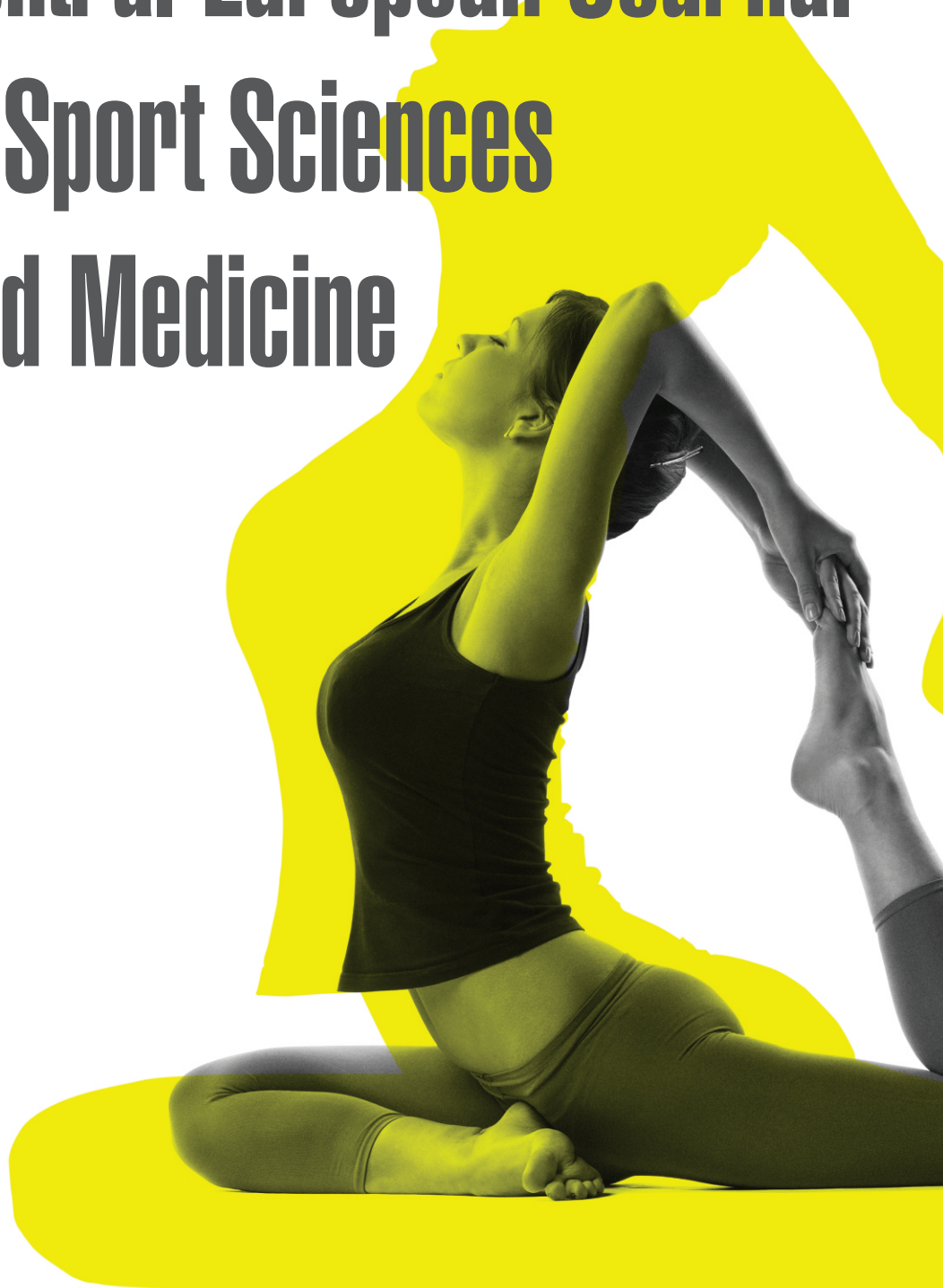
University of Szczecin
Faculty of Physical Culture
and Health Promotion

3/2017

Central European Journal of Sport Sciences and Medicine



EDITORIAL OFFICE
University of Szczecin
Faculty of Physical Culture and Health Promotion
Al. Piastów 40B, building 6, 71-065 Szczecin, Poland

SECRETARIAT
Joanna Szwak
e-mail: joanna.szwak@usz.edu.pl

FUNDING BODY
Faculty of Physical Culture and Health Promotion
University of Szczecin, Poland

TEXT DESIGN AND TECHNICAL EDITORIAL | Wiesława Mazurkiewicz

COVER DESIGN | Agnieszka Nawrocka

Print edition is the original published version of the journal
Indexed in: AGRO, Index Copernicus, Google Scholar, PSJD, SafetyLit

The names of the reviewers are available on the journal's website: www.cejssm.usz.edu.pl

ISSN 2300-9705

PUBLISHER | Wydawnictwo Naukowe Uniwersytetu Szczecińskiego

Central European Journal of Sport Sciences and Medicine

a quarterly journal

University of Szczecin
Faculty of Physical Culture
and Health Promotion

Vol. 19, No. 3/2017

Contents

IS IT POSSIBLE TO ESTIMATE MATCH RESULT IN VOLLEYBALL: A NEW PREDICTION MODEL

Cengiz Akarçeşme

Gazi University School of Physical Education and Sports, Ankara, Turkey

Address for correspondence:
Cengiz Akarçeşme
Gazi University School of Physical Education and Sports
Abant Sokak No 12
Postal Code: 06560 Ankara, Turkey
E-mail: cengizakarcesme@gazi.edu.tr

Abstract This study investigates the power of variables in a logistic regression model (the efficacy model or (EM)) to explain the match results in the Turkish Men's Volleyball League (TMVL) and the Turkish Women's Volleyball League (TWVL) in terms of the players' positions. The dependent variable was the match result, and the power of the variables libero player efficiency (LPE), setter efficiency (SE), middle blocker efficiency (MBE), outside hitter efficiency (OHE) and universal player efficiency (UPE) were separately investigated for both genders. The EM accurately classified 83.45% of the games won and lost in the TWVL. The sensitivity (proportion of won games classified as won) and specificity (proportion of lost games classified as lost) was 85.03 and 81.88%, respectively. In the TMVL analysis, the classification accuracy, sensitivity and specificity were 78.23, 78.77 and 77.70%, respectively. Moreover, for both genders, the match results were chiefly explained by the SE, MBE, OHE and UPE. The LPE variable could not predict the results in the TWVL.

Key words volleyball, gender, logistic regression, result, efficacy model

Introduction

Almost all Olympic sports hold separate tournaments for men and women. The main reason for not competing men against women is the gender factor, which is considered to have an important influence on sport performance (Beim, Winter, 2003, p. 35). Men and women largely differ in their physical body composition, muscle mass, hormonal secretions and oxygen consumption (Rickenlund et al., 2003; Korhonen, Mero, Suominen, 2003). Kinanthropometric properties significantly differ by gender and somatotype, affecting the selected sports, positions and performances of men and women (Gualdi-Russo, Graziani, 1993). However, the only gender-based rule of volleyball is the height of the net. The similarities and differences between male and female volleyball players have not been investigated from a modelling perspective. In volleyball, as in other branches of sports, numerous statistical data have been collected by match analysis programs. To interpret this large body of data and make inferences, we need statistical tools. In particular, statistical models can reveal the relationships among various variables and extract information

on team performance. Such information can assist team coaches in developing their training strategies and game tactics. Rendering statistical information interpretable will also increase the accuracy and effectiveness of decision-making processes. Among the acquired data, a coach can identify elements that encourage winning approaches by the team or set numerical targets that are likely to be reached. At this stage, the biggest problem is the dozens of volleyball game variations that may affect basic techniques such as pass, attack, block, serve and serve reception and combinations of these variations. In addition, considering the team elements and competition against the other team, the effects of individual elements on the game cannot be identified.

The variables affecting the results of volleyball matches have been analysed in the literature, but the effects of movements used during the game, referred to as technical elements, have been rarely investigated. Asterios, Kostantinos, Athanasios, Dimitrios (2009) investigated the relationship between some of the technical elements and the match results of the Men's Volleyball World Championship, held in Japan in 2006. Using discriminant analysis, they found that attack error, jump serve point, quick ball error and jump serves effectively explained the match results. Monteiro, Mesquita, Marcelino (2009) studied the relationship between set outcome and the dig and attack efficacy in female volleyball. They reported a significant correlation between attack efficacy and set outcome, but no correlation between dig efficacy and set outcome. However, attack and dig efficacy were interdependent. Araujo, Mesquita, Marcelino (2009) observed a high correlation between the set blocking system and set outcome. Drikos, Kountouris, Laios, Laios (2009) calculated the efficacy variables of volleyball techniques employed by Greek premier league male volleyball teams during 2005–2006 and determined that the team performance was most affected by the serve and attack efficacy ratios. Marelic, Resetar, Jankovic (2004) studied the effects of technical elements on the match result and proposed discriminant functions for predicting the match outcome from the serve, serve reception, spike in the phase of attack, block and spike in the phase of counter attack. They concluded that all these variables, especially the spike in the attack phase, significantly discriminate the win and loss outcomes.

In almost all previous studies on variables affecting match performance, the efficacy variables were either defined by their direct values or expressed as percentages. In the present study, the variable definitions are based on the players' positions. To facilitate their efficacy evaluation, all variables except the *libero player efficiency* (LPE) are calculated as the differences between the scores achieved and lost. In addition, most of the published studies have correlated the variables and identified the effective ones. The present study adopts a predictive logistic regression model called the efficacy model (EM) to extract further information and perform tactical simulations. We also investigate the effects of gender differences on the volleyball variables, which have not been previously reported.

To this end, we evaluate the power of the EM variables to explain the match results in the Turkish Women's Volleyball League (TWVL) and the Turkish Men's Volleyball League (TMVL).

Methods

The efficacy model (EM) employed in this study was developed in Akarçeşme's (2010) PhD thesis. The EM has successfully predicted the match results in women's volleyball. From the models formed in this study Efficiency Model estimates the match result right with 87.65%; Technical Elements Model estimates the match result right with 84.66%.

The EM model outputs a binary variable *result*. Therefore, we employed a logistic link function and analysed the data by logistic regression. Before obtaining the EM, we trialled many variables that would likely affect the match

result. The match outcome did not singly depend on excellent serve reception by the libero, the ratio of excellent serve reception of the team (excepting the libero), points achieved from block, serve and other motions by the setter (for example setter tip, setter kill block), serve reception fault, points from attack and other motions by the outside hitter, points from block, block error and other motions by the middle blocker or the total number of points from attack, attack error and other motions by the universal player. Therefore, we calculated the net differences in player positions between the teams' successes and failures, defined new variables and examined whether these variables significantly explained the match results. Because these derived variables define the efficacies in terms of player positions, they are referred to as *efficacy variables*.

Using the models yielded by the analyses, we predicted the match results of TWVL and TMVL by estimating the model coefficients and conducting a diagnostic study. The initial model prediction was based on data from the women's league. The variance inflation factor (VIF), conditional eigenvalues and index values were derived from the multicollinearity between independent variables. Moreover, the goodness of fit of the model was determined from the Bayesian and Akaike information criteria (BIC and AIC respectively), which quantify the model fitness. The predictive power of the model was assessed by constructing a classification table. Finally, the effect of potentially anomalous data on the goodness of fit was analysed using standardised Pearson residuals and deviance residual statistics. The influence of likely anomalous observations on the fitted function was checked by calculating leverage values. The model based on these new efficacy variables obtained very satisfactory goodness of fit values, confirming the statistical significance of the model. The power of the individual efficacy variables in explaining the match result was significant at the 0.05 level. Accordingly, the variable *libero efficacy* (LE) made the largest contribution to a match win bet (the probability ratio of a match win to a match loss). The other variables also contributed, but to a lesser extent. However, the sensitivity of the coefficient prediction (proportion of won games classified as won) was lower for LE than for the other parameters, because the standard error of parameter prediction was highest for LE.

The study population was the match data of 12 teams competing in Men's and Women's Premier Volleyball Leagues in Turkey during the 2010–2011 season. The sample sizes of the men's and women's leagues were 296 observations (games) in 148 matches and 300 observations in 150 matches, respectively. As these samples covered the whole population, the modelling created from the obtained data was assumed to be valid. The statistical data were used under the consent of the Turkish Volleyball Federation. Moreover, in the leagues of both genders, the teams were entitled to align three foreign players in each game.

In this study, the results of the volleyball matches were correlated with the variables establishing the results for each gender.

Model variables

Result: This variable defines the result of a match. The winning team is represented by 1 and the losing team by 0.

Libero player efficiency (LPE): This variable evaluates the error made by a libero player during serve reception throughout the match. The libero is specialised in defensive skills and cannot attack the ball, so this value starts from 0 and becomes more negative with increasing error. The LPE is generally negative because libero players lack technical flexibility, which would reverse their likelihood of making an error during serve reception.

Setter efficiency (SE): This variable represents the difference between the points scored and points conceded by a setter during all games attended by that setter throughout a match.

Middle blocker efficiency (MBE): The MBE represents the difference between the points scored and points conceded by middle players during all game events throughout a match. The simultaneous evaluation of the MBEs of two middle players is called the MBE.

Outside hitter efficiency (OHE): The OHE represents the difference between the points scored and points conceded by both number 4 hitters during all games throughout a match.

Universal player efficiency (UPE): This variable represents the difference between the points scored and points conceded by a universal player, also referred to as an opposite or power spiker, during all games throughout a match.

In the first part of this study, we constructed the EM, a logistic regression function. For this purpose, we examined the multicollinearity, conducted goodness of fit tests and analysed the influential observations and regression diagnostics (Weisberg, 2005, pp. 211–216). Potential problems with the model were also examined. The efficient observation analysis, which identifies potential anomalous observations that significantly affect the regression model, was conducted first. Certain observations in the dataset may deviate from the general trend and show characteristics that are very distinct from those of other observations. Such anomalous observations can potentially, but do not necessarily, worsen the goodness of fit of the predicted regression model. Efficient observations are anomalous observations that largely affect the predicted parameters (Hosmer, Lemeshow, 2000, pp. 48–56).

One way to handle efficient observations is to exclude them from the analysis. As the predictive model is an average model, such observations attract the regression line, distorting the overall trend. Therefore, we identified and excluded the efficient observations from the model prior to the prediction.

Efficient observations may be analysed by a variety of methods. Any single one of these analyses would give an inaccurate assessment, so several analyses were performed.

The dependent variable *Result* in the EM, which takes values of 1 or 0, is a categorical variable with a binomial distribution. Therefore, the model was based on a logistic function. To explain the dependent variable *Result* through the independent variables LPE, SE, MBE, OHE and UPE, we formulated the EM as follows.

Formula 1

$$\Pi(X) = \frac{e^{\beta 1+\beta 2LPE+\beta 3SE+\beta 4MBE+\beta 5UPE+\beta 6OHE}}{1+e^{\beta 1+\beta 2LPE+\beta 3SE+\beta 4MBE+\beta 5UPE+\beta 6OHE}}.$$

The logistic regression model is a probability model and $\Pi(X)$ refers to the probability of winning a match. Such a nonlinear function cannot be predicted by the least squares (LS) method, as in linear regression models. To allow an LS interpretation, we perform a logit transformation of $\Pi(X)$. The transformed function is referred to as a logit function.

Formula 2

$$Y = \ln\left(\frac{\Pi(X)}{1-\Pi(X)}\right) = \beta 1 + \beta 2LPE + \beta 3SE + \beta 4MBE + \beta 5UPE + \beta 6OHE.$$

Here, $\left(\frac{\Pi(X)}{1-\Pi(X)}\right)$ defines the bet ratio of winning the match. The βparameters define the variation in the log (bet ratio) for each unit change in the respective efficacy variable.

Results

Table 1 lists the outputs of the predictive logit function.

Table 1. Results of the logistic regression prediction model for Turkish Women's Volleyball League

				Number of obs	=	298
				LR chi^2	=	175.66
				Prob > chi^2	=	0.0000
Log likelihood = –118.72549				Pseudo R^2	=	0.4252
Result	Odds ratio	Std. err.	Z	P > |z|	[95% Conf. interval]	
LPE	1.0959980	0.1088412	0.92	0.356	0.9021496	1.3314980
SE	1.1471020	0.0576021	2.73	0.006	1.0395820	1.2657430
MBE	1.1712270	0.0322284	5.74	0.000	1.1097340	1.2361280
OHE	1.1648600	0.0266240	6.49	0.000	1.1094590	1.2138590
UPE	1.1504290	0.0326458	4.94	0.000	1.0881920	1.2162270
_cons	0.1435445	0.0531523	–5.24	0.000	0.0694704	0.2966016

As the results of the prediction model, without the setter efficiency (SE) variable, all other variables explains the result variable at the significance level of α = 0.05. The values of the variables effects the result of the match at significance level. The SE variable is significant at the level of α = 0.06.

Table 2 summarises the anomalous value analysis of the prediction model. For this purpose, we calculated the Pregibon residuals, the standardised Pearson residuals and the deviance statistics (Pregibon, 1981). Observations 145 and 286 satisfied the efficient observation criterion for all three statistics, so they were identified to avoid overestimation.

Table 2. Analysis of anomalous observations for the Turkish Women's Volleyball League

Obs	Stdres	p	result	LPE	SE	MBE	OHE	UPE
196	–13.44465	0.9944860	0	–1	1	14	13	21
173	–8.770069	0.9871173	0	–1	1	20	15	6
53	–6.335862	0.9755138	0	–4	4	14	17	5
272	–4.700630	0.9563127	0	–1	–6	12	14	14
157	–4.518397	0.9526947	0	0	3	10	1	20
125	2.226154	0.1717495	1	–1	1	–3	11	–6
293	2.444222	0.1495814	1	–6	–7	–5	14	3
286	2.989338	0.1027186	1	–3	–6	12	–5	–2
58	3.710107	0.0686178	1	–1	1	–8	–1	5
145	6.597115	0.0225887	1	–3	0	–4	–9	3

As shown in Table 2, the teams in observations 196, 173, 53, 272 and 157 lost the matches they were expected to win; conversely, the teams in observations 125, 293, 286, 58 and 145 won the matches they were expected to lose.

Table 3. Analysis of efficient observations 145 and 286 in the Turkish Women's Volleyball League

obs	Pgbon	stdres	dv
145	0.2535106	6.597115	2.753291
286	0.2054256	2.989338	2.133430

Table 3 analyses the anomalous observations 145 and 286 in the Turkish Women's Volleyball League. The Pgbon, stress and dv columns list the Pregibon residuals, Pearson residuals and deviance residuals, respectively. The Pregibon residuals of both observations exceed 0.2 and the Pearson and deviance residuals are higher than 2, confirming that observations 145 and 286 are efficient observations.

After removing these observations and re-performing the logit regression, we obtained the results of Table 4.

Table 4. Results of the logit regression model in the Turkish Women's Volleyball League after removing the efficient observations (observation 145 and 286)

				Number of obs	=	296
				LR chi^2	=	185.68
				Prob > chi^2	=	0.0000
Log likelihood = –112.32597				Pseudo R^2	=	0.4525
Result	Odds ratio	Std. err.	Z	P > |z|	[95% Conf. interval]	
LPE	1.122077	0.1146316	1.13	0.260	0.9184677	1.3708240
SE	1.159955	0.0600320	2.87	0.004	1.0480650	1.2837900
MBE	1.178630	0.0336398	5.76	0.000	1.1145070	1.2464410
OHE	1.178919	0.0289830	6.70	0.000	1.1234610	1.2371160
UPE	1.164912	0.3474270	5.12	0.000	1.0987690	1.2350360
_cons	0.119661	0.0469490	–5.41	0.000	0.0554604	0.2581795

As a final diagnostic analysis of the accuracy of the model, we determined whether any of the independent variables (LE, PE, OOE, PCE and number 4 efficiency (N4E)) were multicollinear. Any linear correlations between these variables would expand the variance of the coefficient predictions, causing errors in the model parameter predictions. Multiple correlations can be identified by several approaches. The correlation matrix provides an initial indicator of such correlations.

Table 5. Multicollinearity diagnostic tests in the Turkish Women's Volleyball League (with observations 145 and 286 removed)

Variable	VIF	SQRT VIF	Tolerance	R-Squared
LPE	1.09	1.04	0.9179	0.0821
SE	1.01	1.01	0.9863	0.0137
MBE	1.06	1.03	0.9400	0.0600
UPE	1.01	1.01	0.9889	0.0111
OHE	1.12	1.06	0.8898	0.1102
Mean VIF	1.06			

	Eigenval	Cond index
1	3.0789	1.0000
2	0.9734	1.7785
3	0.6709	2.1423
4	0.6119	2.2432
5	0.4758	2.5439
6	0.1892	4.0336
Condition number		4.0336

As shown in Table 5, the VIFs are very close to 1, the tolerances are approximately or slightly less than 1, the R^2 values are small, all eigenvalues except the first are small and the conditional indexes are below 10. All these results confirm that there is no multicollinearity between the independent variables, and the prediction model can be considered as successful.

The predicted efficiency model successfully passed all diagnostic tests. Therefore, we can reliably state that *result* is a function of LE, PE, OOE, PCE and N4E. Next, the extent to which the predicted efficacy model can accurately predict the match result was examined in a classification table. The classification table for the TWVL EM is given as Table 6.

Table 6. Classification table for the efficacy model in the Turkish Women's Volleyball League

	True		
Classified	D	~D	
+	125	27	152
–	22	122	144
Total	147	149	296
Classifield+if predicted Pr (D) > = 0.5 True D defined as sonuç ! = 0			
			%
Sensitivity	Pr (+ I D)		85.03
Specificity	Pr (– I ~D)		81.88
Positive predictive value	Pr (D I +)		82.24
Negative predicttive value	Pr (~D I –)		84.72
False – rate for true ~D	Pr (+ I ~D)		18.12
False – rate for true D	Pr (– I D)		14.97
False + rate for classified+	Pr (~D I +)		17.76
False – rate for classified -	Pr (D I –)		15.28
Correctly Classified			83.45

According to these findings, the logistic regression model correctly classified 83.45% of the games won and lost in the TWVL. The sensitivity and specificity (proportion of lost games classified as lost) of the model were 85.03 and 81.88%, respectively.

The same analyses were then performed for the TMVL. The results of the logistic progression model for TMVL are presented in Table 7.

To identify the anomalous observations, we calculated the standardised Pearson residuals and plotted them against the observations. Some of the game results stray far from the main group of observations. For these observations, the model predicted a lost match as won with a very high probability or vice versa. Table 7 has the power to identify all prediction model's variables on the 0.05 significance level. On the other hand, with 1 point increase at efficiency values, all variables are constant without Odds Ratio values which increased by 1.290 at LPE, 1.125 at SE, 1.082 at MBE, 1.156 at OHE and 1.152 at UPE on the bet levels, between match results as won rather than loss.

Table 7. Logistic regression prediction model for the Turkish Men's Volleyball League

				Number of obs	=	296
				LR chi^2	=	136.49
				Prob > chi^2	=	0.0000
Log likelihood = –136.92593				Pseudo R^2	=	0.3326
Result	Odds ratio	Std. err.	Z	P > |z|	[95% Conf. interval]	
LPE	1.2903700	0.1259308	2.61	0.009	1.0657200	1.5623750
SE	1.1256910	0.0555178	2.40	0.016	1.0219720	1.2399360
MBE	1.0828660	0.0275310	3.13	0.000	1.0302290	1.1381930
OHE	1.1569310	0.0244180	6.91	0.000	1.1100490	1.2057940
UPE	1.1526960	0.0307475	5.33	0.000	1.0939800	1.2145630
_cons	0.2838023	0.0936025	–3.82	0.000	0.1486881	0.5416963

Table 8. Anomalous observation analysis in the Turkish Men's Volleyball League

Obs	stdres	p	Result	LPE	SE	MBE	OHE	UPE
773	–35444010	0.9255406	0	–1	1	9	20	2
895	–3.058787	0.9027569	0	–1	2	6	12	9
711	–3.039091	0.9012191	0	0	3	1	14	7
722	–2.836845	0.8886646	0	–1	0	9	9	11
933	–2690464	0.8763931	0	–2	–1	9	1	21
802	2.118333	0.1887364	1	0	–2	–9	12	–7
770	2.199616	0.1729381	1	–1	–2	–1	–5	7
917	2.504905	0.1397109	1	0	–4	8	–3	–2
935	3.898944	0.0629296	1	–6	–6	5	–7	10
901	4.069080	0.0576677	1	–3	–3	11	–3	–6

As shown in the anomalous observation analysis (Table 8), the teams in observations 773, 895, 711, 722 and 933 lost the matches they were expected to win; conversely, the teams in observations 802, 770, 917, 93,5 and 901 won the matches they were expected to lose. After analysing these anomalous observations, observations 901 and 935 passed the criteria for influential observations in three different checks, as seen in Table 9.

Table 9. Analysis of efficient observations in the Turkish Men's Volleyball League

Obs	pgbon	stdres	dv
901	0.2195599	4.069080	2.388748
935	0.3174982	3.898944	2.351909

As shown in the table 9; 901 and 935 observations are the most efficient observations which could affect the prediction model.

Table 10 presents the results of the logit regression model after removal of the efficient observations 901 and 935, and Table 11 summarises the results of the multicollinearity analysis. The classification table for the TMVL EM is given as Table 12.

Table 10. Results of logit regression model in the Turkish Men's Volleyball League after removing the efficient observations (observations 901 and 935)

				Number of obs	=	294
				LR chi^2	=	145.79
				Prob > chi^2	=	0.0000
Log likelihood = –130.88419				Pseudo R^2	=	0.3577
Result	Odds ratio	Std. err.	Z	P > |z|	[95% Conf. interval]	
LPE	1.3761730	0.1427224	3.08	0.002	1.12304	1686362
SE	1.1475500	0.0585278	2.70	0.007	1.038385	1.268192
MBE	1.0782460	0.0279459	2.91	0.004	1.024841	1.134434
OHE	1.1690990	0.0259125	7.05	0.000	1.119399	1.221006
UPE	1.1641720	0.0323627	5.47	0.000	1.10244	1.229362
_cons	0.2784306	0.0944237	–3.77	0.000	0.1432354	0.541232

It seems that the results of logit regression prediction results in the table 7 with 296 compared observed results, without 901 and 935 observations, model's adaptability has improved. The value of LR chi^2 = 136.49 has been raised to LR chi^2 = 145.79; the value of Pseudo R^2 = 0.3326 has been raised to Pseudo R^2 = 0.3577. Excluding these two observations, effects logit regression factors as impoving explanatory power of the LPE's result variable from p> |z| = 0.009 to p > |z| = 0.002. At the same time all variables in this table has the power to identify efficiency model. Also Odds Ratio bet results has increased at all variables without LPE.

Table 11. Multicollinearity diagnostic tests in the Turkish Men's Volleyball League (after removing observations 901 and 935)

Variable	VIF	SQRT VIF	Tolerance	R-Squared
LPE	1.01	1.00	0.9922	0.0078
SE	1.10	1.05	0.9104	0.0896
MBE	1.04	1.02	0.9657	0.0343
OHE	1.05	1.02	0.9558	0.0442
UPE	1.04	1.02	0.9649	0.0351
Mean VIF	1.04			

Eigenval		Cond index
1	2.8614	1.0000
2	1.0694	1.6358
3	0.7252	1.9864
4	0.6708	2.3797
5	0.5053	2.3797
6	0.1679	4.1281
Condition number		4.1281

It has confirmed that there is no multiple linearity between the model's arguments with Table 11; VIF (Variance Sweeling Factors) are close to 1, tolarance values are below 1 and close to 1, R^2 values are minor, eigenvalues (Eigenval) are majör at the first value and the condition indexes (Con Index) are smaller than 10.

Table 12. Classification table for the efficacy model in the Turkish Men's Volleyball League

	True		
Classified	D	~D	
+	115	33	148
–	31	115	146
Total	146	148	294
Classifield+if predicted Pr (D) > = 0.5 True D defined as sonuç ! = 0			
			%
Sensitivity	Pr (+ I D)		78.77
Specificity	Pr (– I ~D)		77.70
Positive predictive value	Pr (D I +)		77.70
Negative predicttive value	Pr (~D I –)		78.77
False – rate for true ~D	Pr (+ I ~D)		22.30
False – rate for true D	Pr (– I D)		21.23
False + rate for classified +	Pr (~D I +)		22.30
False – rate for classified –	Pr (D I –)		21.23
Correctly Classified			78.23

The model correctly classified 78.23% of the wins and losses in TMVL. The sensitivity and specificity of the model in TMVL were 78.77 and 77.70%, respectively.

Discussion

There are several researches in the literature to predict the match result in volleyball, but the number that evaluates them in a model that includes many parameters are very less.

Nikos, Elissavet (2011) investigated the relationship between impulse performance and attack tempo and they found that the success rate of the offenses with quick tempo attackers was more high and setter's performance and attack tempo as determinants of attack efficacy in Olympic level male volleyball teams.

In a similar manner, Marcelino, Sampaio, Mesquita (2012) investigated the relationship between attack and serve performance in different periods of time and opponent team level from 600 rallies which were selectively sampled from a total of 5.117 rallies at Men's World Cup 2007 and determined that service and attack performance changed in relation to both opponent team level and match period.

Silva, Lacerda, Joao (2013) analyzed 24 matches during the men's Senior Volleyball World Championship-Italy 2010 for to understand what happens when the setter is in the attack zone (zones 4, 3 and 2). They determined that the team had a negative effect on the successful outcome when setter came to attack zone position (zones 4, 3, 2) because the team could not effectively perform the offensive skills needed to win such as offensive side out.

In the Men's Volleyball World Championship, the outcomes were best explained by attack error, jump serve point, quick ball error and jump serves (Asterios et al., 2009). Analysing the Greek premier league male volleyball teams during 2005–2006, Drikos et al. (2009) found that team performance was most affected by the serve efficacy ratio and attack efficacy ratio.

In female volleyball, Monteiro et al. (2009) linked the set outcome to attack efficacy. Marelic et al. (2004) concluded that all their tested technical elements (serve, serve reception, spike in the phase of attack, block and spike in the phase of counter attack variables) effectively determine the game outcomes.

Pena, Rodriguez-Guerra, Busca, Serra (2013) studied on high-level men's volleyball in the Spanish Superliga during the 2010–2011 season, to see which skills and factors were more effective to predict winning and losing. They found that the points obtained in the break point phase, number of reception errors and the number of blocked attacks by the opponent were significant predictors of winning or losing the matches.

Gonzalez-Silva, Domingues, Fernandez-Echeverria, Rabaz, Arroyo (2016) sampled 5,842 game actions carried out by the 16 male category and the 18 female category teams that participated in the Under-16 Spanish Championship for to evaluate setting efficacy in young male and female volleyball players. Results showed that the best predictive variables of setting efficacy, both in female and male categories, were reception efficacy, setting technique and tempo of a set.

Rentero, Joao, Moreno (2015) analyzed libero's participation and their influence in the attack and defense phases in men's elite volleyball with the sample of 1,101 pass and defense game actions of the four highest-placed teams in the 2008 Beijing Olympic Games. The results of the study revealed that there were significant associations during the defensive stage of the game between the defending player and the defensive phase, the libero's defence predominating in zone 5; the defending player and defense efficiency, which is improved by the libero; the defending player and counterattack, as attacks increased in zone 6 when the libero was defending.

In another study of Silva, Lacerda, Joao (2014) shows that service points, reception errors, and blocking errors were the discriminating variables that identify the final outcome of the match (won/loss). Moreover, successful service points were the major variable most likely associated with match success (won). In this sense, increasing the effectiveness of service should be a top priority in coaching elite volleyball teams.

As seen in the literature examples above, the results of the match or the factors that determine whether to win or loss are always influenced by the researchers. In the researches conducted, one or more volleyball techniques or the effects of the player's positions were searched and the results were obtained. This study differs from others in that it contains all the techniques and player's positions in volleyball.

To test the success of the predicted efficacy model in predicting the match result, we compared the predicted and actual results. The model correctly predicted the outcomes of 83.45% of the games in TWVL and 78.23% of the games in TMVL. In other words, the probability of correct prediction by the model is 83.45% in women's league and 78.23% in men's league.

The results of this study were derived from the match data of teams in the Turkish Elite Volleyball League. However, to determine whether these results characterise the league, the same league should be reanalysed for both genders using data of the 2014–2015 season. Repeating the study for the elite men's volleyball league would determine whether the results are generalisable and would highlight the gender differences. These analyses have been planned as extensions to this study and are currently being investigated.

Conclusion

Statistical reports of sports matches contain many variables. Such numerous and varied data on the teams and individual players are difficult to organise into a performance evaluation by match analysis programs. Therefore,

by identifying the variables that significantly establish the match result, coaches can develop the contents of both development and tactical training programs.

In this context, Akarçeşme (2010) determined that the match results were well explained by an efficacy model based on the team's position and the technical skills that determine success or failure. The validity and reliability of the model was confirmed in an analysis of the next two years' worth of league data. The model can also explain gender differences in volleyball matches.

Recommendations

The data in the present study were sampled from Turkish men's and women's volleyball leagues in 2010 and 2011. In that season, teams in both leagues were entitled to align 3 foreign players and the teams were found to exercise this right. The study could be repeated for seasons in which teams were entitled to align 2 foreign players. Currently, we are analysing the data of the 2011–2012 and 2012–2013 seasons. These additional analyses will further validate the model and will reveal the tendencies of the leagues employing various numbers of foreign players, in terms of the EM variables.

Acknowledgement

The author wishes to thank to Dr. Tolga SINOFOROGLU, for all his support and assistance.

References

Akarçeşme, C. (2010). *Determination of the variables explaining the match result with the logistic regression method and estimation of the probability model aimed at winning the match in the elite women's volleyball.* Unpublished Doctorate Thesis. Ankara: Gazi University Institute of Health Sciences.

Arauj, R., Mesquit, I., Marcelino, R. (2009). Relationship between Block Constraints and set outcome in elite male volleyball. *International Journal of Performance Analysis in Sport*, *9* (8), 306–313.

Asterios, P., Kostantinos, C., Athanasios, M., Dimitrios, K. (2009). Comparison of technical skills effectiveness of men's national volleyball teams. *International Journal of Performance Analysis in Sport*, *9*, 1–7.

Beim, G., Winter, R. (2003). *The female athlete's body book: How to prevent and treat sports injuries in women and girls*. New York: The McGraw Hill Companies.

Drikos, S., Kountouris, P., Laios, A., Laios, Y. (2009). Correlates of team performance in volleyball. *International Journal of Performance Analysis in Sport*, *9*, 149–156.

Gonzalez-Silva, J., Dominguez, A.M., Fernandez-Echeverria, C., Rabaz, F.C. Arroyo, M.P.M. (2016). Analysis of setting efficacy in young male and female volleyball players. *Journal of Human Kinetics, 53* (1), 189–200.

Gualdi-Russo, E., Graziani, I. (1993). Anthropometric somatotype of Italian sport participants. *The Journal of Sports Medicine and Physical Fitness*, *33*, 282–291.

Hosmer, D.W., Lemeshow, S. (2000). *Applied Logistic Regression* (2 ed.). New York: Wiley-Interscience Publication.

Korhonen, M.T., Mero, A., Suominen, H. (2003). Age-related differences in 100-m sprint performance in male and female master runners. *Medicine and Science in Sports and Exercise*, *35*, 1419–1428.

Marcelino, R.O., Sampaio, J.E., d Mesquita, I.M. (2012). Attack and serve performances according to the match period and quality of opposition in elite volleyball matches. *Journal of Strength and Conditioning Research*, *26* (12), 3385–3391.

Marelic, N., Resetar, T., Jankovic, V. (2004). Discriminant analysis of the sets won and the sets lost by one team in A1 Italian volleyball league – A case study, *Kinesiology*, *36*, 75–82.

Monteiro, R., Mesquita, I., Marcelino, R. (2009). Relationship between the set outcome and the dig and attack efficacy in elite male volleyball game. *International Journal of Performance Analysis of Sport*, *9*, 294–305.

Nikos, B., Elissavet, N.M. (2011). Setter's performance and attack tempo as determinants of attack efficacy in Olympic-level male volleyball teams. *International Journal of Performance Analysis in Sport*, *11* (3), 535–544.

Pena, J., Rodriguez-Guerra, J., Busca, B., Serra, N. (2013). Which skills and factors better predict winning and losing in high-level men's volleyball? *Journal of Strength and Conditioning Research*, *27* (9), 2487–2493.

Pregibon, D. (1981). Logistic regression diagnostic. *The Annals of Statistics*, *9*, 705–724.

Rentero, L., Joao, P.V., Moreno, M.P. (2015). Analysis of the libero's influence of the libero in different phases of game in volleyball. *Revista Internacional De Medicina Y Ciencias De La Actividad Fisica Y Del Deporte, 15* (60), 739–756.

Rickenlund, A., Carlstrom, K., Jörn Ekblom, B., Brismar, T.B., von Schoultz, B., Hirschberg, A.L. (2003). Hyperandrogenicity is an alternative mechanism underlying oligomenorrhea or amenorrhea in female athletes and may improve physical performance. *Fertility and Sterility*, *79*, 947–955.

Silva, M., Lacerda, D., Joao, P.V. (2013). Match analysis of discrimination skills according to the setter attackzone position in high level volleyball. *International Journal of Performance Analysis in Sport, 13* (2), 452–460.

Silva, M., Lacerda, D., Joao, P.V. (2014). Game-related volleyball skills that influence victory. *Journal of Human Kinetics*, *41* (1), 173–179.

Weisberg, S. (2005). *Applied Linear Regression* (3 ed.). New Jersey: Wiley & Sons Inc. Publication.

Cite this article as: Akarçeşme, C. (2017). Is it Possible to Estimate Match Result in Volleyball: A new Prediction Model. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 5–17. DOI: 10.18276/cej.2017.3-01.

EFFECTIVENESS OF TRAINING FOR 11–13 YEAR-OLD SOCCER PLAYERS ON THE BASIS OF SMALL AND SUPPORTING GAMES IN THE CONTEXT OF ACTION EFFICIENCY IN THE SITUATION OF A ONE AGAINST ONE GAME

Andrzej Lachowicz

Akademia Morska w Gdyni, Poland

Address for correspondence:
Andrzej Lachowicz
Akademia Morska w Gdyni
Morska 81–87, 81-225-Gdynia, Poland
E-mail: a.lachowicz@swfis.am.gdynia.pl

Abstract A particular meaning in contemporary soccer games is gained by the efficiency of actions in the situation of a 1 on 1 game. The application of an increased number of exercises based on small and supporting games in soccer training can help to increase the effectiveness of training in this aspect. The aim of the work was to determine the effectiveness of training for 11–13 year-old soccer players with the use of small and supporting games to improve actions during a one against one game. The tests were applied to a group of 11–13 year-old soccer players. We have conducted a pedagogical experiment, the fundamental element of which was to apply training based on small and supporting games in the experimental group, and then tracing the changes on the background of the comparative group. In order to diagnose differences in the effects of training, we have applied a set of test tasks (cycle of 1 × 1 simulation games, test of general physical fitness INKF). The applied training improved the actions in 1 × 1 simulation games. Throughout the experiment, the players from both teams presented a comparable level of the tested motor skills. The training based on small and supporting games seems to be an effective method of increasing training effectiveness in the context of action improvement in the situation of a 1 × 1 game.

Key words football, training, boys at 11–13 years of age, small and auxillary games, 1v.1 plays

Introduction

The dominant trend in the organization of actions when playing soccer in the tactics of the best teams is the obligation to narrow and shorten the game field in a defensive game as well as to aggressively attack the opponent with the intention of provoking him to make a mistake and in consequence take the ball from him (Duda, 2004, 2006; Panfil, Żmuda, 1996; Stępiński, 2005, 2006; Stuła, 1998; Talaga, 2006; Wrzos, 1999, 2000, 2005; Zieliński, 1999).

