JOURNAL OF ATHLETIC PERFORMANCE AND SPORTS MEDICINE

https://journalapsm.com

e-ISSN 3062-4517 2025, 2 (1), 25-35 *Original Article*

Comparison of MSS, MAS, and ASR Performance Indicators Among Female Football Players Across League Levels in Türkiye

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Authors' Contribution: *A: Study design, B: Data collection, C: Data analysis, D: Manuscript preparation, E: Discussion and conclusion*
Corresponding author: A. Çıkıkcı
Published: 31.08.2025
** This article was presented as an oral presentation at the International Conference on Social Science Research Budapest, May 2025*
DOI: 10.5281/zenodo.17014072

ABSTRACT

Purpose: This study aimed to compare the maximum sprint speed (MSS), maximal aerobic speed (MAS), and anaerobic speed reserve (ASR) of female football players competing in Türkiye's Super League (Division 1) and Second League (Division 3), highlighting differences in physical performance across competition levels.
Methods: A total of 28 female players (mean age 24.5±6.47) participated (Super League: 14, Second League: 14). MSS was measured via a 40-meter sprint test, MAS was assessed with the 30-15 IFT, and ASR was calculated as the difference between MSS and MAS. Data were analyzed using the Mann-Whitney U test due to non-normal distribution ($p < 0.05$).
Results: Super League players demonstrated significantly higher values in MSS (30.31 ± 1.94 km/h), MAS (16.05 ± 0.6 km/h), and ASR (14.25 ± 1.93 km/h) compared to Second League players (MSS: 22.56 ± 0.92; MAS: 13.6 ± 0.9; ASR: 8.97 ± 1.35) ($p < 0.001$ for all). The effect sizes were also substantial ($r = -1.00$).
Conclusion: Higher league levels in women's football are associated with greater anaerobic and aerobic performance capacities. These findings emphasize the physical demands and training needs of elite-level female footballers.
Keywords: Female Football, Female Soccer, MSS, MAS, ASR.

INTRODUCTION

Soccer is one of the most extensively researched sports disciplines, particularly due to its complex physiological and technical demands (Reilly et al., 2000; Datson et al., 2014). Characterized as a high-intensity, intermittent team sport, soccer requires players to exhibit a synthesis of technical proficiency, tactical awareness, physical capacity, and psychological resilience (Stølen et al., 2005; Gledhill et al., 2017; Olmedilla et al., 2018, 2019). However, existing literature has predominantly focused on male athletes (Mohr et al., 2008; Olmedilla et al., 2019), resulting in a substantial knowledge gap regarding female players (Milanović et al., 2017; Randell et al., 2021). Recent years have witnessed a notable surge in the professionalization and participation rates in women's soccer globally (Olson, 2008; Alahmad et al., 2020). Alongside this growth, research interest in the female game has also expanded (Okholm Kryger et al., 2022; Harkness-Armstrong et al., 2022). Nonetheless, much of this work has concentrated on injury prevention and conditioning strategies, with limited exploration into match-related physical demands.

Achieving optimal performance in soccer necessitates the efficient use of both aerobic and anaerobic energy systems (Svensson & Drust, 2005; McCurdy et al., 2010). While total distance covered informs aerobic workload, parameters such as sprint distance, maximal speed, and sprint frequency inform anaerobic demands. These performance indicators differ by competitive level and serve as a foundation for individualized training interventions (Choice et al., 2022).Despite a growing understanding of match demands, additional insights are needed to enhance training specificity (Milanović et al., 2017; Fernandes et al., 2022). For this purpose, performance monitoring through field tests—such as the 30–15 Intermittent Fitness Test (30–15 IFT) and maximal sprint assessments—has become integral in evaluating both aerobic capacity (MAS) and anaerobic potential (ASR) (Buchheit, 2008; Buchheit & Laursen, 2013).

The concept of Anaerobic Speed Reserve (ASR)—defined as the differential between an athlete's maximal sprinting speed (MSS) and their maximal aerobic speed (MAS)—has garnered attention due to its predictive value in high-intensity performance and fatigue responses (Bundle et al., 2003; Buchheit et al., 2012). Athletes with higher ASR values tend to experience reduced neuromuscular fatigue and lower perceived exertion during high-intensity intervals (Buchheit & Laursen, 2013; Sandford et al., 2021). Although total distance covered has been positively associated with match outcomes in women's soccer (Bradley et al., 2014; Trewin et al., 2018), holistic performance evaluation must incorporate technical, tactical, and psychological elements (Ali, 2011; Russell & Kingsley, 2011). Technical competency, in particular, has shown strong correlations with match success, especially at higher competition levels (Rampinini et al., 2009; Pedersen et al., 2014).

