the organism’s way to protect itself from excessive food intake, and through physical activity from an increase in body mass. Broom et al. (2007, 2009) and Marzullo et al. (2008) proved that after an aerobic exercise, the level of acylated ghrelin is suppressed and its level decreases after exertion in both lean and obese people. It is thought that ghrelin-O-acyl transferase enzyme participating in ghrelin acylation is an important factor regulating glucose level. In conditions of caloric restrictions, the ghrelin – GOAT system can play a significant role in maintaining physiological level of glucose through stimulation of growth hormone secretion (Kirchner et al. 2012).

Thus, it seems that, most of all, an organism’s metabolic state affects secretion of ghrelin, whose task it is to maintain life-sustaining energy homeostasis. In conditions of caloric restrictions, ghrelin increases glucose level, inhibiting secretion of insulin by the pancreas. This adaptive mechanism is to limit removing glucose from the blood and to maintain and provide a quick supply of energy to working cells (Enriori et al. 2012).
Acknowledgements

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References


EFFECT OF DEER ANTLER VELVET ON AEROBIC, ANAEROBIC AND STRENGTH PERFORMANCE

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Abstract. Deer antler velvet (DAV) supplementation purportedly increases athletic performance; however, little data support this claim. The primary aim of our study is to examine DAV and exercise performance. We randomized 32 men (18–35 y) participating exclusively in resistance training (>4 y) to 10-weeks of randomly assigned, double blind, DAV (1350 mg, 2×/day) or placebo treatments. Primary outcomes included maximal aerobic capacity (VO2max), maximal strength (1RM; bench press and squat) and anaerobic cycling power. Secondary outcomes included comprehensive blood profiles and body composition. We used general linear models to determine changes following treatment. Eighteen participants (n = 9) completed the study with DAV participants showing significant improvements in VO2max (4.30 ±0.45 to 4.72 ±0.60 L/min, P < 0.04). The placebo and DAV groups increased bench press and squat 1RM (both, P < 0.04); yet, when expressed relative to body mass, only the DAV group showed significant bench press (4%) and squat (10%; both, P < 0.02). Neither group improved cycling performance or showed adverse changes in blood chemistries. We did observe a significant reduction in LDL-C (12%) accompanying DAV supplementation and both groups significantly reduced percent body fat (P < 0.05). Our results suggest that DAV may have ergogenic effects in men participating solely in resistance training.

Key words: Antler velvet, strength training, performance, aerobic power, anaerobic power

Introduction

Deer antler “velvet” (DAV) is a soft skin, with a texture similar to velvet, and is considered a mammalian organ owing to its annual regeneration (Goss 1984; Suttie et al. 1989). Anecdotal evidence and some research reports suggest that antler velvet promotes health, alleviates anemia, reduces arthritis, increases growth rates in children,
and improves some aspects of athletic performance (Allen et al. 2002; Sleivert et al. 2003; Wang et al. 1988a; Wang et al. 1988b; Zhou et al. 1999). Obtained during the growing process, DAV is produced systemically by insulin-like and transforming growth factors is subsequently used for various medicinal purposes (Francis and Suttie 1998; Li 2013; Li and Suttie 2000; Sadighi et al. 1994; Suttie et al. 1989; Suttie and Haines 2004). Overall, DAV derived from the antler tip and upper sections are lower in ash, calcium, and phosphorous than the mid and base sections. In contrast, the tip has greater lipid, nitrogen reflecting protein content, and selenium than all other sections. Finally, the tip and upper sections of the velvet antler are rich sources of iron. Several studies also reveal a variety of growth factors in antler velvet including insulin like growth factor, transforming growth factor beta, fibroblast growth factor, bone morphogenetic protein, vascular endothelial growth factor, and nerve growth factors (Francis and Suttie 1998; Lai et al. 2007; Sadighi et al. 1994). These constituents may be important factors for improving exercise performance and body composition.

Few reports exist regarding the efficacy and dosage required to promote ergogenesis in sport. Syrotuik et al. (2005) observed no significant improvements in maximal aerobic capacity, maximal strength, or rowing time following 560 mg/d of DAV (Syrotuik et al. 2005). In contrast, Sleivert et al. (2003) demonstrated significant improvements in isokinetic knee extensor strength following 10 weeks of strength training using higher doses (1,500 mg) compared to a placebo group (Sleivert et al. 2003). According to a review by Suttie and Haines, it has been suggested that dosing protocols <1,000 mg/d typically lack efficacy for health or sports performance, while dosages from 1,000–1,500 mg/d exert small, yet statistically meaningful performance effects, and dosages >2,000 mg elicit clear, statistically significant effects following ≥ 8-weeks of supplementation (Suttie and Haines 2004). Regardless, the efficacy of DAV remains unclear. The primary aim of our current study is to examine the efficacy of DAV on exercise performance, body composition and blood chemistries as a means of assessing supplement safety. We hypothesized that DAV will improve exercise capacity, as determined by assessments of aerobic, anaerobic and strength performance.

**Methods**

We recruited participants for this study with a minimum of four years of resistance training activity and not currently involved in aerobic training. Eligible participants began the study by signing an informed consent outlining the study procedures approved by the East Tennessee State University Institutional Review Board and performed in accordance with the Declaration of Helsinki. We initially screened eligible participants with an ECG monitored cardiac stress test and, upon clearance to participate; we randomized participants in a double-blind manner to treatment or placebo conditions. Treatment consisted of ingesting an encapsulated DAV supplement (1,350 mg, 2×/d) or matched placebo capsules of similar size and color for 10 weeks. We instructed participants to ingest one capsule at breakfast and one immediately before bed. We also instructed participants to maintain their current training regimen, while random supplement checks performed approximately every two weeks to verify their adherence to the supplement routine. We have presented all participant demographics, anthropometry, and performance indices in Table 1 and hematology indices in Table 2.
Table 1. Demographic and fitness characteristics of study participants

<table>
<thead>
<tr>
<th></th>
<th>All (N = 18)</th>
<th>Placebo (n = 9)</th>
<th>DAV (n = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anthropometry</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Weight (kg)</td>
<td>95.45 ± 14.07</td>
<td>95.84 ± 17.72</td>
<td>95.06 ± 10.31</td>
</tr>
<tr>
<td>Follow-up</td>
<td>94.94 ± 13.69</td>
<td>94.92 ± 17.12</td>
<td>94.97 ± 10.26</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>29.83 ± 3.58</td>
<td>30.73 ± 4.30</td>
<td>28.93 ± 2.63</td>
</tr>
<tr>
<td>Follow-up</td>
<td>29.73 ± 3.25</td>
<td>30.47 ± 3.84</td>
<td>28.99 ± 2.55</td>
</tr>
<tr>
<td>Body Fat (%)</td>
<td>20.52 ± 5.55</td>
<td>21.51 ± 6.13</td>
<td>19.53 ± 5.06</td>
</tr>
<tr>
<td>Follow-up</td>
<td>19.16 ± 5.08</td>
<td>20.08 ± 5.79</td>
<td>18.23 ± 4.41</td>
</tr>
<tr>
<td>Fat Mass (kg)</td>
<td>20.01 ± 7.13</td>
<td>21.41 ± 8.64</td>
<td>18.60 ± 5.38</td>
</tr>
<tr>
<td>Follow-up</td>
<td>18.57 ± 6.53</td>
<td>19.74 ± 7.97</td>
<td>17.40 ± 4.89</td>
</tr>
<tr>
<td>Fat Free Mass (kg)</td>
<td>75.49 ± 9.47</td>
<td>74.54 ± 9.87</td>
<td>76.45 ± 9.54</td>
</tr>
<tr>
<td>Follow-up</td>
<td>76.38 ± 9.36</td>
<td>75.19 ± 10.16</td>
<td>77.57 ± 8.93</td>
</tr>
<tr>
<td><strong>Fitness Indices</strong></td>
<td></td>
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<tr>
<td>VO₂max (L/min)</td>
<td>4.21 ± 0.50</td>
<td>4.10 ± 0.56</td>
<td>4.31 ± 0.45</td>
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<tr>
<td>Follow-up</td>
<td>4.41 ± 0.66</td>
<td>4.09 ± 0.58</td>
<td>4.72 ± 0.60</td>
</tr>
<tr>
<td>VO₂max (ml/kg/min)</td>
<td>44.84 ± 7.52</td>
<td>43.16 ± 6.90</td>
<td>46.53 ± 8.14</td>
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<td>Follow-up</td>
<td>46.90 ± 7.92</td>
<td>44.00 ± 5.93</td>
<td>49.8 ± 8.91</td>
</tr>
<tr>
<td>Maximum HR (b/min)</td>
<td>189.44 ± 8.97</td>
<td>186.56 ± 8.56</td>
<td>192.33 ± 8.89</td>
</tr>
<tr>
<td>Follow-up</td>
<td>188.44 ± 6.62</td>
<td>188.67 ± 7.28</td>
<td>188.22 ± 6.32</td>
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<tr>
<td>Peak Power (W)</td>
<td>733.78 ± 167.92</td>
<td>690.67 ± 193.19</td>
<td>776.89 ± 131.08</td>
</tr>
<tr>
<td>Follow-up</td>
<td>725.17 ± 179.13</td>
<td>677.56 ± 193.19</td>
<td>772.78 ± 160.50</td>
</tr>
<tr>
<td>Time to Peak Power (sec)</td>
<td>7.39 ± 2.37</td>
<td>6.83 ± 2.10</td>
<td>7.94 ± 2.62</td>
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<tr>
<td>Follow-up</td>
<td>6.94 ± 1.52</td>
<td>6.84 ± 1.68</td>
<td>7.04 ± 1.44</td>
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<tr>
<td>Average Power (W)</td>
<td>581.00 ± 120.75</td>
<td>542.56 ± 131.94</td>
<td>619.44 ± 101.25</td>
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<tr>
<td>Follow-up</td>
<td>560.83 ± 129.71</td>
<td>515.44 ± 144.38</td>
<td>606.22 ± 101.36</td>
</tr>
<tr>
<td>Bench Press 1MR (kg)</td>
<td>121.36 ± 23.11</td>
<td>123.00 ± 23.92</td>
<td>119.71 ± 23.59</td>
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<tr>
<td>Follow-up</td>
<td>126.38 ± 25.84</td>
<td>128.01 ± 27.47</td>
<td>124.74 ± 25.66</td>
</tr>
<tr>
<td>Squat 1MR (kg)</td>
<td>154.61 ± 35.32</td>
<td>150.20 ± 28.14</td>
<td>159.02 ± 42.60</td>
</tr>
<tr>
<td>Follow-up</td>
<td>165.82 ± 37.66</td>
<td>156.24 ± 30.34</td>
<td>175.40 ± 43.45</td>
</tr>
<tr>
<td>Total Lifting Volume (kg)</td>
<td>313,955 ± 97,170</td>
<td>283,047 ± 64,065</td>
<td>348,051 ± 119,922</td>
</tr>
</tbody>
</table>

All data are expressed as mean ± SD. Body composition measures are determined by DXA.

* Represents a significant within group change from baseline (P < 0.05).
** Represents a significantly difference versus Placebo.

Testing Procedures

Baseline and follow-up testing included a series of tests to determine maximal cardiorespiratory fitness (VO₂max), anaerobic power output (PO, W), and upper and lower muscular strength. Participants performed all performance tests after abstaining from strenuous exercise for 12 hours and the consumption of a large meal four hours before testing. We performed all blood testing procedures under fasting conditions (8–10 hours) to assess blood cholesterol, blood glucose, liver and kidney function enzymes (Table 2).
Table 2. Hematology of study participants

<table>
<thead>
<tr>
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<th>All (N = 18)</th>
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<th>DAV (n = 9)</th>
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<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
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<tr>
<td>Baseline</td>
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<td>52.86</td>
<td>115.78</td>
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<td>115.28</td>
<td>48.89</td>
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<tr>
<td>Total Cholesterol (mg/dL)</td>
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<tr>
<td>Baseline</td>
<td>177.28</td>
<td>46.64</td>
<td>170.97</td>
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<td>Follow-up</td>
<td>171.00</td>
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<td>178.22</td>
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<td>HDL-C (mg/dL)</td>
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<td>45.22</td>
<td>9.53</td>
<td>42.89</td>
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<td>Follow-up</td>
<td>43.39</td>
<td>9.55</td>
<td>42.89</td>
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<td>LDL-C (mg/dL)</td>
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<td>111.11</td>
<td>38.17</td>
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<td>104.50</td>
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<td>109.56</td>
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<td>Total-C/HDL-C Ratio</td>
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<tr>
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<td>4.01</td>
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<tr>
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<td>21.89</td>
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<td>Follow-up</td>
<td>15.25</td>
<td>1.14</td>
<td>15.48*</td>
</tr>
</tbody>
</table>

Indicators of (1) Kidney and (2) liver function: BUN, blood urea nitrogen; ALP, Alkaline phosphatase; AST, aspartate aminotransferase; ALT, alanine transaminase. To convert to SIU multiple respective variables by: Triglycerides (0.0113), total cholesterol, HDL-C, and LDL-C (all, 0.0259), glucose (0.055), BUN (0.357), Creatinine (88.4), Bilirubin (17.104), ALP, AST, and ALT (all, 0.0167), Hematocrit (0.01), Hemoglobin (10).

* Represents a significant within group change from baseline (P < 0.05).

** Represents a significantly difference versus Placebo.

Maximal Oxygen Uptake

To measure VO2 max we performed a maximal ECG monitored treadmill exercise test. Oxygen consumption was assessed via open circuit spirometry (SensorMedics 2900, Yorba Linda, CA). Maximal aerobic capacity was defined as a plateau in VO2 (<2–3 ml) with increasing workloads, a respiratory exchange ratio >1.1, and heart rate within 10 beats of each participant’s age predicted maximum heart rate (220-age). If a participant did not meet the above criteria, they returned to the laboratory to repeat the test.
Anaerobic Power Testing

We assessed anaerobic power on a Computrainer (Seattle, WA), whereby participants were asked to cover a standardized distance (320 m) as quickly as possible. Testing consisted of three cycling trials interspersed with light tension recovery until heart rate dropped below 100 bpm. The trial eliciting the best performance was used to record each individual’s maximum and average power output. Forty-eight hours after their first test, participants repeated the test to verify their power output. No significant differences were observed between the repeated power trials; therefore, the data reported herein are the mean for both trials.

Prior to testing, the Computrainer was calibrated at 1.47 kg of resistance for each participant’s trials with the cycle rear tire inflated to the maximal pressure allowed to minimize friction related power variance. After the calibration procedure, we instructed participants on how to perform the test before beginning the protocol. Participants initiated each test with a light intensity warm-up lasting five minutes. During the test, the participant remained seated on the cycle and began cycling in a 52/23-gear combination at 60 rpm for one minute. Participants continued to cycle for another minute in order to change gearing before subsequently cycling at maximal effort.

Strength Assessment

Upper and lower body maximal strength was determined using a one repetition maximum (1MR) protocol for both the bench press and leg squat. All lifts were performed with a spotter. The initial weight lifted was estimated based on the previous lifting experience of the participants and what they normally used for each respective movement. A successful bench press attempt involved fully lowering the weight to the chest and then extending fully upward until the arms were straight without assistance from the spotter. For the maximal squat attempt the participant was instructed to squat until the leg reached a 90° degree angle. Between lifts, participants recovered for 1–3 minutes of rest to ensure recovery as they neared their maximal effort. We considered a successful 1MR as the weight lifted immediately prior to a failed attempt.

Anthropometry

Height, body mass and body mass index (BMI) were recorded using standardized methodology and body composition was determined using DXA (Lunar System, GE Corporation, Wauwatosa, WI) in order to examine percent body fat and fat free mass.

Statistical Analyses

We used general linear models to examine changes in all parameters from baseline and within-group statistical significance was established by examining 95% confidence interval (95% CI) and regression analyses were performed in order to examine relationships between changes in outcomes as appropriate. Between group differences were assed using least squared differences. Owing to a high dropout rate (described below), we covaried all of our analyses using respective baseline analysis measures reasoning that the number of dropouts would offset the randomness of our initial treatment assignments. In addition, we boot strapped our analyses using 1,000 imputations in order to better examine the surrounding confidence intervals of our analyses. Lastly, we performed Pearson correlations to examine respective changes candidate variables to denote significant relationships regarding potential mechanisms of action. Effect sizes were calculated and presented as partial eta
squared. We have reported all data as means ± SD or 95% confidence intervals when appropriate. Statistical significance is set at $P \leq 0.05$.

**Results**

We initially recruited 32 individuals into our study. However, 14 participants were excluded due to: Failure to complete all testing requirements ($n = 7$), lack of adherence to the study protocol ($n = 3$), study dropout due to scholastic time commitments ($n = 2$), an injury obtained outside the study ($n = 1$), desire to change their work routine ($n = 1$). We have presented participant demographics, anthropometry, and performance indices in Table 1 and hematology indices in Table 2. Changes from baseline and individual response values for VO$_2$max and 1MR strength measures are presented in Figure 1.

![Figure 1](image-url)

**Figure 1.** Data represent mean change from baseline (±95% CI) for relative VO$_2$max and one repetition maximum bench press and squat performance. Black circles represent individual participant responses. Statistical significance is represented as (a) significant within group change and (b) significantly different from placebo.

Overall, we observed no significant between group differences at baseline for age (27 ±6 y), height (1.79 ±0.1 m), weight (95.5 ±14 kg), BMI (29.8 ±3.5 kg/m$^2$) or dietary intake measures including total energy intake (2491 ±803 kcal), protein (128 ±61 g) and carbohydrate (314 ±96 g). Analysis of participant training records showed...
that each group trained ~4 d/wk. At follow-up, we found that the DAV group exhibited a greater total lifting volume (348,051 ±119,922 kg) during the intervention compared to the placebo group (283,647 ±64,065 kg, P < 0.05). We did not observe any significant changes in body mass at follow-up; however, both the placebo (−1.30, 95% CI −2.75, −0.16) and DAV group (−1.43%, 95% CI, −2.52, −0.49) demonstrated significant reductions in percent fat mass, as well as for percent body fat (P < 0.05). No significant between group differences were noted for either parameter, nor for changes in fat free mass (Table 1).

Maximal Cardiorespiratory Capacity. We observed no significant between group differences at baseline for absolute or relative VO\textsubscript{2}max. At follow-up, the placebo group showed no significant difference in VO\textsubscript{2}max (−0.012 L/Min, 95% CI −0.20, 0.19), while the DAV group exhibited a significant improvement (0.41 L/min, 95% CI 0.26, 0.60) that was also different versus placebo (P < 0.05). A similar pattern of improvement was noted when VO\textsubscript{2}max was expressed in relative terms (Figure 1a), while we did not observe any significant difference in maximal heart rate obtained during exercise testing. When expressed as percent improvement, the DAV group exhibited a 9.6% (95% CI, 6.1, 13.5) and 7.4% (95% CI, 3.5, 11.8) for absolute and relative VO\textsubscript{2}max, respectively. Respective responses for the placebo group were −0.2% (95% CI, −5.2, 4.6) and 2.1% (95% CI, −0.3, 7.0).

Anaerobic Power and Muscular Strength. We observed no significant improvements for time to peak power, peak power, or average power for either treatment group. For the bench press, both groups exhibited a significant improvement in 1RM bench press (Figure 1b). Only the DAV group improved squat performance (Figure 1c). While no between group differences were noted, the DAV group exhibited a numerical trend toward greater improvement (16.40 kg, 95% CI, 7.9, 25.5) versus the placebo group (6.02 kg, 95% CI, 1.7, 11.2; P = 0.07) although statistical significance was not reached. When we analyzed our data in relative terms (wt/kg), we found the same patterns for improvement (data not shown).

Hematology. Overall, we observed no significant changes in hematological variables with the exception of blood lipids and hematocrit (Table 2). For total cholesterol, we observed a significant reduction within the DAV group (−8 mg/dL, 95% CI, −14.74, −1.30). No significant reduction was noted for the placebo group (−4 mg/dL, 95% CI, −8.17, 16.38), nor were any between group differences otherwise noted. The observed reduction in total cholesterol was associated with a significant reduction in low density lipoprotein cholesterol (LDL-C) within the DAV group (−13.96 mg/dL, 95% CI, −24.37, −3.54), with only minor changes observed within the placebo group (0.74 mg/dL, 95% CI, −6.66, 9.07). No significant changes in triglycerides are noted (Table 2). For hematocrit, the DAV group exhibited a significant improvement (1.28%, 95% CI, 0.60, 2.64), whereas the placebo group showed a significant reduction (−1.33%, 95% CI, −2.040, −0.51), significant differences observed between the treatment groups (P = 0.003). We also observed significant correlations between changes in VO\textsubscript{2}max and hematocrit (r = 0.68, β = 0.11, P = 0.003) versus changes in body mass (r = −0.075, β = 0.011, P = 0.70) and total lifting volume (r = 0.46, β = 0.008, P = 0.72).

Discussion

The primary aim of our study was to examine the effect of DAV supplementation on parameters of aerobic, anaerobic and muscular strength performance. Secondary to this purpose we also performed a body composition and blood chemistry analyses in order to gain insight into potential safety issues associated with DAV supplementation. Overall, we found that DAV supplementation increased aerobic capacity when expressed in absolute (9.6%) and relative terms (7.4%). While we did not observe significant improvements for various indices
of anaerobic power, both groups did exhibit a significant improvement in bench press and squat performance. However, no differences between the placebo and DAV group existed despite a numerical trend for between group differences for the squat (P = 0.07). Of particular importance to our study is the observation that 10 weeks of DAV supplementation was not associated with negative alterations in blood chemistries associated with hepatorenal function. Additionally, DAV supplementation was associated with lowered plasma LDL-C levels. Based on these results, we accept the hypothesis that DAV improves aerobic capacity; reject the hypothesis that DAV will improve anaerobic power and view the hypothesis that DAV will increase strength performance as equivocal based on the inconsistency of responses for bench press and squat performances observed in the current study.

The most intriguing finding of our study is the observed improvement in the DAV group VO₂max. However, the mechanisms responsible for these changes remain unclear. A simplistic reason for these changes may simply be the increase in total training volume observed in the DAV group. While extensively reviewed elsewhere, heavy strength training can improve running performance in non-endurance athletes and may be related to delayed activation of less efficient type II fibers, improved neuromuscular efficiency, conversion of fast-twitch type IIIX fibers into more fatigue-resistant type IIa fibers, or improved musculotendinous stiffness (Aagaard and Andersen 2010; Ronnestad and Mujika 2013). Collectively, these observations explain the current findings as the participants in this study participated exclusively in resistance training. Thus, it is reasonable to anticipate a modest increase in maximal cardiorespiratory capacity in conjunction with the greater levels of exercise energy expenditure associated with 10 weeks of DAV supplementation.

A second possible reason for the increase in VO₂max may be related to changes in hemoglobin (1.4%, non-significant) and hematocrit concentrations (2.7%) as the observed change in VO₂max was correlated with a small, yet significant increase in hematocrit (r = 0.67; mean 1.28%, 95% CI; 0.60, 2.64) accompanying DAV supplementation. However, given that our calculations were performed to Dill and Costill, it is hard to reconcile the changes in VO₂max to blood parameters alone and the observed improvements in VO₂max may be due to the combined effects between increased training volume (r = 0.46, β = 0.008,) and hematocrit (r = 0.68, β = 0.11) (Costill et al. 1974; Costill and Fink 1974). Our results for the anaerobic and strength performance are difficult to interpret. While it is clear that DAV has no ergogenic effect on anaerobic performance as assessed by a Wingate-like test, changes in upper and lower body strength are less certain. These differences could be accounted for by examining the dose of DAV associated with various studies as well as the respective training status of the study participants.

Syrotuik et al. (2005) showed no significant improvements in leg press strength, bench press strength or circulating concentrations of testosterone or insulin-like growth factor following a lose dose (560 mg/d) DAV supplementation routine for 10 weeks while also participating in strength and rowing training. (Syrotuik et al., 2005) In contrast, Sleivert et al. (2003) used a higher dose (1,500 mg/d) of DAV per day and demonstrated significant improvements in knee extension strength and endurance following after 10 weeks of supplementation(Sleivert et al. 2003). Thus, dose appears to be an issue as both Sleivert and our study used DAV doses ~2.7 and 4.8 fold higher to Syrotuik. Finally, training status cannot be discounted. While Sleivert et al. (2003) examined “active males,” we specifically focused on chronically resistance trained participants not currently participating in aerobic conditioning. Thus, chronic resistance training may not elicit as great a supplement effect in chronically resistance-trained men owing to a plateauing of neurological and potential for musculoskeletal strength gains compared lesser-trained individuals (Sale 1988).
Both groups in our current study showed a similar change in percent body fat; therefore, DAV supplementation does not appear to offer any direct or indirect (i.e., via increased training volume) affect on anthropometry. Supplementation with DAV also does not appear to adversely affect indices associated with hepatorenal function. Curiously, however, DAV supplementation did affect LDL-C (−12%), which subsequently altered the LDL/HDL cholesterol ratio in the DAV (3.8%) versus the placebo conditions (<1%). Given that blood parameters were a tertiary are of research interest, we were unable to offer a direct mechanism of action responsible for these change in LDL-C. However, IGF concentrations have been shown previously to be inversely associated with LD-C in fasted individuals (Savendahl and Underwood 1999). While beyond the scope of this article, IGF levels in DAV vary with the antler growth cycle, and therefore, may be an area of future interest with regard to potential alterations in lipid metabolism (Francis and Suttie 1998; Suttie et al. 1989).