The above-mentioned method of defensive game is applied by all the best teams in the world regardless of the assumed game system. As a consequence, a change of conditions occurs in which the players of the attacking team have to play. We observe a distinct increase in the number of actions in the situation of a 1 × 1 game and also

its meaning for the final result of meeting. Szwarc and Kromke (2011) analyze the matches played during the final tournaments of world's and Europe's championships in the years 1994–2008 (semifinals and finals) and stated that soccer players with the highest sport competence use on average from 200 to 300 duels in 1 × 1 game situations during one match, with average 50% reliability.

Individual actions of a player in a 1 on 1 situation, both in attack and defense, should be recognized as essential for a modern soccer game (Bergier, 1998; Clemente, Couceiro, Martins, Dias, Mendes, 2013; Duda, 2006; Paluszek, Nosal, 1997; Paluszek, Panfil, 1995; Panfil, Żmuda, 1996; Stępiński, 2006; Stępiński, Dorna, 2011; Szwarc, 2004, 2005a, 2005b, 2005c, 2007; Talaga, 1997b; Witkowski, Ljach, 2004; Wrzos, 1998, 1999, 2000, 2005; Zieliński, 1999).

Szwarc (Szwarc, 2012, p. 32) defines a 1 on 1 (1 × 1) game as the "direct influence of two players of competitive teams, heading for the realization of contradictory aims in the form of rules determined by regulations. A 1 × 1 game in attacking is the entirety of reactions and actions of the player owning the ball oriented on one rival, going for scoring points (goals) or creating a situation in order to achieve it or the intention of capturing the field and/or holding the ball. The actions and behaviors of a player against the player with the ball striving to take it away, interrupting his actions or hindering the movement of the ball, is the game one against one in defense".

All the elements of game technique should be improved with a creative and reproductive method in conditions approaching the games with high involvement of trained players (Panfil, Żmuda, 1996). Hence, the application of a higher number of exercises based on small and supporting forms in soccer player training seems to be helpful in solving the problem of proper forms, methods and training resource choice, as to cope with the requirements of modern soccer. Such training creates open problems for the players, the solution of which needs technical skills, physical fitness, knowledge and tactic awareness as well as an adequate level of mental preparation, and all these in direct confrontation with a rival (Dorna, Robakiewicz, Dorożała, 2015).

Small-sided games constitute a tool for coaches to boost their trainees' motivation, and thus to improve exercise intensity and enhance the players' stamina (Mallo, Navarro, 2012; Hill-Haas, Coutts, Rowsell, Dawson, 2008; Hill-Hass, Dawson, Coutts, Rowsell, 2009; Hill-Haas, Coutts, Dawson, Rowse, 2010; Martone, Giacombbe, Capobianco, Imperlini, Mancini, Campasso, Buono, Orru, 2016). They may also serve as a talent identification tool with respect to young players (Fenner, Iga, Unnithan, 2016).

For the needs of the work, we accepted the definition of small games by Talaga (Talaga, 1997b), who claims that we can consider a game as small when the rules, and mainly the field dimension, goal dimension, size and weight of ball, game time, number of players is simplified, adapted to training needs and age of players, in each case the number of struggling players on each side is similar (equal chances); moreover, the number of players on both sides does not exceed 14. Hence, the following forms can be treated as small games: 1 × 1, 2 × 2, 3 × 3, 4 × 4, 5 × 5, 6 × 6, 7 × 7 (Talaga, 2000, p. 19).

In turn, the number of supporting games (Przybylski, Szwarc, 1996, p. 63) can include "games with an uneven number of attacking and defending players (i.e. 2 × 1, 4 × 2, 3 × 4)".

The objective and aim of research

The objective of the research was the training process of 11–13 year-old soccer players with orientation on small and supporting games.

The aim of the research was to determine the effectiveness of training for 11–13 year-old soccer players with the usage of small and supporting games to improve actions during a proper game.

Research questions

1. Will the soccer training based on small and supporting games applied in the experimental group prove the effect of increased efficiency of actions in relation to the comparative group in a simulation game of 1 × 1?
2. Which level of motor skills is representative for the tested players of both research groups?
3. How will the differentiation of training influence the changes in the level of motor skills in both research groups?

Methods

To solve the research problem, we conducted a pedagogical experiment. The tests were conducted on a group of 11–13 year-old boys, who specialize in playing soccer at Uczniowski Klub Sportowy Cisowa Gdynia.

Before we proceeded to the realization of the pedagogical experiment, we conducted a recruitment, selection, and a two-year soccer training based on the assumptions of the initial stage of preparation (Kapera, Śledziewski, 1997; Szyngiera, Bibrzycki, 1994). The recruitment was conducted among students of the third classes of primary schools in Gdynia. After 10 months of training, among 40 selected boys, we randomly chose 20 players for each of the training groups. The following year, both teams were still trained in identical conditions, with the same intensity and according to the same training plan.

After two years of initial training, we started the pedagogical experiment, the essential element of which was to introduce differences in training plans prepared for both groups. From that moment, the comparative group (n = 18) was training in a "traditional" way, with the use of variable forms and training methods, in proportion choice basing on available topic literature (Bauer, 2001; Behnke, Sass, 1990; Cicirko, Syryjczyk, 2000; Gołaszewski, 2003; Hamsun, Daniel, 2000; Harwey, Dungworth, 1999; Kapera, 1999; Kapera, Śledziewski, 1997; Kollatch, 1998; Mayer, 1996; Naglak, 1996, 2005; Paluszek, 2003; Panfil, Żmuda 1996; Patz, 2000; Przybylski, 1998; Przybylski, Szwarc, 1996; Stuła, 2001; Szyngiera, Bibrzycki, 1994; Talaga, 1997a). At the same time, the experimental group (n = 18) underwent soccer training, the basis of which were small and supporting games. The contents included in the training were chosen for the particular aims of training in the range of technique, tactics improvement and shaping particular motor skills realized basing on small and supporting games.

Training plans prepared for both groups were constructed in respect to the number of trainings, control meetings, championship meetings, days on camps and free days. The differences in training plans concerned a proportion of the applied training forms during the main parts of particular training units.

The time structure of the applied training forms towards the experimental group, during a two-year period of training, included: 70% of small and supporting games, 10% of teaching and improving technique elements in a proper form, other training forms (play, fragments of game, school game, stream, alternate, balance, parallel, station, peripheral, related – 20%). In turn, during the discussion period, in the comparative group, we used training with the following time structure (in the main parts of all training units conducted in the testing period): proper form – 40%, play form – 20%, game form – 30%, the other forms (game fragments, stream, alternate, balance, parallel, station, peripheral, related) – 20%.

Training in this form was finished after two macrocycles, which, for the tested group, coincided with the end of primary school.

It should be emphasized that everyone participated in the research at their own free will and did not report any complaints of physical disorders.

To diagnose the differences in the effects of training between the comparative and the experimental group, all the players were subjected to cyclic tests repeating above the presented set of test tasks every half a year.

The first set of test tasks was conducted at the starting point of the first training macrocycle (the beginning of the experiment); the last – at the end of the second macrocycle (the end of the experiment).

The set of test tasks

1. The cycle of 1 × 1 simulation games between the experimental and the comparative group is a system of play in which each player from a given team fights with each player from the other. We used the method of diagnosing sportsmen's actions in simulation games (Paluszek, Panfil, 1995). Thirteen players from each team participated in the games. Altogether, 169 games were played (each player played 12 games) during 6 training units. The 1 × 1 simulation game took place on a field with dimensions of 15 × 20 meters with goal posts of 1 × 0,7 meters. The duration of the game was 120 s. The aim of the game was to achieve a maximal number of points by putting the ball to a goal post of the opponent and preventing the opponent from scoring the goal. The point was regarded as valid when a ball passed the light of goal with its whole circumference or when it touched a goalpost or a crossbar. After each point loss, the game started from the central area. During the game, the defending player was able to fight for a ball on the whole field of game, but he could only move back to the central area. He could move into his own goalpost only during a fight for the ball, in direct contact with the opponent. Moving the ball after the line limiting the field of game was equal with its loss. The opponent introduced the ball to the game in the place from which it left the field.

In this method, the evaluation as a whole for each player included:

- indicator of efficiency in the attack Wa = z where z – points achieved in all the 1 × 1 games,
- indicator of efficiency in defense Wo = s where s – points lost in all the 1 × 1 games,
- indicator of complex efficiency Wk = z–s, complex efficiency understood as the difference in the points achieved and lost in all the 1 × 1 games.

All the games were conducted on the soccer field of UKS "Cisowa" in Gdynia.

2. Test of general physical fitness INKF (formulated by J. Pachla and T. Ulatowski) (Talaga, 1997b). The test is composed of the following elements:

- pull-ups on a bar – attempt of an evaluation of arm muscle strength,
- bending and strengthening of arms in support on rail – attempt of an evaluation of arm muscle strength,
- reaching jump – attempt of an valuation of vault,
- run on a 60-meters distance – attempt of speed evaluation,
- run on a 300-meters distance – attempt of endurance evaluation,
- run "zigzag on an envelope" – attempt of agility evaluation.

We have interpreted the obtained results on the basis of a point chart in T scale comparing the proper values in points. All the tests of physical fitness were conducted in a gymnasium and on the sport field of Akademia Morska in Gdynia.

To determine changes in the level of the tested parameters, we used a classic experimental plan (Table 1) (Ryguła, 2003).

Table 1. Scheme of classic experimental plan

Groups	Selection	Initial measurement	Experimental factor	Final measurement	Difference
Experimental	R	P_1	X	P_2	$d_e = P_2 - P_1$
Comparative	R	P_3	–	P_4	$d_c = P_4 - P_3$

X – independent variable (experimental factor).
P_1, P_2, P_3, P_4 – measurements of dependent variable.
R – selection to a group (randomization).
D_e – difference between the final and the initial measurement in the experimental group.
D_c – difference between the final and the initial measurement in the comparative group (control).

The results obtained in the tests of power, agility, speed, endurance were evaluated based on a point chart in scale T with the respective values in points.

The measurement data were statistically studied at the beginning, evaluating the compatibility of the obtained results with normal distribution, applying the Shapiro-Wilk's test. To compare the level of changes of the dependent variable in the experimental and the comparative group during the experiment's duration, we conducted the test of comparing the relative differences for all the tested variables between the results of the fourth test (final) and the first (initial). In the case of rejection of the thesis about normal distribution, to determine the significance of differences in the level of the tested features, we used the U Mann-Whitney test. In the case of the thesis about normal distribution acceptance, we used the test of the significance of the differences between two averages for no connected variables, hence, the t-Student test. To choose the proper version of the test, we checked the variance equality of the obtained results with the help of the F test. In case of rejection of thesis about distribution's variance equality of features we applied Cochran-Cox test.

Results

Efficiency of actions in 1 × 1 simulation games in the experimental and the comparative group during two-year research period

Efficiency of defensive actions in 1 × 1 simulation games

Analyzing the results of 1 × 1 simulation games, we evaluated the points scored and lost by a chosen player in all 12 played matches in frames of one test, which is the 1 × 1 tournament between the players from the experimental and the comparative group.

When evaluating the efficiency of the players' defensive actions, we set up the indicator of efficiency of game in attack Wa = z, where z – indicates all the points scored by a chosen player during one tournament of a simulation game (Paluszek, Panfil, 1995).

On the first term of tests, for the experimental group, the average indicator of efficiency was 24.31 points, whereas for the comparative group, it was 30.69 points. The difference in the averages was 6.59 points and it was

not statistically significant ($p \leq 0.05$). On the second term, the average indicator decrease in both groups (the players played less effectively in attack, scoring fewer points). In the following tests, the players from the comparative group maintain the frequency of effective offensive actions at a similar level; however, the players from the experimental group regularly improved the discussed element, achieving higher and higher values of the indicator during the third and the fourth test. In the last test, the average indicator of play in attack in the experimental group reached the value of 29.26 points; however, in the comparative group, it was 25.15. In this case, the difference in the averages was 4.08, which also was not statistically significant ($p \leq 0.05$). Between the first and the fourth test, the value of the game's indicator in attack in the experimental group increased on average by 4.92 points, whereas for the comparative group, it decreased by 5.53. The comparison of the relative differences between the average results in the fourth and the first test in both groups indicates statistically significant ($p \leq 0.02$) differences for the benefit of the experimental group. It can be stated that during the two-year research period, the players from the experimental group streamlined their offensive actions in a 1 × 1 simulation game in relation to the players from the comparative group (Table 2).

Ineffective defensive actions in 1 × 1 simulation games

The efficiency of defensive actions in a one against one game was determined by setting the indicator of the game's efficiency in defense Wo = s, where s – is the number of all points lost by a chosen player during 12 1 × 1 games during the defined test (Paluszek, Panfil, 1995). The indicator of the game's efficiency in defense for one team is the opposite of the efficiency indicator of the game in attack for the second team, as each point scored by a player on one team means a point lost by the rival.

In the first test, the players gained in the discussed element average results of 30.96 points in the experimental group and 24.31 in the comparative group. Hence, the difference in the average results was 6.38 and proved not to be statistically significant ($p \leq 0.05$). During the fourth test, the indicator of the game in defense was as follows: 25.15 in the experimental group and 29.23 in the comparative group. This time, the differences in the averages between both groups were also statistically insignificant ($p \leq 0.05$), and reached the value of 4.08. During the two-year period, the value of the tested elements decreased in the experimental group by 5.53 points, whereas in the comparative group, it increased by 4.92 points.

A comparison of the relative differences between the average results of the tested groups in the first and the fourth test indicated a statistical significance ($p \leq 0.02$). Hence, we stated an improvement of defensive actions in the experimental group in comparison with the comparative group during the two-year period of research (Table 2).

Complex efficiency of actions in 1 × 1 simulation games

The efficiency of the players' actions in simulation game one against one was determined by finding the indicator of complex efficiency Wk = z–s, so the difference between the points scored and lost during all the 1 × 1 games that happened during chosen test (Paluszek, Panfil, 1995).

In the first cycle of tests, the players from the experimental group reached the average level of complex efficiency – 6.38 points, whereas for the comparative group, the above-mentioned indicator was on the level of 6.38. The difference of the averages in both groups was 12.8 points and was not statistically significant ($p \leq 0.05$). In each following test, the average indicator in the experimental group increased, whereas for the comparative group, it decreased. In the fourth test, finishing the experiment, it amounted in the experimental group to 4.08, on average

and in the comparison group –4.08. This time, the average difference in the averages, which was on the level of 8.16 points, showed also not to be statistically significant ($p \leq 0.05$). During two-year period, it was evident that there was a very definite increase of fitness among players from the experimental group in this element; the difference between the fourth test was 10.46 points. The average indicator decrease in the comparative group was of the same value. The comparison of the differences between average results of complex efficiency indicator in the fourth and the first test presented the existence of statistically significant ($p \leq 0.02$) differences between the tested groups.

Considering the changes in the level of efficiency indicator of play in defense, in attack and the indicator of complex efficiency, it can be stated that during the observed two-year period, we noted a distinct improvement of the actions of the experimental group in relation to the comparative group in simulation game one against one (Table 2). Therefore, we stated that, during the experiment, the players of the experimental group improved their actions in relation to players from the comparative group in simulation game one against one.

Table 2. Results of measurements of number of technique-tactic actions during simulation games one against one

Tested indicator	Test number	Experimental group				Comparative group				Xe – Xp	U Test
		Xe	SD	Min	Max	Xp	SD	Min	Max		
Indicator of game's efficiency in attack	I	24.10	8.60	13	36	30.69	9.73	18	52	–6.59	84.0
	II	19.31	8.02	7	31	24.62	9.79	12	45	–5.31	
	III	26.92	7.55	15	39	26.23	10.99	9	50	0.69	
	IV	29.23	9.06	10	41	25.15	9.37	12	45	4.08	110.5
	IV – I	5.13	0.46	–3	5	–5.54	–0.36	–6	–7		138.5*
Indicator of game's efficiency in defense	I	30.69	10.64	12	52	24.31	8.32	13	39	6.38	91.0
	II	24.62	8.35	14	37	19.31	5.82	8	27	5.31	
	III	26.23	9.96	13	46	26.92	7.25	14	38	–0.69	
	IV	25.15	10.03	13	45	29.23	6.65	19	42	–4.08	59.5
	IV – I	–5.54	–0.61	1	–7	4.92	–1.67	6	3		27.0*
Indicator of complex efficiency	I	–6.38	15.81	–39	22	6.38	16.29	–21	39	–12.80	49.5
	II	–5.31	13.17	30	15	5.31	15.02	–15	37	–10.60	
	III	0.69	16.71	–31	24	–0.69	16.90	–24	32	1.38	
	IV	4.08	17.32	–35	27	–4.08	14.60	–30	23	8.16	115.0
	IV – I	10.46	1.51	4	5	–10.5	–1.69	–9	–16		151.0*

Xe – arithmetic mean in the experimental group.
Xp – arithmetic mean in the comparative group
SD – standard deviation.
Min – minimal value.
Max – maximal value.
Xe – Xp – the difference between average value of the experimental and the comparative group.
Test-U – value of U Mann-Whitney test between the results of the experimental and the comparative group.
IV – I – relative difference between the fourth and the first test.
* The difference of averages statistically significant ($p \leq 0.02$).

Level of motor skills in the experimental and the comparative group in two-year research period on the stage of elementary teaching

The analysis of the results of the conducted test of general physical fitness INKF included in Table 3 indicates a lack of differences in the level of particular motor skills between both research groups during the experiment. In each of the four conducted tests, the average results of particular tests of motor skills between groups did not

differ between each other in a statistically significant way ($p \leq 0.05$). In case of each test, which determines chosen motor skill, we noticed in the following an increase of its level in both groups. The direction and pace of changes in both groups were also similar; thus, comparative differences between average results of particular tests in the fourth and the first test in none of the cases did not show to be statistically significant. Thus, we noticed that during the two-year research period, in both groups, the general physical fitness of players was on a comparative level.

Table 3. Level of motor skills in the research groups

Motor skill	Test number	Experimental group				Comparative group				Xe – Xp	T test
		Xe	SD	Min	Max	Xp	SD	Min	Max		
Strength	I	27.69	2.75	26	35	27.46	1.76	26	32	0.23	0.36
	II	27.69	2.56	26	34	27.38	1.55	26	31	0.31	
	III	28.31	3.30	26	31	27.54	1.61	26	31	0.77	
	IV	30.38	7.61	26	55	28.92	1.80	26	30	1.46	0.67*
	IV – I	2.69	4.86	0	20	1.46	0.04	0	–2		0.56*
Power	I	12.69	8.10	1	26	9.92	3.06	7	15	2.77	1.15*
	II	14.69	8.01	1	27	12.08	4.69	5	19	2.61	
	III	16.85	7.25	2	27	14.38	5.91	7	25	2.47	
	IV	17.38	8.71	1	26	16.23	7.82	5	26	1.15	0.35
	IV – I	4.69	0.61	0	0	6.31	4.76	–2	11		0.90
Agility	I	43.00	10.12	13	55	40.38	6.53	28	50	2.62	1.15*
	II	46.23	7.96	25	55	42.23	5.31	30	49	4.00	
	III	48.00	6.00	38	57	44.77	4.53	35	50	3.23	
	IV	49.00	7.06	37	56	47.00	5.18	37	55	2.00	0.82
	IV – I	6.00	–3.06	24	1	6.62	–1.35	9	5		0.29
Speed	I	42.31	12.65	22	60	40.15	10.68	25	53	2.16	0.66
	II	46.92	11.69	25	60	41.15	10.06	16	55	5.77	
	III	50.92	1/.81	33	66	45.54	12.48	27	62	5.38	
	IV	52.85	12.57	31	69	48.77	14.13	31	69	4.08	0.78
	IV – I	10.54	–0.08	9	9	8.62	3.45	6	16		0.78
Endurance	I	12.62	10.66	0	30	15.08	6.56	0	22	–2.46	1.00
	II	16.54	12.89	0	38	18.86	10.20	0	34	–2.32	
	III	18.46	14.64	0	46	22.00	12.98	0	42	–3.54	
	IV	21.31	16.51	2	46	27.15	13.86	2	46	–5.84	0.98
	IV – I	8.69	5.85	2	16	12.07	7.30	2	24		1.02

T test – t-Student test between average values of the experimental andd the comparative group.
* Results of Cochran-Cox test.

Discussion

Taking into consideration the collected research results, we unequivocally stated the influence of the two-year training applied in the experimental group, based on small and supporting games, on improvement of actions in 1 × 1 simulation games.

Testing the relations between the effectiveness in simulation games one against one and predispositions conditioning cooperation in small and qualified games, was the area of interest of Szwarc (Szwarc, 2005a, 2005b, 2005c, 2007). The author demonstrated that young players acting more effectively in simulation game 1 × 1 have

also high predispositions to cooperate in games with the participation of a higher number of players and in proper game.

An essential connection between the effectiveness of a 1 × 1 game in a simulation game and the proper game was also noted by Paluszek and Becella (2005b). In another publication, these authors also stated that 1 × 1 simulation games are very similar to the proper game when it comes to their criteria and that they allow to objectively determine the abilities of individual action in games and thus classify particular players on the background of the tested group.

In turn, Witkowski and Duda (2005), researching "small 1 × 1 game tests", stated that the efficiency indicator of a 1 × 1 game is characterized by a high level of information allowing to evaluate the perspectives of soccer players.

Taking into consideration the results of the conducted INKF general fitness test, we tried to answer the question on how will the schooling based on small and supporting games influence the changes in the level of motor skills in the experimental group in comparison with the comparative group.

The analysis of the initial level of the discussed skills in both groups allow to make a statement that in each case players from both teams represented comparable level motor skills throughout the whole period of the experiment's duration. The observed slight differences were always statistically insignificant ($p \leq 0.05$). It means that the differences in the level of some soccer player skills between groups observed during the experiment were not conditioned by the differences in the level of motor skills.

The relations between the level of motor skills and the effectiveness in a one against one game was tested, among others, by Paluszek (2000), who stated that a higher level of conditional predispositions is connected with higher effectiveness in a 1 × 1 simulation game. Among the conditional predispositions, endurance and speed predispositions especially have a large influence on the effectiveness of the player's behavior in a one against one game, whereas strength predispositions have a small influence.

According to other researches, the level of "explosive" strength and the level of "functional" strength have a significant influence on the effectiveness of play one against one (Żak, Pleszka, Klocek, 2005).

The above-mentioned issue was discussed also by Szwarc (2007), who stated that the high level of most of the motor predisposition (condition and coordination) positively influence the efficient behavior of player in game one against one. According to the author, strength-speed predispositions have a particularly essential meaning for efficient actions.

The analysis of the results allows to conclude that the differences, which occurred between the tested groups in the level of some soccer player's skills during two-year experiment, were not the effect of the differences in the level of motor skills.

Conclusions

The applied training based on small and supporting games positively influences the improvement of individual's actions in 1 × 1 simulation games, both in attacking and in defense.

Throughout the whole period of the experiment's duration, the players from both teams represented comparative levels of motor skills (strength, power, agility, speed and endurance), hence the differences that occurred between the tested groups in soccer player skills are not caused by differences in the level of general physical fitness of the tested individuals.

Soccer training based on small and supporting games can be an effective method for the improvement of the training's effectiveness in the range of action efficiency in the situation of a 1 × 1 game during a proper game, which is essential for a modern game, both in an attack and defense.

Soccer training based on small and supporting games can also be a method of increasing the effectiveness of football training in the range of an improvement of individual actions accomplished in difficult situations because they are a necessary condition of effective actions in modern soccer games.

References

Bauer, G. (2001). *Lehrbuch Fussball: Erfolgreiches Training von Technik, Taktik und Kondition.* BLV Verlagsgesellschaft mbH.

Behnke, D.K., Sass, H. (1990). Ziele Aufgaben und Methoden der Fussballausbildung im Schulsport. *Korpererziehung*, *8–9*, 350–353.

Bergier, J. (1990). *Piłka nożna dzieci i młodzieży.* Warszawa: AWF.

Bergier, J. (1998). W poszukiwaniu wyznaczników skuteczności gry w piłkę nożną. *Wychowanie Fizyczne i Sport*, *2*, 81–91.

Cicirko, L., Syryjczyk, J. (2000). *Zarys teorii i praktyki piłki nożnej.* Biała Podlaska: Calamus.

Clemente, F.M., Couceiro, M.S., Martins, F.M.L., Dias, G., Mendes, R. (2013). Interpersonal Dynamics: 1v1 Sub-Phase at Sub-18 Football Players. *Journal of Human Kinetics*, *36*, 179–189.

Dorna, M., Robakiewicz, R., Dorożała, R. (2015). Rola gier zadaniowych w szkoleniu. *Trener*, *1*, 8–11.

Duda, H. (2004). EURO' 2004 – analiza działań ofensywnych najlepszych zespołów. *Sport Wyczynowy*, *11–12*, 9–15.

Duda, H. (2006). Jak Europa gra w piłkę nożną? Analiza sytuacji bramkowych w ME – Portugalia 2004. *Sport Wyczynowy*, *5–6*, 13–22.

Fenner, J.S., Iga, J., Unnithan, V. (2016). The evaluation of small-sided games as a talent identification tool in highly trained prepubertal soccer players. *J Sports Sci*, *34* (20), 1983–1990.

Gołaszewski, J. (2003). *Piłka nożna.* Poznań: AWF.

Hamsun, G., Daniel, J. (2000). *Fussball Jugentraining.* Hamburg: Rororo Verlag.

Harwey, G., Dungworth, R. (1999). *Szkoła piłki nożnej.* Warszawa: Coronei.

Hill-Haas, S., Coutts, A., Rowsell, G., Dawson, B. (2008). Variability of acute physiological responses and performance profiles of youth soccer players in small-sided games. *J Sci Med Sport*, *11* (5), 487–490.

Hill-Haas, S., Coutts, A., Dawson, B., Rowsell, G. (2010). Time-motion characteristics and physiological responses of small-sided games in elite youth players: The influence of player number and rule changes. *J Strenght Cond Res*, *24* (8), 2149–2156.

Hill-Haas, S., Dawson, B., Coutts, A., Rowsell, G. (2009). Physiological responses and time-motion characteristics of various small-sided soccer games in youth players. *J Sport Sci*, *27* (1), 1–8.

Kapera, R. (1999). *Piłka nożna.* Warszawa: Estrella.

Kapera, R., Śledziewski, D. (1997). *Piłka nożna. Unifikacja procesu szkolenia dzieci młodzieży.* Warszawa: PZPN.

Kollath, E. (1998). *Piłka Nożna. Technika i Taktyka.* Wrocław: Oficyna Wydawnicza Marshal.

Mallo, J., Navarro, E. (2008). Physical load imposed on soccer players during small-sided training games. *J Sport Med Phys Fit*, *48* (2), 166–171.

Martone, D., Giacombbe, M., Capobianco, A., Imperlini, E., Mancini, A., Campasso, M., Buono P., Orru, S. (2016). Exercise intensity and technical demands of small-sided soccer games for under-12 and under-14 players: effect of area per player. *J Strength Cond Res*, *18*, 1615–1623.

Mayer, R. (1996). *Fussball trainieren.* Reinbeck: Rowohlt Taschenbuch Verlag Gmb.

Naglak, Z. (2005). *Nauczanie i uczenie się wielopodmiotowej gry z piłką. Kształcenie gracza na wstępnym etapie.* Wrocław: AWF.

Naglak, Z. (1996). *Zespołowa gra sportowa. Studium. Wyd. II.* Wrocław: AWF.

Paluszek, K. (2000). Związek pomiędzy skutecznością w grze „jeden przeciwko jednemu" a zdolnościami kondycyjnymi i koordynacyjnymi. In: Bergier, J. (ed.), *Sport dzieci i młodzieży na przełomie wieków* (pp. 129–135). Biała Podlaska: IWFiS.

Paluszek, K. (2003). *Nowoczesne nauczanie gry w piłkę nożną.* Wrocław: BK Wydawnictwo i Księgarnie.

Paluszek, K., Becella, Ł. (2005a). Gry symulacyjne 1 × 1 jako czynnik doboru i selekcji np. piłki nożnej. In: Stuła, A. (ed.), *Wybrane zagadnienia treningu sportowego piłkarzy nożnych* (pp. 183–192). Gorzów Wielkopolski: ZWKF.

Paluszek, K., Becella, Ł. (2005b). Skuteczność gry 1 × 1 w warunkach symulacyjnych i w grze właściwej. In: A. Stuła (ed.), *Wybrane zagadnienia treningu sportowego piłkarzy nożnych* (pp. 29–36). Gorzów Wielkopolski: ZWKF.

Paluszek, K., Nosal, J. (1997). Gra 1 × 1 w nauczaniu i doskonaleniu działań występujących podczas gry w piłkę nożną. In: J. Bergier (ed.), *Piłka nożna - teoria i praktyka: Konferencja naukowo-metodyczna* (pp. 89–107). Biała Podlaska: IWFiS.

Paluszek, K., Panfil, R. (1995). Diagnozowanie działań sportowców w grach symulacyjnych. In: Z. Naglak, R. Panfil (eds.), *Zespołowe gry sportowe w wychowaniu fizycznym i sporcie* (pp. 111–119). Wrocław: AWF.

Panfil, R., Żmuda, W. (1996). *Nauczanie gry w piłkę nożną*. Wrocław: Sportex.

Patz, D. (2000). *Moje hobby piłka nożna. Poradnik dla dzieci*. Warszawa: Delta W-Z.

Przybylski, W. (1998). *Piłka nożna. Cz. II. Trening*. Gdańsk: AWF.

Przybylski, W., Szwarc, A. (1996). *Piłka nożna. Cz. I. Technika i taktyka*. Gdańsk: AWF.

Ryguła, I. (2003). *Proces badawczy w naukach o sporcie*. Katowice: AWF.

Stępiński, M. (2005). Pojęcie pressingu we współczesnej piłce nożnej. *Trener, 2*, 24–29.

Stępiński, M. (2006). Taktyka na MŚ w Niemczech. *Trener*, *5*, 1–5.

Stępiński, M., Dorna, M. (2011). *Gra 1 × 1 w piłce nożnej*. Wrocław: MWW Mirosław Matoga.

Stuła, A. (1998). Skuteczność wybranych elementów gry najlepszych zespołów piłkarskich Mistrzostw Europy – Anglia '96. *Sport Wyczynowy*, *5–6*, 20–25.

Stuła, A. (2001). *Współczesna piłka nożna. Teoria i praktyka*. Gorzów Wielkopolski: IWF.

Szwarc, A. (2005a). Gra jeden przeciwko jednemu - próba opisu i klasyfikacji zjawiska na przykładzie gry w piłkę nożną. In: A. Stuła (ed.), *Wybrane zagadnienia treningu sportowego piłkarzy nożnych* (pp. 177–182). Gorzów Wielkopolski: ZWKF.

Szwarc, A. (2012). Identyfikacja sprawności działania w grze w piłkę możną w sytuacjach jeden przeciwko jednemu. In: R. Panfil, H. Zdebska (eds.), *W kręgu zespołowych gier sportowych: księga jubileuszowa z okazji 80-lecia urodzin Profesora Zbigniewa Naglaka* (pp. 32–39). Wrocław: AWF.

Szwarc, A. (2005b). Niezawodność we współdziałaniu a indywidualna sprawność działania gracza – badanie zależności na przykładzie gry w piłkę nożną. In: A. Stuła (ed.), *Wybrane zagadnienia treningu sportowego piłkarzy nożnych* (pp. 201–206). Gorzów Wielkopolski: ZWKF.

Szwarc, A. (2004). Poszukiwania wyznaczników skutecznej gry w piłkę nożną na podstawie obserwacji gry najlepszych drużyn europejskich. *Wychowanie Fizyczne i Sport*, *48*, 53–59.

Szwarc, A. (2007). *Sprawność działania w wybranych fragmentach zespołowej gry sportowej. Na przykładzie piłki nożnej*. Gdańsk: AWFiS.

Szwarc, A. (2005c). Zależność pomiędzy skutecznością działania w małych grach i grze rzeczywistej u młodocianych piłkarzy. *Sport Wyczynowy*, *5–6*, 44–47.

Szwarc, A., Kromke, K. (2011). Zmiany sprawności działania w sytuacji gry jeden przeciwko jednemu piłkarzy nożnych najwyższego poziomu zaawansowania sportowego w zależności od upływającego czasu gry i wyniku rywalizacji. In: *Rocznik naukowy* (pp. 23–32). Gdańsk: AWFiS.

Szyngiera, W., Bibrzycki, K. (1994). *Piłka nożna dzieci i młodzieży*. Katowice: AWF.

Talaga, J. (2006). *ABC młodego piłkarza*. Warszawa: Zysk i S-ka.

Talaga, J. (2006a). *ABC młodego piłkarza. Nauczanie techniki*. Poznań: Zysk i S-ka.

Talaga, J. (1997a). Atakowanie zespołowe w piłce nożnej. *Trener*, *3*, 13–19.

Talaga, J. (2000). *Atlas ćwiczeń piłkarskich. Tom II: Taktyka*. Warszawa: Ypsylon.

Talaga, J. (2006b). Mundialowe refleksje. *Sport Wyczynowy*, *5–6*, 7–12.

Talaga, J. (1996). *Technika piłki nożnej*. Warszawa: RCMSKFiS.

Talaga, J. (1997b). *Taktyka piłki nożnej*. Warszawa: RCMSKFiS.

Talaga, J. (1997c). *Trening piłki nożnej*. Warszawa: RCMSKFiS.

Witkowski, Z., Duda, H. (2005). Przydatność „małych gier-testów 1 × 1" w ocenie perspektywiczności piłkarzy nożnych. In: A. Stuła (ed.), *Wybrane zagadnienia treningu sportowego piłkarzy nożnych* (pp. 193–200). Gorzów Wielkopolski: ZWKF.

Witkowski, Z., Ljach, W. (2004). *Ćwiczenia kształtujące koordynacyjne zdolności motoryczne w piłce nożnej*. Warszawa: COS.

Wrzos, J. (2005). Piłkarska reprezentacja Polski na tle europejskiej i światowej elity. *Sport Wyczynowy*, *3–4*, 28–47.

Wrzos, J. (1998). Piłkarskie Mistrzostwa Świata '98 – skuteczność wybranych działań techniczno-taktycznych (I). Sytuacje 1 × 1. *Sport Wyczynowy*, *9–10*, 28–33.

Wrzos, J. (1999). Skuteczność działań techniczno-taktycznych w sytuacjach 1×1 na najwyższym poziomie światowym w piłce nożnej. *Trener*, *3*, 9–17.

Wrzos, J. (2000). Wzorce czynności technicznych piłkarzy światowej klasy. *Sport Wyczynowy*, *5–6*, 17–38.

Zieliński, A. (1999). Czynniki określające przebieg i skuteczność akcji ofensywnej w grze w piłkę nożną. *Sport Wyczynowy*, *7–8*, 39–47.

Żak, S., Pleszka, P., Klocek, T. (2005). Poziom wybranych zdolności motorycznych i cech somatycznych a efektywność indywidualnej gry młodych piłkarzy nożnych. In: S. Żak, M. Spieszny, T. Klocek (eds.), *Gry zespołowe w wychowaniu fizycznym i sporcie* (pp. 190–196). Kraków: AWF.

Cite this article as: Lachowicz, A. (2017). Effectiveness of Training for 11–13 year-old Soccer Players on the Basis of Small and Supporting Games in the Context of Action Efficiency in the Situation of a One Against One Game. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 19–30. DOI: 10.18276/cej.2017.3-02.

ADDRESSING CARDIOVASCULAR DISEASE RISK IN HUNGARIAN-AMERICAN POPULATIONS: A CULTURAL EXPLORATION OF TRANSDISCIPLINARY HEALTH PROMOTION

Nicholas Laszlo,[1, A, B, C, D] Basil H. Aboul-Enein,[2, A, B, C, D] Josh Bernstein,[3, C, D] Joanna Kruk[4, D]

[1] Northeastern University, College of Professional Studies
Boston, MA 02115, USA
[2] London School of Hygiene & Tropical Medicine, Department of Global Health & Development
London, United Kingdom
[3] A.T. Still University of Health Sciences, College of Graduate Health Studies
Kirksville, MO 63501, USA
[4] University of Szczecin, Faculty of Physical Culture and Health Promotion
Al. Piastów 40b/6, 71-065 Szczecin, Poland
[A] Study Design; [B] Data Collection and Analysis; [C] Manuscript Preparation; [D] Revision of the Article and Final Approval

Address for correspondence:
Joanna Kruk
University of Szczecin, Poland
Faculty of Physical Culture and Health Promotion
Al. Piastów 40b/6
71-065 Szczecin, Poland
E-mail: joanna.kruk@univ.szczecin.pl

Abstract Hungarian Americans share a unique culture of food traditions associated with their value system and way of life. Researchers, health care providers, and nutrition professionals counseling and treating a Hungarian-American population should develop a baseline of cultural understanding to achieve successful and long-lasting behavior change outcomes. The leading causes of death among Hungarians include ischemic heart disease (21.3%), stroke (13.4%), and cirrhosis (5.8%); all are directly or indirectly attributed to a traditional Hungarian diet coupled with a sedentary lifestyle. Health behaviors among Hungarian Americans can be partially explained by the Health Belief Model's value-expectancy construct. Understanding cultural expectations and their associated values serve as a foundation for health promotion programming to reduce risk of cardiovascular disease and comorbidities. This review explored numerous facets of Hungarian-American dietary habits in psychosocial, economic, historical, and cultural contexts. Health education and health promotion considerations were also examined.

Key words Cardiovascular disease, Hungarian-American, Health promotion, culture

Introduction

Hungarian Americans share a unique millennia-old culture of food traditions serving as a correlate to a value system and way of life that can be traced as far back as the earliest agricultural expansion in Northern and Eastern Europe (Teuteberg, 1992). The tumultuous Hungarian commonality of a colorful history, shared vicissitudes, and numerous global migrations spanning over ten centuries are culturally interwoven with traditional Hungarian food preparations, many of which may be linked directly to seminal events and phases in Hungarian history (Benda, Hanák, Nagy, Makkai, Niederhauser, 1988). Health care providers and nutrition professionals counseling a Hungarian American population should therefore endeavor to achieve a baseline understanding of the value systems of Hungarian culture, in order to accomplish successful epidemiological outcomes within the target population in respect to coronary heart disease (CHD) (Sisa, 1995). As such, it would behoove health educators to acquire a working knowledge of underlying Hungarian values that influence food and lifestyle choices.

The internal value systems of Hungarians involve complex social and religious constructs blended with a diverse panoply of external cultural components arising from numerous occupations by foreign powers throughout history, e.g. Austria, Turkey, and Romania (Benda et al., 1988). Perhaps the most salient academic concern in this regard is illustrated by the challenging proposition of counseling the quintessentially proud Hungarian who declares with indignation that they *would rather die* than abandon their traditional diet (Cartledge, 2011). Health education programs designed by well-intentioned nutrition or healthcare professionals unacquainted with the traditional Hungarian mindset presents as a dubious proposition at best. This consideration is especially pertinent to any nutritional scrutiny of home-cooked Hungarian fare from the perspective of health, especially when prepared by a Hungarian male's spouse, mother, or grandmother; thus likely to engender considerable resistance (Schuchat, 1981). Hungarians in general are prone to perceive any changes to their diet as equivalent to a form of *cultural mutiny*, a forsaking of one's core identity as a Hungarian (Cartledge, 2011). The confounding nature of these interventional challenges embedded in a practical discussion of the diet of Hungarian Americans may appear a seemingly insurmountable obstacle to overcome for the traditionally-trained American healthcare professional. Yet it may be reasonably posited that any cultural impediment to health promotion may be overcome when great care is exercised by healthcare professionals in the culturally-sensitive deployment of dietary modifications (Mark, Nagy, Kondacs, Deli, 1998). Individual health behaviors have been well-established as reliably consistent with the value-expectancy construct of the Health Belief Model (HBM) (Glanz, Rimer, Viswanath, 2015). An effective health promotion strategy directed at Hungarians should therefore incorporate potential value (risk reduction) and inherent expectations (cultural maintenance) within its methodology. Risk reduction emerges as a priority in this population when we examine epidemiological data revealing that, as of 2015, Hungary had the highest death rate from chronic diseases (including heart disease) of any nation in the European Union; thus it may be inferred that if this data is even marginally translatable to the Hungarian American population, specifically, then it should be a source of concern for American healthcare professionals, given that Hungarians are particularly prone to transplant traditional dietary and lifestyle proclivities from Hungary to the United States (European Commission..., 2015).

