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Women's volleyball performance indicators according to age category and teams' final position in international competitions

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Abstract: The aim was to determine which performance indicators show significant differences in connection with age category and team's level in women's international volleyball. The competitions analyzed were Senior Volleyball Nations League (n= 130 games) and U20 (n= 64 games) and U18 (n= 63 games) World Championships held in 2019. The results obtained in this study showed that in the U18 category there were more errors per set (U18 8.33 vs. Senior 5.25 vs. U20 6.00 errors points, p< .001) and greater serve effectiveness (U18 9.00% vs. Senior 6.00% vs. U20 7.00%, p< .001). In U20 there was a huge leap in quality with maximum values in block performance (U20 25.00% vs. Senior 15.00% vs. U18 15.00%, p< .001) and an increase in attack variables (U20 39.00% vs U18 33.00%, p< .001) accompanied by a decrease in errors points per set (U20 6.00 vs U18 8.33 errors points, p< .001) and serve effectiveness (U20 7.00% vs U18 9.00%, p< .001). In the Seniors category, there was a decrease in block effectiveness (Senior 15.00% vs U20 25.00%, p< .001) and an increase in attacks points per set (Senior 13.30 vs U20 12.00 vs U18 9.70 points, p< .001). In the comparison between levels, more differences were detected when teams were further apart in the ranking, and attack and block effectiveness were the most relevant indicators in the three-age category. Based on the findings of this study, we can determine performance indicators for each age category and level, allowing coaches and technical staff to establish new training strategies for their team's improvement and success.

Keywords: Performance analysis, game statistics, scouting, international volleyball, technical-tactical analysis, team sport

1. Introduction

Technical-tactical analysis in sport has been defined as a variety of techniques for recording and classifying actions to determine performance effectiveness and thus identify key factors associated with sports success (Barris & Button, 2008; Nevill et al., 2002). The information obtained with technical-tactical analysis is used to monitor performance, improve feedback processes, and establish databases from criteria models to provide new training strategies (Franks & Goodman, 1986; Liebermann et al., 2002; Smith & Loschner, 2002). Furthermore, comparisons between positions, teams, levels, or categories allow coaches to have objective information to improve decision-making (Filipcic et al., 2021; Hughes & Bartlett, 2002).

In volleyball, technical-tactical analysis of the game has become a fundamental aspect for optimizing teams' performance over their opponents (Drikos et

al., 2021; Palao & Hernández-Hernández, 2014; Silva et al., 2016). Drikos et al. (2021) emphasized the importance of identifying the strengths and weaknesses of teams, to create more effective strategies for match planning. This topic has been studied from different approaches, establishing methods and protocols for an overall evaluation of the game (Akarçeşme, 2017; Calero, 2010; Collet et al., 2011), and others that aim to delve deeper into specific skills impact (Alfonso et al., 2010; Sotiropoulos et al., 2021; Ureña-Espa et al., 2002). The latter are the most widespread, possibly due to the need to find, among all the variables that influence the game, those that can be used as performance indicators (Ávila et al., 2018). In this sense, serve (Fernández-Echeverria et al., 2015; García-Alcaraz et al., 2016; Sotiropoulos et al., 2021), reception (Garcia-Alcaraz et al., 2014; Paulo et al., 2018; Ureña-Espa et al., 2002), set (Alfonso et al., 2010; Calero-Morales, 2011; Michalopoulos et al., 2020), attack (García-Alcaraz et al., 2015), block and defense (Araújo et al., 2009; García-Alcaraz et al., 2016; Montoro-Escano & Hernandez-Mendo, 2014), background influence (Campos et al., 2014; García-Alcaraz & Marcelino, 2017; Marcelino et al., 2011), and game actions have been studied among others. In men's volleyball it was found that as the category advances, serving performance decreases (Garcia-Alcaraz et al., 2014), reception improves (Paulo et al., 2018), attacking becomes more effective due to an increase in the use of quick attacks (Araújo et al., 2009) and blocking contacts and defenses increase with a higher percentage of defensive actions (Montoro-Escano & Hernandez-Mendo, 2014).

