

Performance Indicators in Elite Croatian Women's Handball: A Longitudinal Analysis

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Abstract

The analysis of performance indicators in modern sport has an increasingly important impact on a better understanding of trends in sports games, including handball. The aim of this study was to determine which defensive, offensive, and transition variables influence the final team ranking between successful and less successful teams. The analysis included a total of 3,044 matches of the First Croatian Women's Handball League (1st HRL) from 2011 to 2020, covering nine competitive seasons. Twenty seven variables describing offensive play, defensive play, transition phases, and goalkeeper performance were analyzed. Teams were classified as successful or less successful according to their final placement in the season. The results showed statistically significant differences between successful and less successful teams in the combination of the observed variables (Wilks' Lambda =0.47; $p < 0.001$) for the absolute variables, and for the relative variables (Wilks' Lambda =0.50; $p < 0.001$). Out of the 27 variables analyzed, 16 significantly differentiated the observed groups. The most important factor of success were: goalkeeper efficiency ($p = 0.00$, $F = 63.46$), shooting efficiency ($p = 0.00$, $F = 58.35$), accuracy of shots from outside positions 9 meters ($p = 0.00$, $F = 43.03$) and higher number of fast break attempts ($p = 0.00$, $F = 24.67$). The results of this study should serve as important guidelines for coaches and practitioners and contribute to the systematic development of young female handball players, with the aim of preparing future elite athletes.

Keywords: *match outcome, game impact, team quality, situational efficiency, fast break*

Introduction

Situational efficiency represents a partial indicator of the actual quality of a player and the game. It is conditioned by the individual and collective level of athletic performance, the degree of team coordination, and the overall preparedness of the player and team. In essence, statistics are used both to interpret past events and to guide a team's future decisions (Clemente et al., 2020). In practice, coaches often prioritize certain measures of situational efficiency based on their personal understanding of the game. Recent technologies have enabled the analysis of match record data, allowing for the quantitative assessment of various events and situations occurring during competition. Additionally, the content and flow of the match can be monitored and analyzed in real time, enabling timely adjustments to tactical and strategic decisions (Kim et al., 2008). Ideally, greater emphasis should be placed on factors that are most directly linked to winning (Foretić, 2012).

Currently, match analysis occupies a central position in scientific research aimed at monitoring and improving performance. Special interest in this topic is evident in numerous studies covering football (Beato, Youngs, & Costin, 2024) basketball (Gervasi et al., 2024), and water polo (Parezzetti et al. 2023). The theoretical understanding of performance in team sports can be enhanced by integrating frameworks such as Performance Profiling and Ecological Dynamics, which offer important perspectives on how situational factors interact with individual and collective behaviors to affect match outcomes. These models highlight the role of contextual constraints and team coordination, allowing for a more nuanced interpretation of performance in competitive settings.

Situational efficiency in handball has also been the subject of scientific research over the past few decades and plays an increasingly important role in the systematic monitoring, analysis, and improvement of competitive performance

(Foretic et al., 2021; Landure et al., 2019). Player and team actions in handball are recorded using advanced data collection systems, which have evolved significantly from the early manual video analysis methods (Gómez López et al., 2021; Prieto, Gómez, & Sampaio, 2015). Match analysis can be approached through two main levels of complexity: static and dynamic (Sampaio, Ibáñez, & Lorenzo, 2013). In the static approach, players' and teams' actions, as well as key events during the game, are recorded using notation systems (which were once manual but are now mostly automated). This method focuses on producing final match statistics while paying little or no attention to the situational context of the game at any given moment hence it is referred to as a structure-oriented model (Hatzimanouil et al., 2023; Krawczyk et al., 2022; Pfeiffer & Perl, 2006). While static analysis is valuable for descriptive and comparative purposes, it is inherently limited for understanding deeper causes of play outcomes. It can't capture the complex, adaptive, and context-dependent nature of decision-making in dynamic environments (Araújo et al. 2006). To overcome these limitations, static data should be complemented with temporal, spatial, and contextual analyses (e.g., sequential analysis, positional data, or constraint-based frameworks) that better reflect the realities of in-game decision processes.

