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Dear Readers,

If ever a field needed greater attention and more outlets for theory and research, sports science and sports medicine is it. The proportion of sports science and sports medicine related journals to overall journals are negligible (just 81 recognized by Web of Science in 2014). The proportion of sport science to all other fields is overwhelming as is the contribution of sports science and sports medicine to the development of the sports systems worldwide. It is with this in mind that we ship on this journey of discovery and trigger a new scientific journal: Montenegrin Journal of Sports Science and Medicine.

Over the past three years, the journal has undergone a major change. Hence, important to its continuing growth, regular and timely publication has been ensured. On a positive note, there has been a steadfast increase of articles received for publication indicating a growing interest among researchers to publish their work in our journal. The journal has published per issue, an average of five articles of mixed variety, from authors from Croatia, USA, Sweden, Portugal, Spain, Austria, Switzerland, France, Czech Republic, Turkey, India, Serbia, Japan, Brazil, as well as from Montenegro.

The editorial board has taken an initiative in the direction of indexing the journal. The journal has also employed a team of editors to strengthen the process of indexation. It was represented by Assist. Prof. Stevo Popovic, PhD and Assist. Prof. Selçuk Akpinar, PhD. The strengths and weaknesses of the journal were highlighted by the committee. A few recommendations were made to increase chances for a successful indexation, especially in Thomson Reuters and Scopes databases (still under evaluation). These include the need for a more constant editorial board and to include, in the board, members from as many participating countries as well as renowned researchers from the larger international world; and the need for a more regular of at least a quarterly publication per year.

I would also remind all authors that Montenegrin Journal of Sports Science and Medicine provides an ideal forum for exchange of information on aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side, in various formats: original papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers.

Finally, we wish to encourage more contributions from the scientific community and industry practitioners to ensure a continued success of our journal. Authors, reviewers and guest editors are always welcome. We also welcome comments and suggestions that could improve the quality of our journal.

Thank you for reading us and we hope you will find this issue of MJSSM informative enough.

Editor-in-Chief
Prof. Duško Bjelica, PhD
Effect of Egg White Protein Supplementation Prior to Acute Resistance Training on Muscle Damage Indices in Untrained Japanese Men

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A B S T R A C T

The purpose of this study was to assess the effects of egg white (E) protein supplementation on the muscle damage indices and muscular soreness after acute resistance training (RT) compared with soy (S) or no protein supplementation (C). In this cross-over study, six healthy untrained men completed three RT trials. Participants were asked to consume a meat-free diet and refrain from high-intensity activities during all trial periods. On the day of RT, participants ingested one of three test beverages containing water only or water containing either 20 g of E or S protein 1.5 hours after breakfast, then performed 60 minutes of RT. Blood was drawn at baseline, before, immediately after, and 30 minutes after RT to assess blood glucose, lactate, insulin, growth hormone (GH), creatine kinase activity (CK) and cortisol levels. Urinary 3-methylhistidine (3-MetHis), urea nitrogen (UN), and creatinine (CRE) were measured using 24-h urine samples, and muscular soreness was measured by a visual analog scale. The daily protein intake was approximately 0.8 g/kg body weight in all three groups. Each lactate, GH, CK, cortisol, 3-MetHis, or muscular soreness increased significantly after RT, with no significant differences between the three groups. The UN was significantly higher in the E and S groups compared to the C group. The RT exercise protocol successfully induced blood biochemical changes, muscle damage or muscle soreness in all three groups with no significant differences, and pre-exercise protein supplementation taken in excess may accelerate protein catabolism.

Key words: 3-methylhistidine, urea nitrogen, muscle soreness.

Introduction

For athletes, the most important issue is how to induce muscle hypertrophy than concerning their health. Evans (1992) proposed that exercise-induced muscle damage or muscle protein breakdown (MPB) may be the primary stimulus for muscle hypertrophy. Furthermore, Phillips, Hartman, and Wilkinson (2005) used established models of muscle amino acid (AA) turnover to examine how protein source (milk versus soy) acutely affects the processes of muscle protein synthesis (MPS) and MPB after resistance exercise training (RT). The authors also showed that even if balanced quantities of total protein and energy were consumed, milk proteins were more effective in stimulating AA uptake and net protein deposition in skeletal muscle after RT than hydrolyzed soy proteins, suggesting that some kinds of protein and AA supplements decrease MPB while concurrently increase MPS (Phillips et al., 2005; Moore et al., 2009).

On the other hand, there are many reports to study the impact of protein supplementation on RT and nutritional interventions such as whey hydrolysate, soy protein or casein (Tang, Moore, Kujbida, Tarnopolsky, & Phillips, 2009), essential amino acid (EAA, Bird, Tarpenning, & Marino, 2006) or branched-chain amino acids (BCAAs, Howatson et al., 2012). However, there are little available data regarding the effects of egg white protein supplementation on post-exercise MPS or MPB. Egg white protein is also an ordinary, high-protein, low-fat food, and like soy protein, has the highest AA score (100%) (Gilani, 2012). Moore et al. (2009) reported that post-exercise ingesting 20 g of intact whole egg protein was sufficient to maximally stimulate MPS, and AA availability was the main factor driving muscle anabolism associated with feeding after RT. Although it is necessary to
just carry out protein balance to muscular hypertrophy, there was few available data whether pre-exercise dietary protein supplementation increases post-exercise MPS or MPB.

RT fundamentally stimulates the process of MPS which was depend on exercise-induced increases in endogenous anabolic hormones, such as growth hormone (GH) and insulin-like growth factors (Ghanbari-Niaki, Nabatchian, & Hedayati, 2007; Hoffman et al., 2008; West & Phillips, 2012). In addition, urinary nitrogen (UN) sometimes used as an index of protein intake (Young, El-Khoury, Raguso, Forslund, & Hambraeus, 2000). Furthermore, a perceived muscle discomfort and soreness (MS), perceived fatigue or urinary 3-methylhistidine (3-MetHis) sometimes used as an index of MPB (Evans, 1992; Lukaski, Mendez, Buskirk, & Cohn, 1981).

The aim of this study was to estimate the effect of pre-exercise egg white protein on bloody and urinary biochemical changes after RT. Our hypothesis was that pre-exercise egg white supplementation, as well as soy protein which was previously reported to be effective in MPS, would produce significant effects on MPS but decrease MPB compared with no protein supplementation. We have used cortisol and GH as indicators of MPS, urinary UN excretion as an index of protein intake, and urinary 3-MetHis and serum creatine kinase (CK) activity as indicators of MPB after RT.

Materials and Methods

Participants

Six healthy male university students with no allergic to egg white or soy, and who did not exercise on a regular basis at least four months prior to study, volunteered to participate in this study. The mean (±SE) age, height, and body mass weight (BW) were 21.2 (±0.3) years, 173.6 (±2.8) cm, and 62.7 (±2.8) kg, respectively. All participants voluntarily provided written informed consent prior to study initiation after a full explanation of all procedures and possible risks of the study. This study was approved by the Human Research Ethics Committee of Tokyo University of Agriculture (ID: 0802, June 2008).

Experimental Design

This cross-over study was based on eight-day testing periods separated by intervals of at least seven days. Each testing period began on Day-1 and ended the meat-free diet consisting of grains, beans, and milk, and 24-hour urine sample collection on Day-8 (Figure 1). Participants were allocated into one of three groups; egg white protein (E), soy protein (S), and mineral water control (C) group with no additive, and all were carried out this study protocol three times, and asked not to change their lifestyle behaviors.

Figure 1. Experimental protocol

On Day-5 RT loading day, participants arrived at the laboratory at 8:00 AM, and had a breakfast consisting of a rice ball (energy, 355 kcal; protein, 6.7 g; carbohydrate, 78.1 g). At 9:30 AM, after baseline blood sample collection and perceived MS measurements, one of the three test beverages was ingested. At 11:00 AM, participants started a RT exercise protocol. Blood samples were collected additional three times (before, immediately after, and 30-minutes after RT), perceived MS was four more times at 30-minutes, 24-hour, 48-hour, and 72-hour after RT, and a 24-hour urine sample was for five days from Day-3 to Day-8.

Test Beverages

Each test protein beverages for the E and S group contained 20 g of protein per package (Table 1), and were prepared isoenergetically and donated by Kewpie Corporation, Tokyo, Japan. Each supplement was delivered as a dry powder in sealed packages with a number code, and was stored in a refrigerator until use. Supplements were reconstituted and dissolved in 200-ml of mineral water prior to intake.
Resistance Exercise
Two weeks before the experimental protocol, one-repetition maximum (1-RM) strength and preliminary measurements were undertaken. After a standardized warm-up exercise, 1-RM estimates were determined by using multiple-RM tests (Bachle, Earle, & Wathen, 2000) with standard gym equipment (Senoh, Chiba, Japan) such as seated row, fly, leg extension, and leg press. After equipment familiarization, each participant performed five or less loading sets during which the weight stack was adjusted to determine the amount of weight the participant could lift 5-12 times repeatedly. Then, 1-RM was predicted using the determined amount of weight and number of repetitions.

On the Day-5, participants completed warm-up sets, and the RT bout three sets of 10 repetitions at ~80% 1-RM with one min rest between sets and two minutes between each RT exercise. Test protocol was concluded with stretching (10 minutes). Verbal encouragement was consistently given during all attempts.

Rating of Perceived Fatigue and Muscle Soreness
Participants sat on a chair and rated their perceived fatigue and MS at four sites: anterior thigh, posterior thigh, chest, and back using a visual analogue scale which consisted of a line from 0-mm (no fatigue/pain) to 100-mm (unbearable fatigue/pain). The scores at the four sites were summed to obtain a total perceived MS score. Data were expressed in centimeters.

Blood Biochemistry and Urine Analysis
Lactate levels in whole blood were measured with Lactate Pro (Arkray, Inc., Shiga, Japan). A tube containing EDTA was used to collect blood for analyses of red blood cell (RBC) counts, hemoglobin and hematocrit levels, a tube containing sodium fluoride was glucose, and a tube with no additives was triglycerides, total protein, albumin, immunoreactive insulin (IRI), GH, cortisol, and CK, respectively. Blood biochemical parameters, urinary daily 3-MetHis and UN, and MS were analyzed using a two-factor repeated measures analysis of variance (ANOVA) with within–subjects factors for protein type treatment (egg, soy and control) and time. In cases in which significant main effects or interactions were present, a post hoc analysis was conducted by using Bonferroni adjustments.

Dietary intakes and Activity Records
Participants completed a self-reported weighed food record during each trial to assess compliance with the meat-free diet and changes in daily food intake between trials. They were given verbal and written instructions for food recording before initiation of the first trial. Daily energy and nutrient intake were calculated based on the Standard Tables of Food Composition in Japan 2010 by a registered diettian. Physical activity levels between trials were also determined using dietary analysis software by a total MET-hour score for that day (Excel Eiyokun FFQg ver. 2.5, Kenpakusha, Japan).

Statistics
All data were expressed as mean±SE. A one-factor repeated-measured ANOVA was used to characterize protein types in physical activity level, BW, total weight lifted, dietary intakes, AUC 3-MetHis or AUC UN for 3 days, respectively. Blood biochemical parameters, urinary daily 3-MetHis and UN, and MS were analyzed using a two-factor repeated measures analysis of variance (ANOVA) with within–subjects factors for protein type treatment (egg, soy and control) and time. In cases in which significant main effects or interactions were present, a post hoc analysis was conducted by using Bonferroni adjustments. The α level for significance was set at p <0.05. All data were analyzed using IBM SPSS Statistics 20.0 for Windows (IBM Japan, Tokyo, Japan).

Results
Participant Characteristics
There was no significant difference between the three groups in physical activity levels, BW, total weight lifted on Day-5 and dietary intakes (Table 2). Most of the participants had a dietary protein intake of approximately 0.8 g/kg BW/day. During the experimental periods, participants consumed 62.0% of dietary protein from grain, 16.3% from soy beans, 10.9% from whole egg, 9.1% from milk products, 1.0% from meat, and 0.7% from fish. The volume of mineral water intake during RT was not different between the three groups.

Table 1. Nutrient profiles of protein supplements

<table>
<thead>
<tr>
<th></th>
<th>E group</th>
<th>S group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Composition (26 g/package)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dried egg-white (g)</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Isolated soy protein (g)</td>
<td>0</td>
<td>23.3</td>
</tr>
<tr>
<td>Powdered oil (g)</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Dextrin (g)</td>
<td>1.2</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Nutritional profile (26 g/package)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>98</td>
<td>95</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>EAA (mg)</td>
<td>10,240</td>
<td>8,860</td>
</tr>
<tr>
<td>BCAA (mg)</td>
<td>4,560</td>
<td>3,940</td>
</tr>
<tr>
<td>Amino acid score</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Note. E: egg white protein group; S: soy protein group; EAA: essential amino acids; BCAA: branched chain amino acids. Energy (kcal), protein (g) and amino acids (mg) were calculated based on the Standard Tables of Food Composition in Japan 2010: Amino acid composition of foods.
Table 2. Participant characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>E (kg)</th>
<th>S (kg)</th>
<th>C (kg)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weighta</td>
<td>62.08 ± 3.11</td>
<td>61.94 ± 2.96</td>
<td>62.63 ± 3.34</td>
<td>0.411</td>
</tr>
<tr>
<td>Total weight liftedb</td>
<td>8670 ± 416</td>
<td>8316 ± 399</td>
<td>8505 ± 309</td>
<td>0.553</td>
</tr>
<tr>
<td>Physical activity levelc</td>
<td>1.75 ± 0.09</td>
<td>1.71 ± 0.10</td>
<td>1.78 ± 0.10</td>
<td>0.315</td>
</tr>
</tbody>
</table>

Energy and nutrient intake d

<table>
<thead>
<tr>
<th>Energy (kcal/day)</th>
<th>E</th>
<th>S</th>
<th>C</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1961 ± 112</td>
<td>1941 ± 105</td>
<td>1849 ± 60</td>
<td>0.375</td>
</tr>
<tr>
<td>(kcal/kg BW/day)</td>
<td>32.2 ± 2.9</td>
<td>32.0 ± 2.9</td>
<td>30.1 ± 2.3</td>
<td>0.502</td>
</tr>
<tr>
<td>Protein (g/day)</td>
<td>52.0 ± 2.9</td>
<td>50.4 ± 2.8</td>
<td>47.7 ± 1.3</td>
<td>0.164</td>
</tr>
<tr>
<td>(g/kg BW/day)</td>
<td>0.85 ± 0.08</td>
<td>0.83 ± 0.07</td>
<td>0.77 ± 0.04</td>
<td>0.090</td>
</tr>
<tr>
<td>Fat (g/day)</td>
<td>47.8 ± 6.4</td>
<td>48.0 ± 5.8</td>
<td>44.5 ± 5.3</td>
<td>0.613</td>
</tr>
<tr>
<td>(g/kg BW/day)</td>
<td>0.79 ± 0.11</td>
<td>0.79 ± 0.11</td>
<td>0.73 ± 0.10</td>
<td>0.529</td>
</tr>
<tr>
<td>Carbohydrate (g/day)</td>
<td>315.4 ± 15.8</td>
<td>308.1 ± 16.8</td>
<td>304.2 ± 9.7</td>
<td>0.713</td>
</tr>
<tr>
<td>(g/kg BW/day)</td>
<td>5.19 ± 0.47</td>
<td>5.08 ± 0.47</td>
<td>4.95 ± 0.40</td>
<td>0.546</td>
</tr>
</tbody>
</table>

Note. Values are expressed as mean±SE (n=6). E: egg white protein group; S: soy protein group; C: control group (no protein group).
aOne-factor repeated measures ANOVA.
bBody weight was at baseline on Day-5.
cParticipants lifted this total mean weight during RT.
dPhysical activity level, and energy and nutrient intake were for seven days.

