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Professional paper

COMPARATIVE ANALYSIS OF EXPLOSIVE STRENGTH ABILITIES AND MORPHOLOGICAL CHARACTERISTICS OF TEAMS PARTICIPATING IN THE EUROPEAN WOMEN'S VOLLEYBALL CHAMPIONSHIPS, 2021 AND 2023"

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Abstract

The anthropometric and motor traits of female volleyball players who competed in the 2021 and 2023 European Championship finals are examined in this study. The finalist teams and their qualifying teams were to be compared in terms of bodily metrics and explosive powers. Each year's sample comprised 252 athletes, including qualifying teams and the teams from Italy, Serbia, and Turkey. Age, The variables to be studied included age, body height, body weight, spike jump, block jump, jump and body mass index (BMI) were among the variables that were examined. Descriptive (BMI). The data was analysed using descriptive statistical metrics, metrics such as mean, standard deviation, minimum, maximum, skewness, variance and kurtosis, were used to analyze the data.kurtosis.Pearson and Spearman correlations were used to assess relationships between variables, and T-tests and One-Way ANOVA were used to analyze differences across years. LSD post-hoc tests were then used to identify particular group differences. Correlation Pearson and Spearman correlations were used to assess relationships evaluate the relationship between variables, and T-tests and One-Way ANOVA one-way ANOVAs were used to analyze analyse the differences across between years. LSD Subsequently, post-hoc LSD tests were then used to identify particular group differences. specific differences between the groups. The groups' results showed that the height, weight, spike jump, jump and block jump were all similar, according to similar between the results, groups, with only slight variations that were differences not statistically significant. The only metric that changed significantly in 2023 was BMI, the Body Mass Index, which indicated showed a more ideal body composition. According to the data, The data showed that the players had a consistently high levels level of physical and explosive performance throughout time.This over time. The study can be used as a reference for future research on maximizing into the maximisation of athletic performance and offers provides a strong foundation solid basis for examining exploring the physical and motor development of elite female women volleyball players.

Keywords: senior volleyball players, anthropometry, motor skills, body mass index, T-tests.

1. Introduction

One of the most crucial components of attaining excellent volleyball play is physical preparation.To ensure the best possible movement execution, the techniques and exercises chosen should be in line with the technical requirements of the game. In practice, an artificial separation between physical preparation and technical development is often observed, which is considered incorrect, as these two components are closely interconnected and directly influence performance (Hraski et al., 2003). Over time, volleyball has evolved significantly and is now regarded as a multidisciplinary discipline that integrates knowledge from various fields such as pedagogy, physiology, biomechanics, and social sciences. This development requires a scientific approach for the advancement and popularization of the sport (Banković, 2012). Performance in volleyball is conditioned by certain morphological characteristics and motor

abilities. The analysis of these factors is essential for the selection and development of athletes, taking into account the differences between sports disciplines and individuals (Malacko & Rađo, 2004). In particular, in women's volleyball, body height and jumping ability are key factors for success in blocking and attacking (Mladenović-Ćirić & Đurašković, 2008). Studies indicate that body height and physical composition are important predictors of performance, although their relationship with jumping ability varies with age (Marelić et al., 2008; Cabral et al., 2011). Additionally, noticeable differences exist in the anthropomotor profile among players of different levels (Dopsaj et al., 2010). Success in volleyball requires fast and explosive actions, along with the ability to produce force in a short time. This ability is decisive for movements such as jumps and fast strikes. Although genetics play a part, this ability can still be developed through consistent and well-planned training (Afonso & Mesquita, 2011; Vujmilović, 2012; Veličković et al., 2017). Good jumping comes from fast movements, proper coordination, and the athlete's body characteristics. A combination of muscle strength, precise technique, and movement synchronization is necessary to achieve an efficient jump (Vujmilović, 2012). Modern volleyball is characterized by the specialization of roles on the court, with the 5:1 system being the most commonly used. Each player has clearly defined responsibilities in attack and defense. The introduction of the libero position has contributed to improving the quality of defensive play and enabling more efficient attack organization (Vujmilović, 2012). Achieving high performance in the sport requires a combination of technical, tactical, and physical skills, along with speed, agility, and explosive power, which are important in all phases of the game (Oliveira et al., 2025).