There are studies that have focused on gender comparison indicating that women's volleyball presents more effectiveness in serve and lower quality of reception, possibly because of the difference in the height of the net (Drikos et al., 2020; Kountouris et al., 2015). In addition, it has been found that women's volleyball is less effective in first tempo attacks, but attacks points are the most important performance indicator (Drikos et al., 2020). Regarding blocking, effectiveness tends to be lower in women's volleyball and is reflected in a greater continuity of the game, with longer points and a greater number of defensive and attacking actions (Drikos et al., 2020; Palao et al., 2009).

It must be emphasized that the main objective of any competitive volleyball team is to score and win. For this reason, it is important to focus on performance by analyzing final actions, as they relate to the result of the game and the team success in competition (Campos et al., 2014; Drikos et al., 2019; García-Alcaraz & Marcelino, 2017). Moreover, these performance indicators could be analyzed regarding the team's final ranking in the competition or in connection with age category to assess how those performance parameters evolve through categories (Drikos et al., 2019; García-Alcaraz & Marcelino, 2017; Palao et al., 2004). Recent studies have focused on this type of analysis and comparison in men's international volleyball (Drikos et al., 2019; García-Alcaraz et al., 2016; García-Alcaraz et al., 2020; García-Alcaraz & Marcelino, 2017), but there is lack of research into women's international volleyball. Palao et al. (2004), carried out a study comparing levels in the Senior category in both women's and men's volleyball. The main results were that in men, spiking and blocking made differences between levels, while in women only spiking showed a difference with level 1 (teams ranked from 1st to 4th place in the competition), although an increase in performance of reception, spiking, blocking, and defense was observed at the higher levels. However, as far as the authors are aware, there are no recent studies analyzing women's international volleyball performance that take team levels and age categories into account. From the authors perspective, new studies are necessary because in the last decades, international women's volleyball has evolved and professionalized, tending towards a faster, more explosive, and forceful game.

Therefore, the aim of this study was to assess the differences in performance indicators between team age categories and

levels during women's international competitions played in 2019. It was hypothesized, based on previous studies (Drikos et al., 2020; J. Palao et al., 2004; Palao et al., 2009), that spike and block effectiveness would present a significant evolution during age categories, and that both performance indicators would establish differences between levels, even though serve and error variables would improve as the level increases in each category (Palao et al., 2004).

2. Materials and Methods

Participants — The study sample consisted of all matches played by the top 16 teams, based on the final ranking of the following competitions: Women's Senior Volleyball Nations League (n= 130 games, FIVB 2019), U20 Women's Volleyball World Championship (n= 64 games, FIVB 2019) and the U18 Women's Volleyball World Championship (n= 63 games, FIVB 2019). Therefore, this dataset comprised a total of 257 matches, 956 sets, 58,767 attacks, 25,791 blocks, 41,548 serves and 11,586 errors actions.

Design — The groups compared were formed based on two criteria: the "age competition category" (Senior, U20 and U18) and the "performance level" according to the position of the teams in the final classification: Level 1 (top 4 teams), Level 2 (teams from 5th to 8th), Level 3 (teams from 9th to 12th) and Level 4 (teams from 13th to 16th) (García-Alcaraz & Marcelino, 2017; J. Palao et al., 2004).

Moreover, performance variables were obtained from the final actions data: total attacks, attack points, total blocks, block points, total serves, serve points, own errors, and opponents' errors. With the intention of relativizing and comparing the data, the total number of sets was also recorded, and the final variables were established from the following ratios: effectiveness (attack, block and serve), point per set (attack, block and serve), and errors (own errors per set, opponents' errors per set and coefficient between opponents' errors/own errors).

Methodology — Data were obtained from the official match statistics reports, compiled by professional analysts certified by the FIVB with more than 5 years of experience, that are published on the competitions' websites. These data were recorded with Data Volley software (Data Project Sport Software, Bologna, Italy) widely used in high level volleyball and whose validation and reliability has been demonstrated in many studies (Drikos et al., 2009; García-Alcaraz et al., 2015; Peña et al., 2013).