Table 3. Changes in blood biochemical parameters

<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline</th>
<th>Before</th>
<th>Immediately after</th>
<th>30 min after</th>
<th>G</th>
<th>T</th>
<th>G x T</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC (10^6/μL)</td>
<td>E 473 ± 10</td>
<td>465 ± 13</td>
<td>509 ± 15</td>
<td>466 ± 13</td>
<td>0.191</td>
<td>&lt;0.001</td>
<td>0.346</td>
</tr>
<tr>
<td>Hb (g/dL)</td>
<td>E 14.2 ± 0.3</td>
<td>14.0 ± 0.4</td>
<td>15.0 ± 0.4</td>
<td>14.0 ± 0.4</td>
<td>0.097</td>
<td>&lt;0.001</td>
<td>0.850</td>
</tr>
<tr>
<td>Ht (%)</td>
<td>E 43.5 ± 0.9</td>
<td>42.5 ± 1.0</td>
<td>47.2 ± 1.5</td>
<td>42.7 ± 1.3</td>
<td>0.298</td>
<td>&lt;0.001</td>
<td>0.361</td>
</tr>
<tr>
<td>TP (g/dL)</td>
<td>E 6.9 ± 0.1</td>
<td>6.8 ± 0.2</td>
<td>7.8 ± 0.2</td>
<td>7.2 ± 0.2</td>
<td>0.160</td>
<td>&lt;0.001</td>
<td>0.381</td>
</tr>
<tr>
<td>Alb (IU/L)</td>
<td>E 4.3 ± 0.1</td>
<td>4.2 ± 0.1</td>
<td>4.9 ± 0.1</td>
<td>4.4 ± 0.1</td>
<td>0.581</td>
<td>&lt;0.001</td>
<td>0.139</td>
</tr>
<tr>
<td>Glu (mg/dL)</td>
<td>E 89.8 ± 5.0</td>
<td>75.5 ± 4.4</td>
<td>83.5 ± 2.0</td>
<td>84.5 ± 3.3</td>
<td>0.881</td>
<td>0.037</td>
<td>0.302</td>
</tr>
<tr>
<td>TG (mg/dL)</td>
<td>E 56.8 ± 11.2</td>
<td>53.3 ± 10.8</td>
<td>57.7 ± 11.6</td>
<td>50.3 ± 10.3</td>
<td>0.675</td>
<td>0.232</td>
<td>0.342</td>
</tr>
<tr>
<td>Lactate (mmol/L)</td>
<td>E 1.3 ± 0.1</td>
<td>1.1 ± 0.1</td>
<td>1.0 ± 0.1</td>
<td>1.0 ± 0.0</td>
<td>0.863</td>
<td>&lt;0.001</td>
<td>0.524</td>
</tr>
<tr>
<td>Cortisol (μg/dL)</td>
<td>E 122 ± 20.6</td>
<td>121.8 ± 19.3</td>
<td>140 ± 20.4</td>
<td>141.8 ± 24.7</td>
<td>0.107</td>
<td>&lt;0.001</td>
<td>0.804</td>
</tr>
</tbody>
</table>

Note. Values are expressed as mean±SE (n=6). E: egg white protein group; S: soy protein group; C: control group (no protein). RBC: red blood cell; Hb: hemoglobin; Ht: hematocrit; Glu: blood glucose; TG: triglyceride; TP: total protein; Alb: albumin; IRI: immunoreactive insulin; GH: growth hormone; CK: creatine kinase activity; G: protein group; T: time; G x T: interaction effect of protein type x time.
aTwo-factor repeated measures ANOVA was used for the analysis.
Blood Biochemical Parameters

For all blood biochemical parameters, there was no significant main effect of protein type or interaction effect of protein type with time (Table 3). However, there was a significant main effect of time in RBC, hemoglobin, hematocrit, total protein, albumin, glucose, lactate, CK, GH, and cortisol levels. Increases in lactate, CK, GH, and cortisol levels immediately after RT were higher than increases in RBC, hemoglobin, hematocrit, total protein, and albumin. Lactate levels showed an 8-fold increase immediately after RT compared to before, and then decreased to a 2.7-fold increase at 30-minutes after RT (p=0.013 and p=0.007, respectively). CK increased significantly just after RT and remained high at 30-minutes after RT compared to before (p=0.003 and p=0.020, respectively). GH and cortisol levels significantly increased immediately after RT and thereafter, gradually decreased 30-minutes after RT. However, there was no significant main effect of time in TG and IRI.

Urinary 3-MetHis and UN Response

Urinalyses were performed except one who failed to collect a urine sample. There were no main effects of protein type and time, or interaction effects of 3-MetHis (Figure 2a), and there was no significant difference in AUC of 3-MedHis by protein type (Figure 2c). In contrast, UN showed a significant interaction effect (Figure 2b). Bonferroni post-hoc test revealed that AUC of UN was significantly higher in both E and S groups compared to C group (Figure 2d; E vs. C group: p=0.025, S vs. C group: p=0.044).

Perceived Fatigue and Muscle Soreness

Neither a significant main effect of protein group nor an interaction effect was found in perceived fatigue or all MS scores. A significant main effect of time was observed for perceived fatigue scores (Figure 3a, p=0.029). Perceived fatigue scores increased 30-minutes after RT, and then decreased gradually until 72-hours after. Perceived MS scores in the anterior thigh (Figure 3c), chest (Figure 3e), and back (Figure 3f) except for the posterior thigh (Figure 3d), all showed a significant main effect of time. Accordingly, total perceived MS scores showed a main effect of time (Figure 3b). The Bonferroni post-hoc test revealed that anterior thigh, chest, and total MS scores increased 30-minutes after RT and significantly increased 24-hours post-exercise compared with the baseline, respectively. These scores were the highest in the C group, but not significant.
Discussion

To our knowledge, this is the first study to investigate the effects of pre-RT supplementation of E protein on muscle damage induced by acute RT exercise in untrained young men. Our protocol successfully caused blood biochemical changes and muscle damage with time, but no significant differences was found between the three groups. Furthermore, urinary UN excretion increased significantly in protein supplementation groups compared to the C group.

In our study, participants ingested 20 g of E or S protein. Moore et al. (2009) examined the ingestion of 0, 5, 10, 20, or 40 g whole egg protein following RT on MPS, and reported that ingestion of 20 g intact protein (~8.6 g EAAs) maximally stimulated MPS. And also dietary protein consumed after RT in excess of the rate at which it could be incorporated into tissue protein stimulated irreversible oxidation. Furthermore, Borsheim, Tipton,
Wolff, and Wolfe (2002) showed that post-exercise stimulation of MPS almost twice as greater after ingestion of 6 g compared with only 3 g EAAs. In our present study, 20 g of E and S protein contained 10.2 g and 8.9 g EAA, respectively. Even if MPS is stimulated with 20 g protein intakes (Moore et al., 2009; Borsheim et al., 2002), participants in our study had sufficient levels of protein or EAA to stimulate MPS.

In addition, hemoglobin, hematocrit, TP, and albumin levels increased significantly immediately after RT, suggesting that hemo-concentration might be occurred. We also observed significant increases in lactate, CK, GH, and cortisol levels immediately after RT. Evidence has accumulated that circulating GH and insulin-like growth factor I play crucial roles in growth, development, and maintenance of skeletal muscle (Ghanbari-Niaki, Nabatchian, & Hedaya, 2007; Hoffman et al., 2008; West & Phillips, 2012), strongly suggesting that our present RT protocol is as effective for inducing GH and lactate response, and enhancing MPS or MPB.

On the other hand, there were no significant changes in urinary 3-MetHis excretion between the three groups in our study. Several methodological and physiological factors may influence the measurements, including protein (Candow et al., 2008), and carbohydrate (CHO) (Roy, Fowles, Hill, & Tarnopolsky 2000; Bird, et. al., 2006) supplementation during and/or after RT. Candow et al. (2008) examined the effect of low-dose creatine and protein supplementation during RT (3/day for 10 wk), and reported that creatine and protein supplementation induced a significant decrease in 3-MetHis compared with an increase of placebo (p <0.05). Additionally, Roy et al. (2000) provided iso-energetic CHO (1 g/kg BW) and CHO/protein/fat supplements and placebo immediately and 1-hour following RT, and reported that no significant differences were observed for urinary 3-MetHis between the trials. Therefore, we used a cross-over design to control for inter-individual variations in the contributions of skeletal muscle vs. non-skeletal muscle protein to urinary 3-MetHis excretion. In addition, this study was undertaken under the meat-free conditions because it is difficult to determine whether marked suppression of MPB occurs due to protein intake.

Bird et al. (2006) also reported that blood biochemistry, insulin, cortisol, and urinary 3-MetHis excretion were affected by the CHO treatment during the exercise, and CHO-induced suppression of cortisol release contributed to the reduction in 3-MetHis excretion, but not EAA. The result is possibly the same case in our present study: changes in serum cortisol level were minor, daily meals containing higher CHO could have led to attenuate an acute RT-induced increase in cortisol, and this probably concern with small changes in 3-MetHis excretion. In fact, Roy, Tarnopolsky, MacDougall, Fowles, and Yardasheki (1997) reported that a CHO supplement consumed immediately after RT (1 g/kg BW) decreases urinary 3-MetHis excretion.

In a point of supplement timing, Candow, Chilibeck, Facchi, Abeyesekara, and Zello (2006) determined the effects of protein supplementation immediately before (PRO-B) and after (PRO-A) RT for 12 weeks in older men, and observed that there were no significant changes in 3-MetHis. In the present study, 3-MetHis excretion might not be independent of supplement timing.

Assessing of muscle damage can also use the perceived MS scores, and these scores elevated after an RT bout. We hypothesized that pre-RT supplementation with E or S protein would reduce skeletal muscle damage and perceived soreness: because of the net effect of RT to induce muscle hypertrophy is to shift net protein balance to a more positive value (Phillips et al., 2005), net protein balance remains negative in the absence of feeding and stimulating MPS to an extent where net protein balance becomes positive, for a transient time. However, our data showed that perceived MS peaked at 24-hours post-RT with or without protein supplementation. These peak MS times are consistent with observations by Nelson, Conlee, and Parcell (2004) and Buckley et al. (2010), but not with other reports (Green, Corona, Doyle, & Ingalls, 2008; Howatson et al., 2012). There are conflicting data on MPB or MS with protein supplementation, suggesting the possibility that in contrast to our hypothesis, protein supplementation might have no effect on various MPB indices. Potential explanations for these negative findings include time (pre-RT, during, after RT) and duration of protein supplementation, with or without CHO supplementation and the type of exercise (downhill training, eccentric, ultra-marathon).

Surprisingly, UN excretion increased significantly in both protein supplementation groups compared with the C group. UN is a major vehicle for elimination of nitrogen arising from AA in the body, and UN excretion increases in response to increased dietary protein intake in humans (Young, El-Khoury, Raguso, Forslund, & Hambraeus, 2000). This suggested that pre-exercise protein consumption or dose in excess would ultimately lead to oxidative loss of the MPS response to RT.

There are several limitations of this study. First, the study participants were all untrained individuals. In addition, we had no positive control and could not properly determine under our protocol. Second, we did not set up a no-breakfast control group. Thirdly, we examined only the acute response following RT, and we cannot address long-term effects. Finally, our sample size was too small, which could have caused large variations in 3-MetHis. Previous studies have used nearly the same samples as our present studies (Moore et al., 2009; Howatson et al., 2012; Bird et al., 2006). Despite these limitations, our results clearly showed that the present experimental protocol properly induced muscle damage with no significant influence of E protein supplementation, and pre-exercise protein supplementation may accelerate protein catabolism.

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Conflict of Interest

The authors declare no conflict of interest.

References


Comparison of the Anaerobic Power of Brazilian Professional Football Players Grouped by Tactical Position

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ABSTRACT

Football is characterized as a predominantly aerobic modality, however, during a match; the most important actions performed by the players are in short duration and high intensity. In addition, this sport presents to have some particularities, such as, highlights differences of each tactical position. Thus, this study aimed to compare the anaerobic power of professional football players grouped by different tactical positions. Thirty professional football players separated in three groups, goalkeepers+fullbacks, sideways+DMF (defensive middlefields) and OMF (offensive middlefields)+forwards, performed two anaerobic power tests, Running anaerobic sprint test and Sargent jump test. Goalkeepers+fullbacks showed higher values of body mass index and absolute anaerobic power (w), using Sargent jump test than the others, but when analyzed the RAST results, this same group presented lower values (p<0.05) of relative AP (w·kg⁻¹). OMF+forwards showed to have the best Pmed and Pmax values (p<0.05), and absolute anaerobic power (w), using Sargent jump test than the others, but when analyzed the RAST results, this same group presented lower values (p<0.05) of relative AP (w·kg⁻¹).

Key words: Anaerobic power, Sprint test, Football, Tactical position.

Introduction

Football is one of the most popular sports practiced in the world and moves in their matches, televised or not, millions of fans who enrich this sport. This way, with the growing of the communication vehicles and the high investment from the soccer clubs for the formation and preparation of athletes, some researchers passed to pursue better understanding about this modality with the goal to improve performance of those individuals. This sport is characterized as a predominantly aerobic modality being 80-90% of the energy used coming from the oxidative system (Santos & Soares, 2001). However, during an official football match, the athletes also realize another physical actions of short duration and high intensity (sprints, jumps, spins), being predominant, in this cases, the anaerobic-glycolytic system. Souza (1999) examined that, in a football match, a player performs one sprint every 90 seconds. Besides, some studies (Di Salvo, Tschan, Calderon Montero, Bachl and Pigozzi, 2007; Di Salvo, Gregson, Atkinson, Tordoff and Drust, 2009) pointed that, is executed 17 sprints of 20 meters per match by each player. This way, the decisive moments of a football match seem to depend these actions, independent of the player’s position in the tactical formation, so, is justified the need to monitor the anaerobic power for a better performance in these athletes (Asano, Oliveira and Bartolomeu, 2009).

Anaerobic Power (AP) is defined by Franchini (2002) as the maximal liberated energy for time unit by the anaerobic-glycolytic system, being evaluated using several methods: Wingate (Franchini, 2002), Continuous Jump (Bosco, 1999), Squat and Countermovement Jump Test (Markovic, Dizdar, Jukic and Cardinale, 2004), Sargent Jump Test (SJT) (Salles, Mello, Vasconcellos, Júnior and Dantas, 2010), Running-bases Aerobic Sprint Test (RAST) (Zacharogiannis, Paradisis and Tziortis, 2004) and yo-yo test (Bangsbo, Laia and Krustrup, 2008). However, according to Kiss (2003), the greater the similarity of the mechanical test mode in question, the greater the practical usefulness of the training. Nevertheless, the RAST stands out, by maybe being the test that is more related to the actions of football.

In addition, football presents to be a complex sport with some particularities, among which, highlights differences of each tactical position, such as, traveled distance per match (Santos et al., 2001; Zagatto, Miyagi, Sakugawa and Papotii, 2013), anaerobic threshold (Santos et al., 2001; Zagatto et al., 2013), VO₂max (Santos et al., 1999), body composition (dos Santos, 1999), and especially the quantity of actions in high intensity that each player executes.

On the other hand, there’s a lack of studies that investigate the AP of professional football players grouped by tactical position, in a way that, studies such as Santos, Coledam and dos Santos (2009), Dal Pupo, Almeida, Detanico, Silva, Guglielmo and Santos (2010), Asano et al. (2009) and Asano, Bartholomeu-Neto, Ribeiro, Barbosa and Sousa (2009), made use of the sample distribution and different methodologies of analysis from those employed in the present study, using overall average as in indicative of data central tendency, not showing the
possible tendencies of different physiological demands and consequent adaptations between each position that the sport may have.

Thus, in order to contribute to a better physical preparation of football athletes, the present study aimed to compare the AP values of professional players grouped by different tactical positions.

Methods

Sample

The sample consisted in thirty professional football players with 25.1±4.4 years old from a professional soccer club registered in the Brazilian Football Confederation. All volunteers signed an informed consent and were informed about the risks and procedures adopted. The experimental protocol followed the legal resolution 466 of the National Health and were approved by the ethics committee of the university research center UNIRG (process number 0001/2008).

Protocols

Was evaluate the values of maximal AP (Pmax), medium AP (Pmed) and minimal AP (Pmin) through the Running Aerobic Sprint Test (RAST) validated by Zacharogiannis et al (2004), which consisted in six sprints of 35 meters with 10 seconds of interval between then. Were also used the Sargent Jump Test (SJT), following the protocol previously described by Matsudo (2005), in order to verify the vertical jumping as well as to estimate the anaerobic power. All calculations to obtain the AP values were obtained by using the Lewis equations as suggested by Asano, Oliveira and Bartolomeu (2009).

Statistical Treatment

The normality and homogeneity of data were assessed by the Shapiro-Wilk and Levene tests, respectively. Only the variables Pmax, Pmed e Pmin RAST absolute (W) of the attackers (n=5) didn’t showed normal distribution, being p=0.009, p=0.007, p=0.034, respectively. This way, the results referring to those variables were expressed in median and confidence intervals of 95% (CI=95%). Some of the tactical positions had just a few players, therefore, the subjects were grouped according to his physiological need during the match: goalkeepers+fullbacks (n=9), sideways+defensive middlefields (DMF) (n=11) and offensive middlefield (OMF)+forwards (n=10). To compare all variables between groups were applied the One Way ANOVA followed by Tukey’s Post-hoc. The significance level were fixed in 5% (p<0.05). All procedures were realized with support of the software Statistical Package for the Social Sciences 20.0 for Windows.

