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Lektor
Stevo Popović

Prepress
Boris Šundić

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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 renounced 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

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Original scientific paper
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Effect of Egg White Protein Supplementation Prior to Acute Resistance Training on Muscle Damage Indices in Untrained Japanese Men

Yuko Hasegawa
Tokyo University of Agriculture, Department of Nutritional Science, Tokyo, Japan
Yuko Mekata
Bunkyo University, Department of Registered Dietitians, Chigasaki, Japan
Ayaka Sunami, Yuri Yokoyama and Takahiro Yoshizaki
Tokyo University of Agriculture, Department of Food and Nutritional Science, Tokyo, Japan
Maya Hagiwara
Tokyo University of Agriculture, Department of Nutritional Science, Tokyo, Japan
Kae Yanagisawa
Sagami Women's University, Department of Nutritional Sciences, Sagamihara, Japan
Mika Usuda and Yasunobu Masuda
Kewpie Corporation, Research & Development Division, Tokyo, Japan
Yukari Kawano
Tokyo University of Agriculture, Department of Nutritional Science, Tokyo, Japan

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

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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.

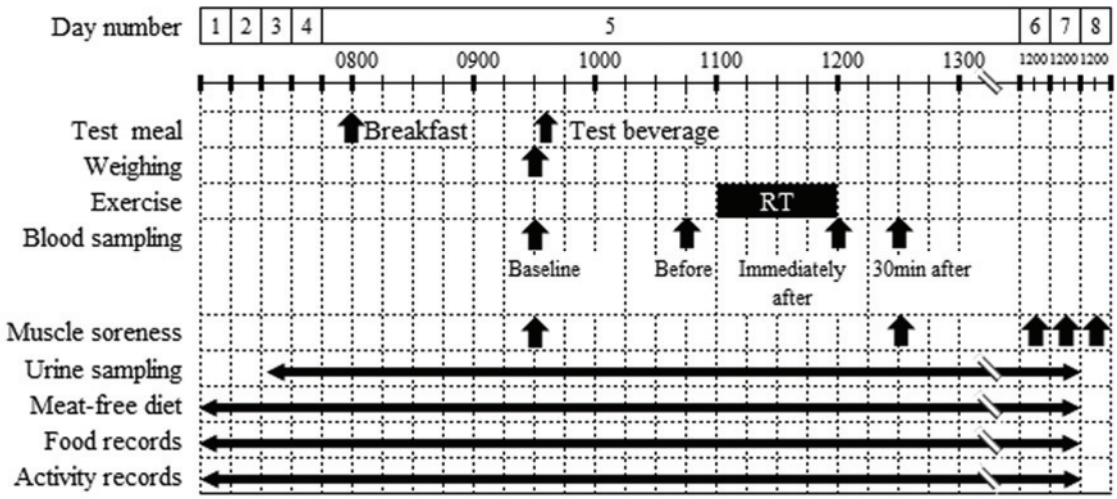
Materials and Metods

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.



RT: resistance training. Each participant (n=6) followed this protocol and consumed one of the three test beverages. A bout of RT exercise consisted of approximately 10 minutes of warm-up, 40 minutes of RT, and 10 minutes of cool-down exercise. After a seven-day washout period, participants crossed-over into the remaining condition. Each participant performed the experimental protocol three times.

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.

Table 1. Nutrient profiles of protein supplements

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

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.

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 analyses except lactate were performed by Medical Laboratory Systems (Kanagawa, Japan) in the same run or same assay plate.

A urine sample was collected each day for 24-hours beginning at 7:00 AM one day and ending at 7:00 AM the next day using a portable device (Urine Mate P, Sumitomo Bakelite, Tokyo, Japan). Participants could easily transport this device that could collect one-fiftieth volume from each urine excretion, and 24-hours urine volume was estimated by multiplying the sample quantity of the portable device by 50. Daily urinary levels of 3-MetHis, UN, and creatinine (CRE) were measured by Medical Laboratory Systems (Kanagawa, Japan). Furthermore, the area under the curve (AUC) of 3-MetHis or UN for three days after RT loading was calculated.

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 dietitian. Physical activity levels between trials were also determined using dietary analysis software by a total MET-hour score for that day (Excel Eiyo-kun 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 2. Participant characteristics

Characteristics		E	S	C	*P value*[a]
Body weight[b]	(kg)	62.08 ± 3.11	61.94 ± 2.96	62.63 ± 3.34	0.411
Total weight lifted[c]	(kg)	8670 ± 416	8316 ± 399	8505 ± 309	0.553
Physical activity level[d]		1.75 ± 0.09	1.71 ± 0.10	1.78 ± 0.10	0.315
Energy and nutrient intake[d]					
Energy	(kcal/day)	1961 ± 112	1941 ± 105	1849 ± 60	0.375
	(kcal/kg BW/day)	32.2 ± 2.9	32.0 ± 2.9	30.1 ± 2.3	0.502
Protein	(g/day)	52.0 ± 2.9	50.4 ± 2.8	47.7 ± 1.3	0.164
	(g/kg BW/day)	0.85 ± 0.08	0.83 ± 0.07	0.77 ± 0.04	0.090
Fat	(g/day)	47.8 ± 6.4	48.0 ± 5.8	44.5 ± 5.3	0.613
	(g/kg BW/day)	0.79 ± 0.11	0.79 ± 0.11	0.73 ± 0.10	0.529
Carbohydrate	(g/day)	315.4 ± 15.8	308.1 ± 16.8	304.2 ± 9.7	0.713
	(g/kg BW/day)	5.19 ± 0.47	5.08 ± 0.47	4.95 ± 0.40	0.546

Note. Values are expressed as mean±SE (n=6).
E: egg white protein group; S: soy protein group; C: control group (no protein group).
[a]One-factor repeated measures ANOVA
[b]Body weight was at baseline on Day-5.
[c]Participants lifted this total mean weight during RT.
[d]Physical activity level, and energy and nutrient intake were for seven days.

Table 3. Changes in blood biochemical parameters

	Group	Baseline	Before	Immediately after	30 min after	ANOVA *(P value)*[a] G	T	G x T
RBC	E	473 ± 10	465 ± 13	509 ± 15	466 ± 13			
(10^4/μL)	S	479 ± 14	475 ± 11	507 ± 11	475 ± 14	0.191	<0.001	0.346
	C	470 ± 9	465 ± 8	497 ± 13	460 ± 11			
Hb	E	14.2 ± 0.3	14.0 ± 0.4	15.0 ± 0.4	14.0 ± 0.4			
(g/dL)	S	14.3 ± 0.4	14.3 ± 0.4	15.1 ± 0.4	14.2 ± 0.4	0.097	<0.001	0.850
	C	14.0 ± 0.2	14.0 ± 0.2	14.8 ± 0.3	13.7 ± 0.3			
Ht	E	43.5 ± 0.9	42.5 ± 1.0	47.2 ± 1.5	42.7 ± 1.3			
(%)	S	43.7 ± 1.3	43.3 ± 1.0	47.0 ± 1.2	43.3 ± 1.4	0.298	<0.001	0.361
	C	43.0 ± 0.6	42.7 ± 0.8	46.0 ± 1.2	42.2 ± 1.0			
TP	E	6.9 ± 0.1	6.8 ± 0.1	7.8 ± 0.1	6.9 ± 0.1			
(g/dL)	S	7.0 ± 0.2	7.1 ± 0.2	7.8 ± 0.2	7.2 ± 0.3	0.160	<0.001	0.381
	C	6.8 ± 0.2	6.8 ± 0.2	7.6 ± 0.2	6.9 ± 0.2			
Alb	E	4.3 ± 0.1	4.2 ± 0.1	4.9 ± 0.1	4.4 ± 0.1			
(IU/L)	S	4.4 ± 0.2	4.6 ± 0.2	5.0 ± 0.2	4.6 ± 0.2	0.581	<0.001	0.139
	C	4.4 ± 0.1	4.4 ± 0.1	4.9 ± 0.1	4.5 ± 0.1			
Glu	E	89.8 ± 5.0	75.5 ± 4.4	83.5 ± 2.0	84.5 ± 3.3			
(mg/dL)	S	94.8 ± 6.6	73.7 ± 5.9	83.8 ± 3.2	80.7 ± 2.0	0.881	0.037	0.302
	C	95.5 ± 10.2	83.2 ± 2.7	79.2 ± 2.4	81.0 ± 3.5			
TG	E	56.8 ± 11.2	53.3 ± 10.8	57.7 ± 11.6	50.3 ± 10.3			
(mg/dL)	S	72.3 ± 23.5	54.0 ± 13.1	58.0 ± 12.4	51.3 ± 10.5	0.675	0.232	0.342
	C	62.8 ± 19.7	48.8 ± 10.0	48.8 ± 7.2	43.2 ± 5.9			
Lactate	E	1.3 ± 0.1	1.1 ± 0.1	8.6 ± 1.7	2.4 ± 0.6			
(mmol/L)	S	1.1 ± 0.1	1.0 ± 0.1	7.9 ± 1.0	3.0 ± 0.8	0.863	<0.001	0.524
	C	1.3 ± 0.2	1.0 ± 0.1	7.7 ± 1.3	2.7 ± 0.8			
CK	E	122.5 ± 20.6	121.8 ± 19.3	148.0 ± 24.0	141.8 ± 24.7			
(IU/L)	S	113.5 ± 7.8	114.8 ± 7.9	138.0 ± 7.4	136.0 ± 8.2	0.107	<0.001	0.804
	C	163.3 ± 34.7	170.7 ± 38.9	188.2 ± 34.3	179.8 ± 32.5			
IRI	E	10.7 ± 1.6	8.6 ± 0.6	8.1 ± 0.3	7.6 ± 0.3			
(μU/dL)	S	11.8 ± 2.7	9.6 ± 1.0	7.6 ± 0.4	7.8 ± 0.4	0.367	0.191	0.478
	C	18.0 ± 7.9	8.8 ± 0.4	8.1 ± 0.4	7.7 ± 0.2			
GH	E	0.2 ± 0.0	3.8 ± 2.7	19.1 ± 4.2	6.6 ± 2.0			
(ng/mL)	S	0.4 ± 0.2	0.6 ± 0.3	20.9 ± 2.2	8.9 ± 1.9	0.611	0.006	0.462
	C	0.2 ± 0.1	2.1 ± 1.2	27.6 ± 9.4	8.0 ± 0.9			
Cortisol	E	13.9 ± 1.7	10.4 ± 1.4	19.7 ± 2.3	15.4 ± 1.5			
(μg/dL)	S	16.3 ± 2.0	15.6 ± 2.9	20.0 ± 2.8	20.2 ± 3.0	0.197	0.005	0.140
	C	17.7 ± 0.8	13.6 ± 1.3	20.3 ± 2.8	17.3 ± 2.7			