2. Aim of the paper

The aim of this paper is to conduct a comparative analysis of explosive strength abilities and morphological characteristics of female volleyball players participating in the last two editions of the European Women's Championship, specifically in 2021 and 2023. The study seeks to evaluate the impact of body features and motor abilities on the performance of elite volleyball players, as well as to identify factors that may have influenced the success of finalist and qualifying teams.

3. METHODOLOGY

3.1. Sample

The study covered the qualifying teams of the two finalist teams' qualifying squads teams and the elite female women's volleyball players from of the 2021 and 2023 European Women's Championships were the subject of the study. There In 2023, there were 252 players in all in 2023—126 - 126 from Serbia's the eight qualifying teams of Serbia and 126 from Turkey's the eight qualifying teams.teams of Turkey. 126 from Turkey as well as and their teams. In addition to their qualifying teams, 252 players from Serbia and Italy were Montenegro also involved took part in the group in for the year 2021. In total, A total of 504 players participated took part in the two both competitions.

3.2. Variable Sample

This study analyzed several specific morphological and motor variables in the female volleyball players who participated in the finals of the European Women's Volleyball Championship in 2021 and 2023. The variables included in the study are: chronological age

(AGE), body height (HEIGHT), body weight (WEIGHT), spike reach height (SPIKE), block reach height (BLOCK), and body mass index – BMI (BMI).

3.3. Statistical Methods

Quantitative techniques were applied to examine and compare morphological and motor variables.Descriptive statistical measures—minimum, maximum, mean, standard deviation, and coefficient of variation—were calculated for all variables. The data distribution was evaluated through skewness and kurtosis, while an independent T-test was applied to compare the two groups.

4. Interpretation of results

Table 1 shows the statistical measures of body measurements and explosive strength for the Turkish and Serbian teams in 2023, along with their qualifying teams.This table includes: maximum value, minimum value, arithmetic mean, standard deviation (deviation from the mean), coefficient of variation (or homogeneity), as well as data distribution parameters, specifically the skewness coefficient (Skewness – asymmetry) and kurtosis (indicator of the peakedness or convexity of the distribution).

Table 1. Key statistics for anthropometric measures and explosive strength of the Turkish and Serbian teams, and their qualifying teams, in the 2023 European Women's Women's Volleyball Championship.

	N	Min	Maxi	Mean	Std. Dev	Skew	Kur	Kv
AGE23	252	16	39	25.92	3.81	0.407	0.23	14.70
HEIGHT23	252	160	203	184.54	7.49	-0.825	1.206	4.06
WEIGHT23	252	53	88	70.75	6.84	-0.051	-0.24	9.67
SPIKE23	252	240	344	300.17	15.36	-0.787	1.277	5.12
ABLOCK23	252	230	321	287.02	15.25	-0.667	0.829	5.31
BMI23	252	16	23.7	20.09	1.56	-0.072	-0.429	7.76

