Table 1: Frequencies of the individual variables

Variable	Description	Frequency [n]	Percent [%]
Dependent variable			
Shooting performance	Successful	99	48.1
	Unsuccessful	107	51.9
Independent variables			
Defensive pressure	Low	112	54.4
	Moderate	61	29.6
	High	33	16
Ball possession duration	0–8 s	105	51
	9–16 s	83	40.3
	17–24 s	18	8.7
Intensity of load	<85% of HR_{max}	25	12.1
	85-95% of HR_{max}	145	70.4
	>95% of HR_{max}	36	17.5
Shooting distance	<2.5 m	140	68
	2.5–6.75 m	43	20.9
	>6.75 m	23	11.2
Period	1st	61	29.6
	2nd	49	23.8
	3rd	53	25.7
	4th	43	20.9

Table 2: Variables in the final model

		B	SE	Wald	df	p value	Exp(B)	95% CI for Exp(B)	
								Lower	Upper
Step 4	Defensive pressure			20.106	2	0			
	Defensive pressure(1)	-0.694	0.415	2.797	1	0.094	0.5	0.222	1.127
	Defensive pressure(2)	1.57	0.5	9.848	1	0.002*	4.805	1.803	12.808
	Shooting distance			15.566	2	0.000*			
	Shooting distance(1)	1.651	0.459	12.941	1	0.000*	5.214	2,12	12.821
	Shooting distance(2)	1.503	0.558	7.254	1	0.007*	4.493	1,506	13.411
	Constant	-0.461	0.293	2.479	1	0.115	0.631		

* Statistically significant

As s in Okazaki & Rodacki (2012) and Miller & Bartlett (1996), we may also state that the shooting distance is a statistically significant predictor of shooting successfulness. These authors verified this statement under artificial conditions but in our case we demonstrated, as Gómez et al. (2015), that shooting distance was also a predictor in the actual game. This study, as Csataljay et al. (2013), confirms the influence of high defensive pressure on shooting successfulness. Ball possession duration, period and intensity of load are factors which do not affect the shooting performance. Vencurik (2015) also proves that the intensity of load is an insignificant factor. On the other hand, we believe that also other contextual factors are necessary to include for the analysis of shooting successfulness. Our recommendation, as in Erčulj & Štrumbelj (2015), is to include, e.g. the type of defense, score difference, loss or win, etc.

Conclusion

Based on this study, we recommend to practice shooting under high defensive pressure and from all horizontal distances to increase the shooting performance. Nevertheless, analysis of thousands of field goal attempts under the actual game conditions is needed to reach more generally applicable conclusions.

Acknowledgements

This publication was written at Masaryk University as part of the project "Identification of endogenous and exogenous factors affecting the motor skills in women's basketball" number MUNI/51/10/2017.

References

1. Álvarez, A., Ortega Toro, E., Salado, J., & Gómez, M. Á. (2009). Study of the defensive performance indicators in peak performance basketball. *Revista de Psicología del Deporte*, *18*, 0379-384.
2. Ben Abdelkrim, N., Castagna, C., Jabri, I., Battikh, T., Fazaa, S.E. & Ati, J.E. (2010). Activity profile and physiological requirements of junior elite basketball players in relation to aerobic-anaerobic fitness. *Journal of Strength and Conditioning Research*, *24*(9), 2330-2342.
3. Csataljay, G., James, N., Hughes, M. & Dancs, H. (2013). Effects of defensive pressure on basketball shooting performance. *International Journal of Performance Analysis in Sport*, *13*(3), 594-601.
4. Erčulj, F. & Supej, M. (2009). Impact of Fatigue on the Position of the Release Arm and Shoulder Girdle over a Longer Shooing Distance for an Elite Basketball Player. In *Journal of Strength and Conditioning Research*, *23*(3), 1029-1036.
5. Erčulj, F., & Štrumbelj, E. (2015). Basketball Shot Types and Shot Success in Different Levels of Competitive Basketball: e0128885. *PLoS One*, *10*(6).
6. Gómez, M., Alarcón, F., & Ortega, E. (2015). Analysis of shooting effectiveness in elite basketball according to match status. *Revista de Psicologia del Deporte*, *24*(3), 37-41.
7. Hughes, M. D., & Bartlett, R. M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, *20*(10), 739-754.
8. Ibáñez, S.J., García, J., Feu, S., Lorenzo, A. & Sampaio, J. (2009). Effects of consecutive basketball games on the game-related statistics that discriminate winner and losing teams. In *Journal of Sports Science and Medicine*, *8*(3), 458-462.
9. Landau, S., & Everitt, B. (2004). *A handbook of statistical analyses using SPSS*. Boca Raton: Chapman & Hall/CRC.
10. Léger, L.A., Mercier, D., Gadoury, C. & Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Sciences*, *6*, 93-101.
11. Miller, S. & Bartlett, R. (1996). The relationship between basketball shooting kinematics, distance and playing position. In *Journal of Sports Sciences*, *14*, 243-253.
12. Okazaki, V.H.A. & Rodacki, A.L.F. (2012). Increased distance of shooting on basketball jump shot. In *Journal of Sports Science and Medicine*, *11*, 231-237.
13. O'Donoghue, P. (2010). *Research methods for sports performance analysis*. London: Routledge.
14. Rojas, F. J., Cepero, M., Ona, A., & Gutierrez, M. (2000). Kinematic adjustments in the basketball jump shot against an opponent. *Ergonomics*, *43*(10), 1651-1660.
15. Vencurik, T. (2015). Can the intensity of game load affect the shooting performance in basketball? *Journal of Human Sport and Exercise*, *11*(Proc1), 201-206.