A strength of our study is that we have extended the small body of research examining DAV using a clinically focused trial. While our study shows a positive effect on aerobic capacity accompanying DAV supplementation, some caution is advised to readers given the high number of dropouts associated with our trial. Though we considered using various imputation techniques to overcome this obstacle, the breadth of imputation compared to the number of dropouts within the study outweighs the utility of imputation. Thus, we opted to covary our analyses using the respective baseline variable for each assessed parameter. In addition, we used bootstrapping techniques to improve the confidence intervals surrounding our outcomes. Finally, we re-examined all of our initial analyses by also co-varying for total lifting volume a posteriori, which only served to inflate the responses of the DAV group further. We believe our current approach is conservative means for addressing our study findings. We are further limited by our inability to expound on hormonal responses to DAV supplementation, nor generalize our findings beyond those involved in chronic resistance training only. This latter limitation however, is also a strength to our study, as we explored the relationship between DAV supplementation, exercise performance, and blood safety factors associated with hepatorenal function in those individuals most likely to use DAV as a nutrition supplement specifically, those heavily involved in strength training. Additional strengths of our study include using DAV in higher doses than previously reported, which not only improved aerobic capacity, but also appear to modulate LDL-C concentrations, subsequently the LDL/HDL cholesterol ratio. Taken as a whole, our findings suggest that DAV shows potential ergogenic effects in athletic populations. The use of DAV should also be explored in clinical populations targeted for improved muscular strength and effective lipid management.

Acknowledgements and Disclosures

Professor Earnest works as the director of research for Nutrabolt International and serves on the graduate faculty at Texas A&M University. Nutrabolt International is a commercial entity that sells nutrition supplements. However, the work presented herein was conceived, performed, and completed several years prior to his employment with Nutrabolt and does not represent a product of interest to the company.

Dr. Broeder presented this work previously as a conference presentation that was not peer reviewed. Since that time the paper has been substantially re-written and re-analyzed.

References


EFFECTS OF YELLOW-TINTED LENSES ON VISUAL ATTRIBUTES RELATED TO SPORTS ACTIVITIES AND DAILY LIFE IN LATE MIDDLE-AGED ADULTS

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A Study Design; B Data Collection; C Statistical Analysis; D Manuscript Preparation; E Funds Collection

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Abstract. The purpose of this study was to clarify the effects of colored lenses on the visual performance of middle-aged people. The subjects were 19 middle-aged people with a mean age of 57.4 ±6.0 years. Five different functional lenses were used in the experiments: colorless lenses and four colored lenses (Light-yellow, Dark-yellow, Light-gray, and Dark-gray). Using each lens type, contrast sensitivity, depth perception, hand–eye coordination, dynamic visual acuity, and visual acuity/low-contrast visual acuity were measured. Visual acuity/low-contrast visual acuity was measured under the four conditions of Evening, Evening+Glare, Day, and Day+Glare. Results showed that dynamic visual acuity and depth perception did not differ among the lens types, but hand–eye coordination measurements had a significantly shorter time with the Light-yellow and Dark-yellow lenses than the Dark-gray lenses. Low-contrast visual acuity under Evening and Evening+Glare conditions tended to be lower with the Dark lenses than the Colorless and Light-yellow lenses. The subjects rated the Yellow lenses as bright in a subjective questionnaire evaluation.

Key words: low-contrast visual acuity, contrast sensitivity, dynamic visual acuity, hand–eye coordination, sports

Introduction

Many previous studies have investigated the relationship between sports and visual performance (Christenson and Winkelstein 1988; Zwierko 2007; Zwierko et al. 2010). People who engage in sports consider visual performance to be a key attribute. Factors such as hand–eye coordination, contrast, dynamic visual acuity, and depth perception are representative components of visual performance in the context of sports activities (Stine et al. 1982; Hoffman et al. 1984, Laby et al. 2011). Individuals who engage in such activities, regardless of age, take care while playing to ensure that these aspects of visual performance are maintained. Visual performance is also regarded as important for performing daily activities.
People must consider protecting their eyes from ultraviolet and blue light rays when engaging in sports and other outdoor activities. Many people play sports for much of their life or are generally active outdoors as part of life. Functional colored lenses help avoid eye damage from many years of light stimulation. Cataracts and other eye disorders related to ultraviolet light have already been reported by McCarty and Taylor (2002). It is even feared that within the visual spectrum, short-wavelength blue light rays can cause retinal disorders (Lawwill et al. 1977; Ham et al. 1976). Moreover, the high-energy, easily scattered properties of blue light rays cause glare.

People generally wear sunglasses to protect their eyes from ultraviolet and other damaging rays. Several studies have described the sunglasses (Cooper et al. 2001; Miller 1974; Fishman 1986). Lawler et al. (2007) reported on athletes’ use of sunglasses in field hockey, soccer, tennis, and other sports. Black has been probably the most commonly used lens color of sunglasses to date. Black lenses, however, may affect visual performance in certain daily activities and types of sports because they darken the field of view. Kohmura et al. (2013) reported on a study of the effects of several colors of lenses on visual performance of young adults (mean age: 21 years) in sports activities. In that study, Kohmura et al. (2013) showed that yellow-tinted lenses did not adversely affect the visual performance of young adults. Aging, however, appears to alter a variety of factors such as differences in the visual performance of young and middle-aged adults. The ways in which colored lenses affect visual performance, which is essential for sports and daily activities, have not been clarified in middle-aged adults.

A variety of colors and transmittances for functional colored lenses has been developed and marketed in recent years, and this implies much complication for the best selection of lens for many users. Yellow has gained attention for its ability to cut short-wave visible blue light rays while maintaining high luminous transmittance near 550 nm, a wavelength suited for optical sensitivity in humans. Investigators in non-sports-science fields have already evaluated and reported on the effects of yellow lenses on components of visual performance, primarily contrast sensitivity (Wolffsohn et al. 2000; Yap 1984; Kelly et al. 1984; Rieger 1992).

The purpose of this study was to characterize how the use of several types of functional colored lenses affects the visual performance of middle-aged people. Indices related to daily activities and sports were used to measure visual performance.

Methods

Participants

The subjects were 19 middle-aged people (16 men and 3 women). Their mean age was 57.4 ±6.0 years. Sixteen of the subjects used no form of visual correction, one used contact lenses, and two used eyeglasses. The subjects were people who had no organic disorder of the eye other than ametropia.

Measures

1. Contrast sensitivity

Contrast sensitivity was measured as the ability to distinguish shades. The Sine Wave Contrast Test (Stereo Optical Co., Inc., Chicago, IL, USA) was used to measure contrast sensitivity. Contrast sensitivity was measured at the spatial frequencies of 1.5, 3, 6, 12, and 18 cycles/degree. For the test, targets of the same spatial frequency are arranged on the same lines in a chart. The subjects were asked to distinguish the direction of the patterns (left, right, or up) while viewing the chart at a distance of 3.0 m. The test evaluated how faint a target the subjects were able to distinguish.
2. Depth perception

A depth perception meter (AS-7JS1, Kowa Co., Ltd., Aichi, Japan) was used to measure depth perception. The testing apparatus contained three bars, the middle one of which moved back and forth at 50 mm/s. The two bars on either side of the moving bar were stationary. The subjects viewed these bars through a window in the testing apparatus at a distance of 2.5 m and were asked to press a button when they thought the three bars were aligned horizontally. The difference in the positions of the center bar and two side bars was measured in millimeters when the button was pressed, and the absolute value of this difference was recorded. The difference was measured three times, and the mean was calculated as the final measurement.

3. Dynamic visual acuity

Dynamic visual acuity was measured with a dynamic visual acuity meter (HI-10, Kowa Co., Ltd., Aichi, Japan). For the test, each subject was asked to determine the direction of the gap of a Landolt ring moving horizontally from left to right on a semicircular screen. The rotational speed of the Landolt ring was gradually reduced from an initial speed of 40.0 rpm. Each subject pressed a button and stated the direction immediately after determining the direction of the Landolt ring gap. When a response was correct, the rotational speed at the time the button was pressed was recorded. The size of the Landolt ring was equivalent to decimal visual acuity 0.025 (log MAR: 1.6). The direction of the gap of the Landolt ring could be up, down, left, or right and was presented in random order. The measurement was repeated until three correct responses were obtained and the mean was calculated as the final measurement. The data of a subject giving three or more incorrect responses was excluded from analysis. The sample size for dynamic visual acuity analysis only was 16.

4. Hand–eye coordination

Hand–eye coordination was measured with an AS-24 (Kowa Co., Ltd., Aichi, Japan). The panel of the test apparatus contained 120 lights that were individually illuminated in random order. Once a light was illuminated, the next light was illuminated after 1.3 s or when pressed by the subject, whichever happened first. The subjects were asked to press the lights as accurately and quickly as possible. The time required for all 120 lights to be illuminated was measured. Hand–eye coordination was measured once for each subject.

5. Visual acuity and low-contrast visual acuity

Low-contrast visual acuity was measured with a CAT-CP (NEITZ Co., Ltd., Tokyo, Japan). For the test, each subject was asked to peer into the test apparatus to determine the direction of the gap of a Landolt ring. The measurements were automatically taken. The measurement conditions were Evening, Evening+Glare, Day, and Day+Glare. The luminances of the target were 200 cd/m² in the Day condition and 10 cd/m² in the Evening condition. The intensity of the Glare was 200 lux. A visual acuity test (100% contrast) and low-contrast visual acuity test with markers having 5% and 10% contrast were performed under each condition. Measurements were performed with the dominant eye. The dominant eye was determined by having the subjects either point at an object with their index finger or place an object in a circle drawn with the hands. In cases when a subject was unable to determine the direction even at the lowest setting of the measurement apparatus (log MAR 1.3) under the 5% and 10% contrast conditions (i.e., data not obtained), the result was handled as log MAR 1.4.

6. Questionnaire

The subjects answered the questionnaire based on their subjective evaluation or impression for each question in reference to a visual analog scale. The subjects marked the location on a 100 mm straight line that corresponded with their assessment. The questionnaire was inscribed with lines without length values (millimeters) noted, and
only numbers for each question. The subjects completed the questionnaire after finishing all visual performance measurements, and the locations marked by the subjects were measured in millimeters. The questions evaluated the following five qualities: brightness (bright: maximum 100 mm, dark: minimum 0 mm), clarity (sharp: 100, blurry: 0), changes in color (not changed: 100, changed: 0), glare (no glare: 100, glare: 0), and overall impression (good: 100, bad: 0).

**Procedures**

Each aspect of visual performance was measured in the subjects using Colorless lenses (C) and four colored lenses: Light-yellow (LY), Dark-yellow (DY), Light-gray (LG), and Dark-gray (DG). The lenses were similar to those of the lenses used in previous study (Kohmura et al. 2013). The transmittance values for the lenses were 92.0% for the Colorless lenses, 65.2% for the Light-yellow lenses, 30.4% for the Dark-yellow lenses, 65.9% for the Light-gray lenses, and 30.2% for the Dark-gray lenses.

The lenses were used in random order, with at least 15 min rest period between each measurement. The measurements of subjects wearing eyeglasses were taken with the colored lenses worn over the glasses. A summary of the measurement procedures is given below. The subjects filled out a questionnaire after completing all measurements. The measurements were similar to those of the measurements used in previous study (Kohmura et al. 2013).

The study was conducted after all subjects had been informed of the details of the experiment and gave written consent. The study was conducted with the approval of the Research Ethics Committee of the Juntendo University School of Health and Sports Science.

**Statistical Analysis**

One-way repeated measures analysis of variance (ANOVA) was used to analyze depth perception, hand–eye coordination, visual acuity, and the questionnaire results. Two-way repeated measures ANOVA was used to analyze contrast sensitivity and low-contrast visual acuity. The Bonferroni correction was used for multiple comparisons. The level of statistical significance was set at p < 0.05.

**Results**

Visual performance measurement results.

The measurement results are shown in Table 1 and Figures 1 and 2.

<table>
<thead>
<tr>
<th></th>
<th>Colorless</th>
<th>Yellow light</th>
<th>Yellow dark</th>
<th>Gray light</th>
<th>Gray dark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic visual acuity (rpm)</td>
<td>29.5 (7.6)</td>
<td>28.8 (8.1)</td>
<td>28.2 (8.5)</td>
<td>30.2 (7.0)</td>
<td>28.8 (8.1)</td>
</tr>
<tr>
<td>Depth perception (mm)</td>
<td>16.5 (13.7)</td>
<td>22.1 (20.1)</td>
<td>20.1 (19.7)</td>
<td>19.9 (16.8)</td>
<td>21.7 (22.1)</td>
</tr>
<tr>
<td>Eye-hand coordination (sec)</td>
<td>95.8 (9.4)</td>
<td>95.6 (9.9)</td>
<td>95.4 (8.9)</td>
<td>96.7 (9.9)</td>
<td>98.9 (8.3)</td>
</tr>
<tr>
<td>Visual acuity (log MAR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evening</td>
<td>0.30 (0.23)</td>
<td>0.25 (0.23)</td>
<td>0.36 (0.18)</td>
<td>0.31 (0.21)</td>
<td>0.38 (0.23)</td>
</tr>
<tr>
<td>Evening + Glare</td>
<td>0.29 (0.20)</td>
<td>0.29 (0.18)</td>
<td>0.35 (0.18)</td>
<td>0.30 (0.21)</td>
<td>0.41 (0.20)</td>
</tr>
<tr>
<td>Day</td>
<td>0.08 (0.17)</td>
<td>0.16 (0.23)</td>
<td>0.18 (0.23)</td>
<td>0.16 (0.23)</td>
<td>0.19 (0.17)</td>
</tr>
<tr>
<td>Day + Glare</td>
<td>0.13 (0.22)</td>
<td>0.22 (0.24)</td>
<td>0.21 (0.25)</td>
<td>0.18 (0.23)</td>
<td>0.21 (0.22)</td>
</tr>
</tbody>
</table>
Effects of Yellow-Tinted Lenses on Visual Attributes in Late Middle-aged Adults

Figure 1. Measurements results for low-contrast visual acuity are shown

Figure 2. Means of contrast sensitivity with each of the lenses are shown

For hand–eye coordination, the ANOVA results were significant at p < 0.05 (F = 3.57, p = 0.01), and the results of multiple comparisons showed a significant difference between Light-yellow and Dark-gray (p = 0.01) and Dark-yellow and Dark-gray (p = 0.02) at p < 0.05. For visual acuity, the ANOVA results were significant for the Evening...
condition at $p < 0.05$ ($F = 2.99, p = 0.02$). For the Evening+Glare condition, the ANOVA results were significant at $p < 0.01$ ($F = 4.14, p = 0.00$), and there was a significant difference between Colorless and Dark-gray at $p < 0.05$ ($p = 0.05$). For the Day condition and Day+Glare condition, visual acuity was not significantly different. No significant differences were noted for dynamic visual acuity or depth perception.

For contrast sensitivity, the interaction was not significant, and the main effects of lens and spatial frequency were both significant at $p < 0.01$ (lens: $F = 3.99, p = 0.01$, spatial frequency $F = 78.49, p = 0.00$).

For low-contrast visual acuity, the interaction was not significant, and the main effect of contrast was significant at $p < 0.01$ under all conditions (Day: $F = 257.81, p = 0.00$, Day+Glare: $F = 216.01, p = 0.00$, Evening: $F = 319.91, p = 0.00$, Evening+Glare: $F = 231.71, p = 0.00$).

Under the Evening condition, the main effect of lens was significant at $p < 0.01$ ($F = 12.36, p = 0.00$), and the results of multiple comparisons showed a significant difference between Colorless and Dark-gray ($p = 0.00$) and Light-yellow and Dark-gray ($p = 0.00$) at $p < 0.01$. Moreover, there was a significant difference between Colorless and Dark-yellow ($p = 0.01$) and Light-yellow and Dark-yellow ($p = 0.03$) at $p < 0.05$. There was also a significant difference between Light-gray and Dark-gray at $p < 0.01$ ($p = 0.00$).

Under the Evening+Glare condition, the main effect of lens was significant at $p < 0.01$ ($F = 14.90, p = 0.00$), and the results of multiple comparisons showed Colorless to be significantly different from both Dark-yellow ($p = 0.00$) and Dark-gray ($p = 0.00$) at $p < 0.01$. Light-yellow was significantly different from both Dark-yellow ($p = 0.00$) and Dark-gray ($p = 0.00$) at $p < 0.01$. There was also a significant difference between Light-gray and Dark-gray at $p < 0.05$ ($p = 0.01$).

Under the Day condition, the main effect of lens was significant at $p < 0.01$ ($F = 4.38, p = 0.00$). Under the Day+Glare condition, the main effect of lens was significant at $p < 0.01$ ($F = 4.99, p = 0.00$), and there were significant differences between Colorless and Dark-yellow at $p < 0.01$ ($p = 0.00$) and Colorless and Dark-gray at $p < 0.05$ ($p = 0.02$).

**Questionnaire results**

The Questionnaire results are shown in Figure 3.

The results of one-way ANOVA were significant at $p < 0.01$ for all questions (brightness: $F = 28.85, p = 0.00$, clarity: $F = 5.77, p = 0.01$, color: $F = 35.02, p = 0.00$, glare: $F = 11.66, p = 0.00$, overall: $F = 16.17, p = 0.00$). The results of multiple comparisons revealed Colorless to be significantly different from Light-gray ($p = 0.00$) and Dark-gray ($p = 0.00$) at $p < 0.01$ for the questions related to brightness. Light-yellow was significantly different from Dark-yellow ($p = 0.00$), Light-gray ($p = 0.00$), and Dark-gray ($p = 0.00$) at $p < 0.01$. Dark-yellow was significantly different from Dark-gray at $p < 0.05$ ($p = 0.01$). Light-gray was significantly different from Dark-gray at $p < 0.01$ ($p = 0.00$).

Colorless was significantly different from Dark-gray ($p = 0.00$) at $p < 0.01$ for the questions related to clarity. Light-yellow was significantly different from both Dark-yellow at $p < 0.05$ ($p = 0.02$) and Dark-gray at $p < 0.01$ ($p = 0.01$). Light-gray was significantly different from Dark-gray at $p < 0.01$ ($p = 0.00$).

For the questions related to change in color, Light-yellow was not significantly different from Dark-yellow, but a significant difference was noted for all other combinations at $p < 0.01$. Only the combination of Colorless and Light-gray was significant at $p < 0.05$ ($p = 0.03$).
Figure 3. Questionnaire results (Score)

Colorless was significantly different from Light-gray (p = 0.01) at p < 0.05 and Dark-gray (p = 0.00) at p < 0.01 for the questions related to glare. Light-yellow was significantly different from both Light-gray at p < 0.05 (p = 0.01) and Dark-gray at p < 0.01 (p = 0.00). Dark-yellow was significantly different from Dark-gray at p < 0.01 (p = 0.00). Light-gray was significantly different from Dark-gray at p < 0.05 (p = 0.02).

Colorless was significantly different from Dark-yellow (p = 0.00) at p < 0.01 for the questions related to overall impression. Light-yellow was significantly different from both Dark-yellow at p < 0.01 (p = 0.00) and Light-gray at p < 0.05 (p = 0.02). Dark-yellow was significantly different from both Light-gray at p < 0.01 (p = 0.00) and Dark-gray at p < 0.05 (p = 0.01). Light-gray was significantly different from Dark-gray at p < 0.01 (p = 0.00).

Discussion

The lenses tested did not differ significantly with regard to dynamic visual acuity or depth perception. It is likely that the effects of lens color and transmittance are small in cases like the dynamic visual acuity test, which required the subjects to analyze a target in the central fovea, and in cases like the depth perception test, in which the subjects were asked to match the distances between three bars. In these situations, the differences among the lenses appeared to be small in the present experiment, as they were revealed to be similar to the results of previous
study in young adults (Kohmura et al. 2013). The adverse effects of the lenses used in this study in middle-aged people also appear to be minimal with regard to these visual performances in sports and daily activities.

However, hand–eye coordination measurements had significantly shorter times with the Light-yellow and Dark-yellow lenses than the Dark-gray lenses. Shorter test times indicated better assessment, or an ability to press lights quickly and accurately, because the test measured the time required for 120 lights to illuminate. The Dark-gray condition appeared to have an effect when repeatedly performing the task of accurately pressing illuminated lights found in the peripheral vision. The use of Dark-gray and similar lenses may therefore not produce uniformly favorable results in sports requiring quick and accurate judgments of, and response to, the athlete’s surroundings. The significant differences noted for the yellow lenses may be attributable to the ability of yellow lenses to limit the passage of short-wavelength visual light while maintaining the transmittance of long-wavelength light, which has high relative luminosity. The ability of yellow lenses to make objects appear brighter and clearer may have also contributed to these results. Previous research also reported on the effect on brightness of yellow lenses (Kelly 1990; Chung and Pease 1999).

The above findings largely agree with the results of previous study in young adults (Kohmura et al. 2013). In contrast, the findings on low-contrast visual acuity showed significant differences in more items. Although significant differences were seen between some lenses under the light (Day) condition, many significant differences were noted between the Colorless/Light-yellow lenses and dark lenses under the Evening condition. The use of Light-yellow and Colorless lenses tended to produce higher visual acuity measurements than even the dark lenses. Differences were noted between the Colorless lenses and dark lenses in the young adults, but the additional differences between the Light-yellow lenses and dark lenses in many areas of measurement in the present study in middle-aged people were remarkable. Values for visual acuity are expected to decrease substantially with the low contrast, difficult-to-see targets under darker conditions, but the use of Light-yellow lenses appears to produce low-contrast visual acuity results comparable to those for the Colorless lenses. As the environment is not necessarily bright nor the contrast between objects clear in daily activities and sports, the use of Light-yellow and similar lenses may produce satisfactory results under various conditions and environments.

The questionnaire results largely agreed with the results of the questionnaires completed by young adults in previous study. Colorless and Light-yellow lenses were rated bright and Dark-gray lenses were rated dark in the questions about brightness. The Dark-gray lenses were rated more poorly than the Colorless, Light-yellow, and Light-gray lenses in the questions about clarity. On the questions about changes in color perception, the Light-yellow and Dark-yellow lenses were not significantly different, while the other lenses were rated as producing a significantly different change in color perception. The middle-aged subjects indicated that they could sense that yellow lenses changed the color. Previous studies (De Fez et al. 2002; Hovis et al. 1989) similarly reported on the effects that yellow lenses have on color perception. As mentioned, a number of advantages have been reported for yellow lenses. However, the change in color perception caused by using yellow lenses is a drawback that must be considered. Some results related to glare differed from those noted by the young adults. The young adults (Kohmura et al. 2013) reported that the Colorless lenses produced the greatest glare, while the middle-aged subjects in this study found the Light-yellow lenses produced the greatest glare. As the Light-yellow lenses were also rated highest in terms of brightness, the subjects may have used similar standards to evaluate brightness and glare or may have been more susceptible to glare than the young adults. Although clarifying causes such as these is difficult, the fact
that middle-aged people subjectively perceive greater glare in association with light-yellow lenses than colorless lenses bears acknowledging.

The above questionnaire results suggest that, like the young adults, the middle-aged subjects tended to rate the darker colors more poorly on questions not related to glare, which indicates that light-colored lenses are viewed favorably. It is also likely that middle-aged subjects are accustomed to black lenses. This appears to mean they are likely unfamiliar with the changes in color perception produced by yellow lenses. In order to convince others to use yellow lenses, it is important to properly convey both the strengths and weaknesses of this lens color to the user. Previous research has similarly reported that yellow lenses affect color perception (De Fez et al. 2002; Hovis et al. 1989). Other researchers have also started to investigate the effects of different color lenses (Lee et al. 2002). Thus, future studies should investigate which types of lenses are suited for which situations, factoring in differences due to age.

Many of the measurements in this study differed to a certain degree from the visual performance data for young adults (Kohmura et al. 2013). Visual performance also probably decreases with age. The differences appeared to be most substantial particularly for depth perception, hand–eye coordination, and other faculties particularly relevant to sports. Low target frequencies in the contrast sensitivity test did not produce appreciable differences, but the middle-aged subjects had lower scores when the frequency was high. However, the difference between young and middle-aged adults in low-contrast visual acuity appeared small, which indicated that there are cases where the effect of increased age differed depending on the visual performance attribute. Nevertheless, further research is needed to validate these hypotheses.

The results of the present study indicated, as in the young adults in previous study, that contrast-related performance was more readily affected by the use of dark lenses. Under evening and cloudy conditions, it is possible that light-yellow lenses can be used without adversely affecting visual performance. Lens color probably has minimal effect on visual performance when directing the line of sight to follow objects or determine distance. Dark-gray lenses, however, may have an effect on tasks requiring the user to identify and accurately and promptly react to objects in the peripheral vision, as well as their repetition. Dark lenses therefore probably have certain effects on daily activities and sports. In the subjective opinions of the subjects, as assessed by the questionnaire, relatively high ratings were given to the Light-gray lenses, a color which is both light, and to which they were accustomed in black lenses. It was expected that middle-aged people, like young adults, would feel no significant discomfort towards, and would be accustomed to, black lenses. They may also be unaccustomed to the color perception changes and sense of brightness associated with yellow lenses.