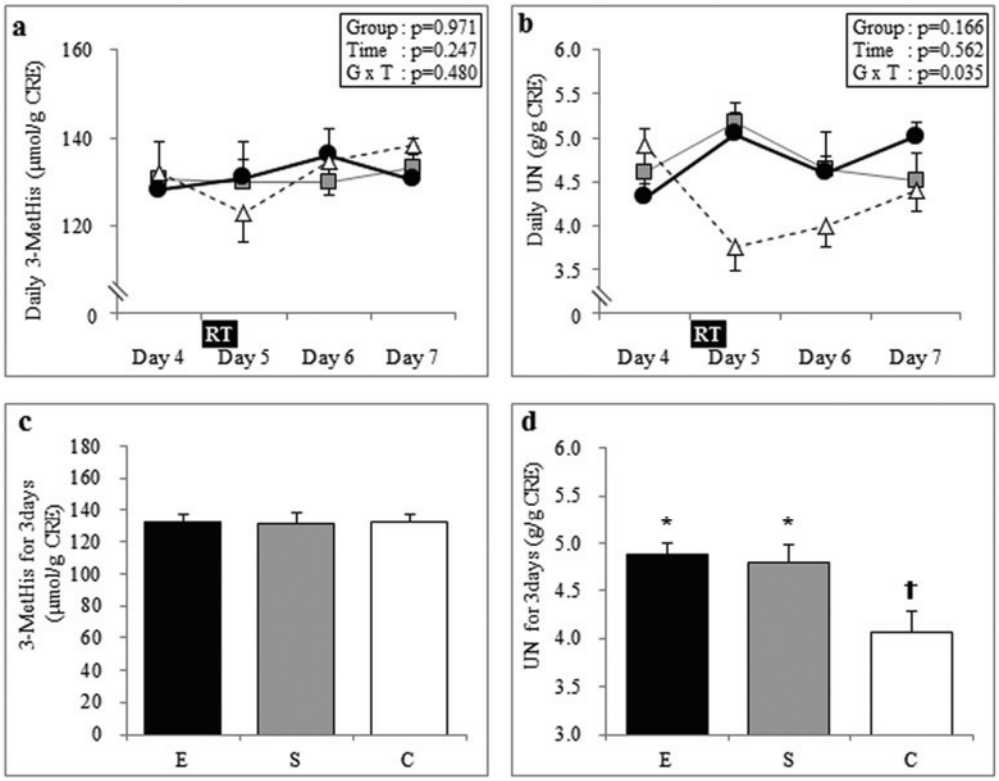
Note. Values are expressed as mean±SE (n=6). E: egg white protein group; S: soy protein group; C: control group (no protein). RBC: red blood cell; Hb: hemoglobin; Ht: hematocrit; Glu: blood glucose; TG: triglyceride; TP: total protein; Alb: albumin; IRI: immunoreactive insulin; GH: growth hormone; CK: creatine kinase activity; G: protein group; T: time; G x T: interaction effect of protein type x time.
[a]Two-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: $p=0.044$).



a: Daily 24-hour urinary excretion values for 3-MetHis (μmoles/g CRE). b: Daily 24-hour urinary excretion values for UN (g/g CRE). c: AUC of the 3-MetHis concentrations for three days. d: AUC of the UN concentrations for three days. Data are expressed as mean±SE (n=5).

E: Egg white protein group, S: Soy protein group, C: Control group.

3-MetHis: 3-methylhistidine, UN: urea nitrogen; CRE: creatinine; RT: resistance training.

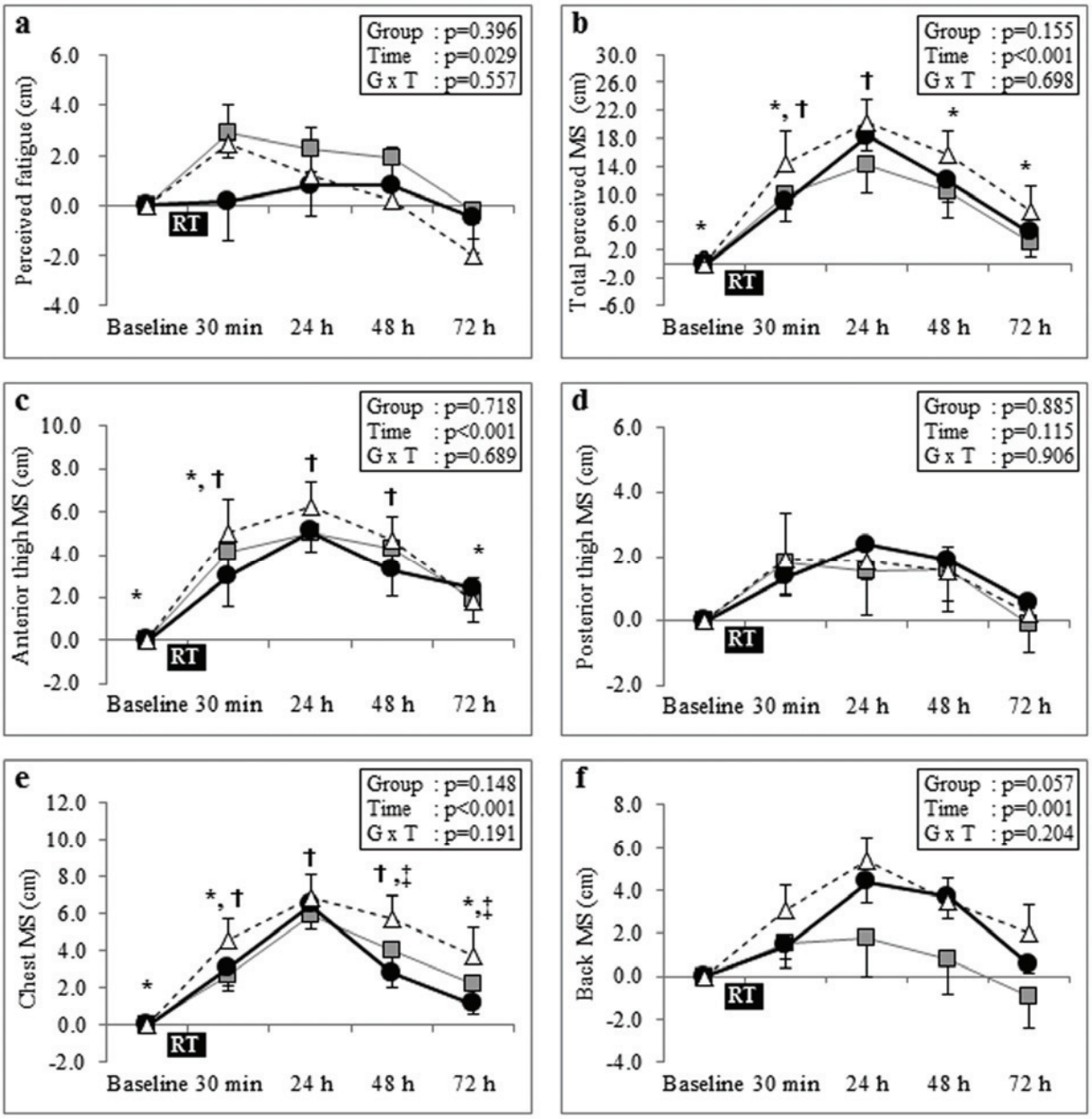
G x T: interaction effect of protein type x time by two-factor repeated measures ANOVA.

