

Yzan Saavedra ¹
Sveinn Þorgeirsson ^{2*}
Ólafur Sigurgeirsson ³
Jose M. Saavedra ²



DIFFERENCES IN GOALS, SAVES, EXCLUSIONS, AND CARDS BETWEEN WINNERS AND LOSERS BASED ON CATEGORY AND GENDER IN YOUNG HANDBALL PLAYERS

RAZLIKE V GOLIH, OBRAMBAH, IZKLJUČITVAH IN KARTONIH MED ZMAGOVALCI IN PORAŽENCI GLEDE NA KATEGORIJO IN SPOL PRI MLADIH ROKOMETAŠIH

ABSTRACT

The objectives of the present study were: (i) to compare handball game-related statistics by match result (winning and losing teams) based on category [Under 18 (U18) and Under 16 (U16) years old] and sex (males and females), and (ii) to determine whether there are differences in handball game-related statistics based on category (U18 and U16) and sex (males and females). One thousand eight hundred seventy-three matches were analysed, (1034 male, 839 female) from the categories (U18 and U16) played in the 2022/23 and 2023/24 Icelandic League for both sexes were analysed. The dependent variable in the study was the match outcome (winning/losing teams), while the independent variables were the game-related statistics (goals, saves, two-minute exclusions, yellow and red cards), with category (U18 and U16) and sex (male and female) used as grouping variables. Basic statistical descriptors (mean and standard deviation) were calculated for each game-related statistic by match outcome (winning and losing teams) and by category and sex. Since normality was not met for any of the analyzed variables, the non-parametric Mann-Whitney U test was applied. The number of goals and saves differentiated winning and losing teams, both for the overall sample and based on category and sex; clear differences were observed based on category; males achieved a higher number of goals and saves than females, while also displaying greater extralegal aggression (2-minute exclusions, yellow cards, and red cards).

Keywords: Winners, losers, performance analysis, goalkeeper, aggression

¹ *Sports Science Department, Faculty of Social Sciences, Reykjavik University, Iceland*

² *Physical Activity, Physical Education, Sport and Health (PAPESH) Research Centre, Sports Science Department, Faculty of Social Sciences, Reykjavik University, Iceland*

³ *HBStatz, Seltjarnarnes, Iceland*

IZVLEČEK

Cilji študije so bili: (i) primerjati rokometne statistične kazalce glede na rezultat tekme (zmagovalne in poražene ekipe) glede na kategorijo [do 18 let (U18) in do 16 let (U16)] in spol (moški in ženske) ter (ii) ugotoviti, ali obstajajo razlike v rokometnih statističnih kazalcih glede na kategorijo (U18 in U16) in spol (moški in ženske). Analiziranih je bilo 1873 tekem (1034 moških, 839 ženskih) iz kategorij U18 in U16, ki so bile odigrane v islandski ligi v sezonah 2022/23 in 2023/24 za oba spola. Odvisna spremenljivka v študiji je bil izid tekme (zmagovalne/poražene ekipe), medtem ko so bile neodvisne spremenljivke rokometni statistični kazalci (goli, obrambe, dvominutne izključitve, rumeni in rdeči kartoni), kategorija (U18 in U16) ter spol (moški in ženske), ki so bili uporabljeni kot združevalne spremenljivke. Izračunani so bili osnovni statistični opisi (povprečje in standardni odklon) za vsak rokometni statistični kazalec glede na izid tekme (zmagovalne in poražene ekipe) ter glede na kategorijo in spol. Ker normalnost ni bila dosežena za nobeno od analiziranih spremenljivk, je bil uporabljen neparametrični Mann-Whitneyjev U-test. Število doseženih golov in obramb je ločevalo zmagovalne in poražene ekipe tako v celotnem vzorcu kot glede na kategorijo in spol; opažene so bile jasne razlike glede na kategorijo; moški so dosegli več golov in zabeležili več obramb kot ženske, obenem pa so pokazali tudi več agresivnosti (dvominutne izključitve, rumeni in rdeči kartoni).