The table provides an overview of 252 players in 2023, including their physical and motor-related variables.Mosha mesatare është 25.92 vjet, me një shpërndarje relativisht të qëndrueshme (Kv=14.70), që tregon se shumica e lojtareve janë në kulmin e formës fizike. Gjatësia mesatare prej 184.54 cm konfirmon rëndësinë e këtij parametri në volejbollin elitar, ndërsa asimetria negative tregon se shumë lojtare janë mbi mesataren. Pesha mesatare është 70.75 kg dhe ka shpërndarje pothuajse simetrike, duke reflektuar balancë të mirë trupore. BMI mesatar (20.09) tregon përbërje trupore optimale për performancë sportive. Vlerat e "spike reach" (300.17 cm) dhe "block reach" (287.02 cm) tregojnë nivel të lartë të forcës shpërthyese. Devijimet standarde relativisht të ulëta në këto variabla tregojnë homogjenitet në performancë. Asimetria negative tek këto tregues sugjeron dominim të vlerave më të larta. Kurtosi pozitiv tek gjatësia dhe kërcimet tregon përqendrim të vlerave rreth mesatares. Në përgjithësi, të dhënat tregojnë një profil të balancuar fizik dhe aftësi të larta motorike të lojtareve. Low deviations and coefficients of variation around 5% indicate high homogeneity in these abilities. Negative skewness in these two variables shows that most players achieve above-average results. Overall, all data indicate a highly physically prepared group, with standardized characteristics and a high competitive level.

Table 2 presents the statistical indicators of morphological variables and explosive strength for the Italian team in 2021 and the Serbian team in 2021, as well as their qualifying teams. This table includes: maximum value, minimum value, arithmetic mean, standard deviation (deviation from the mean), coefficient of variation (or homogeneity), as well as data

distribution parameters, specifically the skewness coefficient (Skewness – asymmetry) and kurtosis (indicator of the peakedness or convexity of the distribution).

Table 2. Statistical parameters of anthropometric variables and explosive strength of the Italian and Serbian teams in 2021, as well as their qualifying teams, in the 2021 European Women's Volleyball Championship

	N	Min	Maxi	Mean	Std. Dev	Skew	Kur	Kv
AGEV 21	252	18	42	26.62	4.81	0.212	-0.594	18.06
HEIGHTV21	252	163	198	183.47	7.44	-0.436	-0.151	4.06
WEIGHTV21	252	54	94	71.04	7.38	0.257	-0.025	10.38
SPIKEV21	252	250	344	299.03	14.87	-0.492	0.879	4.97
ABLOCKV21	252	245	321	287.07	14.23	-0.503	0.544	4.96
BMI21V	252	16.3	27.34	21.09	1.66	0.238	0.4	7.85

The statistics Table 2 shows the statistical information for the of 252 volleyball players who represented representing Italy, Serbia, Montenegro, Montenegro and their respective qualifying qualification teams in for the 2021 European Volleyball Championship is shown in Table 2. Championship. The mean teams. Median age of 26. 62 years suggests indicates that this cohort was somewhat older than that of the cohort in 2023, with a standard deviation of 4. 81 and a the coefficient of variation at 18. 06%, is 18.81. 06.0, indicating a wider age range of ages among the competitors. The average height recorded observed was 183. 183 centimeters. 47 cm,centimeters, which is marginally less than the height noted in 2023; the standard deviation and coefficient of variation (Std Dev 7. 44, CV 4. 06%) imply a comparable distribution and a relatively uniform composition. The bulk of the players are taller than average, indicating a physical advantage in the sport, according to the negative skewness (-0. 436). The average body weight of 71. 04 kg points to a balanced physique and a healthy body makeup for top-tier athletes, with an almost even distribution and a standard deviation of 7. 38. BMI mesatar i regjistruar ishte 21.09, çka tregon se lojtarët kanë një peshë trupore të përshtatshme për volejboll. Krahasuar me vitin 2023, vërehet një rritje e lehtë, e cila mund të lidhet me ndryshime në përbërjen trupore ose në mënyrën e stërvitjes. The spike reach average of 299. 03 cm and block reach average of 287. 07 cm reflect exceptional explosive power, characterized by low variability and a fairly consistent distribution. The presence of negative skewness shows that most players achieve higher-than-average results in these skills. The presence of negative skewness shows that most players achieve higher-than-average results in these skills. The majority of athletes seem to be taller than average, giving them a physical advantage in the game, as indicated by their negative skewness of -0.436. In conclusion, despite a larger age range than the 2023 cohort, the 2021 group is acknowledged for being made up of physically developed athletes who exhibit considerable homogeneity in explosive and physical performance.