A two-factor repeated measures of variance was used for daily 3-MetHis (a) or daily UN (b) analysis, and a one-factor repeated measures of variance (protein group) was used in AUC analysis for 3-MetHis (c) or UN (d) to detect differences. *,† Different letters indicate significant differences ($p<0.05$).

Figure 2. Urinary 3-MetHis and UN excretion following RT loading

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.



a: Perceived fatigue. b: Total perceived MS. c: Perceived MS in the anterior thigh. d: Perceived MS in the posterior thigh. e: Perceived MS in the chest. f: Perceived MS in the back. Data are expressed as mean±SE scored by VAS (n=6).
E: Egg white group, S: Soy protein group, C: Control group.
RT: resistance training; MS: perceived muscle soreness; G x T: interaction effect of the protein type x time. A two-factor repeated measures of variance was used for perceived fatigue and various MS analysis. As a significant main effect of the time was present, post hoc analysis was conducted by using a Bonferroni adjustment. *,†,‡ Different letters indicate significant differences ($p < 0.05$)

Figure 3. Changes in perceived fatigue and muscle soreness scores following RT loading

Discusion

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, Børsheim, Tipton,

Wolf, 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; Børsheim 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, & Hedayati, 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/wk 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 Yarasheski (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, Facci, Abeysekara, 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 turn, 3-MetHis excretion might not be in dependent 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 feeding stimulates 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. Secondly, 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

Bachle, T.R., Earle, R.W., & Wathen, D. (2000). Resistance training. In Bachle, T.R. & Earle, R.W (Eds.), *Essentials of Strength Training and Conditioning* (2nd ed.). (pp. 395-425). Champaign, IL: Human Kinetics.

Bird, S.P., Tarpenning, K.M., & Marino, F.E. (2006). Liquid carbohydrate/essential amino acid ingestion during a short-

term bout of resistance exercise suppresses myofibrillar protein degradation. *Metabolism, 55*(5), 570-577. doi: 10.1016/j.metabol.2005.11.011

Børsheim, E., Tipton, K.D., Wolf, S.E., & Wolfe, R.R. (2002). Essential amino acids and muscle protein recovery from resistance exercise. *American Journal of Physiological Endocrinology and Metabolism, 283*(4), E648-E657. doi: 10.1152/ajpendo.00466.2001

Buckley JD, Thomson RL, Coates AM, Howe PR, DeNichilo MO, & Rowney MK. (2010). Supplementation with a whey protein hydrolysate enhances recovery of muscle force-generating capacity following eccentric exercise. *Journal of Science and Medicine in Sport*, *13*(1), 178-181. doi: 10.1016/j.jsams.2008.06.007

Candow, D.G., Chilibeck, P.D., Facci, M., Abeysekara, S., & Zello, G.A. (2006). Protein supplementation before and after resistance training in older men. *European Journal of Applied Physiology, 97*(5), 548-556. doi: 10.1007/s00421-006-0223-8

Candow, D.G., Little, J.P., Chilibeck, P.D., Abeysekara, S., Zello, G.A., Kazachkov, M., Cornish, S.M., & Yu, P.H. (2008). Low-dose creatine combined with protein during resistance training in older men. *Medicine and Science in Sports and Exercise, 40*(9), 1645-1652. doi: 10.1249/MSS.0b013e318176b310

Evans, W.J. (1992). Exercise, nutrition and aging. *Journal of Nutrition, 122* (3 suppl), 796-801.

Ghanbari-Niaki, A., Nabatchian, S., & Hedayati, M. (2007). Plasma agouti-related protein (AGRP), growth hormone, insulin responses to a single circuit-resistance exercise in male college students. *Peptides, 28*(5), 1035-1039. doi: 10.1016/j.peptides.2007.02.004

Gilani, G.S. (2012). Background on international activities on protein quality assessment of foods. *British Journal of Nutrition, 108* (2), S168-S182. doi: 10.1017/S0007114512002383

Green, M.S., Corona, B.T., Doyle, J.A., & Ingalls, C.P. (2008). Carbohydrate-protein drinks do not enhance recovery from exercise-induced muscle injury. *International Journal of Sport Nutrition and Exercise Metabolism, 18*(1), 1-18.

Hoffman, J.R., Ratamess, N.A., Ross, R., Shanklin, M., Kang, J., & Faigenbaum, A.D. (2008). Effect of a pre-exercise energy supplement on the acute hormonal response to resistance exercise. *Journal of Strength and Conditioning Research, 22*(3), 874-882. doi: 10.1519/JSC.0b013e31816d5db6

Howatson, G., Hoad, M., Goodall, S., Tallent, J., Bell, P.G., & French, D.N. (2012). Exercise-induced muscle damage is reduced in resistance-trained males by branched chain amino acids: a randomized, double-blind, placebo controlled study. *Journal of the International Society of Sports Nutrition, 9*(1), 20. Retrieved from http://www.jissn.com/content/9/1/20

Lukaski, H.C., Mendez, J., Buskirk, E.R., & Cohn, S.H.(1981). Relationship between endogenous 3-methylhistidine excretion and body composition. *American Journal of Physiology, 240* (3), E302-E307.

Moore, D.R., Robinson, M.J., Fry, J.L., Tang, J.E., Glover, E.I., Wilkinson, S.B., Prior, T., Tarnopolsky, M.A., & Phillips, S.M. (2009). Ingested protein dose response of muscle and albumin protein synthesis after resistance exercise in young men. *American Journal of Clinical Nutrition, 89* (1), 161-168. doi: 10.3945/ajcn.2008.26401

Nelson, M.R., Conlee, R.K., & Parcell, A.C. (2004). Inadequate carbohydrate intake following prolonged exercise does not increase muscle soreness after 15 min of downhill running. *International Journal of Sport Nutrition and Exercise Metabolism*, *14*(2): 171-184.

Phillips, S.M., Hartman, J.W., & Wilkinson, S.B. (2005). Dietary protein to support anabolism with resistance exercise in young men. *Journal of the American College Nutrition, 24*(2), 134S-139S.

Roy, B.D., Tarnopolsky, M.A., MacDougall, J.D., Fowles, J., & Yarasheski, K.E. (1997). Effect of glucose supplement timing on protein metabolism after resistance training. *Journal of Applied Physiology, 82* (6), 1882-1888.

Roy, B.D., Fowles, J.R., Hill, R., & Tarnopolsky, M.A. (2000). Macronutrient intake and whole body protein metabolism following resistance exercise. *Medicine and Science in Sports and Exercise, 32*(8), 1412-1418.

Tang, J.E., Moore, D.R., Kujbida, G.W., Tarnopolsky, M.A., & Phillips, S.M. (2009). Ingestion of whey hydrolysate, casein, or soy protein isolate: effects on mixed muscle protein synthesis at rest and following resistance exercise in young men, *Journal of Applied Physiology, 107*(3), 987-992. doi: 10.1152/japplphysiol.00076.2009

West, D.W., & Phillips, S.M. (2012). Associations of exercise-induced hormone profiles and gains in strength and hypertrophy in a large cohort after weight training. *European Journal of Applied Physiology*, *112* (7), 2693-2702. doi: 10.1007/s00421-011-2246-z

Young, V.R., El-Khoury, A.E., Raguso, C.A., Forslund, A.H., & Hambraeus, L. (2000). Rates of urea production and hydrolysis and leucine oxidation change linearly over widely varying protein intakes in healthy adults. *Journal of Nutrition, 130*(4), 761-766.

Y. Kawano
Department of Nutritional Science, Faculty of Applied Bio-Sciences, Tokyo University of Agriculture, Setagaya, Tokyo 156-8502, Japan
e-mail: y1kawano@nodai.ac.jp

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

Renan Renato Cruz dos Santos
University of Brasilia, Faculty of Health Sciences, Brasília, Brazil
Caio Victor de Sousa, Rafael Reis Olher, Ivo Vieira de Sousa Neto, and Lilian Alves Pereira
Catholic University of Brasília, Graduate Programme of Physical Education, Taguatinga, Brazil
Marcelo Magalhães Sales
Catholic University of Brasília, Graduate Programme of Physical Education, Taguatinga, Brazil
UDF Centro Universitário, Health School, Brasília, Brazil

A B S T R A C T

Football is characterized as a predominately 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 ($p<0.05$), when compared with defensive players. These results suggest the use of running anaerobic sprint test and sargent jump test together when is proposed to 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.

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), Continous 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 Papoti, 2013), anaerobic threshold (Santos et al., 2001; Zagatto et al., 2013) VO_2max (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

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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 ($w \cdot kg^{-1}$) separated according to playing position.

Table 1. Comparison of age, anthropometric variables (BM, Height, BMI, BF), anaerobic power - SJT (cm, w, $w \cdot kg^{-1}$), RAST Pmax, Pmed, Pmin (w, $w \cdot kg^{-1}$) - between the groups (goalkeepers+fullbacks, sideways+DMF, OMF+forwards).