Results

Table 1 contains values relating to characterize the sample, as well as the absolute values of absolute AP (w) and relative AP (w·kg⁻¹) separated according to playing position.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Goalkeepers+Fullbacks (n=9)</th>
<th>Sideways+DMF (n=11)</th>
<th>OMF+Forwards (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>26.9±6.0</td>
<td>24.1±3.8</td>
<td>24.5±3.3</td>
</tr>
<tr>
<td>BM (kg)</td>
<td>85.1±8.2*</td>
<td>71.5±6.3</td>
<td>72.9±7.0</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>186.6±4.4*</td>
<td>177.6±4.2</td>
<td>175.4±5.5</td>
</tr>
<tr>
<td>BMI (kg·m⁻²)</td>
<td>24.4±1.4†</td>
<td>22.6±1.6</td>
<td>23.7±1.3</td>
</tr>
<tr>
<td>BF (%)</td>
<td>11.4±1.2</td>
<td>10.9±1.5</td>
<td>11.2±2.3</td>
</tr>
<tr>
<td>SJT (cm)</td>
<td>42.3±2.9</td>
<td>42.2±6.1</td>
<td>46.2±3.6</td>
</tr>
<tr>
<td>SJT (w)</td>
<td>1200.1±112.0*</td>
<td>1005.4±102.9</td>
<td>1074.3±92.2</td>
</tr>
<tr>
<td>SJT (w·kg⁻¹)</td>
<td>14.1±0.5</td>
<td>14.1±1.0</td>
<td>14.8±0.6</td>
</tr>
<tr>
<td>Pmax RAST (w)</td>
<td>903.9±108.2</td>
<td>862.3±102.9</td>
<td>976.7±124.5</td>
</tr>
<tr>
<td>Pmed RAST (w)</td>
<td>743.9±85.1</td>
<td>712.1±92.4</td>
<td>771.5±89.5</td>
</tr>
<tr>
<td>Pmin RAST (w)</td>
<td>595.6±82.3</td>
<td>584.9±91.4</td>
<td>626.5±79.0</td>
</tr>
<tr>
<td>Pmax RAST (w·kg⁻¹)</td>
<td>10.7±1.5†</td>
<td>12.1±1.4</td>
<td>13.4±1.4</td>
</tr>
<tr>
<td>Pmed RAST (w·kg⁻¹)</td>
<td>8.8±1.3‡</td>
<td>10.0±1.1</td>
<td>10.6±1.0</td>
</tr>
<tr>
<td>Pmin RAST (w·kg⁻¹)</td>
<td>7.0±1.1*</td>
<td>8.2±1.0</td>
<td>8.6±1.2</td>
</tr>
</tbody>
</table>

*- Significant difference (p<0.05) from the others; †- Significant difference (p<0.05) from the sideway+MDF group; ‡- Significant difference (p<0.05) from the OMF+forwards group.

Table 2 presents the results grouped by tactical position with similar physical requirements for a football match. Thus, when analysed the anthropometric variables was observed that the group formed by goalkeepers+fullbacks had higher values (p<0.05) of body mass (BM) and height in relation to the other groups, as well as higher BMI values (p<0.05) compared to the sideways+DMF group. In regarding to the SJT, goalkeepers+fullbacks also showed higher values (p<0.05) of absolute AP (w) than the other groups. However, the relative AP (w·kg⁻¹) values showed no significant difference (p>0.05).

When analyzed the RAST results, goalkeepers+fullbacks had lower values (p<0.05) of relative Pmin (w·kg⁻¹) in relation to the other groups (Table 2). The same players, also showed lower values (p<0.05) of relative Pmed and Pmax (w·kg⁻¹) when compared to the OMF+forwards group. No statistical differences were founded in the remaining variables (p<0.05).

With regard the associations between the tests, absolute values of AP (w) from the SJT and RAST, the results indicated a weak (r=0.432), but significant correlation (p = 0.017). On the other hand, when analyzed the same association, but, in relative values to BM (w·kg⁻1), the results showed a moderate (r=0.517) and significant (p=0.003) association.
Table 2. General characteristics of the sample (n = 30). Data expressed as mean (±) standard deviation, and median and their respective 95% confidence intervals (95% CI).

<table>
<thead>
<tr>
<th>Tactical Position</th>
<th>Goalkeepers (n=3)</th>
<th>Sideways (n=4)</th>
<th>Fullbacks (n=6)</th>
<th>DMF (n=7)</th>
<th>OMF (n=5)</th>
<th>Forwards (n=5)</th>
<th>Total (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>29.8±6.8</td>
<td>23.6±2.7</td>
<td>25.4±5.5</td>
<td>24.3±4.5</td>
<td>25.1±4.2</td>
<td>23.9±2.6</td>
<td>25.1±4.4</td>
</tr>
<tr>
<td>BM (kg)</td>
<td>87.8±13.9</td>
<td>70.1±9.5</td>
<td>83.8±4.8</td>
<td>72.3±4.3</td>
<td>71.3±5.1</td>
<td>74.5±8.8</td>
<td>76.1±9.2</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>187.7±7.2</td>
<td>178.0±4.2</td>
<td>186.0±3.0</td>
<td>177.4±4.5</td>
<td>173.4±5.6</td>
<td>177.4±5.3</td>
<td>179.6±6.6</td>
</tr>
<tr>
<td>BMI (kg·m⁻²)</td>
<td>24.8±2.1</td>
<td>22.0±2.0</td>
<td>24.2±1.1</td>
<td>23.0±1.3</td>
<td>23.7±1.0</td>
<td>23.6±1.6</td>
<td>23.5±1.6</td>
</tr>
<tr>
<td>BF (%)</td>
<td>11.2±1.4</td>
<td>10.8±2.0</td>
<td>11.5±1.2</td>
<td>10.9±1.3</td>
<td>11.4±1.9</td>
<td>11.1±2.9</td>
<td>8.0±1.2</td>
</tr>
<tr>
<td>SJT (cm)</td>
<td>40.7±3.2</td>
<td>45.5±7.7</td>
<td>43.0±2.6</td>
<td>40.3±4.6</td>
<td>45.6±3.4</td>
<td>46.8±4.1</td>
<td>43.6±4.8</td>
</tr>
<tr>
<td>SJT (W)</td>
<td>1213.8±169.9</td>
<td>1021.4±135.9</td>
<td>1193.2±91.5</td>
<td>996.3±90.3</td>
<td>1044.6±58.1</td>
<td>1104.0±116.5</td>
<td>1086.2±129.9</td>
</tr>
<tr>
<td>SJT (W·kg⁻¹)</td>
<td>13.9±0.5</td>
<td>14.6±1.2</td>
<td>14.2±0.4</td>
<td>13.8±0.8</td>
<td>14.7±0.5</td>
<td>14.8±0.6</td>
<td>14.3±0.7</td>
</tr>
<tr>
<td>Pmáx RAST (W)</td>
<td>871.0±95.0</td>
<td>919.3±102.3</td>
<td>919.3±119.1</td>
<td>829.7±94.9</td>
<td>922.2±141.8</td>
<td>1079.0 (924.7-1137.7)</td>
<td>912.7±118.7</td>
</tr>
<tr>
<td>Pméd RAST (W)</td>
<td>706.7±88.2</td>
<td>728.5±70.0</td>
<td>762.5±85.0</td>
<td>702.7±107.3</td>
<td>739.2±89.9</td>
<td>803.8 (697.3-910.3)</td>
<td>741.4±89.9</td>
</tr>
<tr>
<td>Pmin RAST (W)</td>
<td>557.3±114.0</td>
<td>591.3±67.2</td>
<td>614.7±65.8</td>
<td>581.3±107.8</td>
<td>589.0±48.2</td>
<td>664.0 (551.7-776.3)</td>
<td>602.0±83.8</td>
</tr>
<tr>
<td>Pmáx RAST (W·kg⁻¹)</td>
<td>10.4±1.6</td>
<td>13.2±1.4</td>
<td>11.0±1.5</td>
<td>11.5±1.0</td>
<td>12.9±1.7</td>
<td>13.9±1.1</td>
<td>12.1±1.8</td>
</tr>
<tr>
<td>Pméd RAST (W·kg⁻¹)</td>
<td>8.1±1.4</td>
<td>10.5±0.7</td>
<td>9.1±1.2</td>
<td>9.7±1.2</td>
<td>10.4±1.1</td>
<td>10.8±1.0</td>
<td>9.8±1.3</td>
</tr>
<tr>
<td>Pmin RAST (W·kg⁻¹)</td>
<td>6.4±1.1</td>
<td>8.5±0.4</td>
<td>7.4±1.1</td>
<td>8.0±1.2</td>
<td>8.3±0.8</td>
<td>8.9±0.9</td>
<td>8.0±1.2</td>
</tr>
</tbody>
</table>

Discussion

The present study proposed to compare AP values in professional football players grouped by tactical position with similar physical demand. This way, the obtained results contribute to the evaluation and monitoring of the variable in question. Since Santos et al. (2009) suggest that, due to the tactical position specificity and the bioenergetic source of each test, some methods should be more specific to each athlete, taking into account his tactical position and/or his anthropometric characteristics.

The findings referring to RAST diverge from the present literature that used similar samples to this study. Cetolin, Foza, Silva, Guglielmo, Siqueira, Cardoso and Crescente (2009) applied the RAST in adult football players and Sideways showed the better results in Pmax and Pmed values, whereas, our study, OMF+forwards has the best Pmax and Pmed values. Furthermore, it was also observed that, goalkeepers+fullbacks group showed worse results than the OMF+forwards group in all relative AP values and a Pmed relative value worse than the Sideways+DMF group.

Which may be partly explained due to the metabolic demand of RAST and the specific adaptive response to training of each tactical positions investigated. So, means that, the Sideways+DMF and OMF+forwards groups had stimulus during their training and matches that required more anaerobic actions, generating better results in his RAST values.

Moreover, the results obtained in SJT showed no statistical difference between the groups when using the relative values of AP (w·kg⁻¹), on that account, we suggest that this test has a higher anaerobic demand than the RAST, being so, a more adequate test for fullbacks and goalkeepers. About the significant differences in SJT absolute values, the results can be justified by the anthropometric profile of each group, such as goalkeepers+fullbacks that have higher values of height and body mass, therefore, showed much higher values of absolute AP than the other groups, but, this difference is diluted and inexistent in AP relative values (w·kg⁻¹).

Another studies used similar methodologies, such as Coelho et al. (2010) that made a comparison between a Sprint Test and SJT and didn’t find any significant difference when comparing the values between tactical positions. On the other hand, the players’ anaerobic power were evaluated only in absolute values, not taking in account the body composition of each athlete, what may explain the results.

Cruz (2005) evaluated the AP of 279 Portuguese professional football players, since 1996 to 2006, by using RAST and found that forwards has the better results than the other positions. Cruz explain that, this may happen because forwards perform a higher volume of high intensity actions during the match. Corroborating with Cruz (2005) and the present study, Mohr, Krustrop, Nybo, Nielsen and Bangsbo (2003) pointed that offensive middlefields and forwards travels more distance and in a higher speed during a football match when compared with the other tactical positions.

Therefore, football athletes that play in a more forward tactical position performs much more anaerobic actions such as jumps, sprints, spins and goal kicks, so forwards tend to express great glycolytic capacity and a higher anaerobic efficiency, being more tolerant to acidosis, enabling then to perform much more movements in a high intensity with less reduction of mechanical efficiency (Rienzi, Drust, Reilly, Carter and Martin, 2000).
Nevertheless, football is very a complex sport and is played all around the world by many different countries, creating different “football cultures”. All these cultures, has his on methods of training in each stratum, such as infant, base category, amateur and professional, creating a lot of different players profiles to all tactical positions. So, there is not a universal method of physical training for football players that will work with his high efficiency in all football cultures, generating a need of monitoring and study every one of those to understanding his better capacities and potentials.

Therefore, the association of the values of maximal AP from different tests point that these tests should be used together with a monitoring and evaluation process of the athletes, in a way that the physiological demand of each test can extract the maximal capacity of the player, resulting a more accurate value of anaerobic power, and if is to be compared with another player, their anthropometric measures should be taken in account.

Conclusion

Given the exposed, we conclude that offensive middlefields and forwards have better relative AP values (w·kg⁻¹) of Pmax and Pmed using RAST when compared to other tactical positions. Goalkeepers and fullbacks had the worst values of AP when using RAST values, but not when used SJT. Moreover, we suggest the use of SJT and RAST together when is proposed measure the anaerobic power of football players, and also a anthropometric evaluation, so the training can be more specific e efficient to each tactical position and athlete.

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Comparative Study of Anthropometric Measurement and Body Composition between Elite Handball and Basketball Players

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ABSTRACT
The purpose of this study was to describe anthropometric characteristics and body composition of elite handball and basketball players as well as to make comparisons between them. Fifty-nine males were enrolled in the study, divided into three groups: fifteen handball players, fourteen basketball players and thirty healthy sedentary subjects. The descriptive statistics were expressed as a mean (SD) for each variable, while the ANOVA and LSD Post Hoc tests were carried out to detect the effects of each type of sport. The results showed there was no significant difference in body mass index among the groups, while a significant difference was found for body height and body weight as well as for all three of the body contents measured (muscle, bone and fat) among the groups. These findings may give coaches from the region better working knowledge and suggest to them to follow recent selection process methods and to be more careful during the recruitment.

Key words: Sport, Top-Level, Handball, Basket, Male.

Introduction
Improvement of the athletes performance is a relevant topic in wide scientific literature (cited in Popovic, Akpinar, Jaksic, Matic, & Bjelica, 2013; Popovic, Bjelica, Jaksic, & Hadzic, 2014) as well as identifying talent, strengths and weaknesses, assigning player positions and helping in the design of optimal training programmes (cited in Hadzic, Bjelica, & Popovic, 2012). However, authors prefer to research the issues such as increasing the physical fitness of athletes than considering the assessment of their body composition and their nutritional status (Triki et al., 2012). The main goal of the modern scientific approach in the area of sport sciences is recognize the standard performance of elite players and recognize and utilize the talents as early as possible. However, this work is not quite easy; mostly due to the reason the various athletic events require differing body types to achieve maximum performance. From this reason, it is important to get to know the characteristics of the body composition of elite players well enough, due to the reason this is considered an essential part of the total management process (Wilmore, 1982). On the other hand, it is relevant to specify that young athletes grow in a manner similar to non-athletes (cited in Popovic et al., 2014), it is widely recognized in the scientific literature that adequate profiles are primarily important in various sports disciplines, mostly due to the reason that absolute size contributes a significant percentage of total variance associated with athletic success (Carvajal et al., 2012). Therefore, scientists all over the world are looking for a standard formula that can improve the performance of elite players and discover talents as early as possible.

The anthropometrical characteristics and body composition of athletes has been the subject of many investigations as many researchers hypothesized the practicing athletes might be expected to exhibited structural and functional characteristics that are specifically favorable for the sport (S. Singh, K. Singh, & M. Singh, 2010).

According to Massuca & Fragoso (2011), body composition and body mass contribute among other factors to optimal exercise and performance, body mass can influence an athlete’s speed, endurance, and power, whereas body composition can affect strength and agility. However, there is most of descriptive data concerning characteristics of handball and basketball players from America and Western Europe, although there is a lack of data from Eastern Europe and this study aims to check if this is true for Serbian athletes. Hence, many previous studies have evaluated ideal anthropometric profile of successful handball player (Srboj, 2002; Chauauach et al., 2009) as well as basketball player (Gualdi-Russo & Zaccagni, 2001; Bayios, Bergeles, Apostolidis, Noutsos, & Koskolou, 2006; Hooper, 1997) that provide insights into the requirements for competing at top level in particular sports. Indeed, handball is team sport that is generally played in an indoor field and requires a high standard of aerobic and anaerobic fitness in order to complete 60 minutes of competitive play and to achieve success through an intermittent high intensity body-contact and well-coordinated activities (Buchheit, Lepretre, Behaegel, Millet, & Ahmadi, 2009). Team handball is one of the fastest and the most endurance required team sports and is epitomized by special maneuvers such as jumping, shooting under the pressure, faking against hard defense players and attempting fast breaks despite all the fatigue (Bilge, 2013). On the other hand, basketball is a team sport that is generally also played in an indoor field that is smaller than that of a handball field, and it requires a high standard of preparation in order to complete for 40 minutes of competitive play and to achieve success. In this game, movement patterns differ from handball, as it requires different specific work/rest ratio and/or effort distributions during games.

Hence, the purpose of this study was to describe anthropometrical characteristics and body composition profiles of elite handball and basketball players and to detect possible differences in relation to competition level.
Methods

Participants

Fifty-nine males were enrolled in the study. They were divided into three groups: fifteen handball players (23.13±0.22 yrs.) from the handball premier league in Serbia, fourteen basketball players (23.50±2.77 yrs.) from the basketball premier league in Serbia and thirty healthy sedentary subjects from the same country (24.77±3.00 yrs.). The measurements were carried out in the first three months of 2007.

Variables

All subjects were clinically healthy and had no recent history of infectious disease, asthma or cardio-respiratory disorders. All of them gave their written consent and the local ethics committee approved the protocol of the study. All subjects were assessed for the anthropometric measures required for the calculation of body composition variables, using the standardized procedure recommended by the International Biological Program (IBP) standards respecting the basic rules and principles related to the parameter choice, standard conditions and measurement techniques, as well as the standard measuring instruments adjusted before measurement was carried out. Height and weight were measured in the laboratory with the subject dressed in light clothing. Height was measured to the nearest 0.1 cm using a fixed stadiometer, and weight was measured to the nearest 0.1 kg with a standard scale utilizing a portable balance. Body mass index (BMI) was calculated as body mass in kilograms divided by height in meters squared (kg/m²). Skinfolds (mm) were measured at six sites: triceps skinfold thickness, forearm skinfold thickness, thigh skinfold thickness, calf skinfold thickness, chest skinfold thickness and abdominal skinfold thickness (using a skinfold caliper). Each individual measurement and the sum of the six measurements were used for analysis. The circumferences of the upper and lower arm and the upper and lower leg were measured in centimeters and the following diameters were measured to the nearest 0.1 cm: elbow diameter, wrist diameter, knee diameter, ankle diameter, upper arm diameter, forearm diameter, thigh diameter, and calf diameter. To reduce measurement variation, the same investigator examined all of the subjects.