Given the limited data available on female soccer players in Türkiye, especially across different league levels, the present study aims to compare key performance indicators namely MAS, MSS, and ASR among athletes from the Turkish Women's First and Third Divisions.

METHOD

Participants

A total of 28 female soccer players voluntarily participated in this study during the 2024–2025 season of the Turkish Women's Super League (First Division) and Turkish Women's Second League (Third Division). The mean age of the participants was 24.5 ± 6.47 years. To ensure balanced group sizes, 14 players were randomly selected from a Super League team, and 14 players from a Second League team were available and agreed to participate. For the purposes of this study, the Super League was categorized as Division 1 and the Second League as Division 3.

Study Design

The research design was based on in-season performance assessments conducted within the teams' existing training schedules. All testing protocols were standardized and administered under similar conditions across both league levels.

Performance Assessments

30-15 IFT (MAS)

Maximal aerobic speed (MAS) was assessed using the 30–15 Intermittent Fitness Test (30–15 IFT), a widely validated field test (Buchheit, 2008). Participants performed 30-second running intervals at increasing speeds, interspersed with 15-second passive recovery periods. The initial running speed was set at 10 km/h. The test was terminated after three consecutive failures to reach the designated 3-meter zone at the required time.

Maximal Sprint Speed (MSS) Test

Maximal sprint speed (MSS) was measured using Fusion Sport SmartSpeed™ PRO timing gates (Fusion Sport, Queensland, Australia) placed every 10 meters along a 40-meter sprint lane. MSS was determined from the 10-meter segment with the highest recorded speed. Prior to testing, players completed a standardized 5-minute warm-up followed by preparatory 5-meter sprints. Each player performed two maximal sprints, with the higher value recorded for analysis (Kayhan et al., 2021).

Anaerobic Speed Reserve

Anaerobic speed reserve ASR was calculated as the difference between MSS and MAS, with the following equation ASR (km · h–1) = MSS – MAS (Mendez-Villanueva A. et.al., 2013).

Data Analysis

All statistical analyses were conducted using JASP (Version 0.19.3). Normality of the variables was assessed via the Shapiro–Wilk test. Since MSS ($W = 0.850$, $p < 0.001$), MAS ($W = 0.912$, $p = 0.022$), and ASR ($W = 0.903$, $p = 0.013$) values violated normality assumptions ($p < 0.05$), non-parametric tests were used. Mann–Whitney U tests were applied to compare MAS, MSS, and ASR values between First and Third Division players.

FINDINGS

Table 1. Descriptive Statistics of MSD, MSS and ASR by League Level

Variable	Division	N	X±Ss
MSS	**Third Division**	14	22.56 ± 0.92
	First Division	14	30.31 ±1.94
MAS	**Third Division**	14	13.6 ± 0.9
	First Division	14	16.05 ± 0.6
ASR	**Third Division**	14	8.97 ± 1.35
	First Division	14	14.25 ± 1.93

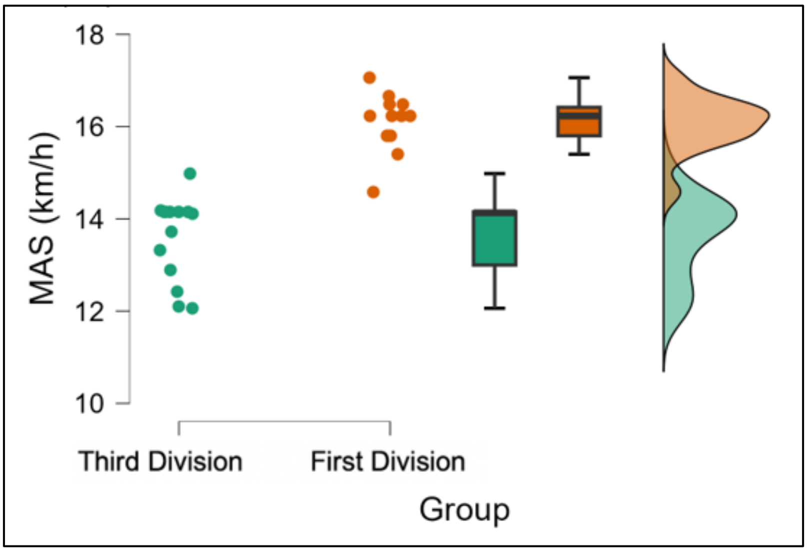

Figure 1. Raincloud plot showing the distribution of Maximal Aerobic Speed (MAS) values for First Division and Third Division players