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References


INTERRELATION OF FOOTBALL PLAYERS’ (13 TO 14 YEARS OLD) INDICES OF MOVEMENT IN VARIOUS DIRECTIONS

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A Study Design; B Data Collection; C Statistical Analysis; D Manuscript Preparation

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Abstract. The aim of the work – to establish motor skills peculiarities in young football players (aged 13 to 14 years). Methods of the research: Tests for speed and velocity and Tensodynamometry (Radžiukynas 1997). Average height of football players is 168 cm, their body mass – 55.84 kilos, BMI – 19.58. The vertical body movement speed in two foot takeoff of the players is 2.49 m/sec, running results: in 10 m run – 1.88 sec (5.31 m/sec), in 20 m run – 3.31 sec (6.04 m/sec), in 30 m run – 4.68 sec (6.41 m/sec), jumping in hexagon area result – 17.16 sec, angular movement result – 2.35 m/sec. Individual movement skills are expressed by kinematic and kinetic indices of interaction with support, such as: squat time (0.348 sec), takeoff duration (0.249 sec), squat speed (1.02 m/sec), squat depth (19.5 cm), reactivity of legs’ muscles (22.1 Hz), jump height (31.4 cm), absolute power of takeoff (1555 N), relative capacity (28.5 W). Football players do not experience fatigue performing intense two foot vertical jumps, in average 45 jumps in 30 sec. Correlation analysis of all movement directions kinematic and kinetic indices relation significance highlighted the main indices which most objectively allow evaluation, prognosis, and correction of various directions movement level and abilities of young football players. Alteration of these indices’ significance interrelation shows peculiarities of athletes’ body functional systems’ adaptation to training loads, also serves as an effective methodical direction in improving preparation of young football players.

Key words: young football players, vertical jumps, kinematic and kinetic indices

Introduction

Human sport movement is the main practical form of sport expression. Its content is made up and conditioned by various sports movements, teaching and training programs, while a variety of movement forms is disclosed during training sessions and competitions.
The aim of the sport movement is regular training sessions and participation in competitions, systematically aiming at optimal sport results. Human movement possessing no such features performs other social, cultural, health enhancing and remedial functions.

Possibilities to perform sport movement depend on person’s body constitution, age, support and movement parts abilities, body functional systems capacities, use of accumulated energy, special training condition, etc. (Skurvydas 2010; Radžiukynas 2013).

Sport movement is particularly complex in game sports, as the athlete in his relation with support has to overcome gravity force, to move in various directions, at the same time possessing a ball.

The exceptional feature of football game is intense, short-lasting and frequently repeated locomotion movement in various directions with or without a ball, aiming to acquire space and time advantage in regard to one or several opponents. It was established that the most integral indices, indicating effectiveness of movement in various directions and competitive activity are absolute and momentum speed, absolute and momentum capacity, absolute and relative power, as well as precision of movements and actions (Gražulis 2013).

The data of the researches, carried out on athletes representing other sport games, of different age and mastership level proved that effectiveness of moving in various directions is mainly conditioned by kinematic and kinetic take-off from the support indices (Radžiukynas 1997; Radžiukynas et al. 2010). Presumably, effectiveness of young football players’ moving can be recognized and evaluated according to the same kinematic and kinetic indices of relation with support. Less investigations are carried out on young (aged 13 to 14 years) football players’ movement in various directions abilities. The aim of our work was to establish relation between young (aged 13 to 14 years) football players’ indices of movement in various directions.

Organization and methods of the research

Young football players (aged 13 to 14 years), members of football school “Ateitis”, participated in the research. Anthropometric indices: height (m), body mass (kg), BMI (body mass index, (c/u) were recorded. Applying the method of tenzodynamometry, football players’ abilities of moving in vertical direction were established by performing three single jumps: 1. Standing vertical jump by both legs, with a natural squat and a hand movement. 2. Standing vertical jump by both legs without a hand movement. 3. Vertical jumps in 30 seconds by both legs with a hand movement.

The following indices were recorded and calculated: ds (sec.) – squat duration, dt (sec.) – take-off duration, df (sec.) – flight phase duration, dj (sec.) – total jump duration, Vs (m/sec.) – squat speed, V (m/sec.) – body movement speed, sd (m) – squat depth, h (m) – total body mass centre lifting height, h1 (m) – jump height, Fmax (N) – greatest take-off force, Fav (N) – average take-off force, R (Hz) – muscle reactivity, A (J) – work, P (W) – power, Pr (W/kg) – relative power.

Established were such measurements: 5 m, 10 m, 20 m and 30 m running time (sec.) and speed (m/sec.), jumping in hexagon time (sec.) and speed (m/sec.)(Hexagonal Obstacle Test. ARNOT, R. and GAINES, C. (1984), angular body movement time (sec.) and speed (m/sec.) performing 7 jumps.

Mathematical statistic. Calculations were carried out to find out arithmetical mean X, mean error ± Sx, standard deviation ± S, level of significance of difference t and p, correlation between indices – r. SPSS program (13.0 version) was used for calculation.
The results and discussion

It was established that young football players (13 to 14 years old) had reached the appropriate level of anthropometric indices. This natural process, also influenced by the training, determines the content of movement, its forms, effectiveness, as well as natural biologic maturity (Table 1).

Table 1. Biometric indices of football players aged from 13 to 14 years (n = 26)

<table>
<thead>
<tr>
<th>Indices</th>
<th>x</th>
<th>±S</th>
<th>±Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>13.60</td>
<td>0.11</td>
<td>0.50</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.68</td>
<td>0.02</td>
<td>0.09</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>55.85</td>
<td>1.98</td>
<td>8.88</td>
</tr>
<tr>
<td>BMI</td>
<td>19.58</td>
<td>0.41</td>
<td>1.85</td>
</tr>
</tbody>
</table>

The jump height when performing vertical jump by both legs with a hand movement is 0.307 m, while without a hand movement it is 0.268 m, the difference being 3.9 cm (p < 0.05). Vertical jump with a hand movement is natural action, used in games, more objectively reflecting movement abilities. No significant differences were established in other indices (Tables 2 and 3).

Table 2. Vertical jump by both legs with a hand movement

<table>
<thead>
<tr>
<th>Indices</th>
<th>x</th>
<th>±S</th>
<th>±Sx</th>
</tr>
</thead>
<tbody>
<tr>
<td>ds (sec.)</td>
<td>0.353</td>
<td>0.058</td>
<td>0.011</td>
</tr>
<tr>
<td>dt (sec.)</td>
<td>0.245</td>
<td>0.041</td>
<td>0.008</td>
</tr>
<tr>
<td>df (sec.)</td>
<td>0.496</td>
<td>0.043</td>
<td>0.008</td>
</tr>
<tr>
<td>dj (sec.)</td>
<td>0.850</td>
<td>0.094</td>
<td>0.018</td>
</tr>
<tr>
<td>Vs (m/sec.)</td>
<td>−1.005</td>
<td>0.200</td>
<td>0.038</td>
</tr>
<tr>
<td>V (m/sec.)</td>
<td>2.426</td>
<td>0.274</td>
<td>0.053</td>
</tr>
<tr>
<td>sd (m)</td>
<td>−0.191</td>
<td>0.050</td>
<td>0.010</td>
</tr>
<tr>
<td>h (m)</td>
<td>0.499</td>
<td>0.102</td>
<td>0.020</td>
</tr>
<tr>
<td>h1 (m)*</td>
<td>0.307</td>
<td>0.053</td>
<td>0.010</td>
</tr>
<tr>
<td>Fmax</td>
<td>1,529.130</td>
<td>380.472</td>
<td>73.222</td>
</tr>
<tr>
<td>Fav</td>
<td>1,136.103</td>
<td>238.653</td>
<td>45.929</td>
</tr>
<tr>
<td>R (Hz)</td>
<td>21.620</td>
<td>7.671</td>
<td>1.476</td>
</tr>
<tr>
<td>A (J)</td>
<td>375.801</td>
<td>90.347</td>
<td>17.387</td>
</tr>
<tr>
<td>P (W)</td>
<td>1,545.624</td>
<td>416.786</td>
<td>80.210</td>
</tr>
<tr>
<td>Pr (W/kg)</td>
<td>27.684</td>
<td>4.783</td>
<td>0.921</td>
</tr>
</tbody>
</table>

Higher vertical jump with a hand movement results are achieved due to the fact that this movement creates additional kinetic energy, which influences prolongation of flight phase duration (ds) and altogether increases body movement speed (V) and jump height (h1). Other indices did not possess significant differences.
Table 3. Vertical jump by both legs without a hand movement

<table>
<thead>
<tr>
<th>Indices</th>
<th>x</th>
<th>±Sx</th>
<th>±x</th>
</tr>
</thead>
<tbody>
<tr>
<td>ds (s)</td>
<td>0.323</td>
<td>0.056</td>
<td>0.011</td>
</tr>
<tr>
<td>dt (s)</td>
<td>0.226</td>
<td>0.030</td>
<td>0.005</td>
</tr>
<tr>
<td>df (s)</td>
<td>0.463</td>
<td>0.038</td>
<td>0.007</td>
</tr>
<tr>
<td>dj (s)</td>
<td>0.786</td>
<td>0.084</td>
<td>0.014</td>
</tr>
<tr>
<td>Vs (m/sec.)</td>
<td>−0.987</td>
<td>0.194</td>
<td>0.033</td>
</tr>
<tr>
<td>V (m/sec.)</td>
<td>2.301</td>
<td>0.290</td>
<td>0.056</td>
</tr>
<tr>
<td>sd (m)</td>
<td>−0.175</td>
<td>0.064</td>
<td>0.012</td>
</tr>
<tr>
<td>h (m)</td>
<td>0.464</td>
<td>0.118</td>
<td>0.022</td>
</tr>
<tr>
<td>h1 (m)</td>
<td>0.268</td>
<td>0.044</td>
<td>0.008</td>
</tr>
<tr>
<td>Fmax</td>
<td>1,664.822</td>
<td>425.867</td>
<td>80.481</td>
</tr>
<tr>
<td>Fav</td>
<td>1,174.031</td>
<td>247.210</td>
<td>46.719</td>
</tr>
<tr>
<td>R (Hz)</td>
<td>25.099</td>
<td>10.942</td>
<td>2.068</td>
</tr>
<tr>
<td>A (J)</td>
<td>349.841</td>
<td>95.862</td>
<td>18.116</td>
</tr>
<tr>
<td>P (W)</td>
<td>1,557.304</td>
<td>440.831</td>
<td>83.309</td>
</tr>
<tr>
<td>Pr (W/kg)</td>
<td>27.671</td>
<td>5.123</td>
<td>0.965</td>
</tr>
</tbody>
</table>

Table 4. Vertical jump by both legs after 30 sec. load

<table>
<thead>
<tr>
<th>Indices</th>
<th>x</th>
<th>±Sx</th>
<th>±S</th>
</tr>
</thead>
<tbody>
<tr>
<td>ds (sec.)</td>
<td>0.365</td>
<td>0.099</td>
<td>0.019</td>
</tr>
<tr>
<td>dt (sec.)</td>
<td>0.248</td>
<td>0.046</td>
<td>0.009</td>
</tr>
<tr>
<td>df (sec.)</td>
<td>0.495</td>
<td>0.038</td>
<td>0.007</td>
</tr>
<tr>
<td>dj (sec.)</td>
<td>0.865</td>
<td>0.124</td>
<td>0.024</td>
</tr>
<tr>
<td>Vs (m/sec.)</td>
<td>−1.030</td>
<td>0.239</td>
<td>0.047</td>
</tr>
<tr>
<td>V (m/sec.)</td>
<td>2.430</td>
<td>0.328</td>
<td>0.064</td>
</tr>
<tr>
<td>sd (m)</td>
<td>−0.192</td>
<td>0.053</td>
<td>0.010</td>
</tr>
<tr>
<td>h (m)</td>
<td>0.512</td>
<td>0.158</td>
<td>0.031</td>
</tr>
<tr>
<td>h1 (m)</td>
<td>0.305</td>
<td>0.046</td>
<td>0.009</td>
</tr>
<tr>
<td>Fmax</td>
<td>1544.126</td>
<td>424.889</td>
<td>83.328</td>
</tr>
<tr>
<td>Fav</td>
<td>1139.728</td>
<td>253.217</td>
<td>49.660</td>
</tr>
<tr>
<td>R (Hz)</td>
<td>20.027</td>
<td>6.324</td>
<td>1.240</td>
</tr>
<tr>
<td>A (J)</td>
<td>383.602</td>
<td>105.899</td>
<td>20.768</td>
</tr>
<tr>
<td>P (W)</td>
<td>1563.013</td>
<td>451.265</td>
<td>88.500</td>
</tr>
<tr>
<td>Pr (W/kg)</td>
<td>27.888</td>
<td>5.261</td>
<td>1.032</td>
</tr>
</tbody>
</table>

During 30 seconds, the young football players, aged from 13–14 years, performed an average of 45 jumps. Such load was not of remarkable influence on change of indices (Tables 3 and 4). Duration of squat (sec.) prior the load was 0.353 sec., after it – 0.365 sec (p > 0.005). Take-off duration was 0.245 sec. and 0.248 sec. (p > 0.005), flight phase duration – 0.496 sec. and 0.495 sec. (p > 0.005), body movement speed in take-off phase was 2.42 m/sec. and 2.43 m/sec.; jump duration – 0.850 sec. and 0.865 sec., squat speed – 1.005 m/sec. and 1.030 m/sec., squat depth – 0.191 m and 0.192 m did not experience change, too. Jump height was 0.307 m and 0.305 m, absolute force of take-off – 1529 N and 1544 N, average force – 1136 N and 1139 N, muscle reactivity – 21.626 Hz and 20.027 Hz.
N (p > 0.005). Similar results were of the performed work, absolute and relative power; this shows that football players are able to carry out training loads of similar character, lasting up to 30 sec., without experiencing fatigue. It is purposeful to carry out future investigations, exploring the fatigue of one legs muscles performing same number of jumps in the same time, establishing the muscle working recovery. This would be of use aiming at more precise modeling of similar trend training loads.

Football players of 13 to 14 years, moving in horizontal direction, reach the speed of 6.41 m/sec, while their speed moving in various directions fluctuates from 1.38 m/sec. to 2.43 m/sec. (Figure 1).

![Figure 1](image_url)

The least body movement speed is achieved when the athlete, moving horizontally, changes the direction of movement.

Football players', aged from 13 to 14 years, kinematic and kinetic indices of locomotion movement in various directions, as well as their anthropometric indices possess significant inter-correlation. This demonstrates the level of their sport movement and practical abilities for improvement of various movements and action in training sessions and competitions.

In this period of age, football players' height is in correlation with body mass (0.856**), with take-off from support maximum and average force (F) (0.693**, 0.774**), performed work (0.544*) and power (0.640**). Higher athletes possess a deeper squat (0.488*), thus prolonging body mass centre distance during the jump (0.466*).

Body mass is in correlation with body mass (0.821**), take-off speed (0.536*), maximum (0.742**) and average (0.921**) force, performed work (0.777**), absolute and relative power (0.845**, 0.510*), and running speed indices: 20 m (–0.563*), 30 m (–0.601**) and V m/sec (0.594**).

In this period of athletes' age, a very significant for them is BMI. It is in close correlation with majority of body movement indices, flight phase duration (0.498*), take-off speed (0.617**), total body mass centre lifting height (0.612**), jump height (0.519*), maximal (0.529*) and average force (0.794**), performed work (0.772**), absolute (0.772**) and relative power (0.529*), 20 m running (–0.555*), 30 m running (–0.602**), time of jumping in hexagon (–0.462*).
Squat duration in performing jump by both legs with a hand movement is in correlation with take-off duration (0.629**), jump duration (–0.903**), squat depth (–0.686**), maximal force (–0.645**).

![Figure 2. Take-off duration (dt) correlation](image)

Jump height (h) is in correlation with BMI (0.519*), flight phase duration (0.998**), body movement speed (0.795**), total body mass centre lifting height (0.596**), work (0.639**), absolute power (0.627**), relative power (0.697**), 10 m running (0.568*), 20 m running (–0.596**), 30 m running (–0.664**) and average 30 m running speed m/sec (0.668**), as well as with angular body movement time (sec.) (0.636**).

![Figure 3. Jump height (h) correlation](image)

Body movement speed V has correlation with majority of anthropometric and movement indices: body mass, BMI, flight phase duration, total body mass centre lifting height, jump height, average force, work, absolute and relative power, 10 m, 20 m, 30 m running results (Figure 4).
Figure 4. Body movement speed $v$ (m/sec.) correlation

Maximal and average force is in correlation with height ($0.693^{**}$, $0.747^{**}$), body mass ($0.742^{**}$, $0.921^{**}$), BMI ($0.529^*$, $0.794^{**}$), ds ($-0.645^{**}$), dt ($0.585^{**}$), dj ($0.634^{**}$), squat depth ($0.733^{**}$, $0.532^*$), total body mass centre lifting height ($-0.639^{**}$), work ($0.730^{**}$), power ($0.720^{**}$, $0.917^{**}$), relative power ($0.547^*$, $0.697^{**}$), 5 m running time ($0.463^*$), running speed m/sec. ($0.490^*$), 10 m running time ($-0.637^{**}$, $-0.488^*$), 20 m running time ($-0.720^{**}$, $-0.640^{**}$), 30 m running time ($-0.729^{**}$, $-0.642^{**}$), average 30 m running speed ($0.723^{**}$, $0.636^{**}$)(Figure 5).

Figure 5. Maximal force $F_{max}$ correlation
Reactivity is in correlation with squat speed (0.642**), squat depth (0.586**), angular jumping (0.617*).

Work has correlation ties with height (0.544*), body mass (0.777**), BMI (0.772**), flight phase duration (0.619*), jump height (0.639**), total body mass centre lifting height (0.940**), jump height (0.639**), Fav (0.730), absolute power (0.792**) and relative power (0.591**), 20 m running speed (−0.466*), 30 m running speed (−0.498), 30 m running speed (0.501*), angular jumping time (−0.558*).

It should be noted that body movement in hexagon and angular jumping time has weaker correlation with other indices. This fact testifies more difficult performance of such tests, as well as points out devoting more attention to training and use of such tests in training sessions.

The research results confirm existing wide practical possibilities in perfecting and improving young football players', aged form 13 to 14 years, moving in various directions abilities, using our presented tests, adequate to football game activity. Creation and evaluation of various special training programs and their practical effectiveness can be given evaluation according to the main indices of movement effectiveness, such as force, which is the main cause of moving, absolute, momentum speed, acceleration and power, ensuring advantage in space and time aspect.

**Discussion**

The results of our research confirm that sport movement of young football players (13 to 14 years old) is a complex and specific training system, which requires fast, mighty and precise learning of moving in various directions, as well as effective performance of it.

It was established that take-off force and duration are the main indices of locomotion moving. They determine momentum, absolute, average body movement speed in various directions, and its acceleration, as well as absolute and relative power. Change in these indices make preconditions for effective learning and performance of similar movement possessing a ball.
Our research confirms and supplements research data of similar trend, carried out on basketball players of various age (Radžiukynas 1997), as well as on track-and-field athletes (Žilinskienė 2008), handball and football players (Gražulis 2013).

Presumably, body movement in vertical direction speed of football players, aged from 13 to 14 years, as well as of basketball players of the same age, in future might increase from 2.42 m/sec. (established in this research) to 2.90 m/sec., at the age of 20–21. Take-off force index might increase from 1529 N till 1600 N, while the jump height – till 43–44 cm. These would be the main factors, making influence on the effectiveness of moving in various directions with or without a ball, and this is the relevant trend for future investigations.

The data of this and previous researches, carried out by us and other authors confirm that in other sport games (such as volleyball, basketball and other), sport locomotion movement of the athletes in various directions might be evaluated according to the same indices, the main ones being take-off force and duration, which are followed by optimal to each athlete squat duration, depth, speed, body movement speed, take-off and flight phase duration, absolute and relative power, and muscle reactivity. Integral expression of all those indices and their change ensure athletes’ possibilities to successfully move in space and time. Such research results might be the guidelines for changing and improving young athletes’ training systems, programs, impact of training load and its change, duration, content and forms of recovery after training sessions. Its implementation can be ensured by: 1) individual and purposeful group special educational tasks; 2) coach-athlete creative interaction; 3) knowledge on 13 to 14 years old athlete’s mechanical and biological movement possibilities.

Conclusions

It was established that young football players’ (13 to 14 years old) height mean is 168 cm, body mass – 55.58 kg, BMI – 19.58 c/u. Such anthropometric indices make favorable preconditions for abilities of moving in various directions. Their vertical body movement speed in standing take-off by both legs is 2.49 m/sec., in running 10 m they reach 5.31 m/sec., in 20 m – 6.04 m/sec., in 30 m – 6.41 m/sec., in jumping in hexagon – 1.38 m/sec, angular movement speed – 2.35 m/sec. Such movement in various directions speed makes preconditions to effectively move in various directions with a ball, too.

Football players, aged 13 to 14, have already reached appropriate physical condition level of legs muscles, which are the main to ensure the locomotion movement effectiveness. Performing intense vertical standing jumps by both legs, the average number of take-offs being 45 in 30 sec, the athletes do not experience fatigue. Take-off force, jump height and take-off duration indices do not remarkable change after such load, which means that in this period of age, more difficult trainings loads of similar character might be applied.

As demonstrated correlation analysis of significance of all movement directions kinematic and kinetic indices, the main indices for the most objective evaluation, prognosis and correction of football players’, aged 13 to 14 years, level and possibilities for movement in various directions, is BMI, take-off duration, flight phase duration and jump height, absolute force and relative power, as well as body movement speed. Change of these indices’ interrelation significance indicates peculiarities of athletes’ biological maturity, biometric indices change, purposefulness of training sessions, body functional systems adaptation to training loads, and serves as an effective methodic trend in improving young football players’ training.
References


KINESIO TAPING AND PATELLOFEMORAL PAIN SYNDROME: A SYSTEMATIC REVIEW

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Abstract. Patellofemoral pain syndrome occurs when there is a degeneration of the patellar cartilage between both bone surfaces of the femur and the patella. Its characteristic symptom is anterior knee pain that worsens when this joint is moved. The aim of the study was to determine the effectiveness of kinesio taping on patellofemoral pain syndrome through the analysis of published scientific studies up until June 2014. A literature search was carried out in the following electronic databases: Scopus, Sport Discus, PEDro, Cochrane Library Plus, Embase, Web of Science and Science Direct to locate studies that were relevant to this review. Out of 159 articles examined, after eliminating duplicates and upon completion of reading them, the review was finally reduced to 12 articles. After reviewing the literature regarding the effectiveness of kinesio taping on the improvement of knee pain, we concluded there is insufficient scientific evidence to support this theory. It is an inexpensive technique that can be combined with other therapies and has no side effects, but there is controversy in the analyzed studies on its possible benefits on the patellofemoral pain syndrome. For this reason, it is essential to carry out further methodologically sound research regarding the usefulness of kinesio taping in the treatment of this syndrome.

Key words: kinesio tape, elastic tape, chondromalacia patella, knee pain

Introduction

Patellofemoral pain syndrome (PFPS) or chondromalacia patella is a degeneration of the patellar cartilage existing between both bone surfaces of the femur and the patella. Its most important clinical symptom is characterized by anterior knee pain that is magnified when movements from flexion to extension are performed by the knee while the patella does not move smoothly within the trochlear groove (Dutton et al. 2014). There are several reasons that can cause this syndrome: a disalignment femoro-tibial, muscle weakness, patellar prior traumatic injury (fracture, dislocation), overuse of the joint, arthritis, etc. (Dutton et al. 2014; Freedman et al. 2014; Kase et al. 2003). The main objectives to rehabilitate this pathology will be to reduce the pain and improve the neuropropioceptive information (Mendez et al. 2014).
Different rehabilitation strategies like electrotherapy, exercise, cryotherapy, etc. can be used to achieve both objectives. However the present review will focus on the effectiveness of a specific treatment: the use of kinesio taping (KT). KT is a cotton tape with a layer of hypoallergenic adhesive which can elongate up to 140% of its original length. Its characteristics are similar to human skin and have several mechanisms of action such as: biomechanics, exteroceptive, circulatory, analgesic... (Brateanu 2009). KT lifts the skin forming convolutions, increases the blood and lymphatic circulation of the subdermal area where it is applied (Kase et al. 2003; Celiker et al. 2011; Bassett et al. 2010). This methodology of elastic tape is being increasingly used by trainers, osteopaths and physiotherapists around the world (Bandyopadhyay and Mahapatra 2012; Calero and Cañón 2012). However, there is still controversy about the effects of KT in the treatment of PFPS. Some studies which have been performed on PFPS found improvements in parameters such as muscle activity, functionality and especially on pain intensity (Campolo et al. 2013; Osorio et al. 2013; Montalvo et al. 2013; Chen et al. 2008; Chang et al. 2012; Yang et al. 2014). However, others do not achieve results that support such effectiveness (Aytar et al. 2011; Akbas et al. 2011; Mendez et al. 2014; Bayracki et al. 2008). Therefore, this systematic review was conducted to shed light on the effectiveness of KT. Consequently, the objectives of this review will be: To update data on the effectiveness of KT in the treatment of PFPS, provide possible guidelines for the application of KT on PFPS and promote future research on this issue.