Table 1. Anthropometric Measurement and Body Composition among the Subjects

<table>
<thead>
<tr>
<th>Variables</th>
<th>Handball (N=26)</th>
<th>Basketball (N=14)</th>
<th>Control (N=31)</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± Standard Deviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>188.16±0.81</td>
<td>199.50±7.37</td>
<td>183.72±7.60</td>
<td>0.000*</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>86.63±0.87</td>
<td>99.57±11.60</td>
<td>86.74±14.68</td>
<td>0.007*</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.47±0.65</td>
<td>24.94±1.40</td>
<td>25.61±3.49</td>
<td>0.330^</td>
</tr>
<tr>
<td>Muscle content of body (%)</td>
<td>52.85±0.80</td>
<td>51.26±1.99</td>
<td>48.32±3.27</td>
<td>0.000*</td>
</tr>
<tr>
<td>Bone content of body (%)</td>
<td>15.29±0.36</td>
<td>16.22±0.77</td>
<td>14.78±1.78</td>
<td>0.014*</td>
</tr>
<tr>
<td>Fat content of body (%)</td>
<td>12.41±0.08</td>
<td>11.54±1.97</td>
<td>18.51±5.89</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

Note: N - number of subjects; BMI - body mass index; ^ - non-significant; * - significant difference between groups.

Statistical analyses

The data obtained in the research was processed using the application statistics program SPSS 20.0, adjusted for use on personal computers. The descriptive statistics were expressed as a mean (SD) for each variable. Analysis of the variance (ANOVA) and the LSD Post Hoc test were carried out to detect the effects for each type of sport (handball or basketball) on each variable: body height, body weight, body mass index (BMI), and muscle, bone and fat content of the body, as well as to control it by sedentary subjects. The significance was set at an alpha level of 0.05.

Table 2. Differences among the Subjects

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>(I) Group</th>
<th>(J) Group</th>
<th>Mean Difference (I-J)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>Basketball</td>
<td>Handball</td>
<td>11.34</td>
<td>0.00*</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>Basketball</td>
<td>Control</td>
<td>15.63</td>
<td>0.00*</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Control</td>
<td>4.29</td>
<td>0.07^</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>12.94</td>
<td>0.01*</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Control</td>
<td>12.34</td>
<td>0.00*</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Control</td>
<td>-0.60</td>
<td>0.88^</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>-1.59</td>
<td>0.16^</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Control</td>
<td>3.00</td>
<td>0.03*</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Control</td>
<td>4.60</td>
<td>0.00*</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>0.94</td>
<td>0.09^</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Control</td>
<td>1.45</td>
<td>0.04*</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Control</td>
<td>0.51</td>
<td>0.27^</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Handball</td>
<td>-0.87</td>
<td>0.60^</td>
</tr>
<tr>
<td></td>
<td>Basketball</td>
<td>Control</td>
<td>-7.23</td>
<td>0.08*</td>
</tr>
<tr>
<td></td>
<td>Handball</td>
<td>Control</td>
<td>-6.36</td>
<td>0.00*</td>
</tr>
</tbody>
</table>

Note: ^ - non-significant; * - significant difference between groups.

Results

The anthropometric characteristics of subjects are shown in Table 1. There was no significant difference in body mass index among the groups, while a significant difference was found for body height (F=22.22), body weight (F=5.37) and all contents of body among the groups: muscle (F=4.63), bone (F=6.75) and fat (F=16.96).
The significant differences of anthropometric characteristics among particular sports are shown in Table 2. The LSD Post Hoc test indicates that basketball players were significantly heavier than handball players and the subjects of control group, while there was no significant difference between the height of handball players and the height of the subjects in the control group. This test also indicates that basketball players were significantly heavier than handball players and the subjects of control group, while there was no significant difference between the weight of handball players and the subjects of the control group. The muscle contents of the bodies of the subjects in control group were significantly lower than that of all of the other subjects, while there was not any difference between handball and basketball players, while the fat contents of the bodies of the subjects in control group were significantly higher than that of all of the other subjects, while there was not any difference between handball and basketball players. Lastly, the bone content in the bodies of the subjects in the control group was significantly lower than the basketball players, while there was not found any other differences in this content.

**Discussion**

The results support previous investigations indicating a significant difference regarding the body height. Thus, selection criteria, different type of play and game rules between the basketball and handball game can explain the observed difference. However, our handball players are shorter than European players from the 2007 World Handball Championship. For example, the average height of Germany, the winning team was 194 centimeters, while the 15th Korea had an average of 187 centimeters and the 18th Kuwait had 184 centimeters. However, the teams from Africa and Asia are comparably shorter than the majority of European Teams (Taborsky, 2007). Therefore, this doubt may give coaches from Serbia better working knowledge of this particular group of athletes and suggest them to follow recent selection process methods and to be more careful during the recruitment as they have very tall population in general (Popović, Bjelica, Molnar, Jakšić, & Akpiner, 2013). On the other hand, the average height of professional basketball players in 2007 to 2008 season, according to available data from NBA.com, was 200.6 centimeters. From the other side, the average heights of the national basketball team’s participants of the semi-finals in the 2012 Olympic Games in London, according to available data from official website, were following USA (200.1 cm), Spain (202.4 cm), Russia (201.2 cm) and Argentina (197.4 cm). This proves that the players from our basketball premier league are tall enough and they do not lag behind the top players in the world. However, this is not a surprise, as it is well known that the density of very tall subjects appears to be characteristic of the people from this area, since 28% of people from the general population were measured 190 centimeters or above in body height (Bjelica, Popović, Kezunović, Petković, Jurak, & Grasgruber, 2012). Therefore, this fact may give coaches from Dinaric Alps better working knowledge of this particular group of athletes and suggest them to follow recent selection process methods and to be more careful during the recruitment, as they have a very tall population in general (Pineau, Delamarche, & Božinović, 2005) which confirms the high score of the subjects from control group (183.72 cm).

Furthermore, it was expected that basketball players were heavier than handball players and the subjects of the control group, mostly due to the reason they are significantly taller than both mentioned groups. However, the reason we have such heavier players in basketball has also to do with the fact that the average size of the basketball players has increased dramatically in the past decades. This could be a function of better nutrition, especially in professional basketball leagues, partly due to the use of nutritional supplements as well as anabolic steroids etc. If we compare our data to the average personal details of all participants in the 2012 Olympic Games in London by each sport: handball (82.5kg) and basketball (87.0kg), we can prove that the players from our premier leagues are much heavier. The body mass index (BMI; weight/height2) is parameter that is widely used in adult populations such as an internationally recognized definition of overweight and obesity (cited in Kovač, Jurak, & Leskošek, 2012). Fortunately, the body mass index of all three groups is in the area of normal weight according to the established literature and it did not show any significant differences among the groups.

Indeed, we found that muscle content of handball and basketball players were significantly higher than control subjects, while bone content of basketball players were insignificantly higher than handball players and significantly higher than control subjects. These results may be explained by the fact that both, handball and basketball players have to use both, upper and lower extremities, and have higher percent of the muscle content than the players use just lower extremities (Popović, Bjelica, Petković, & Muratović, 2012). These results may be also explained by more demands to grow the muscle contents of the body in games that requires intermittent activities when high-intensity activities are followed by low-intensity intensity type of movements (Buchheit et al., 2009), such as handball, basketball etc. Moreover, it was expected that the percent of fat mass of the control group is significantly higher than the handball and basketball players and these results could be explained by less physical activity in controls (Popović et al., 2014). However, it is interesting that the percent of fat content in the body of handball players are insignificantly higher than the percent of fat content in the body of basketball players. These results may be explained by an increased aerobic activity in basketball players, whereas handball trainings contains more anaerobic activity than basketball as this game requires higher intensity body-contact and well-coordinated activities (Buchheit et al., 2009). Although handball matches have duration of 60 minutes divided in two halves lasting 30 minutes each, handball players cover a total distance ranging approximately from 2,000 to 6,000 meters (Popović et al, 2012). This is less shorter distance (5,000 to 7,000 meters) that basketball players cover (Dezman & Erçuli, 2005; Erçuli & Sup, 2006), although basketball matches have duration of 48 minutes divided in four parts lasting 12 minutes each. These distances are based upon different circumstances in each sport. The first of all it depends on position, then tactical defensive or offensive characteristics, or characteristics of the game.

This study suggests that handball and basketball decreased percent of fat content if we compare it to control group. On the other hand, this study also suggests that the muscle content of handball and basketball players seems to be explained by a greater percent compared to the subjects of control subjects, while the differences in the bone content are logical consequences. Lasty, the part attributed to the body height is the main causes of selection process.

Considering that the measurements were conducted in the middle of the season, this study is limited by the fact that changes in body composition and physical performance may occur from the start to the end of an athlete’s training and competitive season (cited in Silvestre et al., 2006). Kraemer et al. (2004)
reported that athletes who enter a season with a high catabolic metabolic status could experience reductions in performance during a competitive season accompanied by detrimental changes in body composition. Accordingly, further studies should be very careful in projecting timelines for measuring anthropome- 

R E F E R E N C E S


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Analysis of the Relevant Factors of Retaining Women in Judo

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ABSTRACT

This study aimed to determine the latent dimensions of all relevant factors about engagement of women in judo, to determine the intercorrelations among these latent dimensions, as well as the correlations with three relevant variables. Final goal was to determine the differences in revealed latent dimensions, in relation to several independent variables: educational level, marital status, impulses to engage in judo, then depending are the women athletes (competitors) or not, members of the Board or not, trainers or not. A total of 50 female judokas from a larger number of Croatian clubs were examined, by specially composed the survey. The results showed that all seven questionnaires showed medium to high satisfactory reliability, together with good construct validity, in 15 latent dimensions that are revealed. It can be noticed that relatively older women have more obligations and more barriers that oppose to their engagement in judo. Only small number of differences are found among women engaged in judo, mainly among participants who are members of the Board in the club or Croatian Judo Federation, as compared with those who are not. Small number of statistically significant differences (as well as the correlations) can be also observed as the fact that all women partially share similar problems, while the media strategies are perceived as the most powerful to increase women’s persistence in judo, in any type of engagement.

Key words: barriers, commitments, judo, motivation, strategies.

Introduction

Combat sports (judo included) are traditionally seen as a male sport. Judo has been an Olympic sport since 1964, while women’s judo has been an unofficial part of the Olympic Games since 1988, and officially since 1992 (Lucić & Gržeta, 2000). Unlike the situation with many other sports, there is equal interest in men’s and women’s judo, which was certainly aided by the fact that both the men’s and women’s judo competitions are held together and promoted equally by international sports organizations: the European Judo Union (EJU) and the International Judo Federation (IJF).

Judo is a relatively new sport in Croatia. The first judo club in Croatia was founded in 1951 in Zagreb by Hugo Roshanz, a former judo competitor for Germany, who came to Croatia after World War II as a prisoner of war (Lucić & Gržeta, 2000). Women started training judo at the same time as their male counterparts in Croatia and, according to the recollections of the authors of this article, the training session were seldom held separately. Although the history of women’s judo in Croatia starts at the same time as that of men’s judo, there were far fewer female judo practitioners at the very beginning (Croatian Judo Federation, 2013). The national policy concerning gender equality in Croatia stresses the need to make sports more accessible to women (Štimac Radin, 2011). The Croatian National Policy for Gender Equality 2011 – 2015 redefines national priorities and ways of implementation of measures that need to be taken, in accordance with changing social and political circumstances, past accomplishments and further challenges in achieving real gender equality (Štimac Radin, 2011). The Croatian Olympic Committee (COC) had in 2012, with the goal of increasing the percentage of women participating in sports, and especially in sports management, recommended to all of its national governing body members that there should be at least 40 percent of women in all sports associations by the end of 2015. The COC Commission for Women in Sports was also founded in 2012 (Croatian Olympic Committee, 2012).

According to the membership records of the Croatian Judo Federation (Croatian Judo Federation, 2013), women comprise 23 percent of registered contestants in all age groups. However, a significant number of female practitioners in the senior age group (5%) stop competing completely. According to data from 2013, only 13 percent of female judo practitioners are in management positions (not connected with contests). In other words, the percentage of women in judo, and especially in sports management, is far lower than the recommended 40 percent (Croatian Judo Federation, 2013). Based on the number of active male and female competitors (the percentage of female competitors ranges from 17 to 27 percent in different age groups), as well as coaches and those working in sports management (the percentage of women ranges from 0 to 25 percent), it can be safely assumed that women’s judo is not a popular sport in...
Croatia (Croatian Judo Federation, 2013). According to official data, only 13 percent of women occupy other positions in judo, and the real percentage is probably even lower. Women often hold several positions in judo, so a significant number of the same women in judo can be found among contestants, coaches, judges and in club management (Croatian Judo Federation, 2013). However, the head of the Croatian Judo Federation has now for several mandates been a woman. On the other hand, although there are fewer women in judo than there are men, out of 260 medals Croatia has won in important judo competitions (European and world championships) from 2005 to 2013, 70% of them were won by female competitors. It is also important to mention the recent great success of the junior female team at the World Judo Championship in Ljubljana in 2013 (one gold medal and 2 bronze medals by single competitors and one team bronze) and two bronze medals at the recently held European championship for younger seniors (Croatian Judo Federation, 2013).

The aims of this study were to identify reasons and factors of practicing judo in Croatian women, barriers that they perceive disturbing for their continued engagement judo, either as competitors or as sport employees. Furthermore, we wanted to determine what are the important issues to be addressed that could encourage greater participation of women in sports, which are specific strategies to encourage judoka to stay in judo, and what are the ways to improve the intense media coverage of women in judo. All these findings could allow us to create effective programs to motivate women to practice judo and to persevere in it, either as competitors, or as advanced recreational sports employees. Except determining the latent dimensions of all relevant factors about engagement of women in judo (1), the goals of this research were to determine the correlations among these latent dimensions of all relevant factors about engagement of women in judo (2), as well as the correlations with three relevant variables (number of children, age and period spent engaged in judo) (3). Final goal was to determine the differences in revealed latent dimensions of relevant factors about engagement of women in judo, according to several independent variables: educational level, marital status, impulses to engage in judo, then depending are the women athletes (competitors) or not, members of the Board or not, trainers or not.

Methods

Participants

Fifty female judo competitors and employees, members of 19 Croatian judo clubs, were surveyed as a part of this research: Panda (3), Zagreb (5), Mdosl Osijek (3), Tempo (1), Randori (1), Medvedgrad (3), Maksimir (1), Auto Čuljak Vinkovci (8), Nijenci (1), Pulafit (1), Pujanke (10), Dubrovnik (5), Lika (2), Dalmacijacement (1), Samobor (3), Zagrebačka judo škola (2), Remete (17), Istarski borac (1), Rijeka (1), and from Croatian cities: Zagreb (18), Split (11), Osijek (2), Split (7), Pula (3), Staro Rača (1), Vinkovci (8), Nijenci (1), Dubrovnik (5), Kaštel Lukšić (10), Lastovo (1), Rijeka (1), Samobor (2). The questionnaires were distributed by email from December 2013 to the end of February 2014, with the aid of the Croatian Judo Federation. The questionnaires were also returned to the researchers by email, signed by the surveyed judo practitioners to give their informed consent to participate in the research. The average age of the surveyed female judo practitioners was (M±SD) 26.10±10.77 (a range from 15 to 54 years of age), their average work experience in years 4.70±7.93 (a range from 0 to 34 years), their average years spent practicing judo 14.78±8.21 (a range from 2 to 41), and the average age of children of the surveyed female judo practitioner was 0.48±0.95 (a range from 0 to 3 children). As far as education is concerned, 13 surveyed female judo practitioners have only finished primary school, 22 of them have only a high school diploma, 3 of them have finished post-secondary schools other than college, and ten of them have finished college without enrolling into a postgraduate program. Only two have a postgraduate academic degree. As far as their marital status is concerned, 34 of them are unmarried, 14 are married, and two of them are divorced. Only five of the surveyed practitioners have not won a medal in a national level championship, while 45 of them have. Thirty nine of the surveyed female judo practitioners have won a medal at an international level, while 11 of them have not. Only 19 of them are a part of club management, while the other 31 are not. Only three of the surveyed female judo practitioners are heads of judo clubs. Nine surveyed female judo practitioners hold administrative positions in judo clubs or organizations, while 41 of them do not. Thirty one female judo practitioners from our test set compete in judo tournaments (19 of them do not compete), 14 of them are coaches (36 of them are not), 14 of them work at the tournaments in some official respect, e.g. as judges or notaries (36 of them do not work at the tournaments in some official capacity). Twenty nine surveyed female judo practitioners live at home with their mother, stepmother, or foster mother (21 do not), and 27 of them live at home with their father, stepfather or foster father (23 do not). Thirty seven surveyed female judo practitioners do not have children, while 5 have one child, four of them have 2, and four of them have 3 children. Not a single surveyed female judo practitioner lives with her grandchildren. Only one lives together with her grandfather, and only three of them live together with one of their grandmothers. Thirty five of the surveyed female judo practitioners do not live together with their brothers or sisters. Sixteen of them have a sibling, 7 of them have two siblings, and one has three siblings. Finally, 35 of the surveyed female judo practitioners live alone, while 15 of them do not (they usually live with a husband or with a partner out of wedlock).