Conversely to static, the dynamic approach records actions and significant events in direct relation to the ongoing flow of the match, capturing them in a chronological and sequential manner. This process-oriented model provides insight into how performance evolves throughout the game (Pfeiffer & Perl, 2006). The research we conducted was carried out using a static approach due to the complexity of collecting measurement data across a large number of matches.

A systematic review of the literature conducted in the field of handball on the topics of "match analysis," "performance analysis," "notational analysis," "game analysis," "tactical analysis," and "patterns of play" showed that most of the research was carried out using statistical data available from the tournament organizers. The focus of the studies was directed toward four main variables: total shots and finals, end match outcome, Time Outs (TTOs), and the relationship between home advantage (Landure et al., 2019; Pascual et al., 2024).

In this study, the final league ranking was used as the criterion of success because it represents an integrated and cumulative outcome of all matches played during the season and reflects the long term stability of team performance. Unlike goal difference, which can be strongly influenced by individual matches with large score margins, the final ranking better captures team consistency, efficiency, and the ability to adapt to different competitive contexts.

Scientific research on male handball is significantly more represented in the literature compared to female handball. A systematic review of scientific studies showed that 75% of the studies were conducted on male teams, while only 25% included female handball (Prieto, Gómez, & Sampaio, 2015). The lack of longitudinal research is particularly pronounced in female handball. The only longitudinal comparative analysis conducted between 2017 and 2021 across four major international competitions identified variables that significantly

influence match outcomes: shooting efficiency from 6 and 9 meters, goalkeeper saves, number of goals from fast breaks, and number of steals (Park et al., 2021).

Longitudinal studies have most often been conducted on major tournaments, whereas research on professional leagues over multiple seasons is rare. For example, in the Swedish Women's First League over two seasons, short periods of better or worse performance in situational parameters were observed (Moesch et al., 2014). Therefore, our study contributes to the understanding of situational efficiency in female handball within a league system.

The aim of this study is to conduct a longitudinal analysis of situational parameters across nine competitive seasons in the Croatian Women's Handball League and to determine which defensive, offensive, and transition variables influence the final team ranking between successful and less successful teams.

Materials and methods

Participants and design

The research was conducted over the period from 2011 to 2020, covering nine competitive seasons. A total of 3,044 matches were analyzed, including all matches of the 1st Croatian Women's Handball League (1. HRL) in the national championship. The analysis was performed on a large portion of the data recorded in defense, offense, and transitions. Players' identities were anonymized following the principles of the Declaration of Helsinki to ensure confidentiality.

Procedures

Data were collected from the official website of the Croatian Handball Federation (HRS). A software program for data collection was developed based on the TOMASOFT platform, which is used for analysis and processing of data. During each match, an official entered the recorded data into a software system according to the situational events occurring in the game. All recorded results were immediately processed and subsequently recorded and stored in the database.

Variables

For the purposes of this study, 27 variables were used in a previous study conducted on a sample of male handball players in the 1st Croatian Handball League (Bajgorić et al., 2017). All variables are part of the system employed by the Croatian Handball Federation (HRS) and are applied in all matches of the national championship. The sample of variables included relative variables expressed as percentages (%): SHT % (shot efficiency), 7M % (7 metre throw efficiency), OUT % (outside shot accuracy), 6M % (6-metre shot accuracy), FB GLS % (fast break efficiency), AST % (assist efficiency), and GS % (goalkeeper save percentage). The absolute variables included: TOT SHT (total shots attempted), GLS (goals scored), TOP GLS (most goals scored in a game), 7M ATT (7 metre throws attempted), 7M GLS (7 metre goals scored), OUT ATT (outside shots attempted), OUT GLS (outside shot goals), 6M ATT (6 metre shots attempted), 6M GLS (6 metre goals), FB ATT (fast break shots attempted), FB ATS (fast break attempts),

AST (assists), TO (turnovers), TO/G (turnovers per game), STL (steals/interceptions), STL/G (steals per game), SUS (suspensions), SUS/G (suspensions per game), GOLKSHT (shots faced by the goalkeeper), and GOLKSAV (goalkeeper saves).

mality assumptions. The level of statistical significance was set at $p < 0.05$. Statistical analysis was carried out using Statistical Package Software for Social Science, version 28 (SPSS Inc., Chicago, IL, USA).