Ključne besede: zmagovalci, poraženci, analiza nastopa, golman, agresivnost

Corresponding author:* Sveinn Þorgeirsson

Physical Activity, Physical Education, Sport and Health (PAPESH) Research Centre, Sports Science Department, Faculty of Social Sciences, Reykjavik University Menntavegur 1, 102, Reykjavik, Iceland
E-mail: sveinntho@ru.is
<https://doi.org/10.52165/kinsi.31.1.119-130>

INTRODUCTION

Handball is a dynamic and physically demanding sport characterized by a variety of high-intensity actions, including jumps, tackles, and rapid changes of direction. These actions are sometimes interspersed with lower-intensity activities such as passing, walking, or jogging (Pori, & Šibila, 2006). Players frequently engage in explosive movements such as sprinting and jumping, which are essential for both offensive and defensive plays. To excel in this sport, athletes must possess the ability to perform repeated high-intensity actions while maintaining endurance. The capacity to withstand physical contact during one-on-one situations is also critical, as players often engage in tacking and holding maneuvers to gain an advantage over their opponents (Dello Iacono *et al.*, 2017). To meet these physical requirements, training regimens for handball players must focus on developing explosive power, agility, and physical resilience (Hermassi *et al.*, 2019). Additionally, targeted training programs that incorporate plyometric exercises can improve players' performance in high-intensity situations, making them better equipped to handle the demands of the game. Overall, the combination of strength, agility, and endurance is vital for success in handball, underscoring the importance of comprehensive training approaches for player development and performance enhancement (Muñoz *et al.*, 2022). The ultimate goal of all training programs in sports is to perform at the highest level during matches and achieve victory. To facilitate this, the information gathered from game-related statistics provides relevant data for scientists and coaches, enabling them to devise strategies for future matches. Performance analysis has emerged as a crucial component in this context, allowing sports scientists, coaches, and athletes to objectively assess performance metrics and identify areas for improvement. Recently, a study has gone further, showing the use of machine learning models to predict and evaluate performance in female handball players, demonstrating how advanced analytical techniques can enhance understanding of player capabilities and inform training decisions (Oytun *et al.*, 2020).

In recent years, research on handball has increased significantly, with the analysis of variables that lead to successful performance becoming one of the most studied topics (Saavedra, 2018). In this context, the analysis of game-related statistics, whether through web-sourced data or observational data, has emerged as a highly relevant subtopic. In this way, a widely utilized method in handball involves analyzing game-related statistics based on various factors, including game situations (such as fast breaks and static attacks) and player positions (goalkeeper, pivot, wings—right and left, backs—right and left, and center). A study examining

nine major tournaments, including the Olympic Games, World Championships, and European Championships from 2004 to 2010, found a strong correlation between the efficiency of fast breaks, pivot positions, and backcourt players with the high rankings of European teams in international competitions (Bilge, 2012). More recent studies conducted on the Olympic Games (2004-2016) for men found that 82% of winning teams could be predicted using four variables: shots, goalkeeper-blocked shots, technical fouls, and attacks (Saavedra *et al.*, 2017). For women, the percentage was similar (83%) but with five variables: shots, goalkeeper-blocked shots, technical fouls, steals, and goalkeeper-blocked fast-break shots (Saavedra *et al.*, 2018). Recent research has highlighted the importance of shot and defense effectiveness from specific zones. A study on World Championship-level games found that efficiency in wing and 9-meter shots, along with more blocked shots in defense, characterized the top eight teams compared to less successful ones (Almeida *et al.*, 2020). Another study on men's World Championships from 2005 to 2019 (Meletakos *et al.*, 2020) identified breakthrough efficiency, goalkeeper saves, 6-meter shot efficiency, and the number of defensive steals as factors distinguishing the top four teams from the rest. Meanwhile, an analysis of offensive actions in Women's World Championships from 2007 to 2017 highlighted the distinct profiles of backcourt players, whose goal attempts tend to be more predictable compared to pivots and wings, who demonstrate lower efficiency in this area (de Paula *et al.*, 2020).

In turn, studies conducted in regular leagues have shown that teams reaching the finals and winning games display a diverse and well-defined set of offensive actions, allowing them to engage effectively in all aspects of the game (Ferrari *et al.*, 2014). In the Croatian League, for example, the offensive variables distinguishing winning from losing teams included the frequency of multi-interruption attacks, pivot-led attacks, and wing attacks (Rogulj *et al.*, 2004). Research on semi-professional leagues, such as the Icelandic league, has shown that winning teams could be predicted (84%) using five variables: shots, goalkeeper-blocked shots, steals, technical fouls, and goalkeeper-blocked 7-meter shots. In contrast, in women's teams, only two variables (87%) shots and goalkeeper-blocked shots—predicted winners (Þorgeirsson *et al.*, 2022a). Frequently analyzed additional game statistics include home advantage, game period, and team quality (Gómez *et al.*, 2014), timeouts (Prieto *et al.*, 2016), along with the impact of player exclusions (Prieto *et al.*, 2015b), the effect on outcomes in the last 10 minutes (Þorgeirsson *et al.*, 2022b), and game statistics of the league-winning team (Þorgeirsson *et al.*, 2023).