Methods

Search strategy

The following seven electronic databases were searched from their inception through June 2014: Scopus, Cochrane Library Plus, Physiotherapy Evidence Database (PEDro), Sport Discus, Embase, Web of Science (all databases) and Science Direct. The search terms used were based on two concepts. Concept one included terms for the Kinesio tape (Kinesio* tap*, elastic tap*, neuro tap*, vendaje neuromuscular) and concept two included terms for patellofemoral syndrome (PFS) (Knee, chondromalacia, patell*, femoro-tibial). The terms of the same concept were combined together with the Boolean operator “OR” and then the two concepts were combined using the Boolean operator “AND” (Benito et al. 2007). The keywords that consisted of more than one word were enclosed in quotes. In addition, the reference lists of all included papers were manually searched.

Selection criteria

The selection criteria to identify studies that examined the effect of KT on the patellofemoral syndrome were: Clinical trials whose main objective was to evaluate the effect of KT treatment on anterior knee pain. In addition to papers, master/doctoral dissertations and conference proceedings were also accepted. No language or publication date restrictions were imposed.

The initial screening of papers was conducted from the title and summary of them. Finally with the selected studies, we proceeded to read the full texts. Names of the authors, years of publication, sample sizes, study variables, KT techniques applied and results of each study were extracted for this review.
Results

After the literature review, 12 relevant studies about the effectiveness of KT on PFPS were selected. The results that describe each study (Table 1) and most studied parameters are detailed below:

Table 1. Summary of selected studies

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Sample size</th>
<th>Outcomes</th>
<th>KT technique</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akbas et al. 2011</td>
<td>N = 31 F Age = 45 GC = 16 GE = 15</td>
<td>Pain intensity, Functionality, Flexibility, Patellar alignment</td>
<td>Common E for both Gs. GE: I-shaped KT over TFL from origin to insertion, Y-shaped KT over internal vastus, hamstrings and femoris rectus. The strip over femoris rectus surrounds patella with 50–75% tension.</td>
<td>To add KT to conventional treatment does not improve pain, but seems to improve hamstring flexibility.</td>
</tr>
<tr>
<td>Aytar et al. 2011</td>
<td>N = 20 M Age = 24 GE = 12 GP = 10</td>
<td>Muscle strength, joint range, static and dynamic balance, pain</td>
<td>GE: I-shaped KT over medialis and lateralis vastus from origin to insertion. A I-shaped strip over femoris rectus ending Y-shaped form to both sides of patella (hight tension). KT was applied without tension in the sham G.</td>
<td>KT did not work on the reduction of pain or on the proprioceptive sensation, but improved strength and balance.</td>
</tr>
<tr>
<td>Campolo et al. 2013</td>
<td>N = 20 Age = 24 – 3 15 F y 5 M</td>
<td>Knee pain climbing stairs Sore Knees doing squats with weight</td>
<td>One of Gs, a I-shaped KT strip was applied over femoris rectus (10% tension) ending Y-shaped form to both sides of patella (50–75% tension). Another G had the McConnell technique applied: rectangular tape over knee.</td>
<td>Both methods (KT y McConnell taping) reduce pain during functional activities (climbing stairs, for example) vs control.</td>
</tr>
<tr>
<td>Jancaitis et al. 2007</td>
<td>N = 14 Age = 25 ±8 8 F y 6 M GE GP</td>
<td>Pain during activities or at rest</td>
<td>No provided information.</td>
<td>KT did not improve pain and functionality in the KT G vs. Sham KT although there was improvement on pain when walking downstairs. The results were not significant.</td>
</tr>
<tr>
<td>Kuru et al. 2012</td>
<td>N = 30 26 F y 4 M Age = 32 ±12 1 = KT + E 2 = E” + E</td>
<td>Pain, joint and muscle range, functionality, life quality</td>
<td>I-shaped KT was applied over rectus femoris from origin to insertion ending Y-shaped over both sides of patella. The same application was carried out over the internal vastus.</td>
<td>KT and electrostimulation improve pain intensity, functionality, strength and quality of life. No differences between both Gs.</td>
</tr>
<tr>
<td>Osorio et al. 2012</td>
<td>N = 20 Age = 21 ±9 13 F 7 M</td>
<td>Strength Pain Isokinetic resistance</td>
<td>Taping McConnell: A KT strip over knee and a leukotape strip over internal side of patella. Taping Spider: A previously cut strip on inferior pole of patella and two Y-shaped strips surrounding patella with tension.</td>
<td>KT improves PFPS but no differences were found between the KT techniques applied.</td>
</tr>
<tr>
<td>Chen et al. 2008.</td>
<td>GE = 15 F Diagnosed with PFPS GC = 10 healthy F</td>
<td>Reaction force, EMG activity of medialis and lateralis vastus</td>
<td>KT over medialis and lateralis vastus according to Kase manual. Evaluation of different Gs to walk up and down stairs: KT G, CG, sham G.</td>
<td>KT can reduce pain and improve activity of certain muscles that stabilize the patella</td>
</tr>
<tr>
<td>Bayrakci et al. 2008.</td>
<td>15 F diagnosed with PFPS 15 healthy F Age = 44</td>
<td>Go and up test, 10 m walking test, down and up stair test</td>
<td>Both Gs had the McConnell taping technique applied and patellar KT</td>
<td>There was positive effect of KT on healthy subjects but not in patients diagnosed with PFPS.</td>
</tr>
<tr>
<td>Chang et al. 2012.</td>
<td>N = 15 Age = 23</td>
<td>Pain Strength EMG activity</td>
<td>KT was applied over lateralis and medius vastus of quadriceps but patients were asked prior to flex their knee.</td>
<td>Pain was reduced significantly and increased maximal isometric contraction. KT applied around the knee improves functionality.</td>
</tr>
</tbody>
</table>
Effect of KT on Pain

Some studies found reduced pain in the experimental group (EG) after applying KT compared with the control group (CG) (Chen et al. 2008). Others found no difference between the KT and other types of taping (Campolo et al. 2013; Kuru et al. 2012; Osorio et al. 2013). Finally, there were studies in which the KT had no effect on pain (Akbas et al. 2011; Aytar et al. 2011).

Effect of KT on muscle activity

On the other hand, some studies found an increase in muscle activity of the lower limb (mainly quadriceps) in the EG after applying KT compared to CG (Aytar et al. 2011; Yang et al. 2014; Chen et al. 2008). Others, however, found no difference between the KT and other therapies for muscle stimulation (Kuru et al. 2012) or between other types of taping (Osorio et al. 2013).

Additionally, other parameters were also studied: Akbas et al. (2011) observed an improvement in the flexibility of certain muscle groups (hamstrings and tensor fascia lata) at 6 weeks after applying KT compared with the control group; another studied parameter was the patellar alignment in which Akbas et al. (2011) found no differences between the control and KT group, conversely Chen reported that KT encouraged a previous activation of quadriceps muscles and a patellar alignment in the trochlear groove. Another studied parameter was balance; in this case the author Aytar et al. (2011) found an improvement in static balance after applying KT.

Discussion

Aytar et al. (2011) carried out a study on 20 patients diagnosed with PFPS in order to analyse the short-term effects of KT on pain. The application of KT did not decrease pain intensity nor did it influence the proprioceptive sense of the patients. However, there was a reported increase in quadriceps strength 45 minutes after KT application. Along the same lines, Akbas et al. (2011) compared two groups that did the same type of strengthening and flexibility exercises for lower limbs, but differed in that one group had KT applied and the other did not. At the end of the study it was demonstrated that KT did not decrease pain nor did it improve functionality. Campolo et al. (2013)
found a beneficial effect of KT in patients diagnosed with PFPS in functional activities such as climbing stairs or standing up from a sitting position. However Jancaitis et al. (2007) observed that after applying KT on patients with PFPS, they could walk down stairs better than before; however, these results were not statistically significant, so it was concluded that KT could have had a placebo effect.

Kuru et al. (2012) conducted a comparative study to show which of the two treatments (KT or electrostimulation) reported greater improvements on PFPS. 30 patients were separated into two groups: one of the groups had KT applied and were given knee exercises and the other had electrostimulation applied and had to perform exercises. Sessions were individual and lasted for 45 to 50 minutes, 3-times a week for 6 weeks. Patients were asked to do exercises at home on non-treatment days. These were strengthening exercises (Quadiceps muscle isometric contraction) and stretching exercises of quadiceps, hamstring, gastrocnemius and iliotibial muscles. There were improvements in both groups on pain and muscle activity. In addition, Yang et al. (2014) achieved an increase in muscle activity in the rectus femoris, hamstrings and tibialis anterior after KT application.

In a study by Osorio et al. (2013) on 20 patients with active PFPS it was observed how KT improved perceived pain. Osorio noted a decrease in pain after applying both Spider and McConnel techniques versus the baseline; however there was a greater decrease in pain after applying the Spider technique. It is assumed that the reason for this difference is because the latter type of bandage (Spider) covers a larger area on the knee than the McConnel technique. Moreover, Osorio et al. (2013) noticed an increase in isokinetic quadriceps strength after applying both Spider & McConnel techniques compared to the baseline, but found no difference between the two.

Chen et al. (2008) demonstrated the effectiveness of KT, which improved patellar pain and stability in 15 women diagnosed with PFPS compared with a control group of 10 healthy women; it was thought that the quadricep muscle was activated earlier in the KT group than in the no tape group, in addition there were no differences found between the placebo and the no tape group. Finally, Chen et al. (2008) also found a decrease in pain after application of KT.

On the other hand, Bayracki et al. (2008) obtained improvement on the physical condition of healthy subjects but not on patients with PFPS after using KT. Chang et al. (2012) wanted to analyse the effect of KT on muscle activity of the vastus medialis and lateral quadriceps and on pain in patients with patellar pain. The results obtained on 15 patients were positive regarding these two parameters, and therefore it was concluded that KT applied around the patella improved the functionality of the femoro-patellar joint. In the same vein, other authors agree with these results (Hassan et al. 2002; Yang et al. 2014; Chen et al. 2012).

Miller et al. (2013) applied KT on the gluteus medius; this was combined with lumbo-pelvic osteopathic manipulation on 18 patients with unilateral patellar pain, who obtained improvement over postural stability of the lower limbs.

To sum up, from the results mentioned above it can be concluded that there is a discrepancy regarding the effectiveness of KT on the treatment of anterior knee pain; some studies show statistically significant improvement in the pain variable after applying KT and others are inconclusive.

In certain studies, KT seems to influence other variables other than pain such as: muscle flexibility, muscle strength, balance, joint stability, functionality and quality of life (Akbas et al. 2011; Aytar et al. 2011; Kuru et al. 2012; Chang et al. 2012).

On the other hand, there is a more or less homogenous protocol on how to apply the KT bandage for the treatment of PFPS.
An I-strip is applied on the rectus femoris from its origin to its insertion with 10% stretch applied (muscular facilitation mode) ending in a Y-shape on either side of patella with 50–75% tension, while maintaining a slight knee flexion at 30 degrees. Finally, the ends of the bandage are applied with no tension. This technique is explained in greater detail by Campolo et al. (2013) (Figure 1). (Aytar et al. 2011; Kuru et al. 2012).

This protocol of KT differs from the explained protocol by Kase et al. (2003), who reports three different options for the treatment of PFPS:

– One protocol consists in applying an I-strip over one side of the patella with 50–57% tension to make a mechanical correction.

– In the second option a Y-shaped strip is applied transversely from the internal side of the knee, passing a strip of bandage with 50% stretch applied over the upper pole of the patella and the other strip below the lower pole, without applying tension on the ends of the tape.

– Finally, the third option is similar to that described above, but is performed from the lateral side of the knee.

– These three techniques can be combined with an optional bandage that would go from origin to insertion over the vastus medialis to stimulate muscle activity, or insertion to origin to inhibit its activity (Kase et al. 2003).

KT in addition has benefits not only on the knee pain caused by PFPS. Osterhues (2004), in a study of a case of patellar dislocation, observed that using KT had improved quadriceps muscle activity and joint stability during functional activities. Chang-Mo et al. (2011) in another study on 19 subjects with an average age of 65 diagnosed with degenerative osteoarthritis of the knee, obtained positive outcomes with KT on measured parameters (pain, joint range and muscle strength) in the group treated with KT. In a similar vein, other authors have also verified in their studies the beneficial effects of KT on knee osteoarthritis (Hinman et al. 2003; Hassan et al. 2002; Chen et al. 2012; Quilty et al. 2003). By contrast, there are other knee pathologies where the utility of KT is not well defined. For example, Smith et al. (2013), in a meta-analysis they designed, considered KT a nonsurgical treatment for patellar dislocations, but concluded that its clinical effectiveness was not yet clear.

Figure 1. KT for the treatment of PFPS
Limitations of the studies: Gender, age and size of the samples, the variability in the number of sessions applied, different types of therapies that were applied with KT, different modes of application of KT for the same diagnosis... All of these factors made it difficult to determine the effect of KT.

After reviewing the literature on the effectiveness of KT on PFPS it was concluded that KT seems to improve knee pain in clinical practice, but there is insufficient scientific evidence to verify this theory. That is why we stress the importance of conducting more methodologically sound studies to clarify some questions that exist among health professionals about the scientific evidence of the effect of KT on PFPS (Mendez et al. 2014; Montalvo et al. 2013; Mostafavifar et al. 2012).

In conclusion KT is a novel therapeutic tool that can be used alone or in combination with other therapies. However, there is much controversy over its effectiveness in this clinical symptomatology. For this reason it is essential to conduct methodologically sound trials to prove the usefulness of KT in the treatment of PFPS.

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References


THE CONCEPT OF TREATMENT OF SCOLIOSES EMPLOYING ASYMMETRICAL AQUATIC EXERCISES

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Abstract. According to the statistical data, there is being observed a definite increase in percentage of children affected by posture defects, particularly scolioses. The aquatic environment facilitates treatment of scolioses, since it provides relief conditions used in order to perform prophylactic, corrective and therapeutic tasks. Hydrokinetic therapy is one of the many rehabilitation methods. It seems, however, that corrective and therapeutic swimming is far too rarely used as an auxiliary measure for treatment of scolioses. This paper presents the concept of treatment of scolioses employing asymmetrical exercises in aquatic environment, the author of which in Poland is Iwanowski. In the study desk research of literature studies was applied along with the analysis of publications, including available study reports, articles, documents and also own video and photographic materials. The author suggests the concept of conservative treatment of scolioses through the application of asymmetrical swimming exercises in aquatic environment. Such procedure is efficient in preventing significant spinal deformations, which may protect against surgical intervention.

Key words: corrective and therapeutic swimming, asymmetric swimming exercises, hydrokinetic therapy, rehabilitation in water, scolioses

Introduction

The results of studies, carried out in different regions of the country, regarding evaluation of body posture found significant percentages (from 32.5 to 93.2%) of children and youth with apparent abnormalities within the scope of motor organ and body statics (Janiszewska et al. 2009; Łubkowska 2003, 2012; Maciałczyk-Paprocka et al. 2011, 2012; Mrozkowiak 2007; Stoliński and Kotwicki 2011; Żukowska 2012; Żukowska et al. 2014).

Advanced scolioses, which in Poland are also called lateral spinal distortions, are particularly hazardous to health. The incidence of this dysfunction amounts to 4–18% of the general population, depending on a source (Grudzień 2012). In children and youth the most numerous group of scolioses are the so-called idiopathic scolioses, without determined etiology – 80–90% (Kasperczyk 2002; Schleip et al. 2005, 2007; Szulc 2011). It is probable that there exists a relation between distortions in proprioception and development of scolioses (Keesen et al. 1992). The
studies carried out by the team of Łubkowska et al. (2000) and Łubkowska and Troszczyński (2011), regarding the scope of the shape of posterior and anterior curvatures of the spine in children and youth demonstrated that they may be a symptomatic element in diagnosing scolioses. When planning physiotherapy sessions for children with idiopathic scoliosis (IS) the spine mobility should be systematically evaluated (Łubkowska et al. 2014). Any symptoms of body posture asymmetry should not be underestimated by treating them as manifestations of individual variation (Zeyland-Malawka and Prętkiewicz-Abajcew 2006). The team of Łubkowska et al. (2002) considered detecting asymmetry symptoms and striving to eliminate them the appropriate course of action. The team of Czaprowski et al. (2011) demonstrated that the excessive spinal mobility appears more often in children with idiopathic scoliosis (51.4%) than in healthy children (19%). Using one arm (right or left) predominantly is detrimental from the point of view of the body functions (Zeyland-Malawka and Prętkiewicz-Abajcew 2006), and Starosta (1993, 2012) sees a symmetrization of movements as a measure preventing spinal deformation and injuries in sports. Diagnosing asymmetry is not time-consuming and is based on tests that are easy to carry out. They can be carried out by means of a Bunnel’s scoliometer (Kotwicki 2008, 2011), the presence of which in each primary school would be a valuable objective of the health policy (Stoliński and Kotwicki 2011). In the United States and Europe this device is used for screening tests in kindergartens and schools (Kotwicki 2011).

In the reference books regarding conservative treatment of scolioses exercises that stabilize scoliosis and active triplanar self-correction exercises carried out in functional positions with the use of proprioceptive stimulation and biofeedback dominate. The possibilities of using manual therapy in treatment of scoliosis are demonstrated. The studies conducted by Białek (2011) and Białek and M’hango (2008) showed a significant reduction in scoliosis angle within a very short period as a result of manual therapy, post-isometric exercises for relaxation of cramped muscles and strength training of weakened muscles. The advantages of Active Movement Participation (AMP) during manual myofascial release within the scope of chest (Schleip 2003) are also underlined. Balls and elastic tapes (Schleip et al. 2005, 2007), triplanar scoliosis correction device (Harężlak 2005) and scoliosis self-correction device with pelottes (Rusin et al. 2007) are employed.

An alternative for children and youth with idiopathic scoliosis is corrective and therapeutic swimming and corrective swimming exercises that take place in relief conditions thanks to the properties of the aquatic environment (Łubkowska et al. 2014) and constitute a method for relaxing muscles (Starosta 2012).

Despite the variety of methods and differences in the therapeutic procedure, the treatment of scolioses is still one of the main problems of physiotherapists, rehabilitation therapists, physical education teachers and corrective gymnastics teachers. Harężlak and Ślężyński (2009) are of the opinion that, unfortunately, it happens too often that the inefficiency of corrective actions is explained by idiopathic nature of distortions. The more likely cause of lack of corrective effects should rather be sought within the methodology adopted and sometimes also in insufficient abilities to apply it.

Depending on the views on the complex process of changes that accompany scolioses, either symmetrical exercises or asymmetrical exercises exclusively are preferred. As Grudzień (2012) rightfully notes, the current knowledge on the pathomechanics of scolioses speaks clearly in favour of asymmetrical exercises. The asymmetrical therapy conducted by the author slowed down the progression of scolioses. Additionally, an earlier view suggesting that a strong muscular corset provides protection against progression of distortions and results in correction of it has not been confirmed either scientifically or empirically (Grudzień 2012). Irrespective of these disputes, most of the experts in the field do not question the necessity of concurrent triplanar correction of scolioses.
This paper presents the concept of treatment of scolioses employing asymmetrical exercises in aquatic environment. The aim of this elaboration is the attempt to evaluate the significance of asymmetrical swimming exercises as a factor forming the posture of children and youth with lateral dystonic distortion of the spine. Additionally, selected corrective and therapeutic exercises in aquatic environment with application of various forms of swimming are presented. In the study desk research of literature studies was applied along with the analysis of publications, including available study reports, articles, documents and also own video and photographic materials.

The concept of asymmetrical swimming exercises

The corrective and therapeutic swimming in cases of scolioses with application of asymmetric swimming exercises was suggested for the first time in Poland by Iwanowski (1997). In hydrokinetic therapy of scolioses, in asymmetrical exercises the correction is achieved by appropriate asymmetrical positioning of the body and diagonal positioning of the lines of shoulders and hips. This concept requires individual selection of corrective, hypercorrective and isolated output positions. They enable a triplanar influence. The basis for rational corrective actions is an inquisitive analysis of each case. The influence on the spine takes place through asymmetrical mobilization of muscular, ligamental and fascial structures on the concave side of the distortion and relaxation of structures and derotation of the convex side. This method is included among difficult treatment methods since it requires high qualifications of the person conducting the sessions.

Asymmetric swimming should not be applied:
- in multiple curve scolioses;
- in double curve scolioses with short curves located close to each other;
- in scoliosis with small curve arc (Iwanowski 1997).

Static scheme of Rubcowa

In order to analyze the influence of asymmetrical swimming exercises on lateral distortions of the spine, Iwanowski (1997) used the static scheme of Rubcowa, determining static changes in standing position, depending on the positioning of the shoulder line and hip line. It is characterized by the following:

- the spine maintains a vertical straight line during symmetrical parallel positioning of the shoulder line and hip line;
- with diagonal position of the shoulder line the spine bends in the thoracic section in the direction of the raised shoulder;
- with diagonal position of the hip line bending of the spine in the lumbar section takes place, with its bulge directed towards the lowered hip.

![Figure 1. The static scheme specifying spinal changes depending on the positioning of the shoulder and hip lines](image)
This scheme can be used for planning corrective exercises for particular cases of scoliosis. In the aquatic environment, particularly in the lying position, the spine behaves slightly differently. Iwanowski (1997) underlines that e.g. in swimming exercises only the maximum pull-up of a lower extremity results in change to the line of the lumbar section, in contrast to the standing position where each change in the hip line results in the spine bending in the frontal plane.

Making such assumptions and analyzing them in practice, Iwanowski (1997) found that:

a) in a single curve thoracic scoliosis what has a decisive influence on the distortion correction is the position of shoulders, which is controlled by proper arrangement of upper extremities (top-down control). Extending an arm on the concave side of the distortion forwards and upwards and bringing the arm close to the body on the convex side results in maximum reduction of the distortion. The legs should be straightened and joined, which guarantees an even positioning of the hip line (Figure 2a);

b) in a single curve lumbar scoliosis it is the arrangement of lower extremities that decides on the distortion correction (bottom-up control). The leg on the convex side of the distortion should be bent in the hip joint and knee joint, and the leg on the concave side should be straightened. The arrangement of arms should ensure an even positioning of shoulders - the arms should be straightened and stretched to the front (Figure 2b);

c) in a single curve thoracic-lumbar scoliosis the correction depends on diagonal positioning of the shoulder line and hip line, so the arrangement of both arms and legs. On the convex side the arm should be placed along the torso and the leg should be bent in the hip and knee joints, while on the concave side both the arm and leg should be straightened and extended (Figure 2c);

d) in a double-curve thoracic-lumbar scoliosis the corrections are also achieved by asymmetric positioning of the shoulders and hip lines. A corrective position in such case is the sum of arrangements of extremities in a single curve thoracic scoliosis and single curve lumbar scoliosis, so the arm is straightened and extended on the concave side of distortion and the arm on the convex side of the thoracic distortion the arm remains along the torso. As for the legs, the one on the convex side of the lumbar distortion should be bent and the one on the concave side should be straightened (Figure 2d).

Figure 2. Positions of the shoulder and hip lines and movement of extremities recommended for correction in case of: a) single curve thoracic right-sided scoliosis, b) single curve right-sided lumbar scoliosis, c) single curve thoracic-lumbar left-sided scoliosis, d) double curve thoracic-lumbar left-sided scoliosis
Figure 3. Example of the effect of exercising on a single curve thoracic-lumbar right-sided scoliosis. As a result of movement of extremities, the spine bent to the left. Output position: prone position, the arm on the concave side of distortion is straightened along the long axis of the torso, while the other arm is moving like in breaststroke, the leg on the concave side does not move and the leg on the convex side of the distortion moves like in breaststroke.

Source: author’s own materials. Corrective swimming classes with students of the physical education major at the Physical Education and Health Promotion Faculty of the University of Szczecin.

Figure 4. Example of the exercise for a single curve lumbar right-sided scoliosis. Output position: prone position, the arms move like in breaststroke, legs: right leg moves like in breaststroke, left one with a flipper is still

Source: author’s own materials. Corrective swimming classes with students of the physical education major at the Physical Education and Health Promotion Faculty of the University of Szczecin.
Figure 5. Example of the exercise for a single curve lumbar left-sided scoliosis. Output position: prone position, both arms are still, both legs oscillate like in crawl on the chest – a flipper is worn on the leg on the convex side of the distortion.

Figure 6. Example of the exercise for a single curve thoracic left-sided scoliosis. Output position: prone position, the arm on the concave side of distortion is extended along the long axis of the body, the other arm is close to the torso, legs are oscillating.

Figure 7. Example of the exercise for a single curve thoracic right-sided scoliosis. Output position: prone position, the arm on the concave side of distortion is extended along the long axis of the body, the other arm moves like in breaststroke, legs are oscillating.

Figure 8. Example of the exercise for a single curve thoracic-lumbar left-sided scoliosis. Output position: prone position, the arm on the concave side of distortion is extended along the long axis of the body, the other arm is close to the torso, legs are oscillating - a flipper is worn on the leg on the convex side of distortion.