Statistics

For the description of the basic characteristics of the analyzed variables, descriptive statistics was used (mean, minimum, maximum, standard deviation, skewness, kurtosis, Max D). The normality of variable distributions was examined using the Kolmogorov–Smirnov test. Differences between successful and unsuccessful teams were first examined using multivariate analysis of variance (MANOVA) with the application of Wilks’ Lambda. After establishing multivariate significance, univariate analyses of variance (ANOVA) were conducted for variables with normal distributions, while the Kruskal–Wallis test was used for variables with violated nor-

Results

Table 1 presents the results of descriptive statistics for all variables included in the analysis of the observed situational parameters. The results indicate that, unlike the other variables which show a normal distribution, four variables deviate from normality: 7M ATT (Max D=0.45), 7M GLS (Max D=0.40), STL (Max D=0.18), and STL/G (Max D=0.18). The normality of variable distributions was examined using the Kolmogorov–Smirnov test, with the criterion values for deviation from normal distribution set at Max D=0.12 at the significance level of $p < 0.10$, and Max D=0.15 at the significance level of $p < 0.05$.

Table 1. Descriptive statistics of examined variables

| VAR | AM | Min | Max | SD | Skew | Kurt | Max D |
|---------|---------|--------|---------|--------|-------|-------|-------|
| TOT SHT | 1023.75 | 394.00 | 1384.00 | 202.92 | -1.10 | 1.11 | 0.15 |
| GLS | 584.22 | 198.00 | 888.00 | 127.71 | -0.64 | 0.89 | 0.07 |
| SHT % | 57.49 | 43.61 | 71.84 | 5.70 | 0.17 | -0.18 | 0.06 |
| TOP GLS | 26.40 | 18.64 | 56.79 | 4.56 | 2.83 | 15.73 | 0.13 |
| 7M ATT | 173.20 | 33.00 | 1281.00 | 271.31 | 3.34 | 9.61 | 0.45 |
| 7M GLS | 112.46 | 24.00 | 713.00 | 140.04 | 3.33 | 9.88 | 0.40 |
| 7M % | 74.05 | 49.14 | 87.96 | 7.95 | -1.12 | 1.65 | 0.11 |
| OUT ATT | 419.66 | 153.00 | 665.00 | 114.79 | -0.24 | -0.65 | 0.07 |
| OUT GLS | 176.00 | 67.00 | 275.00 | 45.21 | -0.20 | -0.49 | 0.07 |
| OUT % | 42.30 | 27.68 | 57.30 | 5.72 | 0.17 | 0.08 | 0.05 |
| 6M ATT | 236.99 | 92.00 | 562.00 | 64.12 | 0.92 | 5.25 | 0.11 |
| 6M GLS | 171.30 | 55.00 | 345.00 | 46.11 | 0.30 | 1.51 | 0.08 |
| 6M % | 72.36 | 51.07 | 82.14 | 4.72 | -0.79 | 2.43 | 0.05 |
| FB ATT | 59.26 | 7.00 | 197.00 | 35.72 | 1.19 | 1.70 | 0.12 |
| FB ATS | 46.68 | 4.00 | 158.00 | 28.53 | 1.17 | 1.83 | 0.11 |
| FB GLS% | 78.30 | 54.55 | 97.22 | 7.85 | -0.72 | 0.76 | 0.09 |
| AST | 2.92 | 0.41 | 10.18 | 2.00 | 1.42 | 2.13 | 0.13 |
| AST % | 64.68 | 8.00 | 240.00 | 46.03 | 1.40 | 2.26 | 0.12 |
| TO | 218.76 | 23.00 | 382.00 | 77.08 | -0.22 | -0.55 | 0.06 |
| TO/G | 9.46 | 1.83 | 14.69 | 2.60 | -0.45 | -0.04 | 0.05 |
| STL | 46.17 | 1.00 | 176.00 | 35.13 | 1.98 | 4.52 | 0.18 |
| STL/G | 1.98 | 0.06 | 7.86 | 1.43 | 2.08 | 5.12 | 0.18 |
| SUS | 67.11 | 16.00 | 103.00 | 17.55 | -0.39 | -0.17 | 0.08 |
| SUS/G | 3.01 | 1.63 | 9.72 | 0.82 | 4.35 | 35.34 | 0.14 |
| GOLSHT | 837.79 | 258.00 | 1137.00 | 171.99 | -1.17 | 1.81 | 0.12 |
| GOLSAV | 251.26 | 74.00 | 421.00 | 70.54 | -0.16 | -0.50 | 0.05 |
| GS % | 29.91 | 17.99 | 43.38 | 5.90 | 0.22 | -0.23 | 0.06 |