Instruments

We have asked the female judo practitioners to respond on the set of questionnaires: the reasons for practicing judo, positive and negative aspects of judo, involvement in other sports, and how much time judo takes away from other obligations. In this research we used modified sentences and questions from the following questionnaires: “Attitudes towards women in judo” and “Obstacles for women in judo” (Khan et al., 2012); “Obstacles for women in sports”, “Promoting greater involvement of women in sports”; “Media coverage of female sports” (Sparks, 2007); “Motivation for participation in sports” (Sports and Physical Activity, 2010). The items in all the questionnaires can be seen in the Tables 1-7, while the assessment scales and detailed descriptive statistics for all the items is performed in our previous articles (Rendulić, Sindik, and Corak, 2013; Rendulić, Sindik, and Corak, 2014).

Statistical Analyses

In the statistical analyses of the data, the software package SPSS 11.0 is used. In the process of determining the main metric properties of the questionnaires, for determining the construct validity of the questionnaires, the method of Principal Component Analysis (PCA) is used (with or without Varimax rotation), while in the case of “Specific strategies to encourage participation and involvement of women in judo”, the most convenient appeared Alpha factoring extraction method with Promax rotation. Several criteria are combined to obtain final
component (factor) solutions: saturation higher than 0.300; Scree Plot; Guttman-Kaiser criterion (eigenvalue greater than 1.00) and interpretability criterion. The results in extracted principal components (factors) in certain questionnaires are expressed in regression factor scores, and then used in further analysis (differences and correlations). The reliability type internal consistency for all components (factors) revealed was determined using Cronbach's alpha coefficient. To determine the differences between each two groups of participants, the Mann Whitney U test is used (in comparison of two samples), while in case of multiple groups of participants, the Kruskal-Wallis test is used. The correlation analyses were performed using Spearman rank-correlation coefficients. The significance of differences commented on the probability level \( p < 0.05 \).

**Results**

Kaiser-Meyer-Olkin's measures of the data matrix's convenience for the factorization and Bartlett's sphericity shown that the intercorrelation matrix suitable for factorization, in all questionnaires (Tables 1-5).

**Table 1.** Component Structure and Reliability of the Questionnaire “Attitudes Towards Women in Judo” (Principal Components Analysis, Varimax rotation)

<table>
<thead>
<tr>
<th>Attitudes towards women in judo</th>
<th>Positive personal motives</th>
<th>Negative environment motives</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you like judo?</td>
<td>.885</td>
<td></td>
<td>.793</td>
</tr>
<tr>
<td>Do you like to be active in judo?</td>
<td>.891</td>
<td></td>
<td>.820</td>
</tr>
<tr>
<td>Do you participate in judo to progress (physically, mentally, socially, emotionally, and psychologically)?</td>
<td>.894</td>
<td></td>
<td>.800</td>
</tr>
<tr>
<td>Our country (Croatia) generally encourages women to get involved in judo for improving health and fitness.</td>
<td>.322</td>
<td></td>
<td>.141</td>
</tr>
<tr>
<td>Croatian culture prohibits women from engaging in judo.</td>
<td></td>
<td>.776</td>
<td>.603</td>
</tr>
<tr>
<td>Cultural factors (e.g. environment in which we live) substantially affect my engagement judo.</td>
<td></td>
<td>.554</td>
<td>.330</td>
</tr>
<tr>
<td>Judo is generally not desirable activity for women in Croatia.</td>
<td></td>
<td>.827</td>
<td>.685</td>
</tr>
<tr>
<td>Family, relatives and social environment in general restrict the possibility for women to deal with judo.</td>
<td></td>
<td>.837</td>
<td>.705</td>
</tr>
<tr>
<td>KMO measure of sample adequacy</td>
<td>0.684</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bartlett's Sphericity test (df=28)</td>
<td>138.178</td>
<td></td>
<td>( p&lt;0.001 )</td>
</tr>
<tr>
<td>Reliability (Cronbach's alpha)</td>
<td>0.666</td>
<td>0.730</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.510</td>
<td>2.366</td>
<td></td>
</tr>
<tr>
<td>Variance explained</td>
<td>31.380%</td>
<td>29.575%</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2.** Component Structure and Reliability of the Questionnaire “Why Are You Engaged in Judo (Motivation)?” (Principal Components Analysis, Varimax rotation)

<table>
<thead>
<tr>
<th>Why are you engaged in judo (motivation)?</th>
<th>Social motives</th>
<th>Relaxation and fun</th>
<th>Ambition and self-esteem</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>to slow down the effects of aging</td>
<td>.782</td>
<td>.369</td>
<td>.614</td>
<td></td>
</tr>
<tr>
<td>for weight control</td>
<td>.743</td>
<td>.369</td>
<td>.691</td>
<td></td>
</tr>
<tr>
<td>to be with friends</td>
<td>.735</td>
<td></td>
<td>.581</td>
<td></td>
</tr>
<tr>
<td>to gain new friends</td>
<td>.642</td>
<td>.335</td>
<td>.594</td>
<td></td>
</tr>
<tr>
<td>to be better integrated into society</td>
<td>.373</td>
<td></td>
<td>.457</td>
<td></td>
</tr>
<tr>
<td>to better look</td>
<td>.562</td>
<td>.444</td>
<td>.515</td>
<td></td>
</tr>
<tr>
<td>to meet people from different cultural backgrounds</td>
<td>.561</td>
<td>.322</td>
<td>.435</td>
<td></td>
</tr>
<tr>
<td>for relaxation</td>
<td>.862</td>
<td>.740</td>
<td>.771</td>
<td></td>
</tr>
<tr>
<td>for improving fitness</td>
<td></td>
<td>.317</td>
<td>.700</td>
<td></td>
</tr>
<tr>
<td>for fun</td>
<td>.306</td>
<td>.730</td>
<td>.636</td>
<td></td>
</tr>
<tr>
<td>to advance self-esteem (feel more valuable)</td>
<td></td>
<td></td>
<td>.844</td>
<td>.738</td>
</tr>
<tr>
<td>to develop new skills</td>
<td>.336</td>
<td>.794</td>
<td>.746</td>
<td></td>
</tr>
<tr>
<td>the spirit of competition</td>
<td></td>
<td></td>
<td>.786</td>
<td>.655</td>
</tr>
<tr>
<td>to be successful in sport</td>
<td>.345</td>
<td>.465</td>
<td>.408</td>
<td></td>
</tr>
<tr>
<td>for schemes to promote health</td>
<td>.377</td>
<td>.387</td>
<td>.332</td>
<td></td>
</tr>
<tr>
<td>KMO measure of sample adequacy</td>
<td>0.741</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bartlett's Sphericity test (df=105)</td>
<td>348.912</td>
<td></td>
<td>( p&lt;0.001 )</td>
<td></td>
</tr>
<tr>
<td>Reliability (Cronbach's alpha)</td>
<td>0.842</td>
<td>0.820</td>
<td>0.753</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>3.391</td>
<td>2.773</td>
<td>2.709</td>
<td></td>
</tr>
<tr>
<td>Variance explained</td>
<td>22.606</td>
<td>18.485</td>
<td>18.060</td>
<td></td>
</tr>
</tbody>
</table>
In the questionnaire “Attitudes towards women in judo” (Table 1), two principal components occurred, which showed moderate high and satisfactory reliability and interpret over 60% of the total variance. Based on the contents of the statements (items) that saturated the principal components, these components are named: Positive personal motives and Negative environmental motives.

In the questionnaire “Why are you engaged in judo (motivation)” (Table 2), three principal components occurred, which showed moderate high and high satisfactory reliability and interprets something less than 60% of the total variance. Based on the contents of the statements (items) that saturated the principal components, these components are named: Social motives, Relaxation and fun and Ambition and self-esteem.

Table 3. Component Structure and Reliability of the Questionnaire “Obstacles to Your Participation in Judo” (Principal Components Analysis, Varimax rotation)

<table>
<thead>
<tr>
<th>Obstacles to your participation in judo</th>
<th>Environmental barriers</th>
<th>Obligations as barriers</th>
<th>Financial, rules, traffic</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural barriers (undesirable that women play sports)</td>
<td>.929</td>
<td>.876</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment unfriendly to women</td>
<td>.921</td>
<td>.875</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timing of the competition</td>
<td>.536</td>
<td>.381</td>
<td>.478</td>
<td></td>
</tr>
<tr>
<td>Time - with regard to family responsibilities</td>
<td>.821</td>
<td>.678</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time - related to business commitments</td>
<td>.765</td>
<td>.591</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of capacity to cater for children</td>
<td>.611</td>
<td>.328</td>
<td>.484</td>
<td></td>
</tr>
<tr>
<td>Equal rules for women and men</td>
<td>.611</td>
<td>.436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prices (financial reasons)</td>
<td>.349</td>
<td>.623</td>
<td>.601</td>
<td></td>
</tr>
<tr>
<td>Lack of transportation options</td>
<td>.595</td>
<td>.436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KMO measure of sample adequacy</td>
<td>0.580</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bartlett’s Sphericity test (df=15)</td>
<td>136.156</td>
<td>p&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability (Cronbach’s alpha)</td>
<td>0.777</td>
<td>0.586</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.207</td>
<td>1.797</td>
<td>1.721</td>
<td></td>
</tr>
<tr>
<td>Variance explained</td>
<td>24.526</td>
<td>19.968</td>
<td>19.119</td>
<td></td>
</tr>
</tbody>
</table>

In the questionnaire “Obstacles to your participation in judo” (Table 3), three principal components occurred, which showed low to moderate high but satisfactory reliability and interprets something over 63% of the total variance. Based on the contents of the statements (items) that saturated the principal components, these components are named: Environmental barriers, Obligations and Combined (financial, rules, traffic).

In the questionnaire “Importance of the following issues in promoting inclusion and participation of women in sports in general” (Table 4), two principal components occurred, which showed moderate high and satisfactory reliability and interprets something over 69% of the total variance. Based on the contents of the statements (items) that saturated the principal components, these components are named: Organization of sport commitments for women and Organization of out-sport commitments for women.

Table 4. Component Structure and Reliability of the Questionnaire “Importance of the Following Issues in Promoting Inclusion and Participation of Women in Sports in General” (Principal Components Analysis, Varimax rotation)

<table>
<thead>
<tr>
<th>Importance of the following issues in promoting inclusion and participation of women in sports in general</th>
<th>Organization of sport commitments for women</th>
<th>Organization of out-sport commitments for women</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase the number of available choices ways sports</td>
<td>.923</td>
<td>.859</td>
<td></td>
</tr>
<tr>
<td>Develop sports in which women can participate and have fun</td>
<td>.914</td>
<td>.856</td>
<td></td>
</tr>
<tr>
<td>Develop a strategy for harmonization obligations with sports</td>
<td>.482</td>
<td>.397</td>
<td>.390</td>
</tr>
<tr>
<td>Develop strategies for occasional babysitting</td>
<td>.894</td>
<td>.805</td>
<td></td>
</tr>
<tr>
<td>Consider the style of dress (dress code)</td>
<td>.743</td>
<td>.641</td>
<td></td>
</tr>
<tr>
<td>Consider the time of the competition</td>
<td>.485</td>
<td>.612</td>
<td>.610</td>
</tr>
<tr>
<td>KMO measure of sample adequacy</td>
<td>0.695</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bartlett’s Sphericity test (df=15)</td>
<td>107.654</td>
<td>p&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Reliability (Cronbach’s alpha)</td>
<td>0.777</td>
<td>0.719</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.251</td>
<td>1.909</td>
<td></td>
</tr>
<tr>
<td>Variance explained</td>
<td>37.521</td>
<td>31.822</td>
<td></td>
</tr>
</tbody>
</table>

In the questionnaire “Specific strategies to improve media coverage of women in judo” (Table 5), only one principal component occurred, which showed moderate high and satisfactory reliability and interprets something over 66% of the total variance. Based on the contents of the statements (items) that saturated the principal component, this component is named: Specific strategies to improve media coverage of women in judo.

In the questionnaire “Specific strategies to encourage participation and involvement of women in judo” (Table 6), two factors occurred, which showed moderate high and very low but still satisfactory reliability and interprets something around
47% of the total variance. Based on the contents of the statements (items) that saturated two factors, these factors are named: Indirectly - judo official and Directly in judo. The correlation among these two factors was 0.548.

Table 5. Component Structure and Reliability of the Questionnaire “Specific Strategies to Improve Media Coverage of Women in Judo” (Principal Components Analysis)

<table>
<thead>
<tr>
<th>Specific strategies to improve media coverage of women in judo</th>
<th>Specific strategies for media</th>
<th>Communaliites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create new internal position specifically designed to promote women's sports</td>
<td>.872</td>
<td>.761</td>
</tr>
<tr>
<td>Increase understanding of the athletes on how to work with the media</td>
<td>.866</td>
<td>.750</td>
</tr>
<tr>
<td>Use of external experts (outside consultants)</td>
<td>.856</td>
<td>.732</td>
</tr>
<tr>
<td>Explore the area of digital media (that potentially allows for greater control of content and distribution)</td>
<td>.838</td>
<td>.702</td>
</tr>
<tr>
<td>Cooperation with other sports</td>
<td>.800</td>
<td>.640</td>
</tr>
<tr>
<td>Use rewards and recognition</td>
<td>.772</td>
<td>.595</td>
</tr>
<tr>
<td>Continue current efforts - be regular and persistent</td>
<td>.671</td>
<td>.450</td>
</tr>
</tbody>
</table>

KMO measure of sample adequacy 0.841
Bartlett's Sphericity test (df=21) 230.329 p< 0.001
Reliability (Cronbach's alpha) 0.913
Eigenvalue 4.631
Variance explained 66.152

Table 6. Factor Structure and Reliability of the Questionnaire “Specific Strategies to Encourage Participation and Involvement of Women in Judo” (Alpha Factoring, Promax Rotation)

<table>
<thead>
<tr>
<th>Specific strategies to encourage participation and involvement of women in judo</th>
<th>Indirectly – judo official</th>
<th>Directly in judo</th>
<th>Communaliites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity to become a member of the Board</td>
<td>.801</td>
<td></td>
<td>.723</td>
</tr>
<tr>
<td>Opportunity to become an official competitions</td>
<td>.667</td>
<td>.514</td>
<td>.476</td>
</tr>
<tr>
<td>Voluntary participation by organizations and sports associations</td>
<td>.585</td>
<td>.309</td>
<td>.342</td>
</tr>
<tr>
<td>Programs for top athletes</td>
<td>.554</td>
<td>.364</td>
<td>.312</td>
</tr>
<tr>
<td>Volunteer roles that can be downloaded</td>
<td>.743</td>
<td>.841</td>
<td>.821</td>
</tr>
<tr>
<td>Identification of the talents</td>
<td>.491</td>
<td>.522</td>
<td>.332</td>
</tr>
<tr>
<td>Training (the ability to become a coach)</td>
<td>.478</td>
<td>.487</td>
<td>.271</td>
</tr>
</tbody>
</table>

KMO measure of sample adequacy 0.748
Bartlett's Sphericity test (df=21) 82.965 p< 0.001
Reliability (Cronbach's alpha) 0.733
Eigenvalue 2.672
Variance explained 38.176

Table 7. Component Structure and Reliability of the Questionnaire “Already Present Initiatives to Encourage Greater Involvement of Women in Judo” (Principal Components Analysis)

<table>
<thead>
<tr>
<th>Already present initiatives to encourage greater involvement of women in judo</th>
<th>Already present initiatives</th>
<th>Communaliites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creation of new programs / games that are specifically aimed at women</td>
<td>.839</td>
<td>.704</td>
</tr>
<tr>
<td>Differentiated funding, with the aim of attracting women</td>
<td>.758</td>
<td>.575</td>
</tr>
<tr>
<td>Programs designed just for women</td>
<td>.756</td>
<td>.571</td>
</tr>
<tr>
<td>Educational activities to promote women's involvement</td>
<td>.671</td>
<td>.450</td>
</tr>
<tr>
<td>Tacit encouragement through promotional events and communication</td>
<td>.653</td>
<td>.427</td>
</tr>
</tbody>
</table>

KMO measure of sample adequacy 0.606
Bartlett's Sphericity test (df=10) 87.396 p< 0.001
Reliability (Cronbach's alpha) 0.777
Eigenvalue 2.727
Variance explained 54.450

In the questionnaire “Already present initiatives to encourage greater involvement of women in judo” (Table 7), only one principal component occurred, which showed moderate high and satisfactory reliability and interprets something over 54% of the total variance. Based on the contents of the statements (items) that saturated the principal component, this component is named: Already present initiatives to encourage greater involvement of women in judo.