The core principles of cultural understanding serve as a useful framework that is customizable to virtually any cultural group sharing the underlying commonality of intrinsic human values that transcend but do not conflict with distinctive cultural proclivities (Peto, 2007). The premise of this discussion specific to the Hungarian American population is thus predicated upon the principle that persons of every culture and ethnicity are imbued with a shared humanity that can serve as a platform for positive change, while also acknowledging with sensitivity that cultural

nuances should be considered by the healthcare provider or dietician as an indispensable component of program design and implementation (Glanz et al., 2015). The purpose of this review is focused on identifying effective CHD intervention strategies for the Hungarian American community via well-established principles of cultural acceptance, understanding, and competency tailored to the needs of Hungarian American populations.

Discussion

The Nutritional Content, Caloric Density and Cardiovascular Risk Factors

A typical Hungarian diet is generally described as *rich* by those new to traditional Hungarian foods, although not necessarily *rich* in respect to nutritional value or nutritional density, instead referring to caloric density and saturated fat content (Jenei, Pall, Katona, Kakuk, Polgar, 2002; Mark et al., 1998). To gain a better understanding of Hungary's cuisine, one must first examine Hungarian foods from a historical perspective. Hungarian dietary traditions, as practiced in Hungary and abroad, are essentially a delicate synthesis of ancient Asiatic influences amalgamated with Germanic, Italian, and Slavic elements (Teuteberg, 1992). The nomadic history of Hungarians, originally influenced by a hunter-gatherer diet and later by agrarianism, is apparent in the prominence of meat: pork, poultry, lamb, and beef, with fatty cuts more highly prized than leaner meat, cooked in lard or pork fat and served with generous portions of starches, followed by sugary pastries, sweet wines, and liqueurs (Martos, Kovacs, Bakacs, Kaposvari, Lugasi, 2012). To the quintessential Hungarian, these tastes are fondly reminiscent of his or her youth, imbued with considerable emotional context. Traditional foods also remind Hungarians of their proud indignant history of prevailing against occupation, oppression, and seemingly insurmountable odds (de Zepetnek, Vasvári, 2011; Sisa, 1995). The full impact of this sentimental consideration in Hungarian cuisine is difficult to quantify and rather difficult to grasp for persons not of Hungarian descent (Cartledge, 2011). To a typical Western cardiologist, Hungarian cuisine must surely epitomize the proverbial "heart attack waiting to happen", especially when consumed with any degree of regularity (Jenei et al., 2002; Mark et al., 1998). In any reasonable discussion of the Hungarian diet, fatty foods and sugary pastries appear at the forefront of CHD-related nutritional concerns among healthcare professionals equipped with even a rudimentary knowledge of the Hungarian diet (Muller-Nordhorn, Binting, Roll, Willich, 2008; Peto, 2007).

As documented by the 2010 Global Burden of Diseases Study (The Institute..., 2016), a collaborative project of over 500 researchers in 50 countries led by the Institute for Health Metrics and Evaluation at the University of Washington, the leading causes of death in Hungary include Coronary Heart Disease (21.3%), Stroke (13.4%) and Cirrhosis (5.8%), all of which may be directly attributed to a traditional Hungarian diet coupled with a mostly sedentary lifestyle (Jenei et al., 2002; Mark et al., 1998). It is indeed an axiom that correlation does not equal causation; however, an abundance of epidemiological and observational studies have established the etiology of CHD as closely linked to the overconsumption of sugary foods, starches, alcohol, and saturated fat (Labarthe, 2011; *The World Health Organization MONICA*, 1988). These dietary factors continue to endure as endemic influences on not only the development of atherosclerotic plaque but also hypertension, systemic inflammation, fatty liver disease, pancreatitis and cirrhosis (Jenei et al., 2002; Labarthe, 2011; Szigethy et al., 2012). Atherosclerotic plaque associated with diet-induced CHD is implicated in a host of cardiac-related chronic and acute conditions, including myocardial infarction, ischemic stroke, angina, and sudden cardiac death. A few studies have also identified the multivariate influences of diet versus a sedentary lifestyle as weighted measures of risk factors for ischemic heart disease (Jenei et al., 2002). By a significant margin, dietary influences and the comorbidity of central

adiposity appear to statistically surpass lack of physical activity as independent variables in the epidemiology of CHD. It may be argued empirically that no amount of physical exercise can overcome the powerful influence of an extremely atherogenic diet such as traditional Hungarian fare. One recent study (Móczár, Borgulya, Kovács, Rurik, 2012) addressed the challenge of presenting a practical summation of primary care prevention strategies for CHD risk amongst a Hungarian population in the Hungarian countryside (2,489 adult patients of 29 primary care physicians between April 2004 and April 2006), which examined the interrelated influence of diet and lifestyle in the management of cardiovascular disease risk. Since this was a large-scale epidemiological investigation conducted by Hungarian researchers working with Hungarian primary care providers treating Hungarian patients, a lack of cultural understanding could not be reasonably postulated as a limitation in study design and implementation. Móczár, Borgulya, Kovács, Rurik (2012) conclusions highlighted distinct improvements in CHD risk reduction following a year of diet and lifestyle modifications of study participants. What remains unclear is, whether or not similar positive outcomes could have been achieved, from the perspective of patient compliance who had study protocol been implemented by foreign healthcare workers or dieticians lacking cultural competency in respect to the target population (Mitic, Abdelaziz, Madi, 2012). Extrapolated from known principles of cultural understanding in the healthcare profession correlated to the HBM, it does present as speculative that study participants responded well to change strategies as a direct result of not only a well-designed diet and exercise program, but also as a result of implementation guided by cultural sensitivity on the part of researchers and healthcare providers, therefore serving as a potentially useful template for CHD-targeted health intervention strategies for Hungarian populations residing external to Hungary, such as Hungarian Americans (Schuchat, 1981). The results of the aforementioned study may be viewed as empowering healthcare providers in the United States with the knowledge that positive health outcomes may indeed be achieved among Hungarian Americans, provided that a practical template of cultural understanding serves as the foundation for intervention strategies (Mitic et al., 2012).

Additionally, statistical data relevant to this discussion highlight the Hungarian diaspora of nearly 5,000,000 is roughly half the number of Hungarians residing in Hungary itself (9,844,686), hence about a third of Hungarians in the world live outside the borders of Hungary, including 1,501,736 in the United States (Hungarian Central Statistical Office, 2016; The World Bank, 2016). These numbers represent a statistically significant migration of culture and food traditions that cannot be reasonably disregarded by healthcare professionals practicing in the United States (Peto, 2007).

Cultural Characteristics Influencing Dietary Choices

In the interest of facilitating a coherent discussion of dietary choices implicit to individuals identifying as Hungarian, the following psychosocial constructs are worthy of consideration in the context of cultural understanding:

1. Most Hungarian males do not expect to live past age 60 and therefore tend to consciously choose “quality of life”, e.g. enjoyment of traditional foods and spirits shared with cherished family and friends, over health behaviors aimed at maximizing longevity (de Zepetnek, Vasvári, 2011).
2. The perception of traditional Hungarian foods as immutable iconic symbols honoring Hungarian culture and history, e.g. when celebrating traditional Hungarian holidays (frequent throughout the year), overindulgence in food and drink is generally considered a source of pride for the *true Hungarian* (Sisa, 1995).

3. Hungarian hosts tend to take personal offense if their guests do not willingly overindulge in food and drink to the point they feel physically uncomfortable. Hungarians are not generally known for their self-restraint in regard to self-indulgent behaviors (Sisa, 1995).

The aforementioned psychosocial constructs demonstrate that individuals hailing from a culture such as that of Hungary may indeed present as a considerable interventional difficulty for healthcare professionals employing conventional interventional strategies who are unused to what presents as an irrational resistance to positive change (Mark et al., 1998). The root cause of a quintessential Hungarian's unhealthy dietary behaviors is usually not a lack of education, it is instead attributable to a cultural perspective consistent with a somewhat unmindful attitude toward the future consequences of one's actions (Berend, Gyorgi, 1979).

These observations of typical Hungarian behaviors and social norms are not intended to stereotype or marginalize the Hungarian American population. The intent of examining cultural distinctions is to create a rational foundation for health promotion strategies aimed specifically at Hungarian Americans following their diet and lifestyle, not toward the outlier of individuals within this population group who have chosen to eschew their traditional foods in favor of a heart-healthy diet. The thoughtful health care professional should therefore temper cultural competency with a specific concern for treating each Hungarian American *as an individual* who may or may not be abiding by the traditions of their ethnographic origin (Miller, Rollnick, 2013).

Interventional Components of Ecological Approaches to Dietary Change

A comprehensive understanding of the psychosocial foundation for dietary choices of a specific demographic serves as the contextual basis health promotion strategies likely to elicit authentic behavioral changes leading to reduced cardiovascular disease risk in a target population (Glanz et al., 2015; *The World Health Organization MONICA*..., 1988). A discussion of cultural context in dietary choices should ideally evolve into discussions of effective interventional strategies. The value-expectancy principle of the HBM proposes that successful behavioral change templates should factor in the inherent duality of a specific motivation serving as both a determinant of sustaining an unhealthy behavior and, conversely, as a potentiator for positive change. An individual must weigh the value they place on a specific pattern of behavior against their perceived susceptibility to a chronic disease state such as CHD or an acute episode such as myocardial infarction arising as a result of that behavior (Glanz et al., 2015; Skrabski, Kopp, Rózsa, Réthelyi, Rahe, 2005). The established premise of this investigation is that Hungarian Americans' consumption of their traditional foods deemed hazardous to their health by cardiologists and nutrition professionals are also foods that are strongly associated with their culture. Nevertheless, this emotional drive replete with potentially negative health consequences can also serve as a platform for change. The core psychological principle of this argument is that an individual who is a sociocultural product of a specific population may be motivated to safeguard her health in the service of *interpersonal* rather than *intrapersonal* motivations (Miller, Rollnick, 2013). The same Hungarian American who emphatically proclaims that they would never forsake greasy blood sausage, pancakes and sweet wine, may also readily admit that the only priority which ranks higher for them than enjoying traditional foods is the empowerment of surviving to participate in social activities with family and friends in the years ahead, e.g. holidays and family milestones, and to be able to pass on their accumulated wisdom to a new generation (Skrabski et al., 2005). This dichotomy highlights the HBM construct of cultural fatalism contrasted against a traditional Hungarian belief system of self-efficacy and the willpower to overcome adverse circumstances, both within the external context of family and society, as well as the internal context of personal

health. This duality of purpose may indeed present as a challenge for the healthcare professional seeking to reconcile the health implications of Hungarian cultural norms related to diet counterbalanced against a deep abiding love of family (Skrabski et al., 2005). Furthermore, it may also be useful to consider that the culturally-sensitive application of change strategies based on the HBM aimed at reducing dietary risk factors in CHD may be best accomplished within this demographic via carefully designed elicitation of incremental changes in diet and lifestyle, as opposed to unrealistic expectations of complete dietary overhaul that proposes the elimination of staples in the traditional diet. This approach necessitates a prudent elicitation of the third HBM principle – an expectation or belief that certain actions will prevent or resolve a specific chronic or acute disease state at an "acceptable cost"; in this example, "cost" defined as a perceived compromise of the individual's visceral enjoyment of life (Glanz et al., 2015). This impediment to progress may be ameliorated, or at least diminished, via the healthcare professional or dietician suggesting, for example, that fatty cuts of meat may be substituted with leaner cuts, traditional pastries replaced with lower glycemic versions using alternative sweeteners, and strong liqueurs such as palinka substituted with red wine, all accomplished without drastic alterations of traditional recipes thereby encouraging higher patient compliance (Martos et al., 2012; Sarkadi-Nagy et al., 2012). When counseling Hungarian Americans on diet, one must remain mindful that any proposed dietary alternatives are being directed at a community of individuals that take great pride in indignation toward their mortality and personal vulnerability, as previously delineated (Cartledge, 2011). It may nonetheless be posited that the basic human instinct for survival and the desire to endure are drives that may supplant cultural paradigms, if appropriately presented to the individual, consistent with the core principles of the HBM (Glanz et al., 2015).

An additional consideration in the emotional cost analysis of traditional Hungarian fare is the actual financial costs of those foods versus a healthier diet, often falsely perceived by Hungarian Americans as much more expensive than their traditional diet, a factor that was examined in a recent study (Iski, Biro, Ungvari, Rurika, 2016) in respect to Hungarians living within Hungary, one which may not implicitly apply to Hungarian Americans per say, yet is still worthy of consideration. In this comparative study, researchers analyzed the cost in Hungarian currency of three specific dietary protocol: traditional Hungarian, low energy, and diabetic, while accounting for the ingredients of each meal and corresponding retail costs. Energy content, relevant medications, and expenses related to lifestyle were also factored into study design. Researchers concluded that the low energy diet and a physically active lifestyle were not only the most cost-effective combination but also the one most likely to achieve favorable health outcomes. The authors referenced similar findings by studies in the United States and the United Kingdom examining the costs of a junk food diet contrasted against that of a healthy foods diet, all arriving at similar conclusions in their cost analyses. One notable concern uncovered by the Hungarian study was the occasional inclusion of pizza and fast food by study participants, illustrating the point that even Hungarians consuming a mostly traditional diet sometimes stray from their customary eating habits at American fast food chains that have become ubiquitous cross-cultural contaminants of traditional diets both in the United States and in Hungary (Schröder, Fito, Covas, 2007). It is pertinent to note that Hungarians who infrequently stray from their traditional diet do so by eating foods at Western fast-food chains that are even more unhealthful than their own traditional diet, highlighting the health impact of the corporatization and globalization of the food supply in modern industrialized nations (Popkin, 2006), a separate topic outside the scope of this investigation.

Genetic Commonalities of Hungarians as a Haplogroup

A *haplotype* is a group of genes in an organism that are inherited together from a single parent, while a *haplogroup* is a group of similar haplotypes sharing a common ancestor with a single-nucleotide polymorphism (SNP) mutation. Numerous SNP mutations associated with Hungarians specifically and Eastern Europeans in general have been identified, with minor genomic variations from median values specific to individuals within the population (Cambien, Tiret, 2007). A statistically relevant genetic blueprint emerges as significant to this discussion, which include the following SNP's that have been identified as genomic influences in the etiology of CHD:

1. Atherosclerosis: USF-1 and FGB (Kalina, Czeizel, 2004).
2. Cardiovascular disease (general): FMN2, FSRC1, CRP, HSPD1, HSPE1, MTHFD1L, NOS3, MMP3, MYBPC3, SMAD3, CDH13, ACE AND SEZ6l (Szalai et al., 2004; Tregouet et al., 2009).
3. Cardiovascular disease (cholesterol level): CELSR3, ARHGAP30, EDN1, LPL, LIPC, CETP, MC4R and PLTP (Bereczky et al., 2007).
4. Familial hypercholesterolemia (common amongst Eastern European haplogroups): PCSK9, APOB AND LDLR (Kalina, Szab ki, Czeizel, 2003).
5. Myocardial infarction: MIA3 and WDR12 (Andrikovics et al., 2006).

The topic of predisposing genetic etiologies presents anachronistically as an expression of genetic determinism. A subset of society believes that our DNA dictates the destiny of our health outcomes, including CHD. This fatalistic notion unfortunately conforms to the Hungarian zeitgeist of destiny as an insurmountable force in one's life. The HBM emerges again as a potential vehicle for change, sharply contrasted against the flawed notion of hereditary determinism embedded in the mindset of many Hungarians (Cartledge, 2011). Hungarian Americans *want* to believe that they can change; they need only be *lead to the light*. Successfully addressing the topic of genetic predispositions lies in educating the Hungarian American, in layman's terms, about the critical role of nutrigenomics and epigenetics in gene expression, to convince the individual that their genes are in fact *not* their immutable destiny. Genetics may be a loaded gun, but it is environment that pulls the trigger (Egger, Liang, Aparicio, Jones, 2004; Mutch, Wahli, Williamson, 2005).

Non-Dietary Comorbidities of CHD Presenting as Additional Risk Factors

Comorbidities in the etiology of CHD in the Hungarian American population includes the prevalence of Metabolic Syndrome, both in Hungary and in the United States (Ford, Giles, Dietz, 2002). Metabolic Syndrome is comprised of five chronic conditions: Central obesity, elevated serum glucose, hypertension, hypertriglyceridemia, and hyperlipidemia/decreased HDL (Grundy et al., 2005). A recent cross-sectional study (Szigethy et al., 2012) examining Metabolic Syndrome in Hungarian populations profoundly spotlights the endemic nature of this problem. The study's methodology involved physical and laboratory screening of 2,006 Hungarian individuals, aged 20–69 years, for indicators of Metabolic Syndrome. Population prevalence was estimated via sample frequencies. The age-adjusted prevalence was found to be 38% in males and 30% in females, pointing in the direction of both genetic and epigenetic influences (Egger et al., 2004; Poyrazoglu, Bas, Darendeliler, 2014).

Additional covariate etiologies of CHD include the prevalence of smoking and excess alcohol consumption in the Hungarian culture (Chow et al., 2010; Popova, Rehm, Patra, Zatonski, 2007; Tombor et al., 2010). The influence of alcohol and nicotine as prominent causative factors common to numerous chronic disease states, e.g. CHD, cancer, diabetes, cirrhosis, pancreatitis and lung disease, are well-documented. Studies published in the last

decade (Britton, McKee, 2000; Popova et al., 2007) compared alcohol consumption in Eastern Europe, including Hungary, to other European countries. Researchers concluded that heavy alcohol consumption by Hungarian males is the second-highest in Europe, accentuated by a high proportion of binge drinking, and the highest in Europe in Hungarian females. The alcohol-attributable burden of disease in the Hungarian population can hardly be overstated as a CHD risk factor. The degree to which these findings are applicable to Hungarian Americans is difficult to quantify, as is the relative contribution of diet, alcohol consumption, and nicotine use to CHD risk, but it is logical to deduce from known data that CHD risk is indeed multifactorial in nature. Positive adoptions in health behavior tend toward concomitance and are rarely mutually exclusive, as proposed by Protection Motivation Theory (Milne, Sheeran, Orbell, 2000). Many Hungarian Americans who have transplanted their traditional atherogenic diet from Hungary may also have transplanted other unhealthful habits, such as smoking and excessive alcohol consumption (see Table 1). Therefore, successful dietary interventions to reduce CHD risk may also need to address the correlative issues of alcohol and nicotine use, as well as numerous other lifestyle factors outside the scope of this discussion, e.g. excess stress, inadequate sleep, and a sedentary lifestyle, as part of a complete and holistic approach to CHD prevention.

Table 1. Selected Social Determinants of Health for Hungarian-Americans

Social Determinants of Health	Health Effects
Language Barriers; Dietary Shift towards a Westernized diet; Tobacco Use; Cultural Barriers; Excess Alcohol Intake; Sedentary Lifestyle/Physical Inactivity; Resistance to Dietary or Lifestyle Changes	CVD; Diabetes (Type 2); Obesity (BMI ≥ 30); Hypercholesterolemia; Ischemic Stroke; Metabolic Syndrome

Culturally Influenced Cognitive Dissonance

Hungarians for the most part will tend to eat whatever they *want* to eat, not what they are *told* to eat (Szeitz-Szabó, Biró, Biró, 2012). The health promotion challenge is therefore implicit to convincing Hungarian Americans to want to eat healthier foods, while at the same time taking great care to respect their culture and traditions, constructed on a solid foundation of self-efficacy (Glanz et al., 2015; Mitic et al., 2012). It presents as unrealistic in a cultural context to seek a quick and easy solution to health promotion via the oversimplification and dichotomizing of self-indulgent behavioral patterns contrasted against the relatively trite counterpoint of safeguarding one's health, which is often not a priority for many individuals, Hungarian or otherwise. When counseling a Hungarian American, he or she, especially if older, may expect a specific form of formality in verbal communications between strangers that bears some resemblance as a cultural nuance to that of traditional Japanese societies. An example of this cultural nuance in conversation translatable to English would be a statement such as "It is better for *a person* to eat this, not that", instead of "It is better for *you* to eat this, not that". A conservative Hungarian American might very well take offense from the latter. In exploring the various permutations of health promotion aimed at Hungarian Americans, we find ourselves returning consistently to the recurring themes of cultural sensitivity and cultural competency as common threads in effective health promotion strategies (Mitic et al., 2012).

Summary

This review explored numerous facets of the psychosocial, economic, and cultural context of dietary habits of Hungarian Americans as an extension of their cultural roots in Hungary. We have highlighted key points in Hungarian history that have profoundly affected traditional Hungarian foods and the associated cultural mores. We also reviewed an array of relevant empirical evidence for cultural norms influencing diet that are consistent within the target population. The role of predisposing genetic and epidemiological factors in the progression of CHD and associated comorbidities common to haplogroups of Hungarian origin were also examined. Analyses of health-related statistical data pertinent to Hungarian populations in the US and Hungary were presented and quantified, with an emphasis on migrational components of epidemiology. Dietary recommendations relevant to reduction of CHD risk with the highest potential for realistic integration into a traditional Hungarian diet were identified and delineated, contrasted against recommendations deemed contextually unrealistic. The aim of this investigation is not to offer quick solutions for health promotion strategies; it is intended solely as a rational framework for dietary CHD intervention that respectfully acknowledges the distinct cultural identity of the Hungarian American, recognizing that a significant portion of that population is heavily influenced by the culture and food traditions of their native country and, as a result, continues to suffer negative health consequences. The authors' aspiration is that this investigation may serve as a useful template for healthcare professionals seeking to approach the Hungarian American population with a higher benchmark of cultural competency. The foundation for cultural competency in a healthcare setting, in respect to *any* culture, should ideally be predicated on the responsibility of healthcare professionals to first demonstrate empathy via knowledge and understanding of a given culture before they can proceed effectively with eliciting authentic behavior change within a population of likeminded individuals sharing a common thread of history and culture.

References

Andrikovics, H., Pongracz, E., Kalina, E., Szilvasi, A., Aslanidis, C., Schmitz, G., Tordai, A. (2006). Decreased frequencies of ABCA1 polymorphisms R219K and V771M in Hungarian patients with cerebrovascular and cardiovascular diseases. *Cerebrovascular Diseases (Basel, Switzerland), 21* (4), 254–259. DOI: 10.1159/000091223.

Benda, K., Hanák, P., Nagy, Z.L., Makkai, L., Niederhauser, E. (1988). *One Thousand Years – A Concise History of Hungary.* Budapest, Hungary: Corvina.

Bereczky, Z., Balogh, E., Katona, E., Pocsai, Z., Czuriga, I., Szeles, G., ..., Muszbek, L. (2007). Modulation of the risk of coronary sclerosis/myocardial infarction by the interaction between factor XIII subunit A Val34Leu polymorphism and fibrinogen concentration in the high risk Hungarian population. *Thrombosis Research, 120* (4), 567–573. DOI: 10.1016/j.thromres.2006.12.013.

Berend, I.T., Gyorgi, R. (1979). *Underdevelopment and economic growth: studies in Hungarian social and economic history.* Budapest, Hungary: Akadémiai Kiadó.

Britton, A., McKee, M. (2000). The relation between alcohol and cardiovascular disease in Eastern Europe: Explaining the paradox. *Journal of Epidemiology and Community Health, 54* (5), 328–332. DOI: 10.1136/jech.54.5.328.

Cambien, F., Tiret, L. (2007). Genetics of cardiovascular diseases: from single mutations to the whole genome. *Circulation, 116* (15), 1714–1724. DOI: 10.1161/circulationaha.106.661751.

Cartledge, B. (2011). *The Will to Survive: A History of Hungary.* New York: Columbia University Press.

Chow, C.K., Jolly, S., Rao-Melacini, P., Fox, K.A.A., Anand, S.S., Yusuf, S. (2010). Association of diet, exercise, and smoking modification with risk of early cardiovascular events after acute coronary syndromes. *Circulation, 121* (6), 750–758. DOI: 10.1161/CIRCULATIONAHA.109.891523.

de Zepetnek, S.T., Vasvári, L.O. (2011). *Comparative Hungarian Cultural Studies.* West Lafayette, IL: Purdue University Press.

Egger, G., Liang, G., Aparicio, A., Jones, P.A. (2004). Epigenetics in human disease and prospects for epigenetic therapy. *Nature, 429* (6990), 457–463. DOI: 10.1038/nature02625.

European Commission – Eurostats. (2015). Sustainable development – public health. Retrieved from http://ec.europa.eu/eurostat/statistics-explained/index.php/Sustainable_development_-_public_health#Determinants_of_health.

Ford, E.S., Giles, W.H., Dietz, W.H. (2002). Prevalence of the metabolic syndrome among US adults: Findings from the Third National Health and Nutrition Examination Survey. *Journal of the American Medical Association, 287* (3), 356–359.

Glanz, K., Rimer, B.K., Viswanath, K. (2015). *Health behavior and health education: theory, research, and practice* (5 ed.). San Francisco, CA: Jossey-Bass.

Grundy, S.M., Cleeman, J.I., Daniels, S.R., Donato, K.A., Eckel, R.H., Franklin, B.A., ..., Costa, F. (2005). Diagnosis and management of the metabolic syndrome: An American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Circulation, 112* (17), 2735–2752. DOI: 10.1161/CIRCULATIONAHA.105.169404.

Hungarian Central Statistical Office (2016). Retrieved from https://www.ksh.hu/?lang=en.

Iski, G., Biro, L., Ungvari, T., Rurika, I. (2016). How much is your diet? (estimation about prices of "traditional hungarian", diabetic, low energy diets, and related life-style expenses). *Acta Alimentaria, 45* (3), 434–441. DOI: 10.1556/066.2016.45.3.15.

Jenei, Z., Pall, D., Katona, E., Kakuk, G., Polgar, P. (2002). The epidemiology of hypertension and its associated risk factors in the city of Debrecen, Hungary. *Public Health, 116* (3), 138–144. DOI: 10.1038/sj.ph.1900840.

Kalina, A., Czeizel, A.E. (2004). The methylenetetrahydrofolate reductase gene polymorphism (C677T) is associated with increased cardiovascular mortality in Hungary. *International Journal of Cardiology, 97* (2), 333–334. DOI: 10.1016/j.ijcard.2003.08.021.

Kalina, A., Szab ki, F., Czeizel, E. (2003). 2P-0362 The 677-TT genotype of MTHER gene is associated with increased cardiovascular mortality in Hungary. *Atherosclerosis Supplements, 4* (2), 118. DOI: 10.1016/S1567-5688 (03)90505-8.

Labarthe, D.R. (2011). *Epidemiology and prevention of cardiovascular diseases: A global challenge*. Sudbury, MA: Jones & Bartlett.

Mark, L., Nagy, E., Kondacs, A., Deli, L. (1998). The change of attitude of Hungarian physicians towards the importance of risk factors of coronary heart disease over the period 1985–1996. *Public Health, 112* (3), 197–201. DOI: 10.1038/sj.ph.1900449.

Martos, E., Kovacs, V.A., Bakacs, M., Kaposvari, C., Lugasi, A. (2012). [Hungarian diet and nutritional status survey – the OTAP2009 study. I. Nutritional status of the Hungarian population]. *Orvosi hetilap, 153* (26), 1023–1030. DOI: 10.1556/oh.2012.29375.

Miller, W.R., Rollnick, S. (2013). *Motivational interviewing: Helping people change* (3 ed.). New York: Guilford Press.

Milne, S., Sheeran, P., Orbell, S. (2000). Prediction and Intervention in Health-Related Behavior: A Meta-Analytic Review of Protection Motivation Theory. *Journal of Applied Social Psychology, 30* (1), 106–143. DOI: 10.1111/j.1559-1816.2000.tb02308.x.

Mitic, W., Abdelaziz, F.B., Madi, H. (2012). Health education: theoretical concepts, effective strategies and core competencies – a foundation document to guide capacity development of health educators. Retrieved from http://applications.emro.who.int/dsaf/EMRPUB_2012_EN_1362.pdf.

Móczár, C., Borgulya, G., Kovács, E., Rurik, I. (2012). Could primary care dietary intervention combined with lifestyle changes be effective in the cardiovascular prevention? *Acta Alimentaria, 41* (2), 248–256. DOI: 10.1556/AAlim.41.2012.2.11.

Muller-Nordhorn, J., Binting, S., Roll, S., Willich, S.N. (2008). An update on regional variation in cardiovascular mortality within Europe. *European heart journal, 29* (10), 1316–1326. DOI: 10.1093/eurheartj/ehm604.

Mutch, D.M., Wahli, W., Williamson, G. (2005). Nutrigenomics and nutrigenetics: The emerging faces of nutrition. *FASEB Journal, 19* (12), 1602–1616. DOI: 10.1096/fj.05-3911rev.

Peto, A. (2007). Food-talk: Markers of identity and imaginary belongings. In: L. Passerini, D. Lyon, E. Capussotti, I. Laliotou (eds.), *Women Migrants From East to West: Gender, Mobility and Belonging in Contemporary Europe*. New York: Berghahn.

Popkin, B.M. (2006). Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. *The American Journal of Clinical Nutrition, 84* (2), 289–298.

Popova, S., Rehm, J., Patra, J., Zatonski, W. (2007). Comparing alcohol consumption in central and eastern Europe to other European countries. *Alcohol and Alcoholism, 42* (5), 465–473. DOI: 10.1093/alcalc/agl124.

Poyrazoglu, S., Bas, F., Darendeliler, F. (2014). Metabolic syndrome in young people. *Current Opinion in Endocrinology, Diabetes and Obesity, 21* (1), 56–63. DOI: 10.1097/01.med.0000436414.90240.2c.

Sarkadi-Nagy, E., Bakacs, M., Illes, E., Zentai, A., Lugasi, A., Martos, E. (2012). [Hungarian Diet and Nutritional Status Survey – the OTAP2009 study. II. Energy and macronutrient intake of the Hungarian population]. *Orvosi hetilap, 153* (27), 1057–1067. DOI: 10.1556/oh.2012.29376.

Schröder, H., Fito, M., Covas, M.I. (2007). Association of fast food consumption with energy intake, diet quality, body mass index and the risk of obesity in a representative Mediterranean population. *British Journal of Nutrition, 98* (6), 1274–1280. DOI: 10.1017/S0007114507781436.

Schuchat, M.G. (1981). Hungarian Americans in the Nation's Capital. *Anthropological Quarterly, 54* (2), 89–93. DOI: 10.2307/3318012.

Sisa, S. (1995). *The Spirit of Hungary: A Panorama of Hungarian History and Culture*. Morristown, NJ: Vista Court.

Skrabski, Á., Kopp, M., Rózsa, S., Réthelyi, J., Rahe, R.H. (2005). Life meaning: An important correlate of health in the Hungarian population. *International Journal of Behavioral Medicine, 12* (2), 78–85. DOI: 10.1207/s15327558ijbm1202_5.

Szalai, C., Keszei, M., Duba, J., Prohászka, Z., Kozma, G.T., Császár, A., ..., Czinner, A. (2004). Polymorphism in the promoter region of the apolipoprotein A5 gene is associated with an increased susceptibility for coronary artery disease. *Atherosclerosis, 173* (1), 109–114. DOI: 10.1016/j.atherosclerosis.2003.12.003.

Szeitz-Szabó, M., Biró, L., Biró, G. (2012). Nutritional and vital statistical features of the Hungarian population: A review about the past 25 years. *Acta Alimentaria, 41* (2), 277–291. DOI: 10.1556/AAlim.41.2012.2.15.

Szigethy, E., Széles, G., Horváth, A., Hidvégi, T., Jermendy, G., Paragh, G., ... Vokó, Z. (2012). Epidemiology of the metabolic syndrome in Hungary. *Public Health, 126* (2), 143–149. DOI: 10.1016/j.puhe.2011.11.003.

Teuteberg, H.J. (1992). *European Food History: A Research Review.* Leicester, UK: Leicester University Press.

The Institute for Health Metrics and Evaluation (2016). GBD Profile: Hungary. Retrieved from http://www.healthdata.org/sites/default/files/files/country_profiles/GBD/ihme_gbd_country_report_hungary.pdf.

The World Bank (2016). Hungary. Retrieved from http://data.worldbank.org/country/hungary.

The World Health Organization MONICA Project (monitoring trends and determinants in cardiovascular disease): a major international collaboration. WHO MONICA Project Principal Investigators (1988). *Journal of Clinical Epidemiology, 41* (2), 105–114.

Tombor, I., Paksi, B., Urbán, R., Kun, B., Arnold, P., Rózsa, S., Demetrovics, Z. (2010). Epidemiology of smoking in Hungary – A national representative study. *Orvosi hetilap, 151* (9), 330–337. DOI: 10.1556/OH.2010.28817.

Tregouet, D.A., Konig, I.R., Erdmann, J., Munteanu, A., Braund, P.S., Hall, A.S., ..., Samani, N.J. (2009). Genome-wide haplotype association study identifies the SLC22A3-LPAL2-LPA gene cluster as a risk locus for coronary artery disease. *Nature genetics, 41* (3), 283–285. DOI: 10.1038/ng.314.

Cite this article as: Laszlo, N., Aboul-Enein, B.H., Bernstein, J., Kruk, J. (2017). Addressing Cardiovascular Disease Risk in Hungarian-American Populations: A Cultural Exploration of Transdisciplinary Health Promotion. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 31–41. DOI: 10.18276/cej.2017.3-03.

THE DIFFERENTIATION OF VISUAL SENSORIMOTOR PROCESSES IN THE REPRESENTATIVES OF VARIOUS SPORT DISCIPLINES

Piotr Lesiakowski,[1, A, B, C, D, E] Justyna Krzepota,[2, B] Teresa Zwierko[2, A, D, E]

[1] Pomeranian Medical University in Szczecin, Department of Physical Education and Sport, Szczecin, Poland
[2] University of Szczecin, Faculty of Physical Culture and Health Promotion, Szczecin, Poland
[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation; [E] Funds Collection

Address for correspondence:
Piotr Lesiakowski
Pomeranian Medical University in Szczecin, Department of Physical Education and Sport
Dunikowskiego 6a, 70-123 Szczecin, Poland
E-mail: lesiakowskipiotr@gmail.com

Abstract Sport activities usually require a high efficiency of visual information processing. Therefore, it seems justified to determine the efficiency of visual sensorimotor processes in sports requiring a variety of perception competencies. The aim of this study was to assess the differentiation of sensorimotor processes in terms of simple and choice reaction time, and visual stimulus discrimination in various athletes and untrained persons. The study involved 119 men, of which 95 were athletes: football players (n = 24), volleyball players (n = 22), boxers (n = 26), and rowers (n = 23). The efficiency of sensorimotor processes was evaluated with the Vienna Test System (Schuhfried, Austria). The evaluations included simple reaction time (SRT), choice reaction time (CRT), and visual stimulus discrimination. Analysis of the results showed that volleyball and football players had shorter ($p < 0.01$) reaction times compared to non-athletes and representatives of the other sports. We found significant differences ($p < 0.01$) between athletes and non-athletes in visual stimulus discrimination. In addition, boxers showed fewer correct reactions than volleyball players, and shorter times of stimulus detection than in volleyball and soccer players.

Key words reaction time, selective attention, sport training

Introduction

It is widely accepted that regular physical activity positively affects the efficiency of motor reactions. For example, Baylor and Spirduso (1988) found that regular physical activity improves the efficiency of simple reaction times, more with regards to the pre-motor fraction (70%) than to motor fraction of the reaction time (30%). Many researchers confirm this thesis, reporting faster response times in athletes in comparison with non-athletes (Ando, Kida, Oda, 2001; Kioumourtzoglou, Kourtessis, Michalopoulou, Derri, 1998; Kokubu, Ando, Kida, Oda, 2006; Overney, Blanke, Herzog, 2008; Piras, Lobietti, Squatrito, 2014; Vansteenkiste, Vaeyens, Zeuwts, Philippaerts, Lenoir, 2014; Zwierko, Osiński, Lubiński, Czepita, Florkiewicz, 2010). On the other hand, not all articles confirm the existence of a relationship between the efficiency of motor reactions and physical fitness (Cojocarlu and Abalasel

2014; Fontani, Lodi, Felici, Migliorini, Corradeschi, 2006; Soto-Rey, Pérez-Tejero, Rojo-González, Reina, 2014). Importantly, most research in this field refers to laboratory measurements of reactions in athletes and non-athletes, and a lack of difference is observed more frequently in less complex tasks (Kida, Oda, Matsumura, 2005; Mero, Jaakkola, Komi, 1989; Thomson, Watt, Liukkonen, 2008).

Attention is considered to be an important factor influencing the effectiveness of motor performance in sport, and hence the athletes' tolerance to fatigue (Williams, Davids, Williams, 1999). It is generally defined as the state of readiness (vigilance) of the body to detect specific stimuli. Various reports show that a higher level of attention increases the perceptual sensitivity of athletes, as manifested by an increased efficiency of visual search and specific decision-making processes, as well as by a shorter time of information processing (Cañal-Bruland, 2009; Hagemann, Schorer, Cañal-Bruland, Lotz, Strauss, 2010; Lu, Dosher, 1998; Taliep et al. 2008). For example, football, handball and hockey players, as well as modern pentathletes, have been observed to have a higher level of attention than non-athletes (Enns, Richards, 1997; Lum, Enns, Pratt, 2002; Nougier, Ripoll, Stein, 1989; Zwierko, Florkiewicz, Fogtman, Kszak-Krzyżanowska, 2014).

The specificity of each discipline requires performing different physical activities under established rules. However, there is a scarcity of research comparing the effectiveness of sensorimotor processes in disciplines with a wide spectrum of perceptual requirements. Existing research suggests differences in the level of visual sensorimotor processes between sports with varied requirements regarding perception. For example Giglia et al. (2011) compared the effectiveness of perceptual processes in volleyball and rowing, and found a significantly faster response and greater accuracy in volleyball players. The dependence of reaction time and attention on the type of sporting activity is partly explained by other experimental studies (Foroghipour, Monfared, Pirmohammadi, Saboonchi, 2013; Hijazi, 2013; Matser, Kessels, Lezak, Troost, Jordan, 2000; Mokha, Kaur, Sidhu, 1992; Sánchez-López, Fernández, Silva-Pereyra, 2008; Warden et al. 2001).

Given the aforementioned assumptions, it seems important to determine the scope of adaptation of visual functions to conditions associated with the nature and duration of sports training. The aim of this study was to evaluate differences in sensorimotor processes in terms of simple and choice reaction time, and visual stimulus discrimination, in athletes training in sports requiring different levels of perceptual involvement compared to non-athletes. We hypothesized that the efficiency of visual sensorimotor processes depends on the kind of sports activity taken up, that means that the higher the level of requirements for the engaged visual functions resulting from the specificity of motor behavior in a given sports discipline, the higher the efficiency of visual sensorimotor processes.

Material and methods

The study involved 119 men. Of those, 95 were professionally involved in sport: football (n = 24), volleyball (n = 22), boxing (n = 26), rowing (n = 23). The control group consisted of non-athletes (n = 24). Table 1 shows the main characteristics of the study groups.

To evaluate the effectiveness of sensorimotor processes we applied measurement methods included in the Vienna Test System, version 29.01 (Schuhfried, Austria). The study used a computer (CPU 1.6GHz) and a screen (Dell P791, diagonal 17", resolution 640 × 480 pixels, refresh rate 85Hz). The study evaluated the simple reaction time (SRT), choice reaction time (CRT) and ability to maintain attention during visual stimulus discrimination.