	Groups		
	Goalkeepers+Fullbacks (n=9)	Sideways+DMF (n=11)	OMF+Forwards (n=10)
Age (y)	26.9±6.0	24.1±3.8	24.5±3.3
BM (kg)	85.1±8.2*	71.5±6.3	72.9±7.0
Height (cm)	186.6±4.4*	177.6±4.2	175.4±5.5
BMI ($kg \cdot m^{-2}$)	24.4±1.4†	22.6±1.6	23.7±1.3
BF (%)	11.4±1.2	10.9±1.5	11.2±2.3
SJT (cm)	42.3±2.9	42.2±6.1	46.2±3.6
SJT (w)	1200.1±112.0*	1005.4±102.9	1074.3±92.2
SJT ($w \cdot kg^{-1}$)	14.1±0.5	14.1±1.0	14.8±0.6
Pmáx RAST (w)	903.1±108.2	862.3±102.9	976.7±124.5
Pméd RAST (w)	743.9±85.1	712.1±92.4	771.5±89.5
Pmin RAST (w)	595.6±82.3	584.9±91.4	626.5±79.0
Pmáx RAST ($w \cdot kg^{-1}$)	10.7±1.5‡	12.1±1.4	13.4±1.4
Pméd RAST ($w \cdot kg^{-1}$)	8.8±1.3‡	10.0±1.1	10.6±1.0
Pmin RAST ($w \cdot kg^{-1}$)	7.0±1.1*	8.2±1.0	8.6±1.2

*- 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 sideway+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 ($w \cdot kg^{-1}$) values showed no significant difference ($p>0.05$).

When analyzed the RAST results, goalkeepers+fullbacks had lower values ($p<0.05$) of relative Pmin ($w \cdot kg^{-1}$) in relation to the other groups (Table 2). The same players, also showed lower values ($p<0.05$) of relative Pmed and Pmax ($w \cdot kg^{-1}$) 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 ($w \cdot kg^{-1}$), 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).

	Tactical Position						
	Goalkeepers (n=3)	Sideways (n=4)	Fullbacks (n=6)	DMF (n=7)	OMF (n=5)	Forwards (n=5)	Total (n=30)
Age (y)	29.8±6.8	23.6±2.7	25.4±5.5	24.3±4.5	25.1±4.2	23.9±2.6	25.1±4.4
BM (kg)	87.8±13.9	70.1±9.5	83.8±4.8	72.3±4.3	71.3±5.1	74.5±8.8	76.1±9.2
Height (cm)	187.7±7.2	178.0±4.2	186.0±3.0	177.4±4.5	173.4±5.6	177.4±5.3	179.6±6.6
BMI ($kg \cdot m^{-2}$)	24.8±2.1	22.0±2.0	24.2±1.1	23.0±1.3	23.7±1.0	23.6±1.6	23.5±1.6
BF (%)	11.2±1.4	10.8±2.0	11.5±1.2	10.9±1.3	11.4±1.9	11.1±2.9	8.0±1.2
SJT (cm)	40.7±3.2	45.5±7.7	43.0±2.6	40.3±4.6	45.6±3.4	46.8±4.1	43.6±4.8
SJT (W)	1213.8±169.9	1021.4±135.9	1193.2±91.5	996.3±90.3	1044.6±58.1	1104.0±116.5	1086.2±129.9
SJT ($W \cdot .kg^{-1}$)	13.9±0.5	14.6±1.2	14.2±0.4	13.8±0.8	14.7±0.5	14.8±0.6	14.3±0.7
Pmáx RAST (W)	871.0±95.0	919.3±102.3	919.3±119.1	829.7±94.9	922.2±141.8	1079.0 (924.7-1137.7)	912.7±118.7
Pméd RAST (W)	706.7±88..2	728.5±70.0	762.5±85.0	702.7±107.3	739.2±89.9	803.8 (697.3-910.3)	741.4±89.9
Pmin RAST (W)	557.3±114.0	591.3±67.2	614.7±65.8	581.3±107.8	589.0±48.2	664.0 (551.7-776.3)	602.0±83.8
Pmáx RAST ($W \cdot kg^{-1}$)	10.4±1.6	13.2±1.4	11.0±1.5	11.5±1.0	12.9±1.7	13.9±1.1	12.1±1.8
Pméd RAST ($W \cdot kg^{-1}$)	8.1±1.4	10.5±0.7	9.1±1.2	9.7±1.2	10.4±1.1	10.8±1.0	9.8±1.3
Pmin RAST ($W \cdot kg^{-1}$)	6.4±1.1	8.5±0.4	7.4±1.1	8.0±1.2	8.3±0.8	8.9±0.9	8.0±1.2

Discusion

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 contributes with the evaluation and monitoring of the variable in question. Since Santos et al. (2009) suggest that, due the every 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 of 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. 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 his 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 ($w \cdot kg^{-1}$), 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 ($w \cdot kg^{-1}$).

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, Krustrup, Nybo, Nielsen and Bangsbo (2003) pointed that offensive middlefileds 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 ($w \cdot kg^{-1}$) 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.

REFERENCES

Santos, P. J. & Soares, J. M (2001). Capacidade aeróbia em futebolistas de elite em função da posição específica no jogo. Revista Portuguesa de Ciências do Desporto. 1(2), 7-12.

Campeiz, J. M., Oliveira, P. R. (2006). Análise comparativa de variáveis antropométricas e anaeróbias de futebolistas profissionais, juniores e juvenis. Movimento e Percepção. 6(8).

Asano, R. Y., Oliveira, H. P., Bartolomeu, J. (2009). Avaliação das potências aeróbia e anaeróbia em jogadores de futebol da. Revista Cereus. 1(4).

Souza, J. (1999). Variáveis antropométricas, metabólicas e neuromotoras de jogadores de futebol das categorias mirim, infantil, juvenil e junior em relação a posição de jogo: um estudo comparativo. Revista de Treinamento Desportivo. 4(3), 43-8.

Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. International Journal of Sports Medicine, 28(3), 222-227.

Di Salvo V., Gregson W., Atkinson G., Tordoff P., Drust B. (2009). Analysis of high intensity activity in premier league soccer. International Journal of Sports Medicine, 30, 205-12.

Franchini, E. (2002). Teste anaeróbio de Wingate: conceitos e aplicação. Revista Mackenzie de Educação Física e Esporte. 1(1), 11-27.

Bosco C. (1999). Strength assessment with the Bosco's test. Italian Society of Sport Science.

Markovic, G., Dizdar, D., Jukic, I., Cardinale, M. (2004). Reliability and factorial validity of squat and countermovement jump tests. Journal of Strength and Conditioning Research. 18(3), 551-555.

Salles, P. G., Mello D.B., Vasconcellos, F.V., Júnior, A.A., Dantas, E.H. (2010). Validity and reliabilty of the Sargent Jump Test in assessing the explosive strength of soccer players. Revista Brasileira de Ciências da Saúde. 14(1), 21-6.

Zacharogiannis, E. Paradisis, G. Tziortzis, S. (2004). An evaluation of tests of anaerobic power and capacity. Medicine and Science in Sports and Exercise. 36, 116.

Bangsbo J., Laia F. M., Krustrup P. (2008). The yo-yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports. Medicine and Science in Sports and Exercise. 38, 37-51.

Kiss, M. A. (2003). Esporte e exercício: avaliação e prescrição. São Paulo: Roca.

Barros, R., Misuta, M. S., Menezes R. P., Figueroa P. J., Moura F. A., Cunha S. A., Leite N. J. (2007). Analysis of the distances covered by first division brazilian soccer players obtained with an automatic tracking method. Journal of Sports Science and Medicine. 6, 233-42.

Rampinini, E., Coutts, A. J., Castagna C., Sassi R., Impellizzeri F. M. (2007). Variation in top level soccer match performance. International Journal Sports Medicine. 28(12), 1018-24.

Zagatto A. M., Miyagi W. E., Sakugawa R. L., Papoti, M. (2013). Utilização da distância total percorrida no teste específico de HOFF como preditor da velocidade de limiar anaeróbio no futebol. Revista Brasileira de Medicina do Esporte. (19), 266-69.

dos Santos, J. A. R. (1999). Estudo comparativo, fisiológico, antropométrico e motor entre futebolistas de diferente nível competitivo. *Rev. paul. Educ. Fís., São Paulo*, *13*(2), 146-59.

De Barros, T. L., & Guerra, I. (2004). *Ciência do futebol*. Editora Manole Ltda.

Mohr, M., Krustrup, P., Nybo, L., Nielsen, J. J., & Bangsbo, J. (2004). Muscle temperature and sprint performance during soccer matches–beneficial effect of re-warm-up at half-time. *Scandinavian journal of medicine & science in sports, 14(3)*, 156-162.

Santos, D., Coledam, D. C., & dos-Santos, J. (2009). Alterações na potência anaeróbia após a pré-temporada em atletas profissionais de futebol. *Movimento e Percepção*, *10*(15).