Studies on game-related statistics in players under 18 years old are limited and have primarily been conducted in international championships. Some of these studies focus on comparing shooting effectiveness between males and females (Acsinte & Alexandru, 2014), between the first and second halves of games (Chelly *et al.*, 2011), or on the influence of the relative age effect on statistics in females (Saavedra & Saavedra, 2020) or in both males and females (de la Rubia *et al.*, 2021). Thus, studies on players under 18 years old in national leagues are nonexistent. In this context, the objectives of the present study were: (i) to compare handball game-related statistics by match result (winning and losing teams) based on category [Under 18 (U18) and Under 16 (U16) years old] and sex (males and females), and (ii) to determine whether there are differences in handball game-related statistics based on category (U18 and U16) and sex (males and females).

METHODS

Participants

One thousand eight hundred seventy-three matches were analysed, (1034 male, 839 female) from the categories (U18 and U16) played in the 2022/23 and 2023/24 Icelandic League for both sexes were analysed. Archival data was obtained from the manager of HBStatz statistics company. This company provided game-related statistics to the Icelandic National Handball Federation, and put a summary of these game-related statistics up on their official website. Fourty-four matches were eliminated due to having resulted in a draw.

Procedures

The data were originally entered by a trained observer on a computer/tablet into an online database on a custom-designed website platform. They were subsequently extracted and entered into an Excel spreadsheet by a technician, a random check by one of the authors (YS) in order to detect possible errors, followed by their statistical analysis. No informed consent was necessary as the information used is in the public domain on the website (<https://hbstatz.is/>). The analysis of public data taken from websites is common in the field of handball (Hatzimanouil *et al.*, 2020; Laxdal & Ivarsson, 2023; Meletakos *et al.*, 2020; Pueo & Espina-Agullo, 2017; Saavedra *et al.*, 2017; 2018; Þorgeirsson *et al.*, 2022a,2022b; 2023). The dependent variable in the study was the match outcome (winning/losing teams), while the independent variables were the game-related statistics (goals, saves, two-minute exclusions, yellow and red cards), with category (U18 and U16) and sex (male and female) used as grouping variables. An observational method was used to validate the study data (Anguera, 2003; Anguera *et al.*, 2017), and an ad hoc instrument was designed to observe and register data using

the LINCE software package (Gabin *et al.*, 2012). Cronbach's alpha (α) was used to determine internal consistency, and the intra-class correlation coefficients (ICC) values to determine reliability. Two randomly chosen matches for each sex were analysed, calculating the intra-observer internal consistency and reliability (at two different times; one of the authors who did this was (YS) and inter-observer internal consistency and reliability. In this last case, the observation record (YS) was compared with the record downloaded from the official website, resulting in the website data being used in the final analysis. The internal consistency and the reliability thresholds, between 0 and 1 (Peterson, & Kim, 2013), were set at: for α (internal consistency), <0.50 unacceptable, 0.51–0.60 poor, 0.61–0.70 questionable, 0.71–0.80 acceptable, 0.81–0.90 good, and ≥ 0.91 excellent (George, & Mallery, 2003); for ICC (reliability), ≤ 0.50 poor, 0.51–0.75 moderate, 0.76–0.90 good, and ≥ 0.91 excellent (Koo & Li, 2016). Table 1 lists the internal consistency and reliability of the intra-observer and inter-observer means. Both can be considered to be excellent for both male and female.

Table 1. Intra- and inter-observer internal consistency (Cronbach's alpha – α) and reliability (intra-class correlation coefficient – ICC).

Variable Group	Males				Females			
	Intra-observer		Inter-observer		Intra-observer		Inter-observer	
	α	ICC	α	ICC	α	ICC	α	ICC
Shots	0.982	0.964	0.992	0.984	0.999	0.998	1.000	0.999
Saves	0.998	0.996	0.960	0.923	0.999	0.997	0.998	0.996
Yellow cards	1.000	1.000	0.930	0.870	0.990	0.980	0.999	0.999
Red cards	1.000	1.000	1.000	1.000	0.938	0.875	1.000	1.000
Two minutes exclusions	1.000	1.000	0.967	0.936	1.000	1.000	1.000	1.000
Mean	0.996	0.992	0.970	0.943	0.985	0.970	0.999	0.999

Statistical analysis

Basic statistical descriptors (median and interquartile range - IQR) were calculated for each game-related statistic by match outcome (winning and losing teams) and by category and sex. The normality of each variable was determined using the Kolmogorov-Smirnov test, and heteroscedasticity was assessed through Levene's test. Since normality was not met for any of the analyzed variables, the non-parametric Mann-Whitney U test was applied. A p-value <0.05 was considered statistically significant. The statistical analysis was performed using the SPSS software package version 25.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

Table 2 presents the basic descriptors of the variables by match outcome (win/lose) for the whole sample and U18 and U16 categories. Differences were found only in the variables goals and saves. There were differences only in the variables goals and saves.