Statistical Analysis — Statistical analysis was performed using SPSS software (Version 21.0, SPSS Inc., Chicago, IL, USA). Firstly, a preliminary regression analysis was performed. This analysis consisted in two stepwise multiple linear regression models. The first model had as a predictive variable the classification position, and as an inputs the performance variables and the competition category. In the second model, the predictive variable was the competition category, and the inputs were the performance variables and the classification position. Secondly, a descriptive and comparative analysis of performance indicators according to "competition category" was carried out. Thirdly, the "level" comparison was undertaken by separating the groups into categories. The Kolmogorov-Smirnov test was performed to check the normal distribution of the variables. This test indicated the existence of non-normal distribution in practically all the performance variables ($p < .05$), so non-parametric statistics were used, and data were reported by median and quartiles 1 (Q1 and 3 (Q3). The H Kruskal Wallis test was chosen for more than two groups comparison and the U Mann Whitney test for pairwise comparison. Significance was considered at $p < .05$ for pairwise comparisons, and to reduce the risk of type 1 errors, Bonferroni correction was applied adjusting the degree of significance to $p < .01$ for 3-group comparisons and $p < .008$ for 4-group comparisons (6 options). The effect size was calculated using r Rosenthal, where 0.1 value is considered small (s), 0.3 moderate (m) and 0.5 large (l).

3. Results

Stepwise regression models —The model obtained to explain the classification position explained a 26% of the variance (Table 1). A better classification position (lower number) was related with having good values of attack effectiveness, block points/set and opponent errors/set. The regression model of competition category explained the 62% of the variance. A higher category (lower number) was related with better scores of 6 performance variables: attack points/set, block points set, serve points/set, attack effectiveness, block effectiveness, own errors/set and opponent errors/set. Competition category and classification category were not selected by the stepwise method as variables related between them. Moreover, we forced to introduce both variables in the models, but they were not significative (p >. 7). Therefore, for the further analysis, it was decided not to consider the interaction of both variables as it would increase the type error I for the high number of non-parametric comparisons.

Differences between age categories — Table 2 shows that all the technical-tactical performance variables presented differences between categories, except for the opponents' errors/own errors ratio. The pairwise comparison analysis showed the following differences between categories:

Senior vs U20

- - 10% block effectiveness (p < .001, ESr = .5)
- + 1.30 attack point/set (p < .001, ESr = .3)
- - 0.75 opponent errors/set (p < .001, ESr = .2)

Table 1. Stepwise multiple linear regression models performed.

Regression models obtained			
Variable	Coefficient	Standardized coefficient	R^2 (p-value)
Input: Classification position			
Constant	21.87	-	**0.26 (< 0.001)**
Attack Effectiveness	-22.90	-0.40	
Block Points/Set	-1.11	-0.26	
Opponent Errors/Set	-0.35	-0.15	
Input: Competition category			
Constant	0.47	-	**0.62 (< 0.001)**
Attack Points/Set	-0.04	-0.13	
Block Points/Set	-0.13	-0.17	
Serve Points/Set	0.14	0.16	
Attack Effectiveness	-1.14	-0.11	
Block Effectiveness	2.61	0.28	
Own Errors/Set	0.14	0.34	
Opponent Errors/Set	0.14	0.35	

Note: Competition category was coded as 1 (senior), 2 (under 20) and 3 (under 18).

Senior vs U18

- + 3.60 attack point/set (p < .001, ESr = .6)
- - 3.08 opponent errors/set (p < .001, ESr = .7)
- + 7% attack effectiveness (p < .001, ESr = .4)
- - 3% serve effectiveness (p < .001, ESr = .4)

U20 vs U18

- + 10% block effective (p < .001, ESr = .5)
- - 2.33 opponent errors/set (p < .001, ESr = .6)

- + 6% attack effectiveness (p < .001, ESr = .4)
- + 2.30 attack points/set (p < .001, ESr = .4)
- + 0.52 block points/set (p < .001, ESr = .3)
- - 0.55 serve points/set (p < .001, ESr = .3)

Differences according to level — Tables 3, 4 and 5 present the differences between levels for Senior, U20 and U18 categories, respectively. In Table 3, the variables that show differences between levels for Senior are: attack effectiveness, attack points/set, block effectiveness, block points/set, own errors/set and the ratio of opponents' errors/own errors. The pairwise comparison presented the following results:

Level 1 vs Level 2

- + 3% attack effectiveness (p < .001, ESr = .3)
- - 1.33 own errors/set (p < .001, ESr = .3)

Level 1 vs Level 3

- + 5% attack effectiveness (p < .001, ESr = .4)
- + 6% block effectiveness (p < .001, ESr = .3)
- + 0.97 block points/set (p < .001, ESr = .4)

Level 1 vs Level 4

- + 8% attack effectiveness (p < .001, ESr = .6)
- + 1.1 attack points/ set (p < .001, ESr = .4)
- + 5% block effectiveness (p < .001, ESr = .4)
- + 0.92 block points/set (p < .001, ESr = .4)
- + 0.28 opponents' errors/own errors ratio (p < .001, ESr = .3)
- - 1.04 own errors/ set (p < .001, ESr = .4)

Table 2. Analysis by category of the final game actions and their relativized values.