Dal Pupo, J., Almeida, C. M. P., Detanico, D., Silva, J. F. D., Guglielmo, L. G. A., & Santos, S. G. D. (2010). Potência muscular e capacidade de sprints repetidos em jogadores de futebol. *Rev Bras Cineantropom Desempenho Hum*, *12*(4), 255-61.

Asano, R. Y., Bartholomeu-Neto, J., Ribeiro, D., Barbosa, A., & Sousa, M. (2009). Potência anaeróbia em jogadores jovens de futebol: Comparação entre três categorias de base de um clube competitivo. *Brazilian Journal of biomotricity*, *3*(1), 76-82.

Matsudo, V. K. R. (Ed.). (1987). *Testes em ciências do esporte*. Centro de estudos do laboratorio de aptidao fisica.

Cetolin, T., Foza, V., Silva, J. F. D., Guglielmo, L. G. A., Siqueira, O. D., Cardoso, M. F. D. S., & Crescente, L. A. B. (2013). Comparison of anaerobic power between tactical positions in soccer players: a retrospective study. *Revista Brasileira de Cineantropometria & Desempenho Humano*, *15*(4), 507-516.

Coelho, D. B., Coelho, L. G. M., Braga, M. L., Paolucci, A., Cabido, C. E. T., Junior, J. B. F., ... & Garcia, E. S. (2011). Correlação entre o desempenho de jogadores de futebol no teste de sprint de 30m e no teste de salto vertical. *Motriz*, *17*, 63-70.

Cruz, S. (2005). Avaliação da capacidade física em futebolistas profissionais: análise em função da posição específica.

Rienzi, E., Drust, B., Reilly, T., Carter, J. E., & Martin, A. (2000). Investigation of anthropometric and work-rate profiles of elite South American international soccer players. *The Journal of sports medicine and physical fitness*, *40*(2), 162-169.

Frykman, P. N., Harman, E. A., Kraemer, W. J., Rosenstein, R. M., & Rosenstein, M. T. (1988). Estimation of Human Power Output from Maximal Vertical Jump and Body Mass.

Ekblom, B. (1986). Applied physiology of soccer. *Sports Medicine*, *3*(1), 50-60.

Helgerud, J., Engen, L. C., Wisloff, U., & Hoff, J. (2001). Aerobic endurance training improves soccer performance. *Medicine and Science in Sports and Exercise*, *33*(11), 1925-1931.

M.M. Sales
Catholic University of Brasília, Graduate Program of Physical Education,
QS 07, AREA 1 s/n, Room 112, Saint John Bosco's Bulding (G), Águas Claras, Brasília, DF, Brazil. CEP: 72030-170
e-mail: marcelomagalhaessales@gmail.com

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

Aldijana Muratovic, Dobrislav Vujovic, and Rasid Hadzic
University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro

A B S T R A C T

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 relevant topic in wide scientific literature (cited in Popović, Akpinar, Jakšić, Matić, & Bjelica, 2013; Popović, Bjelica, Jakšić, & Hadžić, 2014) as well as identifying talent, strengths and weaknesses, assigning player positions and helping in the design of optimal training programmes (cited in Hadžić, Bjelica, & Popović, 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 Massuça & 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 (Srhoj, 2002; Chaouach 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, & Ahmaidi, 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 anthropometric characteristics and body composition profiles of elite handball and basketball players and to detect possible differences in relation to competition level.

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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

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

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.

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).

Table 2. Differences among the Subjects

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Sig.
Height (cm)	Basketball	Handball	11.34	0.00*
	Basketball	Control	15.63	0.00*
	Handball	Control	4.29	0.07^
Weight (kg)	Basketball	Handball	12.94	0.01*
	Basketball	Control	12.34	0.00*
	Handball	Control	-0.60	0.88^
Muscle content of body (%)	Basketball	Handball	-1.59	0.16^
	Basketball	Control	3.00	0.03*
	Handball	Control	4.60	0.00*
Bone content of body (%)	Basketball	Handball	0.94	0.09^
	Basketball	Control	1.45	0.04*
	Handball	Control	0.51	0.27^
Fat content of body (%)	Basketball	Handball	-0.87	0.60^
	Basketball	Control	-7.23	0.00*
	Handball	Control	-6.36	0.00*

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

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 taller 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 bat 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.

Discusion

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, & Akpinar, 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 to 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 (Popovic 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 (Popovic et al, 2012). This is less shorter distance (5,000 to 7,000 meters) that basketball players cover (Dezman & Erculj, 2005; Erculj & Supej, 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. Lastly, 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 anthropometric characteristics and body composition, mostly due to the fact that it has to be conducted either at the beginning or at the end of a season. It also has to be explicitly reported when the measurement was conducted.

REFERENCES

Bayios, I.A., Bergeles, N.K., Apostolidis, N.G., Noutsos, K.S., & Koskolou, M.D. (2006). Anthropometric, body composition and somatotype differences of Greek elite female basketball, volleyball and handball players. *Journal of Sports Medicine and Physical Fitness*, 46(2), 271–280.

Bilge, M. (2013). Interval Training Specific to Handball and Training Programme Designs. *World Applied Sciences Journal*, 25(7), 1066-1077.

Bjelica, D., Popović, S., Kezunović, M., Petković, J., Jurak, G., & Grasgruber, P. (2012). Body Height and Its Estimation Utilizing Arm Span Measurements in Montenegrin Adults. Anthropological Notebooks, 18(2), 69–83.

Buchheit, M., Lepretre, P.M., Behaegel, A.L., Millet, G.P., & Ahmaidi, S. (2009). Cardiorespiratory responses during running and sport-specific exercises in handball players. *Journal of Science and Medicine in Sport*, 12(3), 399-405.

Carvajal, W., Betancourt, H., León, S., Deturnel, Y., Martínez, M., Echevarría, I., Eugenia Castillo, M., & Serviat, N. (2012). Kinanthropometric Profile of Cuban Women Olympic Volleyball Champions. *MEDICC Review,* 14(2), 16-22.

Chaouachi, A., Brughelli, M., Levin, G., Boudhina, N., Cronin, J., & Chamari, K. (2009). Anthropometric, physiological and performance characteristics of elite team-handball players. *Journal of Sports Science*, 27(2), 151-157.

Dežman, B. & Erčulj, F. (2005). *Conditioning for Basketball* (In Slovene). Ljubljana: Faculty of Sport, Institute of Sport.

Erčulj, F. & Supej, M. (2006). The Impact of Fatigue on Jump Shot Height and Accuracy over a Longer Shooting Distance in Basketball. *Ugdymas. Kûno Kultûra. Sportas*, 63(4), 35-41.

Hadžić, R., Bjelica, D., & Popović, S. (2012). Comparative study of anthropometric measurement and body composition between elite basketball and volleyball players. *Research in physical education, sport and health*, 1(1), 103-108.

Hooper, D.M. (1997). Somatotype in high performance female netball players may influence player position and the incidence of lower limb and back injuries. *British Journal of Sports Medicine*, 31(3), 197–199.

Gualdi-Russo, E. & Zaccagni, L. (2001). Somatotype, role and performance in elite volleyball players. *Journal of Sports Medicine and Physical Fitness*, 41(2), 256–262.

Kovač, M., Jurak, G., & Leskošek, B. (2012). The prevalence of excess weight and obesity in Slovenian children and adolescents from 1991 to 2011. *Anthropological Notebooks*, 18(1), 91–103.

Kraemer, W.J., French, D.N., Paxton, N.J., Häkkinen, K., Volek, J.S., Sebastianelli, W.J., Putukian, M., Newton, R.U., Rubin, M.R., Gómez, A.L., Vescovi, J.D., Ratamess, N.A., Fleck, S.J., Lynch, J.M., & Knuttgen, H.G. (2004). Changes in exercise performance and hormonal concentrations over a Big Ten soccer season in starters and nonstarters. *The Journal of Strength & Conditioning Research*, 18(1), 121-128.

Massuça, L. & Fragoso, I. (2011). Study of Portuguese handball players of different playing status. A morphological and biosocial perspective. Biology of Sport, 28(1), 37-44.

Pineau, J.C., Delamarche, P., & Božinović, S. (2005). Average height of adolescents in the Dinaric Alps (in French). *Comptes Rendus Biologies*, 328(9), 841–846.

Popović, S., Bjelica, D., Petković, J., & Muratović, A. (2012). Comparative Study of Anthropometric Measurement and Body Composition between Elite Soccer and Handball Players. In: *4th International Scientific Conference "Contemporary Kinesiology"* (pp.102-108). Split: Faculty of Kinesiology, University of Split.

Popović, S., Akpinar, S., Jakšić, D., Matić, R. & Bjelica, D. (2013). Comparative Study of Anthropometric Measurement and Body Composition between Elite Soccer and Basketball Players. *International Journal of Morphology*, 31(2), 461-467.

Popović, S., Bjelica, D., Molnar, S., Jakšić, D. & Akpinar, S. (2013). Body Height and Its Estimation Utilizing Arm Span Measurements in Serbian Adults. International Journal of Morphology, 31(1), 271-279.