Table 2. Basic descriptors (median and interquartile range- IQR-), and p-value for each variable according to the match outcome in the whole sample and U-18 and U-16 categories.

	Whole sample			U-18			U-16		
	Winners	Losers	p	Winners	Losers	p	Winners	Losers	p
	Md (IQR)	Md (IQR)		Md (IQR)	Md (IQR)		Md (IQR)	Md (IQR)	
Goals	36.3 (32.8-41.0)	28.1 (25.7-31.6)	<0.001	38.7 (35.1-43.3)	31.6 (27.0-35.1)	<0.001	34.0 (29.3-38.7)	25.7 (21.1-30.42)	<0.001
Saves	12.9 (10.5-17.6)	10.5 (10.5-17.5)	<0.001	15.2 (11.7-18.7)	12.9 (9.4-16.4)	<0.001	12.9 (9.4-16.4)	10.5 (7.0-14.0)	<0.001
2 min	1.2 (1.2-2.3)	1.2 (1.2-2.3)	0.247	1.2 (1.2-2.3)	1.2 (1.2-2.3)	0.053	1.2 (1.2-2.3)	1.2 (1.2-2.3)	0.954
Yellow card	0.0 (0.0-1.2)	0.0 (0.0-1.2)	0.779	0.0 (0.0-1.2)	0.0 (0.0-1.2)	0.918	0.0 (0.0-1.2)	0.0 (0.0-1.2)	0.751
Red card	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.710	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.893	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.284

Table 3 presents the basic descriptors of the variables by match outcome (win/lose) based on category and sex. There were differences only in the variables goals and saves in all cases, and in 2-minute exclusions in U18 females (bold p<0.001).

Table 3. Basic descriptors (median and interquartile range- IQR), and p-value for each variable according to the match outcome in the whole sample and U-18 and U-16 categories.

	U-18 male			U-18-female		
	Winners	Losers	p	Winners	Losers	p
	Md (IQR)	Md (IQR)		Md (IQR)	Md (IQR)	
Goals	38.8 (36.3-44.5)	32.8 (29.3-36-3)	<0.001	37.4 (33.9-42.1)	28.1 (25.5-31.6)	<0.001
Saves	16.4 (12.3-18.7)	12.9 (9.4-16.4)	<0.001	15.2 (10.5-18.7)	12.9 (9.4-15.5)	<0.001
2 min	2.34 (1.2-3.5)	2.34 (1.2-3.5)	0.829	1.2 (0.0-2.3)	1.4 (1.0-2.3)	0.004
Yellow card	0.0 (0.0-1.2)	0.0 (0.0-1.2)	0.624	0.0 (0.0-1.2)	0.0 (0.0-1.2)	0.454
Red card	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.867	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.560
	U-16 male			U-16 female		
	Winners	Losers	p	Winners	Losers	p
	Md (IQR)	Md (IQR)		Md (IQR)	Md (IQR)	
Goals	36.3 (31.6-41.0)	28.1 (23.4-32.8)	<0.001	31.6 (28.1-35.1)	22.2 (18.7-25.7)	<0.001
Saves	14.0 (10.5-17.6)	11.7 (8.2-15.2)	<0.001	12.9 (9.4-16.4)	10.5 (9.4-16.4)	<0.001
2 min	2.34 (1.2-3.5)	2.34 (1.2-3.5)	0.125	2.34 (1.2-3.5)	2.34 (1.2-3.5)	0.220
Yellow card	0.0 (0.0-1.2)	0.0 (0.0-1.2)	0.943	0.0 (0.0-1.2)	0.0 (0.0-1.2)	0.974
Red card	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.562	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.157

Table 4 presents the basic descriptors of the variables by category and sex. There were differences in all the studied variables.

Table 4. Basic descriptors (median and interquartile range- IQR), Mann-Whitney U test, and p-value, for each variable according to category (U18 and U16) and sex.