DIFFERENCES BETWEEN WINNING AND DEFEATED HANDBALL TEAMS IN COMPETITION PERFORMANCE INDICATORS

Dinko Vuleta[1], Nenad Rogulj[2], Dragan Milanović[1]

[1]Faculty of Kinesiology, University of Zagreb, Croatia
[2]Faculty of Kinesiology, University of Split, Croatia

Summary

The aim was to find out differences between the winning and defeated women and men's handball teams in game performance indicators. The sample of entities was comprised of 60 winning (30 men's and 30 women's) teams and 60 defeated (30 men's and 30 women's) teams participating in the preliminary round of the handball tournament at the London Olympic Games in 2012. Seventeen variables were occurrence frequencies of both the completed and unsuccessfully executed technical-tactical elements of finishing actions in attack and defence. Canonical discriminant analysis was used to establish the differences between the winning and defeated teams in game performance indicators. The significant differences were obtained in six variables. The winning teams scored significantly higher in the following variables: fast-break shot scored (p=.01), long range (9-line) shot scored (p=.02), short range (6m-line) shot scored (p=.04), and in one variable of play in defence: blocked balls/shots (p=.03), whereas the defeated teams scored higher in the breakthrough shot scored (p=.01) and long range (9-line) shot missed (p=.03). These differences contributed significantly to the match final outcome. The applied system of handball game performance indicators was proven good in explaining the differences between the winning and defeated men and women's handball teams and, consequently, in explaining the determinants of match final outcomes.

Key words: *handball, competition performance, men's handball, women's handball, canonical discriminant analysis, 2012 Olympic Games*

Introduction

Objective indicators of game performance or situation-related efficiency of players and teams provide optimal opportunities to rationally assess players' fitness and preparedness for the match played as well as their individual contribution in the certain phases of the game.

Within research of numerous technical-tactical (TE-TA) elements of handball game with winning and defeated men's teams (Czerwinski, 1998; Rogulj, et al., 2011., Foretić, i sur., 2011; Hianik, 2011; Skarbalius, 2011; Vuleta, et al., 2009, 2011, 2015) it has been established that the winning teams perform much more short-lasting attacks (fast-breaks and counter-attacks) against the not yet consolidated defence, which are usually finished by breakthroughs or open realization from the 6m-line. Contrary, the defeated teams perform more positional intermittent attacks against consolidated defence, due to which they are usually forced to overlong their TE-TA activities in attack.

Research of handball game with winning and defeated women's teams (Yamada, Aida, Fujimoto, & Nakagawa, 2014; Taborski, 2013; Varbanov, 2013; Ohnjec, et al., 2008; Hianik, 2007; Vurgun, Işik, Şahan, & Işik, 2014) has revealed statistical significance of the number of scored long range shots, performed by backcourt players, and of the number of short range shots (performed from the wing and pivot positions) for the match final outcome.

The aim of this research was specific since our goal was to determine the presupposed differences between the winning men and women's handball teams and defeated men and women's handball teams, the participants of the Olympic handball tournament in London in 2012, in the indicators of their game performance or situation-related efficiency. In this way we expected to provide an answer to the question which variables of game performance differentiated the most between the winning and defeated handball teams.

It was hypothesized that:

H1 – the statistically significant difference exists between the winning and defeated women and men's handball teams in game performance indicators;

H2 – the contribution of individual variables to either victory or defeat in handball matches is variable.

