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Original Article

Performance indicators and competition ranking in women's and men's World Handball Championship 2017

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Abstract:
The study aimed to evaluate the efficacy of performance indicators to influence the final team ranking in the 2017 men's and women's World Handball Championship. Nine teams were selected based on their final ranking and were divided into three groups (n=144 in each group), as follows: Top-ranked group (1st, 2nd and 3rd ranked teams), middle-ranked group (9th, 10th and 11th ranked teams), and low-ranked group (22nd, 23rd and 24th ranked teams) for the men and the women, respectively. Data for eight performance indicators (comprising the anthropometric, the expertise and the scoring index) was obtained from the official Box Scores of the International Handball Federation http://www.ihf.info. Statistics included descriptive measures (mean ± standard deviation), one way analysis of variance followed by post hoc comparisons (with Bonferroni correction) for the group ranking group differences, non-parametric Spearman's Rho correlation analysis for the relation of performance indicators to team ranking, and a three component factor analysis (varimax rotation) to test if the eight performance indicators loaded in components that distinctly reflected the anthropometric, the expertise and the scoring index. All statistics were performed separately in men and in women (SPSS 24.0, $p \leq 0.05$). In agreement with studies regarding previous World Handball Championships, the results confirm the efficacy of specific performance indicators to influence the final team ranking in the 2017 men's and women's World Handball Championship. These performance indicators do not appear to be the same in men and women, highlighting that coaching strategy should focus to different performance indicators in men compared to women handball teams. In particular, the expertise, the scoring and the anthropometric index appears to be the order of index importance in men, whereas, a combination of expertise and scoring index appears to be of greater importance in women, with the anthropometric index not playing an important role.
Keywords*:* competitive level, national teams, performance analysis

Introduction

Achieving top performance in handball depends on many factors such as technical skills, tactical abilities, and physical and anthropometric characteristics of the athletes (Bilge, 2012; Wagner et al., 2014). The analysis of top performance in high-level competition, as the World and European Championships and the Olympic Games, is a necessity for the determination of the current developments in handball (Taborsky, 2007). High-level performance indicators in World Handball Championships have pronounced coaching and scientific interest as they relate to the development of the sport, not only with regard to the physical characteristics but also with regard to the tactical abilities (Bilge, 2012; Wagner et al., 2014). Today, the outcome of a handball game lies in the small details of the match, especially at highly competitive levels, establishing the analysis of successful performance indicators as a decisive factor in the process of evaluation and applying the coaching strategy (Meletakos et al., 2010; Willian et al., 2014).

The variety of movements during a handball match makes it one of the most complex (Rogulj et al., 2004) and multifactorial athletic game, especially when trying to discriminate the specific parameters that affect performance (Wagner et al., 2014). According to Hassan et al. (2013), there is a clear discrimination, qualitatively and quantitatively, among national teams that achieve top performance in high-level competitions. Previous studies in handball (Bilge M, 2012; Rogulj et al., 2004) mainly include game data analysis or video

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analysis. The game data analysis approach comprises descriptive statistics, frequencies, and percentage of various performance indicators that may provide a comprehensive game insight. Other handball studies examine the association of team ranking with various performance indicators such as the anthropometric characteristics (Chaouachi et al., 2009; Michalsik et al., 2015a;2015b; Milanese et al., 2011; Rousanoglou et al., 2014), the players' expertise (Skarbalius, 2009; Weber & Wegner, 2016), and critical indicators of offensive performance (Meletakos et al., 2011). The majority of studies converge that the efficacy of performance indicators to influence the final team ranking provides important and objective data for a comprehensive game evaluation (Bilge, 2012; Daza et al., 2017; Hughes & Bartlett, 2002; Rogulj et al., 2004) and portray the performance profile that predicts the outcome (O'Shaughnessy, 2006; Wagner et al., 2014). Furthermore, the association of performance indicators with final team ranking allows the coaches to focus their training strategy on the indicators that specifically influence the outcome of the game. Thus, it is a necessity to expand our knowledge about the critical indicators that may predict success and discriminate a successful compared to an unsuccessful team. The study aimed to evaluate the efficacy of specific performance indicators to influence the final team ranking in the 2017 men's and women's World Handball Championship.