Popović, S., Bjelica, D., Jakšić, D. & Hadžić, R. (2014). Comparative Study of Anthropometric Measurement and Body Composition between Elite Soccer and Volleyball Players. International Journal of Morphology, 32(1), 267-274.

Silvestre, R., Kraemer, W.J., West, C., Judelson, D.A., Spiering, B.A., Vingren, J.L., Hatfield, D.L., Anderson, J.M., & Maresh, C.M. (2006). Body Composition and Physical Performance during a National Collegiate Athletic Association Division I Men's Soccer Season. *Journal of Strength and Conditioning Research*, 20(4), 962-970.

Singh, S., Singh, K., & Singh, M. (2010). Anthropometric measurements, body composition and somatotyping of high jumpers. Brazilian Journal of Biomotricity, 4(4), 266-271.

Srhoj, V., Marinović, M., & Rogulj, N. (2002). Position specific morphological characteristics of top-level male handball players. *Collegium antropologicum*, 26(1), 219-227.

Taborsky, F. (2007). *The Body Height and Top Team Handball Players*. Vienna: EHF Web Periodical.

Triki, M., Rebai, H., Abroug, T., Masmoudi, K., Fellmann, N., Zouari, M., & Tabka, Z. (2012). Comparative study of body composition and anaerobic performance between football and judo groups. *Science and Sports*, 27(5), 293–299.

Wilmore, J.H. (1982). Body composition and athletic performance. In W. Haskell; J. Scala & J. Whittam (Eds.), *Nutrition and Athletic Performance* (pp. 158-175). California, USA, Bull Publishing.

A. Muratović
University of Montenegro, Faculty for Sport and Physical Education, Narodne omladine bb, 81400 Niksic, Montenegro
e-mail: adamuratovic@yahoo.com

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Analysis of the Relevant Factors of Retaining Women in Judo

Joško Sindik
Institute for Anthropological Research, Zagreb, Croatia
Dina Rendulić
Kindergarten Maslačak, Zaprešić, Croatia
Sanda Čorak
Institute for Tourism, Zagreb, Croatia
Ana Perinić Lewis
Institute for Anthropological Research, Zagreb, Croatia

A B S T R A C T

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

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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 determing 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), Mladost Osijek (3), Tempo (1), Randori (1), Medvedgrad (3), Maksimir (1), Auto Čuljak Vinkovci (8), Nijemci (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), Stara Rača (1), Vinkovci (8), Nijemci (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 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 in is performed in our previous articles (Rendulić, Sindik, and Čorak, 2013; Rendulić, Sindik, and Čorak, 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 showed 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)

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

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

Why are you engaged in judo (motivation)?	Social motives	Relaxation and fun	Ambition and self-esteem	Communalities
to slow down the effects of aging	.782			.614
for weight control	.743	.369		.691
to be with friends	.735			.581
to gain new friends	.642	.335		.594
to be better integrated into society	.573			.457
to better look	.562	.444		.515
to meet people from different cultural backgrounds	.561		.322	.435
for relaxation		.862		.771
for improving fitness		.740	.317	.700
for fun	.306	.730		.636
to advance self-esteem (feel more valuable)			.844	.738
to develop new skills		.336	.794	.746
the spirit of competition			.786	.655
to be successful in sport		.345	.465	.408
for schemes to promote health		.377	.387	.332
KMO measure of sample adequacy	0.741			
Bartlett's Sphericity test (df=105)	348.912		p<0.001	
Reliability (Cronbach's alpha)	0.842	0.820	0.753	
Eigenvalue	3.391	2.773	2.709	
Variance explained	22.606	18.485	18.060	

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)

Obstacles to your participation in judo	Environmental barriers	Obligations as barriers	Financial, rules, traffic	Communalities
Cultural barriers (undesirable that women play sports)	.929			.876
Environment unfriendly to women	.921			.875
Timing of the competition	.536		.381	.478
Time - with regard to family responsibilities		.821		.678
Time - related to business commitments		.765		.591
Lack of capacity to cater for children		.611	.328	.484
Equal rules for women and men			.836	.708
Prices (financial reasons)	.349	.302	.623	.601
Lack of transportation options			.595	.436
KMO measure of sample adequacy	0.580			
Bartlett's Sphericity test (df=15)	136.156		p<0.001	
Reliability (Cronbach's alpha)	0.777	0.591	0.586	
Eigenvalue	2.207	1.797	1.721	
Variance explained	24.526	19.968	19.119	

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)

Importance of the following issues in promoting inclusion and participation of women in sports in general	Organization of sport commitments for women	Organization of out-sport commitments for women	Communalities
Increase the number of available choices ways sports	.923		.859
Develop sports in which women can participate and have fun	.914		.856
Develop a strategy for harmonization obligations with sports	.482	.397	.390
Develop strategies for occasional babysitting		.894	.805
Consider the style of dress (dress code)		.743	.641
Consider the time of the competition	.485	.612	.610
KMO measure of sample adequacy	0.695		
Bartlett's Sphericity test (df=15)	107.654	p< 0.001	
Reliability (Cronbach's alpha)	0.768	0.719	
Eigenvalue	2.251	1.909	
Variance explained	37.521	31.822	

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)

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

Specific strategies to encourage participation and involvement of women in judo	Indirectly – judo official	Directly in judo	Communalities
Opportunity to become a member of the Board	.801		.723
Opportunity to become an official competitions	.667	.514	.476
Voluntary participation by organizations and sports associations	.585	.309	.342
Programs for top athletes	.554	.364	.312
Volunteer roles that can be downloaded	.743	.841	.821
identification of the talents	.491	.522	.332
Training (the ability to become a coach)		.487	.271
KMO measure of sample adequacy	0.748		
Bartlett's Sphericity test (df=21)	82.965	p< 0.001	
Reliability (Cronbach's alpha)	0.733	0.508	
Eigenvalue	2.672	1.606	
Variance explained	38.176	8.652	

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

Already present initiatives to encourage greater involvement of women in judo	Already present initiatives	Communalities
Creation of new programs / games that are specifically aimed at women	.839	.704
Differentiated funding, with the aim of attracting women	.758	.575
Programs designed just for women	.756	.571
Educational activities to promote women's involvement	.671	.450
tacit encouragement through promotional events and communication	.653	.427
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: number of children, age and period spent (engaged) in judo (Table 8).

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

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

* 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

	Positive personal	Negative environment	Social motives	Relaxation, fun	Ambition and self-esteem	Environmental	Obligations	Financial rules	Organization sport	Organization out-sport	Media strategies	Indirectly	Directly in judo	Already present initiatives
Positive personal motives	1.00	0.00	0.07	0.30*	0.52**	0.12	0.19	0.07	0.46**	0.20	0.37**	0.05	-0.07	0.19
Negative environment motives		1.00	0.23	-0.07	0.01	0.06	0.26	-0.28*	0.15	0.08	0.28*	0.14	0.14	-0.02
Social motives			1.00	0.00	0.00	-0.01	0.05	-0.05	0.29*	0.24	0.54**	-0.03	0.14	0.00
Relaxation, fun				1.00	0.00	-0.02	0.32*	0.24	0.13	0.03	0.34*	0.07	0.07	0.06
Ambition and self-esteem					1.00	0.26	0.18	0.00	0.44**	0.08	0.21	0.36*	0.18	0.02
Environmental barriers						1.00	0.00	0.00	0.03	0.13	0.16	-0.12	-0.27	0.09
Obligations as barriers							1.00	0.00	0.08	0.17	0.28*	0.39**	0.24	0.13
Financial, rules, traffic barriers								1.00	0.18	0.10	0.09	0.02	-0.10	0.39**
Organization of women sport commitments									1.00	0.00	0.47**	0.09	0.02	0.32*
Organization of women outsport commitments										1.00	0.50**	0.19	0.22	-0.02
Specific strategies media											1.00	0.17	0.14	0.15
Indirectly - judo official												1.00	0.65**	0.10
Directly in judo													1.00	-0.06
Already present initiatives														1.00

* 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 odler are mostly trainers and/or members of the Board. On the other hand, it can be suprising that marital status is reflected only in the Environmental barriers (in 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 engaging 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.

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REFERENCES

Acosta, V. & Carpenter, L. J. (2012). *Women in Intercollegiate Sport. A Longitudinal, National Study - Thirty-Five Year Update 1977-2012*. West Brookfield, MA: Smith College's Project on Women and Social Change and Brooklyn College of the City University of New York.

Birrell S. & Cole C. (Ed.) (1994). *Women, Sport & Culture*.