Methods

The sample of entities consisted of 30 men's and 30 women's handball matches (which gave a total of 60+60 opponents) played during the preliminary round (group phase) at the 2012 Olympic Games in London. By 12 national handball teams competed in the men's and women's parts of the handball tournament.

In our study we used data collected from altogether 60 handball matches played by 120 opposing team participants. The total number of 120 entities was big enough, under the established number of degrees of freedom, to allow for testing of the specified hypotheses.

The sample of variables consisted of occurrence frequencies of completed and attempted TE-TA elements of actions performed during handball games in the phases of defence and attack. These data were objective recordings of teams' situation-related efficiency indicators (notation analysis; game statistics). The data were compiled from the IHF official statistics data, published on the IHF official internet site at www.ihf.info/. Most variables (14 out of 17) were numerical indicators of game performance in attack, whereas the rest of three indicators of TE-TA activities referred to play in defence.

Canonical discriminat analysis was used to establish the differences between the winning and defeated men and women's handball teams in game performance variables. Statistical significance of global differences between the two groups of teams was tested using the Burttlet's χ^2-test. The level of statistical significance was set at p=.05.

Results

Table 1: Discriminant analysis of the winning and defeated teams' play as manifested in handball game performance (situation-related effectiveness) indicators

df	λ	Rc	Wilks' λ	χ^2	df	p
1	1.14	0.73	0.47	77.87	17	0.00

Note: DF – number of discriminant functions; λ – variance of the discriminant function; Rc – coefficient of canonical discrimination; Wilks' λ – Wilks' lambda; χ^2 test – Burttlet's Chi-square test; df – degrees of freedom; p – error of statistical inference.

The obtained canonical discriminat function (Table 1) differentiated between the groups of winning and defeated teams at the 0.01 (p<.01) significance level together with a high coefficient of canonical discrimination (Rc=.73). Such a high coefficient of thee Burttlet's χ^2-test of canonical discrimination suggests a globally significant difference between the analysed groups of handball teams in the game performance indicators. Victory in handball game depends on a specific structure of TE-TA actions in attack and defence which are finished by the performance of only limited number of TE-TA elements. Performance of these finishing actions can be expressed as situation-related efficiency or game performance indicators of play in defence and attack. A research question arises here: Which game performance indicators are we talking about here?

Table 2: Discriminant analysis of the differences between the winning and defeated men and women's handball teams in game performance indicators

	Mean WINN.	SD WINN.	MAX D WINN.	Mean DEFT.	SD DEFT.	MAX D DEFT.	F-remove (1,101)	p-value	FACT. STR.	STAND. COEFFIC. CAN. VAR.
ŠUT6MUS	5.20	2.51	0.14	4.68	2.62	0.15	4.48	***0.04****	0.28	**0.46**
ŠUT6MNE	2.30	1.63	0.24	1.73	1.67	0.17	1.27	0.26	-0.05	-0.18
ŠUTKRUS	4.03	2.04	0.20	3.83	1.96	0.16	2.42	0.12	0.19	0.26
ŠUTKRNE	3.35	1.39	0.19	2.95	1.71	0.20	1.62	0.21	-0.05	-0.20
ŠUT9MUS	7.73	3.03	0.09	6.70	3.10	0.13	5.43	***0.02****	0.15	**0.45**
ŠUT9MNE	11.67	5.53	0.14	11.95	4.26	0.10	4.87	***0.03****	-0.54	**-0.40**
ŠUT7MUS	2.47	1.52	0.16	2.73	1.93	0.15	0.05	0.83	0.06	-0.04
ŠUT7MNE	0.80	0.86	0.22	1.05	1.14	0.26	1.42	0.24	-0.20	-0.19
ŠUTKOUS	4.15	2.79	0.13	4.05	2.49	0.15	6.45	***0.01****	0.46	**0.49**
ŠUTKONE	1.30	1.17	0.24	1.37	1.37	0.22	1.21	0.27	0.01	-0.17
ŠUTPRUS	2.63	1.68	0.15	3.17	2.04	0.18	6.40	***0.01****	0.24	**0.41**
ŠUTPRNE	1.18	1.35	0.23	1.38	1.30	0.22	3.51	0.06	0.10	0.31
ASISTEN	13.52	5.24	0.10	12.62	3.98	0.15	0.30	0.59	0.41	-0.12
IZGULOP	12.58	4.04	0.08	15.88	5.08	0.13	0.06	0.80	-0.22	-0.05