	U18	U16	p	Male	Female	p
	Md (IQR)	Md (IQR)		Md (IQR)	Md (IQR)	
Goals	35.1 (20.4-39.8)	29.6 (25.7-36.3)	<0.001	34.0 (28.0-38.5)	29.6 (25.1-34.4)	<0.001
Saves	14.0 (9.6-16.3)	11.7 (9.3-16.8)	0.006	12.9 (9.4-16.0)	11.7 (9.3-16.4)	<0.001
2 min	1.2 (0.00-2.3)	1.2 (0.00-2.3)	<0.001	2.34 (1.2-3.5)	2.34 (1.2-3.5)	<0.001
Yellow card	0.0 (0.0-1.2)	0.0 (0.0-1.2)	<0.001	0.0 (0.0-1.2)	0.0 (0.0-1.2)	<0.001
Red card	0.0 (0.0-0.0)	0.0 (0.0-0.0)	<0.001	0.0 (0.0-0.0)	0.0 (0.0-0.0)	<0.001

DISCUSSION

The present study analyzed 1,873 matches played (1,034 male, 839 female) in the U-18 and U-16 categories during the 2022/23 and 2023/24 Icelandic League for both sexes. The objectives of this study were: (i) to compare handball game-related statistics by match result (winning and losing teams) based on category (U18 and U16) and sex (males and females), and (ii) to determine whether there are differences in handball game-related statistics based on category (U18 and U16) and sex (males and females). To the best of our knowledge, this is the first study to analyze game statistics in U18 and U16 players. All winning teams, both in the total sample and based on category and sex, achieved a higher number of goals and saves. Meanwhile, the U18 category showed higher values in all variables studied except saves, while in all variables studied, males achieved higher values than females.

The number of goals and the number of saves proved to be the variables that most differentiated the winning teams from the losing teams, whether analyzing the sample as a whole or by category and sex (table 2 and 3). This finding, which was expected, is consistent with previous studies conducted in senior categories analyzing shooting and saving efficiency (Saavedra et al., 2017; 2018; Þorgeirsson, 2022; 2023). It is worth noting that the role of the goalkeeper has already been shown to be decisive in youth categories. This should emphasize the need to work specifically on this role, even when players are young, especially considering that psychomotor skills are crucial for the goalkeeper's performance (Krawczyk *et al.*, 2019), and the developmental ages are an ideal time to work on them. Anyway, it should be noted that the goalkeeper's efficiency is influenced by the shooting distance (Hatzimanouil, 2020), and this variable was not analyzed in the present study. On the other hand, none of the variables related to extralegal aggression (2-minute exclusion, yellow card, and red card) showed differences

between winning and losing teams, except for 2-minute exclusions in U18 females. Studies conducted in female international championships (Saavedra *et al.*, 2018) or in national leagues (Icelandic) (Þorgeirsson *et al.*, 2022a) showed that winning teams are penalized with fewer red cards. This aligns with research conducted in senior categories where, for example, exclusions are not decisive for the final outcome of the match, neither in international championships (Pueo & Espina-Agullo, 2017; Milanović *et al.*, 2018) nor in leagues (French) (Debanne, 2018). However, if aggression remains within the bounds of the rules (legal stops), it does become decisive in the outcome of matches (Laxdal & Ivarsson, 2023).

Regarding differences based on category, it was shown that the number of goals increased between U16 and U18 (median=29.6, IQR=25.7-36.3; *vs* median=35.1, IQR=20.4-39.8) (table 4). This seems to indicate greater mastery of offensive actions with age progression. The number of goals scored in the U18 category is higher than those scored in the men's World Championships (27.5, 27.1, and 28.5 respectively) (Meletakos *et al.*, 2024) or in the women's Olympic Games in 2004, 2008, and 2012 (26.8, 26.9, and 25.1 respectively) (Vidūnaitė & Skarbalius, 2013). In any case, it is worth highlighting that the trend in the number of goals scored is to increase over time in men's World Championships (Meletakos *et al.*, 2024), although this is not the case in the European Championships, where it remains stable (Pascual *et al.*, 2024). Meanwhile, in the women's Olympic Games, the number of goals has increased (Vidūnaitė & Skarbalius, 2013).