Figure 9. Example of the exercise for a double curve thoracic-lumbar right-sided scoliosis. Output position: prone position, the arm on the concave side of distortion is with board and is straightened along the long axis of the body, while the other arm is moving like in breaststroke, the leg on the convex side is straightened and the other moves like in breaststroke.
The Application of Asymmetrical Aquatic Exercises in Treatment of Scolioses

Discussion

The issue of posture defects, including scolioses, is still valid. The use of aquatic environment as one of the forms of supplementation of treatment procedure is well known. The relief provided by the aquatic environment causes the muscles to relax, which facilitates maintaining correct posture (Barczyk et al. 2005, 2009; Barczyk-Pawełec et al. 2012; Bulicz and Murawow 2004; Deskur and Zawadzki 2006; Iwanowski 1997; Łubkowska et al. 2014; Naal et al. 2007; Nonn-Wasztan et al. 2011; Nonn-Wasztan 2012; Ozer et al. 2007; Pasek et al. 2009; Radzimińska et al. 2013; Rożek et al. 2005; Rusin et al. 2007; Różański and Dorosz 2002; Sefańska and Zawadzka 2006; Stefańska et al. 2008; Tuzinek 2004; Weber-Nowakowska et al. 2011). The spasticity is reduced and thus it is possible to make movements within a larger painless scope, which would be difficult to achieve in the conditions of a gymnasium (Pasek et al. 2009; Radzimińska et al. 2013).

As a result of many years of research and investigation, Iwanowski (1997) confirmed the therapeutic influence of aquatic environment and the efficiency of asymmetrical swimming exercises for treatment of scolioses. In the experiment conducted, he discovered, on the basis of radiological examinations, that the progress of distortion was halted in 80% of children examined, with the group that noted improvement having average reduction of distortion angle by 8.45° and the group that did not note any changes – by 1.24°. The experiment encompassed all the therapy stages (1st, 2nd and 3rd), according to the methodology of hydrokinetic therapy procedure suggested by Iwanowski (1997). The average length swum during the whole experiment for the people who achieved improvement amounted to 137 800 meters, which gives on average 880 metres swum during a single hour of classes (total amount of swimming hours – 156.5). The therapy applied showed that the thoracic-lumbar and thoracic scolioses respond best to correction.

Until now, there have been no analytic studies within that scope in the literature that could be used for comparing the study results obtained. In the Roman Liszka School Corrective and Compensatory Gymnastics Centre in Bielsko Biała, asymmetrical exercises conducted in aquatic environment are applied as a supplementation of the applied concept of asymmetrical exercises for correction of lateral spinal distortions (Rusin et al. 2007). It includes exercises on a triplanar scoliosis corrector, lumbar section scoliosis corrector and asymmetric equipment-free exercises. The cyclic clinical and radiologic examinations of about a thousand permanent participants of corrective classes within the age range from 7 to 19 in the Centre showed a large percentage of improvements and stabilizations of spinal distortions (Harężlak and Śleżyński 2009).

Deskur and Zawadzki (2002) suggested a corrective aquatic procedure program scheme taking into account examinations of body posture and corrective exercises in a hall conducted simultaneously with aquatic classes. The same authors (Deskur and Zawadzki 2006) demonstrated a positive impact of corrective aquatic exercises on lateral spinal distortions in 40% of children examined. The program of corrective aquatic exercises encompassed asymmetrical breathing exercises. Within the framework of the program presented, the corrective aquatic exercises conducted allowed to obtain a reduction in spinal distortion and approximation of distortions of particular spinal sections in the sagittal plane down to physiological values in children with body posture defects and lateral spinal distortions. The changes in transverse plane receded. Selected organizational issues within the framework of corrective exercises and corrective swimming in case of scolioses in school-age children were presented by Wiażewicz and Zawadzki (2014).
Conclusions

The concept of application of asymmetrical swimming exercises in aquatic environment has two aspects of influence – therapeutic and prophylactic. Such procedure is efficient in preventing significant spinal deformation, which may protect against surgical intervention, constituting a conservative treatment for scolioses.

However, asymmetrical swimming exercises are employed far too rarely as a supplementary measure in treatment of scolioses, in spite of the fact that the aquatic environment facilitates the therapy of these ailments, enabling various types of swimming movements and combinations of exercise movements.

References


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DEPENDENCE OF AEROBIC PERFORMANCE OF ATHLETES ON POLYMORPHISM OF GENES

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Abstract. The adaptation of an athlete to systematic physical exercise has been shown to be determined by a combination of great many genes. The aim of our study was to investigate the dependence of the aerobic capacity parameters in sport on the set of gene polymorphisms. Cardio-respiratory system (CRS) adaptation reactions to exercise of 72 endurance athletes were assessed using the gas analysis. The analysis of the obtained results has shown both single and combined effect of the gene polymorphisms on the aerobic capacity. The impact of 6 polymorphisms on the aerobic performance level was analyzed: T→C polymorphism of the promoter of eNOS gene as well as ACE I/D polymorphism, Pro/Ala polymorphism of PPARG gene, G/C polymorphism of PPARα gene, Pro582Ser polymorphism of HiFIα gene, and Ala203Pro polymorphism of PPARGC1B. It was found that a single impact on the $HR_{max}$ providing ACE I/D polymorphism. Individual influence of ACE gene accounts for 2% of this index dissipation. Results showed that there is a dependence between the amount the maximum volume of consumed oxygen ($VO_{2max}$) from the set of gene polymorphisms. Cumulative impact of these polymorphisms in the combination with the individual parameters (gender; qualification; kind of sport) stipulates 71% of dispersion of $VO_{2max}$ value.

Key words: sport selection, molecular-genetic markers, aerobic performance, gene polymorphisms

Introduction

Introduction The current level of sports results reaches the limits of physiological capabilities of a human. World record results can be attained only when the individual sports abilities are combined with the correctly managed pedagogical process, which, in its turn, puts forward the process of the search of the genetically gifted athletes (Platonov 2005).
In kind of sports, where competitive activities are mainly based on aerobic mechanisms of ATP synthesis, sports results depend on the physical aerobic capacities, the measure of which is the scope, intensity, and maximum period of time required for work performance (Mishchenko and Suchanowsky 2010).

The generally accepted criterion for assessment of cardiorespiratory system productivity (CRS) and maximum aerobic performance of the organism applicable for assessment of the level of athletes physical capabilities is the amount of maximum consumed O₂ (VO₂ max). Direct or indirect dependence of sports results on the type of aerobic metabolism and maximum aerobic energy capacity is typical for the majority of kinds of sports, so, in assessing the level of functional capacities of the athletes’ organism testing of the maximum aerobic performance is of major importance. The general element of tests intended to determine maximum aerobic capacity is based on the necessity to attain the level of O₂ consumption under physical loads with the incrementally growing intensity lasting for 12–16 minutes till the moment when the maximum VO₂ max is achieved.

Dependence of a person’s aerobic capacity level on the hereditary traits was discovered in the 70–80s of the last century. The adaptation of an athlete to systematic physical exercise has been shown to depend on an individual’s inherited properties (Bouchard et al. 1999). These properties are determined by a combination of great many genes polymorphisms (Williams and Folland 2008; Bray et al. 2009; Timmons et al. 2010).

Rapid progress in the development of methods for the molecular genetics in sports for the last 12 years allows us to identify the genotype of a person with high aerobic performance (Rankinen et al. 2010). Recent research helped to find out that the increase in VO₂ max in the course of a 20-week training program by 47% depends on the hereditary traits (Bouchard et al. 2010). Based on the today’s knowledge, aerobic capacities are determined by the combination of a great number of gene polymorphisms. As of today, the genetic map of physical activity of a person contains more than 200 genes, polymorphisms of which are associated with the development and demonstration of physical qualities, as well as small morpho-functional and biochemical characteristics that change under various physical loads (Bray et al. 2009). By today, there is no exact answer to the question as to the number of polymorphisms that have direct effect on demonstration of stamina under intensive physical loads and on aerobic performance of athletes and that are required for diagnostics of aerobic capacity of athletes. A number of authors suggests that the model containing 11 polymorphisms that account for 23% of differences in the growth of VO₂ max demonstrated by volunteers subjected to endurance training (Timmons et al. 2010). Research conducted under the program “Heritage Family Study” has revealed that 39 polymorphisms are associated with the growth of VO₂ max, 21 of which account for 49% maximum oxygen consumption variability in the course of the training process (Bouchard et al. 2010). People who had 9 favorable allels of VO₂ max polymorphisms have improved by 221 ml∙min⁻¹, and in case of people who had more than 19 favorable allels, the growth of maximum oxygen consumed had an average value of 604 ml∙min⁻¹.

The conducted analysis of scientific reference literature has allowed the following polymorphisms be attributed to genetic markers that determined aerobic capacity of athletes: the angiotensin I-converting enzyme (ACE) insertion/deletion (I/D) gene polymorphisms (Puthucheary et al. 2011), T-786C gene polymorphism of endothelial NO-synthase (eNOS) (Gómez-Gallego et al. 2009), Pro/Ala gene polymorphism of the peroxisome proliferator-activated receptor γ (PPARG) (Ahmetov et al.2009), intron7 G/C polymorphism of the peroxisome proliferator-activated receptor α gene (PPARA) (Ahmetov et al. 2006; Eynon et al. 2010), Pro582Ser (C/T) gene polymorphism of the hypoxia- inducible factor-1α (HIF1A) (Döring et al. 2010), Ala203Pro gene polymorphism of the peroxisome
proliferator-activated receptor gamma coactivator 1β (PPARG1B) (Ahmetov et al. 2009). There is a need for elaboration of recommendations on usage of molecular and genetic markers in particular sports. In our research we investigated the dependence of the aerobic capacity parameters in sport on the gene polymorphisms. The impact of 6 polymorphisms on the aerobic performance level was analyzed. Cumulative impact of these polymorphisms in the combination with the individual parameters (gender; qualification; kind of sport) stipulates 71% of dispersion of VO2max value.

Methods

Maximal oxygen consumption of 72 endurance athletes was determined. There were 23 athletes classified as “elite”, 33 athletes were classified as “sub-elite”, 16 athletes were classified as “non-elite”.

This study was pre-approved by the Ukrainian National Academy Of Sciences Bogomoletz Institute of Physiology Biomedical Ethics Committee, Kiev, Ukraine, and all subjects were fully informed of the risk and benefits involved in participation before providing their written consent to participate.

Experimental base of the laboratory for “Theories and methodics of sport preparation and reserve capacities of athletes” of the NDI NUFVSU was used to study indicators of athlete's physical capabilities and reaction of the cardiorespiratory system (CRS), the degree of acidimetric shifts under boundary (maximum) and standard physical loads that allow to determine aerobic capacity of an organism.

Endurance of aerobic mechanisms of energy supply for physical exercises was characterized by the maximum aerobic endurance - maximum level of oxygen consumption (VO2max) and capacity of loading (Wmax) under test loads with incremental endurance lasting for 14–20 minutes till the moment of “refusal to work”, as well as intensity of loading at the level of anaerobic threshold (Wthr). Treadmill “Laufband” (Germany) and rowing ergometer Concept – II (USA) were used for loading. Tests were conducted after one day of rest by applying a standard dietary pattern and water-intake regime. Athletes were informed on the test program and gave their permission to conduct such tests.

Nonstop measurements of gas exchange and CRS reaction to physical loads were conducted on a real time basis (breath by breath) by applying the ergospirometric complex “MetaMax3B” (Cortex, Germany). Lung ventilation (VE), respiratory frequency (f1), respiratory capacity (V1), concentration of CO2 and O2 in expiratory (FE O2, FE CO2) and alveolar air (FA O2, FA CO2), O2 (VO2), CO2 generation (VCO2), gas exchange ratio (RQ = VCO2/VO2), ventilation equivalents for O2 (EQO2 = VE/VO2⁻¹) and for CO2 (EQCO2 = VE/VCO2⁻¹), oxygen pulse (O2-pulse = VO2/HR). Taking into account the fact that measurements were taken in the open system, external respiration indices were reduced to BTPS conditions, and gas exchange – to STPD conditions. Registration of exercise heart rate (HR, beats per minute⁻¹) was conducted by applying “Sport Tester Polar” (Finland).

DNA preparation and SNP analysis. Genomic DNA was isolated from oral epithelial cells following a standard protocol according to the manufactures instructions (Diatom™ DNA Prep (Bikom, Russia)). The T−786→C polymorphism of the promoter of eNOS gene as well as I/D polymorphism of ACE gene, Pro/Ala polymorphism of PPARG gene, G/C polymorphism of PPARA gene, Pro582Ser polymorphism of HIF1α gene, and Ala203Pro polymorphism of PPARG1B gene were identified using the method of polymerase chain reaction (PCR), with a subsequent analysis of the restriction length fragments.

Statistical analysis of research results was carried out by applying the SPSS ver.17.0 software package.
Data regarding gas exchange indexes were analyzed for normal distribution with the help of Shapiro-Wilk test. Homogeneity of variances were analyzed with Levine test with the following application of analysis of variance (ANOVA). In case of heterogeneity Brown-Forsythe test was used instead.

To discover functional links between polymorphisms of genes and gas analysis indices, multiple regression analysis method was applied with the resulting linear polynomial curve models with regard to independent parameters.

Results

Influence of 6 polymorphisms on the level of aerobic performance was analyzed with the resulting linear polynomial curve models with regard to independent parameters.

Analysis of the structure of the constructed regression equations by taking into account the models multicollinearity allows to make the following conclusions. Model that determines amounts of VO$_2$max in terms of the body weight depending on polymorphisms of genes-candidates is composed of 17 regressors. The dissipation rate that is explained by this model equals 0.71. Statistically significant influence on the level of VO$_2$max depends on the athletes’ gender (23.36%) and kind of sports (15.76%).

The above facts are well-known in muscular activity physiology and are easily explainable. The remaining 60.9% are contributed by factors that are represented by the variety of gene polymorphisms combination.

Presence of T/T genotype with regard to T/C polymorphisms of eNOS genes in combination with high qualification of a sportsman results in high values of VO$_2$max.

Combinations of polymorphisms of PPARA and PPARG, ACE and PPARA genes explain the same degree of index value dissipation (≈6%). Individual influence of ACE gene accounts for 2% of this index dissipation.

To avoid the influence of gender, kind of sports, and sporting qualification factors on the CRS reaction characteristics under physical loads, groups of athletes belonging to the same gender (feminine) and the same event (rowing), as well as of the same age and the same sporting qualification (sub-elite) were formed. These sportswomen were subjected to multiple tests (from 6 to 14 times each) in the course of three years. As a result of such selection, this group demonstrated frequent changes in gene polymorphisms occurrence. The selection became homogeneous with reference to polymorphisms of PPARG, PPARA, and PPARGC1B genes. Based on examination results, regressives model was constructed and it demonstrates the relation between polymorphisms of genes and the level of VO$_2$max. The share of dissipation explained by the model equals 41%. Statistically probable influence on the relative value of maximum oxygen consumption was demonstrated by the following indices: 1) T/C polymorphisms of eNOS gene promoter. Individual influence of this factor explains 35% of VO$_2$max dissipation with regard to the body weight with reference to this selection; 2) I/D polymorphisms of ACE gene in combination with the characteristics of the functional state at the time of the sportsman’s training accounts for 5% of the index dissipation. This model proves that polymorphic variant of eNOS gene has a more significant effect on the amount of the consumed oxygen than on the functional state of the sportsman, and does not depend on the period and micro-cycles of preparation test conducted.

Stability of CRS reaction characteristics was accessed by applying the coefficient of variation (V) that is one of the dissipation factors that allows to compare various indices. Variability analysis of basic cardiorespiratory system reaction characteristics of sportswomen (Figure 1) specializing in rowing allows to assert that the more stable index is exercise heart rate at maximum levels of VO$_2$, by taking into account the fact that tests have been conducted.
several times. Exercise heart rate coefficient (V_Hr) equals 1.5%. With reference to the mathematical statistics on sports indices, the coefficients of variation of which do not exceed 10–15% indicate stable homogeneous values, so the following indices are regarded as stable: gas exchange rate – \( \frac{V_{CO2}}{V_{O2}} \), (V = 5.5%), relative level of maximum oxygen uptake (V_{O2max} \cdot kg^{-1}, V = 5.7%) and absolute level of maximal oxygen uptake (V_{O2max}, V = 5.8%), exercise heart rate (HR) at the level of anaerobic metabolism threshold (HR_{th}, V = 5.8%), maximum work performance intensity (W_{max}, V = 5.9%, W_{max} \cdot kg^{-1}, V = 5.9%), maximum level of CO2 (V_{CO2max}, V = 5.9%, V_{CO2max} \cdot kg^{-1}, V = 6.0%), oxygen effect of cardial cycle (“O2-pulse” or \( \frac{V_{O2}}{HR} \), V = 6.1%); time required to attain V_{O2max} (t_{min}, V = 6.5%), maximum level of lung ventilation (V_{Emax} and V_{Emax} \cdot kg^{-1}, V = 7.4%), ventilation equivalent to O2 (EQ_{O2}, V = 7.6), respiratory frequency at the level of VO2max (f_{T}, V = 7.9%).

The most stable parameters of the cardio-respiratory system reactions of the athletes in the repeated testing included: HR_{max} (V = 1.5%), V_{CO2}/V_{O2}, (V = 5.5%), V_{O2max} \cdot kg^{-1} (V = 5.7%), V_{O2max} (V = 5.8%), HR_{th} (V = 5.8%), W_{max} \cdot kg^{-1} (V = 5.9).

We presume that the specified CRS reaction characteristics to physical loads of aerobic nature are, in a greater degree, determined by genetics when compared with other CRS reaction characteristics that have higher variability. Almost all cardiorespiratory system reaction characteristics registered at the level of anaerobic metabolism threshold, except HR_{th}, are characterized by high variability, i.e. they depend on the state the sportsman is in at the time of the test, as well as on the level of fitness.
Construction of multiple regressive models for other aerobic possibilities for athletes allows to discover that interaction between polymorphisms of PPARγ and eNOS genes statistically, very likely, has an effect on the level of lung ventilation ($V_{Emax}$) ($p = 0.040$); which demonstrates responsiveness of the athlete's cardiorespiratory system to physical loads. Another model proves that polymorphisms of eNOS gene have an effect on the oxygen ventilation equivalent ($EQO_2$) ($P = 0.046$); which demonstrate efficiency of lung ventilation for $O_2$ utilization from the air (Figure 2).

![Figure 2. Dependence of ventilation equivalent value of oxygen on polymorphism of eNOS gene: T/T – athletes with genotype T/T, T/C – athletes with genotype T/C, C/C – athletes with genotype C/C, * – statistical reliability of differences between T/T and C/C – genotypes at level of $P < 0.05$](image)

To understand separate influence of gene polymorphisms on CRS reaction under test loads, single-factor dispersion analysis method was applied. This method helped to determine that polymorphisms of ACE gene, probably, have an effect on the efficiency of lung ventilation for utilization of $O_2$ demonstrated by the value of oxygen ventilation equivalent ($EQO_2$) while performing under incrementally increasing loads ($p = 0.020$). The highest values of $EQO_2$ that demonstrate the least efficiency of lung ventilation for utilization of $O_2$ were typical for athletes with $I/I$ genotype. The average-team index of athletes with $I/I$ genotype was exceeding the same index of the group with $I/D$ genotype by 11.5%. No difference was discovered in values of oxygen ventilation equivalent in groups of athletes with $I/D$ and $D/D$ genotypes.

Besides, it was discovered that the factor of I/D polymorphism, very likely, has an effect on the value of $HR_{max}$ that is believed to characterize the aerobic capacity ($p = 0.029$) (Figure 3). The highest level of $HR_{max}$ under hard physical work was demonstrated by qualified athletes with $I/I$ genotype, their indices are exceeding similar level of athletes with $D/D$ – genotype by 6.5%. The tendency was discovered as to the demonstration of a higher level of $VO_2_{max}$ by athletes with $I/I$ genotype and its reduction in the athletes with the higher than usual number of D-alleles ($I/D$ and $D/D$ genotypes). Thus, $I$-allele of I/D polymorphism of ACE gene is associated with the maximum aerobic capacity. This factor is quite understandable by taking into account the fact that the protein product of this gene – angiotension-converting enzyme (ACE) participates in vasomotor reactions and influences metabolism of cardiac muscle. I/D polymorphism of the studied gene is not structural, but influences the level of this gene expression.
People with D/D genotype demonstrated maximum levels of ACE, and people with I/I genotype – two times less, and heterozygote – medium (Montgomery et al. 1999).

By applying the method of the single-factor dispersive analysis it was discovered that the factor of polymorphisms of PPARA gene, most likely, has an effect on both the absolute (p = 0.04) and relative value of work intensity (p = 0.009) being performed at the level of anaerobic threshold. In certain kinds of sports, where aerobic endurance is the main requirement for the functional fitness and special work capabilities of qualified athletes, intensity of work performance at the level of anaerobic metabolism threshold is the best indicator of a high grade athletes’ fitness growth compared with the maximum aerobic capacity (MacDougall et al. 1991). Among carriers of G-allele, the lowest level of work intensity being carried out at the level of anaerobic metabolism threshold is typical for athletes with G/G genotype (209.4 ±4.8 W). Absolute value of W_Thr in the athletes with this genotype was lower by 20.3% compared with the similar index of the athletes with G/C genotype. W_Thr with regard to the body weight of the athletes with G/G genotype equaled (3.05 ±0.12) W · kg⁻¹, whereas athletes with G/C genotype – (3.67 ±0.19) W · kg⁻¹. Thus, it may be stated that G/C polymorphisms of PPARA gene are associated with the intensity of physical work at the level of anaerobic metabolism threshold. This condition can be explained by the fact that the specified gene controls activity of genes that participate in lipid exchange and carbohydrate metabolism, and the rate with which anaerobic-aerobic metabolism threshold is being achieved depends on the intensity of these processes.

Athletes-carriers of the T-allele of C/T polymorphisms HIF-1α were characterized by more reduced indices of VO₂max, reduced effect of cardiac cycle (with regard to “O₂-pulse”) and high indices of the ventilation equivalent with regard to O₂ that characterizes the reduced efficiency of lung ventilation compared with the athletes with C/C genotype, but no probable differences in basic characteristics of CRS reactions amount athletes with different genotypes in terms of C/T polymorphism of HIF 1A gene were discovered. By taking into account the fact that the main functional role of the HIF 1α transcription factor is to provide for the adequate adaptation of the organism to hypoxia, and qualified athletes who, in the course of endurance exercises, are subjected to the effects of training load hypoxia, absence of the probable difference may be explained by the fact that with the rising level of adaptation and fitness of athletes individual differences in their respiratory system sensitivity to hypoxia become even. But the tendency of VO₂max level reduction, worsening of cardiac cycle and lung ventilation efficiency of the athletes-carriers of T-allele makes allows to assert that availability of T-allele results in the reduction of cardiorespiratory system reaction efficiency when physical work is being performed at maximum aerobic capacity. Very likely that this is the reason for fact that the athletes with C/C – genotype (Döring et al. 2010) who are known for their endurance prevail when selected for endurance sporting events.
Discussion

The analysis of the obtained results has shown both single and combined effect of the gene polymorphisms on the aerobic capacity in the sports with the prevailing development of endurance. In analyzing genetic aptitude to go in for endurance sports, special attention should be paid to polymorphisms of genes that control metabolic limits of fats and carbohydrates, as well as genes, the expression products of which can influence the processes that limit aerobic performance and have a pleiotropic effect.

Though many studies demonstrated the exceptional significance of the maximal oxygen uptake to achieve the high sport results in the endurance sports, the necessity of VO2max high level is overestimated (Platonov 2005). Each sport should have its own criteria of the aerobic capacity evaluation. It is necessary to focus on the sport-specific molecular-genetic markers.

In different sporting events that require demonstration of endurance, competitive activities pose their requirements to the level and balance of factors in the structure of the funtional fitness. In case of rowing, 70% of the distance is covered for the account of aerobic metabolism (Hagerman 1984). This being the case, the balance of aerobic and anaerobic metabolism in the rowing is distributed as 70% to 30%, and in case of long distance cross-country skiing, the balance of aerobic and anaerobic metabolism is distributed as 95% to 5%. Certain polymorphisms may play key role in the performance of intensive physical work attributed to a certain sporting event that requires demonstration of various endurance aspects, but is of no importance for any other event of the same classification group. That is why, each sporting event requires specific criteria developed for the assessment of aerobic capacities and may be oriented on specific molecular-genetic markers.

The received data allowed to affirm that availability of C-allel T-786 → C polymorphism of eNOS gene in the homozygous state contributes to a greater reduction of lung ventilation efficiency during long, intensive physical loads at maximum aerobic capacity. The received results are clearly explained by the fact that C-allel contributes to the reduction of eNOS gene activity, and insufficiency of endothelial nitric oxide synthase that takes place in this case is the reason for synthesis reduction, release of nitric oxide and dysfunction of vessel endothelial (Dosenko et al. 2006).

Conclusions

1. Analysis of the received results testified influence of gene polymorphisms on aerobic capacity in the endurance sports. One of the aerobic performance components is aerobic intensity that is characterized by the amount of the maximum oxygen consumption and depends on the type of the set of 6 polymorphisms in combination with individual indices (gender, classification, sporting event). These factors account for 71% the VO2max dissipation.

2. Association of single polymorphisms with various characteristics of aerobic capacities of the qualified athletes' organisms has been established: I/D polymorphism of ACE gene associated with the maximum aerobic intensity, T/C polymorphisms of eNOS gene associated with the efficient lung ventilation required for utilization of O2 from the air, G/C polymorphisms of PPARA gene associated with physical working capacity at the level of anaerobic metabolism threshold. The received result may be used for creation of the system of molecular-genetic diagnostics of young athletes's aptitude to go in for sports with the prevailing anaerobic mechanisms of energy supply.
Acknowledgments

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References


Mishchenko V., Suchanowsky A. Athletes’ endurance and fatigue characteristics related to adaptability of specific cardiorespiratory reactivity. Gdansk: AWFiS. 2010; 176.