Table 1. Somatic parameters and length of training groups studied ($\bar{x}$ ± SD)

Group	Age (years)	Body height (cm)	Body mass (kg)	Sport experience (years)
Football	20.25 ±1.91	181.04 ±7.29	73.93 ±7.39	6.54 ±2.96
Volleyball	21.92 ±2.11	194.06 ±6.22	84.92 ±7.04	8.14 ±1.31
Boxing	20.16 ±1.84	173.41 ±5.16	61.51 ±6.05	6.03 ±3.22
Rowing	21.83 ±1.86	185.89 ±5.81	82.36 ±12.41	6.82 ±3.48
Non-athletes	20.14 ±1.42	182.04 ±3.95	80.23 ±7.21	–

Simple reaction time (SRT) was evaluated using the reaction test (T) – variant S1. The reaction cycle consisted of 28 yellow light stimuli generated at different and randomly selected time intervals (2.5–6.0 s). Each stimulus lasted 1 second. The participants were supposed to perform a key-press response to the programmed visual stimuli. Below the 'reaction key', the panel had a 'stand-by key'. An examined individual maintained a finger on the 'stand-by key'; in reaction to a visual stimulation, the finger was supposed to be moved as quickly as possible from the 'stand-by key' to the 'reaction key'.

Choice reaction time (CRT) was assessed using the reaction test (T) – variant S4. Similarly, to test the response time of a simple choice, the person tested sat in front of the screen. Presentation of complex visual stimuli consisted of 48 stimuli with different characteristics (light yellow and/or red with a sound signal frequency 2000 Hz). The length of the emitted stimulus was 1.2 seconds, and the interval between stimuli was varied in the range 1.5 to 4.0 seconds. The test duration was five minutes.

Choice reaction time (variant S4). In the test phase 48 stimuli were presented of which 16 required a reaction. The critical combination to which the subject was instructed to respond consisted of two visual stimuli (yellow and/or red light with a sound signal at 2000 Hz). An examined individual was supposed to react to the programmed visual stimuli (simultaneous yellow and red lights) by pressing the 'reaction key' according to the procedure mentioned above (SRT). The measurements of SRT and CRT were recorded by a computer program and the following values were calculated: (1) median of total reaction time (duration between the beginning of a given stimulus and pressing the 'reaction key', in ms), (2) median of pre-motor reaction time (duration between the beginning of a given stimulus and the release of the 'stand-by' key, in ms), (3) median of motor reaction time (duration between the release of the 'stand-by' key and pressing the 'reaction key', in ms).

Figure. 1. White signals (dots) on a black background and the critical stimulus constellation in the Special Ability Signal Test

The ability to maintain attention during the discrimination of visual stimuli (long-term selective attention) was assessed using the standard variant of the *Special Ability Signal Test* (S1). The test measured the visuospatial differentiation of a relevant signal within irrelevant signals. In our experiment we used the standard version S1 with white signals (dots) on a black background. Dots were displayed over the entire screen area; pseudo-randomly some of the dots disappeared and others appeared. The participants were requested to perform a key-press response to a programmed stimulus constellation whenever it occurred. This critical stimulus constellation consisted of four dots forming a square (Figure 1). The total testing time was between 13 and 14 minutes (including instruction and practice phase). The main variables calculated were the numbers of correct, omitted and incorrect reactions and the median reaction time as a measure of the speed of the detection process.

Results

Table 2. Arithmetic means, standard deviations, minimum and maximum values, and variance analysis of simple reaction time [s] and choice reaction time [s] in the examined groups

Group	Simple reaction time			Choice reaction time		
	$\bar{x} \pm$ SD	Minimum	Maximum	$\bar{x} \pm$ SD	Minimum	Maximum
Football	0.255 ±0.018	0.221	0.275	0.365 ±0.028	0.318	0.406
Box	0.307 ±0.039	0.236	0.393	0.428 ±0.030	0.366	0.496
Rowing	0.296 ±0.036	0.231	0.389	0.440 ±0.045	0.351	0.530
Volleyball	0.253 ±0.024	0.221	0.299	0.365 ±0.028	0.318	0.406
Non-athletes	0.289 ±0.037	0.239	0.387	0.403 ±0.061	0.282	0.507

Table 2 shows the descriptive statistics and the variance analysis of simple reaction time (SRT) and choice reaction time (CRT) in the examined groups. The shortest combined SRT and CRT were obtained by volleyball and football players. Detailed comparative analysis (Table 3) indicated their significantly shorter SRT ($p < 0.01$) in relation to the results achieved by boxers, rowers and the control group. Also in CRT (Table 4), football and volleyball players had significantly better results ($p < 0.01$) than rowers and boxers. In two out of four analyzed cases (soccer, volleyball), the sport groups had better CRT than the control group ($p < 0.05$).

Table 3. The results of the Tukey post-hoc test for simple reaction time [s] in the study groups

Group	{1}	{2}	{3}	{4}	{5}
Soccer {1}	–	**	**	ns	**
Boxing {2}	**	–	ns	**	ns
Rowing {3}	**	ns	–	**	ns
Volleyball {4}	ns	**	**	–	**
Non-athletes {5}	**	ns	ns	**	–

** $p < 0.01$; ns – not significant.

Table 4. The results of the Tukey post-hoc test for choice reaction times [s] in the studied groups

Group	{1}	{2}	{3}	{4}	{5}
Soccer {1}	–	**	**	ns	*
Boxing {2}	**	–	ns	**	ns
Rowing {3}	**	ns	–	**	*
Volleyball {4}	ns	**	**	–	*
Non-athletes {5}	*	ns	*	*	–

* $p < 0.05$; ** $p < 0.01$; ns – not significant.

We observed statistically significant differences in selective attention expressed by correct responses ($F_{(4,111)} = 7.865$; $p < 0.05$) and the time of stimulus ($F_{(4,111)} = 4.645$; $p < 0.05$). In the case of incorrect responses, we found no significant differences between the groups (Table 5).

Table 5. Arithmetic means, standard deviations and variance analysis of selective attention during visual stimulus discrimination

Group	Correct responses		Incorrect responses		Detection time [s]	
	$\bar{x} \pm SD$	F	$\bar{x} \pm SD$	F	$\bar{x} \pm SD$	F
Football	53.208 ±2.903		1.083 ±0.775		0.760 ±0.050	
Boxing	50.612 ±4.104		1.903 ±2.150		0.830 ±0.082	
Rowing	52.947 ±4.870	7.865*	1.631 ±1.256	1.278	0.783 ±0.076	4.645*
Volleyball	54.047 ±3.721		1.904 ±1.410		0.766 ±0.059	
Non-athletes	48.619 ±2.558		1.574 ±1.028		0.798 ±0.060	

* $p < 0.05$.

Analysis of differences between groups in correct reactions and stimulus detection time are shown in Tables 6 and 7.

Table 6. Results of the Tukey post-hoc test for correct reactions in the visual stimulus discrimination

Group	{1}	{2}	{3}	{4}	{5}
Soccer {1}	–	ns	ns	ns	**
Boxing {2}	ns	–	ns	*	ns
Rowing {3}	ns	ns	–	ns	**
Volleyball {4}	ns	*	ns	–	**
Non-athletes {5}	**	ns	**	**	–

* $p < 0.05$; ** $p < 0.01$; ns – not significant.

Detailed analysis of results of the researched groups of athletes showed the groups of athletes, volleyball players characterized more ($p < 0.05$) correct responses compared to those boxing. Moreover, the reaction was significantly better ($p < 0.01$) in the groups of volleyball players, football players, rowers, when compared with the non-athletes.

Table 7. The results of the Tukey post-hoc test for the detection time [s] of visual stimulus discrimination in groups

Group	{1}	{2}	{3}	{4}	{5}
Football {1}	–	**	ns	ns	ns
Boxing {2}	**	–	ns	*	ns
Rowing {3}	ns	ns	–	ns	ns
Volleyball {4}	ns	*	ns	–	ns
Non–athletes {5}	ns	ns	ns	ns	–

* $p < 0.05$; ** $p < 0.01$; ns – not significant.

The selection of a correct sequence of stimuli on the computer screen was fastest for football players, and then volleyball players. The results obtained by these groups of athletes were significantly better ($p < 0.01$ and $p < 0.05$) compared to the results achieved by the boxers (Table 8). In other cases we found no significant differences between groups ($p > 0.05$).

Discussion

The aim of this study was to evaluate differences in visual sensorimotor processes in terms of simple and choice reaction time, and visual stimulus discrimination in the representatives of various sport disciplines. We expected that the higher the level of requirements for the engaged visual functions resulting from the specificity of motor behavior in a given sports discipline, the higher the efficiency of visual sensorimotor processes. This hypothesis was partly confirmed. Our results partially indicate a shorter reaction time ($p < 0.01$) in athletes compared with non-athletes, albeit only in the groups of footballers and volleyball players. This confirms earlier reports by Ando et al. (2001) who determined changes in the bioelectrical charge in the forearm muscles to assess the reaction to stimuli appearing in the central and peripheral vision in highly-skilled footballers. The specificity of football requires a state of readiness to respond to stimuli that may arise in the field of view. When it comes to volleyball players, our results are in line with the observations of Piras et al. (2014) and Vansteenkiste et al. (2014) who evaluated the reaction time based on the video of registered sequences of volleyball actions. Also, studies of other authors (Kokubu et al. 2006; Kioumourtzoglou et al. 1998; Zwierko et al. 2010) confirmed shorter reaction times straight in volleyball players compared to non-athletes.

Interestingly, we found no significant differences in simple and choice reaction times between boxers and non-athletes. The control group had an even shorter mean simple reaction time, although the difference was not statistically significant ($p > 0.05$). It seems that the nature and specificity of boxing requires a high level of rapid response capabilities, as documented in the works of Darby et al. (2014) and Bianco et al. (2011), etc. However, the results of our study do not confirm it. Some explanation of this discrepancy may be provided by the traumatic effect of boxing, especially regarding head injuries (Zazryn, Finch, McCrory, 2003). A common phenomenon in combat sport is a long-term presence of symptoms indicative of previous head injuries (Galetta et al. 2011). For example, McKee et al. (2009) presented detailed results of football players and boxers, confirming the long-term effects of repeated head injuries, resulting in progressive neurological deterioration known as chronic traumatic encephalopathy (CTE). Some results of research conducted among athletes also indicate the possible influence of frequent blows to the head on the speed of sensorimotor processing speed and the efficiency of cognitive

functions. They mainly related to football players (Koerte, Ertl-Wagner, Reiser, Zafonte, Shenton, 2012; Matser et al. 2001), hockey players (McAllister et al. 2012) and boxers (Chappell et al. 2006; Jordan et al. 1997; Zhang, Heier, Zimmerman, Jordan, Ulug, 2006).

In this study, rowers had slower reactions ($p < 0.05$) than non-athletes. Of course, given the specificity of the sport, it can be predicted that this group of athletes may not be different from untrained persons. Previous research on rowers showed that the choice reaction time was clearly longer than volleyball players (Giglia et al. 2011). It is assumed, therefore, that in the absence of additional effects which would modulate the reactivity to stimuli (forced by the specificity of the discipline), reactivity is strongly influenced by stimuli not related to sports.

When it comes to selective attention during visual stimulus discrimination, most analyzed sports showed significant differences between the athletes and non-athletes in the number of correct responses in stimulus discrimination. No differences were found in the time of discrimination.

It seems that sporting experience should result in faster and more efficient information processing associated with attention (Borysiuk, Sadowski, 2007; Di Russo, Taddei, Aprile, Spinelli, 2006). An optimal level is considered significant for the efficiency of visual search as well as the time needed to process the information (Cañal-Bruland, 2009; Hagemann et al. 2010). Our results confirm only an increase in the efficiency of information processing manifested by a greater number of correct answers from athletes, which is consistent with the results of other authors. In previous studies we observed a higher level of attention in athletes involved in sports such as football, handball, hockey and modern pentathlon, when compared to untrained persons (Enns, Richards, 1997; Lum et al. 2002; Nougier et al. 1989; Pesce, Tessitore, Casella, Pirritano, Capranica, 2007; Zwierko et al. 2014).

Therefore, it is possible that sport training facilitates a wider range of adaptation and enhances selective attention during stimulus discrimination, particularly in the case of sports requiring a strong involvement in visual perception. Specific explanations may be provided here by a list of sports arranged according to the involvement of visual perceptual functions.

In our study, the selection of disciplines was based on the classification proposed by Williams et al. (1999) and Erickson (2007), where the highest requirements in terms of perception are found in football, followed by volleyball and boxing, and the least demanding in terms of visual perception is rowing. Our results were similar, with the shortest reaction times observed in football and volleyball players, with significantly better ($p < 0.01$) results than representatives of other sports. Our findings seem to be consistent with previous research by other authors. Giglia et al. (2011) compared the effectiveness of perceptual processes in volleyball players and rowers, and clearly showed a faster reaction and greater accuracy in volleyball players, especially with regard to peripherally appearing stimuli. The dependence of the reaction time to the type of sport activity is explained in other experimental studies. For example, Foroghipour et al. (2013) subjected two groups of people to a systematic sport activity. One group trained table tennis while the other trained volleyball (24 training sessions each). The group training table tennis had significantly reduced simple and choice reaction time when compared to the test before the training sessions ($p < 0.05$), while in the volleyball group a reduction in just the choice reaction time was observed ($p < 0.05$). Similar results were obtained by Mokha et al. (1992), who evaluated the reaction time after 20 days of intensive hockey training. It turned out that the speed of reaction to visual stimuli significantly improved in defenders and attackers. As can be seen, our results and previous reports confirm the assumption that the engagement of perceptual functions in a sport is a factor determining the reaction time. Probably, one of the factors that is crucial for the efficiency of sensorimotor processes is the ability to quickly focus attention during body movement.

Our results, concerning selective attention during visual stimulus discrimination, showed differences between the sports. Volleyball and football players needed less time to detect a stimulus compared to boxers. In addition, volleyball players obtained a greater number of correct answers than boxers. Therefore, our research shows that athletes training sports with high requirements regarding visual perception achieve better results in long-term attention tests. However, the results of previous studies do not clearly confirm this, showing slightly different dependencies. In an analysis of three primary (non-specific) tasks independently determining the level of attention in handball players and athletes of individual sports, Memmert et al. (2009) did not register any significant difference in the efficiency of processes related to attention. In this case, the discrepancy with our results may be due to the cross-sectional selection of the study groups, which included several individual sports differing in perceptual requirements and so in the levels of attention.

A direct comparison between the level of attention between combat athletes representing three martial arts was performed by Sánchez-López et al. (2013). These included kung-fu, judo and taekwondo, seemingly similar in terms of the involvement of sensorimotor processes. Based on the TOVA test results, the authors found a shorter time of stimulus detection ($p < 0.05$) and more effective attention in kung-fu athletes, which was manifested by a higher level of refraining from reacting to disturbing stimuli than the other groups. The authors associated these observations with more time spent on meditation or self-control in kung-fu athletes, which seems to confirm the results of our study indicating that attention depends on the type of activities performed in individual sports. In yet another study, Khani et al. (2012), analyzed selected attention parameters: accuracy, impulsiveness, and speed of information processing, in boxers with different sport experience and sprinters at the beginner level. The authors did not observe any significant differences in the attention between the two groups. Given the results of our research, it is therefore possible that the lower level of attention observed in boxers when compared to the representatives of team sports, may result from the effects of trauma they experienced during fights. Previous studies show the negative effects of combat sports on cognitive functions such as planning and attention (Matser et al. 2000; Warden et al. 2001). Yet, as can be seen in literature, results regarding attention in boxing are ambiguous.

In the case of football or volleyball, i.e. disciplines with a high level of perceptual requirement, long-term attention is a consequence of the specific nature of the motor activities. There are scientific studies confirming the association between observations of motor activities and the mechanisms of attention in sports with high perceptual requirements. For example, Taliep et al. (2008) when analyzing the efficiency of attention processes in cricket players, observed a lower amplitude of the P300 wave (recognized as a psychophysiological measure of attention processes), faster reaction time and better discrimination and recognition of correct stimuli (film presentation of different kinds of ball throws). The authors suggested that players training sport with high perceptual requirements engaged less attention during recognition of the type of throw than other persons. This shows the significance of perceptual training in improving attention in sports. The use of software in improving perception functions brings positive results in the form of an increased level of attention, which directly increases the effectiveness of motor learning and consequently improves sport performance (Cañal-Bruland, 2009; Hagemann et al. 2010; Uehara, Button, Davids, 2008; Wulf, McConnel, Gärtner, Schwarz, 2002).

With reference to the direct usefulness in the process of sports practice, the visual attention exercises should be treated as a necessary element of sports training, especially in the disciplines characterized by high requirements connected to visual perception.

References

Ando, S., Kida, N., Oda, S. (2001). Central and peripheral visual reaction time of soccer players and nonathletes. *Perceptual and Motor Skills*, *92* (3), 786–794.

Baylor, A.M., Spirduso, W.W. (1988). Systematic aerobik exercise and components of reaction time in older women. *Journal of Gerontology and Psychological Sciences*, *43*, 121–126.

Bianco, M., Ferri, M., Fabiano, C., Giorgiano, F., Tavella, S., Manili, U., Faina, M., Palmieri, V., Zeppilli, P. (2011). Baseline simple and complex reaction times in female compared to male boxers. *Journal of Sports Medicine and Physical Fitness*, *51* (2), 292–298.

Borysiuk, Z., Sadowski, J. (2007). Time and spatial aspects of movement anticipation. *Biology of Sport*, *3*, 285–295.

Cañal-Bruland, R. (2009). Visual cueing in sport-specific decision making International. *Journal of Sport and Exercise Psychology*, *7* (4), 450–464.

Chappell, M.H., Ulug, A.M., Zhang, L., Heitger, M.H., Jordan, B.D., Zimmerman, R.D., Watts, R. (2006). Distribution of microstructural damage in the brains of professional boxers: A diffusion MRI study. *Journal of Magnetic Resonance Imaging*, *24* (3), 537–542.

Cojocarlu, A., Abalasel, B. (2014). Does the reaction time to visual stimuli contribute to performance in judo? *Archives of Budo*, *10*, 73–78.

Darby, D., Moriarity, J., Pietrzak, R., Kutcher, J., McAward, K., McCrory, P. (2014). Prediction of winning amateur boxers using pretournament reaction times. *Journal of Sports Medicine and Physical Fitness*, *54* (3), 340–346.

Di Russo, F., Taddei, F., Aprile, T., Spinelli, D. (2006). Neural correlates of fast stimulus discrimination and response selection in top level fencers. *Neuroscience Letters*, *408*, 113–118.

Enns, J.T., Richards, J. (1997). Visual attentional orienting in developing hockey players. *Journal of Experimental Child Psychology*, *64*, 255–275.

Erickson, G. (2007). *Sports Vision: Vision Care for the Enhancement of Sports Performance*. St. Louis: Butterworth-Heinemann.

Fontani, G., Lodi, L., Felici, A., Migliorini, S., Corradeschi, F. (2006). Attention in athletes of high and low experience engaged in defferent open skill sports. *Perceptual and Motor Skills*, *102* (3), 791–805.

Foroghipour, H., Monfared, M.O., Pirmohammadi, M., Saboonchi, R. (2013). Comparison of Simple and Choice Reaction Time in Tennis and Volleyball Players. *International Journal of Sport Studies*, *3* (1), 74–79.

Galetta, K.M., Barrett, J., Allen, M., Madda, F., Delicata, D., Tennant, A.T., Branas, C.C., Maguire, M.G., Messner, L.V., Devick, S., Galetta, S.L., Balcer, L.J. (2011). The King-Devick test as a determinant of head trauma and concussion in boxers and MMA figters. *Neurology*, *76* (17), 1456–1462.

Giglia, G., Brighina, F., Zangla, D., Bianco, A., Chiavetta, E., Palma, A., Fierro, B. (2011). Visuospatial attention lateralization in volleyball players and in rowers. *Perceptual and Motor Skills*, *112* (3), 915–925.

Hagemann, N., Schorer, J., Cañal-Bruland, R., Lotz, S., Strauss, B. (2010). Visual perception in fencing: do the eye movements of fencers represent their information pickup? *Attention, Perception and Psychophysics*, *72* (8), 2204–2214.

Hijazi, M. (2013). Attention, Visual Perception and their Relationship to Sport Performance in fencing. *Journal of Human Kinetics*, *39*, 195–201.

Jordan, B.D., Relkin, N.R., Ravdin, L.D., Jacobs, A.R., Bennett, A., Gandy, S. (1997). Apolipoprotein E epsilon4 associated with chronic traumatic brain injury in boxing. *Journal of the American Medical Association*, *278* (2), 136–140.

Khani, M., Farrokhi, A., Kheslat, S.D.N., Sadri, K., Farrar, A. (2012). Chronic attention impairments in amateur boxing: Effect of repeated blows to the head. *Serbian Journal of Sports Sciences*, *6* (1), 23–28.

Kida, N., Oda, S., Matsumura, M. (2005). Intensive baseball practice improves the Go/NoGo reaction time, but not the simple reaction time. *Cognitive Brain Research*, *22* (2), 257–264.

Kioumourtzoglou, E., Kourtessis, T., Michalopoulou, M., Derri, V. (1998). Differences in several perceptual abilities between experts and novices in basketball, volleyball and water-polo. *Perceptual and Motor Skills*, *86* (3), 899–912.

Koerte, I.K., Ertl-Wagner, B., Reiser, M., Zafonte, R., Shenton, M.E. (2012). White matter integrity in the brains of professional soccer players without a symptomatic concussion. *Journal of the American Medical Association*, *308* (18), 1859–1861.

Kokubu, M., Ando, S., Kida, N., Oda, S. (2006). Interference effects between saccadic and key press reaction times of volleyball players and nonathletes. *Perceptual and Motor Skills*, *103* (3), 709–716.

Lu, Z.L., Dosher, B.A. (1998). External noise distinguishes attention mechanisms. *Vision Research*, *38*, 1183–1198.

Lum, J., Enns, J.T., Pratt, J. (2002). Visual orienting in the college athletes: Explorations of athlete type and gender. *Research Quarterly for Exercise and Sport*, *73*, 156–167.

Matser, E.J., Kessels, A.G., Lezak, M.D., Troost, J., Jordan, B.D. (2000). Acute traumatic brain injury in amateur boxing. *The Physician and Sportsmedicine*, *28* (1), 87–92.

Matser, J.T., Kessels, A.G., Lezak, M.D., Troost, J. (2001). A dose-response relation of headers and concussions with cognitivie impairment in professional soccer players. *Journal of Clinical and Experimental Neuropsychology*, *23* (6), 770–774.

McAllister, T.W., Flashman, L.A., Maerlender, A., Greenwald, R.M., Beckwith, J.G., Tosteson, T.D., Crisco, J.J., Brolinson, P.G., Duma, S.M., Duhaime, A.C., Grove, M.R., Turco, J.H. (2012). Cognitive effects of one season of head impacts in a cohort of collegiate contact sport athletes. *Neurology*, *78* (22), 1777–1784.

McKee, A.C., Cantu, R.C., Nowinski, C.J., Hedley-Whyte, E.T., Gavett, B.E., Budson, A.E., Santini, V.E., Lee, H.S., Kubilus, C.A., Stern, R.A. (2009). Chronic traumatic encephalopathy in athletes: Progressive tauopathy after repetitive head injury. *Journal of Neuropathology and Experimental Neurology*, *68* (7), 709–735.

Memmert, D., Simons, D.J., Grimme, T. (2009). The relationship between visual attentionand expertise in sports. *Psychology of Sport Exercise*, *10* (1), 146–151.

Mero, A., Jaakkola, L., Komi, P.V. (1989). Neuromuscular, metabolit and hormonal profile sof young tennis players and untrained boys. *Journal of Sport Sciences*, *7* (2), 95.

Mokha, R., Kaur, G., Sidhu, L.S. (1992). Effect of training on the reaction time of Indian female hockey players. *Journal of Sports Medicine and Physical Fitness*, *32* (4), 428–431.

Nougier, V., Ripoll, H., Stein, J.F. (1989). Orienting of attention with highly skilled athletes. *International Journal of Sport Psychology*, *20*, 205–223.

Overney, L.S., Blanke, O., Herzog, M.H. (2008). Enhanced temporal but not attentional processing in expert tennis players. *PLoS ONE*, *3* (6), 1–9.

Pesce, C., Tessitore, A., Casella, R., Pirritano, M., Capranica, L. (2007). Focusing of visual attention at rest and during physical exercise in soccer players. *Journal of Sports Science*, *25* (11), 1259–1270.

Piras, A., Lobietti, R., Squatrito, S. (2014). Response Time, Visual Search Strategy and Anticipatory Skills in Volleyball Players. *Journal of Ophthalmology*. DOI: 10.1155/2014/189268.

Sánchez-López, J., Fernández, T., Silva-Pereyra, J. (2013). Differences between Judo, Taekwondo and Kung-fu Athletes in Sustained Attention and Impulse Control. *Psychology*, *4* (7), 607–612.

Soto-Rey, J., Pérez-Tejero, J., Rojo-González, J.J., Reina, R. (2014). Study of reaction time to visual stimuli in athletes with and without a hearing impairment. *Perceptual and Motor Skills*, *119* (1), 123–132.

Taliep, S.M., St Clair, G.A., Gray, J., Van der Merwe, L., Vaughan, C.L., Noakes, T.D., Kellaway, L.A., John, L.R. (2008). Event-related potentials, reaction time, and response selection of skilled and less-skilled cricket batsmen. *Perception*, *37*, 96–105.

Thomson, K., Watt, A., Liukkonen, J. (2008). Skill-related differences between athletes and nonathletes in speed discrimination. *Perceptual and Motor Skills*, *107*, 893–900.

Uehara, L.A., Button, C., Davids, K. (2008). The effects of focus of attention instructions on novices learning soccer chip. *Brazilian Journal of Biomotricity*, 63–77.

Vansteenkiste, P., Vaeyens, R., Zeuwts, L., Philippaerts, R., Lenoir, M. (2014). Cue usage in volleyball: a time course comparison of elite, intermediate and novice female players. *Biology of Sport*, *31* (4), 295–302.

Warden, D.L., Bleiberg, J., Cameron, K.L., Ecklund, J., Walter, J., Sparling, M.B., Reeves, D., Reynolds, K.Y., Arciero, R. (2001). Persistent prolongation of simple reaction time in sports concussion. *Neurology*, *57*, 524–526.

Williams, A.M., Davids, K., Williams, J.G. (1999). *Visual perception and action in sport*. London: Taylor & Francis.

Wulf, G., McConnel, N., Gärtner, M., Schwarz, A. (2002). Enhancing the Learning of Sport Skills Through External-Focus Feedback. *Journal of Motor Behavior*, *34* (2), 171–182.

Zazryn, T.R., Finch, C.F., McCrory, P. (2003). A 16 year study of injuries to professional boxers in the state of Victoria, Australia. *Britain Journal of Sports Medicine*, *37*, 321–324.

Zhang, L., Heier, L.A., Zimmerman, R.D., Jordan, B., Ulug, A.M. (2006). Diffusion anisotropy changes in the brains of professional boxers. *American Journal of Neuroradiology*, *27* (9), 2000–2004.

Zwierko, T., Osiński, W., Lubiński, W., Czepita, D., Florkiewicz, B. (2010). Speed of Visual Sensorimotor Processes Conductivity of Visual Pathway in Volleyball Players. *Journal of Human Kinetics*, *23*, 21–27.

Zwierko, T., Florkiewicz, B., Fogtman, S., Kszak-Krzyżanowska, A. (2014). The ability to maintain attention during visuomotor task performance in handball players and non-athletes. *Central European Journal of Sport Sciences and Medicine*, *7* (3), 99–106.

Cite this article as: Lesiakowski, P., Krzepota, J., Zwierko, T. (2017). The Differentiation of Visual Sensorimotor Processes in the Representatives of Various Sport Disciplines. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 43–53. DOI: 10.18276/cej.2017.3-04.

UNDERREPRESENTATION OF WOMEN IN SPORTS ORGANIZATIONS. POLISH, BRITISH AND INTERNATIONAL ORGANIZATIONS – A COMPARATIVE ANALYSIS

Natalia Organista

Józef Piłsudski University of Physical Education, Department of Humanities and Social Sciences, Poland

Address for correspondence:
Natalia Organista
Józef Piłsudski University of Physical Education
Department of Humanities and Social Sciences
Marymoncka 34, 00-968 Warszawa, Poland
E-mail: Natalia.organista@gmail.com

Abstract From feminist and critical point of view sport has been a sexist institution. Despite the women empowerment in sport they are still trivialized and marginalized. Research also shows that sport organizations may be exceptionally opposed to women, valuing hegemonic masculinity. Therefore the aim of this article is to check whether gender inequalities occur in Polish sports organizations and what is the scale of those inequalities in comparison to international and British organizations. The study used methods of examining official documents (information generated by other empirical data from official documents of the organisation). The sample consists of 17 Polish, 17 international and 17 British sports organisations. The results of research showed that in Polish sports organisations there are working less women than in the international and British organisations, there are also less women in committees and women committees (if they have been established). More women work in organisations which represent women-orientated sports disciplines.

Key words sport organisations, gender, equality, Polish, British, international sport organisations

Introduction

Sport holds a significant position in the western culture. It is no longer seen as inoffensive pastime, and its political, economic and commercial dimension is increasingly noticed. The feminist and critical paradigm in sport studies also points to the fact that sport is a mechanism for the construction and reproduction of masculinity and femininity (Kay, 2003). It symbolically separates women from men and creates a hierarchy between genders, which is reproduced in other areas of social life (Messner, 1992). What is more, it is the area confirming the traditional masculine power and strength (Messner, Sabo, 1994). Sport reproduces hegemonic masculinity, which is the variant of masculinity most commonly occurring in sport. The concept of hegemony refers to dominance achieved by means of specific practices set in the social structure. Acknowledging that physicality is the fundamental source for interpreting femininity and masculinity, it should be stated that one of the social institutions where the role of

the body in maintaining gender relationships is most easily observed is actually sport. Strength, stamina or perfect training sustains the traditional view on masculinity. It is characterized by aggression, negation of pain and suffering, suppressing emotions and orientation to achieve established goals. It remains a certain ideal model reproduced through sport. In relation to other masculinities and femininities (Connell, 2001), hegemonic masculinity allows for the reproduction of the gender order. The feminist paradigm in sport studies shows that women's efforts in sport are compared to the male pattern, which hinders its autonomy and makes women's sports marginalized and trivialized (Hall, 2002).

Sport perceived as a masculine venture results in low employment of women in sports organizations. Sports organizations highly appreciate hegemonic masculinity as well as practices related to power and privileges resulting therefrom. Anderson thinks that sports organizations are a perfectly integrated, self-reinforcing system, which reproduces itself with no internal contradictions or conflicts (Anderson, 2009). Apart from the discussed problems related to perceiving sport as a man's business, there are other issues related to identification of the public sphere as belonging to men, linking the power as well as managerial (*think manager, think masculine*) or technical skills with masculinity (Powell, Butterfield, Parent, 2006). Gender stereotypes related to perceiving masculinity as objectivity, neutrality or firmness are responsible for the belief that men are better suited to perform professional duties. All these factors have led to identifying the problems behind gender inequality on the labor market such as: ghettoization, tokenism, glass ceiling, sticky floor, etc. At the same time, we have to bear in mind that structural factors related to organizational culture are responsible for the reproduction of these phenomena (Alvesson, Billing, 1997). Drawing attention to gender problems at work has led to the creation of a theory of gendered organizations (Acker, 1990, 1992).

Research on sports organizations has shown a number of barriers which women have to face when starting employment in sports organizations. As a reason for resigning from work in the organization women mention the following: struggles for power, lack of influence on organization functioning (Pfister, Radtke, 2009, 2006) plus working environment and formal processes related to employment and promotion. Without contacts, it is more difficult for women to gain recognition, and the so-called *old-boys network* does not perceive the small number of women employed at organizations as a problem (Skirstad, 2009; Knoppers, 2010). The structure of the organization and implemented practices affect the role and importance of women working there. As Australian studies show, women are delegated to administrative duties which have no impact on organizational changes, although they occupied the same positions as men who at that time were involved in defining the operational framework of a given institution (Sibson, 2010). The practices of gender inequalities occurring in sports organizations described above have also been defined by Claringbould and Knoppers (2012). They have distinguished the practices of gender neutrality, normalcy and passivity, which reinforce and sustain underrepresentation of women in sports organizations (Claringbould, Knoppers, 2012; Hoeber, 2007). The practices of gender neutrality in organizations make people deny masculine hegemony (e.g. belief that women and men have equal opportunities in the recruitment process). The "power" of practices of gender normalcy is based on believing that male dominance is "natural". These practices legitimize passivity in combating gender discrimination which may show itself in rejecting any type of affirmative activities.

Methods

Therefore, the purpose of the research is to find out if gender inequalities exist in sports organizations, and if they do, what the scale of this phenomenon is. The specific purpose is to analyze the staffing of basic positions (president, vice-president, chairperson and members of commissions and committees (composition of management boards, bureaus, committees and commissions) in domestic and international sports organizations in the gender perspective.

The sample is composed of 17 Polish, 17 British and 17 international sports organizations. Polish organizations have been selected for the analysis in order to verify compliance with the rules of gender equality in sport and to compare them with international organizations which supervise Polish organizations and also function as some kind of a "paradigm" for Polish sports organizations.

British organizations, with a much longer democratic tradition, have been selected to compare their observance of gender equality with Polish sports organizations. The number of organizations selected for the study has been dictated by the wish to analyze both the organizations representing team and individual sports, collision sports, contact and non-contact sports, and also such sports which are generally considered to be women's or men's sports. Selected organizations are the largest in given countries and also represent the most popular sport disciplines in a given cultural environment.

The selected organizations constitute a purposive sample. They include those representing both, sports considered to be women's sports (rhythmic gymnastics), men's sports (football, weightlifting, boxing), and those considered to be neutral (tennis, swimming, track and field). Due to the division of sports, which functions in the culture, into those perceived as women's or men's sports, an appropriate approach is to select a sample which will allow for collecting reliable empirical data, establishing the dependencies which are of interest, and consequently solving the formulated research problem (Babbie, 2009).

The composition of sports organizations may differ among organizations representing disciplines considered to be women's and men's disciplines. Despite the dynamics of women's entering the sports fields reserved for men, the division into typically women's and men's sports persists, which is reflected in the studies conducted in this field (Koivula, 2001). What is important, there are still few sports considered to be women's sports. There is a certain number of disciplines considered to be neutral, however the majority are associated with masculinity. The division into individual and team sports is also essential, since the latter are still treated as a bastion of masculinity. Due to their brutality and aggressiveness, collision sports (ice hockey or boxing) and contact sports (football, handball) are explicitly associated with masculinity (Messner, 1992, 1994). Due to the above statements, the sample was purposive to ensure obtaining of the data necessary to answer the formulated research question and solve the research problem.

The research was conducted between November 2013 and October 2014 based on the documents and statistics published by sports organizations on their websites or, as in the case of statutes of British organizations, included in the British court register.

With the aim to achieve the formulated research purpose, the analysis of secondary data, such as reports, statistics, compilations and other documents plus analysis of specialist texts have been found to be the most adequate and justified methods. Analysis of secondary data is a method frequently used in sociology, valued mainly for its non-reactivity. Considering that interactions of the researcher with the respondents, suggesting how to respond or imposing one's will constitute a frequent accusation of distorting the results, non-reactive methods are free from this defect (Babbie, 2009). As Earl Babbie writes "the existing statistics, then, can often provide

a historical or conceptual context within which to locate your original research" (Babbie, 2009, p. 370). The analysis of existing documents was not used in sociology for a long time despite the fact that existing data is an "extremely valuable scientific source" (Łuczewski, Bednarz-Łuczewska, 2012, p. 163). Currently, an increasing number of researchers focus not on generating new data, but on the analysis and interpretation of the data collected by others (Łuczewski, Bednarz-Łuczewska, 2012). This article makes use of formal documents, i.e. public documents (of sports organizations) as well as statistics and reports of non-governmental organizations, which monitor the work of sports associations: *Trophy Women? NGB Leadership Audit 2013*, *From Kumamoto to Sydney. Women and sport progress report 2006–2010.*

Results

Managerial positions in national and international sports organizations from the gender perspective

Subject literature frequently addresses the underrepresentation of women holding top positions in companies and barriers that prevent women from becoming promoted to managerial positions. As long as there are no women holding managerial positions, it will be difficult to change the stereotype that men are better predisposed to leadership. In terms of leadership, sports organizations seems to be more "accustomed" to men as managers due to the association between masculinity and sports.

The conducted analysis indicates that Polish sports organizations have very few women holding managerial positions (Table 1).

Table 1. Managerial positions in Polish sports organizations according to gender

Name of organization	Women holding the position of president or vice-president	Women holding the position of committee chairperson	Women holding the position of committee vice-chairperson	Women holding the position of women's sports committee chairperson
Polish sports organizations*				
PZPC	none	none	1	no committee
PZB	none	none	none	no committee
PZPS	none	none	none	no committee
PZKosz	none	none	none	no committee
PZLA	none	none	none	no committee
PZPN	none	1	none	none
POLSWIM	none	none	2	no committee
PZG	president	2	2	no committee
PZHL	none	none	none	1
ZPRP	none	none	none	no committee
PZZ	none	1	none	no committee
PZJ	vice-president	none	none	no committee
PZR	none	1	none	no committee
PZŻ	none	none	none	no committee
PZN	none	1	1	no committee
PZKol	none	none	none	no committee
PZT	none	no data	no data	no committee
Total managerial positions held	3	6	6	1

* PZB – Polish Boxing Association; PZG – Polish Gymnastics Association; PZHL – Polish Ice Hockey Association PZPN – Polish Football Association; PZJ – Polish Judo Association; PZKOSZ – Polish Basketball Association; PZN – Polish Ski Association; PZPC – Polish Weightlifting Association; PZPN – Polish Football Association; PZPS – Polish Volleyball Association; PZR – Polish Rugby Association; PZSWIM – Polish Swimming Association; PZT – Polish Tennis Association.

Women hold the position of vice-president in only two organizations, and only one organization has a woman as president, i.e., PZG (Polish Gymnastics Association). PZG is unique among Polish sports organizations in that, in addition to its president and vice-president being women, two women are committee chairpersons and two are committee vice-chairpersons. The high number of women holding managerial positions (as far as Poland is concerned) may stem from gymnastics being perceived as a women's sports discipline wherein the barriers to the presence of women in the structure of the organization are lower than in other disciplines. Apart from PZG, only one of the remaining 16 sports organizations employs a woman as the vice-president, four women are committee chairpersons, and four are committee vice-chairpersons. Among the two active women's sports committees, only one, in PZHL (Polish Ice Hockey Federation), is led by a woman. Furthermore, women do not hold managerial positions on the most important committees. Even though the Audit Committee Chairpersons in PZN (Polish Ski Federation) and PZR (Polish Rugby Federation) are women, women hold positions on committees that have little influence on the functioning of the organization. No woman leads a budget, financial, or statute committee. A woman is the Chairperson of the Chamber for Sports Dispute Resolutions in PZPN (Polish Football Association), and in PZZ (Polish Wrestling Association), a woman leads the Committee for Distinctions. In as many as eight organizations, no woman holds any managerial position.

International sports organizations employ more women as committee chairpersons and vice-chairpersons, though it should be noted that these organizations are structurally more developed. Nonetheless, six women hold the position of vice-presidents in these organizations (Table 2). A much greater number of women (17) compared to the six in Polish organizations leads committees. The same can be said for the position of vice-chairperson: in international organizations, 15 women are vice-chairpersons, compared to six in Poland. Eight of the analyzed international sports organizations have women's sports committees. In all of them, women are the chairpersons. This constitutes a key difference to Polish organizations, among which only PZHL employs a woman as the chairperson, while PZPN and the women's section of PZB (Polish Boxing Association) are led by men.