Material and Methods

Participants

Our sample was selected among the total of the 24 competing national teams in the men's and the women's World Handball Championship in France (21-29/1/2017) and in Germany (1-17/1/2017), respectively. We selected 9 teams based on their final ranking and were divided into three groups, as follows: Top-ranked group (G1) the teams that ranked 1st, 2nd and 3rd, middle-ranked group (G2) the teams that ranked 9th, 10th and 11th, and low-ranked group (G3) the teams that ranked 22nd, 23rd and 24th. A total of 144 athletes were included in each group, for the men (MG: MG1, MG2, MG3) and the women (WG: WG1, WG2, WG3) group, respectively. It is worth noting that, in the top- and the middle-ranked groups all teams originated from Europe, whereas, in the low-ranked groups all teams originated from non-European countries. This is consistent with previous studies (Hasan et al., 2007; Bilge, 2012) indicating that mainly the European teams are those ranking higher in international competitions (Olympic Games, World Championships).

Measures

The data was obtained from the official Box Scores of the International Handball Federation http://www.ihf.info which includes all the game statistics of the 2017 Men's and Women's World Handball Championship. Eight performance indicators were selected for the present study: Age (years), Body Height (BH) (cm), Body Mass (BM) (kg), International Matches Played (n), International Goals Scored (n), Total Shots per Player (n), Total Goals per Player (n) and Team Scoring Efficiency (%) (100% represented the total team shots). These eight performance indicators were grouped into three indices as follows: The anthropometric index (BH and BM), the expertise index (Age, International Matches Played and International Goals Scored) and the scoring index (Total Shots per Player, Total Goals per Player and Team Scoring Efficiency).

Statistics

Statistics included descriptive measures (mean ± standard deviation), one way analysis of variance followed by post hoc comparisons (with Bonferroni correction) for the comparison between groups, non-parametric Spearman's Rho correlation analysis to test the relation of performance indicators with team ranking, and a three component factor analysis (varimax rotation) aiming to test if the eight performance indicators loaded in components that distinctly reflected the anthropometric, the expertise and the scoring index. All statistics were performed separately in men and in women (SPSS 24.0, $p \leq 0.05$).

Results

Comparison among groups.

Table 1 shows the mean and standard deviation of the anthropometric, the expertise and the scoring indices, and the levels of statistical significance for the comparison among the three MG. The ANOVA results indicated significant differences ($p \leq 0.05$) among the three MG in BH, BM, International Matches Played, Total Shots per Player, Total Goals per Player, and Team Scoring Efficiency. The post hoc comparisons revealed significant differences in BH, BM, International Matches Played and Team Scoring Efficiency between MG1 and MG3 ($p \leq 0.05$), as well as between MG2 and MG3 ($p \leq 0.05$), but not between MG1 and MG2 ($p > 0.05$). The Total Shots per Player and Total Goals per Player exhibited significant difference only between MG1 and MG2 ($p \leq 0.05$).

Table 1. Descriptive statistics (mean ± sd) of the performance indicators and the statistical significance for the

comparison among three men groups (MG1, MG2 and MG3).