Variables	Senior (S) Median Q1 - Q3	U20 Median Q1 - IQ3	U18 Median Q1 - Q3	Sig. Kruskal Wallis	Diff. Between categories P values (ESr)		
					S vs. U20	S vs. U18	U20 vs. U18
APS	13.30 11.67 - 14.67	12.00 10.28 – 13.33	9.70 8.00 – 11.00	**< .001**	**< .001 (.3)**	**< .001 (.6)**	**< .001 (.4)**
BPS	2.33 1.56 - 3.00	2.52 2.00 – 3.33	2.00 1.25 – 2.89	**< .001**	**< .012 (.1)**	**< .009 (.1)**	**< .001 (.3)**
SPS	1.33 1.00 – 2.00	1.67 1.00 – 2.33	2.22 1.50 – 3.00	**< .001**	< .083 (.1)	**< .001 (.3)**	**< .001 (.3)**
AE (%)	40.00 35.00 – 44.00	39.00 33.00 – 45.00	33.00 28.00 – 38.00	**< .001**	< .537 (.0)	**< .001 (.4)**	**< .001 (.4)**
BE (%)	15.00 10.00 – 19.00	25.00 19.00 – 31.00	15.00 10.00 – 21.00	**< .001**	**< .001 (.5)**	< .272 (.1)	**< .001 (.5)**
SE (%)	6.00 5.00 – 8.00	7.00 5.00 – 10.00	9.00 7.00 – 13.00	**< .001**	< .021 (.1)	**< .001 (.4)**	**< .001 (.3)**
OwS	5.25 4.33 – 6.33	6.00 5.00 – 7.29	8.00 6.67 – 9.50	**< .001**	**< .001 (.2)**	**< .001 (.6)**	**< .001 (.5)**
OpS	5.25 4.33 – 6.33	6.00 5.00 – 7.29	8.33 7.25 – 9.75	**< .001**	**< .001 (.2)**	**< .001 (.7)**	**< .001 (.6)**
OpE/OwE	1.00 0.76 – 1.31	1.00 0.74 – 1.36	1.04 0.79 – 1.37	<< .692 $^{C}_{g}$	< .977 (.0)	< .423 (.0)	< .473 (.0)

(Q1) Quartile 1, (Q3) Quartile 3, (S) Senior category, (U20) Under 20 category, (U18) Under 18 category, (ESr) effect size r Rosenthal, (APS) Attack Points/Set, (BPS) Block Points/Set, (SPS) Serve Points/Set, (AE) Atack Effectiveness, (BE) Block Effectiveness, (SE) Serve Effectiveness, (OwS) Own Errors/Set, (OpS) Opponent Errors/Set, (OpE/OwE) Opponent Errors/Own Errors. The variables with significant differences are highlighted in bold (p< .05).

Level 2 vs Level 3

- + 5% block effectiveness (p < .001, ESr = .3)
- + 0.88 block points per set (p < .001, ESr = .3)
- + 1 own errors/set (p < .001, Esr = .2).

Level 2 vs Level 4

- + 5% attack effectiveness (p < .001, ESr = .4)
- + 4% block effectiveness (p < .001, ESr = .3)
- + 1.3 attack points/set (p < .004, Esp = .3)
- + 0.83 blocks point/set (p < .001, ESr = .3)

Level 3 vs Level 4

- No differences were found.

For U20 category, all the variables presented differences between levels, except serve effectiveness and opponents' error/set ratio (Table 4). All pairwise comparisons that were significant show a moderate to large effect size, except for the opponents'

errors/own errors ratio in the comparison between levels 1 and 4:

Level 1 vs Level 2

- No differences were found
- + 0.21 opponents' errors/own errors ratio (p < .036, ESr = .3).