Note. VAR: variable; AM: arithmetic mean; Min: minimum value; Max: maximum value; SD: standard deviation; Skew: asymmetry coefficient; Kurt: distribution curvature coefficient; MaxD: maximum difference between real and theoretic cumulative frequencies

Table 2 presents the results of the multivariate analysis of variance (MANOVA) conducted to examine differences between successful and unsuccessful teams for both absolute and relative variables. In both cases, similar results were obtained, with statistically significant differences observed for

the absolute variables (Wilks' Lambda =0.47, p<0.001) as well as for the relative variables (Wilks' Lambda =0.50, p<0.001). The low p values (p<0.001) in both analyses confirm that the observed differences are highly statistically significant.

Table 2. Multivariate analysis of variance (MANOVA)

| Multivariate analysis (MANOVA) of variance between successful and unsuccessful teams using only absolute variables | | | | |
|--|---------|-----|-----|------|
| Wilks λ | Rao's R | df1 | df2 | p |
| 0.47 | 6.17 | 19 | 103 | 0.00 |
| Multivariate analysis of variance (MANOVA) between successful and unsuccessful teams using only relative variables | | | | |
| Wilks λ | Rao's R | df1 | df2 | p |
| 0.50 | 14.34 | 8 | 114 | 0.00 |

Note. Wilks λ: Wilks' Lambda; Rao's R: F-approximation of the Hotelling–Lawley trace (U); df1:degrees of freedom 1; df2: degrees of freedom 2; p - coefficient of significant difference p<0.05.

Table 3 presents the results of the univariate analysis of variance (ANOVA) for all variables and the Kruskal–Wallis test for variables with non-normal distributions between successful and less successful teams. Out of a total of 27 variables, 16 showed a statistically significant difference. The results showed that the variable GS% (p=0.00, F=63.64) was the most important factor distinguishing between the two observed qualitative groups. The second most important variable was SHT% (p=0.00, F=58.35), indicating that shooting efficiency plays a crucial role and is likely correlated with

the previous variable, as well as with the contribution of goalkeepers through saves. The outside shooting percentage OUT% (p=0.00, F=43.03) also significantly contributed to the differences between successful and less successful teams. Furthermore, transition play, which is often a product of effective defensive reactions, was reflected in the variable fast break attempts FB ATS (p=0.00, F=24.67), which proved to be statistically significant and made a substantial contribution to the differences between the two qualitative groups.

Table 3. Univariate analyses of variance (ANOVA) for variables with normal distribution and Kruskal–Wallis test or variables with violated normality assumptions

| VAR | SUCC AM | LS AM | F | p | H | p |
|----------|---------|---------|-------|------|------|------|
| TOT SHT | 1037.10 | 1009.73 | 0.56 | 0.46 | | |
| GLS | 626.48 | 539.85 | 15.86 | 0.00 | | |
| SHT % | 60.65 | 54.18 | 58.35 | 0.00 | | |
| TOP GLS | 28.14 | 24.58 | 22.03 | 0.00 | | |
| 7M ATT | 152.56 | 194.87 | 0.75 | 0.39 | 0.78 | 0.38 |
| 7M GLS | 103.03 | 122.37 | 0.58 | 0.45 | 0.64 | 0.42 |
| 7M % | 75.21 | 72.84 | 2.79 | 0.10 | | |
| OUT ATT | 398.67 | 441.70 | 4.44 | 0.04 | | |
| OUT GLS | 179.03 | 172.82 | 0.58 | 0.45 | | |
| OUT % | 45.15 | 39.31 | 43.03 | 0.00 | | |
| 6M ATT | 249.13 | 224.25 | 4.77 | 0.03 | | |
| 6M GLS | 185.19 | 156.72 | 12.86 | 0.00 | | |
| 6M % | 74.22 | 70.41 | 23.82 | 0.00 | | |
| FB ATT | 73.52 | 44.28 | 24.58 | 0.00 | | |
| FB ATS | 58.10 | 34.70 | 24.67 | 0.00 | | |
| FB GLS % | 79.43 | 77.12 | 2.68 | 0.10 | | |
| AST % | 76.29 | 52.50 | 8.72 | 0.00 | | |
| AST | 3.49 | 2.31 | 11.69 | 0.00 | | |