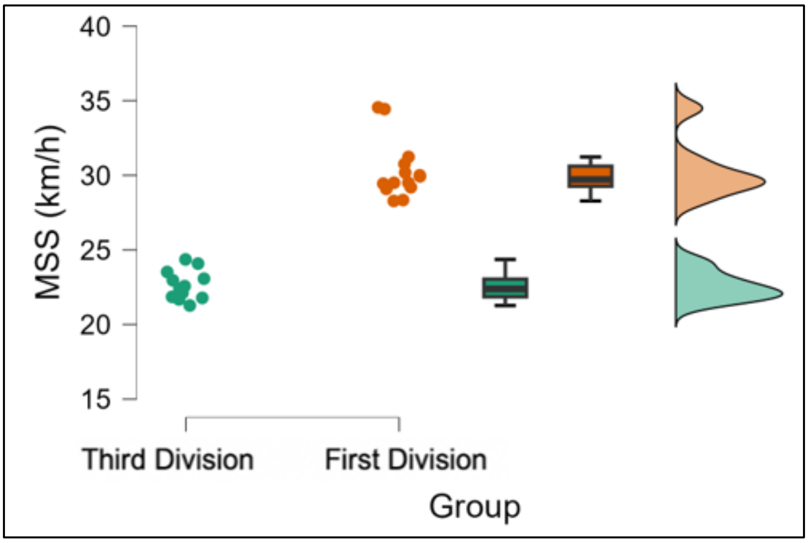

Figure 2. Raincloud plot showing the distribution of Maximal Sprint Speed (MSS) values for First Division and Third Division players

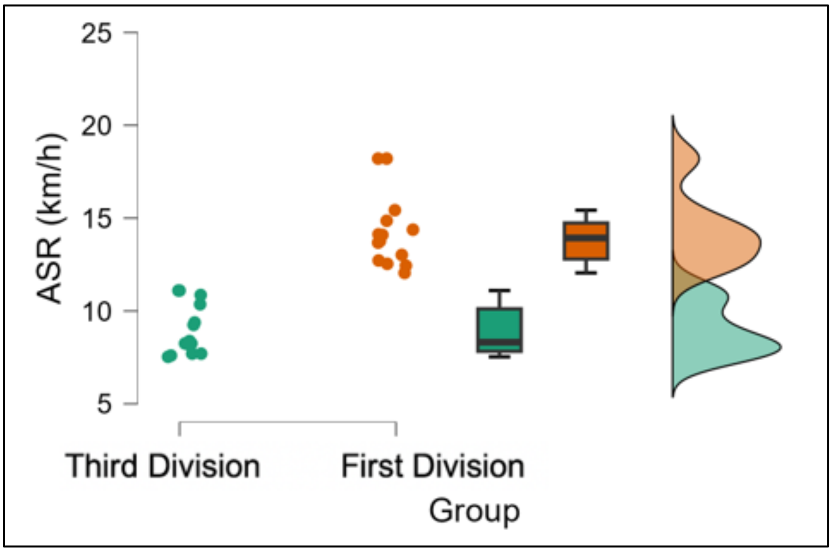

Figure 3. Raincloud plot showing the distribution of Anaerobic Speed Reserve (ASR) values for First Division and Third Division players

Upon examining Table 1, the average values for the Super League (First Division) players were recorded as 30.31 km/h for MSS, 16.05 km/h for MAS, and 14.25 km/h for ASR. In contrast, the Second Division players demonstrated lower values: 22.56 km/h, 13.6 km/h, and 8.97 km/h, respectively. The lower standard deviation and standard error values observed in the Third Division suggest a more homogeneous distribution among players in this group, albeit at a generally lower performance level.