When analyzing gender differences, variations were observed across all variables. The number of goals was higher in men compared to women (median=34.0, IQR=28.0-38.5; *vs* median=29.6, IQR=25.1-34.4) (Table 4). These results align with previous studies conducted on U18 male players and U19 female players (Acsinte & Alexandru, 2014). Similarly, research on the Icelandic league highlighted greater efficiency among senior male players compared to their female counterparts (Þorgeirsson *et al.*, 2022a). The number of saves was also higher in male games than in female games (median=12.9, IQR=9.6-16.0; *vs* median=11.7, IQR=9.3-16.4) (Table 4), potentially indicating a more significant role of goalkeepers in men's handball. However, a study in the Icelandic senior league reported no gender differences in terms of effectiveness (Þorgeirsson *et al.*, 2022a). All variables related to extralegal aggression, 2-minute exclusions (1.6 ± 1.4 *vs* 1.2 ± 1.2), yellow cards (0.5 ± 0.7 *vs* 0.4 ± 0.6), and red cards (0.3 ± 0.2 *vs* 0.1 ± 0.1) showed higher values in men than in women, which aligns with previous studies in the senior category. (Þorgeirsson *et al.*, 2022a). A study conducted in France specifically examining aggressiveness in team sports found that male handball players exhibited more instrumental (repelling, retaining, hitting) and hostile aggressive behaviors (against opponents, referees, and

teammates) than female players across all competitive levels. Additionally, instrumental aggression increased with higher competitive levels, while hostile aggression showed no significant differences across levels for female players (Coulomb-Cabagno & Rascle, 2006). Similar findings have been reported in studies on handball players from Congo (Pambou *et al.*, 2017). However, it is important to note that aggressiveness is influenced by the player's position on the field (Mandala *et al.*, 2022).

This study has several limitations. First, the number of variables studied is limited, which should be taken into account when interpreting the conclusions. Second, although the number of matches analyzed is very large, the differences between the teams (from first to fourth division) could have influenced the results. Third, the approach adopted was static, as the game-related statistics focused solely on "the final result," without considering what occurred during each moment of the match, that is, having a dynamic approach to the analysis (Prieto *et al.*, 2015).

CONCLUSION

The conclusions of this study were as follows: (i) the number of goals and saves differentiated winning and losing teams, both for the overall sample and based on category and sex; (ii) clear differences were observed based on category; (iii) males achieved a higher number of goals and saves than females, while also displaying greater extralegal aggression (2-minute exclusions, yellow cards, and red cards). Overall, these conclusions confirm what occurs in the senior category, allowing us to state that the behavior of the variables studied is similar.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgments

This study has been funded by the Icelandic Research Office (RANNÍS – Íþróttasjóður – reference number 233051-2501).

REFERENCES

- Acsinte, A., & Alexandru, E. (2014). Comparative study regarding the effectiveness of the representative junior handball teams' shots at the goal during international competitions. *Sci J Educ Sports, Health*, 15(1), 33-37.
- Almeida, A. G., Merlin, M., Pinto, A., Torres, R. S., & Cunha, S. A. (2020). Performance-level indicators of men elite handball teams. *Int J Performance Analysis Sport*, 20(1), 1-9. <https://doi.org/10.1080/24748668.2019.1694305>

Anguera, M. T. Observational Methods (General). In R. Fernandez-Ballesteros (ed.), *Encyclopedia of Psychological Assessment* (Vol. 2, pp. 632-637). 2003, London: Sage.

Anguera, M. T., Camerino, O., Castañer, M., Sánchez-Algarra, P. & Onwuegbuzie, A. J. (2017). The specificity of observational studies in physical activity and sports sciences: Moving forward in mixed methods research and proposals for achieving quantitative and qualitative symmetry. *Frontiers Psy*, 8, 2196. <https://doi.org/10.3389/fpsyg.2017.02196>

Bilge, M. (2012). Game analysis of Olympic, World and European Championships in men's handball. *J Human Kinetics*, 35(1), 109–118. <https://doi.org/10.2478/v10078-012-0084-7>

Chelly, M., Hermassi, S., Aouadi, R., Khalifa, R., Tillaar, R., Chamari, K., & Shephard, R. (2011). Match Analysis of Elite Adolescent Team Handball Players. *J Strength Conditioning Res*, 25, 2410-2417. <https://doi.org/10.1519/JSC.0b013e3182030e43>.