Champaign: Human Kinetics.
Croatian Judo Federation (Hrvatski judo savez) (2013). Clubs of Croatian Judo Federation (Klubovi Hrvatskog judo saveza). Retrived 11/30, 2013, from www.judo.hr/?page= clubs
Croatian Olympic Committee (HOO) (Komisija Hrvatskog olimpijskog odbora za žene u sportu) (2012). Retrived 11/1, 2013, from www.hoo.hr/2758-v-ravnopravnost-zena-u-sportu.aspx
Khan, M. Y., Jamil, Asif, K., Umar A., Kareem, U. & Imran, G. (2012). Female Students Opinion about Women's Participation in Sports. *International Journal of Academic Research in Business and Social Sciences*, 2 (9), 275-283.
Lucić J. & Gržeta M. (2000). *Judo u hrvatskoj vojsci*. Zagreb: Ministarstvo obrane Republike Hrvatske.
Rendulić D., Sindik J. & Čorak, S. (2013) Istraživanje čimbenika uključivanja i ustrajanja žena u judu. *Hrvatski športsko-medicinski vjesnik*. 28, 81-91.
Rendulić D., Sindik J. & Čorak, S. (2014) Zadržavanje žena u judu – stanje, stavovi i perspektive. *Zbornik radova Međimurskog veleučilišta u Čakovcu*, 5(1), 93-100.
Sparks, M. (2007). National Womensport & Recreation Survey Australian Womensport & Recreation Association. Retirived March 12, 2014 from http://www.australianwomensport.com.au/images/Reports/AWRA%20Report.pdf
Sport and Physical Activity (2010). Special Eurobarometer 334 / Wave 72.3 – TNS Opinion & Social ter Opinion & Social Avenue Herrmann Debroux. Belgium: Bruxelles. Retrived 3/12, 2014, from www.mhfi.org/sportandphysical.pdf
Štimac Radin, H. (Ed.) (2011). *Nacionalna politika za ravnopravnost spolova za razdoblje od 2011. do 2015. godine.* Zagreb: Vlada RH, Ured za ravnopravnost spolova.
Women's Sport and Fitness Foundation support NGBs (2011). Trends in women's participation in sport. A trend analysis of Active People survey data from 2007-2011 (AP2-AP5). Retrived 11/30, 2013, from www.wsff.org.uk/system/1/assets/files/000/000/265/265/4bfd5faba/original/Trends_Women's_Participation.pdf

J. Sindik
Institute for Anthropological Research, Gajeva 32/2, 10000 Zagreb, Croatia
e-mail: josko.sindik@inantro.hr

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

Selcuk Akpinar
Nevşehir Hacı Bektaş Veli University, Faculty of Education, Department of Physical Education and Sport Education, Nevşehir, Turkey
Bilal Bicer
Hatay Mustafa Kemal University, School of Physical Education and Sport, Hatay, Turkey

A B S T R A C T

Left-handers/footers are found with disproportionately more frequency in many interactive sports compared to the general population. In ıorder 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 & Petrinovich, 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 has 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 Lowrance (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

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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; Ramadhani, Koomen, Grobbee, van Donselaar, Marceline van Furth, & Uiterwaal, 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, Gaffen, Hay, Levy, Martin, & Duffy, 2003), many studies found increased left-handedness in twins and triplets compared to singletons (Sicotte, Woods & Mazziotta, 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, & Mazziotta, 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 emphases 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 likeliness 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 critic 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 the 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, Jancke, 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 ri ght-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, Calvanio, 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 left-handed/footed athletes are over represented compared to general population. For instance, tennis (Holtzen, 2000), baseball (Goldstein & Young, 1996), cricket (Brooks, Bussière, Jennions, & Hunt, 2004), fencing (Harris, 2010), volleyball (Loffing, Schorer, Hagemann, & Baker, 2012) are some interacitve 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 27% among the total players in the team, Arsenal (England) had 4 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 heft-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 Narvatilova, 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 coincidence?". 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 connections 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 lefties 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 backcourt and right wing positions. The main reason to have lefties 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 lefties in the sports and can be also another reason to have more rate of lefties 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 lefties elucidate the reason of overrepresentation of lefties in many interactive sports.

REFERENCES

Amunts, K., Jancke, L., Mohlberg, H., Steinmetz, H., & Zilles, K. (2000). Interhemispheric asymmetry of the human motor cortex related to handedness and gender. *Neuropsychologia, 38*(3), 304-312.

Amunts, K., Schlaug, G., Schleicher, A., Steinmetz, H., Dabringhaus, A., Roland, P. E., et al. (1996). Asymmetry in the human motor cortex and handedness. *Neuroimage, 4*(3 Pt 1), 216-222.

Bailey, L. M., & McKeever, W. F. (2004). A large-scale study of handedness and pregnancy/birth risk events: implications for genetic theories of handedness. *Laterality, 9*(2), 175-188.

Barthélémy, S. & Boulinguez, P. (2001). Manual reaction time asymmetries in human subjects: the role of movement planning and attention. *Neuroscience Letters,* 315(1): 41-44.

Boulinguez, P. & Barthélémy, S. (2000). Influence of the movement parameter to be controlled on manual RT asymmetries in right-handers. *Brain and Cognition,* 44(3): 653-661.

Bourassa, D. C., McManus, I. C., & Bryden, M. P. (1996). Handedness and eye-dominance: a meta-analysis of their relationship. *Laterality, 1*(1), 5-34.

Bradshaw, J. L., & Rogers, L. J. (1993). *The Evolution of Lateral Asymmetries, Language, Tool Use, and Intellect*. San Diego: Academic Press.

Brooks, R., Bussie`re, L. F., Jennions, M. D., & Hunt, J. (2004). Sinister strategies succeed at the cricket World Cup. *Proceedings of the Royal Society of London B*, 271, 64–66.

Brown, E. R., & Taylor, P. (1988). Handedness, footedness, and eyedness. *Percept Mot Skills, 66*(1), 183-186.

Caliskan, E., & Dane, S. (2009). Left-handedness in blind and sighted children. *Laterality, 14*(2), 205-213.

Cicinelli, P., Traversa, R., Bassi, A., Scivoletto, G., & Rossini, P. M. (1997). Interhemispheric differences of hand muscle representation in human motor cortex. *Muscle Nerve, 20*(5), 535-542.

Civardi, C., Cavalli, A., Naldi, P., Varrasi, C., & Cantello, R. (2000). Hemispheric asymmetries of cortico-cortical connections in human hand motor areas. *Clin Neurophysiol, 111*(4), 624-629.

Cherbuin, N & Brinkman, J 2006, 'Efficiency of callosal transfer and hemispheric interaction', *Neuropsychology*, 20, 2, 178-184.

Coren, S., & Porac, C. (1977). Fifty centuries of right-handedness: the historical record. *Science, 198*(4317), 631-632.

Crow, T. J., Close, J. P., Dagnall, A. M., & Priddle, T. H. (2009). Where and what is the right shift factor or cerebral dominance gene? A critique of Francks et al. (2007). *Laterality, 14*(1), 3-10.

Dragovic, M., & Hammond, G. (2005). Handedness in schizophrenia: a quantitative review of evidence. *Acta Psychiatr Scand, 111*(6), 410-419.

Faurie, C., & Raymond, M. (2005). Handedness, homicide and negative frequency-dependent selection. *Proceedings of the Royal Society of London B*, 272, 25–28.

Francks, C., Maegawa, S., Lauren, J., Abrahams, B. S., Velayos-Baeza, A., Medland, S. E., et al. (2007). LRRTM1 on chromosome 2p12 is a maternally suppressed gene that is associated paternally with handedness and schizophrenia. *Mol Psychiatry, 12*(12), 1129-1139, 1057.

Gazzaniga, M. S. (1989). Organization of the human brain. *Science, 245*(4921), 947-952.

Goble, D. J., & Brown, S. H. (2008). The biological and behavioral basis of upper limb asymmetries in sensorimotor performance. *Neurosci Biobehav Rev, 32*(3), 598-610.

Goldstein, S. R., & Young, C. A. (1996). ''Evolutionary'' stablestrategy of handedness in major league baseball. *Journal of Comparative Psychology*, 110, 164–169.

Grouios, G. (2004). Motoric dominance and sporting excellence: Training versus heredity. *Perceptual and Motor Skills*, 98, 53–66.

Hagemann, N. (2009). The advantage of being left-handed in interactive sports. Attention, Perception, & Psychophysics, 71, 1641–1648.

Hardyck, C., & Petrinovich, L. F. (1977). Left-handedness. *Psychol Bull, 84*(3), 385-404.

Harris, L. J. (2007). In fencing, what gives left-handers the edge? Views from the present and the distant past. *Laterality*: Asymmetries of Body, Brain and Cognition.

Hebbal, G. V., & Mysorekar, V. R. (2003). Anatomical and behavioural asymmetries in right and left handers from India. *Ann Anat, 185*(3), 267-275.

Heilman, K.M. & Van Den Abell, T. (1980). Right hemisphere dominance for attention: the mechanism underlying hemispheric asymmetries of inattention (neglect). *Neurology* 30:327–330.

Hepper, P. G., McCartney, G. R., & Shannon, E. A. (1998). Lateralised behaviour in first trimester human foetuses. *Neuropsychologia, 36*(6), 531-534.

Hepper, P. G., Wells, D. L., & Lynch, C. (2005). Prenatal thumb sucking is related to postnatal handedness. *Neuropsychologia, 43*(3), 313-315.