Table 2. Comparison of MSS, MAS, and ASR Values Between First and Third Division Players

Variable	U	p	Hodges-Lehmann Estimate (%95 GA)	Sıra-Biserial Correlation
MSS (km/h)	0.00	**< 0.001***	-7.39 (-8.25, -6.50)	-1.00
MAS (km/h)	0.00	**< 0.001***	-2.45 (-3.10, -1.80)	-1.00
ASR (km/h)	0.00	**< 0.001***	-5.28 (-6.00, -4.50)	-1.00

Table 2 presents the Mann-Whitney U test results comparing maximal sprint speed (MSS), maximal aerobic speed (MAS), and aerobic speed reserve (ASR) between Super League and Second Division players. The U and p values were used to assess the statistical significance of the differences between the groups. As all p-values were below .001, it can be concluded that Super League players exhibited significantly higher values in all performance parameters compared to their Second Division counterparts.

The Hodges-Lehmann estimates and their 95% confidence intervals (CI) indicate the magnitude and direction of the central tendency difference, while the rank-biserial correlation reflects the effect size. As the absolute value of the correlation coefficient approaches 1, the distinction between the groups becomes more pronounced. The findings demonstrate that Super League players possess a clear advantage in terms of speed, aerobic capacity, and repeated sprint ability.

DISCUSSION AND CONCLUSION

Until now, researchers and sports scientists have generally focused on top-level teams (i.e., elite teams), aiming to optimize the physical preparation of these players and achieve great success. Even beyond physical preparation, conducting match analyses exclusively at this level is certainly beneficial for expanding our understanding of the demands faced by top-tier players (and teams), but it is also disconnected from player development models and limits access to evidence-based information about athletes at lower league levels (Vescovi, J.D., 2021). Therefore, the aim of this study is to compare the basic performance components of female footballers in Turkey, namely maximal sprint speed (MSS), maximal aerobic speed (MAS), and anaerobic speed reserve (ASR), across different league levels. A literature review revealed that no other study has examined these performance variables in relation to league level among female soccer players in Turkey. Statistically significant differences were found between league levels in all performance variables analyzed.

The results revealed significant differences between the performance values of players in the Turkish Women's Super League (first division) and those in the Second League (third division) ($p< 0.001$). In the parameters examined, the MSS, MAS, and ASR values of Super League (first stage) players were 30.31 ± 1.94, 16.05 ± 0.6, and 14.25 ± 1.93, respectively, while those of Second League (third division) players were (22.56 ± 0.92, 13.6 ± 0.9, 8.97 ± 1.35), respectively. These results indicate that Super League (first division) players have statistically significantly higher performance values compared to Second League (third division) players ($p< 0.001$). Similar studies in the literature have also found significant physical differences between male and female footballers depending on the league level (Mohr et al., 2008; Baker & Heaney, 2015; Vescovi, 2021; Choice et al., 2022). The main reason for this is that soccer requires a significant level of aerobic and anaerobic fitness, and these requirements vary depending on the type of competition, player position, and playing style (Krustrup P. et al., 2005; Gentles J.A. et al., 2018). Physical fitness is an important variable for soccer, and it has been stated that high-level women's soccer requires a VO_2max value of approximately 55 mL/min/kg (Stolen et al., 2005; Hauegen T.A. et al., 2014; Gentles J.A. et al., 2018). Additionally, aerobic power is a more important parameter for elite female soccer players in terms of in-game physical performance compared to elite male soccer players, and this can be explained by female players having lower anaerobic capacity than their male counterparts (Krustrup P. et al., 2005). In professional women's soccer matches, the average heart rate (HR) was reported to be 87% of maximum heart rate, with peak heart rate at 97%. The average sprint distance was approximately 15.1 ± 9.4 meters, the individual sprint duration is approximately 2.3 ± 1.5 seconds, and the interval between sprints is approximately 2.5 ± 2.5 minutes (Krustrup P. et al., 2005; Vescovi J.J., 2012). The high average heart rate and sprint requirements in matches clearly highlight the importance of anaerobic fitness in women's soccer (Gentles J.A. et al., 2018).