Level 1 vs Level 3

- No differences were found
- + 4% attack effectiveness (p < .014, ESr = .3)
- + 4% block effectiveness (p < .044, ESr = .03)

Level 1 vs Level 4

- + 10% attack effectiveness (p < .001, ESr = .6)
- + 2.97 attack points/set (p < .001, ESr = .6)
- + 8% block effectiveness (p < .001, ESr = .5)
- + 1 block points/set (p < .001, ESr = .5)
- + 0.87 serve points/set (p < .001, ESr = .3)
- + 0.36 opponents' error/own errors ratio (p < .003, ESr = .4)
- - 1.25 own errors/set (p < .007, ESr = .3)

Level 2 vs Level 3

- + 7% block effectiveness (p < .001, ESr = .6)
- + 5% attack effectiveness (p < .024, ESr = .3),
- Moderate effect size in own errors/set (+0.83, p < .044, ESr = .3).

Level 2 vs Level 4

- + 11% attack effectiveness (p < .001, ESr = .6)
- + 2.73 attack points/set (p < .001, ESr = .5)
- + 11% block effectiveness (p < .001, ESr = .5)
- + 1 block points/set (p < .001, ESr = .3)

Level 3 vs Level 4

- +6% attack effectiveness (p < .001, ESr = .4)
- + 2.04 attack point/set (p < .001, ESr = .5)
- + 0.67 block point/set (p < .007, ESr = .3)
- - 0.75 serve point/set (p < .003, ESr = .4)
- - 1.31 own errors/set (p < .003, ESr = .4)

Table 3. Analysis by level of performance in Senior category of the final actions of the game and their relative values.

Variables	Level 1 Median Q1-Q3	Level 2 Median Q1-Q3	Level 3 Median Q1-Q3	Level 4 Median Q1-Q3	Sig. Kruskal Wallis	Diff. Between levels P values (ESr)					
						1 vs. 2	1 vs. 3	1 vs. 4	2 vs. 3	2 vs. 4	3 vs. 4
APS	13.50 12.71-15.22	13.70 11.58-15.22	13.30 11.58-14.39	12.40 11.00-13.63	**< .001**	< .344 (.1)	< .065 (.2)	**< .001 (.4)**	< .434 (.1)	**< .004 (.3)**	< .018 (.2)
BPS	2.67 2.00-3.42	2.58 2.00-3.25	1.70 1.00-2.67	1.75 1.33-2.67	**< .001**	< .426 (.1)	**< .001 (.4)**	**< .001 (.4)**	**< .001 (.3)**	**< .001 (.3)**	< .662 (.0)
SPS	1.67 1.00-2.13	1.33 1.00-2.00	1.56 1.00-2.00	1.33 1.00-1.71	< .248	< .180 (.1)	< .364 (.1)	< .058 (.2)	< .658 (.0)	< .551 (.1)	< .263 (.1)
AE (%)	44.00 40.00-47.00	41.00 37.00-45.00	39.00 34.00-43.00	36.00 33.00-40.00	**< .001**	**< .001 (.3)**	**< .001 (.4)**	**< .001 (.6)**	< .030 (.2)	**< .001 (.4)**	< .088 (.2)
BE (%)	17.00 13.00-22.00	16.00 13.00-19.00	11.00 7.00-17.00	12.00 9.00-15.00	**< .001**	< .188 (.1)	**< .001 (.3)**	**< .001 (.4)**	**< .001 (.3)**	**< .001 (.3)**	< .779 (.0)
SE (%)	7.00 5.00-9.00	6.00 4.00-8.00	7.00 5.00-8.00	6.00 5.00-8.00	< .746	< .294 (.1)	< .784 (.0)	< .542 (.1)	< .476 (.1)	< .713 (.0)	< .650 (.0)
OwS	4.67 3.67-5.53	6.00 4.50-6.58	5.00 4.28-6.29	5.71 5.00-6.25	**< .001**	**< .001 (.3)**	< .047 (.2)	**< .001 (.4)**	**< .001 (.2)**	< .828 (.0)	< .030 (.2)
OpS	5.33 4.55-6.47	5.11 4.22-6.25	5.50 4.56-6.44	5.00 4.29-6.00	< .425	< .694 (.0)	< .658 (.0)	< .191 (.1)	< .406 (.1)	< .528 (.1)	< .107 (.0)
OpE/OwE	1.18 0.85-1.61	0.94 0.73-1.18	1.08 0.78-1.34	0.90 0.70-1.12	**< .002**	**< .004 (.2)**	< .272 (.1)	**< .001 (.3)**	< .076 (.2)	< .537 (.1)	< .021 (.2)