Performance indicators	Descriptives			ANOVA	Post hoc		
	MG1	MG2	MG3	F (p-value)	MG1	MG	MG2
Age (years)	27.1 ± 4.7	27.4 ± 4.59	27.7 ± 3.2	0.28 (.805)	ns	ns	ns
BH (cm)	191.7 ± 6.1	193.5 ± 6.05	182.8 ± 8.7	3.80 (.000)*	ns	.000	.000
BM (kg)	95.0 ± 9.4	94.4 ± 9.34	86.4 ± 9.4	11.37 (.000)*	ns	.000	.000
Int. Matches Played (n)	77.8 ± 83.5	79.3 ± 62.92	38.5 ± 27.3	6.47 (.002)*	ns	.008	.006
Int. Goals Scored (n)	177.4 ± 257.3	180.0 ± 208.5	115.7 ± 154.3	1.40 (.249)	ns	ns	ns
Total Shots per Player (n)	26.5 ± 19.4	16.8 ± 13.9	20.3 ± 17.9	3.81 (.024)*	.022	ns	ns
Total Goals per Player (n)	17.3 ± 12.9	10.5 ± 9.1	11.9 ± 14.3	4.04 (.020)*	.024	ns	ns
Team Scoring Efficiency (%)	56.8 ± 24.1	54.8 ± 28.9	44.0 ± 26.8	3.14 (.046)*	ns	.000	.000

*p ≤ 0.05, Int. =International, Team Scoring Efficiency: the base of percentage (100%) is the total team shots.

Table 2 shows the mean and standard deviation of the anthropometric, the expertise and the scoring indices, and the levels of statistical significance for the comparison among the three WG. The ANOVA results indicated significant differences (p ≤ 0.05) among the three WG in Age, International Matches Played, International Goals Scored, Goals per Player, and Team Scoring Efficiency. The post hoc comparisons revealed significant Age and Team Scoring Efficiency differences between WG1 and WG3 (p ≤ 0.05), as well as between WG2 and WG3 (p ≤ 0.05). Significant differences (p ≤ 0.05) were also found between WG1 and WG3 in International Goals Scored and International Matches Played, as well as between WG1 and WG2 and between WG1 and WG3 in Goals Scored per Player.

Table 2. Descriptive statistics (mean ± sd) of the performance indicators and the statistical significance for the comparison among three women groups (WG1, WG2 and WG3).

Performance indicators	Descriptives			ANOVA	Post hoc		
	MG1	MG2	MG3	F (p-value)	MG1	MG1	MG2
Age (years)	27.4 ± 3.5	27.6 ± 3.9	25.4 ± 3.9	4.95 (.008)*	ns	.037	.014
BH (cm)	175.2 ± 5.0	176.2 ± 6.6	175.7 ± 6.4	0.32 (.723)	ns	ns	ns
BM (kg)	68.8 ± 4.4	70.2 ± 6.2	70.1 ± 7.8	0.56 (.575)	ns	ns	ns
Int. Matches Played (n)	105.5 ± 69.7	55.2 ± 56.1	55.0 ± 45.9	12.02 (.000)*	.000	.000	ns
Int. Goals Scored (n)	214.6 ± 221.6	144.3 ± 212.2	110.2±169.3	3.15 (.046)*	ns	.046	ns
Total Shots per Player (n)	26.2 ± 21.5	19.4 ± 14.0	21.7 ± 16.2	6.18 (.003)*	.037	.003	ns
Total Goals per Player (n)	18.2 ± 13.5	12.4 ± 8.4	10.5 ± 8.1	1.68 (.190)	ns	ns	ns
Team Scoring Efficiency (%)	61.7 ± 11.6	62.3 ± 15.8	48.1 ± 16.5	12.11 (.000)*	ns	.000	.000

*p ≤ 0.05, Int. =International, Team Scoring Efficiency: the base of percentage (100%) is the total team shots.

Correlation between final ranking and performance indicators. In the MG, higher ranking was positively correlated to BH (r = 40*, p = .000), BM (r = .35*, p = .000), International Matches Played (r = .19*, p = .021), Goals per Player (r = .21*, p = .013) and Team Scoring Efficiency (r = .22*, p = .009). In the WG, higher ranking was positively correlated to Age (r = .20*, p = .016), International Matches Played (r = .28*, p = .001), International Goal Scored (r = .18*, p = .038), Goals per Player (r = .28*, p = .002) and Team Scoring Efficiency (r =.41*, p = .000).