Table 2. Managerial positions in international sports organizations according to gender

name of organization	Women holding the position of president or vice-president	Women holding the position of committee chairperson	Women holding the position of committee vice-chairperson	Women holding the position of women's sports committee chairperson
1	2	3	4	5
International sports organizations				
IWF	none	none	none	yes
AIBA	none	1	none	yes
FIVB	2 executive vice-presidents	none	2	no committee
FIBA	none	none	1	no committee
IAAF	none	none	none	yes
FIFA	none	none	4	yes
FINA	none	4	none	no committee
FIG	vice-president	5	7	no committee
IIHF	none	2	none	yes
IHF	none	none	none	no committee
FILA	none	none	none	true
IJF	none	none	none	no committee
IRF	none	none	none	no committee
IASF	president, vice-president	2	2	true

1	2	3	4	5
FIS	none	1	none	no committee
UCI	vice-president	1	none	true
ITF	none	1	none	no committee
Total	6	17	15	8

Three organizations (IJF, IRF, and IHF) do not employ any woman as a committee chairperson, committee vice-chairperson, president, or vice-president. These organizations also lack a women's sports committee. Each of them represents contact disciplines regarded as typically masculine: judo, rugby, and volleyball. In another three organizations, i.e., IWF, IAAF, and FILA, women are the chairpersons only in women's sports committees. In short, in some organizations, e.g., FIG or ISAF, women hold managerial positions, which means that data on the gender-based division of leadership in the individual cells of an organization do not indicate a clear dominance of men, while other organizations do not notice the issue of the underrepresentation of women at all. FIG and ISAF employed a total of 20 women holding managerial positions out of 46 from among all 17 organizations, which translates to 43% of the total number of women leading the individual cells of the organizations.

Compared to their international counterparts, British organizations employ fewer women as their presidents. Only BVT and LTA are managed by women. The available data on committee chairpersons indicate that the position is held by women in only three organizations. A vast of majority of these positions (8) belong to BG, four belong to RYA, and two to LTA. This concerns the Technical Committee in BG and RYA and the Protection and Nominations Committee.

Table 3. Managerial positions in British sports organizations according to gender

Name of organization	Women holding the position of president or vice-president	Women holding the position of committee chairperson	Women holding the position of committee vice-chairperson	Women holding the position of women's sports committee chairperson	Women holding the position of performance director and development director*
1	2	3	4	5	6
British sports organizations					
BWL	none	no data	no data	None	2
ABAE	none	no data	no data	None	1
BVF	president	no data	no data	None	no data
BE	vice-president	no data	no data	no data	no data
UKA	none	no data	no data	no data	1
THEFA	none	none	none	True	0
BS	none	no data	no data	None	1
BG	none	8	none	None	0
BIH	none	no data	no data	no data	1
EH	none	no data	no data	no data	0
BWA	none	none	none	None	0
BJ	none	none	none	None	0
RFU	none	none	none	None	0
RYA	none	4	none	True	0
BSS	none	none	none	None	no data

1	2	3	4	5	6
BC	none	none	none	no data	0
LTA	president	2	none	None	0
Total	2	14	0	2	6

* Data in this column were obtained from the "Trophy Women?" NGB Leadership Audit 2013".

No woman held the position of a committee vice-chairperson in any of the analyzed organizations. The presented data indicate that women hold managerial positions mainly in those sports organizations that represent gender-neutral disciplines, rather than disciplines associated directly with masculinity. No women hold managerial positions in rugby, football, or wrestling associations. In two analyzed organizations, women are the chairpersons of women's sports committees. The "Trophy Women?" report also shows that few women hold the position of development directors or performance directors. In only five out of 14 analyzed organizations, women hold one of the two positions. Women hold both positions only in BWL.

Fundamental positions in Polish, international, and British state organizations

In addition to leadership in sports organizations and their primary organizational units, another important issue is positions held in collegiate bodies according to gender. The conducted analysis concerned the percentage share of positions held on Boards of Directors, executive committees, and other committees according to gender (Table 4).

Table 4. Percentage share of positions in boards of directors and committees of Polish, international, and British sports organizations held by women

Organization	Percentage share of positions in boards of directors and committees of Polish sports organizations held by women	Percentage share of positions in boards of directors and committees of international sports organizations held by women	Percentage share of positions in boards of directors and committees of British sports organizations held by women
Weightlifting	8	6	36*
Boxing	0	10	14*
Volleyball	2	9	50*
Basketball	0	17	20*
Athletics	4	23	26*
Football	5	6	6
Swimming	5	16	17*
Gymnastics	67	32	56
Ice hockey	9	14	38*
Handball	7	0	29*
Wrestling	6	9	11
Judo	13	7	15
Rugby	7	2	7
Yachting	12	24	17
Skiing	12	12	25
Cycling	8	24	5*
Tennis	31	24	30

Data marked with * in the column were obtained from the "Trophy Women? NGB Leadership Audit 2013".

In Polish sports organizations, not only do few women reach managerial positions, but few women are also members of the most important collegiate bodies. Women are members of executive committees in only three of the 17 organizations: PZG, PZJ (Polish Equestrian Federation), and PZT (Polish Tennis Association). The composition of the executive committee and the Board of Directors of PZG is notable, with both bodies having the same number of women and men. The percentage share of the executive committee of PZJ allows women to maintain a minimal threshold of recognizability. In contrast, only one woman was elected for the executive committee in PZT.

The Boards of Directors in Polish sports organizations also include few women, who are the members of only four of them. The Board for PZHL is notable for its equal share of men and women. However, it should be stated that the Board comprises only two persons. Ice hockey is regarded by society as a typically male discipline, as are boxing, weightlifting, and football, none of which have female representatives on the Boards of Directors of their respective sports organizations. PZHL has also established a women's sports committee, where the chairperson and most members are women. The situation is different in PZPN. On the women's football committee, women are in the minority, and the chairperson and vice-chairperson are men.

In 11 sports organizations, there are no female members of the Board of Directors or executive committees. Also, few women are the members of committees. Even though in PZG there are more women than men on committees and the Board of Directors (67% of total members), the corresponding percentage share in other organizations does not exceed 31%. The high percentage share of women employed at PZG may be related to the fact that gymnastics is considered a feminine discipline, especially artistic gymnastics, which has no male representation in Poland.

The conducted research indicates that the Boards of Directors and committees of two sports organizations, i.e., PZB and PZKosz (Polish Basketball Association) do not include any women. In as many as eight organizations, the percentage share of women does not exceed 10%. These organizations represent disciplines not only stereotypically associated with masculinity, such as football (5%), rugby (7%), ice hockey (9%), but also athletics (4%), volleyball (2%), and swimming (5%), i.e., disciplines in which women have participated for a long time, making their engagement (presumably) uncontroversial.

In international sports organizations, women hold more positions than in Polish ones. There are also more organizations that exceed the 25% share of women employed by the Boards of Directors and committees. In six organizations, however, there are no women on either the executive committee or the Board of Directors (AIBA, IHF, IJF, IRB, FIS, and ITF), and only four organizations have appointed a woman to the executive committee (UCI, ISAF, FIG, and FIVB). While as many as seven women are members of the executive committee of FIG, they constitute only 28% of the total number of its members. ISAF has appointed two women to the executive committee (20% share), and FIVB has appointed 2 women among a total of 17 members (12% share). As far as the Boards of Directors of international organizations are concerned, the most women are employed at FIG (7 women and 14 men). This provides women with a minimal threshold of recognizability of 33%. Six women are members of the Board of Directors for IAAF (along 15 men) and five are members of the Board of Directors for FIBA (along 13 men). However, apart from FIG, the percentage share of women employed in Boards of Directors does not exceed 30% in any organization.

Ten of the analyzed organizations either exceeded or (in the case of AIBA) attained exactly a 10% share of positions held by women on Boards of Directors, executive committees, and other committees. Six out of the ten organizations have women's sports committees, which is important because women are a majority there, which

makes them recognizable and allows them to form an important body. This can clearly be seen in the case of AIBA, where the women's boxing committee employs 13 women. Apart from these 13 women, only two women were appointed to the medical committee. As many as 57 women (out of a total of 112 positions) are members of the Women's Forum in ISAF, which greatly improves the percentage share positions held by women in the organization. A similar situation occurs in FIFA: out of 27 positions in the Committee for Women's Football, 16 are held by women. In the Women & Sport Commission of FILA, nine positions out of 19 are held by women.

Women hold the majority or half of available positions in few committees. Women hold the majority of positions in the Synchronized Swimming Committee of FINA (89%) and the Medical & TUE Commission of IJF. Women hold half of the positions in the Ethics Commission, Athletes Commission, and BMX Commission of UCI and in the Audit Committee of ISAF. Women hold positions primarily in women's sports, athlete, athlete rights, disciplinary, and social committees. Women do not hold positions in development, trainer, financial, legal, statutory, or technical committees.

Women hold more positions in key bodies of international sports organizations than of Polish sports organizations. This may be partially related to guaranteed positions for women in other bodies of the organizations. However, the presence of women is minimal in some organizations. In IRF, women hold only two positions in committees, and in IHF, there are no female members on any committees or the Board of Directors. Women hold fewer positions in organizations representing contact and collision sports. In addition to the aforementioned rugby and handball organizations, women also hold few positions in football, judo, and wrestling organizations. Compared to these organizations, the 14% share of positions held by women in IIHF appears to be a relatively good result. Among team disciplines, the largest percentage share of women was found in FIBA.

Compared their international counterparts, British sports organizations show a slightly higher share of positions held by women. In BVF, the share of women and men is equal. Women hold 40% of positions in UKA, 38% in BIH, 38% in BG, and 29% in EH. The share of positions held by women did not exceed 10% in two organizations, and three organizations (BC, BSS, and BWA) did not employ any women as members on their Boards of Directors. The state of affairs is completely different for the executive committees. Out of 14 organizations that publish data about their executive committees, only two, BG and RYA, employ women, with BG employing two, and RYA employing one. More women hold other managerial positions.

BG shows the largest share of positions held by women (56%), and is the only organization in which women hold more positions than men. In BVF, the share of women is 50% for all managerial positions. Other noteworthy organizations are BIH (38% of positions held by women) and BWL (36%). Women hold positions in key bodies of each organization, albeit their share is small in three cases: BC (5%), RFU (7%), and THEFA (6%). Only two out of 13 organizations had a women's sports committee. The women's sports committee in RYA comprised only women, while in THEFA, women were in the minority (41%).

A comparison between British, Polish, and international sports organizations first and foremost shows a consistent lack of women in executive committees. The share of positions held by women on the Boards of Directors of Polish organizations does not differ significantly from international and British sports organizations. However, the share of women is higher in British organizations for all managerial positions, albeit most British organizations do not have women's sport committees.

Conclusions

Compared to their international and British counterparts, Polish sports organizations employ the fewest women. Only in one organization, the Polish Gymnastics Association, there are more women employed than men. A woman is also the president of the association, women are chairpersons of two commissions and also in two they hold the position of vice-chairperson. This fact can be associated with the social identification of gymnastics as a women's sport. As to the remaining organizations, only in four of them women are members of the management board (PZHL, PZG, PZŻ, PZN), in three they are members of the management bureau (PZJ,PZG, PZŻ), only in four a woman is the chairperson of one commission (PZN PZZ, PZR, PZPN). In Polish associations, only two commissions for women's sports have been established (PZHL, PZPN). In the PZPN commission, men chair the commission and women do not have the majority. Women's sport commissions are usually the place where all issues related to women's sport can be put forward, where improvement strategies can be developed, and where the possibilities of influencing the management team in the field of organizational changes can be considered. The lack of it may be a significant hindrance for all those aiming to improve the situation of women in sports organizations and issues related to discrimination of women in sport. The lack of backup for such type of activities complicates work and shows lack of will of the people who take the decision to establish a commission.

In Poland, similar studies were conducted in 1998 (Pawlak, 1998). The data obtained also showed a significant underrepresentation of women in Polish sports organizations and associations. By analyzing sports organizations it was shown that only in 3.8% of women held the position of president, in 3.6% of vice-president, and only in 6.5% they were members of the management board. In total, women held 7.7% of all positions. The analysis of sports associations gave similar results, accordingly: 6.0% of women held the position of president, 5.1% of vice-president, and 6.9% were members of the management board. So, since 1998 the situation of women employed in sports organizations has not improved, they are still marginalized and the degree of their underrepresentation does not allow for having impact on the policy of the associations. Also Jakubowska analyzed polish sport organizations representing summer Olympic disciplines. Only 6% of women were members of board of directors (Jakubowska, 2014, pp. 332–336).

From the female perspective, the situation looks much better in international sports associations, although here the staffing in terms of gender is far from being balanced. However, compared to Polish sports organizations, women are more frequently chairpersons of commissions, in four organizations they are vice-presidents (FIVB, IASF, UCI, FIG). Women are definitely more often present in management boards – in 11 organizations, but only in four they are members of management bureaus. Eight organizations operate a women's sport commissions, in all of them women hold managerial positions and have the majority. Thus, we can see a trend to let women decide about the shape of changes related to women's sports. However, we need to mention ghettoization of women in an organization, dangerous from a women's perspective, which may consist in allowing them to work mainly in a women's sport commission, where they have substantial majority, but are hardly visible in other organization's bodies. A great number of women working in women's commissions, e.g. 57 in IASF, also contributes to a significant percentage increase in the number of positions filled by women in the organization.

Also in British sports organizations more women are "visible" compared to Polish sports organizations. Two organizations are led by women (BVF, LTA), in the majority of the organizations women are board members (only in three organizations there are no female board members). In the BVF management women hold 50% of positions, in BG 38%, similarly to BIH. In six organizations women are executive and development directors.

However, from the available data it turns out that women's sport commissions operate only in two organizations, and only in two women hold positions in management bureaus.

The *Trophy Women? NGB Leadership Audit 2013* report also points to underrepresentation of women in British sports associations; *Women's sport and Fitness Foundation* since 2009, presenting proportions of women holding positions in management boards of British sports organizations and managerial positions. In the years 2009–2013, 22% of women held positions in management boards of British sports organizations. The 2014 data shows an increase to 23% (*Trophy Women? NGB Leadership Audit 2014*). Although it is a positive trend, it needs to be stressed that Sport England imposed a duty on subordinate associations that by 2017 25% of positions in management boards are held by women. At the same time, the 2014 report shows that in 1/4 of the organizations surveyed the percentage of women holding positions in the management board decreased compared to 2013.

The analyzed data also shows that more women are employed by organizations which represent a sport discipline considered to be typically feminine. This can be seen in the example of gymnastics-supervising organizations, but also with regard to the disciplines not explicitly regarded as masculine, like e.g. sailing or tennis. Compared to other institutions, more women were employed at these organizations and more frequently they reached managerial positions. Undoubtedly, fewer positions were held by women in the disciplines which are stereotypically identified with masculinity, such as rugby, football, boxing or weight lifting, although in this case the situation would occasionally be nuanced. Some data, such as the number of positions held by women in the management board of BIH or EH, UCI-related data or a woman being member of the bureau of the management of the Polish Judo Association require restraint in the evaluation of a given discipline in terms of gender employment and handling the problem of gender inequality.

Monitoring the number of women working in various sports organizations and the course of their professional career show that the problem of women underrepresentation is seen and perceived as inappropriate. Based on the analysis of the collected Internet data regarding the percentage of women being board members in sports organizations worldwide in 2012, *Sydney Scoreboard* reports that only four countries have more than 30% of women in management boards (Norway, Sweden, Fiji, Cook Islands), and Poland can be found among the five countries with the lowest percentage of women in management boards (8.4%) (*From Kumamoto to Sydney* 2014).

This shows not only the point in monitoring the situation but also the amount of work to be done to change the present state of affairs. Failure to exploit women's potential may lead to worse functioning of organizations. As relevant literature shows, gender-differentiated work environment is more effective.

References

Acker, J. (1992). Gendering organizational theory. In: A. Mills, P. Tancred (eds.), *Gendering organizational analysis* (pp. 248-260). London: Sage.

Acker, J. (1990). Hierarchies, jobs, bodies. A Theory of gendered organizations. *Gender and Society*, *4* (2), 139–158. DOI: 10.1177/089124390004002002.

Alvesson, M., Billing, Y. (1997). *Understanding gender and organizations*. London: Sage.

Anderson, E. (2009). The maintenance of masculinity among the stakeholders of sport. *Sport Management Review*, *12* (1), 3–14. DOI: 10.1016/j.smr.2008.09.003.

Babbie, E. (2009). *Podstawy badań społecznych*, Warszawa: Wydawnictwo Naukowe PWN.

Connell, R. (2001). *Masculinities*. Cambridge: Polity Press.

Claringbould, I., Knoppers, A. (2012). Paradoxical practices of gender in sport-related organizations. *Journal of Sport Management*, *26* (5), 404–416.

From Kumamoto to Sydney. Women and sport progress report 2006-20010 (2014, January 10). Retrieved from: http:// sydneyscoreboard.com/conference/IWG_progress_report.pdf.

Hall, A. (2002). The discourse of gender and sport: from femininity to feminism. In: S. Scraton, A. Flintoff (eds.), *Sport and gender. A reader.* New York: Routledge.

Hoeber, L. (2007). Exploring the gaps between meanings and practices of gender equity in sport organization. *Gender, Work and Organization*, *14* (3): 259–280. DOI: 10.1111/j.1468-0432.2007.00342.

Jakubowska, H. (2014). *Gra ciałem. Praktyki i dyskursy różnicowania płci w sporcie*. Warszawa: Wydawnictwo Naukowe PWN.

Kay, T. (2003). Women, sport and gender inequality. In: B. Houlihan (ed.), *Sport and society. A student introduction* (pp. 130–155). London: Sage.

Koivula, N. (2001). Perceived characteristics of sports categorized as gender-neutral, feminine and masculine. *Journal of Sport Behavior*, *24* (4), 377–393.

Knoppers, A. (2010). Giving meaning to sport involvement in managerial work. *Gender, Work and Organization, 18* (1), 1–22, DOI: 10.1111/j.1468-0432.2009.00467.

Łuczewski, M., Łuczewska-Bednarz, P. (2012). Analiza dokumentów zastanych. In: D. Jemielniak (ed.), *Badania jakościowe. Metody i narzędzia* (vol. 2, pp. 163–185). Warszawa: Wydawnictwo Naukowe PWN.

McKay, J., Messner, M., Sabo, D. (2006). Studying sport, men and masculinities from feminist perspective. In: J. McKay, M. Messner, D. Sabo (eds.), *Masculinities, gender relations and sport* (pp. 1–12). London: Sage.

Messner, M. (1992). *Power at play: Sport and the problem of masculinity.* Boston: Beacon Press.

Messner, M., Sabo, D. (1994). *Sex, violence and power in sport: Rethinking masculinity.* Crossing Press.

Pfister, G., Radtke, S. (2006). Dropping out: Why male and female leaders in German sports federations break off their careers. *Sport Management Review*, *9*, 111–139.

Pfister, G., Radtke, S. (2009). Sport, women and leadership: results of a project on executives in German organizations. *European Journal of Sport Science*, *9* (4), 229–243.

Pawlak, A. (1998). Sprawozdanie z badań nt. Status polskiej manager-woman sportu. In: A. Pawlak (ed.), *Polska manager-woman sportu* (pp. 7–14). Warszawa, Kraków: Polskie Stowarzyszenie Sportu Kobiet.

Powell, G., Butterfield, A., Parent, J., (2000). Gender and managerial stereotypes: Have the times changed? In: M. Karsten (ed.). *Gender, race and ethnicity in the workplace. Issues and challenges for today's organizations* (vol. 2, pp. 143–163). Westport: Praeger Publishers.

Sartore, M., Cunningham, B. (2007). Explaining the under-representation of women in leadership positions of sport organization: a symbolic interactionist perspective. *Quest*, *59*, 244–265. DOI: 10.1080/00336297.2007.10483551.

Sibson, R. (2010). „I was banging my head against a brick wall": Exclusionary power and the gendering of sport organizations. *Journal of Sport Management*, *24* (4): 379–399.

Skirstad, B. (2009). Gender policy and organizational change: A contextual approach. *Sport Management Review*, *12*, 202–216.

Trophy Women? NGB Leadership Audit 2014 (2014). Retrieved from: http://www.wsff.org.uk/system/1/assets/files/000/001/640/1640/cf1acd74f/original/Trophy_Women_Report_2014_final.pdf (10.01.2014).

Trophy Women? NGB Leadership Audit 2013 (2014). Retrieved from: http://www.wsff.org.uk/system/1/assets/files/000/000/474/474/49193d130/original/Trophy_Women_2013.pdf (10.01.2014).

Cite this article as: Organista, N. (2017). Underrepresentation of Women in Sports Organizations. Polish, British and International Organizations – a Comparative Analysis. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 55–66. DOI: 10.18276/cej.2017.3-05.

EFFECT OF LONG-TERM GREEN TEA EXTRACT SUPPLEMENTATION ON PERIPHERAL BLOOD LEUKOCYTES IN CROSSFIT-TRAINED AND UNTRAINED MEN

Agata Żak,[1, B, E] Ilona Pokora[2, A, C, D, E]

[1] The Doctorial Studies, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland
[2] Department of Physiology, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland
[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation, [E] Funds Collection

Address for correspondence:
Ilona Pokora
The Jerzy Kukuczka Academy of Physical Education, Department of Physiology
Mikolowska 72a, 40-065 Katowice, Poland
E-mail: i.pokora@awf.katowice.pl

Abstract The aim of the study was to evaluate the effects of long-term green tea extract (GTE) supplementation on white blood cells (WBC) in CrossFit-trained and untrained men.
Twenty-eight men were recruited for this study including CrossFit-trained (CF-TR) and untrained (CF-UNT) men. The study was carried out in two phases. Phase 1 involved non-supplemented untrained and trained men. Phase 2 involved the same groups but after 6-week supplementation with 2 GTE capsules once daily. Body weight, body composition and the number and percentage of peripheral blood leukocyte populations were assessed in each phase. The results revealed that the long-term green tea supplementation did not have a significant effect on body weight, body composition and the total white blood cell count of the study participants. However, the percentage of peripheral blood eosinophils increased while monocyte and neutrophil counts decreased. The changes in white blood cells were less pronounced in CrossFit-trained compared to control participants. Summing up, it should be noted that long-term GTE supplementation in CrossFit-trained men did not result in significant changes in body weight and composition and the total white blood cell count. However, the changes in leukocyte subsets were less pronounced in CrossFit-trained compared to untrained participants.

Key words supplementation, green tea, leukocytes, physical training, CrossFit

Introduction

Leukocytes also referred to as white blood cells (WBC) are the mobile units of the body's protective system. Six types of white blood cells are normally found in the blood: (62%) neutrophils, (2.3%) eosinophils, (0.4%) basophils, (5.3%) monocytes and (30%) lymphocytes (Vattem, Maitin, 2016). Although leukocyte subpopulations differ in counts, all of them play a significant role in the immune defense. The granulocytes and monocytes protect the body against invading organisms, whereas the lymphocytes function mainly in connection with the immune system.

For the past 15 years a considerable amount of research has been carried out regarding the effect of polyphenols from unfermented green tea leaves on human health and functions of the immunology system (Mizolf, Szymusiak, Wiglo, Reitjers, Tyrakowska, 2008; Bayer, Jansen, Beltz, 2012). Green tea contains polyphenols of the flavanol and flavonoid groups, proanthocyanidins and phenolic acids, which make up to 30% of fresh leaf dry weight (McKay, Blumberg, 2002). The main green tea polyphenols are catechins including epicatechin (EC), epicatechin gallate (ECG), epigallocatechin (EGC) and epigallocatechin-3-gallate (EGCG). The latter has potent anti-inflammatory (Dona et al., 2003), antibacterial and antiproliferative (Osada et al., 2001; Saleh, Raghupathy, Asfar, Oteifa, Al-Saleh, 2014), antimutagenic and cytoprotective actions (Zhu et al., 2014). The primary targets of the anti-inflammatory compounds are the inhibition of inflammatory cell recruitment and proinflammatory mediator production. EGCG reduces neutrophil and monocyte migration through capillary membranes towards chemoattractants (Qin et al., 2011; Pae, Wu, 2013) and monocyte attachment to vascular endothelium (Ludwig et al., 2004; Takano, Tanaka, Aoi, Yahagi, Fushiya, 2004; Han, Toborek, Hennig, 2012). Catechins also inhibit proinflammatory cytokine production and decrease the activity of neutrophil elastase and ROS production. Through increasing a total plasma antioxidant capacity green tea catehins, may prevent cells from reactive oxygen species (ROS) damage (Benzie, Szeto, Strain, 1999; Yin, Tang, Su, 2008), however an increase in antioxidant activity was recorded with increase pH of the surrounding medium or tissues (Mizolf et al., 2008). Orally administrated EGCG and green tea extract block neutrophil-mediated angiogenesis *in vivo* in an inflammatory angiogenesis model (Dona et al., 2003).

Physical activity induces changes in leukocyte number and functions (Walsh et al., 2011; Orysiak, Witek, Żmijewski, Gajewski, 2012). The magnitude and directions of these changes depend on the duration, intensity and type of exercise (Hulmi et al., 2010). The total number of white blood cells, lymphocytes and neutrophils increase during exercise and decrease below resting values immediately after cessation of the exercise (Pyne, Gleeson, 1998; Horn, Pyne, Hopkins, Barnes, 2010). It is believed that postexercise lymphopenia and neutropenia may result from two parallel processes, i.e., increased migration of lymphocytes and neutrophils to surrounding tissues and enhanced apoptosis (Mooren et al., 2012). The effect of these processes on the relative and absolute postexercise WBC counts depends on concomitant hormonal changes, growth factors, blood oxidative status and adaptation to exercise. On the other hand, regular exercise and physical training cause a change in the immune functions and the mobility of leukocytes, depending on the training characteristics and fitness level (Natale et al., 2003; Mooren, Lechtermann, Völker, 2004; Gleeson, 2007).

CrossFit is a popular training modality which involves a variety of high-intensity functional movements within a “Grace”, “Cindy” or “Fran” workout of short duration (<30 min) but large volume (Kliszczewicz et al., 2015). It produces pronounced responses within the circulatory and endocrine systems; it also alters aerobic and anaerobic capacity and postexercise leukocyte counts in the peripheral blood (Pokora, Żak, Pokora, 2015).

Considering an important role of white blood cells in the body’s defense system against invading organisms, exercise-induced a temporary depression of various aspects of immune functions and the beneficial influence of green tea compounds on the immune system, the aim of the current study was to evaluate the effects of long-term green tea supplementation (GTE) on the total number of white blood cells and leukocyte subsets in CrossFit-trained and untrained men. To conduct this analysis, we used blood samples that we collected before and after 6-weeks GTE supplementation in CrossFit trained and untrained men. We hypothesized that compared with untrained men, GTE supplementation in CrossFit trained men may attenuate a reduction of leukocyte counts during training.

Methods

Twenty-eight men were recruited: a group of CrossFit-trained men (CF-TR) and a group of students of the Academy of Physical Education who regularly participated in mandatory physical exercise courses but not CrossFit training (CF-UNT). The subjects were informed of the aims and methods of the study and gave written consent to participate; they were also informed about the right to withdraw consent to participate at any time without giving reasons. The research project was approved by the Bioethics Committee of the Jerzy Kukuczka Academy of Physical Education in Katowice.

Prior to the study body weight and composition were measured using a body composition analyzer an with an 8-point tactile electrode system (InBody 220, Biospace, Korea) and a gas analyser (MetaLyzer 3B-2R, Cortex, Germany) was used to determine level of physical fitness (maximal oxygen uptake; VO_{2max}). VO_2max was determined in both study groups during a graded intensity exercise test performed until exhaustion (GXT); (Howley, Bassett, Welch, 1995).

A proper study was carried out in two phases. Phase 1 involved non-supplemented untrained and trained men. Phase 2 involved the same groups but after 6-week supplementation with GTE. Once daily (during a 6-week supplementation period), each participant ingested two 250 mg capsules of OLIMP Green Tea Extract (55% EGCG), a dose equivalent to 275 mg EGCG, 498 mg polyphenols and 400 mg catechins were administrated orally. During a 6-week supplementation period the participants attended CrossFit training sessions or regular exercise courses at the Academy of Physical Education.

Prior to and after GTE supplementation blood samples were collected in each group. The fasting blood samples were collected from an antecubital vein. One milliliter of blood sample was immediately transferred into a special container containing anticoagulant (heparin, 75 U/ml) for WBC count. The Sysmex-2100 Automated Hematology System (Roche, Poland) was used to determine: white blood cell count and the leukocyte subsets: neutrophil, lymphocyte, monocyte, eosinophil and basophil counts in the taken blood samples.

Statistical analysis was performed using the STATISTICA 10.0 (StatSoft, Poland). Before statistical analysis, all data were checked to determine if they were normally distributed. Normally distributed blood data were analysed using one way repeated-measures ANOVA to calculate the main effects of time (supplementation) and time x trial interaction. When a significant main effect was evident ($p < 0.05$), post hoc Tukey's tests were used to compare changes over time and differences between the trials. Normally distributed data are presented as mean ± SD. Data that were not normally distributed (eosinophile cell counts) were analysed using U test followed by Wilcoxon's signed-ranked tests to compare changes over time and differences between the trials. Non normally distributed data are presented as median ± interquartile range. The Student's t test (independent samples) was used to verify differences between the subject's characteristics.

Results

The anthropometric characteristics and VO_2max of both study groups are presented in Table 1.

No statistically significant differences were revealed with respect to body weight and composition between CrossFit-trained men and non-trained students. However, the two groups differed significantly regarding the maximal oxygen uptake (Table 1).

Table 1. Characteristics of the study participants

	CF-TR group	*Differences*	CF-UNT group
N =	20		9
Age (years)	24.17 ±2.53		24.14 ±1.06
BH (cm)	180.25 ±5.31		180.57 ±4.03
BW (kg)	80.25 ±7.68		77.5 ±3.56
%BF	14.27 ±4.01		11.7 ±2.91
VO_2max ($L \cdot min^{-1}$)	3.55 ±0.55	*	4.28 ±0.36
VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$)	44.41 ±5.24	**	55.48 ±6.09

The data are presented as means and standard deviations (±SD); body height –BH; body weight –BW; body fat percentage – %BF; maximal oxygen uptake VO_2max; * $p < 0.05$; ** $p < 0.01$.

Resting leukocyte, neutrophil, lymphocyte, monocyte, eosinophil and basophil counts were within normal, physiological ranges (Table 2, Figures 1 and 2) and did not differ significantly between the groups before and after GTE supplementation. However, the total white blood cell count as well as neutrophil and monocyte counts were reduced while the number of eosinophils increased after GTE administration in both study groups.

Table 2. CrossFit-trained men (CF-TR) – changes in the number and percentage of particular leukocyte populations expressed as absolute (x 10^9/L) and percentage values before and after GTE supplementation (* $p < 0.05$)

	Neutrophils [x 10^9/ L]	Lymphocytes [x 10^9/ L]	Monocytes [x 10^9/ L]	Eosinophils [x 10^9/ L]	Basophils [x 10^9/ L]
PRE suppl	3.31 ±1.19	2.18 ±0.54	0.66 ±0.18	0.1 <0.07–0.3>	0.03 ±0.02
AFTER suppl	3.14 ±1.95	2.22 ±0.31	0.63 ±0.07	0.12 <0.08–0.3>	0.03 ±0.01
Δ [%]	–5.45	1.80	–5.70	+20.0*	
	Neutrophils [%]	Lymphocytes [%]	Monocytes [%]	Eosinophils [%]	Basophils [%]
PRE suppl	50.66 ±8.18	35.42 ±7.29	10.71 ±2.5	1.17 <1.1–3.7>	0.48 ±0.22
AFTER suppl	49.78 ±9.48	36.46 ±7.77	10.27 ±3.32	2.2 <1.5–3.6>	0.44 ±0.14
Δ [%]	–1.76	2.85	–4.27	+29.0*	–8.86

Normally distributed data are presented as mean ± SD; non normally distributed data (eosinophils) are presented as median < > interquartile range.

Table 3. Untrained participants (CF-UNT) – changes in the number and percentage of particular leukocyte populations expressed as absolute (x 10^9/L) and percentage values before and after GTE supplementation (* $p < 0.05$)

	Neutrophils [x 10^9/ L]	Lymphocytes [x 10^9/ L]	Monocytes [x 10^9/ L]	Eosinophils [x 10^9/ L]	Basophils [x 10^9/ L]
PRE suppl	3.21 ±2.04	2.04 ±0.56	0.58 ±0.22	0.13 <0.07–0.2>	0.03 ±0.016
AFTER suppl	2.79 ±0.56	1.96 ±0.45	0.49 ±0.11	0.17 <0.12–0.3>	0.024 ±0.013
Δ [%]	–15.05	-4.08	-18.37	+31.0*	–25.0
	Neutrophils [%]	Lymphocytes [%]	Monocytes [%]	Eosinophils [%]	Basophils [%]
PRE suppl	51.20 ±9.18	35.78 ±8.29	9.82 ±2.26	2.15 <1.3–3.9>	0.51 ±0.35
AFTER suppl	51.16 ±3.73	35.61 ±3.21	8.94 ±1.96	2.97 <2.1–5.7>	0.50 ±0.33
Δ [%]	–0.08	–0.47	–9.84	+38.0*	–2.0

Normally distributed data are presented as mean ± SD; non normally distributed data (eosinophils) are presented as median < > interquartile range.

Six-week GTE supplementation resulted in a statistically significant increase in the absolute eosinophil count in the CF-TR group and an increase in the percentage of eosinophils in the CF-TR and CF-UNT groups (Tables 2 and 3) (Figure 3); however, neither group exhibited eosinophilia (>0.600 x 10^9/L). GTE supplementation caused a decrease in absolute monocyte count and percent monocytes in both study groups (Figure 2).

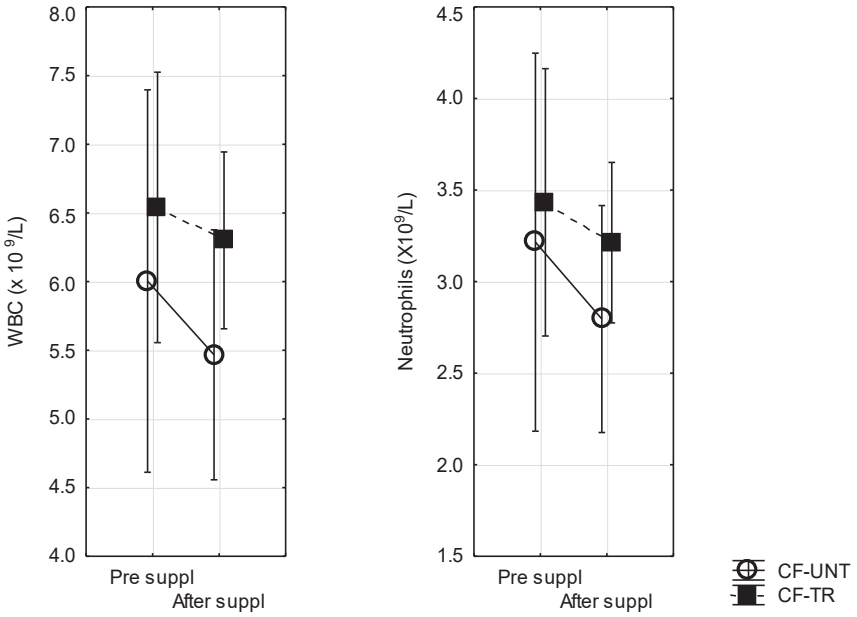


Figure 1. Total white blood cell count and neutrophil count at rest in CrossFit-trained and untrained participants before and after 6-week supplementation with GTE, * $p < 0.05$

The change in leukocyte cell counts in response to GTE supplementation was significantly more pronounced in untrained men as evidenced by a larger decrease in absolute monocyte count and a greater increase in absolute eosinophil count and percent eosinophils (Tables 2 and 3).

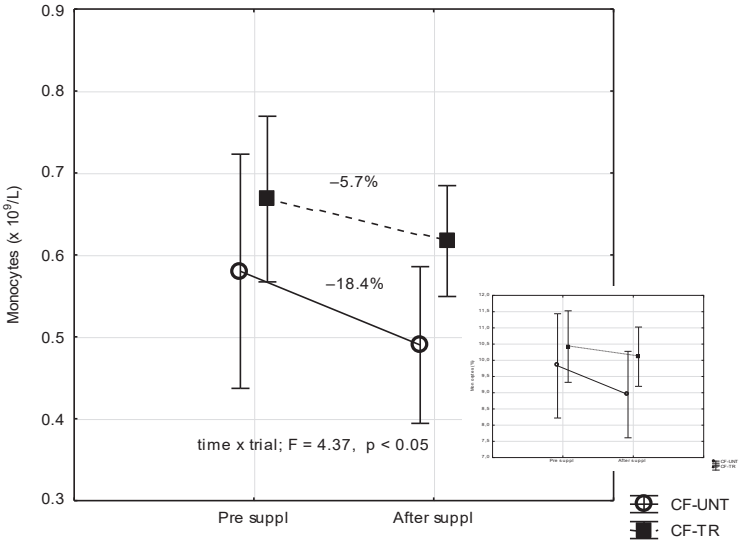


Figure 2. Absolute monocyte count and percent monocytes at rest in untrained (CF-UNT) and CrossFit-trained (CF-TR) men before and after GTE supplementation (* $p < 0.05$)

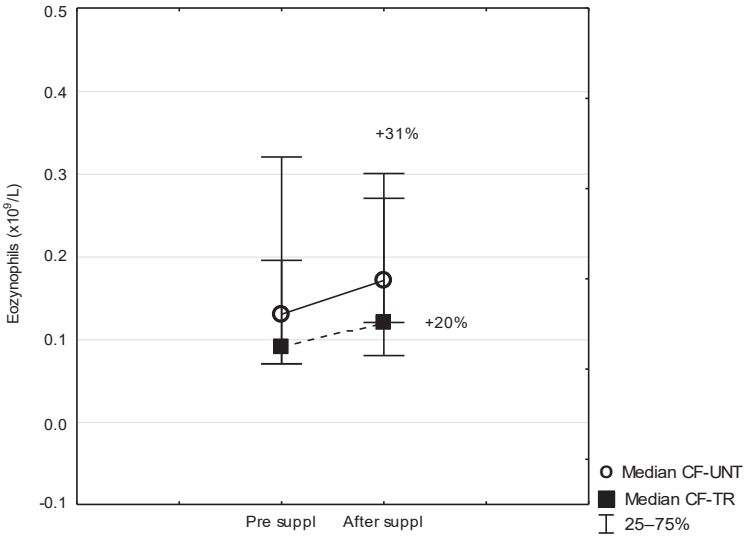


Figure 3. Absolute eosinophil count and percent eosinophils at rest in untrained (CF-UNT) and CrossFit-trained (TR) men before and after GTE supplementation (* $p < 0.05$). Data presented as median and interquartile range

Discussion

The results of our study revealed that 6 weeks of GTE supplements did not have a significant effect on body weight and body composition of CrossFit-trained and control participants although both groups did differed significantly with respect to VO_2max.

The major finding in this study was that, 6-week GTE supplementation did not influenced on the total WBC number but it had impact on the number and percentage of white blood cell subpopulations in the peripheral blood. Neutrophil and monocyte counts were reduced while the number of eosinophils increased significantly in both study groups. The impact of GTE on the WBC number as well as the percentage of white blood cell subpopulations was more visible in men with higher VO_2max.

Physical activity is typically associated with changes in the concentrations of inflammatory markers, numbers of circulating lymphocytes (Kruger, Mooren, 2014) and the reactivity thereof to exogenous stimuli. Moderately active individuals frequently exhibit a 10% lower number of WBC compared to sedentary people. Michishita, Shono, Inoue, Tsuruta, Node (2010), found that monocyte and neutrophil counts were correlated with maximal oxygen uptake (VO_2max). They also found significant correlations between cardiorespiratory fitness and total leukocyte, monocyte and neutrophil numbers and observed that the numbers were higher in women with low VO_2max compared to those with higher levels of physical fitness. Similar results were reported by Metrikat, Albrecht, Maya-Pelzer, Ortlepp (2009), who analysed the relationships between the concentrations of inflammatory markers and physical fitness in over 10,000 young men. They found that leukocyte numbers were inversely proportional to physical fitness level, i.e., higher level of physical fitness was associated with lower WBC. However, leukocyte reactivity to proapoptotic factors was lower (Kruger, Mooren, 2014).

A decrease in WBC number contributes to susceptibility to infections. In this study GTE supplementation did not have a significant effect on total leukocyte number of our study participants although CrossFit-trained men had higher white blood cell counts compared to untrained participants. Both study groups were in the second quartile (5.8–6.8 $x10^9$/l) of the WBC reference range for adult males (according to laboratory reference range values).