Correlations among the variables in the research
In following two analyses we have used obtained latent dimensions, expressed in regression factor scores, to calculate the
correlations among these latent dimensions (Table 9), as well as to establish their correlations with three independent variables:

Table 8. Correlations (Spearman) Among All the Components in All Questionnaires With the Variables: Number of Children, Age and Period Spent in Judo

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of children</th>
<th>Age</th>
<th>Period spent in judo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive personal motives</td>
<td>-0.08</td>
<td>-0.17</td>
<td>-0.16</td>
</tr>
<tr>
<td>Negative environment motives</td>
<td>0.18</td>
<td>0.46**</td>
<td>0.33**</td>
</tr>
<tr>
<td>Social motives</td>
<td>-0.14</td>
<td>-0.13</td>
<td>0.01</td>
</tr>
<tr>
<td>Relaxation and fun</td>
<td>0.06</td>
<td>-0.11</td>
<td>-0.18</td>
</tr>
<tr>
<td>Ambition and self-esteem</td>
<td>-0.05</td>
<td>-0.19</td>
<td>-0.19</td>
</tr>
<tr>
<td>Environmental barriers</td>
<td>-0.15</td>
<td>-0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>Obligations as barriers</td>
<td>0.34*</td>
<td>0.28*</td>
<td>0.23</td>
</tr>
<tr>
<td>Financial, rules and traffic as barriers</td>
<td>-0.04</td>
<td>-0.03</td>
<td>-0.27</td>
</tr>
<tr>
<td>Organization of sport commitments for women</td>
<td>-0.17</td>
<td>-0.22</td>
<td>-0.36**</td>
</tr>
<tr>
<td>Organization of out-sport commitments for women</td>
<td>0.33*</td>
<td>0.23</td>
<td>0.24</td>
</tr>
<tr>
<td>Specific strategies for media</td>
<td>0.07</td>
<td>0.04</td>
<td>-0.01</td>
</tr>
<tr>
<td>Indirectly - judo official</td>
<td>0.25</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Directly in judo</td>
<td>0.36*</td>
<td>-0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>Already present initiatives involving women in judo</td>
<td>-0.10</td>
<td>-0.11</td>
<td>-0.24</td>
</tr>
</tbody>
</table>

* Correlation significant with p<0.05 (two-tailed)
** Correlation significant with p<0.01 (two-tailed)

Among all correlations with three variables (number of children, age and period spent engaged in judo), only seven were statistically significant (six positive and one negative). All significant correlations were low-sized. Negative environmental motives positively and significantly correlated with age and time spent in judo. Women's Obligations as barriers positively and significantly correlated with age and number of children. Organization of sport commitments for women negatively and significantly correlated with time spent in judo, Organization of out-sport commitments for women positively and significantly correlated with number of children, as well as the engagement Directly in judo.

Among all inter-correlations all the components in all questionnaires, only seventeen were statistically significant (all were positive direction). All significant correlations were low to moderate size. Environmental barriers showed none statistically significant correlations with other variables, while Specific strategies to improve media coverage of women in judo showed the highest number of statistically significant correlations with other variables (seven).

Differences in the latent variables of the research

We have tested the differences among three categories of the educational level of participants (elementary school (13); high school (22); bachelor's, master's and doctoral degrees (15)). The only statistical significant difference is found in the variable "Already present initiatives of the involvement in judo" (p<0.05), among elementary school judoka (highest means M±SD 0.990±1.066) and high school judoka (lowest means M±SD -0.453±0.669).

When testing the differences among three categories of the marital status of participants (single (34); married (14); divorced (2)), it appeared that the only statistical significant difference is found in the variable Environmental barriers (p<0.05), among single participants (highest means M±SD 0.156±1.154) and divorced ones (lowest means M±SD -0.400±0.019), as well as married participants (M±SD -0.311±0.474).

When testing the differences among participants in Zagreb (N=15) and in other cities in Croatia (N=35), the only statistical significant difference is found in the variable "Already present initiatives of the involvement in judo" (p<0.05), where lower means (M±SD -0.444±0.721) are found in Zagreb participants than in other cities (M±SD 0.212±1.055).

When testing the differences among participants who are athletes (competitors, N=31) or not (N=19), the only statistical significant difference is found in the variable "Organization of sport commitments for women" (p<0.05), where higher means (M±SD 0.239±0.792) are found in athletes (competitors) than in non-competitors (M±SD -0.389±1.191).

When testing the differences among participants who are members of the Board in the club or Croatian Judo Federation (N=19) or not (N=31), four statistical significant differences are found, in the variables: Organization of out-sport commitments for women (p<0.05; higher means (M±SD 0.144±0.114) for non-members than members 0.002±0.948); Specific strategies to improve media coverage of women in judo (p<0.05; higher means (M±SD; 0.312±0.866) for members than non-members (-0.191±1.141); Environmental barriers (p<0.01; higher means (M±SD; 0.145±0.114) for non-members than members (-0.249±0.763); Combined barriers (financial, rules, traffic) (p<0.05; higher means (M±SD; 0.134±0.951) for non-members than members (-0.231±1.068).

None statistical significant differences are found about the impulses to engage in judo: parents (N=16), friends (N=13) and health, together with being judo fun (N=16). None statistical significant differences are found among those who won the medals on international competitions (N=39) and those who had not (N=11). Also, none statistical significant differences are found about the fact if some participant is a trainer or judo official (referee etc. N=14) or not (N=36).
Table 9. Correlations (Spearman) Among All the Components in All Questionnaires

<table>
<thead>
<tr>
<th></th>
<th>Positive personal motives</th>
<th>Negative environment motives</th>
<th>Social motives</th>
<th>Ambition and self-esteem</th>
<th>Environmental</th>
<th>Obligations</th>
<th>Financial rules</th>
<th>Organization sport</th>
<th>Organization out-sport</th>
<th>Media strategies</th>
<th>Indirectly</th>
<th>Directly in judo</th>
<th>Already present initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive personal motives</td>
<td>1.00</td>
<td>0.00</td>
<td>0.07</td>
<td>0.30*</td>
<td>0.52**</td>
<td>0.12</td>
<td>0.19</td>
<td>0.07</td>
<td>0.46**</td>
<td>0.20</td>
<td>0.37**</td>
<td>0.05</td>
<td>-0.07</td>
</tr>
<tr>
<td>Negative environment motives</td>
<td>1.00</td>
<td>0.23</td>
<td>-0.07</td>
<td>0.01</td>
<td>0.06</td>
<td>0.26</td>
<td>-0.28*</td>
<td>0.15</td>
<td>0.08</td>
<td>0.28*</td>
<td>0.14</td>
<td>0.14</td>
<td>-0.02</td>
</tr>
<tr>
<td>Social motives</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.05</td>
<td>-0.05</td>
<td>0.29*</td>
<td>0.24</td>
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<td>Relaxation, fun</td>
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<td>-0.02</td>
<td>0.32*</td>
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<td>Ambition and self-esteem</td>
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<td>Financial, rules, traffic barriers</td>
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<td>Indirectly - judo official</td>
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* Correlation significant with p<0.05 (two-tailed)
** Correlation significant with p<0.01 (two-tailed)
Discussion

Construct validity and reliability is checked out in seven questionnaires, which are used for the first time in Croatia: all the questionnaires showed satisfactory validity and reliability, and 15 latent dimensions are revealed. These dimensions are named: Positive personal motives, Negative environmental motives, Social motives, Relaxation and fun, Ambition and self-esteem, Environmental barriers to judo participation, Obligations as barriers, Finances and rules and traffic as barriers, Organization of sport commitments for women, Organization of out-sport commitments for women, Specific strategies for media to increase women participation in judo, Indirect strategies—to be judo official, Direct engagement in judo, “Already present initiatives involving women in judo.

When observing the correlations, it can be seen that Negative environmental motives, as well as women's Obligations as barriers positively and significantly correlated with age, time spent in judo and number of children. In other words, relatively older women have more obligations and more barriers that oppose to their engagement in judo, which is the similar trend like in the Europe (Sport and Physical Activity, 2010), or in Australia (Sparks, 2007). Organization of sport commitments for women negatively and significantly correlated with time spent in judo, what can be explained in terms of losing enthusiasm during lifespan, or during the period of increasing number and extent of the obligations. The facts that Organization of out-sport commitments for women positively and significantly correlated with number of children, as well as the engagement Directly in judo, can be explained in terms of the efforts of women that include their children in judo, too, or in other activities. The possible explanation why the Environmental barriers showed none statistically significant correlations with other variables, can lead us to the fact that these barriers couldn’t be easily changed. On the other hand, the fact that highest number of statistically significant correlations with other variables has the variable Specific strategies to improve media coverage of women in judo can be explained in terms of women’s perception of the importance of the media in issues about the engagement of women in sports. All (small number of) statistically significant differences that are found, in relation to several independent variables, can be understood in light of the fact that younger women are mostly competitors, while older are mostly trainers and/or members of the Board. On the other hand, it can be surprising that marital status is reflected only in the Environmental barriers (expected direction: less barriers to single women than in married or divorces ones). Small number of statistically significant differences (as well as the correlations) can be also observed as the fact that women share similar problems, independently of relevant factors to which they are considered. However, negative trend of women’s engagement in sports is perceived in several studies (Sparks, 2007; Sport and Physical Activity, 2010; Women’s Sport and Fitness Foundation support NGBs, 2011; Khan et al., 2012).

To put it succinctly, one the main practical conclusions in this research is that women like judo and that they play various roles in judo (e.g. as competitor or coaches), which in turn enables their personal growth and offers them a sense of accomplishment. However, because of their job-related (and, to a lesser extent, family related) obligations, they cannot devote as much time to judo as they would like to (Rendulić et al., 2014). According to estimates of the participants of the efforts to include women in judo, there is great potential here, and the current initiatives are simply not effective enough. Almost half of the surveyed judo practitioners suggested hiring women in various positions in sports as a solution. These women could work as coaches, judges, tournament officials, members of sports club management, members of the general committee of the Croatian Judo Federation (CJF) and as selectors. Giving women an opportunity to be educated for these positions is one of the prerequisites for women to be able to take over some of these positions. Greater media coverage of the sport could also be of help (Rendulić et al., 2014).

The most important advantage of this research is that it is the first of this type in Croatia, and that we surveyed more than a quarter of female judo practitioners in Croatia. The flaw of the research is the relatively small test set which is not representative of the age groups of the female judo practitioners (which was unavoidable). Creating effective programs to motivate women to practice judo without giving it up in the later stages, either as competitors, for recreational purposes or as sports officials, represents the long-term solution to the problem of female participation in judo (Rendulić et al., 2014). Understanding the issues better could help the Croatian Judo Federation and its members to improve the support given to women in judo, regardless of their role within judo clubs and organizations.

Conclusions

All seven questionnaires used to explore women engagement in Croatian judo showed moderate to high satisfactory reliability, together with good construct validity, in 15 latent dimensions that are revealed. When considering correlations, it has to be noticed that relatively older women have more obligations and more barriers that oppose to their engagement in judo.

Only small number of differences are found among women engaged in judo, mainly among participants who are members of the Board in the club or in Croatian Judo Federation, as compared with those who are not (four statistical significant differences revealed): Board members and non-members perceive different types of barriers, as well as possibilities to stimulate women engagement and persistence in judo. Small number of statistically significant differences (as well as the correlations) can be also observed as the fact that all women partially share similar problems, while the media strategies are perceived as the most powerful to increase women’s persistence in judo, in any type of engagement.

Acknowledgements

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Why Left-handers/footers are overrepresented in some sports?

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ABSTRACT

Left-handers/footers are found with disproportionately more frequency in many interactive sports compared to the general population. In order to point out this issue, we firstly mentioned about handedness in general and secondly the origin of handedness. Based on the studies in the literature, we then gave examples about the anatomical correlation of handedness. Finally, some explanations were provided to explain the higher rate of lefties in some sports compared to the general population. Regarding the last issue, researchers stated that there are mainly two possible hypotheses to explain this phenomenon; innate superiority and negative frequency hypothesis. Besides those hypotheses, we should also consider that there is a need to have left handed/footed players in some sports to get more tactical advantages. We tried to give some examples regarding those ideas. The studies in the literature state that left handed/footed players, in fact, have both tactical and perceptual advantages in some interactive sports and thus, overrepresented in those sports compared to the general population.

Key words: Left handedness/footedness, sports, tactical advantage, and perception.

Handedness

While on gross inspection, the human body appears anatomically symmetric, asymmetry is a basic organizing principle of the human nervous system (Gazzaniga, 1989). Anatomical asymmetries in the hands (Hardyck & Petrinosich, 1977), feet (Brown & Taylor, 1988), eyes (Bourassa, McManus, & Bryden, 1996; Hebbal & Mysorekar, 2003) and ears (Hebbal & Mysorekar, 2003; Jung & Jung, 2003) are generally small. However, functional asymmetries in the nervous system can result in substantial behavioral asymmetries, including human handedness.

There is little doubt that handedness reflects asymmetries in neural function, rather than anatomical asymmetries in the arms and hands. However, a little is currently known about the neural mechanisms that give rise to handedness. In fact, there is controversy about how to define handedness. Some describe it as a preference for using one or the other hand for specific tasks, such as writing (Oldfield, 1971), while others suggest that the main characteristic of handedness is a difference in performance characteristics between the two limbs (Goble & Brown, 2008; Sainburg, 2002).

It well established that most humans are right-handed, and that the incidence of left- or right-handedness can vary slightly across different cultures (Perelle & Ehrman, 2005). According to cross cultural statistical studies, approximately 88 to 95% of the population from different countries and cultures is right-handed and prefer to use the dominant hand for activities such as throwing or writing (Caliskan & Dane, 2009; Jung & Jung, 2009; Perelle & Ehrman, 1994; Vuoksimaa, Koskenvuo, Rose, & Kaprio, 2009). Singh and Bryden (1994) reported differences in handedness between Canadians and Indians. Those two countries were expected to have very different distribution of handedness because of differences in social pressures to use right hand, which were higher in India. The rate of right-handedness was found to be 90.2% in Canada and 94.8% in India. Similarly, the rate of handedness in Japan, where social pressures are also higher, was shown to be higher than that of Canada (Ida & Bryden, 1996). McManus (2009) used a meta-analysis to draw a map, comparing the distribution of handedness between regions of the USA and many European countries. The variation in handedness across the selected regions changed only about 5%.

Considering the discrepancy of methods used for assessment of handedness or type of criterion used for categorization of handedness, it is generally thought that about 90% of the general population is right-handed (Previc & Saucedo, 1992). Surprisingly, this proportion of right-handed people has remained stable across geographical locations and cultures (Goble & Brown, 2008). Similar to human right hand bias, chimpanzees and other animals often prefer to use one hand or paw for particular actions (Bradshaw & Rogers, 1993). For instance, the work of Hopkins and Leavens (1998) has shown that adult chimpanzees significantly gestured with their right hand than with their left hand which shows the evidence for lateralization and right hand bias among chimpanzees. Thus, both humans and some animals show a strong preference for the right hand for several actions. In fact, this right hand bias for humans has maintained over the course of time by most of the population. Markers of hand preference in prehistory are found in material culture from the actions of lateralized tool manufacture and use that leave traces on objects, and in fossil skeletal asymmetries resulting from asymmetric use of the upper limb muscles over an individual’s lifetime (Uomini, 2009). For example, Latimer and Lovance (1965) conducted a research on the weights and lengths of the right and left bones of each pair from 105 human skeletons from Asia. In general, they found that all of the long
bones of the upper extremity were heavier and longer on the right side. The left bones were more variable in weight and length. The upper extremity and its bones noticeably had more asymmetry than the lower (Hebbal & Mysorekar, 2003). For the past 5000 years the best historical data are the study by Coren and Porac (1977), which looked at five millennia of artistic representations of unimanual motor activities (such as playing board games, throwing spears, writing, etc.). Overall about 92% of paintings, drawing, and sculptures show the right hand being used, with little variation over the entire period of recorded history. Thus, even in ancient cultures, humans were predominantly right handed.