Coulomb-Cabagno, G., & Rascle, O. (2006). Team sports players' observed aggression as a function of gender, competitive level, and sport type. *J Appl Social Psy*, 36(8), 1980–2000. <https://doi.org/10.1111/j.0021-9029.2006.00090.x>

de la Rubia, A., Lorenzo, A., Bjørndal, C. T., Kelly, A. L., García-Aliaga, A., & Lorenzo-Calvo, J. (2021). The relative age effect on competition performance of Spanish international handball players: A longitudinal study. *Frontiers Psy*, 12, 673434. <https://doi.org/10.3389/fpsyg.2021.673434>

de Paula, L. V., Costa, F. E., Ferreira, R. M., Menezes, R. P., Werneck, F. Z., Coelho, E. F., & Greco, P. J. (2020). Analysis of discriminatory game variables between winners and losers in women's handball world championships from 2007 to 2017. *Kinesiology*, 52(1), 54–63. <https://doi.org/10.26582/k.52.1.6>

Debanne, T. (2018). Effects of game location, quality of opposition, and players' exclusions on performance in elite male handball. *Rev Int Ciencias Deporte*, 14(51), 71–83. <https://doi.org/10.5232/ricyde2018.05106>

Dello Iacono, A., Eliakim, A., Padulo, J., Laver, L., Ben-Zaken, S., & Meckel, Y. (2017). Neuromuscular and inflammatory responses to handball small-sided games: The effects of physical contact. *Scan J Med Sci Sports*, 27(11), 1122–1129. <https://doi.org/10.1111/sms.12755>

Ferrari, W. R., dos Santos, J. V., & Simoes Vaz, V. P. (2014). Offensive process analysis in handball: Identification of game actions that differentiate winning from losing teams. *Am J Sports Sci*, 2(4), 92–96. <https://doi.org/10.11648/j.ajss.20140204.14>

Gabín, B., Camerino, O., Anguera, M. T. & Castañer, M. (2012). Lince: Multiplatform sport analysis software. *Procedia-Social Beh Sci*, 46, 4692–4694. <https://doi.org/10.1016/j.sbspro.2012.06.320>

George, D. & Mallery, P. SPSS for Windows step by step: A simple guide and reference. 11.0 update (4th ed.). 2003, Boston: Allyn & Bacon

Gómez, M.A., Lago-Peñas, C., Viaño, J. & González-García, I. (2014). Effects of game location, team quality and final outcome on game-related statistics in professional handball close games. *Kinesiology* 46, 249-257.

Hatzimanouil, D. (2020). Goalkeeper's efficiency in relation with throws from different attacking court areas in team handball. *J Phy Edu Sports Manag*, 7(1), 11-18. <https://doi.org/10.15640/jpesm.v7n1a2>

Hatzimanouil, D., Saavedra, J. M., Stavropoulos, N., Skandalis, V., & Gkagkanas, K. (2020). Attack tactics in elite beach handball teams. *Kinesiology Slovenica*, 26(1), 46–56

Hermassi, S., Laudner, K., & Schwesig, R. (2019). Playing level and position differences in body characteristics and physical fitness performance among male team handball players. *Frontiers Bioengineering Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00149>

Koo, T. K. & Li, M. Y. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J Chiropractic Med*, 15(2), 155-163. <https://doi.org/10.1016/j.jcm.2016.02.012>