IMPACT OF TRAINING WITH ADDITIONAL RESPIRATORY DEAD SPACE ON SPIROMETRY AND EXERCISE RESPIRATORY PATTERN IN CYCLISTS

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Abstract. The aim of our 10-week-long experiment was to investigate the impact of training with additional dead space (DS) on spirometry and exercise respiration. Respiratory muscle training is applied to the development exercise capacity. Twenty cyclists were assigned to two groups: the experimental (E) and the control (C). All of them carried on with their initial training programme. During endurance trainings (twice per week) group E used additional DS (1000 cm²). Immediately before and after the experiment each participant was submitted to a spirometry and a continuous test. The spirometry test measured peak inspiratory (PIF) and expiratory (PEF) flows, forced expiratory volume in one second (FEV₁) and forced vital capacity (FVC). The continuous test measured tidal volume (TV), respiratory frequency (RF), along with inspiration and expiration times. Our experiment demonstrated TV increase and RF decrease in both groups. In addition, the TV value was significantly higher in group E than in C. The PIF value also increased significantly, PEF and FEV₁ upward trend was observed in group E only. We concluded the additional respiratory DS used in the experimental group provoked an increase of airflow observed in the spirometry tests at rest and during intensive aerobic exercise.

Key words: respiratory muscle efficiency, dead space, training

Introduction

In response to exercise, ventilation is augmented through an acceleration of respiratory frequency and an increase of tidal volume, which results from the changes in the end inspiratory lung volume, end expiratory lung volume, respiratory cycle time and airflow velocity in the pulmonary airway (Sheel 2002). During the progressive load exercise performed by endurance sports athletes, in some cases, the increase of load above 60–70% of maximal oxygen uptake is accompanied by a plateau phase or a tidal volume (TV) decrease. Further increase of pulmonary ventilation is obtained through an acceleration of respiratory frequency (Carey et al. 2008; Sheel 2002). An opposite pattern of increased TV and respiratory frequency (RF) can be observed in some top level athletes (Lucia et al. 1999). This can alleviate or prevent hypoxemia in areas of fast flowing blood in athletes with high cardiac output (Carey et al. 2008). On the other hand, the growing elastic resistance of lungs and thoracic wall must be
overcome and the increase of TV above the individual critical value entails an intensive internal respiratory work (Carey et al. 2008). Therefore it is difficult to point out unequivocally which modifications of the breathing pattern are beneficial during intensive exercise.

An extension of respiratory dead space may cause an increase of friction inelastic resistance in the airways. As the inspiratory resistance increases, the excitability of the receptors sensitive to pulmonary inflation decreases along with their inhibitory impact on the respiratory center, which leads to an extension of the inspiratory phase (Aleksandrova and Breslav 2009). It has also been observed that a greater respiratory resistance goes along with functional changes in the smooth muscles of the upper pulmonary airway. The airway patency is preserved by the Hering-Bruer reflex (Aleksandrova and Breslav 2009). Moreover, greater respiratory resistance stimulates diaphragmatic nerve activity and excitation of the diaphragmatic muscle. A prolonged respiratory restriction may reduce the activity of the muscle, which, in turn, may lead to hypoxia and hypercapnia (Aleksandrova and Breslav 2009). Similarly, in the initial stage of the obstructive lung disease, inspiratory capacity is reduced and functional residual capacity is augmented (Baarends et al. 1998).

Previous research carried out in our laboratory demonstrated that an extension of respiratory dead space (600–1,400 ml) during exercise is accompanied by an increase of TV, RF, pulmonary ventilation (VE) developing hypercapnia (Zatoń and Smolka 2011). It remains unclear whether increased respiratory activity in the training process actually impacts the breathing pattern during unrestrained exercise and spirometry trial results. The findings of research on resistance respiratory muscle training point to an increase, during maximal aerobic training, of such parameters as TV (Amonette and Dupler 2002; Romer et al. 2002a), maximal inspiratory pressure (Gething et al. 2004; Riganas et al. 2008; Sonetti et al. 2001; Volianitis et al. 2001), maximal inspiratory flow rate (Romer et al. 2002a), the amount of work performed in exercise tests (Gething et al. 2004; Bailey et al. 2010). They also show that the sensation of shortness of breath during exercise is less acute (Romer et al. 2002a), the accumulation of respiratory muscle fatigue resulting from exertion is slowed (Romer et al. 2002b), while lactate concentration is lower and post sprint-exercise restitution is faster (Romer et al. 2002c). Such changes may result from training with additional respiratory dead space.

The objective of our research was to assess the impact of training with increased respiratory dead space on exercise breathing patterns and spirometry results.

We assumed that such training would provoke an increase of tidal volume during intensive aerobic exercise and an improvement of inspiratory and expiratory spirometry parameters.

Methods

The study was approved by the Ethics Committee of University School of Physical Education in Wroclaw and was carried out in accordance with the Declaration of Helsinki. Subjects gave written informed consent before participating.

A group of 20 road cyclists (men, members of the Polish National Team) following a homogeneous training program participated in our research. The participants were divided up in two groups of 10: the experimental group (E) and the control group (C). Table 1 presents basic variables characterizing both groups before the experiment was launched, and shows that there were no statistically significant differences between them.
The experiment was conducted over a period of 10 weeks. Athletes continued with their initial training program based on aerobic exercise; each training session lasted from 180 to 210 min. The program included high volume training, continuous with moderate intensity, and interval training, with intensity above the anaerobic threshold. Heart frequency (measured by Polar S810 sport testers) was used to monitor intensity. The only innovation was the use, in group E, of devices increasing respiratory dead space. A face mask with a tube of an overall volume of 1,000 cm³ (Φ = 29) was used to force subjects to inhale atmospheric air mixed with their own expired air remaining in the mask and tube. The device was used twice every week in continuous high volume training. Group C performed the same work but with no breathing restriction.

Each subject underwent two physiological exercise tests conducted immediately before and after the experiment at the Exercise Testing Laboratory of Wroclaw’s University School of Physical Education (PN – EN ISO 9001:2001 Certificate). Additional respiratory dead space was not resorted to during those tests.

Participants underwent: a progressive test on a cycle-ergometer designed to assess their aerobic capacity, and a spirometry test. The continuous test, with a constant load of 85% of the maximal aerobic power reached in the progressive test, was carried out one week later.

The progressive test was performed on an Excalibur Sport cycle-ergometer (Lode BV, Groningen, the Netherlands) calibrated, in accordance with manufacturer recommendations, before the start of the tests. The exercise began with a workload of 50 W, increased every 3 minutes by an additional 50 W, until the subject was unable to continue. The cycle-ergometer was controlled by a computer which recorded instant power, work time, rotation frequency and calculated total work. The measurement of respiratory parameters began 2 minutes prior to the exercise session and ended 5 minutes after it. The subject breathed through the mask and tidal air was analyzed by a Quark analyzer (Cosmed, Milan, Italy). The device was calibrated with atmospheric air and the following gas mixture: carbon dioxide (CO₂) – 5%, oxygen (O₂) – 16% and nitrogen (N₂) – 79%. Oxygen uptake was measured to assess the subjects’ aerobic capacity. Moreover on the basis of oxygen uptake (VO₂) and carbon dioxide excretion (VCO₂), the anaerobic threshold of metabolism (VT2), was determined. A V-slope method was used in accordance with the guidelines of its creator (Beaver et al. 1986). This assumes an increase VCO₂ in relation to VO₂ at the moment when the production of lactic acid, via glycolysis, increases.

The spirometry test consisted of a maximal inspiration preceded by 2–3 casual breaths and followed by a forced expiration of a maximum air flow, resulting in a minimum volume of residual air. The test was conducted with a Quark spirometer. The following parameters were measured: peak inspiratory flow (PIF), peak expiratory flow (PEF), forced vital capacity (FVC), forced expiratory volume in one second (FEV1). Each subject performed three trials; the one with the best FEV1 value was selected for further analysis. The first trial was considered preliminary.

The continuous exercise test (continuous test) was carried out on an Excalibur Sport cycle-ergometer. The exercise session was preceded by a 10-minute warm-up. The warm-up load was calculated to maintain the heart frequency under the anaerobic threshold. The proper exercise was performed with a constant load of 85% of
the maximal aerobic power reached in the progressive test. Both pre and post experimental trials were conducted with loads calculated on the basis of the initial progressive test. No specific rotation frequency was imposed. The program in control of the cycle-ergometer imposed constant power by modulating resistance in reaction to pedaling cadence changes. The measurement of respiratory parameters began 2 minutes prior to the exercise and ended 5 minutes after it. The subject breathed through the mask and tidal air was analyzed by a Quark analyzer. Respiratory frequency, tidal volume, inspiratory time and expiratory time were measured.

**Data calculation and processing**

The measurement of the respiratory parameters (respiratory frequency, tidal volume, inspiratory time and expiratory time) was conducted breath by breath. In data analysis results were averaged every 60 seconds.

The load in the continuous test was 85% of the maximal aerobic power (individual for every athlete) reached in the progressive test carried out prior to the experiment. Maximal aerobic power was identified as the maximal load in the progressive test at which the subject continued exercising for at least 90 seconds.

A STATISTICA 9 programme was used to develop statistical data. The arithmetic mean and standard deviation were calculated. The ANOVA variant analysis was used for repeated measurements and the post hoc Duncan test to identify significant differences between groups and before vs. after the experiment. A level of statistically significant p < 0.05 was adopted.

**Results**

In the continuous test tidal volume increased in both groups following the experiment. The changes were greater in group E, where in the 2nd and 10th minute of the continuous test TV increase exceeded 0.5 l compared to the results obtained in trials prior to the test (Figure 1). Following the experiment, the TV value was significantly higher in group E than in group C (except in the 9th minute of the exercise). RF decreased in both groups and the significance level was reached from the 3rd minute in group C and from the 4th minute in group E (Figure 2). Inspiratory time increased in both groups; the significance level was reached from the 4th minute in group E and from the 3rd minute in group C (Figure 3). Expiratory time in both groups increased below the significance level starting from the 3rd minute (Figure 4).

The spirometry test showed a significant PIF increase, in group E only. No significant changes were noticed in expiratory spirometry parameters after the experiment. However, an upward trend in FEV1 and PEF appeared in group E (Table 2).

**Table 2.** Results from the spirometry test (forced expiratory volume in one second, peak expiratory flow, forced vital capacity, peak inspiratory flow), before and after experiment, in E and C group

<table>
<thead>
<tr>
<th>Measured parameters</th>
<th>Group E, before (mean ± sd)</th>
<th>Group E, after (mean ± sd)</th>
<th>Group C, before (mean ± sd)</th>
<th>Group C, after (mean ± sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV1 [l]</td>
<td>6.43 ±1.65</td>
<td>7.00 ±1.86</td>
<td>6.98 ±1.29</td>
<td>6.65 ±1.90</td>
</tr>
<tr>
<td>PEF [l/s]</td>
<td>10.12 ±1.46</td>
<td>12.17 ±2.13</td>
<td>11.09 ±1.86</td>
<td>11.3 ±2.41</td>
</tr>
<tr>
<td>FVC [l]</td>
<td>8.27 ±1.9</td>
<td>9.25 ±2.65</td>
<td>8.91 ±1.31</td>
<td>8.93 ±2.71</td>
</tr>
<tr>
<td>PIF [l/s]</td>
<td>2.24 ±0.64</td>
<td>2.81 ±0.58*</td>
<td>2.57 ±0.67</td>
<td>1.61 ±0.96***</td>
</tr>
</tbody>
</table>

Means – arithmetic mean, sd – standard deviation, FEV1 – forced expiratory volume in one second, PEF – peak expiratory flow, FVC – forced vital capacity, PIF – peak inspiratory flow, * – p < 0.05 after vs. before, ** – p < 0.005 after vs. before, *** – p < 0.05 E vs. C.
Dead Space Loading and Breathing Pattern

Figure 1. Tidal volume [l] during continuous test, before and after experiment, in E and C group

Figure 2. Respiratory frequency [breaths/min] during continuous test, before and after experiment, in E and C group

Figure 3. Inspiratory time [s] during continuous test, before and after experiment, in E and C group
Discussion

An increased pulmonary ventilation during exercise requires an extra contribution of the respiratory muscles. Consequently, a prolonged work may result in the fatigue of the corresponding muscle groups and lead to reduced efficiency (Eastwood et al. 2001; Nadiv et al. 2012; Passfield et al. 2005). Nadiv et al. (2012) demonstrated that at low exercise intensity levels (walking at 8 km/h) the respiratory muscles of well-trained young men show no signs of fatigue, however, an additional load (a 15 kg backpack) provokes a significant rise of such electromyographic parameters as root mean square and mean power of the intercostal external muscles. Also Taylor and Romer (2008) established that intensive respiratory work impedes the exercise capacity of the limb muscles. Respiratory muscle training is thus implemented to improve respiratory efficiency. There are two main types of respiratory muscle training: one resorting to inspiratory and expiratory airflow resistance and the other, consisting in unrestrained hyperventilation (Gething et al. 2004; Markov et al. 2001; Passfield et al. 2005; Tong et al. 2008). In our research, we used resistance. It amounted to an extension of respiratory dead space by 1000 ml (Φ = 29), which resulted in an increase of inelastic respiratory resistance.

The results point to the increase of TV during intensive exercise (85% of the maximal aerobic power) as a result of training with additional respiratory dead space. When the values of this parameter are high, the growing elastic resistance of lungs and thoracic wall must be overcome and the increase of TV above the individual critical value entails an intensive internal respiratory work (Carey et al. 2008). It is then difficult to determine whether the change put forth by the present research is beneficial in cycling. It must be underlined however that the diaphragm muscle is resistant to fatigue (Sheel 2002). In addition, our previous research demonstrated a higher work time value in progressive test and, in exercises of submaximal intensity, lower oxygen uptake values were observed, pointing to a lower energetic expenditure of the work performed (Zatoń et al. 2008a; Zatoń et al. 2008b). Therefore, the TV increase probably does not reduce tolerance to intensive aerobic exercise. Other authors have observed similar changes resulting from respiratory muscle training. An increase in the work performed in continuous exercises with constant load was demonstrated by Gething et al. (2004), and by Markov et al. (2001). The increase in the time of aerobic work was accompanied by a decline in metabolite (urea, ammonia and lactate) concentration (Tong et al. 2008) as well as lower heart frequency and pulmonary ventilation (Gething et al. 2004). These changes
are accounted for by improvements in respiratory efficiency and blood redistribution (Amonette and Dupler 2002; Dempsey 2006; Sheel 2002).

Improved TV and the lack of significant changes in inspiratory and expiratory times, point to an increase of the airflow volume in a given time unit. Similar changes were observed at rest for PIF and, below statistical significance level, PEF and FEV1. It may result from a greater pressure difference between the air in pulmonary alveolus and atmospheric air, in both the inspiratory and the expiratory phase (Aleksandrova and Breslav 2009), which could point to an increase in the respiratory muscle tension. Greater values of airflow volume may well be generated by a modification of smooth muscle tension around the airways. And breathing obstacles trigger the Hering-Breuer reflex (Aleksandrova and Breslav 2009). But the pattern of training-induced durable changes remains unclear. Perhaps, regular training sessions with additional respiratory dead space modify the activity of the slow adapting receptors. Further research must comprise inspiratory and expiratory pressure measurement to determine whether the observed changes result from an increase of the force of the respiratory muscles. Hypercapnia, which is caused by exercise with additional respiratory dead space (Zatoń and Smołka 2011), may constitute yet another pattern. Greater carbon dioxide partial pressure ($p_{CO_2}$) in artery blood irritates the chemoreceptors of the circulatory system and causes higher VE, mainly through an increase of TV (Toklu et al. 2003; Ursino et al. 2001; Zhao et al. 2004). Such an intensification of the respiratory work may improve respiratory muscle efficiency. Regular hypercapnia may also modify the responsiveness of the chemoreceptive areas and, in turn, change the respiratory pattern.

Research conducted on non-athletes indicates that resistance training of the respiratory muscles causes improved PEF and FEV1 (Sutbeyaz et al. 2010; Yamashita and Kakizaki 2011). But the results obtained by Amonette and Dupler (2002) showed no spirometry changes in triathlon and marathon athletes, in spite of TV increase and RF decrease during maximal aerobic training. Likewise, no spirometry changes were identified in basketball players by Goosey-Tolfrey et al. (2010), despite an increase in maximal inspiratory and expiratory pressures. Our research indicates a training-induced increase of PIF as well as, statistically insignificant, PEF and FEV1 in cyclists, resulting from additional respiratory dead space. The divergences between our work and other research results may lie in stimulus intensity. Our research project comprised two weekly 3.5-hour respiratory resistance training sessions, while in Amonette and Dupler (2002), only two daily series of 30 inspirations/expirationss executed with additional resistance are described.

**Conclusion**

Training with additional respiratory dead space brought about changes in the exercise breathing pattern, predominantly through an increase of TV. The spirometry trial demonstrated an improvement of inspiration and forced expiration airflows. The mechanism governing those changes requires further research. We presume that the modifications we observed may result from greater respiratory muscle force, changes in smooth muscle tension around the airways, changes in chemoreceptor responsiveness.

**References**


SPORTS DANCE AND THE PROCESS OF SOCIALIZATION

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Abstract. The paper presents the socializing role of sports dance in man’s life. The influence of the activity or movement on the process of socialization of an individual and a group is multi-aspectual and plays significant role in social development of a human. Socialization through sports dance is described as one of the elements shaping character and influencing social communication, as well as affecting a man’s part in co-creation of the surrounding environment.

Key words: dance, socialization, dance community, the Maslow’s hierarchy of needs, activity, sport, ballroom dance

Introduction

Man is a biosocial being so his development derives from an interaction between biological and social factors. Development is possible thanks to wider interpersonal relations which form the role models essential in social life. Experiences of the society, to which he belongs, are acquired as well. The process lasts entire life and is defined as socialisation. The definition is applied on grounds of many sciences: sociological, psychological, pedagogical, anthropology, philosophy, as well as praxeology.

The need of coexistence with other people is innate. Please note that in the initial stage of life we are not able to function on our own, it can be said that we are born with capacity to being humans. However, to become fully human, we need social interactions. “Everyone becomes a human thanks to interactions with other people. We gain character, learn social functioning and learn how to control our lives. This process of entering into culture and social structure, called socialisation is vital both for the society as well as, an individual. Without it we would not know what we should appreciate and do, what to think, how to speak, where to go and how to react. We would not be humans. And, thus socialisation is the most important in an early life stage we are subjected to its processes constantly, till the end of our life. Thanks to socialisation, we are capable of coming into new life situations; without it we would become robots deprived of plasticity, as well as victims of the early life stage experiences” (Turner 1998).
Process of Socialisation

The process of socialisation is the most social element of all of the interactions that we are exposed to. Everyone has to complete it and the result influences both the individual, as well as the society which surrounds him or her.

The socialisation process of the individual is strongly affected by the physical activity. One of such activities is dance which, since the dawn of history, has been an essential element of the oldest in the human history primeval forms of social rites. Cave paintings from the Neolithic period depict dancing figures, proving that dance had been a vital part of social and spiritual life, as early as primitive people. “Moral and religious injunctions have gone hand in hand with social dance for eons” (Malnig 2009). As an element of the transition ritual it was performed on the occasion of birth, weddings, funerals, celebrations connected with changing seasons, start of working in the fields, finishing the harvest, as well as a healing method when the member of the community got ill. By participating in dance rites, the individual was introduced and privy to the customs, ceremonies, and the culture of tradition in which he or she grew up. It used to be a method of teaching and passing on traditional values and behaviours impersonating the wisdom of ancestors and warranting cultural consistency. Such routines were known and practiced among almost all world’s cultures.

Socialisation through dance until today is significant in life of every man, irrespectively of age, sex or nationality. It refers not only to the interaction between the individual and the general public but also performs certain functions relative to personal life. Dance became fashionable and being a member of any dance group is seen as a trend. H. Zdebska points out that it influences social life: “sport fad present in popular culture is the result of an acceptance of sport’s values (health, educational, esthetical). Sport’s craze though, goes far beyond the sport’s world and enters social circles” (Zdebska 2012).

Definition of Socialisation

Bibliography provides many definitions but to understand the nature of socialisation it is worth to analyse the multi-aspectual approaches to the process.

W. Okoń presents socialisation as “all activities coming from the society, especially from family, school and the social environment which intends to create a social being from an individual, i.e. to enable the individual to acquire such qualifications, such a hierarchy of needs, and achieving such a personal development to become a balanced member of the society. Or as all changes that the individual experiences being influenced by social interactions which enable the gradual process of becoming a balanced member of the society” (Okoń 1987).

However, F. Znaniecki illustrates socialisation as the process of growing into culture which consists of getting to know and attaining, by the individual, the tradition and cultural role models which determine a person’s behaviour; it results in the individual’s resemblance to the social environment and therefore in the forming of habits, routines and characters (Znaniecki 1973).

H. Muszyński states that socialisation is a process of attaining, under the social’s influence, mental dispositions which constitute an individual capable of living in a civilised society (Muszyński 1977).

According to J. Szczepański, socialisation is “a part of the whole influence of the environment which introduces an entity to taking part in social life, teaches the behaviour consistent with adopted role models, teaches cultural awareness and makes the individual able to earn a living and perform certain social roles” (Szczepański 1967).
Similarly, A. Kłoskowska, states that: “passing on and acquiring established behaviours, standards, role models and specific knowledge of the surrounding reality takes place in the process of socialisation within certain social groups” (Kłoskowska 1972).

K. Przecławski depicts socialisation as “the process of changes of an individual who is influenced by the socio-cultural environment which entails the development of character in the socially desirable direction” (Przecławski 1971).

To sum up, socialisation is a complex, multilateral process of learning, acquiring knowledge, abilities, values and standards thanks to which a human, as a biological entity, becomes a social being, a member of a particular society and a representative of a specific culture.

**Socialisation in dance**

Dance forms positive personality traits: patience, persistence, courage, and endurance to hardship and fatigue. Thanks to them a man acquires abilities such as cooperation, self-acceptance and acceptance of others, as well as the potential to search and fight his capability barriers. Working in a dance group teaches trust and cooperation which enables experiencing what is community and allows the participant to perform various roles in interpersonal relations. It forms an ability to communicate, teaches obeying the rules, and enables mutual learning. Therefore, it gives a chance of fighting your own shyness, enforces faith in own abilities and enhances the commitment and motivation. Partner dance forces dancers into gaining experience in speaking, listening and being listened to, creates numerous occasions for exchanging information, teaches disputing and reaching compromise, shared taking and completing a variety of tasks, resolving problems and conflicts based on a compromise and the other person’s comfort. Dance couples which spend many hours training often come into conflicts. Usually, this is the result of various move interpretations, or just lack of comfort in a certain sequence. Clashes as well refer to formal issues connected with the choice of coaches, with training, camp and tournament trips, with deciding on the number of individual classes and their financing. However, dancers are aware of the fact that cooperation is the only thing that will enable them achieving success, because they have a common goal. When it comes to dance groups, the situation is similar. Irrespective of the group’s advance, the atmosphere is free, unfettered and the participants are fully engaged. They sense when they work well and they know what hinders their progress. That is why the members do not feel embarrassed when it comes to criticising and they learn to speak honestly because they know that the group will benefit from it. The group is aware of the task which they have to complete, since they have a common goal. The participants have to listen to each other and each comment should be analysed. Obviously, dissents are frequent although, the group is obliged to accept this and be bound to working on proper changes based on a compromise and acceptance of needs of other people. What is more Nieminen writes: “The attitudes of other group members as well as group norms appear to play a significant role in modifying the attitudes of ethnic groups, and this is assumed to also hold true for other kinds of groups” (Nieminen 1998).

The Maslow’s hierarchy of needs shows that belonging to the community is undoubtedly vital for every man. On top of the hierarchy there are of course physiological needs, next is safety, and then belonging, active participation in the group life and fighting the loneliness. Participation in life of a chosen community does not only soothe frustrated mental needs and reduces the feeling of solitude but also, by playing certain roles, allows forming activity, independence, and responsibility for coexistence with other people. It helps defining own identity
because the role models and standards of the group to which the individual belongs reduce problems and hardships connected with self-determination.

Many people are withdrawn and struggle with complexes which prevent them from comfortable behaviour in a group. Dance gives opportunity to break these barriers, helps getting in and keeping verbal and non-verbal communication as well as fighting unnecessary stress connected with the image of yourself. During dance classes it is often to change partners. It allows very close contact with different people. Sharing limited space becomes the source of co-experiencing and integrity. Excluding the solo dance, the most essential is to synchronise many bodies into the whole. Embarrassment towards opposite sex is minimised. There is no problem for the girl to hold hands with scarcely known boy, what in the early youth is usually very intimidating. It can be said that dance is a remedy for shyness and loneliness because it connects people in a natural way, when, taking into account other circumstances it would be difficult or simply impossible. The attractiveness of dance influences the intensification of group processes by tightening the bonds and building the atmosphere which fosters cooperation.