**Origin of Handedness**

As highlighted above, handedness has been studied for years and many theories of the origin of handedness have been proposed, however, answer for the “what determines handedness” is not clearly known. The list of factors that has been proposed to explain handedness is very large. For instance, some researchers attributed left-handedness with pathological disorders. Pathological left-handedness hypothesis has gained some support with higher frequency of left-handedness in schizophrenic patients and after childhood meningitis (Dragovic & Hammond, 2005; Ramadhanis, Koomen, Grobbee, van Donselaar, Marceline van Furth, & Uitterwaal, 2006; Satz & Green, 1999). Besides this, a study showed that the rate of left-handedness was two times more common in infants who had required resuscitation after delivery (Williams, Buss, & Eskenazi, 1992). However, in contrast to Williams et al. study, Bailey and McKeever (2004) stated that only maternal age had a weak association with left-handedness. Moreover, result of some studies did not show a shift towards using left hand more frequently in schizophrenic patients (Malesu, Cannon, Jones, McKenzie, Gilvarry, Rifkin, Toone, & Murray, 1996; Taylor & Amir, 1995) so that pathological left-handedness hypothesis was not supported.

Some researchers have attempted to explain the determinants of handedness with looking at the handedness prevalence in singletons, twins, and triplets. Even though in a recent study of large number of twins and their siblings, Medland and his colleagues (2003) found no difference in left-handedness between twins and singleton sibs (Medland, Wright, Gafflen, Hay, Levy, Martin, & Duffy, 2003), many studies found increased left-handedness in twins and triplets compared to singletons (Sicotte, Woods & Mazzotti, 1999; Vuoksimaa, Koskenvuo, Rose, & Kaprio, 2009; Williams, Buss & Eskanazi, 1992). Some speculate that the higher incidence of left-handedness in twins could be the smaller birth weight in twins than singletons and more stressful pregnancy and traumatic delivery (Sicotte, Woods, & Mazzotti, 1999; Vuoksimaa et al., 2009). As the gestation is the main determinants of birth weight in twins, they are born about 1 kg lighter at birth than singletons. Therefore, observed difference in prevalence of left-handedness between twins and singletons might partially have arisen from the lower average birth weight in twins. However, there is no much clear evidence and support for this idea and association between handedness and birth weight was found weaker (Medland et al., 2003). The controversial results in the literature also leave a question about the prevalence of handedness in twins. Besides, even if we think that stressful and traumatic pregnancy can account for some left-handedness, not all left-handedness does have a pathological origin (Vuoksimaa et al., 2009).

Additionally, it can be speculated as well that the typical uterine position of a fetus during the end of pregnancy can also be caused by the earlier formation of handedness. Many studies have observed handedness postnatally, but some ultrasound studies propose that the formation of handedness takes place prenatally. Researchers found right hand preference, in the form of thumb sucking, in fetuses at 10 weeks gestational age (Hepper, McCartney, & Shannon, 1998). Prenatal thumb sucking has also been found to be related to postnatal handedness at age 10 – 12 (Hepper, Wells, & Lynch, 2005). Thus, these ultrasound studies emphasizes the early formation of human handedness.

Helper et al. (1998) emphasized the relationship between handedness and the age of subjects. They hypothesized that left-handers die at an earlier age than right-handers, and have a greater number of accidents. This hypothesis is controversial and there are some criticisms about the methodology, and failures to replicate empirical claims (Seddon & McManus, 1993). On the other hand, there are general agreements that the incidence of handedness seems to decrease with age and have increased in recent years (Strang, 1991; McManus, 2009).

Francks et al. (2007) recently made a claim to have identified the first potential genetic influence of human handedness. They have found a gene, LRRTM1 (Leucine-rich repeat transmembrane neuronal 1), that increases the likelihood of being left-handed (Francks et al., 2007). Even though this is the first concrete evidence for a genetic determinant of handedness, this claim gained a criticism on the basis that the authors have made unjustified assumptions concerning mode of transmission both of psychosis and relative hand skill that they have failed to establish a parent of origin effect (Crow, Close, Dagnall, & Priddle, 2007). Thus, the origin of handedness is unlikely to be resolved.

The world is made up for the right-handed people. According to the theory which was proposed by Porac and Coren (1981), the general physical environment is in favor of the right-handers. Almost up to 98% of the equipments in every society are designed for right handed people. Examples for those equipments can vary from simple kitchen tools like can openers and utensils to very technological devices like camcorders and cameras. Moreover, left-handers have so many inconveniences in everyday facilities geared for the right-handers: handle position and opening/shutting direction of doors, key holes, position of cash and vending machines buttons, car engine keyholes, gearshift sticks, etc. Because most of those devices are made for right-handers, left-handers have to twist his or her left arm or switch to his or her non-dominant right arm in an unnatural way. We can also hear an offer by our left-handed friend at the table during lunch to sit at the far left end so that he or she will be comfortable during the meal.

There is also some suggestion that handedness may sometimes be the result of socio-cultural and environmental factors. In fact, there are some reports stating that relatively large numbers of adult left-handers have experienced attempts to switch writing hand to the right side (Porac & Searleman, 2002; Porac & Martin, 2007; Searleman & Porac, 2001). Moreover, Perelle and Ehrman (1994) also stated that parents discourage their children to use their right hand in one of the East Asian culture. However, it is very difficult to change hand preference especially at an early age. Indeed, most attempts to change handedness fail, and the process is bound to be difficult, or motor performance skill performance remains worse than originally preferred hand. Overall, although the determinants of human handedness are not clearly known, it seems most likely that both nature (genetics) and nurture (environment) play a considerable role and make a good combination to explain handedness.
Handedness can be related to some anatomical parameters in the brain

Researchers have undertaken potential anatomical substrate for handedness at both macroscopic and microscopic levels. One study using magnetic resonance morphology showed that the depth of the central sulcus was related to handedness: in right-handers the left central sulcus was deeper than the right, and the opposite pattern was shown for left-handers (Amunts et al., 1996). Furthermore, this macroscopic asymmetry was accompanied by microscopic differences in neutrophil volume, with a greater volume in the hemisphere contralateral to the preferred hand. The authors posit that handedness is associated with more profuse horizontal connections (reflected by greater neutrophil volume), and the increased intrasulcal surface of the precentral gyrus which may provide a potential substrate for the more complex movements performed by the preferred hand (Amunts et al., 1996). Volkmann et al. (1998) in their study using magnetoencephalography found a significant increase in the volume of the primary motor cortex contralateral side of the preferred hand (Volkmann, Schnitzler, Witte, & Freund, 1998). The results of these studies show asymmetries of neural structures in motor cortex.

Another study looked at the effects of handedness and gender on the depth of the central sulcus in the area of cortical hand presentation (Amunts, Jäncke, Mohlberg, Steinmetz, & Zilles, 2000). Strongly male right-handers were found to have a significantly deeper left central sulcus than right central sulcus. Interestingly, the difference in the depth of the central sulcus between the hemispheres was found to decrease significantly from strongly male right-handers, to non-strongly male right-handers, to strongly male left-handers. Even though the same effect was found for the left-handers, 62% of the strongly left-handers had a deeper right central sulcus, this effect was not found significant for the group as a whole. Interestingly, this interhemispheric asymmetry for the central sulcus was not found for the females (Amunts et al., 2000). The results of this study suggest that both the degree of handedness and gender differences may also affect the cortical organization of hand movements.

There are also some TMS studies in the area of motor cortex to find the threshold for eliciting a motor response in different intrinsic and extrinsic muscles of preferred and non-preferred arms. Generally, those works showed that a lower threshold of contralateral brain stimulation is needed to activate preferred arm musculature (Macdonell et al., 1991; Triggs, Calvani, Macdonell, Cros, & Chiappa, 1994). However, other studies did not show the same asymmetry between preferred and non-preferred arm musculature activation during the brain stimulation (Cicinelli, Traversa, Bassi, Scivoletto, & Rossini, 1997; Civardi, Cavalli, Naldi, Varrasi, & Cantello, 2000). Additionally, TMS has also been used as a means of mapping the extent of various hand and arm representations in the motor cortex. One prominent in this area was conducted by Triggs et al. (1999). They quantified the number of cortical sites eliciting a motor response in two different arm muscles of left and right arms. They found that right-handed subjects had a larger cortical area in the left hemisphere assigned to the targeted muscles than that seen in the right hemisphere which is also consistent with the other studies where used different techniques to map the cortical areas in the brain. In summary, although asymmetries in both brain structures and activations are correlated to handedness, both cerebral hemispheres appear to contribute to unilateral arm and hand movements. The left hemisphere has long been recognized as being dominant for the motor control of skilled voluntary movements in most right-handed individuals; however right hemisphere superiority has also been shown for certain motor functions. Manual asymmetries, as they are observable behaviors, can therefore provide insight into the organization and functioning of the brain.

Left-handers/footers in the sports

As stated above, whereas left-handers/footers represent about 10-12% of the general population (Caliskan & Dane, 2009; Perelle & Ehrman, 1994), they are found with disproportionately more frequency in interactive sports (Loffing, Hagemann, & Strauss, 2010). In fact, when we look at the many interactive sports, we can see that lefthanded/footed athletes are over represented compared to general population. For instance, tennis (Holzven, 2000), baseball (Goldstein & Young, 1996), cricket (Brooks, Bussière, Jennings, & Hunt, 2004), fencing (Harris, 2010), volleyball (Loffing, Schorer, Hagemann, & Baker, 2012) are some interactive sports to have higher rate of left-handed/footed athletes compared to general population. However, this over representation of left-handed/footed athletes cannot be seen in non-interactive sports, such as gymnastics, darts, and archery (Grouios, 2004). We can also give some specific examples from different sports and different clubs. For example, football clubs in Europe in 2013-2014 season; Real Madrid (Spain) had 2 left-footed players in their first team which equals to 18% among the total players in the team, Barcelona (Spain) had again 2 left-footed players in their first team which equals to 18% among the total players in the team, AC Milan (Italy) had 3 left-footed players in their first team which equals to 36% among the total players in the team, Besiktas (Turkey) had 3 left-footed players in their first team which equals to 27% among the total players in the team. Moreover, in team handball for instance, there should be at least 2 left-handed players in the team to have more tactical advantage during the game and this equals to 28.5% among the total players in the team. In 2013-2014 season in National Basketball Association (NBA), USA, there are 60 left-handed basketball players which equals to 13.3% compared to total of 450 players in the NBA. According to the examples above, it can be said that the incidence of left-handedness/footedness can change from 13% to 36% depending on the type of sport. It is still worthy to point out that this ratio is substantially more compared to general population. In fact, in a recent study by Loffing et al. (2012), it has been stated that the representation of top level left-handed tennis players has decreased over the years compared to past. When we look at 20-30 years back from now, we can see many left-handed top level tennis players like, Monica Seles, Martina Navratilova, Goran Ivanisevic, Jimmy Conors and etc. Even though there are many factors affecting the good performance in tennis like the other sports, it was believed that left-handedness was sometimes considered beneficial. However, this left-handed players advantage in tennis is diminishing in the professional tennis. Loffing et al. (2012) explained this issue with having less left-handed tennis players in the past compared to right-handed counterparts. With the more participation of left-handed players in tennis, right-handed players have had a chance to get more experience playing against a lefty. However, there are still more proportionate of left-handed tennis players in the amateur level.

It is very clear that left-handed or footed people are over represented in the sports compared to general population (13-25%
vs 8-10%). Now, we should ask a question; “is this a coincidencce?”? In fact, it is not; researchers tried to explain this phenomenon and reasoned the high frequency of left-handers/footers with mainly two possible hypotheses; innate superiority hypothesis (based on the perceptual and neuropsychological advantage) and negative frequency hypothesis (players having less experience with left-handed opponents) (Faurie & Raymond, 2005).

Left-handers/footers have generally more advantage over right-handers due to better neuropsychological predispositions. Researchers found that spatiotemporal visual perception areas which is required for attention is located in the right hemisphere (Heilman & Van Den Abell, 1980). Moreover, it has been also stated that left hand has faster reaction time even among the right-handed people (Barthélémy & Boulinguez, 2001; Boulinguez & Barthélémy, 2000) and better anticipation skills (Rodrigues, Vasconcelos, Barreiros, Barbosa & Trifilio, 2009). Cherbuin and Brinkman (2006) study kind of approve those results mentioned above with the support from anatomical data. Cherbuin and Brinkman (2006) concluded that left-handers’ brains are more symmetrical with larger and more efficient connectivities between the two hemispheres. Thus, they are better at processing information across the two sides of the brain. This allow them to display better performance in some certain skills compared to right-handers. Besides the explanation of perceptual and neuropsychological advantage of left-handers/footers for the over representation in some sports, some other researchers also reasoned to have higher ratio of left-handedness/footedness in various sports with the negative frequency hypothesis (Faurie & Raymond, 2005). This hypothesis mainly states that left-handed/footed players have the superiority in interactive sports compared to right-handed/footed counterparts as the right-handed/footed players have less experiences with the left-handed/footed counterparts in the game. This results with a disadvantage to develop a tactical approach for the right-handed/footed players. For instance, Hagemann (2009) showed that both left- and right-handed tennis players with different experience level (expert, intermediate, and novice) predicted better the direction of strokes by right-handed players. He explained this result with the set of strategic advantages of left-handers in sport which partially supports the negative frequency hypothesis.

The similar result was also observed among volleyball players. Loffing et al. (2012) had skilled (n=18) and novice (n=18) players to predict shot directions of left- and right-handed players attacks in a video-based anticipation task. They showed that the outcome of left-handed players’ actions was significantly less accurately predicted compared to that of right-handed players’ attacks. The authors explained the result with players having less experience with left-handed opponents in the game, thus may not develop visual perception with the encountered left-handed actions. These mentioned two studies’ results imply that having less experience with left handed/footed opponents can be a shortage for the right handed/footed players to develop some certain visual perceptions to get more successful in the game. Besides this, researchers showed that tennis players normally try to hit the ball to their right irrespective of their opponent’s handedness (Loffing et al., 2010). This will surely give an advantage to left-handers as they will return the ball with forehand technique.

In addition to two hypotheses stated above, we should also consider another point of view regarding the need of lefthies in some sports. For instance, there should be at least 2 left-handed players in the team who position on the right side of the court to get more angle when they shot the ball to the goal in team handball. These two left-handed players play on the right back-court and right wing positions. The main reason to have lefthies in those positions because they can have wider goal angle when they shot to the goal. This can most probably increase the rate of scoring during the game. This can be also counted as a tactical advantage of lefthies in the sports and can be also another reason to have more rate of lefthies in the sports.

In conclusion, researchers explain the phenomena of left handers/footers being overrepresented in many interactive sports compared to general population with mainly two hypotheses. These are innate superiority hypothesis and negative frequency hypothesis (Faurie & Raymond, 2005). Moreover, it can be also stated that there is also a need to have left handers/footers in some sports to get better tactical advantage during the game. Thus, both hypotheses and the idea of tactical advantage of lefthies elucidate the reason of overrepresentation of lefthies in many interactive sports.

**REFERENCES**


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Guidelines for Authors

Revised September 2014

*** Please use the bookmark function to navigate within the guidelines. ***

When preparing the final version of the manuscripts, either NEW or REVISED authors should strictly follow the guidelines. Manuscripts departing substantially from the guidelines will be returned to the authors for revision or, rejected.

1. UNIFORM REQUIREMENTS

1.1. Overview

The Montenegrin Journal of Sports Science and Medicine (MJSSM) reserves copyright of the materials published.

There is no charge for submissions and no page charge for accepted manuscripts. However, if the manuscript contains graphics in color, note that printing in color is charged.

MJSSM adopts a double-blind approach for peer reviewing in which the reviewer's name is always concealed from the submitting authors as well as the author(s)'s name from the selected reviewers.

MJSSM honors a six-weeks for an initial decision of manuscript submission.

Authors should submit the manuscripts as one Microsoft Word (.doc) file.

Manuscripts must be provided either in standard UK or US English. English standard should be consistent throughout the manuscripts.

Format the manuscript in A4 paper size; margins are 1 inch or 2.5 cm all around.

Type the whole manuscript double size; justified alignment.

Use Times New Roman font, size eleven (11) point.

Number (Arabic numerals) the pages consecutively (centering at the bottom of each page), beginning with the title page as page 1 and ending with the Figure legend page.

Include line numbers (continuous) for the convenience of the reviewers.

Apart from chapter headings and sub-headings avoid any kind of formatting in the main text of the manuscripts.

1.2. Type & Length

MJSSM publishes following types of papers:

Original scientific papers are the results of empirically- or theoretically-based scientific research, which employ scientific methods, and which report experimental or observational aspects of sports science and medicine, such as all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side. Descriptive analyses or data inferences should include rigorous methodological structure as well as sound theory. Your manuscript should include the following sections: Introduction, Methods, Results, and Discussion.
Original scientific papers should be:
- Up to 3000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 30;
- Maximum combined total of 6 Tables/Figures.

Review papers should provide concise in-depth reviews of both established and new areas, based on a critical examination of the literature, analyzing the various approaches to a specific topic in all aspects of sports science and medicine, such as all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

Review papers should be:
- Up to 6000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 100.

Editorials are written or commissioned by the editors, but suggestions for possible topics and authors are welcome. It could be peer reviewed by two reviewers who may be external or by the Editorial Board.

Editorials should be:
- Up to 1000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 10.

Short reports of experimental work, new methods, or a preliminary report can be accepted as two page papers. Your manuscript should include the following sections: Introduction, Methods, Results, and Discussion.