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Table 3. Univariate analyses of variance (ANOVA) for variables with normal distribution and Kruskal–Wallis test or variables with violated normality assumptions

| VAR | SUCC AM | LS AM | F | p | H | p |
|---------|---------|--------|-------|------|------|------|
| TO | 211.56 | 226.33 | 1.13 | 0.29 | | |
| TO/G | 9.03 | 9.92 | 3.74 | 0.06 | | |
| STL | 54.46 | 37.47 | 7.58 | 0.01 | 2.08 | 0.15 |
| STL/G | 2.31 | 1.64 | 7.11 | 0.01 | 2.70 | 0.10 |
| SUS | 70.54 | 63.52 | 5.09 | 0.03 | | |
| SUS/G | 3.21 | 2.80 | 8.04 | 0.01 | | |
| GOLKSHT | 809.52 | 867.47 | 3.56 | 0.06 | | |
| GOLKSAV | 270.13 | 231.45 | 9.91 | 0.00 | | |
| GS % | 33.28 | 26.38 | 63.46 | 0.00 | | |

Note. VAR: variable; AM: arithmetic mean; Min: minimum value; Max: maximum value; SD: standard deviation; Skew: asymmetry coefficient; Kurt: distribution curvature coefficient; MaxD: maximum difference between real and theoretic cumulative frequencies

Discussion

This study has several important findings: 1) the goalkeeper’s save percentage is the most significant situational parameter for final success in women’s handball, 2) shot efficiency has an important impact on the final ranking, 3) outside shot accuracy significantly contributes to the difference between successful and less successful teams, 4) transition play in handball has an increasingly important influence on the game in terms of the number of attempts.

The save percentage of goalkeepers emerged as the most important factor for the final ranking of the team. The role of the goalkeeper in handball is such that achieving top results is very difficult without their contribution in terms of both percentage and number of saves. An interactive approach, often involving two or three goalkeepers participating in matches with their saves, has proven to be an effective strategy for winning top table positions. An increase in the goalkeeper’s save percentage of approximately 6% in our research can have a significant impact on the probability of winning. Consequently, even relatively small differences in save percentage can have a substantial cumulative effect on individual match results and the team’s final ranking (Gómez López et al., 2021). Comparisons with European Championships between 2018 and 2020 showed a variation percentage of 30–33% for men and 33–36% for women (Bojić-Čaćić, 2021). The highest save efficiency for both genders was observed for shots from nine meters and toward the central parts of the goal, while the least successful saves were from fast break shots and shots directed toward lower and side zones. Overall, female goalkeepers achieved a higher percentage of stopped shots regardless of shot position or goal zone (Gómez López et al., 2021). Research conducted by Hianik (2011) in Slovakia using the computer program Assessment Game Performance in Team Handball on first-league players showed that the number of saves from different positions significantly contributes to the final match result. Goalkeepers achieve more saves from outside positions, which can be attributed to more effective