Factor analysis of performance indicators. Table 3 shows the results of the three-component factor analysis including the eight performance indicators. As shown in Table 3, for the MG, in the 1st component (accounting for 28.8% of variance) the performance indicators with heavy loadings (> .60) reflect the expertise index. In the 2nd component (accounting for 28.3% of variance), the performance indicators with heavy loadings reflect the scoring index. Finally, in the 3rd component (accounting for 22.1% of variance), the performance indicators with heavy loadings reflect the anthropometric index. All three components account for 79.23% of the total explained variance. For the WG (Table 3), the performance indicators with heavy loadings in the 1st component (accounting for 37.6% of variance) reflect a combination of the expertise and the scoring indices. In the 2nd component (accounting for 28.3% of variance), the performance indicators with heavy loadings reflect the anthropometric index. Finally, in the 3rd component (accounting for 22.6% of variance), the performance indicators also reflect a combination of the expertise and the scoring indices. All three components account for 77.92% of the total explained variance.

Table 3. The performance indicators' loading in the three components (E, S, A) of the factor analysis, for the men and the women. The indicators with loading ≥ 0.60 are noted in bold.

	Men				Women		
	E	S	A		E+S	A	E+S
Int. Matches Played	**0.94**	0.05	0.13	Total Shots per Player	**0.92**	-0.06	-0.24
Age	**0.86**	-0.19	-0.10	Total Goals per Player	**0.88**	-0.12	-0.01
Int. Goals Scored	**0.81**	0.39	-0.07	Int. Goals Scored	**0.79**	0.07	0.33
Total Goals per Player	0.10	**0.91**	-0.05	Int. Matches Played	**0.74**	0.23	0.42
Total Shots per Player	0.09	**0.90**	-0.12	BH	0.02	**0.91**	-0.07
Team Scoring Efficiency	-0.05	**0.67**	0.11	BM	-0.03	**0.89**	0.09
BH	-0.09	0.04	**0.93**	Team Scoring Efficiency	-0.07	-0.12	**0.81**
BM	0.07	-0.07	**0.92**	Age	0.45	0.32	**0.63**
Variance explained (%)	*28.8*	*28.3*	*22.1*		*37.6*	*28.3*	*22.6*

A =Anthropometric index, E =Expertise index, S =Scoring index

Discussion

The study aimed to evaluate the efficacy of specific performance indicators to influence the final team ranking in the 2017 men's and women's World Handball Championship.

Anthropometric index. The BH and BM of the men's teams in our study were similar to the average BH (191.7 ± 0.8 cm) and the average BM (93.1 ± 1.6 kg) of the total of teams competing in the last five World Handball Championships (2007, 2009, 2011, 2013 and 2013 Championships). However, the BH and BM of the women's teams in our study were similar to the average (BH: 177.1 ± 1.1 cm and BM: 69.8 ± 0.5 kg) of just the three top-ranked teams competing in the last five World Championships (2007, 2009, 2011, 2013 and 2013 Championships). An increasing trend of BH and BM is evidenced in high- compared to lower-level competing handball players during the last decades (Michalsik et al., 2011). The BH and BM predominace in men teams that excel in handball is also documented in the present study with the significant predominance of these anthropometric indicators in the top-ranked compared to the low-ranked teams as well as their significant correlation to higher team ranking. According to Hasan et al. (2007), the most successful teams are taller than the less successful ones. Wagner and coworkers (2010) conclude that BH, as well as BM, might greatly influence the game success in men's modern handball. The study of Ghobadi and coworkers (2013), regarding the 2013 World Men's Championship, illustrated that BH and BM significantly influence game success and distinguish the teams in final ranking. It is of interest though that, in the Women's 2017 World Handball Championship examined in the present study, no significant BH or BM differences were observed among the top-ranked and the low-ranked teams. The weakness of the anthropometric index to influence the women's team ranking is further supported by the absence of significant correlation of BH or BM with team ranking. The different profile of women than men regarding the role of the anthropometric index in team ranking, is further evidenced in the results of the factor analysis. In specific, the anthropometric performance indicators are all grouped as a distinct component in men, whereas, in women, they are combined in two mixed components together with some scoring indicators. It appears that, in women, predominance in elements such as technical and tactical characteristics, physical fitness, and other short space specific skills (i.e. acceleration or directional changes) may allow them to counterbalance the lack of anthropometric predominance due to the BH and BM similarity among teams.