The results in Table 3 come from a t-test that looked at how players' body measurements and movement skills differed between the 2021 and 2023 European Women's Volleyball Championships.The table includes Levene's test values for equality of variances and t-test results, along with statistical significance (Sig. 2-tailed) and mean differences. Age, The study showed that age, height, weight, spike, stroke and block did not change significantly change over time, according to the study. time. However, there was has been a considerable significant shift in BMI, body mass index, which might may be due to changes in physical training or the evolution of volleyball. volleyball development. Table 3: Anthropometric and motor variable variables differences between for the 2023 and 2021 European Women's Volleyball Championships Championship from 2023 to 2021

Table 3. Differences between the 2023 and 2021 European Women's Volleyball Championships in anthropometric and motor variabiles

Independent Samples Test		F	Sig.	t	df	Sig.	Mean Differ.	Std. Error Differ.	Lower	Upper
AGE23 - 21	Equal var ass	20.773	.000	-1.807	502	.071	-.6984	.3864	-1.457	.060
	Equal var not ass			-1.807	477.154	.071	-.6984	.3864	-1.457	.060
HEIGHT 23 - 21	Equal var ass	1.667	.197	1.605	502	.109	1.0674	.6651	-.239	2.374
	Equal var not ass			1.605	501.979	.109	1.0674	.6651	-.239	2.374
WEIGHT 23 - 21	Equal var ass	1.325	.250	-.470	502	.639	-.2976	.6338	-1.542	.947
	Equal var not ass			-.470	499.201	.639	-.2976	.6338	-1.542	.947
SPICE23 –21	Equal var ass	.772	.380	.846	502	.398	1.1388	1.3467	-1.507	3.784
	Equal var not ass			.846	501.461	.398	1.1388	1.3467	-1.507	3.784
ABLOCK23 – 21	Equal var ass	1.345	.247	-.039	502	.969	-.0515	1.3140	-2.633	2.530
	Equal var not ass			-.039	499.638	.969	-.0515	1.3140	-2.633	2.530
BMI23 -21	Equal var ass	.399	.528	-7.002	502	.000	-1.0034	.14330	-1.284	-.721
	Equal var not ass			-7.002	500.217	.000	-1.0034	.14330	-1.284	-.721

This table shows summarises the findings results of an the independent t-test of samples t-test comparing athletes from the European Championships in 2021 and 2023 European Championships. 2023. The age difference in age is not statistically significant (p = 0.071) and is negligible insignificant (-0.698). Despite a slight increase in players' the average height of players in 2023 (+1.067 cm) in 2023, cm), the difference is not statistically significant (p = 0.109). The body weights of Body weight is not significantly different between the two groups do not differ significantly (p = 0.639) and are is almost identical the same (-0.298 kg). Although the height of the 2023 spike reach is slightly greater higher (+1.139 cm), the difference is not statistically significant (p = 0.(p=0.398). There is no appreciable difference between the two groups (p = 0.969), and block reach is essentially unchanged (-0.052 cm). The body mass index Body Mass Index (BMI) is the only metric that demonstrates showing a distinct clear and statistically significant alteration, dropping change, falling from 21.09 in 2021 to 20.09 in 2023 (difference -1.003, p = 0.p=0.000). In general, the The groups between from 2021 and to 2023 shared generally had similar physical and motor profiles, while BMI stood out as being the only measure that decreased.declined. This change may reflect an optimization of body composition for higher athletic performance in 2023. Overall, while age, height, weight, and explosive abilities are similar between the two editions, BMI differs significantly, suggesting a physically "lighter" group, potentially better adapted for modern volleyball.