The 6-week GTE supplementation had an impact on the number and percentage of white blood cell subpopulations. Literature reports indicate that the effect of GTE on the immune system depends on the dose and can either suppress or enhance peripheral blood mononuclear cell proliferation (Qin et al., 2011), (Kim, Quon, Kim, 2014). The effectiveness of GTE supplementation may be related to individual characteristics, age, gender or physical fitness level. Evidence exists that green tea poliphenols may have an antioxidative or pro-oxidative potential. Green tea extract and EGCG exert the pro-oxidative effect in subjects with low baseline oxidative stress, whereas green tea poliphenols may be scavenging ROS in subjects with high baseline oxidative stress. According to Forester and Lambert suggestion, with moderate and low concentrations EGCG, low level oxidative stress may be a beneficial cue for the body to initiate induction of protective anti-oxidant systems and host immune responses (Lambert, Elias, 2010), (Forester, Lambert, 2011). Thus under same (exercise, training) conditions with increased oxidative stress, supplementation of green tea polyphenols may attenuated ROS mediated tissue damage. In addition, EGCG inhibits proinflammatory cytokine and chemokine expression (Dona et al., 2003), decreases the expression of integrins and chemokines (monocyte chemoattractant protein-1) (Majkova, Smart, Toborek, Hennig, 2009), vascular cell adhesion proteins, (Ludwig et al., 2004), (Han et al., 2012), helps lower adhesion and migration of mast cells and reduces monocyte recruitment (Hofbauer et al., 1999). EGCG-mediated inhibition of chemokine

production and chemokine interactions with their receptors on white blood cell surface may alter the range and magnitude of the inflammatory response including white blood cell count and pattern (Forester, Lambert, 2011).

Our findings showed that 6-week GTE supplementation resulted in a significant increase in the absolute eosinophil count as well as eosinophil percentage in both study groups. An increase in eosinophil count in healthy individuals may be induced by non-allergic mechanisms (Jacobsen, Helmers, Lee, Lee, 2012) and a variety of agents (including EGCG) that interrupt eosinophil adhesion to the vascular endothelium (Blanchard, Rottenberg, 2008). Considering the fact that EGCG decreases VCAM-1 expression, it might be speculated that post-supplementation increase in eosinophil count was associated with changes in interaction and enhanced eosinophil recruitment from the marginal to the circulating pool.

Jacobsen et al. (2012) demonstrated that eosinophils were important regulators of local immunity and remodeling/repair (see below) and might play a role in maintaining metabolic homeostasis. Remodeling and repair are associated with physical training-related changes in cell structure and function; the processes may also be induced by thermogenic supplements enhancing adipose tissue metabolism (Mraz, Haluzik, 2014; Sadowska--Krępa, Pokora, Podgórski, Obara, Domaszewski, 2015; Pokora, Sadowska-Krępa, Żak, Domaszewski, 2016). The results of clinical and animal studies indicate a potential role of eosinophils in maintaining metabolic homeostasis and activation of adipose tissue macrophages (Kim, Plutzky, 2016). Although we observed a significant GTE supplementation-related increase in eosinophil count, the absolute number of this blood cell subpopulation was within standard reference ranges (0.100–0.600 $x10^9$/l) and did not exceed a count of over 0.600 $x10^9$/l, which is generally considered eosinophilia in adults.

Summing up, it should be noted that long-term GTE supplementation in CrossFit-trained men did not result in significant changes in body weight and composition and the total white blood cell count. However, the percentage of peripheral blood eosinophils increased while monocyte and neutrophil counts decreased. The changes in white blood cells were less pronounced in CrossFit-trained compared to control participants.

References

Bayer, D., Jansen, J., Beltz, L. (2012). Differential effects of tea extracts on growth and cytokine production by normal and leukemic human leukocytes. *Functional Foods in Health and Disease*, *2* (4), 72–85.

Benzie, I., Szeto, Y., Strain, J. (1999). Consumption of green tea causes rapid increase in plasma antioxidant power in humans. *Nutr Cancer*, *34*, 83–7. DOI: 10.1207/S15327914NC340112.

Blanchard, C., Rothenberg, M. (2009). Biology of the eosinophil. *Adv Immunol*, *101*, 81–121. DOI: 10.1016/S0065-2776(08)01003-1.

Dona, M., Dell'Aica, I., Calabrese, F., Benelli, R., Morini, M., Albini, A., Garbisa, S. (2003). Neutrophil restraint by green tea: inhibition of inflammation, associated angiogenesis, and pulmonary fibrosis. *J Immunol*, *170*, 4335–4341.

Forester, S., Lambert, J. (2011). Antioxidant effects of green tea. *Mol Nutr Food Res*, *55* (6), 844–854. DOI: 10.1002/mnfr.201000641.

Gleeson, M. (2007). Immune function in sport and exercise. *J Appl Physiol*, *103*, 693–699. DOI: 10.1152/japplphysiol.00008.2007.

Han, S., Toborek, M., Hennig, B. (2012). EGCG protects endothelial cells against PCB 126-induced inflammation through inhibition of AhR and induction of Nrf2-regulated genes. *Toxicol Appl Pharmacol*, *261* (2), 181–188. DOI: 10.1016/j.taap.2012.03.024.

Hofbauer, R., Frass, M., Gmeiner, B., Handler, S., Speiser, W., Kapiotis, S. (1999). The green tea extract epigallocatechin gallate is able to reduce neutrophil transmigration through monolayers of endothelial cells. *Wien Klin Wochenschr*, *111*, 278–282.

Horn, P., Pyne, D., Hopkins, W., Barnes, C. (2010). Lower white blood cell counts in elite athletes training for highly aerobic sports. *Eur J Appl Physiol*, *110*, 925–932. DOI: 10.1007/s00421-010-1573-9.

Howley, E.T., Bassett, D.R., Welch, H.G. (1995). Criteria for maximal oxygen uptake: review and commentary. *Med Sci Sports Exerc*, *27* (9), 1292–1301.

Hulmi, J., Myllymäki, T., Tenhumäki, M., Mutanen, N., Puurtinen, R., Paulsen, G., Mero, A. (2010). Effects of resistance exercise and protein ingestion on blood leukocytes and platelets in young and older men. *Eur J Appl Physiol*, *109* (2), 343–353. DOI: 10.1007/s00421-010-1360-7.

Jacobsen, E.A., Helmers, R.A., Lee, J.J., Lee, N.A. (2012). The expanding role(s) of eosinophils in health and disease. *BLOOD*, *120* (19), 3882–3890. DOI: 10.1182/blood-2012-06-330845.

Kim, S.H., Plutzky, J. (2016). Brown fat and browning for the treatment of obesity and related metabolic disorders. *Diabetes Metab J*, *40*, 12–21. DOI: 10.4093/dmj.2016.40.1.12.

Kim, S.H., Quon, M.J., Kim, J.A. (2014). New insights into the mechanisms of polyphenols beyond antioxidant properties; lessons from the green tea polyphenol, epigallocatechin 3-gallate. *Redox Biology, 2* (1), 187–195. DOI: 10.1016/j.redox.2013.12.022.

Kliszczewicz, B., Quindry, C.J., Blessing, L.D., Oliver, D.G., Esco, R.M., Taylor, J.K. (2015). Acute Exercise and Oxidative Stress: CrossFit(™) vs. Treadmill Bout. *J Hum Kinet*, *47*, 81–90. DOI: 10.1515/hukin-2015-0064.

Krüger, K., Mooren, F.C. (2014). Exercise-induced leukocyte apoptosis. *Exerc Immunol Rev*, *20*, 117–134.

Lambert, J., Elias, R. (2010). The antioxidant and pro-oxidant activities of green tea polyphenols: a role in cancer prevention. *Arch Biochem Biophys*, *501* (1), 65–72. DOI: 10.1016/j.abb.2010.06.013.

Ludwig, A., Lorenz, M., Grimbo, N., Steinle, F., Meiners, S., Bartsch, C., Stangl, K., Baumann, G., Stangl, V. (2004). The tea flavonoid epigallocatechin-3-gallate reduces cytokine-induced VCAM-1 expression and monocyte adhesion to endothelial cells. *Biochem Biophys Res Commun*, *316*, 659–665. DOI: 10.1016/j.bbrc.2004.02.099.

Majkova, Z., Smart, E., Toborek, M., Hennig, B. (2009). Up-regulation of endothelial monocyte chemoattractant protein-1 by coplanar PCB77 is caveolin-1-dependent. *Toxicol Appl Pharmacol*, *237*, 1–7. DOI: 10.1016/j.taap.2009.02.016.

McKay, D., Blumberg, J. (2002). The role of tea in human health: An update. *J Am Cool Nutr*, *21*, 1–13.

Mraz, M., Haluzik, M. (2014). The role of adipose tissue immune cells in obesity and low-grade inflammation. *J Edocrinol*, *222* (3), R113–R127. DOI: 10.1530/JOE-14-0283.

Metrikat, J., Albrecht, M., Maya-Pelzer, P., Ortlepp, J.R. (2009). Physical fitness is associated with lower inflammation, even in individuals with high cholesterol – An alternative to statin therapy? *CVD Prevention and Control*, *4* (3), 149–156. DOI: http://dx.doi.org/10.1016/j.cvdpc.2009.05.001.

Michishita, R., Shono, N., Inoue, T., Tsuruta, T., Node, K. (2010). Effect of exercise therapy on monocyte and neutrophil counts in overweight women. *Am J Med Sci*, *339*, 152–156. DOI: 10.1097/MAJ.0b013e3181c6a980.

Mizolf, M., Szymusiak, H., Wiglo, A., Reitjers, I., Tyrakowska, B. (2008). pH-Dependent Radical Scavenging Capacity of Green Tea Catechins. *J Agric Food Chem*, *56*, 816–823.

Mooren, F.C., Lechtermann, A., Völker, K. (2004). Exercise-induced apoptosis of lymphocytes depends on training status. *Med Sci Sports Exerc*, *36* (9), 1476–1483.

Mooren, F.C., Völker, K., Klocke, R., Niko, I.S., Waltenberger, J., Krüger, K. (2012). Exercise delays neutrophil apoptosis by a G-CSF-dependent mechanism. *J Appl Physiol*, *113* (7), 1082–1090.

Natale, V.M., Brenner, I.K., Maldoveanu, A.I., Vasiliou, P., Sheik, P., Shephard, R.J. (2003). Effects of three different types of exercise on blood leukocyte count during and following exercise. *Sao Paulo Med J/Rev Poul Med*, *121* (1), 9–14.

Orysiak, J., Witek, K., Żmijewski, P., Gajewski, J. (2012). White Blood Cells in Polish Athletes of Various Sports Disciplines. *Biol. Sport*, *29*, 101–105. DOI: 10.5604/20831862.988883.

Osada, K., Takahashi, M., Hoshina, S., Nakamura, M., Nakamura, S., Sugano, M. (2001). Tea catechins inhibit cholesterol oxidation accompanying oxidation of low density lipoprotein in vitro. *Comp Biochem Physiol C Toxicol Pharmacol*, *128*, 153–64.

Pae, M., Wu, D. (2013). Immunomodulating effects of epigallocatechin-3-gallate from green tea: mechanisms and applications. *Food Funct*, *4* (9), 1287–1303. DOI: 10.1039/c3fo60076a.

Pokora, I., Żak, A., Pokora, P. (2015). Effect of exercise-induced physiological strain on blood cortisol level and peripheral blood leukocytes in trained and untrained men. *Scientific Review of Physical Culture*, *5* (4), 118–124.

Pokora, I., Sadowska-Krępa, E., Żak, A., Domaszewski, P. (2016). Wpływ suplementacji wyciągiem z zielonej herbaty na odpowiedź metaboliczną i termogenną podczas wysiłku fizycznego u trenujących mężczyzn. *Probl Hig Epidemiol*, *97* (1), 81–86.

Pyne, D.B., Gleeson, M. (1998). Effects of intensive exercise training in immunity in athletes. *Int J Sports Med*, *19*, S183–S194. DOI: 10.1055/s-2007-971991.

Qin, S., Alcorn, J.F., Craigo, J.K., Tjoeng, Ch., Tarwater, P.M., Kolls, J.K., Reinhart, J.A. (2011). Epigallocatechin-3-Gallate Reduces Airway Inflammation in Mice through Binding to Proinflammatory Chemokines and Inhibiting Inflammatory Cell Recruitment. *J Immunol*, *186*, 3693–3700. DOI: 10.4049/jimmunol.1002876.

Sadowska-Krępa, E., Pokora, I., Podgórski, T., Obara, P., Domaszewski, P. (2015). Wpływ suplementacji ekstraktem z zielonej herbaty na profil lipidowy krwi w warunkach spoczynkowych i powysiłkowych. *Probl Hig Epidemiol*, *96* (3), 671–676.

Saleh, F., Raghupathy, R., Asfar, S., Oteifa, M., Al-Saleh, N. (2014). Analysis of the effect of the active compound of green tea (EGCG) on the proliferation of peripheral blood mononuclear cells. *BMC Complement Altern Med*, *30* (14), 322. DOI: 10.1186/1472-6882-14-322.

Takano, F., Tanaka, T., Aoi, J., Yahagi, N., Fushiya, S. (2004). Protective effect of (+)-catechin against 5-fluorouracil-induced myelosuppression in mice. *Toxicology*, *201* (1–3), 133–142. DOI: 10.1016/j.tox.2004.04.009.

Vattem, D.A., Maitin, V. (2016). *Functional Foods, Nutraceuticals and Natural Products: Concepts and Applications*. Lancaster: DES*tech* Publications Inc.

Walsh, N., Gleeson, M., Shephard, R.J., Gleeson, M., Woods, J.A., Bishop, N.C., Fleshner, M., Green, C., Pedersen, B.K., Hoffman--Goetz, L., Rogers, C.J., Northoff, H., Abbas, I.A., Simon, P. (2011). Position statement. Part one: Immune function and exercise. *Exerc Immunol Rev*, *17*, 6–63.

Yin, S.T., Tang, M.L., Su, L. (2008). Effects of Epigallocatechin- 3-gallate on lead-induced oxidative damage. *Toxicology*, *249*, 45–54. DOI: 10.1016/j.tox.2008.04.006.

Zhu, W., Xu, J., Ge, Y., Cao, H., Ge, X., Luo, J., Xue, J., Yang, H., Zhang, S., Cao, J. (2014). Epigallocatechin-3-gallate (EGCG) protects skin cells from ionizing radiation via heme oxygenase-1 (HO-1) overexpression. *J Radiat Res*, *55* (6), 1056–1065. DOI: 10.1093/jrr/rru047.

Cite this article as: Żak, A., Pokora, I. (2017). Effect of Long-Term Green Tea Extract Supplementation on Peripheral Blood Leukocytes in CrossFit-Trained and Untrained Men. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 67–76. DOI: 10.18276/cej.2017.3-06.

TREND OF DRUG ABUSE IN 2011–2014 IN ITALY

Alessia Sacco,[A, D] Alessandra Macchiarella,[A, D] Alessandra Amato,[A, D]
Daniele La Commare,[B] Valentina Contrò,[A, D] Patrizia Proia[A, B, C, D, E]

Department of Psychological, Pedagogical and Educational Sciences, University of Palermo, Italy
[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation, [E] Funds Collection

Address for correspondence:
Patrizia Proia
Department of Psychological, Pedagogical and Educational Sciences, University of Palermo
Viale delle Scienze, Ed. 15
90128 Palermo (PA), Italy
E-mail: patrizia.proia@unipa.it

Abstract Doping, although was born as a medication and not with the purpose of enhancing performance, is a widespread practice in all sports, between amateur and gym-goers. The Italian sports federations were in second place worldwide for positive doping-test, after Russia.

This review focuses on the analysis of data collected by Italian National Olympic Committee (CONI) in the 2012–2014 period, showing that the most commonly used substances were anabolic androgenic agents, glucocorticoids, diuretics and stimulants.

Prevention in doping could be a key to limit the damage caused by this harmful practice both, for the physical health and the athlete's moral integrity and anti-doping campaigns should be direct as much as possible to young people, since about two-thirds of adolescents appear to be dissatisfied with their body. Even coordination between the various professionals that surround athletes could help fight doping by planning specific training and adapted to the individual athlete, taking into account the actual physical limitations and physical features of each.

Key words drug abuse, physical health, AAS, glucocorticoids, diuretics, stimolants

Introduction

Doping, that is the uncontrolled intake of drugs or other substances in order to improve sports performance, is a widespread practice in all sports, not just among competitive athletes but also between amateur and gym-goers. It should be stressed that most of the doping agents are born as medications and not with the purpose of enhancing performance.

In Italy doping is rife, so much that in 2014 the Italian sports federations were in second place worldwide for positive doping-test, after Russia. Some people, however, argue that the finding of such a high number of positives is a direct result of marked controls than other countries of the world.

CONI, Italian National Olympic Committee, is a public institution that controls the associations in professional categories and annually publishes a statistical anti-doping report, normally detected by biological analyzes conducted

on samples of blood or urine, collected during or outside the competition. The analyzed sports federations are about 62, including the Italian Paralympic Committee.

Our report focuses on the analysis of data collected by CONI in the 2012–2014 period by which it was possible to analyze the Italian athletes' behaviour in relation to the use of prohibited substances in the WADA's list. Analyzing the data reported by anti-doping statistical report, it comes out that most of the Italian athletes' doping tests were negative. This trend is a good result because it means that, compared to the past, both athletes and athletic trainers have understood more consciously the risks for health derived from the use of these substances. Despite these encouraging data, we must not underestimate the presence of athletes who take doping substances. Although the percentage is small, an average of 2% of athletes subjected to the test was positive (Figure 1).

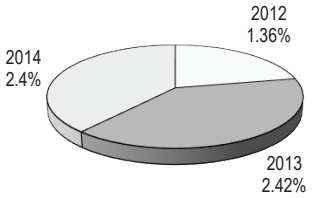


Figure 1. The percentage of positive samples for anti-doping tests

CONI data for the 2012–2014 period

This study focuses on data collected in 2012–2014 to clarify the progress of unhealthy habits among Italian athletes.

Who determines which products are prohibited is the world anti-doping agency (WADA), an international independent agency founded in 1999, which annually draws up a list containing all the performance-enhancing drugs and has developed an anti-doping policy worldwide for all sports, also promoting campaigns of prevention and scientific research (Creado, Reardon, 2016).

Athletes positive to the analysis, are grouped in the CONI report in two categories:

1. Subjects with AAF (adverse outcome) in which the analysis of the biological samples has detected the presence of a prohibited substance or its metabolites.
2. Subjects with ATF (atypical outcome), where the biological analysis yielded results that require further investigations before to claim certainty adverse outcome.

In addition, although many athletes are positive to the investigation, the existence of certifications TEU, i.e. exemptions for therapeutic purposes, which allow athletes with a known disease, to take substances that normally fall into the WADA blacklist, also during the competitive period should be considered.

To be obtained, a TUE must respect some specific criteria, demonstrating the need to take that particular substance, normally prohibited, only for therapeutic purposes. It is important, therefore, that it is established that the non-administration of the drug should cause health problems and that its use, in compliance with the dosage, almost certainly will not make improvements to the sports performance; there must not exist a drug that can be prescribed

as an alternative to face the disease and eventually, the use of this substance should not be consequently "forced" by the use of another one banned previously assumed (Fitch, 2016).

In recent years, sport federations that have the highest number of positive athletes are: cycling, football, athletics and swimming (Figure 2).

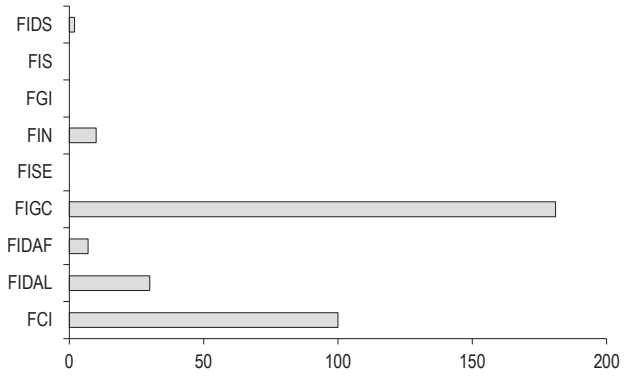


Figure 2. The number of positive individuals within some sports federations

Enhancing drugs most commonly used by athletes

The reports published annually by CONI show that, under review, the most commonly used substances were (Figure 3):

- Anabolic Androgenic Agents,
- Glucocorticoids,
- Diuretics,
- Stimulants.

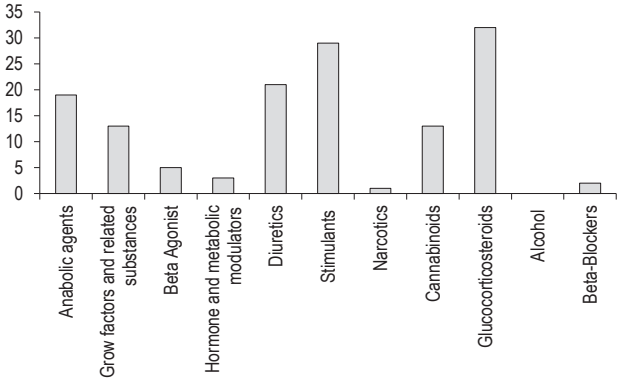


Figure 3. Substances identified in all sports

Anabolic Androgenic Agents

The first category includes all agents that increase anabolism, i.e. protein synthesis in order to increase muscle mass. Anabolic Androgenic Steroid (AAS), included in the WADA blacklist, have anabolic effect and mimics the endogenous steroidal androgens effects associated with virilisation, increase in strength, voice deepening and growth of hair. Testosterone, the androgenic steroid hormone *par excellence*, and its synthetic derivatives accepted for the purpose of doping, have an effect to minimize the androgenic effects and increase anabolic ones. The clinical use of testosterone is exclusively limited to males with hypogonadism (Contrò, Bianco, Proia, 2012).

Among the most serious consequences of AAS use, there is hepatotoxicity which can induce the occurrence of peliosis, adenoma or the most severe form of hepatocellular carcinoma (Bond, Llewellyn, van Mol, 2016). Also it is known to cause dependence exerting several brain actions influencing the behaviour and causing aggression, anxiety, paranoia and manic-depressive states. Furthermore, it should induce cardiovascular system damages, causing for example myocardial infarction or thrombosis.

Some substances, passed as food supplements, may cause similar effects reported for AAS abuse. In 2010 a case was reported about a body builder of 31 years in whom the assumption of SUS 500, a pro hormone, induced liver problems and altered behaviour. In Italy the sale of pro-hormones is not allowed, as well as AAS and even if in some countries of the world they are legal, WADA has placed them among the banned substances since they alter the normal athletic ability (Wingert, Tavakoli, Yoder, 2010).

Doping seen more as a general phenomenon, it affects even women and, as collateral effects it causes alterations in the menstrual cycle and development of male secondary characteristics. A study conducted by the Karolinska Institute on 8 women that took anabolic androgenic steroids (AAS) and/or clenbuterol (beta 2 agonist) found particularly significant side effects; particularly identified in 5 of them, voice changes were observed, in addition to changes in the clitoris and growth of body hair. While in 2 of them tachycardia and depression were detected (Börjesson, Gårevik, Dahl, Rane, Ekström, 2016).

Glucocorticoids

Glucocorticoids are a class of corticosteroids that are synthesized from cholesterol in the adrenal cortex in particular in the zona fasciculata. They modulate the activity of the cells of our body and are essential for life; however, when taken exogenously they may give rise to more or less severe side effects (Buckingham, 2006).

The blood levels of these substances are held constant by a negative feedback mechanism involving the hypothalamus-pituitary axis: in response to various stimuli, for example stress or hypoglycemia, the hypothalamus secretes the corticotrophin releasing hormone (CRH) that stimulates the release by the pituitary adrenocorticotropic hormone (ACTH) into the systemic circulation, which acts in turn on the adrenal cortex resulting in the production of corticosteroids which are released into the systemic circulation. Through the bloodstream, glucocorticosteroids are sent to the target tissues where they will explicate their mechanism of action: it stimulates fundamental processes to maintain constant levels of glucose in the blood such as gluconeogenesis in the liver, transcription of enzymes involved in gluconeogenesis, mobilization of amino acids from extra-hepatic tissues (these serve as substrate for gluconeogenesis), stimulation of lipolysis in adipocytes (Hackney, Walz, 2013).

These substances modulate the blood pressure, act on bone tissue and are also involved in cell growth mechanisms; they play a role in the central nervous system both on neurons and on the glial cells.

These substances also have anti-inflammatory and immunomodulatory effect and in fact they are used in the pharmacological treatment of chronic inflammatory diseases and autoimmune diseases such as sclerosis multiple, eczema, rheumatoid arthritis, atherosclerosis (Coutinho, Chapman, 2011). They are also used in the treatment of severe allergies, adrenal problems, asthma, eye or vision problems, or ulcerative colitis (Matabosch et al., 2011). Chronic use of corticosteroids may lead to the onset of Cushing's disease that manifests as weight gain, fatigue, hirsutism, amenorrhea in women and impotence in men (Kirby, 1989).

Glucocorticoids are lipophilic substances which can cross the phospholipid bilayer of the cell membrane to bind their cytosolicreceptor. The glucocorticoids receptor (GR) is a member of the superfamily of receptors that modulate gene transcription; in fact, this receptor mediates the transcription via transactivation of target genes by binding to glucocorticoid response element (GRE) (Yudt, Cidlowski 2002).

The GR receptor is found in the cytosol bound to heat shock proteins hsp90 that prevent translocation into the nucleus when is unbound to glucocorticoid (Hayashi, Wada, Ito, Adcock, 2004). When the glucocorticoid binds the receptor, the hsp90 proteins dissociate and the hormone-receptor complex migrates to the nucleus where it modulates gene transcription helped by cofactors, bind the promoter regions of anti-inflammatory genes, such as the inhibitor lipocortin-1 and suppresses phospholipase A2 (Karin, 1998; McNally, Muller, Walker, Wolford, Hager, 2000). The glucocorticoids decrease transcription of adhesion molecule, chemokines, cytokines and increase the transcription of secretory leukocyte inhibitory protein (SLPI) and β2-adrenergic receptor (ADRB2).

The main target of glucocorticoids is the muscle tissue where they regulate the metabolism of glucose and protein. Under stress conditions, such as exercise, the levels of glucocorticoids rise and determine the reduction of protein synthesis and the increase of protein catabolism in order to provide aminoacids as substrate for gluconeogenesis; they are used to take advantage as anti-inflammatory and to increase the overall racing performance of the body's response to stress. Chronic use of these substances may determine muscle atrophy and muscle weakness (Kuo, Harris, Wang, 2013).

Large doses of glucocorticoids can alter muscle physiology and susceptibility to neuromuscular blocking drugs by mechanisms not clearly understood (Shin, Fink, Khiroya, Ibebunjo, Martyn, 2000).

Muscle atrophy is called "steroid myopathy" and causes weakness, especially in the muscles of the upper and lower limbs and neck. Different conditions that cause muscle atrophy are correlated with increased levels of glucocorticoids suggesting that these substances play an important role in this process (Cea et al., 2016).

Some athletes use glucocorticoids to improve their performance inducing mobilization of fatty acids, amino acids and stimulate gluconeogenesis, although many of them use it to reduce pain and fatigue, not knowing the side effects in the long term (Nikolopoulos, Spiliopoulou, Theocharis, 2010). For example, glucocorticoids are administered for the treatment of chronic tendinitis and tendon injuries.

Glucocorticoids are used by professional athletes since 1960 in which the chronic abuse was detected through hair analysis and urine (Nichols, 2005); corticosteroids are inserted in the list of prohibited substances that has been drawn up by WADA because they have an ergogenic effect and cause health risks (Matabosch et al., 2013).

Diuretics

Diuretics are substances that cause a greater urine production through increased excretion of water and salt in the kidney but can also interfere with the excretion of other electrolytes such as potassium, calcium and uric acid. Their effect determines the decrease of the liquid in the circulation and, therefore, blood pressure.

There are various types of diuretics, but the most used are the loop diuretics and thiazide diuretics. Loop diuretics, such as furosemide, are organic anions, which act in the loop of Henle structure. In particular, they act on the Na/K/2Cl transporter blocking the reabsorption of sodium and chlorine resulting in a reduction of the concentration of urine. The thiazide diuretics are organic anions which act in the distal tubule and collecting duct by binding to Na/Cl cotransporters preventing sodium reabsorption (Brater, 1998; Brater, 2000; Ellison, 1994). Then both substances cause excretion of sodium and water but by different action mechanisms. Diuretics are used for treatment of cardiac disease, acute pulmonary edema and chronic congestive heart failure, for the treatment of the edema of nephrotic syndrome and for life-threatening hyponatremia. Hypovolemia, hypersensitivity, and ototoxicity are typical side effects, such as electrolyte imbalance which causes a reduction in blood levels of potassium, magnesium, calcium and uric acid. Furosemide can also result in acute interstitial nephritis and skin rash (Se Won Oh, Sang Youb Han, 2015).

Since 1988, the use of diuretics in sports is prohibited (Cadwallader, de la Torre, Tieri, Botrè, 2010), both during and out of competition. This is due to the fact that athletes use diuretics for many reasons: to reduce their body weight or to limit the excessive water retention caused by the abuse of anabolic steroids and to mask the presence of banned substances in urine. Therefore, when urine samples are taken to carry out the doping test, the research of these substances is always carried out (Thevis, Schänzer 2005). However, if the athlete is suffering from a disease that requires treatment with diuretics, the doctor may request the their use for therapeutic purposes (TUE) to WADA and therefore to be considered negative for anti-doping controls (Cadwallader et al. 2010).

Diuretics constitute a default and not advantageous final body weight in some sports such as wrestling, boxing, judo and among athletes who want to maintain a low body weight, such as gymnasts and dancers.

The analysis of the data collected by CONI found out that furosemide and hydrochlorothiazide are diuretics used by most athletes. They are very powerful diuretics that can also result in serious adverse effects if not administered properly.

The use of these substances in healthy subjects can lead to considerable loss of fluids and salts, which can lead to a significant reduction in blood pressure with consequent collapse in athletes which carry out an intense physical effort; hypokalemia can determine onset of severe arrhythmias and cardiac arrest.

Stimulants

Stimulants are substances, which act at the level of the Central Nervous System increasing the responsiveness and concentration and reducing the feeling of fatigue and affect mood; some have anorexiant effect for which they are taken to lose weight. They also act on the cardiovascular system causing, for example, even fatal arrhythmias.

Although many stimulants fall under WADA lists, some of them are prohibited only if they exceed certain concentrations in the urine; moreover their use is prohibited only during competition because they have a very short duration of action that does not cause long-term effects. The use of these substances is not limited to the above effects: in fact they are also hired to counteract the side effects due to AAS.

Are included in this category ephedrine and pseudoephedrine, amphetamine, cocaine and mildest caffeine. Pseudoephedrine, for example, when taken at therapeutic doses (60–120 mg) serves to relieve nasal and sinus congestion, but if taken in overdose (>180 mg) it may determine performance improvement, therefore it shows ergogenic effect carried out in a dose-dependent manner (Trinh, Kim, Ritsma, 2015). Even caffeine is among the stimulants. In concentrations >3–6 mg/kg it may cause ergogenic effects, although this dose ranges do not lead to

exceeding the allowable limit in the urine of 12 mg mL^{-1}; so WADA was forced to remove it from the list of prohibited substances, even if it continues to monitor it (Deventer, Roels, Delbeke, Van Eenoo, 2011).

Discussion

Prevention in doping could be a key to limit the damage caused by this harmful practice both for the physical health and the athlete's moral integrity. Therefore is good acting during adolescence, before puberty, conducting as much as possible anti-doping campaigns for young people (Wippert, Fließer, 2016).

Research conducted over the last 10 years on young people state which about two-thirds of adolescents appears to be dissatisfied with their body (Yager, O'Dea, 2014) and this dissatisfaction involves a perennial pursuit of physical perfection that leads young people to adopt harmful diets for weight loss and to practice strenuous exercise which they try to cope with initially by taking supplements, which can later open a direct route to the use of banned substances and thus doping.

Even coordination between the various professionals that surround athletes could help fight doping by planning specific training, adapted to the individual athlete taking into account the actual physical limitations and physical features of each.

To minimize the phenomenon of doping, information and prevention should be done with young athletes, trying to involve other subjects (e.g. sports physicians, coaches or family) in order to establish and maintain attitudes and behaviours correct. It is very important to involve sports organizations that provide greater resources to psychosocial projects in relation to anti-doping controls at all levels. It would also be desirable to test sport rules by event organizers and federations in order to avoid the potential benefits of using prohibited substances in competitions, trying to change attitudes towards doping and doping culture.

References

Bond, P., Llewellyn, W., van Mol, P. (2016). Anabolic androgenic steroid-induced hepatotoxicity. *Medical Hypotheses*, *93*, 150–153.

Börjesson, A., Gårevik, N., Dahl, M.L., Rane, A., Ekström, L. (2016). Recruitment to doping and help-seeking behavior of eight female AAS users. *Substance Abuse Treatment, Prevention, and Policy*, *11*, 11.

Brater, D.C. (1998). Diuretic therapy. Review. *N Engl J Med*, *339*, 387–395.

Brater, D.C. (2000). Pharmacology of diuretics. *Am J Med Sci*, *319*, 38–50.

Buckingham, J.C. (2006). Glucocorticoids: exemplars of multi-tasking. *British Journal of Pharmacology*, *147*, S258–S268.

Cadwallader, A.B, de la Torre, X., Tieri, A., Botrè, F. (2010). The abuse of diuretics as performance-enhancing drugs and masking agents in sport doping: pharmacology, toxicology and analysis. *British Journal of Pharmacology*, *161*, 1–16.

Cea, L.A., Balboa, E., Puebla, C., Vargas, A., Cisterna, B.A., Escamilla, R. , Regueira, T., Sáez, J.C. (2016). Dexamethasone-induced muscular atrophy is mediated by functional expression of connexin-based hemichannels. *Biochimica et Biophysica Acta*, 1891–1899.

Contrò, V., Bianco, A., Proia, P. (2012). Anabolic-androgenic steroids signaling. *Journal of Sport Sciences and Law*, V (1), SEZ. 2.

Coutinho, A.E., Chapman, K.E. (2011). The anti-inflammatory and immunosuppressive effects of glucocorticoids,recent developments and mechanistic insights. *Molecular and Cellular Endocrinology*, *335*, 2–13.

Creado, S., Reardon, C. (2016). The sports psychiatrist and performance-enhancing drugs. *International Review of Psychiatry*, *28* (6), 564–571.

Deventer, K., Roels, K., Delbeke, F.T., van Eenoo, P. (2011). Prevalence of legal and illegal stimulating agents in sports. *Anal Bioanal Chem*, Aug, *401* (2), 421–432.

Ellison, D.H. (1994). Diuretic drugs and the treat ment of edema: from clinic to bench and back again. Review. *Am J Kidney Dis*, *23*, 623–643.

Fitch, K. (2016). The World Anti-Doping Code: can you have asthma and still be an elite athlete? *Breathe*, *12*, 148–158.

Hackney, A.C., Walz, E.A. (2013). Hormonal adaptation and the stress of exercise training: the role of glucocorticoids. *Trends in Sport Sciences*, *4* (20), 165–171.

Hayashi, R., Wada, H., Ito, K., Adcock, I.M. (2004). Effects of glucocorticoids on gene transcription. *European Journal of Pharmacology*, *500* (1–3), 51–62.

Karin, M. (1998). New Twists in Gene Regulation by Glucocorticoid Receptor: Is DNA Binding Dispensable? *Cell*, *93*, 487–490.

Kirby, B. (1989). A Review of the Rational Use of Corticosteroids. *The Journal of International Medical Research*, *17*, 493–505.

Kuo, T., Harris, C.A., Wang, J.C. (2013). Metabolic functions of glucocorticoid receptor in skeletal muscle. *Molecular and Cellular Endocrinology*, *380* (1–2).

Matabosch, X., Pozo, O.J., Monfort, N., Pérez-Maná, C., Farré, M., Marcos, J., Segura, J., Ventura, R. (2013). Urinary profile of methylprednisolone and its metabolites after oral and topical administrations. *Journal of Steroid Biochemistry & Molecular Biology*, *138*, 214– 221.

McNally, J.G., Muller, W.G., Walker, D., Wolford, R., Hager, G.L. (2000). The Glucocorticoid Receptor: Rapid Exchange with Regulatory Sites in Living Cells. *Science*, *287.*

Nichols, A.W. (2005). Complications associated with the use of corticosteroids in the treatment of athletic injuries. *Clin J Sport Med*, *15* (5), 370–375.

Nikolopoulos, D.D., Spiliopoulou, C., Theocharis, S.E. (2010). Doping and musculoskeletal system: short-term and long-lasting effects of doping agents. *Fundamental and Clinical Pharmacology*, *5*, 535–563.

Se Won Oh, M.D., Sang Youb Han, M.D. (2015). Loop Diuretics in Clinical Practice. *Electrolyte Blood Press*, *13*, 17–21.

Shin, Y.S., Fink, H., Khiroya, R., Ibebunjo, C., Martyn, J. (2000). Prednisolone-induced muscle dysfunction is caused more by atrophy than by altered acetylcholine receptor expression. *Anesthesia & Analgesia*, *91* (2), 322–328.

Thevis, M., Schänzer, W.S. (2005). Examples of Doping Control Analysis by Liquid Chromatography–Tandem Mass Spectrometry: Ephedrines, β-Receptor Blocking Agents, Diuretics, Sympathomimetics, and Cross-Linked Hemoglobins. *Journal of Chromatographic Science*, *43*, January.

Trinh, K.V., Kim, J., Ritsma, A. (2015). Effect of pseudoephedrine in sport: a systematic review. *BMJ Open Sport Exerc Med*, Dec 21, *1* (1).

Wingert, N., Tavakoli, H., Yoder, E. (2010). Acute hepatitis and personality change in a 31-year-old man taking prohormone supplement. *Psychosomatics*, *51* (4), 340–344.

Wippert, P.M., Fließer, M. (2016). National doping prevention guidelines: Intent, efficacy and lessons learned – A 4-year evaluation. *Substance Abuse Treatment, Prevention, and Policy*, *11* (1), 35.

Yager, Z., O'Dea, J.A. (2014). Relationships between body image, nutritional supplement use, and attitudes towards doping insport among adolescent boys: implications forprevention programs. *Journal of the International Society of Sports Nutrition,11*, 13.

Yudt, M.R., Cidlowski, J.A. (2002). The Glucocorticoid Receptor: Coding a Diversity of Proteins and Responses through a Single Gene. *Molecular Endocrinology*, *16* (8), 1719–1726.

Cite this article as: Sacco, A., Macchiarella, A., Amato, A., La Commare, D., Contrò, V., Proia, P. (2017). Trend of Drug Abuse in 2011–2014 in Italy. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 77–84. DOI: 10.18276/cej.2017.3-07.

THE EFFECT OF ACUTE CREATINE SUPPLEMENTATION ON FATIGUE AND ANAEROBIC PERFORMANCE IN SOCCER PLAYERS

Osman Ateş,[1, A, B, D] Burcak Keskin,[1, C, D] Bulent Bayraktar[2, C, D]

[1] Department of Sports Health, Istanbul University Faculty of Sports Sciences, Istanbul, Turkey
[2] Department of Sports Medicine, Istanbul University, Istanbul Faculty of Medicine, Turkey
[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation, [E] Funds Collection

Address for correspondence:
Department of Sports Health, Istanbul University Faculty of Sports Sciences
Postal Code: 34320, Istanbul, Turkey
E-mail: osman-ates@hotmail.com

Abstract The aim of this study is to investigate the effect of acute creatine monohydrate supplementation on fatigue and anaerobic performance. Thirty young soccer players participated in this study. Participants continued their training without taking any food supplements for 5 days, taking 0.3 g of milk dust per kg for 5 days and using 0.3 g creatine monohydrate per kg for 5 days. A total of 6 × 35 m sprint times were used in the fatigue index with a 10-second rest period between them. Single repeated sprint times of 35 m were examined as well. Statistically significant differences ($p < 0.05$) were found both fatigue index and single repeated 35 m sprint time after creatine supplementation. However there was not a statistically significant difference ($p > 0.05$) in Rast Test results. In soccer, it is known that there is a strong positive correlation between game performance and the number of repeated sprint numbers in a game. In conclusion, there was a statistically significant effect of 0.3 g of acute creatine loading per kg over 5 days on the single repeated sprints and fatigue index values. The creatine monohydrate can be used as an ergogenic aid for recovery periods between high-intensity exercises to affect performance.