Expertise index. The absence of significant age difference among the three MG is in agreement with studies indicating the association of high-level competition to specific age range, with the higher age of the players as an underlying feature of greater game participation. The average age of our MG (27.5 ± 4.2 years) and WG (26.8 ± 3.9 years) is within the 23-28 age range considered as optimum under the perspective of adequate game expertise (Michalsik et al., 2015a; 2015b). According to Milanese and coworkers (2011), the game expertise gained through frequent participation in high-level competitive leagues is one of the essential factors contributing to team success. Furthermore, game expertise appears to play an essential role in winning Olympic or European Championships (Skarbalius, 2011). Indeed, in high-level competitions, the participating players are those with greater game experience (Ericsson & Lehmann, 1996; Milanese et al., 2011). More experienced players appear to better foresee their opponents' reactions (Ericsson & Ward, 2007), to control their emotions more efficiently (Maxwell et al., 2009) and to exhibit a significant mental excellence (Gonzales et al., 2013). In contrast to the absence of significant age difference among the three MG, the age differences were significant among the three WG, a finding that may explain the significant positive correlation of age with team ranking in women but not in men. The significant age difference among the three WG is in agreement with the study of Ghobadi and coworkers (2013) that reports a higher average player age in the more successful teams of the 2009 World Women's Handball Championship. The importance of game expertise for team success is also evidenced

in our results, as the men's and the women's top-ranked teams (MG1 and WG1, respectively) showed a significantly greater participation in international games, with women scoring a greater number of goals in international games. Furthermore, the factor analysis, highlighted the expertise index as a distinct component and equivalent to the scoring index component in men, whereas in women, the expertise index emerged combined with the scoring index in two separate mixed components. The combined contribution of the expertise and the scoring indices in women's team ranking, is further enhanced by the correlation results, which show that the performance indicators comprising the scoring index have stronger correlations with team ranking. The importance of game expertise in top-level ranking for women's teams is in accordance with previous studies (Ghobadi et al., 2013; Skarbalius, 2009). Ghobadi and coworkers (2013) report that, in women, the game experience rather than the anthropometric characteristics determine the win-loss of a game, most possibly due to higher competitive maturity of the players which allows them to manage effectively the critical situations during the game (Skarbalius, 2009).

Scoring index. In agreement with previous studies (Daza et al., 2017; Kniubaitė & Skarbalius, 2012; Rogulj, 2000; Srhoj et al., 2001), the scoring index is verified as a valid indicator of team ranking in the 2017 men's and women's World Championship examined in the present study. This is evidenced on the significantly greater scoring indicators in the higher ranking teams, in their positive correlation with higher team ranking, and their heavy loadings in the scoring index component of the factorial analysis. Indeed, the increased number of shots and number of goals was associated to top ranking in the 1999 Men's World Championship in Egypt (Rogulj, 2000; Srhoj et al., 2001), in the 2015 Men's World Championship in Qatar (Daza et al., 2017), as well as in the 2009 World Women's Handball Championship in China (Kniubaitė & Skarbalius, 2012).

Conclusions

In agreement with studies on previous World Handball Championships, the results of the present study confirm the efficacy of specific performance indicators to influence the final team ranking in the 2017 men's and women's World Handball Championship. These performance indicators do not appear to be the same in men and women, highlighting that coaching strategy should focus to different performance indicators in men compared to women handball teams. In particular, the expertise, the scoring and the anthropometric index appears to be the order of index importance in men, whereas, a combination of expertise and scoring index appears to be of greater importance in women with the anthropometric index not playing an important role.

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