collaboration between defensive players and the goalkeeper (Park et al., 2021). Research conducted on a sample of male and female handball goalkeepers who participated in the 2020 European Handball Championship in Denmark showed that the save percentage is equally important for men (-0.34) and women (-0.32) (Foretic et al., 2021). This result is consistent with the findings of Hansen et al. (2017), who stated that the save percentage is a key factor for achieving a better team ranking. Their results indicated a moderate but statistically significant negative correlation between goalkeeper efficiency and the team’s final placement ($R^2=0.464$, $p<0.001$, $r=-0.68$; 95% CI: -0.85 to -0.38). The analysis confirmed that goalkeeper efficiency in matches is one of the most reliable indicators of a team’s final success in major tournaments or national championships. The reasons for these results can be attributed to the goalkeeper’s role, as the goalkeeper occupies a central position in the structure of handball play and is the only player who directly prevents goals, thereby exerting an immediate influence on the match outcome. Also, each successful save, in addition to its defensive value, often creates conditions for a rapid transition to attack and the execution of fast breaks.

Shot efficiency is an important variable that differentiates successful and less successful teams. It is certainly associated with the percentage and number of goalkeepers saves. The results of our research show that the average success rate of successful teams was 60.65%. These results align with similar studies. For example, research by Krawczyk et al. (2022) on the Women’s Handball European Championship 2022 showed that winning teams scored a significantly higher number of goals in attack ($d=1.43$) and had higher attack efficiency ($d=1.71$). Evaluation of data from four Olympic tournaments (2004–2012) for women indicated that, in addition to goalkeeper saves, technical errors, steals, and shot efficiency have a major impact (Saavedra et al., 2018). Offensive efficiency trends are one of the most important predictors of team success. Longitudinal research in men’s handball at World Championships (2011–2019) showed an increase of 19.5% when peak efficiency reached 57.5% (Landure et al.,

2019). Research by Foretić (2012) indicated that teams scored an average of 28.17 goals per match, while more recent studies show this number slightly higher at 30.10 goals per match for top teams (Panagiotis et al., 2020). Shot efficiency significantly influences goal-scoring outcomes, distinguishing more successful teams from less successful ones. Higher shot efficiency is associated with fewer goalkeeper saves and technical errors, thereby enhancing competitive performance. These findings are consistent with previous research, indicating that superior offensive efficiency predicts improved outcomes in international handball competitions (Park et al., 2021).

Outside shooting accuracy is a very important parameter of situational efficiency identified in our study. Research analyzing match play shows that a large proportion of shots are taken from distances of 9 m or more (outside zone); however, the efficiency of these shots is lower compared to shots taken from closer positions (Smolarczyk, 2023). Our research indicated that the average percentage of long range shots from beyond 9 m or more was 45.15% among successful teams. In one analysis, 65.6% of all shots in matches were taken from the outside zone (9 m or more), with an average efficiency of approximately 38–40%, suggesting that these shots still represent an important factor in a team's overall scoring efficiency (Hatzimanouil et al., 2017). Recent trends in offensive structure at the EHF EURO 2020 and 2022 indicate a decrease in the number of shot attempts from the 9 m distance over time, accompanied by an increase in shots taken from closer positions, which reflects tactical changes in modern men's handball (Smolarczyk, 2023). In women's handball, an analysis of five World Women's Handball Championships from 2009 to 2017 showed that technical–tactical variables, including the efficiency of shots from 9 m, improved over successive competitions (Skoufas, 2019). In a comparative analysis of international competitions involving 12 national teams that participated in the Tokyo 2021 Olympic Games, the success rate of 9 m shots was among the indicators that had a positive impact on match outcomes, together with other performance variables (Park et al., 2021). Furthermore, an analysis of the three best women's national teams France, Russia, and Norway at the Tokyo Olympic Games revealed that their style of play was primarily based on shots from 9 m and shots from 6 m. These findings indicate that the aforementioned variables significantly determine offensive performance in modern women's handball (Bajgorić & Đug, 2022). The observed results can be attributed to the fact that outside shooting accuracy directly affects overall offensive efficiency, even though the effectiveness of these shots is lower than that of closer range attempts. The high proportion of shots taken from the 9 m zone indicates that, despite lower individual efficiency, these attempts still contribute substantially to total goals scored and influence the tactical structure of the attack. Moreover, improvements in technical tactical performance and the increased use of closer range shots, demonstrate that these variables play a critical role in determining offensive performance in modern women's handball and significantly impact match outcomes (Saavedra et al., 2018).