Key words creatine, anaerobic performance, fatigue, soccer

Introduction

In recent years, ergogenic supplements to increase performance and delay fatigue have become more common. The most commonly used ergogenic food supplement to increase performance is creatine monohydrate (Toktas, 2006). Anaerobic performance includes brief explosive exercises. The immediate need for such exercises is supplied from ATP-CP and anaerobic glucose. The total amount of energy that can be produced through such procedures comprises the anaerobic capacity (Kenney, Wilmore, Costill, 2012). In soccer, the anaerobic capacity is required for several movements such as starting quickly to run, running quickly, changing the direction quickly, jumping high to head the ball, and flinging the legs quickly to kick the ball (Sporis, Jukic, Ostojic, Milanovic, 2009).

The use of acute creatine significantly predicts not only the increase in body mass and muscular power (Becque, Lochmann, Melrose, 2000; Bemben, Bemben, Loftiss, Knehans, 2001; Eckerson, Stout, Moore, Stone,

Nishimura, Tamura, 2004; Haff et al., 2000; Wilder, Deiuert, Hagerman, 2001) but also the increase in contractile protein synthesis (Willoghby, Rosene, 2001). The maximization of muscle creatine storage requires 20 gr/d^{-1} for 5 days (0.3 gr/kg^{-1}) and maintenance requires 2 g/d^{1} (0.03 g/kg^{-1}) (Glaister, Stone, Stewart, Hughes, Moir, 2004).

Since the 1990s, various studies have been conducted to examine the use of creatine, which is one of the ergogenic substances, to increase the performances of athletes (Ostojic, 2004). The results basically showed that the use of creatine monohydrate increased short-term intense anaerobic performance (The American College of Sports Medicine, 2000; Brenner, Rankin, Sebolt, 2000; Warber et al., 2002). The creatine phosphate (PCr) for muscles serve as a source of energy to refresh ATP during short exercises lasting less than 10 seconds (Glaister et al., 2004; Fox, Bowers, Foss, 1999; Powers, Arnold, Weltman, Perin, 2003). By ensuring an increase in muscle creatine and creatine phosphate through loading creatine, an improvement in energy sources and stimulation of muscle development was observed (Powers et al., 2003, Cox, Mujika, Tumilty, Burke, 2002).

Creatine is in monohydrate form and is an ergogenic supplement commonly used by athletes. The main reason for the performance-improving feature of creatine is that it increases the synthesis of creatine phosphate during recovery time after exercising, which is very useful at specific performance-based and high-intensity sports such as soccer, as it requires single or repeated sprint activities (Buford et al., 2007, Delecluse, Diels, Goris, 2003; Yquel, Arsac, Thiaudiere, 2002). However, there are also several studies indicating no positive effect of acute creatine use on anaerobic performance (Sewell Robinson, Greenhaff, 2008; Cooke, Barners, 1997).

The aim of this study is to investigate the effects of acute creatine monohydrate supplementation on fatigue and anaerobic performance parameters among young soccer players. It is expected that the breaks between the high-intensity short-term exercises will be shorter when acute creatine is used with the phosphate energy system (ATP-CP). Thus, it is also expected that performance losses will be lower in high-intensity exercises.

Methods

Study sample

30 young soccer players participated in this study. The participants and their parents were informed about the aim and potential risks of this study and then signed informed consent forms. Bioethical committee agreement for the research conduction was received from the department.

Data collection/tests and measurements

The participants' heights were measured in cm with the participants' heels attached, standing upright and without shoes. Their body weight and body fat rates were measured with tanita bc-418 and with 0.01 sensitive bio-impedance method when they were in bare feet.

The Rast Test was used to assess the anaerobic performance and fatigues levels. The total time and fatigue indexes recorded. Additionally, the standing long jump and 35 m sprint tests which were among the anaerobic performance indicators, were performed during these tests.

Study design

The pre-tests of the participants were completed and they continued their routine soccer training program during 5 days without taking any food supplement. On the 6th day all the test results were recorded (Rast^{1}, 35 m

sprint[1] and long jump[1]). Beginning with the 7th day, for the placebo condition, 0.3 gr/per kg powder milk was mixed with fruit juice and delivered to the participants until the 12th day, with all the tests conducted again (Rast[2], 35 m sprint[2] and long jump[2]). Starting with the 13th day, participants were placed in the creatine monohydrate condition and received creatine monohydrate. On the 18th day, all the tests were repeated for the last time (Rast[3], 35 m sprint[3] and long jump[3]). Daily total use of powder milk or creatine was 0.3 per kilogram; they were packed in 3 doses equally and consumed 3 times a day by mixing it with fruit juice. The participants did not know which condition they were in during the study. The results were shown as mean and deviation. The paired samples t-test was used to determine the difference between pre and post-tests of groups. SPSS 10.0 statistical program and $p < 0.05$ significance level was used.

Figure 1 shows the study design.

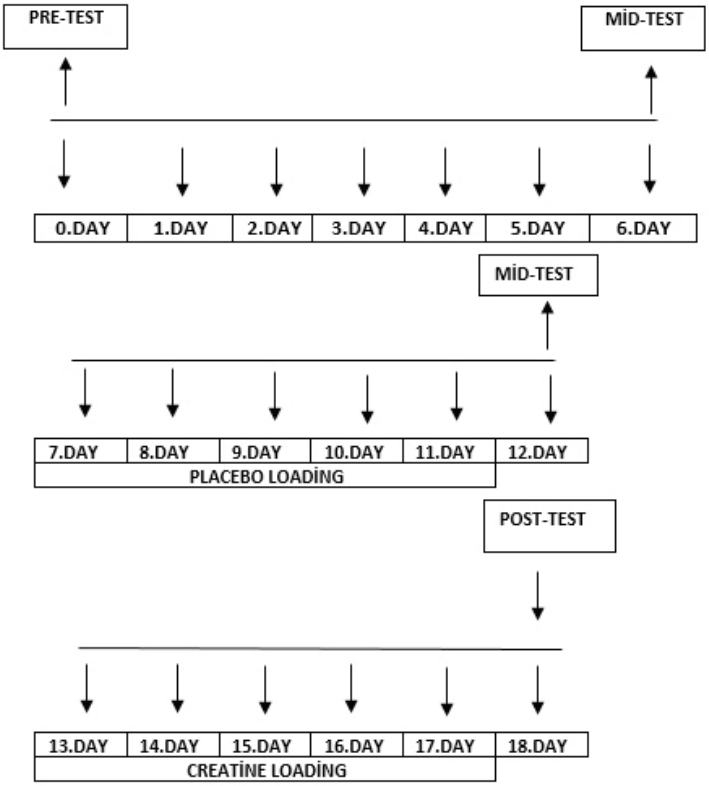


Figure 1. Study design

Results

As seen in Table 1, 30 soccer players participated in this study, with an age average of 16.3 ±0.73 years, with a body weight average of 63.9 ±6.20 kg, with a height average of 175 ±4.70 cm and with a body fat rate average of 13 ±3.04%.

Table 1. Lists the descriptive statistics about the participant soccer players

	N	Average	Sd.
Age (year)	30	16.3	0.73
Body Weight (kg)	30	63.9	6.20
Length (cm)	30	175	4.70
Body Fat (%)	30	13.0	3.04

The descriptive statistics related to soccer players' anaerobic performances

Considering that today's soccer game has gained speed, repeated sprints are a good indicator of performance. Table 2 and Table 3 present the Rast Test results used to assess the repeated sprint performances of the study participants, total sprint times and fatigues indexed.

Table 2. The total repeated sprint times (Rast)

The total repeated sprint times	N	Avg.	Sd.	Std. error	T test	
$Rast^1$ – $Rast^2$	30	32.541 32.518	0.80305 0.89508	0.14662 0.16342	29	0.852
$Rast^2$ – $Rast^3$	30	32.518 32.281	0.89508 0.93780	0.16342 0.17122	29	0.025
$Rast^1$ – $Rast^3$	30	32.541 32.281	0.80305 0.93780	0.14662 0.17122	29	0.070

Table 2 shows the participants' repeated sprint times, $rast^1$ (pre-test), $rast^2$ (powder milk use) and $rast^3$ (creatine monohydrate use). Following the evaluation of main data related to $Rast^1$ – $Rast^3$ and $Rast^2$ – $Rast^3$, non-statistically significant decreases in repeated sprint times were observed after the use of creatine monohydrate ($p > 0.05$).

Table 3. The values related to fatigue indexes (FI)

FI values	N	Avg.	Sd.	Std. error	T test	
FI^1 – FI^2	30	7.0020 6.3010	2.15119 2.19149	0.39275 0.40011	29	0.103
FI^2 – FI^3	30	6.3010 5.2487	2.19149 1.07438	0.40011 0.19615	29	0.001**
FI^1 – FI^3	30	7.0020 5.2487	2.15119 1.07438	0.39275 0.19615	29	0.000**

Table 3 shows the fatigue indexes of participants in 6 × 35 m sprints and reveals that FI^3 (acute creatine use) had positive effect on fatigue index. Fatigue index is a significant indicator of time differences among 6 × 35 m sprints.

Table 4. 35 m Sprint times values (seconds)

35 m sprint times values (seconds)	N	Avg.	Sd.	Std. error	T test	
$Sprint^1$ – $Sprint^2$	30	4.9937 5.0223	0.13235 0.19491	0.02416 0.03559	29	0.308
$Sprint^2$ – $Sprint^3$	30	5.0223 4.8839	0.19491 0.20470	0.03559 0.03737	29	0.000**
$Sprint^1$ – $Sprint^3$	30	4.9937 4.8839	0.13235 0.20470	0.02416 0.03737	29	0.000**

Table 4 demonstrates the $sprint^1$ time when any food supplement was not used; $sprint^2$ after powder milk was used and $sprint^3$ after creatine monohydrate was used. Considering the 35 m sprint averages and standard deviation values of the soccer players, the effect of using acute creatine monohydrate in 35 m sprint was statistically meaningful.

Discussion

The effects of acute creatine monohydrate supplementation on soccer players' fatigue and anaerobic performances were examined in this study. With this aim, 35 m sprint times, 6 × 35 m total sprint times and fatigue indexes of the participant players were examined when no food supplement was given, after they took 0.3 gr/kg powder milk and after they took 0.3 gr/kg creatine, and these processes were statically analyzed. Fatigue index is a significant indicator of time differences among 6 × 35 m sprints. And it is an important criteria of sportive performances of soccer players. Today it is well known that there is directly positive relationship between performance and repeated spring times rather than total sprint times.

In this study, although the use of acute creatine monohydrate supplementation improved total repeated sprint time which was appointed as the indicator of anaerobic performance, no statistically difference was found. In the literature, there are various studies emphasizing different outcomes regarding the use of acute creatine monohydrate on repeated sprint performance. Many of these studies found an increase in high-intensity and short term single or repeated sprint performances when anaerobic energy metabolism was used (Ostojic, 2004; Cox et al., 2002; Izquierdo, Ibazez, Gonzales-Badillo, Gorostiaga 2002). In a study by Mujika et al. (2000), the effects of using 20 gr creatine during 6 days in 6 × 15 m repeated sprints on performance was observed. In addition, that study found statistically significant improvements in the 5 m and 15 m total sprint times ($p < 0.05$).

Oztasyonar and Atasever (2017) investigated the effects of using 10 gr and 20 gr creatine daily on 10 × 20 anaerobic exercises with 30-second breaks between sprints. The participants who took 20 gr creatine daily performed significantly better in sprints compared to controls. Investigating the biomechanical source of creatine loading on sprint performance, Schedel, Terrier, Schutz, (2000) discovered that there was an increase in step frequency of the

athletes taking creatine, which might stem from the shortening in muscle contraction and relaxation occurred as a result of intense intracellular phosphocreatine (pc) (Oztasyonar, Atasever, 2017).

During 6 second or faster sprints, anaerobic sources are used for ATP production (Girard et al., 2011), and it is reasonable to expect a decrease in sprint times because it is expected that creatine use will cause an increase in anaerobic capacity. Redondo, Dowling, Graham, Almada, Williams (1996) found that with ice hockey and soccer players, statistically significant differences were not found in 3 × 60 m sprints with 2 minute resting breaks between the sprints. The reason for the differences among the study results might be the variability in the number of repeated sprint times or possible influences of energy sources. For the current study, the reason for no statistically meaningful difference in performance improvement in 6 × 35 m total repeated sprint times can be the selected protocol.

Regarding the 35 m single sprints in the current study, the performance increase following the use of creatine monohydrate was statistically meaningful ($p < 0.05$). Ostojic (2004) showed that the sprint performances of soccer players improved after creatine loading. In a similar study, Guner et al. (1999) observed the effects of creatine loading on sprint performance and discerned that 0.3 gr./kg creatine loading during 4 days positively influenced sprint performance. The reason for such an improvement in sprint performance after a creatine loading might stem from the increase in creatine phosphate storages in muscles.

In addition, the effects of creatine monohydrate on fatigue index were examined in the current study. As indicated by the statistical data, the use of acute creatine monohydrate had strong positive effects on fatigue index. That is, the difference between the best and the worst rate among the 6 × 35 m sprints was found to decrease. In general, the difference between the sprints of the athletes with high VO_2max values was expected to be low (Eniseler, Gunduz, 2001). If the aerobic power of an athlete is of high alactic anaerobic power, he can perform well in single and repeating sprint times although performance losses can be observed as the number of the repeats increase, because ATP-CP cannot be supplied thoroughly during repeated sprints that are performed with short breaks (Karatepe, 2009).

Significant differences were found in single repeated sprint values, and the improvements in fatigue index during repeating sprints show that the use of creatine facilitates the refilling of ATP-CP storages. These findings are parallel with those in the current literature, and have become an indicator of an increase in anaerobic performance, because the availability of creatine phosphate is of vital importance for power production during the first several seconds of exercise (Mujika, 2000). That the recovery becomes faster between high intensity and short term anaerobic loading with the use of creatine, demonstrates that the losses between repeated sprint times decrease, that is, the performance losses decrease. The creatine phosphate re-synthesis during the recovery period can be enhanced with creatine loading (Buford et al., 2007). This is in a direct and positive relationship with the performance needs of today's soccer.

In conclusion, considering the findings in the study and in the literature, 0.3 gr/kg creatine monohydrate loading during the 5 days had statistically significant effects on single repeated sprint times and fatigue index. In soccer, creatine monohydrate can be used as an ergogenic supplement since the recovery period between the high intensity efforts is known to impact performance. In the study, no significant difference was found in single repeated sprints on total time performance. However, the number of the studies on the effects of creatine loading on repeat sprint average time is quite high, and there is also research indicating that it affects the performance positively.

References

Bangsbo, J., Marcello, L.F., Krustrup, P.T. (2008). The Yo-Yo Intermittent recovery test A useful tool for evaluation of physical performance in intermittent sports, *Sports Medicine*, *38* (1) 37–51.

Barnett, C., Hinds, H., Jenkins, D.G. (1996). Effect of oral creatine supplementation on multiple sprint cycle performance. *Aus. J. Sci. Med. Sport*, *28*, 35–39.

Becque, M.D., Lochmann, J.D., Melrose, D.R (2000). Effects of oral creatine supplementation on muscular strength and body composition. *Medicine & Science in Sports & Exercise, 32*, 654–658.

Bemben, M.G., Bemben, D.A., Loftiss, D.D., Knehans, A.W. (2001). Creatine supplementation during resistance training in college soccer athletes. *Medicine & Science in Sports & Exercise*, *33* (10), 1667–1673.

Brenner, M., Rankin, J.W., Sebolt, D. (2000). The effect of creatine supplementation during resistance training in women. *J. Strength Cond. Res*, *14*, 207–213.

Buford, T.W., Kreider, R.B., Stout, J.R., Greenwood, M., Campbell, B., Spano, M., Ziegenfuss, T., Lopez, H., Landis, J., Antonio, J. (2007). International society of sports nutrition position stand: creatine supplementation and exercise. *Journal of the International Society of Sports Nutrition*, *4* (6), 1–8.

Casey, A., Greenhalff, P.L. (2000). Does dietary creatine supplementation play a role in skeletal muscle metabolism and performance? *Am J Clin Nutr*, *72*, 607–617.

Cox, G., Mujika, I., Tumilty, D., Burke, L. (2002). Acute creatine supplementation and performance during a field test simulating match play in elite female soccer players. *Int. J. Sport Nutr. Exerc. Metab*, *12*, 33–46.

Cooke, W., Barnes, W.S. (1997). The influence of recovery duration on high-intensity exercise performance after oral creatine supplementation. *Can. J. Appl. Physiol*, *22*, 454–467.

Delecluse, C., Diels, R., Goris, M. (2003). Effect of creatine supplementation on intermittent sprint running performance in highly trained athletes. *J Strength and Conditioning Res*, *17*, 446–454.

Eckerson, J.M., Stout, J.R., Moore, G.A., Stone, N.J., Nishimura, K., Tamura, K. (2004). Effect of two and five days of creatine loading on anaerobic working capacity in women. *J Strength Cond Res*, *18* (1), 168–173.

Eniseler, N., Gunduz, N. (2001). The relation between maximal intermittent sprint performance and lactic anaerobic capacity and aerobic power. Gazi University. *Journal of Physical Education and Sports Sciences*, *1* (1), 10–12.

Fox, E.L., Bowers, R.W.,. Foss, M.L. (1999). *The physiological basis of physical education and athletics*. Dubuque IA: Wm. C. Brown Publishers.

Girard, O., Villanueva, A.M., Bishop, D. (2011). Repeated sprint ability. *Sports Medicine*, *41* (8), 673–694.

Glaister, M., Stone, M.H., Stewart, A.M., Hughes, M., Moir, G.L. (2004). The reliability and validity of fatigue measures during short-duration maximal-intensity intermittent cycling. *J. Strength Cond. Res*, *18*, 459–462.

Guner, R., Kunduracıoglu, B., Ozkara, A. (1999). Effect of creatine supplementation on sprint performance in high intensity intermittent running. *Hacettepe University Journal of Sports Scieces*, *10* (2), 16–24.

Haff, G.G., Kirksey, B.K., Stone, M.H., Warren, B.J., Johnson, R.L., Stone, M., O'Bryant, H., Proulx, C. (2000). The effect of 6 weeks of creatine monohydrate supplementation on dynamic rate of force development. *Journal of Strength and Conditioning Research*, *14* (4), 426–433.

Izquierdo, M., Ibazez, J., Gonzales-Badillo, J.J., Gorostiaga, E.M. (2002). Effects of creatine supplementation on muscle power, endurance, and sprint performance. *Medicine & Science in Sports & Exercise, 34*, 332–343.

Karatepe, R. (2009). *Evaluation of relation between repeated sprint times and aerobic power on young football players. Master Thesis*. Ankara University: Institute of Health Sciences.

Kenney, W.L., Wilmore, J.H., Costill, D.L (2012). *Physiology of sport and exercise* (5 ed.). Champaign, Illinois: Human Kinetics.

Mujika, I., Padilla, S., Ibanez, J., Izquierdo, M., Gorostiaga E. (2000). Creatine supplementation and sprint performance in soccer players. *Medicine & Science in Sports & Exercise, 32*, 518–525.

Ostojic, S.M. (2004). Creatine supplementation in young soccer players. *International Journal of Sport Nutrition and Exercise Metabolism*, *14*, 95–103.

Oztasyonar, Y., Atasever, M. (2017). The effect of sprint performance of amateur male soccer using different ratio creatine. Ataturk University. *Journal of Physical Education and Sports*, *19*, 1.

Powers, M.E., Arnold, B.L., Weltman, A.L., Perin, D.H., (2003). Creatine supplementation increases total body water without altering fluid distribution. *Journal of Athletic Training*, *38* (1), 44.

Redondo, D.R., Dowling, E.A., Graham, B.L., Almada, A.L., Williams, M.H. (1996). The effect of oral creatine monohydrate supplementation on running velocity. *Int. J. Sports Nutr*, *6*, 213–221.

Sewell, D., Robinson, T., Greenhaff, P. (2008). Creatine supplementation does not affect human skeletal muscle glycogen content in the absence of prior exercise. *J Appl Physiol*, *104*, 508–512.

Schedel, J.M., Terrier, P., Schutz, Y. (2000). The Biomechanic origin of sprint performance enhancement after one-week creatine supplementation. *Jpn J Physiol*, *50*, 273–276.

Smith, J.C., Stephens, D.P., Hall, E.L., Jackson, A.W., Earnest, C.P. (1998). Effect of oral creatine ingestion on parameters of the work rate-time relationship and time to exhaustion in high-intensity cycling. *Eur. J. Appl. Physiol*, *77*, 360–365.

Sporis, G., Jukic, I., Ostojic, S.M, Milanovic, D. (2009). Fitness profiling in soccer: physical and physiological characteristics of elite players. *Journal of Strength and Conditioning Research*, *23* (7), 1947–1953.

Toktas, N. (2006). *The effects of creatine loading on oxygen uptake rate. Master Thesis*. Akdeniz University, Institute of Health Sciences.

The American College of Sports Medicine. Physiological and Health Effects of Oral Creatine Supplementation (2000). *Medicine & Science in Sports & Exercise*, *32*, 706–717.

Warber, J.P., Tharion, W.J., Patton, B.J., Champagne, M.C., Mitotti, P., Lieberman, H.R. (2002). The Effect of creatine monohydrate supplementation on obstacle course and multiple bench press performance. *Journal of Strength Conditioning Research*, *16* (4), 500–508.

Wilder, N, Deiuert, R.G, Hagerman, F. (2001). The effects of low dose creatine supplementation versus creatine loading in collegiate soccer players. *J Athl Train*, *36* (2), 124–129.

Willoughby, D.S., Rosene, J., (2001). Effects of oral creatine and resistance training on myosin heavy chain expression. *Medicine & Science in Sports & Exercise, 33*, 1674–1681.

Yquel, R.J., Arsac, L.M., Thiaudiere, E. (2002). Effect of creatine supplementation on phosphocreatine resynthesis, inorganic phosphate accumulation and pH during intermittent maximal exercise. *J Sports Sci*, *20*, 427–437.

Cite this article as: Ateş, O., Keskin, B., Bayraktar, B. (2017). The Effect of Acute Creatine Supplementation on Fatigue and Anaerobic Performance. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 85–92. DOI: 10.18276/cej.2017.3-08.

VALIDATION OF THE NEW VISUAL SWIMMING PACE CONTROL SYSTEM IN REAL-TIME

Stefan Szczepan,[A, B, C, D, E] Krystyna Zatoń[A, B, E]

Faculty of Physical Education, Department of Swimming, University School of Physical Education, Wroclaw, Poland
[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation; [E] Funds Collection

Address for correspondence:
Stefan Szczepan
Department of Swimming, University School of Physical Education in Wroclaw, Poland
I.J. Paderewskiego 35, 51-612 Wrocław, Poland
E-mail: stefan.szczepan@awf.wroc.pl

Abstract Controlling swimming speed, i.e. the intensity of physical activity, is an important factor in swimming training. The aim of this study was to validate the new "Swimming Pace Control System" (SPCS) for the control of swimming speed in real time using visual information. Submerged at the bottom of the pool was a system equipped with LEDs and software that informed the swimmer of the appropriate distance and swimming speed. A validation test was completed with an accuracy of ±200ms which compared the predetermined time for the beam of light emitted by the SPCS and the times achieved and recorded by the electronic starting system; "Colorado Time System" (Colorado Time, USA). The average time required to move the beam simulated by the SPCS at fixed distances (150 m, 100 m, 50 m) was within the assumed error of measurement (500 ms). SPCS was proven to be useful for control of swimming speed in real-time with the aid of visual information. The system gives an objective indication of swimming speed, thus it can be used in swimming training and during empirical research.

Key words visual information, swimming speed, speed control system, device validation

Introduction

Objective assessment of the achievements of athletes is a popular topic (Toussaint, Truijens, 2005). With scientific and technological progress there comes the growing possibility of obtaining feedback in order to assess technical capacity and endurance. This then leads to improvements in the performance of athletes across a range of different disciplines.

The need for measuring and evaluating numerous technical parameters and physiological forces is a means of creating improved diagnostic methods and measuring devices. The focal parameters where improvements are highly sought-after are diagnostic evaluation, technique, and stamina. A multitude of methods for recording and quantifying technical data and movement provides trainers and researchers with many possibilities, which in turn results in improved athletic performance.

The origins of evaluation techniques were primarily based on the method of photographic film, which allowed for the opportunity to register the displacement of a point positioned on the body of a subject in time and space (Lees, 2002). Nowadays, contemporary methods allow for film recordings of movements with high frequency footage (up to 1000 frames/s). In the last two decades the most prevalent method for assessing the displacement of the body in space and time has proven to be measurements based on computer programs (Tanabe, Ito, 2007). Typical examples include traffic analysis software, such as Dartfish (Dartfish HQ, CH), or SIMI Motion2D (Reality Motion Systems 2D GmbH, DE). We may also observe the use of more advanced means, such as telemetry data acquisition systems like Qualisys (Qualisys AB, SE). Such methods allow for the precise acquisition and further analysis of the data of an executed movement.

In the assessment of physiological parameters such as Hr, La, and VO_2 the most commonly used devices – Sport-tester (Polar Electro, FI), Lactate scout (SensLab, DE), K4b2 (Cosmed, IT) – are tools that are simple to use and widely available.

Usually, the evaluation is concerned with the structure of the movement based on several types of feedback: speed, time, acceleration, angular velocity, and angle of the joints. Additional analysis requires the use of video and computer equipment. However, there is a significant delay between the completed movement and the time that the data is collected and processed, e.g. when using movement analysis software (Hohmann, Fehr, Kirsten, Krueger, 2008). Hence producers, in cooperation with practitioners, have sought to develop an assessment technique that functions while a given motor skill is in operation (Eskofier, Kugler, Melzer, Kuehner, 2012).

For actions completed on land, measurement of movement and physiological parameters of the human body and its pairing with instantaneous feedback is currently available (Chow, Carlton, Ekkekakis, Hay, 2000). However, in an aquatic environment, numerous barriers interfere with communication devices, often completely preventing the use of such tools. One example is the use of infra-red analysis of the swimming movement, which is not effective due to the density of water. In the case of assessing physiological parameters, systems have been adapted for testing respiratory endurance and circulatory status, e.g. K4b2 (Fernandes et al., 2003). With this in mind, some waterproof sport-testers are currently available.

Despite the many problems associated with methods for measuring the kinematic parameters and physiological parameters of swimmers, there are many works depicting methods of assessing the parameters of the swimming cycle while in the water. Ohgi (2002) estimated fatigue among swimmers using a motion sensor positioned on the wrist. Davey, Anderson, James (2005) used a sensor on swimmers' hips to assess stroke length. Slawson et al. (2008) and Callaway, Cobb, Jones (2009) used an accelerometer to assess the four swimming techniques. Bächlin, Tröster (2012) developed a model of swimming technique and method of measuring the overall effectiveness of swimming with the use of the accelerometer.

These researchers have formed a range of devices that support swimmers in various aspects of their training. An example of this includes a device for wireless communication with the swimmer (Zatoń, Szczepan, 2014), which improves the quality and flow of verbal information between the coach and the swimmer. Also, a visual means for the transmission of information via a timer submerged at the bottom of the pool has been used (Gonzalez et al., 2002; Perez, Llana, Brizuela, Encarnación, 2009). The presented methods of communication with swimmers, when combined with movement and physiological parameters assessment, have demonstrably helped in improving athletic achievement levels.

For swimmers there are only a few devices available commercially which inform about swim times. Devices such as Lap Track (Finis, USA) are equipped with a display that is placed on the pool wall, or a hand chronometer (SportCount Chrono, USA).

Other devices such as Lider (Kuca, PL), GBK-Pacer (GBK-Electronics, PT), Pace2Swim (FADEUP Porto, PT), and SwimLead (Synerte, PL) report the speed of swimming in real time, using a beam of light moving along the bottom of the swimming pool. These are examples of the use of visual information, which have all been found to contribute to the improved execution of physical activities (Seat, Wrisberg, 1990; Proteau, Isabelle, 2002).

This paper presents a test of the SPCS for the control of swim speed in real time with the aid of visual information. This is another device based on new technological solutions. The transmission device communicates visual information in real time to the swimmer regarding the swim speed by means of a beam of light tracking along the bottom of the pool. It can be used in swimming training and for research purposes. This is a departure from traditional methods using a chronometer, and represents a transition to the most modern forms of measuring movement.

Reasons for controlling swimming speed

The ability to control the speed of swimming, that is, the intensity of the effort, can be seen as multifaceted (Szczepan, Zatoń, Klarowicz, 2016).

The first aspect is to increase the chance of a faster adaptation to the level of physical activity during swimming training (Costill et al., 1991; Pelayo, 1995). One example is a swimming speed within pre-designated zones which determine the intensity of the training exercise. For example, movement intensity above or below the anaerobic threshold, which is used for the adaptation process of an athlete to the appropriate concentration of lactate in the blood (Costill et al., 1991; Pérez, Llana, Brizuela, Encarnación, 2009; Scruton et al., 2015). Typically, inexperienced swimmers do not have the ability to maintain adequate swimming speed. Hence, controlling the speed enables the realization of training tasks at appropriate intensities and consequently a faster adaptation to exercise. Maintaining the correct speed is also important during recreational swimming training (aerobic training zone), for health purposes such as cardio training or swimming in order to reduce body fat.

The second aspect is improved swimming efficiency. This is made possible with the help of a stabilized swimming speed, which lowers the physiological cost incurred during exercise (Barbosa et al., 2005). Controlling and maintaining the desired swimming speed helps conserve energy required in order to perform the exercise. As a result, the swimmer's body becomes able to travel longer distances (Åstrand, Rodahl, Dahl, Stromme, 2003; Wilmore, Costill, Kenney, 2008).

The third aspect is the standard mastering of swimming techniques at various exercise intensities. This is primarily important at higher intensities, when a reduction in the precision level of the movement often occurs as it is more challenging under these circumstances to maintain exemplary technique.

The fourth aspect is an increase in the economization of swimming (expressed as speed) by optimizing stroke length and stroke rate. The stroke length and frequency of swimming movements in relation to swimming speed are objective means for the assessment of swimming techniques. Optimal relationships between stroke length and movement frequency at a given speed increases the effectiveness of swimming (expressed in speed), as well as economizing swimming techniques (expressed at the expense of physiological exertion) (Hay, 2002; Zamparo, Pendergast, Mollendorf, Termin, Minetti, 2005).

These arguments constitute hard evidence for the importance of controlling swimming speed. Hence the need for creating a device which may be used for this purpose.

The aim of this study was to validate the new "Swimming Pace Control System" (SPCS) for the control of swimming speed in real time using visual information. It was hypothesized that the SPCS objectively indicates the speed of swimming and is available for use in training and during empirical research. The Ethics Committee of the University approved the conduct of the study.

Methods

The new SPCS was subjected to validation testing. Immersed at the bottom of the swimming pool was a system equipped with LEDs and also controlling software that indicated to the swimmer over a designated distance the appropriate swimming speed. Figures 1 and 2 show a visualization and operational overview of the system. Below is a detailed description of the device.

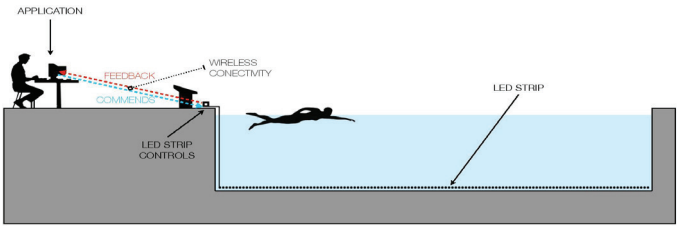


Figure 1. Visualization of the system

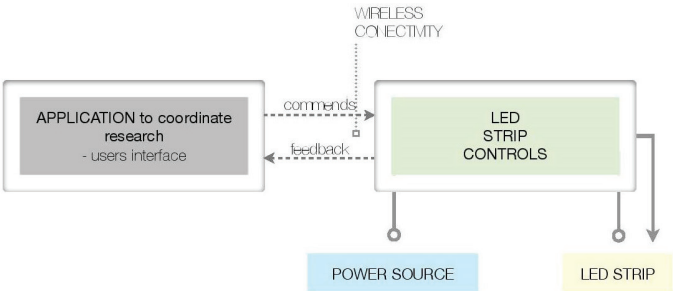


Figure 2. Schematic overview of the system

Construction of the System

SPCS consists of the following elements:

1. Waterproof LED tape:

– 750 LED RGB with 250 sliding registers WS2811 (1 register for 3 LED RGB),

– transparent PVC pipe with a diameter of 19 mm,
– specialized waterproof heat shrink tube with glue,
– waterproof connectors for PVC pipe,
– mains power supply,
– M12 connectors to the controller,
– weights with special handles,
– reel for winding and moving the LED tape (Figure 3).

2. The Light Signal Controller:
– the microcontroller ATmega328, is a timed system with a signal frequency of 16 MHz, which has 32 kB of program memory Flash and 2 kB of SRAM memory,
– bluetooth SPP visible to the system as a virtual COM port with auto speed detection, serial transmission and a control DTR/RTS/DSR. This creates the possibility of remotely controlling the system from anywhere within a 10 m radius,
– software microcontroller for the light signals and remote communication.

3. Device with software for controlling the tests:
– device for the operating software and data storage,
– software for the Windows 10 platform, written in the standard Universal Windows Platform; as a result the application code is able to function on a broad range of devices,
– software for the Android platform,
– software for the iOS platform (Figure 4).

4. Additional elements:
– chest,
– battery,
– cables and Connectors.

Functionality

The prototype constructed has the following functions:

1. Defining the training:
– defining the distance to complete. The distance is given as a multiple of 25 m,
– defining the time to cover a given distance. The minimum time was set at 10 seconds for a distance of 25 m. Time can be set with an accuracy to the nearest full second,
– define the number of series,
– defining the rest time between sets.

2. Control of light signal:
– start light signal,
– stop light signal,
– resume light signal,
– cancel light signal.

3. Presentation of visual information from the LED tape:
– the pre-start pulsing of the LED,

– fixed rate and distance,
– the number of completed lengths of the pool,
– information on the status of the swimmer (ready to start, swimming, resting, resumed, terminated training),
– the possibility of acceleration and deceleration of the LEDs is recurring.

The system supports up to five swimmers at a time. Each swimmer is assigned a unique color so it is possible to easily keep track of the light signal under the water.

The system has two modes of operation:

– fixed intensity (primary) – set distance and time to overcome the distance (e.g. 200 m/2 : 30”),
– constant intensity (advanced) - measured distances and the number of repetitions, along with the time to complete them and the length of the pause between segments (e.g. 10 x 100 m/1 : 30”/rest 30”) – the ability to set a break for 0sec, allowing a start, for example, at 1 : 30”.

Non-functional requirements

Waterproof

One of the most important non-functional requirements is the waterproofing of the LED tape. This requirement is met by the use of specialized PVC pipes, connectors and waterproof heat-shrink tubing for industrial applications. Test sessions revealed that the design solution and the construction itself are fully waterproof.

Accuracy of time over a given distance

In the analysis phase of the project an error accuracy range was set for the time to complete a given distance of ±200 ms. Test sessions have shown that this requirement is met.

Figure 3 shows the LED tape wound on a reel before installation at the bottom of the swimming pool.

Figure 3. LED tape before installation at the bottom of the swimming pool

Figure 4 shows an overview of software for the control system.

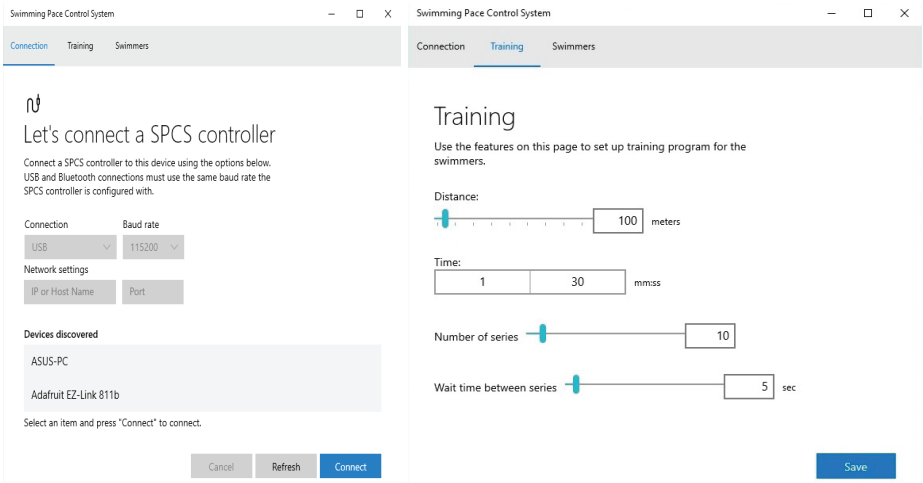


Figure 4. The application control system

Algorithms

A key part of the software is an algorithm for calculating the cycle time for the refresh position of the LED light on the tape. Cycle value provides an accurate reflection of the preset time to complete the distance.

The basic formula for calculating the cycle is as follows:

$$\text{Cycle time} = \frac{\dfrac{\text{fixed time}}{\text{total lenghts}}}{\text{number of LED}} \times 1000 - \text{LED chargetime.}$$

Fixed time – is the time to complete the distance as specified by the user at the moment of defining the sample.

Total lengths – is the result of the quotient of the determined distance and the length of the swimming pool (25 m). The result is divided by the number of LEDs, and the calculated value is converted to milliseconds.

LED charge time – is the result of technical parameters of the LEDs used, which amounts to 15 ms for the entire tape of 250 LEDs. For example, if you determine 100 m to overcome during the 80 seconds, the system will calculate the cycle time of the refresh location LED light at 65 ms.

Results

Validation tests of devices

Over the course of the project three acceptance test sessions were scheduled. The first of these, on land, was to verify the integrity of the entire solution, the accuracy of time, and the ergonomic user interface. Two further

sessions were held in the water with the participation of swimmers. Each session lasted 60 minutes. At this time, the LED tape was at the bottom of the swimming pool. More test cases are described below.

Assessment of the level of brightness of the LED light and its visibility in the aquatic environment

Each of the swimmers is paired to a specific color displayed on the LED tape. At the stage of the assumptions of the project, it was decided that a given swimmer would be represented by three physical LEDs. During the tests, based on interviews with swimmers it was learned that the visibility and perception of the light in the aquatic environment was very good.

Evaluation of the LED tape seal in an aquatic environment

The LED tape was sealed and placed on the bottom of the swimming pool (depth of 1.4 to 1.8 m) for the duration of the test session (2 times 60 minutes). After removing the tape from the water a thorough analysis was conducted for leaks. There were no cases of water penetration to the interior of the LED tape.

Assessment of the level and form of the power system

Power consumption for one RGB LEDs is approx. 60 mA. The design of the project was based on a maximum number of 5 swimmers. Each swimmer is represented by 3 RGB LEDs. The following are estimated on current consumption of the LED tape:

$$60 \text{ mA} \times 3 \times 5 = 900 \text{ mA} \approx 1 \text{ A}.$$

From the equation it follows that the power source system had to use a current of 1 A. In fact, a 2 A AC adapter was used. In addition, the system is adapted to be compatible with a battery power gel with a capacity of 7 Ah. This ensures that the device is comfortably able to handle longer use periods (up to 7 hours). It also ensures energy reserves for the future expansion of the system.

Another source of power tested was the mains supply. A mains supply will maintain a constant voltage (12 V) over the entire length of the LED tape so that all LEDs light up with equal intensity.