Short reports should be:
- Up to 1500 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 15.

Peer review - fair review provides authors who feel their paper has been unfairly rejected (at any journal) the opportunity to share reviewer comments, explain their concerns, and have their paper reviewed for possible publication in MJSSM.

Peer review - fair review should be:
- Up to 1500 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 15.
Invited papers and award papers include invited papers from authors with outstanding scientific credentials. Nomination of invited authors is at the discretion of the MJSSM editorial board. MJSSM also publishes award papers selected by the scientific committee of the International Scientific Conference on Transformation Processes in Sport.

Invited papers and award papers should be:
- Up to 3000 words (excluding title, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References);
- A structured abstract of less than 250 words;
- Maximum number of references is 30;
- Maximum combined total of 6 Tables/Figures.

1.3. Submission

MJSSM only accepts electronic submission to the e-mail of the Journal Office:

Submitted material includes:
- A manuscript prepared according to the Guidelines for the Authors;
- A signed form that states the study was not previously published, nor has been submitted simultaneously for consideration of publication elsewhere, that states that all of the authors are in agreement with submission of the manuscript to MJSSM, and that, for studies that use animal or human individuals, authors must include information regarding their institution’s ethics committee, and which identifies the official approval number;
- A signed form that there is no conflict of interest.

Name the files according to the family name of the first author. Authors submitting revised versions of the manuscript can use the identification number of their manuscript as provided by the Journal Office. See example:
- FAMILY NAME-manuscript.doc – (main manuscript file)
- FAMILY NAME-statement.PDF – (authorship statement)
- FAMILY NAME-declaration.PDF – (declaration of potential conflict of interest)
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1.4. Peer Review Process

An original manuscript submitted for publication will be submitted to the review process as long as it fits the following criteria:
- The study was not previously published, nor has been submitted simultaneously for consideration of publication elsewhere;
- All persons listed as authors approved its submission to MJSSM;
- Any person cited as a source of personal communication has approved the quote;
- The opinions expressed by the authors are their exclusive responsibility;
- The author signs a formal statement that the submitted manuscript complies with the directions and guidelines of MJSSM.

The editors-in-chief and associate editors will make a preliminary analysis regarding the appropriateness, quality, originality and written style/grammar of the submitted manuscript. The editors reserve the right to request additional information, corrections, and guideline compliance before they submit the manuscript to the ad-hoc review process.

MJSSM uses ad-hoc reviewers, who volunteer to analyze the merit of the study. Typically, one or two expert reviewers are consulted in a double-blind process. Authors are notified by e-mail when their submission has been accepted (or rejected). Minor changes in the text may be made at the discretion of the editors-in-chief and/or associate editors. Changes can include spelling and grammar in the chosen language, written style, journal citations, and reference guidelines. The author is notified of changes via email. The final version is available to the author for his or her approval before it is published.
1.5. Publisher Copyright Policies

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MJSSM only publishes studies that have been approved by an institutional ethics committee (when a study involves humans or animals). Fail to provide such information prevent its publication. To ensure these requirements, it is essential that submission documentation is complete. If you have not completed this step yet, go to MJSSM website and fill out the two required documents: Declaration of Potential Conflict of Interest and Authorship Statement. Whether or not your study uses humans or animals, these documents must be completed and signed by all authors and attached as supplementary files in the originally submitted manuscript.

- Authors can archive pre-print (i.e., pre-refereeing)
- Authors can archive post-print (i.e., final draft post-refereeing)
- Authors can archive publisher's version/PDF

1.6. After Acceptance

After the manuscript has been accepted, authors will receive a PDF version of the manuscripts for authorization, as it should look in printed version of MJSSM. Authors should carefully check for omissions. Reporting errors after this point will not be possible and the Editorial Board will not be eligible for them.

Should there be any errors, authors should report them to the Office e-mail address office@mjssm.me. If there are not any errors authors should also write a short e-mail stating that they agree with the received version.

1.7. Code of Conduct Ethics Committee of Publications

MJSSM is hosting the Code of Conduct Ethics Committee of Publications of the COPE (the Committee on Publication Ethics), which provides a forum for publishers and Editors of scientific journals to discuss issues relating to the integrity of the work submitted to or published in their journals.
2. Manuscript Structure

2.1. Title Page

The first page of the manuscripts should be the title page, containing: title, type of publication, running head, authors, affiliations, corresponding author, and manuscript information. See example:

Transfer of Learning on a Spatial Memory Task between the Blind and Sighted People Spatial Memory among Blind and Sighted

Original Scientific Paper

Transfer of learning on a spatial memory task

Selcuk Akpinar¹, Stevo Popović¹², Sadettin Kirazci¹

¹Middle East Technical University, Physical Education and Sports Department, Ankara, Turkey
²University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro

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S. Popovic
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E-mail: stevop@ac.me

Word count: 2,980

Abstract word count: 236

Number of Tables: 3

Number of Figures: 3

2.1.1. Title

Title should be short and informative and the recommended length is no more than 20 words. The title should be in Title Case, written in uppercase and lowercase letters (initial uppercase for all words except articles, conjunctions, short prepositions no longer than four letters etc.) so that first letters of the words in the title are capitalized. Exceptions are words like: “and”, “or”, “between” etc. The word following a colon (:) or a hyphen (-) in the title is always capitalized.

2.1.2. Type of publication

Authors should suggest the type of their submission.

2.1.3. Running head

Short running title should not exceed 50 characters including spaces.

2.1.4. Authors

The form of an author’s name is first name, middle initial(s), and last name. In one line list all authors with full names separated by a comma (and space). Avoid any abbreviations of academic or professional titles. If authors belong to different institutions, following a family name of the author there should be a number in superscript designating affiliation.
2.1.5. Affiliations

Affiliation consists of the name of an institution, department, city, country/territory (in this order) to which the author(s) belong and to which the presented / submitted work should be attributed. List all affiliations (each in a separate line) in the order corresponding to the list of authors. Affiliations must be written in English, so carefully check the official English translation of the names of institutions and departments.

Only if there is more than one affiliation, should a number be given to each affiliation in order of appearance. This number should be written in superscript at the beginning of the line, separated from corresponding affiliation with a space. This number should also be put after corresponding name of the author, in superscript with no space in between.

If an author belongs to more than one institution, all corresponding superscript digits, separated with a comma with no space in between, should be present behind the family name of this author.

In case all authors belong to the same institution affiliation numbering is not needed.

Whenever possible expand your authors’ affiliations with departments, or some other, specific and lower levels of organization.

2.1.6. Corresponding author

Corresponding author's name with full postal address in English and e-mail address should appear, after the affiliations. It is preferred that submitted address is institutional and not private. Corresponding author's name should include only initials of the first and middle names separated by a full stop (and a space) and the last name. Postal address should be written in the following line in sentence case. Parts of the address should be separated by a comma instead of a line break. E-mail (if possible) should be placed in the line following the postal address. Author should clearly state whether or not the e-mail should be published.

2.1.7. Manuscript information

All authors are required to provide word count (excluding title page, abstract, tables/figures, figure legends, Acknowledgements, Conflict of Interest, and References), the Abstract word count, the number of Tables, and the number of Figures.

2.2. Abstract

The second page of the manuscripts should be the abstract and key words. It should be placed on second page of the manuscripts after the standard title written in upper and lower case letters, bold.

Since abstract is independent part of your paper, all abbreviations used in the abstract should also be explained in it. If an abbreviation is used, the term should always be first written in full with the abbreviation in parentheses immediately after it. Abstract should not have any special headings (e.g., Aim, Results…).

Authors should provide up to six key words that capture the main topics of the article. Terms from the Medical Subject Headings (MeSH) list of Index Medicus are recommended to be used.

Key words should be placed on the second page of the manuscript right below the abstract, written in italic. Separate each key word by a comma (and a space). Do not put a full stop after the last key word. See example:

Abstract

Results of the analysis of…

Key words: spatial memory, blind, transfer of learning, feedback
2.3. Main Chapters

Starting from the third page of the manuscripts, it should be the main chapters. Depending on the type of publication main manuscript chapters may vary. The general outline is: Introduction, Methods, Results, Discussion, Acknowledgements (optional), Conflict of Interest (optional), and Title and Abstract in Montenegrin (only for the authors from former Yugoslavia, excluding Macedonians and Slovenes). However, this scheme may not be suitable for reviews or publications from some areas and authors should then adjust their chapters accordingly but use the general outline as much as possible.

2.3.1. Headings

Main chapter headings: written in bold and in Title Case. See example:

✔ Methods

Sub-headings: written in italic and in normal sentence case. Do not put a full stop or any other sign at the end of the title. Do not create more than one level of sub-heading. See example:

✔ Table position of the research football team

2.3.2 Ethics

When reporting experiments on human subjects, there must be a declaration of Ethics compliance. Inclusion of a statement such as follow in Methods section will be understood by the Editor as authors' affirmation of compliance: “This study was approved in advance by [name of committee and/or its institutional sponsor]. Each participant voluntarily provided written informed consent before participating.” Authors that fail to submit an Ethics statement will be asked to resubmit the manuscripts, which may delay publication.

2.3.3 Statistics reporting

MJSSM encourages authors to report precise p-values. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Use normal text (i.e., non-capitalized, non-italic) for statistical term “p”.

2.3.4. ‘Acknowledgements’ and ‘Conflict of Interest’ (optional)

All contributors who do not meet the criteria for authorship should be listed in the ‘Acknowledgements’ section. If applicable, in ‘Conflict of Interest’ section, authors must clearly disclose any grants, financial or material supports, or any sort of technical assistances from an institution, organization, group or an individual that might be perceived as leading to a conflict of interest.

2.4. References

References should be placed on a new page after the standard title written in upper and lower case letters, bold.

All information needed for each type of must be present as specified in guidelines. Authors are solely responsible for accuracy of each reference. Use authoritative source for information such as Web of Science, Medline, or PubMed to check the validity of citations.

2.4.1. References style

2.4.2. Examples for Reference citations

One work by one author

- In one study (Reilly, 1997), soccer players...
- In the study by Reilly (1997), soccer players...
- In 1997, Reilly’s study of soccer players...

Works by two authors

- Duffield and Marino (2007) studied...
- In one study (Duffield & Marino, 2007), soccer players...
- In 2007, Duffield and Marino’s study of soccer players...

Works by three to five authors: cite all the author names the first time the reference occurs and then subsequently include only the first author followed by et al.

- First citation: Bangsbo, Iaia, and Krustrup (2008) stated that…
- Subsequent citation: Bangsbo et al. (2008) stated that…

Works by six or more authors: cite only the name of the first author followed by et al. and the year

- Krustrup et al. (2003) studied…
- In one study (Krustrup et al., 2003), soccer players…

Two or more works in the same parenthetical citation: Citation of two or more works in the same parentheses should be listed in the order they appear in the reference list (i.e., alphabetically, then chronologically)

- Several studies (Bangsbo et al., 2008; Duffield & Marino, 2007; Reilly, 1997) suggest that…

2.4.3. Examples for Reference list

Journal article (print):

Journal article (online; electronic version of print source):

Journal article (online; electronic only):

Conference paper:

Encyclopedia entry (print, with author):

Encyclopedia entry (online, no author):

Thesis and dissertation:
2.5. Tables

All tables should be included in the main manuscript file, each on a separate page right after the Reference section.

Tables should be presented as standard MS Word tables.

Number (Arabic) tables consecutively in the order of their first citation in the text.

Tables and table headings should be completely intelligible without reference to the text. Give each column a short or abbreviated heading. Authors should place explanatory matter in footnotes, not in the heading. All abbreviations appearing in a table and not considered standard must be explained in a footnote of that table. Avoid any shading or coloring in your tables and be sure that each table is cited in the text.

If you use data from another published or unpublished source, it is the authors’ responsibility to obtain permission and acknowledge them fully.

2.5.1. Table heading

Table heading should be written above the table, in Title Case, and without a full stop at the end of the heading. Do not use suffix letters (e.g., Table 1a, 1b, 1c); instead, combine the related tables. See example:

✓ Table 1. Repeated Sprint Time Following Ingestion of Carbohydrate-Electrolyte Beverage

2.5.2. Table sub-heading

All text appearing in tables should be written beginning only with first letter of the first word in all capitals, i.e., all words for variable names, column headings etc. in tables should start with the first letter in all capitals. Avoid any formatting (e.g., bold, italic, underline) in tables.

2.5.3. Table footnotes

Table footnotes should be written below the table.

General notes explain, qualify or provide information about the table as a whole. Put explanations of abbreviations, symbols, etc. here. General notes are designated by the word Note (italicized) followed by a period.

✓ Note. CI: confidence interval; Con: control group; CE: carbohydrate-electrolyte group.

Specific notes explain, qualify or provide information about a particular column, row, or individual entry. To indicate specific notes, use superscript lowercase letters (e.g. a, b, c), and order the superscripts from left to right, top to bottom. Each table’s first footnote must be the superscript a.

✓ One participant was diagnosed with heat illness and n = 19. b n = 20.

Probability notes provide the reader with the results of the texts for statistical significance. Probability notes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || etc.

✓ *P<0.05, †p<0.01.
2.5.4. Table citation

In the text, tables should be cited as full words. See example:

- Table 1 (first letter in all capitals and no full stop)
- ...as shown in Tables 1 and 3. (citing more tables at once)
- ...result has shown (Tables 1-3) that... (citing more tables at once)
- ...in our results (Tables 1, 2 and 5)... (citing more tables at once)

2.6. Figures

On the last separate page of the main manuscript file, authors should place the legends of all the figures submitted separately.

All graphic materials should be of sufficient quality for print with a minimum resolution of 600 dpi. MJSSM prefers TIFF, EPS and PNG formats.

If a figure has been published previously, acknowledge the original source and submit a written permission from the copyright holder to reproduce the material. Permission is required irrespective of authorship or publisher except for documents in the public domain. If photographs of people are used, either the subjects must not be identifiable or their pictures must be accompanied by written permission to use the photograph whenever possible permission for publication should be obtained.

Figures and figure legends should be completely intelligible without reference to the text.

The price of printing in color is 50 EUR per page as printed in an issue of MJSSM.

2.6.1. Figure legends

Figures should not contain footnotes. All information, including explanations of abbreviations must be present in figure legends. Figure legends should be written bellow the figure, in sentence case. See example:

- **Figure 1.** Changes in accuracy of instep football kick measured before and after fatigued. SR – resting state, SF – state of fatigue, *p>0.01, †p>0.05.

2.6.2. Figure citation

All graphic materials should be referred to as Figures in the text. Figures are cited in the text as full words. See example:

- **Figure 1**
- figure 1
- Figure 1.
- ....exhibit greater variance than the year before (Figure 2). Therefore...
- ....as shown in Figures 1 and 3. (citing more figures at once)
- ....result has shown (Figures 1-3) that... (citing more figures at once)
- ....in our results (Figures 1, 2 and 5)... (citing more figures at once)

2.6.3. Sub-figures

If there is a figure divided in several sub-figures, each sub-figure should be marked with a small letter, starting with a, b, c etc. The letter should be marked for each subfigure in a logical and consistent way. See example:

- **Figure 1a**
- ...in Figures 1a and b we can…
- ...data represent (Figures 1a-d)…
2.7. Scientific Terminology

All units of measures should conform to the International System of Units (SI).

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

Decimal places in English language are separated with a full stop and not with a comma. Thousands are separated with a comma.

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Signs should be placed immediately preceding the relevant number.

| ✓ 45±3.4 | ✓ p<0.01 | ✓ males >30 years of age |
| × 45 ± 3.4 | × p < 0.01 | × males > 30 years of age |

2.8. Latin Names

Latin names of species, families etc. should be written in italics (even in titles). If you mention Latin names in your abstract they should be written in non-italic since the rest of the text in abstract is in italic. The first time the name of a species appears in the text both genus and species must be present; later on in the text it is possible to use genus abbreviations. See example:

✓ First time appearing: *musculus biceps brachii*

Abbreviated: *m. biceps brachii*
1. Manuscript title:


2. List all authors in order of appearance on the title page:

(Family name, initials)

3. Publication type:

(Please suggest the type of your publication: original scientific papers, review articles, editorials, short reports, peer review - fair review, or invited papers and award papers)

4. Numbers:

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Number of figures submitted separately:

Total number of FILES submitted (including manuscript):

5. Statement:

The authors herein signed, state that:

a) This manuscript is an original work, has not been previously published nor is being simultaneously submitted elsewhere;

b) The authors agree that the manuscript will be under review for publication in the Montenegrin Journal of Sports Sciences and Medicine;

c) If the study includes participation of human beings or animals, please fill out the compliance/assessment by an ethics committee:
This study complies with the ethics committee of (state the name of the institution):

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6. Authors’ confirmation:

By signing, all authors confirm the agreement with the contents of the statement in the previous chapter and that the information they provided on these pages is true.

(Authors should be listed in the exact order as appearing on the title page of the manuscript. Feel free to copy and add more tables for additional authors if needed, likewise delete the excess if not used. ALL AUTHORS MUST SIGN THIS FORM).

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