5. Discussion

The results of this study indicate an advanced physical and motor profile of elite female volleyball players in the 2021 and 2023 European Championships. In 2023, the players' average age was 25.92 years, showing they were likely at their peak physical condition (Table 1). This matches what other studies say, that athletes in team sports usually reach their best performance in their mid-twenties (Bompa & Haff, 2009). The recorded average heights—184.54 cm in 2023 and 183.47 cm in 2021—point to the significance of height in situations at the net. As noted, "negative skewness indicates that most players have above-average height" (Table 1), reflecting selection oriented towards specific anthropometric characteristics (Sheppard, Gabbett, Taylor, Dorman, Lebedew, & Borgeaud, 2007).Body weight and BMI show a balanced distribution, where "the BMI value (20.09) indicates optimal body composition" (Table 1). The clear BMI difference in BMI between the years (p = .=.000) points to indicates changes in physical preparation fitness over time. The decrease in reduction of the BMI in 2023 supports the idea of optimizing optimising the strength-to-weight power-to-weight ratio, which is crucial for critical to the explosive performance (Ziv & Lidor, 2010). Spike and block jump results demonstrate high levels of explosive strength, where "low deviations and coefficients of variation around 5% indicate high homogeneity" (Table 1). This homogeneity reflects standardized physical preparation at the elite level. Similarly, in 2021, "results are concentrated around the mean, reflecting stability in performance" (Table 2). From the comparative analysis, it is observed that "there are no significant differences for most variables" (Table 12), indicating that the physical demands of elite volleyball have remained relatively stable over the years. However, the change in BMI points to an adaptation to modern game trends. As highlighted, "this change may reflect an optimization of body composition for higher athletic performance" (Table 12). The majority of athletes jump higher than average, indicating strict selection and a competitive environment.This aligns with research demonstrating that explosive power is crucial in volleyball (Markovic & Mikulic, 2010). The groups show almost no differences in their characteristics. This suggests a consistent profile among players across the two periods. This points to a stable standard among elite players. The variation in BMI could reflect a shift toward more efficient physical conditioning. This implies that future development in volleyball will likely focus more on the quality of physical preparation rather than major anthropometric changes.

6. Conclusion

The analysis Analysis of the data for the volleyball player age groups in at the European Volleyball Championships in 2021 and 2023 European Championships shows that the average age was is slightly higher in 2021 (26.62 years) compared to than in 2023 (25.92 years), but this the difference is not statistically significant. The average Average body height weight was 184.54 cm in 2023 and 183.47 cm in 2021, reflecting the homogeneity and a physical advantage for play advantages of playing at the elite levels. Average level. The average body weight was also similar (70.75 kg in 2023 and 71.04 kg in 2021), indicating good physical balance among which indicates that the athletes. Spike athletes are physically balanced. Over the years, the average height and block reach length have remained high and consistent over the years, with averages of stable, at 300.17 cm and 287.02 cm respectively in 2023, 2023 and 299.03 cm and 287.07 cm respectively in 2021, respectively.2021. Low variation The low variability and distribution of the results indicate suggest homogeneity and stable performance. Body mass index Mass Index (BMI) has changed from 21.09 in 2021 to 20.09 in 2023, suggesting a more optimized indicating that your body composition is better optimized for performance. All other anthropometric and motor parameters showed no did not show statistically significant

differences, indicating stability within suggesting that the groups were stable over time. Analysis of skewness and kurtosis shows that the results are distributed clustered around the mean, without mean and do not show extreme values, reflecting which reflects a standardized standardised group with high performance levels. Overall, the results indicate show that the volleyball players are well prepared physically and technically well-prepared, technically, with explosive strength power and a balanced body composition.body. The main difference between the years relates is related to the decrease reduction in BMI, body mass index, which may positively affect can have a positive effect on speed, flexibility, flexibility and reaction during play. the game. The data demonstrate figures show stability and elite-level performance at the elite level in European women's volleyball, providing women's volleyball and provide a solid basis for comparisons comparison and future studies on athletic performance.sports performance studies.

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