Today, various field and laboratory tests are used to assess the training status of elite football players, predict match performance, and determine the effects of training. The advantage of field tests is that they allow all team players to be tested frequently, easily, and quickly at low cost (Krustrup P. et al., 2005). The concept of anaerobic speed reserve (ASR), which represents the difference between maximal aerobic power (MAP) and maximal sprint speed (MSS), can be used to identify differences in individual physical fitness profiles within a football team (Bundle M.W. et al., 2003; Buchheit & Laursen, 2013). Additionally, athletes with similar MAS values may have different MSS values. In this case, athletes with high MSS are expected to have good running economy at supramaximal running speeds (Mendez-Villanueva A. et al., 2008; Buchheit M. & Mendez-Villanueva A., 2013; Ortiz J.G. et al., 2018).

Similar to our study, Choice and colleagues (2022) reported that professional female soccer players perform an average of 43 sprints per game, whereas in lower leagues, this number ranges from 14 to 33 in NCAA Division I and averages 15 sprints in Division III. This indicates that top-level players have the capacity to perform sprints more frequently and effectively during matches. The finding that Super League players had significantly higher MSS values compared to lower league players in this study also supports this conclusion. Similar results were obtained in Vescovi's (2021) study, which examined the physical loads of female soccer players according to their developmental level. It was noted that NCAA-level players cover an average of 9,000–10,000 meters per game, while at the professional level, this value reaches up to 11,000 meters. Additionally, the high-intensity running distance reaches up to 2,800 meters at the professional level. This study also shows that as the league level increases, running loads and, consequently, physiological capacity also increase. The higher MSS, MAS, and ASR values of Super League players in our study support these results. In their study comparing MAS values across different sports, league levels, ages, and genders, Baker and Heaney (2015) found that Norwegian women's soccer players had MAS values of 4.11 m/s for Norwegian national team players, 4.0 m/s for Norwegian 1st League players, 3.32 m/s for Norwegian 2nd League players, 3.86 m/s for Norwegian U20 national team players, and 3.6 m/s for Norwegian professional high school team players. League players at 3.32 m/s, Norwegian U20 National Team players at 3.86 m/s, and Norwegian Professional High School Team players at 3.67 m/s. In a study conducted by Savolainen and colleagues (2024) on 35 female soccer players, the researchers examined the relationship between female soccer players' in-season training load, intensity, and physical performance and changes in in-season total training load, intensity, and physical performance. The results showed that as the athletes' training load (TD) and low-intensity running distance (LIRD) increased, there was a positive correlation with their MAS values ($r = 0.594$ and 0.503, $p < 0.05$). In addition to these results, they noted that athletes' CMJ (counter-movement jump) and MAS performance improvements also showed a positive correlation with increases in very-high-intensity running distance (VHIRD) and acceleration & deceleration intensity ($r = 0.454–0.588$, $p < 0.05$). In another study by Mohr and colleagues (2008), it was reported that top-level international female soccer players performed 28% more high-intensity running and 24% more sprints per match compared to lower-level elite players ($p < 0.05$). Similarly, in this study, the statistically significant higher MSS, MAS, and ASR values of women footballers at the Super League level indicate that both aerobic and anaerobic capacity develop with the level of competition and that higher performance is demonstrated during matches.

When women's soccer matches are examined, it is seen that the performance rates of activities such as standing, walking, running, high-intensity running, and sprinting are similar to those of male soccer players (Stolen et al., 2005; Mohr et al., 2008; Fessi et al., 2016). In another study comparing the physical performance of professional male and female soccer players, Clancy et al. (2024) found that there were certain differences in the MSS values of male and female athletes. Additionally, they found that the ASR values, which represent the ratio between MSS and MAS, were 4.3 m/s for the men's team and 4.1 m/s for the women's team. Based on these results, they noted that this difference could arise because women's teams tend to play a style of game involving more close contact over short distances during matches. In another study comparing the performance of female and male athletes, Del Rosso and colleagues (2016) examined the effects of metabolic differences in ASR performance values on heart rate recovery (HRR) in athletes after two different tests (RSA, UMTT). they examined the effects of metabolic differences in athletes' ASR performance values on heart rate recovery (HRR). Their results revealed significant differences ($P < 0.05$) in HRR values between high and low ASR groups of athletes of the same gender after RSA and UMTT. Additionally, after the RSA test, they found that male athletes in the high ASR group had significantly slower HRR values compared to the low ASR group of males ($P < 0.05$) and the high ASR group of female athletes ($P < 0.05$), female athletes in the high ASR group had faster HRR values compared to female athletes in the low ASR group ($P < 0.05$).