People educated in dance environment reach their sexual awareness earlier than others. Dance teaches controlling your gestures and body language on purpose, forces a habit of flirtatious moves. Generally, it teaches the skilful use of the body applying all of its advantages. Nieminen states that: “Although girls receive less encouragement than boys to engage in sport, which is seen as a highly male-centred activity, in dance the situation may be just the opposite. Dance is a highly organized and scheduled activity unlike many sporting activities, such as jogging, skiing and cycling. Dance, especially art dance, is closely related to aesthetics which in turn are related to femininity and youth” (Nieminen 1998). Girls visually become women at a very early stage by wearing high heels, skimpy and uncovering body dresses with pads for breast imitation. Since young age dancers wear a heavy make-up, apply false eyelashes, nails, and hairpieces. This is all done to emphasise their femininity, but also because it has already became common. Many a father or mother does not approve his child looks in make-up – such a heavy one – nevertheless, no-one will change it. The environment made a habit and it became standard nowadays.

Dance classes participants mature faster and become more responsible than their peers. “The adolescent dancer in a fast paced growth spurt is coping with rapid changes in his/her world” (Daniels 2000). They value time, they are aware that it is not worth being late for training because they miss precious minutes and they will exercise worse than the rest. Everyone wants to get better and better and they can achieve it only by self-improvement. Everyone yearns for making progress but this is possible only in cooperation with the rest of the group. All are equally important and each is an integral component, essential to achieving, intended primarily, results. Time is a resource and they have to take the most of it. What is more, young dancers become independent quicker, owing to numerous trips to tournaments, trainings and camps. Dance instils persistence and regularity. Trainings and trips show that to achieve something an enormous effort is needed, as well as loads of energy in various areas. Reaching your goal, e.g. getting a higher dancing class, winning the tournament or a successful public appearing, as well as just (or even) mastering new steps or coach’s praise boost your self-esteem. Dance teaches how to succeed and deal with failures.

The requirements that the dance community sets up cause that its members quickly become cultural, determined and ambitious people. The ones who go to dance classes meet not only peers but also people at a different age divided accordingly to their advance and not the birth date. As a result, they make friends with people often younger or older than them. It influences the interpersonal abilities in a positive way and opens them up to contacts with others. It allows getting in touch and close relationships with people with whom in different
circumstances it would be unlikely. Undoubtedly, dance develops essential features of cultural coexistence in a social group, such as courtesy and politeness to other people training with them. There is a savoir vivre on the dance floor and all of the community members have to obey its rules. Strict institutional rules have to be obeyed also by the judges, coaches, and even the tournament announcer or social actors, unquestionably meaning parents.

Socialisation through dance is nothing else but shaping vital traits of our characters by dance. Apart from teaching us communication, cooperation, overcoming the barriers and respect towards authorities it primarily brings joy and happiness. Dance classes prove that cooperation does not exclude competitiveness and the other way round. Ballroom dancers work on the couple success, during the tournaments colleagues from the club are rivals. But when the joint performance presenting the club takes place, during opening days, tournaments organised by mutual coach, or other events from which the community can benefit, then they constitute a team. The most important is the cohesion of the group and this is established only by joining forces which influence the participants in terms of being part of the group. It is said that the team is something more than just a sum of separate contestants and that the cohesion of the team is equally important as its members' talents. Lack of consistency in the team can cause that the team composed of stars will achieve poor results. “The roles that people play are based on what they expect of themselves as group members and what they believe others expect of them” (Schmais 1998). The same relates to soloists of modern and contemporary dance. Everyone likes to be the best and unfortunately gets satisfaction from the fact that someone is worse. At tournaments and competitions the rivalry and reaching next dance classes are chief – that is to say – the superiority over peers who represent lower level. It gives them an elite (also for financial reasons) affiliation.

Since childhood we are taught that competition edifies: who paints the prettiest painting, who will get the best exam result, who will get into better school, studies, get better job and so on, till the end of life. Dance as a sport motivates to compete with other contestants, and as far as it is a healthy competition it becomes incredibly enriching. Z. Dziubiński writes: “a man, especially young, has a tendency to testing and confronting his abilities with others. Sport just gives such an opportunity, for competitiveness is an attribute of sport’s practice. A well organised competitiveness serves the man’s development and fosters his balanced growth” (Dziubiński 2012). Unfortunately, the rivalry among dancers, when informal, particular game rules are being established, becomes an intrigue and dishonest manner in a closed circle. Such behaviours are natural everywhere but they are the margin of a sport and social life. Dance insistently implements cooperation idea into the competing community.

Conclusions

Dance as a sport discipline is connected with socialising tendencies because sport itself is one of the most interesting social phenomena (Lipiec 2012). Every year new dance schools are established. They educate new generations and give opportunities of self-fulfilment through movement. The multiplicity of offered classes gives possibility of putting the interests into the right track. Enrolling to dance classes is a conscious entering and co-creation of the group, according to its established rules and standards (Lipiec 2012). By its structure and culture and by introducing into the dance classes’ system and influence on the participants of this system on an individual the hermetic dance environment shapes character. By functioning in the system, a man also creates it, shapes it and transforms with it. He is subjected to a variety of social influences which are more or less significant for his or her life and development.
References


INFLUENCE OF VESTIBULAR IRRITATION ON STABILOMETRIC INDICATORS OF STATOKINETIC STABILITY OF FOOTBALL PLAYERS

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A Study Design; B Data Collection; C Statistical Analysis; D Manuscript Preparation; E Funds Collection

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Abstract. The dynamics of stabilometric indicators of players and non-athletes is considered. It is shown that in the Romberg sample with eyes open and closed disparities in maintaining the balance between players and non-athletes are practically not detected. The most significant shifts of the stabilometric performance we observed in the vestibular stimulation in the Romberg sample with eyes open, which is significantly less than that of the players.

Key words: statokinetic stability, stabilometric indicators, vestibular sensory system, the body’s equilibrium, athletes

Introduction

The specific character of motor activity in situational sports, which include football, involves complex coordination of movement programmed by higher parts of the central nervous system and implemented by the muscular system in the interaction of visual, vestibular, proprioceptive and tactile sensory systems forming the functional statokinetic system. Characteristic features of football are the variable power conjugated with constant changes in the structure and the direction of motor actions, as well as the variability of situations, combined with the lack of time. All this leads to the development of fatigue that in situational sports affects primarily on reducing of the vestibular stability (Nazarenko and Chinkin 2011), in the violation of the differentiation of the fine movements, in the mismatching of regulatory mechanisms and the speed of motor responses.

The aim is to study the effect of load on the vestibular stabilometric statokinetic stability of indicators in football.

Methods and the organization of the research

The investigations were carried out on the basis of the research laboratory of the Department of Medical and Biological Sciences of Volga Region State Academy of Physical Culture, Sports and Tourism. The study involved
24 male persons, 12 of whom are involved in football (the football club “Rubin”, Kazan) and have athletic skills of a candidate master to master of sports of Russia. The control group consisted of students not involved in sports (12 people). All subjects were healthy and almost did not have any restrictions for sports.

The assessment of the functional state of the system was produced by the statokinetic stabilographic hardware-software complex “Stabilan 01-2” (ZAO “OKB” “RITM”, Russia), analyzing the oscillations of the center of pressure. Statokinetic system stability was evaluated before and after the vestibular stimulation. The tested person performed the Romberg test, which consisted of open and closed eyes control (by 52 seconds each). After the stabilographic test the subject was seated in the Barany chair and made 5 rotations with the speed of 180°/sec (1 revolution in 2 seconds), after which he got up on the platform and performed the stabilographic Romberg test with open eyes. To assess the effect of the vestibular stimulation on the statokinetic sustainability the stabilographic indicators in the Romberg test with eyes open were compared with those obtained after the vestibular tests.

To analyze the statokinetic stability of the body in the upright position before and after the vestibular stimulation the following indicators of the stabilographic oscillations of the center of pressure were used: $Q_X$, mm – variation in the frontal plane; $Q_Y$, mm – variation in the sagittal plane; $R$, mm – average spread; $V_{AS}$, mm/s – average speed of the center of pressure; $SV$, mm$^2$/s – the speed of change in the area of the statokinezigramma; $E_{LS}$, mm$^2$ – the ellipse area of the statokinezigramma; IV – the speed index, one unit contingent; OD – the motion estimation, one unit contingent; The quality of equilibrium functions, %; The coefficient of sharp changes of direction, %.

The results are presented as the arithmetic mean of the sample ($M$) ± standard deviation ($\sigma$). The statistical significance of differences of the group of athletes and the control group was determined by t-test method for related and unrelated samples. The normality of distribution in the sample was determined by the Kolmogorov-Smirnov test. Data processing was carried out in the program for statistical data processing “SPSS 20”.

**Results**

In the Romberg trial with eyes open the main indicators of oscillations of the pressure of center football players and non-athletes did not differ, but the football players have less variation on the frontal plane and the area of the ellipse ($p < 0.01–0.001$), which characterizes higher ability to maintain the vertical position of the body with a lower bearing surface (Table 1).

In the Romberg trial with eyes closed in both groups there was an increase of most stabilometric indicators ($p < 0.01–0.001$), resulted in a decline of the integral indicator of “quality equilibrium function”, which gives an idea of the minimum rate of change of the pressure center. The higher the index, the higher the ability to maintain the balance.

However, most stabilographic indicators at the trial with eyes closed of non-athletes and football players are not statistically different, except for growth of the area of the ellipse and the rate of sharp changes of direction, the players’ data are significantly lower than those of people of the control group ($p < 0.01–0.001$), that indicates the advantages in the regulation of the body balance.

After the vestibular stimulation the stability of equilibrium of the body of both non-athletes and football players decreased, which results in the increase of stabilographic indicators (Table 2). However, the degree of increase in the sagittal spread, the average spread, the rate of change of the statokinezigramma area, the area of an ellipse,
the index of speed, the estimation motion, the coefficient of the sharp changes of direction of the players are statistically less significant than that of the control group (p < 0.01–0.001).

Table 1. Stabilometric indicators of the Romberg sample with eyes open and closed of the football players and non-athletes with open and closed eyes (M ± σ)

<table>
<thead>
<tr>
<th>Showing</th>
<th>Test open eyes</th>
<th>Test closed eyes</th>
<th>p1 &lt;</th>
<th>p2 &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>control group</td>
<td>football player</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qx, mm</td>
<td>2.87 ±1.05</td>
<td>2.01 ±0.51</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Qy, mm</td>
<td>2.62 ±0.42</td>
<td>2.91 ±0.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R, mm</td>
<td>4.35 ±2.14</td>
<td>4.15 ±1.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAS, mm/s</td>
<td>8.12 ±1.89</td>
<td>6.20 ±2.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SV, mm²/s</td>
<td>11.64 ±6.81</td>
<td>9.20 ±2.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELLS, mm²</td>
<td>138.51 ±74.3</td>
<td>84.29 ±30.91</td>
<td>0.01</td>
<td>0.001</td>
</tr>
<tr>
<td>IV, one unit contingent</td>
<td>5.30 ±1.18</td>
<td>5.53 ±1.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OD, one unit contingent</td>
<td>43.24 ±12.74</td>
<td>47.87 ±12.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality equilibrium functions, %</td>
<td>84.69 ±6.55</td>
<td>86.99 ±4.33</td>
<td>69.41 ±11.56</td>
<td>74.63 ±5.45</td>
</tr>
<tr>
<td>Coefficient of sharp changes of direction, %</td>
<td>14.10 ±6.81</td>
<td>15.69 ±9.39</td>
<td>17.87 ±6.81</td>
<td>15.35 ±6.31</td>
</tr>
</tbody>
</table>

*p < 0.05; ** p < 0.01; *** p < 0.001 – statistically significant changes compared with the test-open eyes of the corresponding group, p1 – the significance of differences between control and football players, p2 – the significance of the differences in levels in the samples open eyes and closed between the control and the football players.

Table 2. Effect of vestibular stimulation on stabilometric performance of the football players and non-athletes in the Romberg sample with eyes open (M ± σ)

<table>
<thead>
<tr>
<th>Showing</th>
<th>Romberg Trial with eyes open</th>
<th>After vestibular stimulation – Romberg trial with eyes open</th>
<th>p1 &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>control group</td>
<td>football player</td>
<td>control group</td>
</tr>
<tr>
<td>Qx, mm</td>
<td>2.87 ±1.05</td>
<td>2.01 ±0.51</td>
<td>3.99 ±0.88</td>
</tr>
<tr>
<td>Qy, mm</td>
<td>2.62 ±0.42</td>
<td>2.91 ±0.48</td>
<td>6.27 ±2.16</td>
</tr>
<tr>
<td>R, mm</td>
<td>4.35 ±2.14</td>
<td>4.15 ±1.72</td>
<td>15.44 ±5.37</td>
</tr>
<tr>
<td>VAS, mm/s</td>
<td>8.12 ±1.89</td>
<td>6.20 ±2.71</td>
<td>11.86 ±2.81</td>
</tr>
<tr>
<td>SV, mm²/s</td>
<td>11.64 ±6.81</td>
<td>9.20 ±2.99</td>
<td>25.88 ±7.31</td>
</tr>
<tr>
<td>ELLS, mm²</td>
<td>138.51 ±74.3</td>
<td>84.29 ±30.91</td>
<td>266.45 ±94.33</td>
</tr>
<tr>
<td>IV, one unit contingent</td>
<td>5.30 ±1.18</td>
<td>5.53 ±1.56</td>
<td>11.82 ±4.86</td>
</tr>
<tr>
<td>OD, one unit contingent</td>
<td>43.24 ±12.74</td>
<td>47.87 ±12.90</td>
<td>61.87 ±17.53</td>
</tr>
<tr>
<td>Quality equilibrium functions, %</td>
<td>84.69 ±6.55</td>
<td>86.99 ±4.33</td>
<td>66.95 ±3.81</td>
</tr>
</tbody>
</table>

*p < 0.05; ** p < 0.01; *** p < 0.001 – statistically significant changes after the vestibular stimulation compared with rest in the test-open eyes of the corresponding group, p1 – the significance of the differences in levels between the control and the football players.

**Discussion**

Under conditions when the somatosensory information is insufficient, the central vision has a greater impact on the movement control in the frontal plane. The peripheral vision under these conditions largely controls oscillation in the sagittal plane. And yet, despite the high importance of the visual analyzer, it can be compensated by other sensory systems. Spotting pulses are triggering mechanism for activating muscles involved in maintaining
the posture control during body movements, primarily soleus. Neck muscles and the semitendinosus and semimembranosus supraspinal muscle are also connected. The greatest role belongs to the muscles of the ankle, the hip and the knee joints (Skvortsov 2010).

Therefore, the deficiency of the visual information leads to reducing of the equilibrium stability of the body, that increases the proprioceptive system’s role in maintaining the body balance as the balance in an upright position without turning the head is regulated in the absence of the active participation of the vestibular system. The pressure receptors detect the fluctuations of the body, while the mechanoreceptors can determine location, speed, acceleration, pressure and their change. In addition, the position of the ankle joints and their movements are also considered (Skvortsov 2010).

The data of the same ability of the players and non-athletes to maintain an upright posture in the Romberg sample with open and closed eyes is consistent with the results of the other studies (Vuillerme and Nougier 2004; Schmit et al. 2005; Asseman et al. 2008). This may be due to the low system voltage regulation of poses in simple tests that allows to control and compensate the activity of some subsystems of regulating of balance by other subsystems (Horak 2006). It is likely that differences in the regulation of body balance are increasingly detected in more difficult conditions of maintaining the vertical position of the body (Paillard et al. 2007), for example, under the exposition of various types of linear and angular accelerations on to the vestibular apparatus (Nazarenko and Chinkin 2014).

After vestibular stimulation of the players the magnification of the sagittali spread, the average spread, the rate of change of the statokinezigramma area, the area of the ellipse, the index of speed, the motion estimation and the coefficient of sharp changes of the direction is less expressed, that reflects a higher level of statokinetic stability, high quality of operation of the motor control system and the improved proprioceptive sensitivity of postural muscles. To maintain an upright posture the participation of a large number of muscles and their coordinated activities in the implementation of voluntary movements are required. The stabilization of parts of the body relative to each other is achieved by the system of local tensile reflexes and their operation, providing a stable body position in the space, is based on the basis of vestibular and cervical tonic reflexes, and the visual information. This can be seen in the index “the motion estimation», which is optimal when its component indicators “the length of the curve” and “the average spread” reduce, that minimizes the rate of the center of pressure change, increases the integral indicator of “the quality of the equilibrium function» and the statokinetic stability of football players.

As a result of systematic training of football players the resistance of regulatory mechanisms of the body balance increases, i.e. the interaction between the visual, the proprioceptive, the vestibular sensory systems and the central nervous system that promotes the statokinetic stability growth. It follows from this that the systematic exercises contribute to a more rapid formation of new motor patterns that result in multiple repetitions and lead to the improvement of the internal model of signals, i.e. a mechanism for the “recognition” of the new information is created. Proprioceptive impulses arising during the training alter the functional properties of neurons and provide a reduced susceptibility to stimuli of different sensory modalities and the reducing of manifestations of vestibular-motor reactions (Nazarenko and Chinkin 2014).
Conclusions

Thus, statistically significant differences in the regulation of body balance of football players and non-athletes appear under the influence of the vestibular stimulation. In this case the statokinetic resistance of players is higher that is seen in smaller changes of stabilometric indicators under the vestibular stimulation. The more improved regulation of mechanisms of the body equilibrium is developed due to the adaptation of the vestibular analyzer receptors to mechanical forces that periodically and repeatedly impart to a human body multidirectional accelerations during their systematic training.

References

Asseman F.B., Caron O., Cremieux J. Are there specific conditions for which expertise in gymnastics could have an effect on postural control and performance? J. Gait Posture. 2008; 27: 76–81.


GERMAN GYMNASTICS ASSOCIATION (DEUTSCHE TURNERSCHAFT) IN RELATION TO SPORT MOVEMENT IN GERMANY BEFORE THE WORLD WAR I

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Abstract. Modern physical culture was one of the many important processes that have taken over the political, social, and cultural life in Germany in the second half of the 19th century. At the turn of the 19th century in Germany, two big middle-class organizations have been formed to deal with physical activity affairs: the German Gymnastics Association (Deutsche Turnerschaft; the Turnverein) and dynamically-growing English sports. The paper demonstrates the relations between the Turnverein movement and the world of sport in Germany at the beginning of the 20th century. The German Gymnastics Association, an organization founded in the 60s of the 19th century, had long-time achievements initiated by the work of Friedrich Ludwig Jahn. Simultaneously, the world of sport in Germany was concentrated on the newly-founded in 1904 German Olympics Committee – primary organization bringing together several various federations of sport disciplines. It was an organization primarily brought into existence to coordinate the debut appearance of the German Empire in the restored by P. Coubertain Olympic Games.

Key words: German Gymnastics Association, Deutsche Turnerschaft, Turnverein movement, German sports, Olympic Games, II German Empire

Introduction

Modern physical culture was one of the many important processes that have taken over the political, social, and cultural life in Germany in the second half of the 19th century. Meanwhile, the Second Reich started suffering from the consequences of rapid industrialization, urbanization and social migration. The changes were primarily visible in the sphere of physical culture and ways of spending free time. Apart from the usual, sedentary ways of spending leisure time (sitting around in various types of catering and commercial premises), new and more active forms were introduced, with the most popular various kinds of English and French-originating sport disciplines. The latter was popular both among youth and adults. In Germany, physical activity evolved in three different directions. The first group consisted of ‘pedagogical exercises’ such as gymnastics, athletics, and field games; the second included the German Gymnastic Association [Deutsche Turnerschaft – DT], and the third – the so-called ‘English...
sports’. The latter, similarly to rowing, lawn-tennis, or horse riding, was originally the domain of the elite. Sport in the modern world was not so much a compulsion or an escape, but just an active way of spending free time. It was also some kind of identification of an individual with the local and national community outside of work and church, which constituted its greatest advantage (Nipperdey 1993; Glockle 1987).

The following considerations are focused on brief characteristics of the relationship between the German Gymnastics movement and the world of sport in Germany at the beginning of the 20th century. The Turners were members of the German Gymnastics Association, an organization founded in the 1868 of the 19th century. The initiator of Deutsche Turnerschaft was Friedrich Ludwig Jahn who is considered a spiritual mentor of this organization. After his death the reign of the German Gymnastics Association was taken over by the younger generation, including Theodor Georgii and Ferdinand Goetz. At the same time, the world of sport in Germany was focused around the German Olympics Committee, primary organization bringing together several various federations of sport disciplines, formed in 1904 by the German Reich. It was an organization primarily brought into existence to coordinate the debut appearance of the German Empire in the Olympic Games restored by P. Coubertain. The main activists of the organization were: Victor v. Podbielski, Willibald Gerhardt and the youngest in its elite executives - Carl Diem. Both the organizations worked simultaneously and independently with some unsuccessful attempts in cooperation (Lämmer 1999). Deutsche Turnerschaft members boycotted for 40 years Olympic Movement. During first Olympic Games 11 German turners took part without permission from DT. When they came back to Germany they were commonly condemned by turner organizations (Młodzikowski 1984).

Discussion

From the very beginning of its existence, the Turnverein movement, in addition to the physical culture, was also involved in political activism, which German historiography is in full compliance with. The development period of the Turnverein movement fell into the time of the Napoleonic occupation. Several years after the death of Jahn, Prussia defeated Austria at Sadowa (Königrätz) and few years later brought France to their knees. The German Gymnastics Association [Deutsche Turnerschaft] was involved, actively or passively, in all of these battles (Lipoński 2012). After the reunification of Germany, the Gymnastics Association identified themselves with the conservative and monarchist legal and ideological bases of the state, drawing on the experience of fighting the Napoleon ruling as well as the magnitude and visionary of their leaders. National traditions in the field of material, ideological, and aesthetic values were considered by the Turners as sacred, timeless, and independent from any social or cultural changes. The importance of German unification and the sanctity of national values were of greatest importance (DTZ 92 1879; John 1980). To defend the actions of the German Gymnastics Association, its members appealed to the power of tradition, conspicuously glorifying German nationalism, and discarding the tradition of enlightenment and the West. The Turnverein movement wanted their actions to be perceived as an important contribution to the cultural development of Germany. To consistently uphold the movement’s ‘purity’ the tradition, members of the movement, and the statutes came in hand – established in July 1868, in Weimar (Jahrbuch der Turnkunst, Gasch 1907).

The sport movement was a more recent social and cultural phenomenon. Sport promoted values unacceptable for the Turnverein movement, that is, individualism and competition. While the Turnverein movement was mainly based on the hierarchical social structures, demanding complete compliance with the organization’s rules from its members, at the same time, sport and its structures were based on a voluntary participation (Eisenberg 1996). The
German Gymnastics Association did not wish for the invasion of Western influences on the tradition, customs, and German culture. Unfortunately, the dynamic changes in the world of politics, culture, philosophy, and educational concepts forced the association to ‘loosen up’ on the content and form, and to widen the range of practiced sport disciplines. Gradually, new forms, based on athletics and team games, started to appear. Still, the Turnverein movement effectively protected itself from the full adoption of the main characteristics of sport for as long as the end of the Great War (Eichberg 1980; John 1980).

In 1907, Fritz Groh, the editor-in-chief of the leading periodical ‘Deutsche Turnzeitung’ (DTZ), published an extensive article on the dominance of the Turnverein movement over sport. He perceived this superiority in several aspects. Firstly, the turnverein exercises “allowed to enjoy free, unfettered mobility of the body and physical activity.” Secondly, it ensured “moral and ethical upbringing” – moral and physical strength. Thirdly, physical exercises, conducted in a particular community, made it more integrated in the spirit of common purpose and values (DTZ 1, Groh 1907). Without a doubt, the Turnverein elite was convinced to the almost ideal model of symbiosis between the individual and the community, developed under the guidance of Jahn. According to this model, any competition in its deepest form should be developed solely in the national-related field and constitute a way to physical development. The Turners believed that if every nation had developed their own, native games, there would be no place for the international Olympic Games to take place (DTZ 25, Groh 1913; Eichberg 1980, Ueberhorst 1971).

The majority of Turners considered “Festival of the German Turnverein”, celebrated every five years and gathering crowds of athletic young people, much superior to the Olympic Games. All the celebrations were held in different cities of Germany, and apart from physical exercise presentations, the Turners sang, danced and recited poems in honor of Jahn and the victory over France in the years 1815–1870/71 (Krüger 2009). The Turners publicly propagated the German cultural heritage, unveiling thousands of plates and monuments, as well as planting dozens of the so-called “oak trees of Jahn” (John 1976). The Turnverein activists developed strategies to popularize the Turnverein ideas more widely in Germany, and what follows – recruiting more young people. They planned to introduce individual exercise program and philosophy to schools and the army, as well as members of the ruling dynasty, the elites, and the educated.

A sense of uniqueness of the Turners had influenced their approach to the idea of establishing a German alternative to the Olympic Games. In 1896, Emil v. Schenckendorff, the leader of a founded in 1891 Central Committee for Promoting Folk and Youth Games, applied to F. Goetz with an idea of organizing ‘German National Holidays’ that were supposed to take place in Leipzig, Germany, at the Monument to the Battle of the Nations. The German Gymnastics Association cooperated quite actively with the E. v. Schenckendorff’s organization in terms of propagating the notion of popular games and building playgrounds; the idea of ‘German Olympic Games’ however was not seized by F. Goetz (DTZ 29, Reinhardt 1918).