- Krawczyk, P., Bodasiński, S., Bodasińska, A., & Słupczyński, B. (2019). The level of psychomotor abilities as a factor differentiating handball goalkeepers' actions in saves from the wing position. *Polish J Sport Tourism*, 26(4), 3-10. <https://doi.org/10.2478/pjst-2019-0019>
- Laxdal, A., & Ivarsson, A. (2023). Breaking up the play: The relationship between legal stops and winning in team handball. *Int J Sports Sci Coaching*, 18(1), 240–244. <https://doi.org/10.1177/17479541211070787>
- Mandala, G. N., Desai, K., Jose, J., Hussaini, N., & Sucharitha M, M. (2022). Aggression behaviour and physical fitness of national handball girls players. *Int J Human Mov Sports Sci*, 10(1), 1–5. <https://doi.org/10.13189/saj.2022.100101>
- Meletakos, P., Konstantinos, N., & Iaoannis, B. (2020). Stable and changing characteristics of high-level handball as evidenced from World Men's Championships. *J Phy Edu Sport*, 20(3), 1354–1361. <https://doi.org/10.7752/jpes.2020.03187>
- Meletakos, P., Manasis, V., Noutsos, K., & Bayios, I. (2024). Performance differences and determinants of success in world men's handball championships. *Motriz*, 30, e10240068. <https://doi.org/10.5016/s1980-6574e10240068>
- Milanović, D., Vuleta, D., & Ohnjec, K. (2018). Performance indicators of winning and defeated female handball teams in matches of the 2012 Olympic Games tournament. *J Human Kinetics*, 64(1), 247–253. <https://doi.org/10.1515/hukin-2017-0198>
- Muñoz, A., Sánchez-Oliver, A., Rivilla-García, J., López-Samanes, A., & Coso, J. (2022). Ergogenic aids in competitive handball players: a narrative review. *J Sport Health Res*, 14(1), 1-12. <https://doi.org/10.58727/jshr.92827>
- Oytun, M., Tinazcı, C., Şekeroğlu, B., Açıkada, C., & Yavuz, H. (2020). Performance prediction and evaluation in female handball players using machine learning models. *IEEE Access*, 8, 116321-116335. <https://doi.org/10.1109/access.2020.3004182>
- Pambou, L. L., Magementa, J., Bouyena, E., Loufoua Lemay, E. D., Moulongo, J. G. A., & Massamba, A. (2017). Socioanthropological views on transgressive behaviors in Congolese handball players. *Adv Phy Edu*, 7(1), 38–48. <https://doi.org/10.4236/ape.2017.71005>
- Pascual, A., Font, R., Pascual, X., & Lago-Peñas, C. (2024). Evolution of match performance parameters in elite men's handball 2012–2022. *Int J Sports Sci Coaching*, 19(1), 301–305. <https://doi.org/10.1177/17479541221142418>
- Peterson, R. A. & Kim, Y. (2013). On the relationship between coefficient alpha and composite reliability. *J App Psy*, 98(1), 194-198. <https://doi.org/10.1037/a0030767>
- Pori, P., & Šibila, M. (2006). Analysis of high-intensity large-scale movements in team handball. *Kinesiologia Slovenica*, 12(2), 51–58
- Prieto, J., Gómez, M.A. & Sampaio, J. (2015). Players' exclusions effects on elite handball teams' scoring performance during close games. *Int J Performance Analysis Sport*, 15: 983-996.
- Prieto, J., Gómez, M.A., Volossovitch, A. & Sampaio, J.(2016). Effects of team timeouts on the teams' scoring performance in letite handball close games. *Kinesiology*, 48, 115-123.
- Pueo, B., & Espina-Agullo, J. J. (2017). Relationship between exclusions and final results in European Championships, World Championships, and Olympic Games in men's handball 1982–2014. *J Phys Educ Sport*, 17(3), Article 178, 1158–1162
- Rogulj, N., Srhoj, V. & Srhoj, L. (2004). The contribution of collective attack tactics in differentiating handball score efficiency. *Coll Antrop*, 28, 739–746.
- Saavedra, J. M. (2018). Handball research: State of the art. *J Hum Kinetics*, 63(1), 5–8. <https://doi.org/10.2478/hukin-2018-0001>

- Saavedra, Y., & Saavedra, J. M. (2020). The association between relative age effect, goals scored, shooting effectiveness and the player's position, and her team's final classification in international level women's youth handball. *Mon J Sports Sci Med*, 9(1), 19-25. <https://doi.org/10.26773/mjssm.200303>
- Saavedra, J. M., Þorgeirsson, S., Chang, M., Kristjánsdóttir, H., & García-Hermoso, A. (2018). Discriminatory power of women's handball game-related statistics at the Olympic Games (2004–2016). *J Hum Kinetics*, 62(1), 221–229. <https://doi.org/10.1515/hukin-2017-0172>
- Saavedra, J. M., Þorgeirsson, S., Kristjánsdóttir, H., Chang, M., & Halldórsson, K. (2017). Handball game-related statistics in men at Olympic Games (2004–2016): Differences and discriminatory power. *Retos*, 32, 260–263.
- Vidūnaitė, G., & Skarbalius, A. (2013). Peculiarities of selected sport performance in women Olympic handball. *Ugdymas Kūno Kultūra Sportas*, 3(90), 78–83.
- Þorgeirsson, S., Pic, M., Lozano, D., Sigurgeirsson, O., Sekulic, D., Saavedra, J.M. (2022a). Gender-based differences in game-related statistics between winning and losing teams in an amateur handball league. *Acta Gymnica*, 52: article e2022.001. <https://doi.org/10.5507/ag.2022.001>
- Þorgeirsson, S., Pic, M., Lozano, D., Sigurgeirsson, O., Sekulic, D., Saavedra, J.M. (2022b). The difference between winners and losers in balanced handball games in the final 10 minutes. *Mon J Sports Sci Med*, 11(2): 37-43. <https://doi.org/10.26773/mjssm.220905>
- Þorgeirsson, S., Laxdal, A., Sigurgeirsson, O., Sekulic, D., Saavedra, J. M. (2023). Performance profiling in handball using discriminative variables and its practical applications. *Sport Mon*, 21(3): 3-8. <https://doi.org/10.26773/smj.231001>