In a study by Clancy et al. (2023) that applied similar performance components to male soccer players, the development level of team athletes (age: 19.2 ± 1.1 years) compared the MAS, MASS, and ASR values. and ASR values. The first team's ASR values were 8.0% (95% CI 5.6%, 13.1%) at the 25th percentile, 4.0 m/s at the 25th percentile, and 4.5 m/s at the 75th percentile. and 4.5 m/s at the 25th and 75th percentiles, respectively, while the developmental team had an ASR of 5.4% (95% CI 4.0%, 8.9%) with values of 4.1 m/s and 4.4 m/s at the 25th and 75th percentiles, respectively. In contrast, when comparing the MAS and MSS values between the two teams, they concluded that the first team players had higher MAS and MSS values compared to the development team. In terms of MSS values between the teams, the first team had a value of 2.4% (95% CI 1.8%, 3.9%) at the 25th and 75th percentiles, corresponding to 9.2 m/s and 9.5 m/s, respectively, while the development team had a value of 2.4% (95% CI 1.7%, 3.8%) at the 25th and 75th percentiles, corresponding to 9.1 m/s and 9.4 m/s, respectively. At the 25th and 75th percentiles, the values were 9.1 m/s and 9.4 m/s, respectively. In terms of MAS values, the first group had a value of 4.6% (95% CI 3.4%, 7.6%). At the 25th and 75th percentiles, the values were 5.1 m/s and 5.3 m/s, respectively, while the development team's values were 2.6% (95% CI 2.0%, 4.3%) at the 25th and 75th percentiles, with values of 4.9 m/s and 5.1 m/s, respectively.

In addition, factors such as positional situations, opposing teams, and formations may influence players' physical performance values, and these physical values may even affect the win rate in matches (Bradley et al., 2013; Chmura P, et al., 2018; Çıkıkcı et al., 2024). Furthermore, when match activities are analyzed for different positions, it is seen that team success is more dependent on physical actions in some positions and more technical activities in others (Di Salvo et al., 2013). For this purpose, Ozkamcı and colleagues (2021) examined the relationship between players' ASR, MSS, and MAS values with positional performance, found that wing players (30.40±1.94) had higher MSS values than center backs (28.42±2.08) ($p < 0.05$), they did not find any significant difference in ASR values based on positional roles ($p > 0.05$). Additionally, the study found a positive correlation between MSS and ASR performance values ($r = 0.95$, $p < 0.001$), while a negative correlation was observed between MAS and ASR ($r = -0.59$, $p < 0.001$). In conclusion, the findings revealed that wing players outperformed others in MSS performance values, while midfielders outperformed others in MAS values. Similarly, Öztürk and colleagues (2023) compared the MAS, MSS, ASR, and VO2 max values according to the positions they played. They found no significant differences in their results ($p > 0.05$), but concluded that left wing players had higher MSS values than center back players ($p < 0.05$).

In a similar study by Ortiz and colleagues (2018), which compared the ASR values of soccer players according to their playing positions, no significant differences were found in the ASR values of players according to their playing positions (defense, midfield, forward) , they noted that high-speed players with high MSS, regardless of their position, had higher ASR values than players with low MSS ($p < 0.05$). Joel and colleagues (2022), in their study examining the relationship between aerobic performance, body composition, and positions in professional female footballers, concluded that there was no significant difference in VO2 max values between players' positions ($p < 0.05$). Unlike our study, the aforementioned studies examined positional differences within the same team. In this regard, it is expected that future studies incorporating positional differences alongside league levels in women's football will contribute to this field.

RECOMMENDATIONS

For research to be conducted in the Turkish Women's Leagues, more performance and match data is needed first. In addition to this data, the strength and power performance of female athletes, as well as their aerobic and anaerobic endurance performance, must also be examined across a wide range.

Since this is the first study conducted in the Turkish Women's Football Leagues and there is no average data measured in other women's football teams so far, it is expected that the results will be open to discussion in the future.

On the other hand, another reason for this difference in league levels may be the age of training.

In this regard, the age of training may also be a noteworthy factor in future studies.

Additionally, the technical and physical profiles of the athletes should be determined to contribute to this field in the future.

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