This topic was long-discussed within the German Gymnastics Association. Eventually, it was decided to refuse the complicity, stating, among other things, that the so-called ‘German Olympics’ do not originate from the needs of the nation and do not correspond to the philosophy of the natural development propagated by the German Gymnastics Association. The official position, rejecting the proposals of E. v. Schenckendorff, was presented in a slightly milder form during the Turnverian Congress in Naumburg in 1899 (Neuendorff 1936). In his jubilee memoirs, published in 1906, F. Goetz explained the reasons for the rejection of the idea of ‘German National Holidays’ (Eberhardt 1906) which happened to be a huge surprise for the Central Committee for Promoting Folk and Youth Games. The organization had put a lot of effort in the popularization of German alternative to the idea
of international Olympic movement of P. de Coubertin (Raydt 1896; Deutsche Nationalfeste. Mittheilungen und Schriften des Ausschusses 1897). Meanwhile, the Central Committee for Promoting Folk and Youth Games made a decision to organize ‘National Olympic Games’, and confirmed the participation of Germany in the International Olympics (Krüger 1975; Stadion-Kalender für das Deutsche Reich 1913).

The identification of the Turnverein movement with the conservative, imperialistic and monarchist state was not without foundation. In 1907, the DTZ’s editor-in-chief, expressed his full criticism towards the actions of the Empire’s elite, accusing them of the alleged abandonment of the Turnverein movement for sport. In his opinion, ‘higher classes’ used sport as some kind of expensive drug which allowed them to “separate themselves from the rabble”, deepening the gap between different social classes. The obsession with sport, was in his opinion, waste of money and energy. The pursuit of great sporting achievements was ruining the health of young people. As an example of the harmful effects of Anglo-Saxon sports, he pointed to the so-called ‘six-day runs’ and the marathon runs organized in 1912 in Stockholm, “which, according to him, were the very opposite of the health effects of physical exercises”(DTZ 25, Groh 1913). Sport itself, instead of serving the physical culture of men, became ‘the product of fashion’, with men being its victims. It lacked any creative, ethical, or aesthetic strength, with no national-related importance (DTZ 1, Groh 1907). The Olympic disciplines themselves were also criticized. According to Groh, physical exercises introduced to the International Olympic Games were mostly Anglo-Saxon originated – a place where the first international sport events were organized (Sepp 1913). Also the newspapers that marginalized the work on the Turnverein movement, at the same time eagerly informing about the latest victories in all sports arenas where “individuals gave away their own health for a simple entertainment of the heartless spectators” were scrutinized (DTZ 1, Groh 1907). It is worth noting that the majority of newspapers at the time presented a liberal and modern point of view (Wehler 2008).

While analyzing the type of conflict between the Turnverein and sport movements, it is worth to quote one of the leaders of the German Gymnastics Association, Edmund Neuendorff (Neuendorff 1936):

“A lack of nationalism and tendency for individualism have put sport in conflict with the Turnverein movement. What the Turners found the most repulsive in sport was the ultimate pursuance for the absurdly high performance and the accompanying absolute desire of winning.”

At the beginning of the 19th century, the Turners started to sense that their cooperation with the establishment of the German Empire and the Hohenzollern dynasty is deteriorating. Main factors responsible for this situation included the abovementioned modernist processes together with the increasing popularity of the aforementioned ‘English’ sports, which were not any longer the domain of the elites. The Turners started to notice the changing interests of the monarchy and their continuous absence at subsequent German Turnverein Festivals. They could also feel that their ‘bourgeois mentality’ was presented both in the media and press – which now have become a modern communication society. In the expanding world of illustrated press (newspapers and magazines), the Turnverein periodical started to become practically invisible. One of the first signals of the changing – towards sport and the Olympics- interests of the ruling elite, was the designation by the German Reich Chancellor of his own son, prince Philipp Ernst zu Hohenlohe-Schillingsfurst, for the position of the president of the German Olympics Committee, formed for Germany’s participation in the Olympic Games in 1896 in Athens. This project was supported by the Emperor himself (Krüger 1980; Naul and Lämmer 2002). In December 1895, the Turners declined their participation in the Olympics Committee.
Despite constant antagonism between the sport and the Turnverein notions, the Olympics movement became a platform for restricted cooperation between the German Gymnastics Association and German Olympics Committee. It was in the Turners' interest, despite the aversion towards the notion of Olympics, to find a way of amicable coexistence with the monarch and the sport movement. Before the breakout of World War I, there had been three such occasions. The first opportunity took place during the common organization of the VI Olympic Games in 1916 in Berlin. The involvement of aristocratic and middle-class Olympics enthusiasts did not allow the Turners to remain in full opposition. The beginnings of the cooperation, however, were not so promising for the German Olympics Association as the Turners declined their participation in the very first Olympics in 1896 in Athens, claiming that “it was in opposition with the German honor” (Deutsche Turnerschaft 1896). This attitude, however, due to the abovementioned reasons, had changed into more liberal one with time. In 1907, the German Gymnastics Association joined the German Olympics Committee, accepted its membership in the International Olympics Committee, and allowed for the participation of a group of Turners in the Olympics in 1908 in London. The Olympic Games itself, however, happened to be a great disappointment to the Turners, and as a result, their support for participation in subsequent editions of the Olympics was slowly decreasing (DTZ 1, Goetz 1907). Still, DTZ had a wide coverage on the V Olympics, which took place in 1912 in Stockholm. The second opportunity for the Turners was their active and grant participation in the national opening ceremony of the German Stadium in Berlin on June 8, 1913 – the stadium which was built with the large support of the ruling dynasty (Ueberhorst 1971; DTZ 44 1913; Diem 1913; Lennartz 1978). For the Turners, the opening ceremony of the stadium was an opportunity to present before the Emperor the physical and moral strength of its members (Reinberg 1913). The athletes, in turn, treated the event as an important step towards the ‘Berlin Olympics’ and the culmination of the entire organizational work of the German Olympics Committee (Diem 1965). It is worth noting that the Turners did not consider the German Stadium in Berlin to be ‘the biggest stadium in the world’, but a Kampfbahn in Leipzig, where in 1913 the XIII edition of the German Turnverein Festival took place (DTZ 25, Groh 1913). The third important event was the participation of numerous delegations of the Turners during the unveiling ceremony of the Monument to the Battle of the Nations at Leipzig on October 18, 1913. Another example of cooperation with sports officials was the joint participation in the IOC Congress in June 1914, where they discussed the Olympic Games in Berlin. (DTZtg, Toepitz 1914; Lennartz 2005). Earlier, in March 1913, the representatives of the German Gymnastics Association participated in extraordinary general meeting of the German Olympics Committee, dedicated to the actions towards the organization of VI Olympic Games and its popularization in the country. At the end of June 1914, the Turnverein planned on the participation in the so-called ‘Pre-Olympic Games’ which were to be held at the German Stadium (DTZ 28 1914). The state supported this initiative with its authority and a grant in the amount of 300,000 German Marks. Even though, just before the outbreak of World War I, you could feel ‘the spirit of national consent’, the attempts of C. Diem to reach a compromise between sport and Turnverein movements presented in his brochure “Friede zwischen Turnern und Sport”, had been rejected by the president of the German Gymnastics Association. The Turners finally accepted the idea of the Olympic Games in Berlin, mainly due to the fact that they had seen it as a chance to promote the successes of the Third Reich in terms of its economy, science, culture and the vitality of the German nation (Court 2008; Wege 1914).

The outbreak of World War I, and, above all, the prolonged conflict and its escalation, interrupted German dream of the Berlin Olympics. The cancellation of the Olympic Games has been accepted with joy by almost all (except the German Olympics Committee) sport organizations. The chairman of the German Combat Games
Committee, W. Rolfs, wrote that “the international bubble had burst” (DTZ 23, Rolfs 1918). The German Turnverein movement was carried along by the spirit of war against the long-loathed England and France, which they had associated with the Olympics ideals and sport. The war propaganda and the hostility towards the Entente were fully present on the pages of DTZ (DTZ 50, Lissauer 1914; DTZ 35, Wincler 1914).

References
Deutsche Nationalfeste. Mittheilungen und Schriften des Ausschusses, 1 (April 1, 1897).

DTZ, 1. Wege W. Wie bereitet sich die Deutsche Turnerschaft auf die Olympischen Spiele in Berlin vor, und wie beteiligt sie sich an denselben (Januar 1, Spandau 1914): 2.


DTZ, 72. Über die nationale Bedeutung des Turnens (Dezember 11, 1879): 421.


Sepp Dr. Das Recht des deutsche Turnens, Deutsche Turn-Zeitung für dir Angelegenheiten des gesamten Turnwesens. Blätter der Deutschen Turnerschaft, 12 (März 12, Köln 1913): 221.


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Predicting Competitive Swimming Performance

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Abstract. The aim of this study was to present the results of analyses conducted by means of complementary analytic tools in order to verify their efficacy and the hypothesis that Kohonen's neural models may be applied in the classification process of swimmers. A group of 40 swimmers, aged 23 ± 5 years took part in this research. For the purpose of verification of usefulness of Kohonen's neural models, statistical analyses were carried out on the basis of results of the independent variables (physiological and physical profiles, specific tests in the water). In predicting the value of variables measured with the so called strong scale regression models, numerous variables were used. The construction of such models required strict determination of the endogenous variable (Y – results for swim distances of 200 m crawl), as well as the proper choice of variables in explaining the study’s phenomenon. The optimum choice of explanatory variables for the Kohonen’s networks was made on the grounds of regression analysis. During statistical analysis of the gathered material neural networks were used: Kohonen’s feature maps (data mining analysis). The obtained model has the form of a topological map, where certain areas can be separated, and the map constructed in this way can be used in the assessment of candidates for sports training.

Key words: Kohonen feature map, swimming performance, sports selection, regression

Introduction

Dynamical systems theory (DST) has the power to potentially unify existing sub-disciplines such as sports biomechanics, notational analysis, motor control, physiology and psychology under one macroscopic platform (Glazier 2010). Stergiou et al. (2004) proposed several nonlinear tools to study specific features of complex human movements, e.g. Lyapunov exponent (LyE), correlation dimension (CoD), approximate entropy (ApEn) and ANNs. Such tools, which operate with few assumptions about the structure of the dataset, are undoubtedly useful and their application to complex datasets will become increasingly widespread in the future (Dutt-Muzumder et al. 2011).
Many researchers confirm the growing significance of the process of modeling with regard to the utilization of Artificial Neural Networks (ANNs) in the optimization of selection and training processes. The occurrence of linear and non-linear relationships between variables led scientists to develop Artificial Neural Networks for modeling and prediction (Haykin 1994; Zadeh 2002; Mester and Perl 1999; Perl et al. 2002).

The results of conducted research confirm the findings of Bartlett 2006, Maszczyk et al. (2011) concerning the usage of perceptron networks in classification of athletes. Maszczyk et al. (2012) showed the large usefulness of non-linear neural models in the process of prediction, which was also confirmed in this research. The use of clustering which uses Kohonen’s network can be very useful from the practical point of view – in spite of the rather incomprehensive (as not directly defined) operating objectives of this network and despite the lack of forced operating direction. Due to the protection made by this network we are able to better understand data, which in turn gives the possibility of improving the process of its further analysis (Roczniok et al. 2007).

Self organizing maps are a class of the ANN model, based on a method called competitive learning, where the output nodes compete amongst themselves to be activated on a per-group basis. For presented inputs, the output node that wins the competition is called a ‘winnertakes-all neuron’ (Haykin 1999). Each node represents process types (section of a match), and each cluster represents a class of a similar process type. Based on competitive learning, the architecture of the network can be fabricated to develop its model such as that of a KFM and the Willshaw and von der Malsburg model (Konen et al. 994). The term KFM comes from the capability to recognize patterns or clusters in the data without supervision/target data (Kohonen 1997). A KFM is an essential tool for analysing dynamical movement patterns in sports. The KFM architecture compresses surplus high-dimensional...
inputs to a low-dimensional structure (e.g. one- or two-dimensional [2-D]). Dimensionality reduction is performed to recognize and validate structures visually, yet preserve nonlinear topological relationships in the data sets (Perl and Dauscher 2006). This helpful feature retains the relevant information and discards irrelevant information in high-dimensional datasets, which is typical of dynamical systems. They consist of an ‘input layer’ and a presumed ‘competition layer’ (Figure1). The weights of the connections from the input nodes to a single node in the competition layer are interpreted as a reference vector in the input space, i.e. a self-organizing map represents a set of vectors in the input space and one vector for each node in the competition layer (Dutt-Mazumder et al. 2011).

The aim of this study was to present the results of analyses conducted by means of complementary analytic tools in order to verify their efficacy and the hypothesis that Kohonen’s neural models may be applied in the classification process of swimmers.

Methods

Participants

A group of 40 swimmers, aged 23 ±5 years took part in this research. Measurements were performed in the Human Performance Laboratory of the Academy of Physical Education in Katowice and at the swimming pool. In predicting the value of variables measured with the so called strong scale regression models, numerous variables were used. The construction of such models required strict determination of the endogenous variable (Y – results of the 200 m crawl), as well as the proper choice of variables in explaining the study’s phenomenon. The optimum choice of explanatory variables for the Kohonen’s networks was made on the grounds of regression analysis. During statistical analysis of the gathered material neural networks were used: Kohonen’s feature maps (data mining analysis). All study procedures were approved by the Bioethics Committee for Scientific Research at the Academy of Physical Education in Katowice. The research subjects were informed of the aim of the study and experimental risks. All statistical analyses were carried out on a PC using the statistical package STATISTICA 10.0.

Data collection and tools of statistical analyses

Methods of the model experiment and direct observation were used during the research. The structure of the following variables was used: RXn\nYn, with one multi-valued dependent variable (Yn), and n multivalent independent variables (Xn) taking into consideration the principle of randomization (R). The results of the 200 m crawl was the dependent variable (Y) in all tests. Independent variables for multivariate analysis were obtained by measuring the different characteristics of swimmers in the following groups: anthropometric measurements, body mass and body composition were then evaluated by electrical impedance (Inbody 720, Biospace Co., Japan). Two hours after a light breakfast, a ramp cycloergometer test (0.5W/s) was administered to determine aerobic capacity. During the test, heart rate, minute ventilation (VE), oxygen uptake (VO2) and expired carbon dioxide (CO2) were continuously measured using a MetaLyzer 3B-2R stationary spiroergometer (Cortex, Germany). Fingertip capillary blood samples for the assessment of lactate (LA) concentration (Biosen C-line Clinic, EKF-diagnostic GmbH, Germany) were drawn before the test, as well as during the 3rd, 6th, 9th, and 12th min of recovery. In the second day of evaluation the Wingate test (0.45 Nm/kg) was administered to determine anaerobic capacity. Fingertip capillary blood samples for the assessment of lactate (LA) concentration were drawn before the test, as well as in the 4rd, 8th, min of recovery. Resting blood samples were drawn from the antecubical vein to determine hematological
variables (hemoglobin concentration (HGB), haematocrit value (HCT), number of erythrocytes (RBC) (Advida 2120, Siemens, Germany)). All together there were 30 independent variables and one dependent variable Y – result of the 200 m crawl swim.

**Results**

The analysis of the signs showed that a higher level (VO\(_2\)max, Relative Peak Power, Relative Mean Power, haemoglobin, erythrocyte number) results were significantly related distances of the 200 m crawl swim. With the increase of BMI and Percent Body Fat values the swimmers obtain worse results at the distance of 200 m.

**Table 1.** Structural parameters of the regression equation for the dependent variable Y – result for the 200 m crawl swim

<table>
<thead>
<tr>
<th>Variable</th>
<th>beta</th>
<th>St. error beta</th>
<th>B</th>
<th>St. error beta</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td></td>
<td>97.77</td>
<td>15.47</td>
<td>6.32</td>
<td>0.00003</td>
</tr>
<tr>
<td>Relative PeakPower (W/kg)</td>
<td>-2.17</td>
<td>0.49</td>
<td>-4.69</td>
<td>1.05</td>
<td>-4.46</td>
<td>0.00100</td>
</tr>
<tr>
<td>Erythrocyte (mln/ul)</td>
<td>-0.26</td>
<td>0.07</td>
<td>-4.88</td>
<td>1.23</td>
<td>-3.96</td>
<td>0.00200</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>-0.35</td>
<td>0.12</td>
<td>-1.76</td>
<td>0.57</td>
<td>-3.08</td>
<td>0.00900</td>
</tr>
<tr>
<td>PBf %</td>
<td>0.21</td>
<td>0.09</td>
<td>0.19</td>
<td>0.08</td>
<td>2.36</td>
<td>0.03500</td>
</tr>
<tr>
<td>Relative VO(_2)max (ml/min/kg)</td>
<td>-0.75</td>
<td>0.22</td>
<td>-0.40</td>
<td>0.11</td>
<td>-3.47</td>
<td>0.00400</td>
</tr>
<tr>
<td>MeanPower (W/kg)</td>
<td>1.23</td>
<td>0.43</td>
<td>4.21</td>
<td>1.46</td>
<td>2.89</td>
<td>0.01300</td>
</tr>
<tr>
<td>BMI</td>
<td>0.30</td>
<td>0.13</td>
<td>0.55</td>
<td>0.24</td>
<td>2.27</td>
<td>0.04100</td>
</tr>
</tbody>
</table>

**Kohonen Feature Map Learning Algorithm**

The aim of a KFM is to activate different nodes of the network to respond similarly to inputs (Haykin 1999). Node weights are initialized to small random values or sampled evenly by the two largest principal component eigenvectors. An initial neighborhood radius is defined and the subsequent distance between each input and the output node is computed, according to the given equation (Perl and Dauscher 2006):

\[ d_i = \sum_{i=1}^{N} \left( x_i(t) - w_{ij}(t) \right)^2, \]

where \( x_i(t) \) = input to node i at time t and \( w_{ij}(t) \) = weight from input node i to output node j at time t; \( N \) = neighbouring nodes.

For each input vector the ‘winning node’ is determined. There are two methods; maximal dot product: \( i^* = \arg\max (w_i, x) \); minimal Euclidean distance: \( i^* = \arg\min (w_i, x) \). The KFM training phase consists of input vectors (e.g. coordinates of players) in a random order. The KFM training consists of weight updates of ‘winner node’ \( i^* \) and its neighbouring nodes in \( N_{i^*}(t) \) are updated according to the learning equation (Dutt-Muzumder et al. 2011).

\[ w_{ij}(t+1) = w_{ij}(t) + \eta(t) \times N_{i^*}(t) \times (x_i(t) - w_{ij}(t)), \]

where \( w_i(t) \) = initial weight; \( w_{ij}(t+1) \) = updated weight; \( \eta(t) \) = learning rate, which decreases with time and \( N_{i^*}(t) \) = neighbourhood function (Lippmann 1987).
The neighbourhood function can be symmetric (e.g. rectangular and Gaussian) or anti-symmetric:

\[ N_{1}(t) = \begin{cases} 1, & \text{if } d_{M}(i^*i) \leq \lambda(t) \\ 0, & \text{otherwise} \end{cases} \]

where the rectangular neighbourhood function is based on the Manhattan distance between nodes \( d_{M}(i^*i) \) where \( \lambda(t) \) is the neighbourhood parameter. The Gaussian neighbourhood function:

\[ -\frac{d_{E}^{2}(i^*, i)}{\lambda^{2}(t)} , \]

where the neighbourhood function is based on the Euclidean distance between nodes \( d_{E}(i^*, i) \). The Gaussian function is preferred over the rectangular, since it gives smoother mapping from input points to weight coordinates (Leonedes 1998). Regardless of the neighbourhood functional form, both shrink with time. The training can be stopped after it undergoes a number of predefined iterations \( t_{\text{max}} \) defined by \( t = t_{\text{max}} \).

Results

Basing on calculated regression equation coefficients (st. error B), it can be stated that such qualities as: Relative Peak Power, Relative Mean Power, Relative \( \text{VO}_{2}\text{max} \), Erythrocyte number, Hemoglobin, BMI, PBF % have considerable influence on predicting the dependent variable \( y \) – result of the 200 m crawl swim for the studied subjects. If the value of Relative Peak Power variable decreases by one point (one unit of this quality), then the swim result at 200 m will improve by 4.69 s, assuming that the remaining variables remain unchanged. Basing on variables obtained by regression analysis, the Kohonen’s model was constructed.

The colour saturation scale was used in addition to numbering the neurons representing particular cases (Figure 2). This scale was created upon identifying the map areas by means of familiar results of the dependent variable \( y \) – result of the 200 m crawl (very good: below 1 : 53.50; average: 1 : 53.50 – 1 : 59.99 and poor: above 1 : 59.99). The classification table (Figure 2) created on the basis of learning sets for \( y \) – result of the 200 m crawl swim, in the Kohonen’s network can be useful in assessing new objects, not presented during learning. This results from evident, clear ordering of the explained variable value corresponding to particular neurons - one point to large areas of the map containing neighbouring neurons corresponding to approximate values of the explained variable. This indicates that there is a relation between the assumed set of explanatory variables and the explained variable. One can notice that if at the beginning of the study our candidate is classified to neurons with the biggest colour saturation, it may be expected that the candidate will be among the best swimmers in his group. If, on the other hand, our candidate is classified to neurons with the lowest colour saturation, then one can expect this subject to be among the athletes that reach the worst results in that age group. In particular neurons, the neuron point average was also given, which served as the basis for map area identification.
Discussion and conclusions

Recent theoretical contributions to the theory of talent in sport have clearly shown that a complex and longitudinal framework is necessary to successfully address talent identification and the talent promotion issue in most sports (Gagne 1985; Abot and Collins 2004). The nature of recruitment and selection of an athlete consists in finding the vector of the candidate’s abilities with respect to each stage of sports training. Therefore, the selection process can be optimized by creating a large source of information on a candidate’s sport abilities with as few examined features as possible, using a regression model and a neural model (Maszczyk et al. 2012). As talent development is a complex non-linear process, and the different components of early talent make-up not only change over time, but can also mutually suppress or enhance each other, linear models like discriminate analysis can only approximate the non-linear talent development within a very small range of the future performance output. Because of this, neural networks also seem to be appropriate tools for talent detection purposes (Philippaerts et al. 2008). Studying dynamical systems using equations pertaining to perturbations has some practical disadvantages, since these equations are practically limited to weak nonlinearities (Beek and Beek 1998). To overcome this limitation, graphical methods such as Kohonen feature maps (KFM) to analyze nonlinear behavior have had an increasing impact (Dutt-Muzumder et al. 2011). Due to their pattern detection ability, such methods as e.g. the Self-organizing Kohonen Feature Map may allow to predict the future success of talents by revealing distinct patterns in the individual sets of sport specific dispositions.
Predicting Competitive Swimming Performance

The basic objective of this study was to establish Kohonen’s neural models assisting in the classification process in swimming. The use of clustering where the Kohonen’s network is applied can be very useful from the practical point of view – in spite of the rather incomprehensive (as not directly defined) operating objectives of this network and the lack of the forced operating direction. Due to the projection made by this network we are able to better understand the data, which in turn gives the possibility of improving the process of its further analysis. Based upon such great possibilities of data mining analysis, the Kohonen’s network can be also used in the selection of candidates for competitive sports. The results of the conducted study confirmed Bartlett’s (2006), Tidow’s (2000), Lees (2002) and Murakami’s et al. (2005) findings concerning the use of neural networks in classification of sports results.

By recognizing the clusters existing in the multidimensional data vector names can be attributed to them. Thus, the Kohonen’s network acquires the possibility of their classification according to internal logic of the data itself, and not on the grounds of arbitrary criteria. Based upon such great possibilities of data mining analysis, we can use the Kohonen’s network also in the selection of candidates for competitive sports training. The obtained model has the form of a topological map, where certain areas can be separated. Upon determining map areas corresponding to particular athletes or their groups, we can identify the determined map areas. Therefore, it is necessary to specify the average sports development level achieved by the athletes represented by each of the neurons. The map constructed in this way can be used in the assessment of candidates for sports training. On the grounds of a characteristic, a subject is assigned to one of the determined classes. One can expect that the candidate will achieve the level of sports development similar to the average development level of subjects qualified to this group during network learning. In conclusion, models based on Kohonen’s networks showed that by use of independent variables, they could accurately group subjects into categories which after a year achieve very good, average or poor results. This implies that these models may be used for data mining analysis, which aims at assisting in the recruitment process of candidates for the javelin throw. Ročniok et al. (2007) conducted a study on a group 140 swimmers from the Silesia Macroregion in Poland found that models based on Kohonen’s networks showed that by use of independent variables, they could accurately group subjects into categories which after a year, achieve very good, average and very weak performances. This implies that these models may be used for data mining analysis, which is aimed at assisting recruitment of candidates for sport swimming. Hohman and Seidel (2003) show that neural networks are able to recognize global patterns of different talent make-ups, they are a worthwhile tool in the detection of talents under the condition of non-linear talent development. Hence, from a dynamical systems point of view, a successful neural network modeling may be interpreted as a representation of deviations of the different states of the system from equi-probability, in our case the identification of swimmers performance. This is a very interesting aspect of the modeling of competitive performances, because the non-linear dynamic systems perspective is rapidly emerging as one of the dominant meta-theories in the natural sciences, and there is also reason to believe that in the future it will eventually provide a more general integrative understanding in training science, as well.

This objective of this paper was to determine whether the talent development outcome can be modeled by means of the nonlinear mathematical method of artificial neural networks.

We conclude that the results of this research confirm that Kohonen’s Feature Map can be used for optimization of swimmers classification and prediction of sports results. On the grounds of analysis of standardized Beta values one can say that the biggest predictability for the distance of the javelin throw was shown by such qualities as: Relative Peak Power, Relative Mean Power and Relative VO2 max.
References


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