The acceleration of play in handball matches, due to rule changes, improved physical preparation of teams, and tran-

sition to attack (including fast breaks, individual and group counterattacks, and extended counterattacks) against unstructured zone defense, where space-time intervals are maximally exploited, has become an increasingly important factor in modern handball. According to Yiannakos et al. (2005), who analyzed matches of the Greek national championship in 2003, the frequency of fast break shots was higher in the first half (56.1%) than in the second half (43.9%), and conversion was better in the first half (77.1%) compared to 66.9% in the second half, likely due to player fatigue toward the end of the match. These findings are consistent with Hatzimanouil et al. (2023), who demonstrated that 38% of the game was related to fast-break execution, which is a key factor for predicting team success at the EHF EURO 2022. Similarly, Gutierrez et al. (2011) conducted a discriminant analysis to identify differences between winning and losing teams in the 2008–2009 season Asobal league Spain. Results showed that winning teams scored more goals on average from all shooting distances. The most pronounced differences, however, were observed in fast-break goals and attempts, which were the only shooting statistics that significantly distinguished successful from unsuccessful teams. A similar study conducted on the Croatian Men's Premier League (Bajgorić et al., 2017) found that level of significance, average number of goals from counterattacks ($p=0.00$), and average number of shots from counterattacks ($p=0.02$) were important for team success in the final ranking. In women's handball, fast break efficiency was also shown to be crucial. Ohnjec et al. (2003) found that fast break goals significantly contributed to goal difference at the 2003 Women's World Championship in Croatia, with successful teams using this tactic more frequently to score "easy goals" compared to losing teams. Recent research on performance indicators at the 2022 European Women's Handball Championship shows that teams achieving a higher number of fast break attempts are statistically more likely to win matches (Krawczyk, 2025). Fast break actions in modern handball constitute a critical determinant of team success, as they enable the exploitation of unstructured defensive formations and the creation of high-percentage scoring opportunities. The frequency and effectiveness of fast breaks are typically higher in the first half of matches, reflecting optimal player freshness, whereas fatigue in later stages of play reduces execution efficiency. Empirical analyses consistently demonstrate that teams that utilize fast break strategies more frequently achieve superior performance outcomes and exhibit a higher likelihood of winning, a trend evident in both men's and women's handball competitions (Landure et al., 2019).

Despite the relevance of the findings, this study has some limitations that should be acknowledged. First, the analysis was based on situational performance indicators derived from official match statistics, which may not fully capture the dynamic, contextual, and tactical interactions occurring during the game. Second, potential confounding factors such as team quality, coaching strategies, player injuries, and in match contextual variables (e.g., match status or opponent strength) were not explicitly controlled.

All above mentioned findings align with previous studies, and the strength of this research lies in the wide range of

situational parameters analyzed. Future research should be based on longitudinal analyses of multiple consecutive major international competitions in order to systematically monitor changes in tactical and performance related trends in women's handball, with particular emphasis on the proportion of 9m shots, outside shooting efficiency, and the evolution of offensive playing patterns. Furthermore, the application of advanced statistical and analytical approaches, including multilevel modeling and time series analysis, is recommended to enable more robust modeling of match outcomes, more accurate prediction of competitive success, and a deeper understanding of the interdependencies and dynamic relationships among situational performance indicators.

Conclusions

The results of this study confirm that goalkeeper save percentage, shot efficiency, outside shooting accuracy, and transition play represent key situational performance indicators of success in elite women's handball. Goalkeeper efficiency emerged as the most influential factor, highlighting its decisive role in match outcomes and final rankings. In addition, offensive efficiency particularly in positional and outside shooting along with an increased frequency of fast-break attempts, significantly differentiates winning from losing teams. These findings are consistent with previous research and underline the growing importance of transition play in modern women's handball. Overall, the comprehensive analysis of situational parameters provides valuable insights for performance optimization and supports evidence based approaches to training and tactical preparation. Therefore, coaches should structure training to develop tactical skills as well as physical, physiological, and psychological readiness to sustain a high playing tempo. In the long term, these success indicators should guide the development of young female handball players to prepare future elite athletes.

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Conflicts of interest

The authors declare no conflict of interest.

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