Holtzen, D. W. (2000). Handedness and professional tennis. *International Journal of Neuroscience*, 105, 101–119.

Hopkins, W. D., & Leavens, D. A. (1998). Hand use and gestural communication in chimpanzees (Pan troglodytes). *J Comp Psychol, 112*(1), 95-99.

Ida, Y., & Bryden, M. P. (1996). A comparison of hand preference in Japan and Canada. *Canadian Journal of Experimental Psychology-Revue Canadienne De Psychologie Experimentale, 50*(2), 234-239.

Jung, H. S., & Jung, H. S. (2009). Hand dominance and hand use behaviour reported in a survey of 2437 Koreans. *Ergonomics, 52*(11), 1362-1371.

Latimer, H. B., & Lowrance, E. W. (1965). Bilateral asymmetry in weight and in length of human bones. *Anat Rec, 152*(2), 217-224.

Loffing, F., Hagemann, N., & Strauss, B. (2010). Automated processes in tennis: Do left-handed players benefit from the tactical preferences of their opponents? *Journal of Sports Sciences*, 28(4), 435–443.

Loffing, F., Schorer, J., Hagemann, N., & Baker, J. (2012). On the advantage of being left-handed in volleyball: further evidence of the specificity of skilled visual perception. *Atten Percept Psychophys*, 74(2):446-53

Macdonell, R. A., Shapiro, B. E., Chiappa, K. H., Helmers, S. L., Cros, D., Day, B. J., et al. (1991). Hemispheric threshold differences for motor evoked potentials produced by magnetic coil stimulation. *Neurology, 41*(9), 1441-1444.

Malesu, R. R., Cannon, M., Jones, P. B., McKenzie, K., Gilvarry, K., Rifkin, L., et al. (1996). Mixed-handedness in patients with functional psychosis. *Br J Psychiatry, 168*(2), 234-236.

McManus, I. C. (2009). The history and geography of human handedness. In R. S. K. Iris E. C. Sommer (Ed.), *Language Lateralization and Psychosis* (pp. 37-57): Cambridge University Press.

Medland, S. E., Wright, M. J., Geffen, G. M., Hay, D. A., Levy, F., Martin, N. G., et al. (2003). Special twin environments, genetic influences and their effects on the handedness of twins and their siblings. *Twin Res, 6*(2), 119-130.

Oldfield, R. C. (1971). The assessment and analysis of handedness: the Edinburgh inventory. *Neuropsychologia, 9*(1), 97-113.

Perelle, I. B., & Ehrman, L. (1994). An international study of human handedness: The data. *Behav Genet, 24*(3), 217-227.

Perelle, I. B., & Ehrman, L. (2005). On the other hand. *Behav Genet, 35*(3), 343-350.

Porac, C., & Coren, S. (1981). *Lateral Preferences and Human Behaviour*. New York: Springer-Verlag.

Porac, C., & Martin, W. L. (2007). A cross-cultural comparison of pressures to switch left-hand writing: Brazil versus Canada. *Laterality, 12*(3), 273-291.

Porac, C., & Searleman, A. (2002). The effects of hand preference side and hand preference switch history on measures of psychological and physical well-being and cognitive performance in a sample of older adult right-and left-handers. *Neuropsychologia, 40*(12), 2074-2083.

Previc, F. H., & Saucedo, J. C. (1992). The Relationship between Turning Behavior and Motoric Dominance in Humans. *Perceptual and Motor Skills, 75*(3), 935-944.

Ramadhani, M. K., Koomen, I., Grobbee, D. E., van Donselaar, C. A., Marceline van Furth, A., & Uiterwaal, C. S. (2006). Increased occurrence of left-handedness after severe childhood bacterial meningitis: support for the pathological left-handedness hypothesis. *Neuropsychologia, 44*(12), 2526-2532.

Rodrigues, P., Vasconcelos, O., Barreiros, J., Barbosa, R., & Trifilio, F. (2009). Functional asymmetry in a simple coincidence anticipation task: Effects of handedness. *European Journal of Sport Sciences,* 9, 2, 115-123.

Sainburg, R. L. (2002). Evidence for a dynamic-dominance hypothesis of handedness. *Exp Brain Res, 142*(2), 241-258.

Satz, P., & Green, M. F. (1999). Atypical handedness in schizophrenia: some methodological and theoretical issues. *Schizophr Bull, 25*(1), 63-78.

Searleman, A., & Porac, C. (2001). Lateral preference patterns as possible correlates of successfully switched left hand writing: data and a theory. *Laterality, 6*(4), 303-314.

Sicotte, N. L., Woods, R. P., & Mazziotta, J. C. (1999). Handedness in twins: a meta-analysis. *Laterality, 4*(3), 265-286.

Singh, M., & Bryden, M. P. (1994). The factor structure of handedness in India. *Int J Neurosci, 74*(1-4), 33-43.

Strang, J. (1991). Left-Handedness and Life Expectancy. *New England Journal of Medicine, 325*(14), 1041-1042.

Taylor, M. A., & Amir, N. (1995). Sinister psychotics. Left-handedness in schizophrenia and affective disorder. *J Nerv Ment Dis, 183*(1), 3-9.

Triggs, W. J., Calvanio, R., Macdonell, R. A., Cros, D., & Chiappa, K. H. (1994). Physiological motor asymmetry in human handedness: evidence from transcranial magnetic stimulation. *Brain Res, 636*(2), 270-276.

Uomini, N. T. (2009). The prehistory of handedness: archaeological data and comparative ethology. *J Hum Evol, 57*(4), 411-419.

Volkmann, J., Schnitzler, A., Witte, O. W., & Freund, H. (1998). Handedness and asymmetry of hand representation in human motor cortex. *J Neurophysiol, 79*(4), 2149-2154.

Vuoksimaa, E., Koskenvuo, M., Rose, R. J., & Kaprio, J. (2009). Origins of handedness: a nationwide study of 30,161 adults. *Neuropsychologia, 47*(5), 1294-1301.

Williams, C. S., Buss, K. A., & Eskenazi, B. (1992). Infant resuscitation is associated with an increased risk of left-handedness. *Am J Epidemiol, 136*(3), 277-286.

S. Akpinar
Nevşehir Hacı Bektaş Veli University, Faculty of Education, Department of Physical Education and Sport Education, 50300 Nevşehir, Turkey
e-mail: sakpinar@nevsehir.edu.tr

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Revised September 2014

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Original Scientific Paper

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Selcuk Akpinar[1], Stevo Popović[1,2], Sadettin Kirazci[1]

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

Corresponding author:
S. Popovic
University of Montenegro
Faculty for Sport and Physical Education
Narodne omladine bb, 84000 Niksic, Montenegro
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Chantavanich, S. (2003, October). Recent research on human trafficking. *Kyoto Review of Southeast Asia, 4*. Retrieved November 15, 2005, from http://kyotoreview.cseas.kyoto-u.ac.jp/issue/issue3/index.html

Conference paper:

Pasadilla, G. O., & Milo, M. (2005, June 27). *Effect of liberalization on banking competition*. Paper presented at the conference on Policies to Strengthen Productivity in the Philippines, Manila, Philippines. Retrieved August 23, 2006, from http://siteresources.worldbank.org/INTPHILIPPINES/Resources/Pasadilla.pdf

Encyclopedia entry (print, with author):

Pittau, J. (1983). Meiji constitution. In *Kodansha encyclopedia of Japan* (Vol. 2, pp. 1-3). Tokyo: Kodansha.

Encyclopedia entry (online, no author):

Ethnology. (2005, July). In *The Columbia encyclopedia* (6th ed.). New York: Columbia University Press. Retrieved November 21, 2005, from http://www.bartleby.com/65/et/ethnolog.html

Thesis and dissertation:

Pyun, D. Y. (2006). *The proposed model of attitude toward advertising through sport.* Unpublished Doctoral Dissertation. Tallahassee, FL: The Florida State University.

Book:
Borg, G. (1998). *Borg's perceived exertion and pain scales*: Human kinetics.

Chapter of a book:
Kellmann, M. (2012). Chapter 31-Overtraining and recovery: Chapter taken from Routledge Handbook of Applied Sport Psychology ISBN: 978-0-203-85104-3 *Routledge Online Studies on the Olympic and Paralympic Games* (Vol. 1, pp. 292-302).

Reference to an internet source:
Agency. (2007). Water for Health: Hydration Best Practice Toolkit for Hospitals and Healthcare. Retrieved 10/29, 2013, from www.rcn.org.uk/newsevents/hydration

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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.

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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}.

- ✓ ^{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)

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

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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.

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- ✓ Figure 1
- × figure 1
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- ✓ ….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)

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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:

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- ✓ …in Figures 1a and b we can…
- ✓ …data represent (Figures 1a-d)…

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✓ 45±3.4	✓ p<0.01	✓ males >30 years of age
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- ✓ First time appearing: *musculus biceps brachii*

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University of Montenegro

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E-mail:
rektor@ac.me
rektorat@ac.me

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