Tests confirmed that both the AC adapter and battery provide enough electricity to power the entire system. In addition, thanks to the additional mains supply, the voltage drop in the final meters of LED tape was so small that it did not affect the intensity of the light.

Time accuracy

The tests consisted of comparing the time at which the moving light signal emitted by the SPCS relative to the time which was assessed by the electronic startup system (chronometer) using the Colorado Time System (Colorado Time, USA), with an accuracy of ±200 ms. For the test, the light signal SPCS system and the Colorado Time System were turned on at the same time by a single experimenter. The light signal moved at a predetermined time over a fixed distance. Once the distance was covered the light signal stopped, and at the same time the experimenter stopped the chronometer in the Colorado Time System. Table 1 presents the results of the measurements obtained.

Table 1. The results of validation test

Test 1	Test 2	Test 3
Fixed time: 150 s Fixed distance: 150 m	Fixed time: 75 s Fixed distance: 100 m	Fixed time: 60 s Fixed distance: 50 m
Completion time (s)	Completion time (s)	Completion time (s)
150.4	75.1	60.6
150.2	75.6	59.5
149.8	75.3	59.8
150.3	74.6	60.5
149.7	75.2	60.3
149.6	75.6	60.7
150.3	74.6	59.6
150.4	74.8	59.8
$\bar{x}$ 150.08 (150 s 133 ms)	$\bar{x}$ 75.10 (75 s 166 ms)	$\bar{x}$ 60.10 (60 s 166 ms)

Based on these results it can be stated that the average time obtained to move the light beam emitted from the system SPCS at a fixed distance (150 m, 100 m, 50 m) was to be found within the assumed error of measurement. The measurement error was set at 500 ms. Measurement error for distances of 150 m, 100 m, 50 m, amounted to 133 ms, 166 ms, and 166 ms, respectively. This was determined to be the result of human influence, as the starting and stopping of the chronometer Colorado Time System was performed by a person.

Discussion

The aim of this study was to validate the new SPCS for the control of swim speed in real time with the aid of visual information. The hypothesis that the SPCS device objectively indicates swimming speed and is suitable for use in training and during empirical research has been confirmed.

This study holds that the arguments for controlling the speed of swimming in real time, i.e. quicker adaptation to physical exercise, a reduction in the physiological cost incurred during the performance of exercises when training, improved swimming technique at high intensity levels, and optimization of the kinematic parameters of the swimming cycle seem to be convincing. As has been shown, an important role of the coach during exercise is to provide the swimmer with information about swim time and intensity of the training (Micklewright et al., 2012; Chinnasamy, St Clair Gibson, Micklewright, 2013).

Usually this information reaches the swimmer by means of verbal messages from the trainer. Control over exercise intensity is typically in the form of verbal information; for example, the time taken to cover the distance is provided at the completion of the test exercise. Often this is too late to make any adjustment to the speed and thus the intensity of the swim. Additionally, environmental conditions create many barriers that interfere in the process of information exchange. In the aquatic environment these include factors such as noise, head being submerged in water, and wearing a swimming cap.

Methods have been developed to improve the quality of information flow in the aquatic environment. An example is wireless communication using Bluetooth or Wi-Fi, which has been used to assess intensity by

measuring heart rate. Zatoń, Szczepan (2014) have used radio waves for wireless verbal communication with the swimmer in order to improve swimming technique. Turner, Smith, Coleman (2008) reported the swimming rate with the use of an audio system. Gonzalez et al. (2002) and Perez et al. (2009) used a submerged chronometer at the bottom of the pool to transmit swimming time information. Zatoń, Kędrak, Rejman (2016) applied the use of sliding mirrors, mounted on trolleys, along the edge of the swimming pool to transmit visual information to swimmers in an effort to improve their breaststroke technique.

However, these methods cannot provide information on swim speed rates in real time. Numerous studies have recognized visual information as an effective form of communication used to improve the performance of physical activities and which might be used in challenging environments, namely, the aquatic environment (Seat, Wrisberg, 1990; Carroll, Bandura, 1990; Proteau, Isabelle, 2002). Visual information also allows for the ability to transfer information in real time (online) when physical activity is in progress. Thus, in the present study visual information was used in order to control the speed of swimming.

Improvement of athletic performance requires the search for new training methods. To date, various methods have been used to control swimming speed and exercise intensity (Gonzalez et al., 2002; Turner et al., 2008; Perez et al., 2009). The present study uses a new system SPCS which transmits visual information to the swimmer in real time regarding the speed of swimming by means of a beam of light moving along the bottom of the pool. The conducted validation tests revealed that the functionality of the device is established within an error measurement margin of 500 ms. This means that the system objectively indicates swim speed. As such, the system can be used as a support device in training as well as during empirical research.

Conclusions

During the validation tests the usefulness of the SPCS for the control of swim speed in real time with the aid of visual information was confirmed. SPCS can be used in swimming training and for research purposes. An advantage of the system is that it does not limit the movements of the swimmers, which can have a positive impact on their achievements in the water. Additionally, the device features wireless connectivity possibilities using Bluetooth technology and the ability for the application to function within a number of operating systems (Windows, Android, iOS).

Acknowledgments

Development of the “Swimming Pace Control System” (SPCS) was funded by a grant from “Young Scientists Research” 65/22/M/2016 and built by Creosiv Jacek Biernacki, PL.

References

Åstrand, P.O., Rodahl, K., Dahl, H., Stromme, S.B. (2003). *Textbook of Work Physiology. Physiological Bases of Exercise* (4 ed.). Champaign, Illinois: Human Kinetics.

Bächlin, M., Tröster, G. (2012). Swimming performance and technique evaluation with wearable acceleration sensors. *Pervasive and Mobile Computing*, *8* (1), 68–81.

Barbosa, T., Keskinen, K., Fernandes, R., Colaço, P., Lima, A., Vilas-Boas, J.P. (2005). Energy cost and intracyclic variation of the velocity of the centre of mass in butterfly stroke. *European Journal of Applied Physiology*, *93*, 519–523.

Callaway, A.J., Cobb, J.E., Jones, I. (2009). A comparison of video and accelerometer based approaches applied to performance monitoring in swimming. *International Journal of Sports Science & Coaching*, *4* (1), 139–153.

Carroll, W., Bandura, A. (1990). Representational guidance of action production in observational learning: A causal analysis. *Journal of Motor Behavior*, *22*, 85–97.

Chinnasamy, C., St Clair Gibson, A., Micklewright, D. (2013). Effect of spatial and temporal cues on athletic pacing in schoolchildren. *Medicine & Science in Sports & Exercise*, *45* (2), 395–402.

Chow, J.W., Carlton, L.G., Ekkekakis, P., Hay, J.G. (2000). A web-based video digitizing system for the study of projectile motion. *Physics Teacher*, *38*, 37–40.

Costill, D.L., Thomas, R., Robergs, R.A., Pascoe, D., Lambert, C., Barr, S., Fink, W.J. (1991). Adaptations to swimming training: influence of training volume. *Medicine and Science in Sports and Exercise*, *23*, 371–377.

Davey, N.P., Anderson, M.E., James, D.A. (2005). An Accelerometer-Based System for Elite Athlete Swimming Performance Analysis. In: S.F. Al Sarawi (ed.), *Smart Structures, Devices, and System II* (pp. 409–415). Sydney, Australia: Proceedings of the SPIE, 5649.

Eskofier, B., Kugler, P., Melzer, D., Kuehner, P. (2012). Embedded Classification of the Perceived Fatigue State of Runners: Towards a Body Sensor Network for Assessing the Fatigue State during Running. In: Guang-Zhong Yang (ed.), *Proc. 9th International Conference on Wearable Implantable Body Sensor Network* (pp. 113–117). London: IEEE.

Fernandes, R.J., Cardoso, C.S., Soares, S.M., Ascensão, A., Colaço, P.J., Vilas-Boas, J.P. (2003). Time limit and VO_2 slow component at intensities corresponding to VO_2max in swimmers. *International Journal of Sports Medicine*, *24* (8), 576–581.

Gonzalez, V., Sanchis, E., Villalobos, M., Brizuela, G., Llana, S., Tella, V. (2002). A new electronic system for the control of swimming speed. In: J.C. Chatard (ed.), *Book of abstract: Biomechanics and Medicine in Swimming IX* (pp. 67–69). France: Publications de l'Université de Saint-Étienne.

Hay, J.G. (2002). Cycle rate, length and speed of progression in human locomotion. *Journal of Applied of Biomechanics*, *18*, 257–270.

Hohmann, A., Fehr, U., Kirsten, R., Krueger, T. (2008). Biomechanical analysis of the backstroke of the start technique in swimming. *E-Journal Bewegung und Training*, *2*, 28–33.

Lees, A. (2002). Technique analysis in sports: a critical review. *Journal of Sports Sciences*, *20*, 813–828.

Micklewright, D., Angus, C., Suddaby, J., St Clair Gibson, A., Sandercock, G., Chinnasamy, C. (2012). Pacing strategy in schoolchildren differs with age and cognitive development. *Medicine & Science in Sports Exercise*, *44* (2), 362–369.

Ohgi, Y. (2002). Microcomputer-based acceleration sensor device for sports biomechanics, *Sensors*, *1*, 699–704.

Pelayo, P., Moretto, P., Robin, H., Sidney, M., Gerbeaux, M., Latour, M.G., Marc-Lavoie, J. (1995). Adaptation of maximal aerobic and anaerobic tests for disabled swimmers. *European Journal of Applied Physiology Occupational Physiology*, *71*, 512–517.

Pérez, P., Llana, S., Brizuela, G., Encarnación, A. (2009). Effects of three feedback conditions on aerobic swim speeds. *Journal of Sports Science and Medicine*, *8*, 30–36.

Proteau, L., Isabelle, G. (2002). On the role of visual afferent information for the control of aiming movements toward targets of different sizes. *Journal of Motor Behavior*, *34* (4), 367–384.

Scruton, A., Baker, J., Roberts, J., Basevitch, I., Merzbach, V., Gordon, D. (2015). Pacing accuracy during an incremental step test in adolescent swimmers. *Journal of Sports Medicine*, *6*, 249–257.

Seat, J.E., Wrisberg, C.A. (1996). The visual instruction system. *Research Quarterly for Exercise and Sport*, *67*, 106–108.

Slawson, S.E., Justham, L.M., West, A.A., Conway, P.P., Caine, M.P., Harrison, R., (2008). Accelerometer profile recognition of swimming strokes. *The Engineering of Sport*, *7*, 81–87.

Szczepan, S., Zatoń, K., Klarowicz, A. (2016). The effect of concurrent visual feedback on the controlled swimming speed. Polish Journal of Sport and Tourism. *Polish Journal of Sport Tourism*, *23*, 3–6.

Tanabe, S., Ito, A. (2007). A three-dimensional analysis of the contributions of upper limb joint movements to horizontal racket head velocity at ball impact during tennis serving, *Sports Biomechanics*, *6* (3), 418–433.

Toussaint, H.M., Truijens, M. (2005). Biomechanical aspects of peak performance in human swimming. Animal Biology, *55* (1), 17–40.

Turner, A., Smith, T., Coleman, S.G. (2008). Use of an audio-paced incremental swimming test in young national-level swimmers. *International Journal of Sports Physiology and Performance*, *3*, 68–70.

Wilmore, J.H., Costill, D., Kenney, W.L. (2008). *Physiology of Sport and Exercise*. Champaign, Illinois: Human Kinetics.

Zamparo, P., Pendergast, D., Mollendorf, J., Termin, A., Minetti, A. (2005). An energy balance of front crawl. *European Journal of Applied Physiology*, *94*, 134–144.

Zatoń, K., Kędrak, M., Rejman, M. (2016). Synchronized feedback (mirror image) and learning of symmetrical movement activities in breaststroke-kick swimming – pilot study. In: S. Szczepan (ed.), *Book of Abstract: The 8th International Symposium Science & Swimming* (pp. 54–55). Wroclaw: Ata-Druk.

Zatoń, K., Szczepan, S. (2014). The Impact of Immediate Verbal Feedback on the Improvement of Swimming Technique. *Journal of Human Kinetics*, *41*, 129–137.

Cite this article as: Szczepan, S., Zatoń, K. (2017). Validation of the New Visual Swimming Pace Control System in Real-Time. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 93–104. DOI: 10.18276/cej.2017.3-09.

PHYSICAL ACTIVITY AS A HEALTH NEED

Aleksander Olejnik,[1, D] Zofia Kubińska,[2, A, B, D] Anna Pańczuk,[2, B, D] Joanna Kubińska[3, D]

[1] I. Ya. Horbachevsky Ternopil State Medical University, Ukraine
[2] Pope John Paul II State School of Higher Education in Biała Podlaska, Poland
[3] John Paul II Catholic University of Lublin, Poland
[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation, [E] Funds Collection

Address for correspondence:
Joanna Kubińska
John Paul II Catholic University of Lublin
Department of Physical Activity and Sport
Konstantynów 1G, 20-708 Lublin, Poland
E-mail: kubanna@kul.pl

Abstract The scientific concept of human needs has an interdisciplinary nature and is associated with the standards of living and development, health and disease status, quality of life, and life satisfaction. Research results indicate that systematic physical activity at any ontogenesis period is of vital importance for optimal development and maintenance of physical efficiency, fitness, and health. Therefore, it has been assumed that physical activity is a health need of each man. The aim of the study is to find relationships between physical activity and health needs. The analysis was intended to reveal the importance, functions, and consequences of the impact of physical activity on the psychophysical condition of man based on examples from available literature. The relationships between physical activity and health needs have been presented from the perspective of public health and promotion targeted at improvement of public health in a way to ensure the best fulfilment of conscious and unconscious needs.
According to WHO, health needs are disturbances in the health status or social well-being that require intervention measures such as treatment, rehabilitation, or social assistance as well as prevention measures. Systematic moderate physical activity is one of the most important factors with a beneficial effect on human physiological processes and improves the quality of life. The National Health Programme for 2016–2020 recommends increased physical activity among children, adolescents, and the elderly.

Key words human needs, health needs, physical activity

Introduction

The effective information of the society, in every stage of ontogenesis, about a negative influence of the sedentary life style and a positive influence of physical activity on the health, is now a main task of health promotion and education (Jethon, 2013; Kasperczyk, 2000). It requires a support by the scientific research of experts, results of epidemiological studies and recommendations of World Health Organization (2010), as well, as by European and national strategies elaborated on their basis. A model, scientific concept, according to which the components of physical fitness make a health basis and can be advantageously modified by a systematically undertaken physical effort, is a concept of HRF (Health Related Fitness), defined by the Toronto model, elaborated by Bouchard,

Shepherd (1994). According to Jethon (2013), there is usually assumed, that a moderately intensive endurance training is the greatest health promotion and prevents different risk factors. Recently emphasized is, that other forms of exercise may be useful in health promotion. The great significance of physical activity for health, however, didn`t acquire a proper rank of a necessary (*conditio sine qua non)* factor. That`s why undertaken was an attempt of introduction of the physical activity as a health need. In the authors` opinion, it can contribute to its proper valuation. Currently the physical activity, because of its health advantages, is undertaken in Poland by only 12.3% of women and 7.4% of men (GUS, 2013).

Man is a creature with the ability to move, and systematic physical activity in each ontogenesis stage is essential for optimal development and maintenance of physical efficiency, fitness, and health. Therefore, it has been assumed that physical activity is very important health need in the life of every man.

The aim of the study is to find the relationships between physical activity and health needs. The analysis was intended to reveal the importance, functions, and consequences of the impact of physical activity on the psychophysical condition of man based on examples from available literature. The relationships between physical activity and health needs have been presented from the perspective of public health and promotion targeted at improvement of public health in a way to ensure the best fulfilment of conscious and unconscious social needs (Włodarczyk, 2007).

Health needs

In the usual sense, a need in human life always appears at the absence of something. The scientific notion of a need has an interdisciplinary character and is associated with standards of living and development, health and disease status, welfare, quality of life, and life satisfaction (Tobiasz-Adamczyk, 1996). The multidimensionality of needs is usually presented in terms of biology, psychology, sociology, economy, management, and medicine. In psychology, a need is referred to as a permanent condition of balance and development of a living organism, whereas a situation in which certain conditions are not fulfilled is termed deprivation of needs. A need is an objective phenomenon, and a man has as many needs as the number of conditions that have to be fulfilled to ensure development and reproduction (Reykowski, 1970). The hierarchical system of life needs developed by Maslov distinguishes basic needs and higher-order needs, which are activated when the basic needs are satisfied. Fulfilment of needs in the individual (biopsychic) and collective (social) dimensions is aimed at e.g. prevention of dysfunction in the performance of specific social roles, survival, personal development, and human freedom (Bednarz, 2008).

According to WHO, health needs are disturbances in the health status or social well-being that require intervention measures such as treatment, rehabilitation, or social assistance as well as prevention measures (Topór-Mądry, Gilis-Januszewska, Kurkiewicz, Pająk, 2002).

According to Maslov's concept, basic and higher-order life needs are characterised by the following correlations: failure to satisfy the needs results in diseases, fulfilment of the needs prevents diseases, and restoration of the needs eliminates diseases. Additionally, the needs are inactive and not perceived by a healthy person (Topór-Mądry et al., 2002). As suggested by Michalak (2011), the most general definition of health needs in social sciences describes them as deviations in the health of the patient or his environment, which require necessary steps to prevent adverse health effects. From the point of view of the healthcare staff-patient relationship, health needs are divided into expressed needs, i.e. reported by the patient spontaneously, and unexpressed needs, both conscious (known but not reported by the individual) and unconscious (not realised by the individual and

therefore not reported). This approach to needs renders them as a factor motivating individuals to undertake certain health-related behaviour, a rationale for taking certain actions, a criterion for allocation of healthcare resources, and a criterion of the rationality and legitimacy of the objectives of healthcare. From the organisational and economic point of view, health needs have been divided into real needs estimated based on epidemiological and demographic data, expressed needs related to individual and public expectations, and needs that have been satisfied by healthcare (Janaszczyk et al., 2012). The studies reported by Topór-Mądry et al. (2002) and Zarzeczna--Baran (2010) present four types of needs proposed by Bradshaw's classification of health needs. These include a normative need defined by experts or doctors as a need in a specific situation that can serve for comparison of desired and actual situations, felt need identified with a wish for specific health services, expressed need, i.e. a felt need turned into action, and comparative need, which can be important for allocation of healthcare resources. The concept of health needs related to the health status is usually associated with actions pertaining to the healthcare system, and the term "health needs" is used to describe needs expressed by individuals and addressed to the healthcare system. However, this narrow approach to health needs allows regarding them as factors and criteria of health (Zarzeczna-Baran, 2010). As suggested by Leowski (2008), all countries of the world are aware of the inevitability of the systematic growth of real and expressed health needs, which are determined by demographic and epidemiological transformations of society. The most important determinant of the increase in health needs and healthcare costs in medicine is the technological and biotechnological progress. It is bound mainly to increase expressed social needs within a short time.

The term of physical activity and its relation with health, according to the point of view of the selected authors

In literature, physical activity is defined and described in various ways. Drygas, Piotrowicz, Jegier, Kopeć, Podolec (2010), defines it as any body movement necessary for daily life or part of a workout program. The concept of physical activity is often used interchangeably with the term physical exercise. In the English-language definition proposed by Caspersen, Powell, Christenson (1985, p. 126), physical activity is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure". According to Woynarowska (2010), physical activity can be defined as a physical load (work of skeletal muscles accompanied by various functional changes in the organism, exercise, and energy expenditure) imposed on individuals in everyday life, school, work, play, and organised physical exercise. It is also reasonable to define physical activity as an essential component of lifestyle, i.e. health-related behaviour (Bejnarowicz, 1995; Woynarowska, 2008). Health-related behaviour is represented by all forms of targeted activity leading to protection or improvement of individual's health. Many of such activities are associated with personal responsibility and care for health, which are independent of current healthcare systems (Majchrowska, 2003; Słopiecka, Cieślik, 2011; Syrek, 2000).

As suggested by Biernat (2011), scientific discussion about the importance of physical activity for health was started in the fifties by studies conducted by Morris et al., who demonstrated correlations between the development of diseases and a sedentary lifestyle. Successive studies confirmed the impact of physical inactivity on many other chronic diseases. Physical activity was appreciated as early as by physicians in ancient Greece. Hippocrates (460–377 BC) regarded dietetics and gymnastics as the major fundamentals of medicine. He was the first to describe the application of cold, sun heat, light, and physical exercise in medical therapy. In his work "Ars Parva", Galen (130–200 AD) described the positive impact of movement on the development of the body; he also presented the types

and methods of exercise and systematised posture defects. Forerunners of treatment with physical activity can be found among Polish physicians, e.g. Wojciech Oczko (1537–1600), Stefan Batory's doctor and the father of Polish balneology, or Sebastian Petrycy of Pilzno (1554–1626), a distinguished physician, philosopher, and professor at Kraków University, who strongly recommended physical exercises, playing ball, and walks (Brzeziński, 2000).

Moderate physical activity that is recommended currently by experts, i.e. physical exercise causing a slightly increased breathing rate and a slightly accelerated heart rate, has health effects on the organism. This type of activity is perceived subjectively as pleasant and not strenuous. The energy expenditure related to this type of exercise does not exceed 4–6 MET [*Metabolic Equivalent* – amount of oxygen in inhaled air (VO_2) at rest and utilised by the organism] (Drygas et al., 2010). Intense physical activity denotes a heavy effort leading to a substantially increased breathing rate (and an accelerated heart rate). As reported by Rutkowska (2012), already 150 years ago physicians in Poland not only appreciated but also postulated precise doses of physical activity. The author mentions the basic functions of physical activity described by theorists of physical education. The stimulatory function considerably stimulates development in childhood and adolescence, maintains the level of efficiency and performance in adulthood, and mitigates the effects of involutional changes in old age. Adaptive function adjusts organisms to environmental requirements and exercise (habituation) in adolescence and to the specificity of professional work in adulthood. Compensatory and corrective functions are stimuli balancing the effects of inactivity and one-sided overload of the organisms in every stage of life. As indicated by Woynarowska (2010), physical activity plays a preventive role in development of health disorders (obesity, atherosclerosis, arterial pressure) and has a therapeutic function in treatment of many conditions, including obesity, diabetes, asthma, cerebral palsy, and disorders of the musculoskeletal system.

As suggested by Drygas et al. (2010), the positive effect of exercise on organism functions in the elderly and on the *successful ageing* phenomenon should not be underestimated. Regular physical activity has a beneficial effect on mental alertness and prevents memory impairment. In another study, the author emphasises that physical exercise is a protective factor independent of the genetic background and other biological and socio-economic risk factors. Physical activity is useful in the prophylaxis and treatment of many age-related diseases (coronary artery disease, hypertension, obesity, hypercholesterolemia, diabetes, and osteoporosis) (Gray, Di Brezzo, Fort, 2013; Kopiczko, Wierzbicka, 2014; Kostka, 2010; Saravi, Sayegh, 2013; Sygit, 2015). The results of investigations conducted by Kostka (2010) confirm that physical activity is the most potent determinant preventing disability and one of the most important factors mitigating the impact of age on health. The author has found that physical exercise can be regarded as a common element in all prevention and rehabilitation activities, regardless of the elderly patient's health status and fitness.

The prophylactic and therapeutic efficacy of physical activity, repeatedly supported empirically, initiated an American program (American College of Sports Medicine, American Medical Association) Exercise is Medicine (EIM). Since 2007, in line with the strategy of the EIM program, physical activity has been part of practice aimed at prevention, alleviation of symptoms, and treatment of chronic diseases as well as improvement of the quality of life in over 40 countries in the world (Berryman, 2010; Lobelo, Stoutenberg, Hutber, 2014; Tipton, 2014). The EIM program is being increasingly popularised in Poland by two forerunners from the foundation "Zaskoczeni wiekiem" [Surprised with age]: doctor Plucik-Mrożek and fitness instructor Perl. The combination of medicine and fitness has yielded a new trend referred to as medical trend, which is focused on prevention of lifestyle diseases by promotion of physical activity and healthy lifestyle. This is important for individuals affected by health problems who want to feel

good despite the disease. Thanks to the combined work of coaches, physicians, and dieticians, the program offers professional care of health and psychophysical status. Medical fitness activates patients with chronic diseases in a safe and conscious manner. Who can claim that a patient with cardiovascular and heart diseases or type 2 diabetes, obesity, or cancer should not be physically active? (Plucik-Mrożek, Perl, 2016).

The "Healthy People 2010" initiative of the US Department of Health and Human Services has established a list of 10 indicators for assessment of the population health status for the decade 2010–2020. Physical activity has been identified as the first of the five determinants of health. Experts recommend 20-minute physical exercise at least 3 times a week to adolescents and 30-minute daily physical activity to adults (National Center for Health Statistics, 2012). As shown by the results of analyses of the indicators of the quality of primary healthcare and health needs performed by a group of experts from 9 OECD countries, physical activity has been classified in the health promotion group together with five other indicators (Marshall et al., 2006).

Since the beginning of the 90 s, each edition of the National Health Programme (NHP) in Poland has emphasised the importance of the educational and practical impact of physical activity as an operational target. The program for 2016–2020 stresses the need for taking action to increase physical activity in society. It emphasises that physical activity is important throughout the lifetime; however, its role in prevention of overweight and obesity among children and adolescents and in old-age prophylaxis justify the concern about these two age groups (Narodowy Program Zdrowia na lata 2016–2020). The NHP guidelines are included in provincial and local government reports on the health status and are a basis for mapping health needs. The latest report on the health status and health needs of the inhabitants of Lublin Province, prepared for development of health policy programs for 2016–2021, defines health needs in two aspects: health impairment and actions undertaken to reduce or eliminate the problem. With its therapeutic-preventive effect, which can mitigate or eliminate identified health problems, physical activity has been included in 5 health programs, i.e. prevention of cardiovascular disease, reduction of the high incidence of cancer, early diagnosis of diabetes, maintenance of normal body weight, and prevention of the negative consequences of musculoskeletal diseases (Florek-Łuszczki et al., 2015).

Summary

The analysis of studies confirming positive relations of physical activities with health, according to selected authors, revealed also their method of describing it. It can be stated, that there is no unanimity in its naming. Different authors defined it as: gymnastics, mobility, physical effort, physical burden, the work of skeletal muscles, a component of a life style, health behavior, exercise, protective factors, preventive-rehabilitation activities, medical fitness, health determinant, medical-preventive action, health promoting physical activity, whereas according to Drygas et al. (2010) – an underestimated health factor. It must be pronounced, that those different terms show selected functions of physical activity, but also cause a certain dispersion. A contemporary man, determined by a sedentary and consuming life style, demands clear-cut terms, which names stimulate and bring an information about the social status of physical activity as a duty and necessity, contrary to some leisure time activities. Even the creators of the European health policy gave the high rank to the physical activities, emphasizing in the 2nd Article of the European Union Council Recommendations, that the physical activity conditions the healthy life style and good health status of workers, contributes to achieving the main goals defined in the strategy "Europe 2020", especially in relation to economical growth, efficiency and health (Zalecenia Rady Unii Europejskiej, 2013). By way of conclusion of the information, it is reasonable to underline the relevance of the assumption that physical activity

serving as an element of prevention, prophylaxis, therapy, and mitigation or elimination of health disturbances is a real and expressed need in the life of every man. However, knowledge of the health consequences of physical activity has no causal power and only minimally contributes to changes in the awareness and beliefs, stimulation of motivation, and minimisation of sedentary behaviour. Theoretical strategies of health policy-makers do not change the current situation, as they cannot overcome the barrier of financial resources. Similarly, the phenomenon of imposing individual commitment and responsibility for own health and that of other individuals, which was stressed in Poland during the transformation period, does not produce expected results. Various studies confirm that the educational and scientific activities in the realm of public health as well as promotion of health, physical culture, and medicine are not reflected in individual and public physical activity. Given the unsatisfactory epidemiological and demographic results, American and European experts offer an increasing, diverse range of health (prophylactic) programs, attractive individual activities, and available physical activity infrastructure. The decision to take up physical activity remains to be made by individuals.

References

Bednarz, M. (2008). *Polityka społeczna jako zaspokajanie istotnych potrzeb społecznych*. Bydgoszcz: Kujawsko-Pomorska Szkoła Wyższa w Bydgoszczy.

Bejnarowicz, J. (1995). Zmiany stylu życia i stanu zdrowia ludności Polski. In: Z. Czaplicki, W. Muzyka (ed.), *Styl życia a zdrowie. Dylematy teorii i praktyki*. Olsztyn: Polskie Towarzystwo Pedagogiczne.

Berryman, J.W. (2010). Exercise is medicine: a historical perspective. *Curr Sport Med Rep*, *9*, 195–201.

Biernat, E. (2011). *Aktywność fizyczna mieszkańców Warszawy na przykładzie wybranych grup zawodowych*. Warszawa: Oficyna Wydawnicza Szkoła Główna Handlowa w Warszawie.

Bouchard, C., Shepard, R.J. (1994). Physical activity, fitness, and health: the model and key concepts. In: C. Bouchard, R.J. Shepard (eds.), *Physical activity, fitness, and health* (pp. 77–88). Champaign: Human Kinetics.

Brzeziński, T. (ed.) (2000). *Historia medycyny*. Warszawa: PZWL.

Caspersen, C.J., Powell, K.E., Christenson, G.M. (1985). Physical activity, exercise and Physical fitness: definitions for health-related research. *Public. Health Rep.*, *100* (2), 126–131.

Drygas, W., Piotrowicz, R., Jegier, A., Kopeć, G., Podolec, P. (2010). Aktywność fizyczna u osób zdrowych. In: P. Podolec (ed.), *Podręcznik Polskiego Forum Profilaktyki* (vol. 2, pp. 437–446). Kraków: Medycyna Praktyczna.

Florek-Łuszczki, M., Lachowski, S., Kowalczyk-Bołtuć, J., Dziemidok, P., Jaworska, J., Tochman-Gawda, A., Szcześniak, G., Paprzycki, P., Janowska, A., Cisak, E., Wójcik-Fatla, A., Zając, V., Sawczyn, A., Kloc, A., Sroka, J., Dutkiewicz, J., Saran, T., Maruszewska, A., Bajor, I. (2015). *Ocena stanu zdrowia oraz określenie potrzeb zdrowotnych mieszkańców województwa lubelskiego na potrzeby opracowywania programów polityki zdrowotnej realizowanych przez Samorząd Województwa Lubelskiego w latach 2016–2021*. Lublin: Urząd Marszałkowski Województwa Lubelskiego. Retrieved from: http://www.lubelskie.pl/img/userfiles/files/Ocena.pdf.

Gray, M., Di Brezzo, R., Fort, I.L. (2013). The effects of power and strength training on bone mineral density in premenopausal women. *J Sports Med Phys Fitness*, *53* (4), 428–436.

GUS (2013). *Uczestnictwo Polaków w sporcie i rekreacji ruchowej w 2012 r.* Retrieved from: http://stat.gov.pl/cps/rde/xbcr/gus/KTS_uczestnictwo_polakow_w_sporcie_2012.pdf (20.04.2017).

Janaszczyk, A., Sobczak, K., Gajewska, M., Leoniuk, K., Nowakowska, H., Zarzeczna-Baran, M., Wojdak-Haasa, E., Sut, P., Krakowiak, P. (2012). Główne pojęcia konstytuujące perspektywę filozoficzno-społeczną w naukach o zdrowiu. In: A. Janaszczyk, L. Wengler, P. Popowski, P. Pietrzak, I. Andrych-Brzezińska, E. Adamska-Pietrzak, K. Sobczak, E. Bandurska (eds.), *Filozoficzne, społeczne i prawne aspekty nauk o zdrowiu. Cz. I. Filozoficzne i społeczne aspekty nauk o zdrowiu* (pp. 12–67). Gdańsk: Polskie Towarzystwo Programów Zdrowotnych.

Jethon, Z. (2013). Physical activity as a distress. *Hygeia Public Health, 48* (2), 156–161.

Kasperczyk, T. (2000). Poziom sprawności i aktywności fizycznej a zdrowie. *Nowa Medycyna*, *12*. Retrieved from: http://www.czytelniamedyczna.pl/1609,poziom-sprawnosci-i-aktywnosci-fizycznej-a-zdrowie.html (20.04.2017)

Kopiczko, A., Wierzbicka, E. (2014). Stan zmineralizowania tkanki kostnej kobiet uczęszczających na zajęcia fitness. *Medycyna Rodzinna, 2*, 54–58.

Kostka, T. (2010). Aktywność fizyczna u osób w podeszłym wieku. In: P. Podolec (ed.), *Podręcznik Polskiego Forum Profilaktyki T. 2* (pp. 455–460). Kraków: Medycyna Praktyczna.

Leowski, J. (2008). *Polityka zdrowotna a zdrowie publiczne*. Warszawa: CeDeWu.

Lobelo, F., Stoutenberg, M., Hutber, A. (2014). The Exercise is Medicine Global Health Initiative: a 2014 update. *Br J Sports Med, 48*, 1627–1633.

Majchrowska, A. (2003). Zachowania zdrowotne-aspekty socjologiczne. In: A. Majchrowska (ed.), *Wybrane elementy socjologii* (pp. 293–316). Lublin: Wydawnictwo Czelej.

Marshall, M., Klazinga, N., Leatherman, S., Hardy, C., Bergmann, E., Pisco, L., Mattke, S., Mainz, J. (2006). OECD Health Care Quality Indicator Project. The expert panel on primary care prevention and health promotion. *Int. J. Qual. Health Care*, *18*, 21–25.

Michalak, J. (2011). Potrzeby zdrowotne a systemy zapewnienia jakości w opiece zdrowotnej. *Studies & Proceedings of Polish Association for Knowledge Management*, *55*, 52–61.

Narodowy Program Zdrowia na lata 2016–2020. In: Dziennik Ustaw Rzeczypospolitej Polskiej. Rozporządzenie Rady Ministrów z dnia 4 sierpnia 2016 r. w sprawie Narodowego Programu Zdrowia na lata 2016–2020.

National Center for Health Statistics (2012). *Healthy People 2010 Final Review*. Hyattsville, MD.

Plucik-Mrożek, A., Perl, M. (2016). Zaskoczeni wiekiem – wyćwicz swoje zdrowie. Retrieved from: http://zaskoczeni.com.pl/index.php/fitness-medyczny.

Reykowski, J. (1970). Natura ludzka a potrzeby. *Etyka*, *6*, 35–37.

Rutkowska, E. (2012). Ocena aktywności fizycznej w badaniach podmiotowych. *Zamojskie Studia i Materiały. Fizjoterapia*, *1* (35), 119–125.

Saraví, F.D., Sayegh, F. (2013). Bone Mineral Density and Body Composition of Adult Premenopausal Women with Three Levels of Physical Activity. *Journal of Osteoporosis*. DOI: 10.1155/2013/953271.

Słopiecka, A., Cieślik, A. (2011). Zachowania zdrowotne – wybrane definicje. *Studia Medyczne*, *24* (4), 77–82.

Sygit, K. (2015). Fundamental significance of physical activity for seniors' health. *Central European Journal of Sport Sciences and Medicine*, *12* (4), 53–59. DOI: 10.18276/cej.2015.4-06.

Syrek, E. (2000). *Zdrowie w aspekcie pedagogiki społecznej.* Katowice: Wydawnictwo Uniwersytetu Śląskiego.

Tipton, C.M. (2014). The history of "Exercise Is Medicine" in ancient civilizations. *Advances in Physiology Education*, *38* (2), 109–117. DOI: 10.1152/advan.00136.2013.

Tobiasz-Adamczyk, B. (1996). Jakość życia w naukach społecznych i medycynie. *Sztuka leczenia*, *2*, 33–40.

Topór-Mądry, R., Gilis-Januszewska, A., Kurkiewicz, J., Pająk, A. (2002). *Szacowanie potrzeb zdrowotnych*. Kraków: Vesalius.

Włodarczyk, C.W. (2007). *Zdrowie publiczne w perspektywie międzynarodowej. Wybrane problemy.* Kraków: Wydawnictwo Uniwersytetu Jagiellońskiego.

World Health Organization (2010). Global Recommendations on Physical activity for Health. Retrieved from: http://apps.who.int/iris/bitstream/10665/44399/1/9789241599979_eng.pdf (20.04.2017).

Woynarowska, B. (2008). *Edukacja prozdrowotna*. Warszawa: Wydawnictwo Naukowe PWN.

Woynarowska, B. (2010). Aktywność fizyczna w dzieciństwie i młodości. In: P. Podolec (ed.), *Podręcznik Polskiego Forum Profilaktyki T. 2* (pp. 461–466). Kraków: Medycyna Praktyczna.

Zalecenia Rady Unii Europejskiej z dnia 26 listopada 2013 r. w sprawie propagowania we wszystkich sektorach prozdrowotnej aktywności fizycznej (2013/C 354/01). Retrieved from: http://erasmusplus.org.pl/wp-content/uploads/2014/01/HEPA_Zalecenie_Rady.pdf (20.04.2017).

Zarzeczna-Baran, M. (2010). Potrzeby zdrowotne. Baza programów zdrowotnych województwa pomorskiego. Retrieved from: http://ptpz.home.pl/bazaprogramow.zdrowiedlapomorzan.pl/public_html/upload/Potrzeby%20zdrowotne.pdf (20.04.2017).

Cite this article as: Olejnik, A., Kubińska, Z., Pańczuk, A., Kubińska, J. (2017). Physical Activity as a Health Need. *Central European Journal of Sport Sciences and Medicine*, *19* (3), 105–111. DOI: 10.18276/cej.2017.3-10.

Guide for Authors

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

Preparation of manuscripts

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

All experimental work in which humans are participants must conform to the laws of the country in which the work took place. The manuscript should contain a statement to the effect that the work reported has been approved by a local ethics committee or review board. The statements about ethics approval or sources of data should be made at the beginning of the methods section.

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

Title page

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

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

Abstract

The abstract should be placed on individual page (second page of the manuscript) and must not exceed 200 words and it must summarize the paper, giving a clear indication of the conclusions it contains.

Tables and illustrations

Illustrations (photographs and line drawings) and tables must not be included in the text file. The table(s) and figure(s) have to be submitted as separated, source file(s). Table(s) files should be prepared as .doc files. Tables, referred to as 'Table 1', 'Table 2', and so on, must be numbered in the order in which they occur in the text. Illustrations should be prepared referred to as 'Figure 1', 'Figure 2', and so on, must be numbered in the order in which they occur in the text. Diagrams and drawings should be produced using a computer drawing or graphics package at the appropriate resolution. It is in the Author's interest to provide the highest quality figure format possible. Colour figures will be reproduced in the on-line edition of the journal free of charge, in the print version all figures will be reproduced in the greyscale. If you wish to have figures in colour online and black and white figures printed, please prepare both versions.

References

All references must be alphabetized by surname of first author and numbered at the end of the article. Please use APA style for references and citations (see the files "A guide to APA English" and "Styl APA-WNUS Polish" on our website).

Submission of manuscripts

All manuscripts, correspondence and editorial material for publication should be submitted online to: e-mail: joanna.latka@usz.edu.pl and cejssm@gmail.com.

The entire peer-review process will be managed electronically to ensure timely review and publication.

PLEASE NOTE that papers will NOT be assigned for peer review until they are formatted as outlined in the Guide for Authors. The review process will consist of reviews by at least two independent reviewers. Contributors may suggest the names and full contact details of 2 possible reviewers. The reviewers must not be from the same institutions as the authors. The Editor may, at his or her discretion, choose no more than one of those suggested. The reviewers will be blinded to the authorship of the manuscript. The Editor will make a final decision about the manuscript, based on consideration of the reviewers' comments. The journal's Editorial Board does not enter into negotiations once a decision on a manuscript has been made. The Editor's decision is final.

Authors will be asked to sign a transfer of copyright form. This enables the publisher to administer copyright on behalf of the authors and the society, while allowing the continued use of the material by the author for scholarly communication.

ISSN 2300-9705

71-101 Szczecin, ul. Mickiewicza 66
tel. 91 444 20 06, 91 444 20 12
e-mail: wydawnictwo@univ.szczecin.pl
www.wn.usz.edu.pl