(Q1) Quartile 1, (Q3) Quartile 3, (S) Senior category, (U20) Under 20 category, (U18) Under 18 category, (ESr) effect size r Rosenthal, (APS) Attack Points/Set, (BPS) Block Points/Set, (SPS) Serve Points/Set, (AE) Atack Effectiveness, (BE) Block Effectiveness, (SE) Serve Effectiveness, (OwS) Own Errors/Set, (OpS) Opponent Errors/Set, (OpE/OwE) Opponent Errors/Own Errors. The variables with significant differences are highlighted in bold (p< .01).

- With a moderate effect size, it appears the block effectiveness (+4%, p < .023, ESr = .4), the serve effectiveness (+2%, p < .026, ESr = .3) and the opponents' errors/own errors ratio (+0.37, p < .029, ESr = .3).

Finally, in U18 category the variables that determine differences were block and attack effectiveness, block point/set, opponent errors/set and the opponents' errors/own errors ratio (Table 5).

Level 1 vs Level 2

• Moderate effect size in block effectiveness (+4%, p < .033, ESr = .3).

Level 1 vs Level 3

• + 5% block effectiveness (p < .003, ESr = .4)

• Moderate effect size in block point/set (+0.92, p < .030, ESr = .5).

Level 1 vs Level 4

• + 6% block effectiveness (p < .001, ESr = .5)

• + 1.34 block point/set (p < .001, ESr = .5)

• + 0.21 opponents' errors/own errors ratio (p < .005, ESr = .4)

• Moderate effect size higher attack effectiveness (+5%, p < .012, ESr = .3), serve point/set (+0.75, p < .044, ESr = .3)

Level 2 vs Level 3

• No differences were found

Level 2 vs Level 4

• Moderate effect size in attack effectiveness (+4%, p < .052, ESr = .2), block point/set (+1.34, p < .012, ESr = .3) and opponents' errors/set (+1.38, p < .030, ESr = .3).

Level 3 vs Level 4

• Moderate effect size in block point/set (+0.42, p < .046, ESr = .2).

Table 4. Analysis by level of performance in U20 category of the final actions of the game and their relativised values.

Variables	Level 1 Median Q1-Q3	Level 2 Median Q1-Q3	Level 3 Median Q1-Q3	Level 4 Median Q1-Q3	Sig. Kruskal Wallis	Diff. Between levels P values (ESr)					
						1 vs. 2	1 vs. 3	1 vs. 4	2 vs. 3	2 vs. 4	3 vs. 4
APS	12.80 11.89-13.58	12.56 10.88-13.67	11.87 11.00-13.29	9.83 7.67-12.13	**< .001**	< .573 (.1)	< .209 (.2)	**< .001 (.6)**	< .737 (.0)	**< .001 (.5)**	**< .001 (.5)**
BPS	3.00 2.39-3.78	3.00 2.00-3.50	2.67 2.11-3.33	2.00 1.17-2.42	**< .001**	< .404 (.1)	< .091 (.2)	**< .001 (.5)**	< .586 (.1)	**< .010 (.3)**	**< .007 (.3)**
SPS	2.00 1.11-2.67	1.58 1.00-1.89	1.88 1.33-2.83	1.13 0.71-1.67	**< .005**	< .076 (.2)	< .898 (.0)	**< .007 (.3)**	< .064 (.2)	< .077 (.2)	**< .003 (.4)**
AE (%)	42.00 39.00-50.00	43.00 38.00-47.00	38.00 35.00-43.00	32.00 27.00-37.00	**< .001**	< .825 (.1)	< .014 (.3)	**< .001 (.6)**	< .024 (.3)	**< .001 (.6)**	**< .001 (.4)**
BE (%)	28.00 21.00-33.00	31.00 22.00-35.00	24.00 18.00-28.00	20.00 13.00-25.00	**< .001**	< .386 (.0)	< .044 (.3)	**< .001 (.5)**	**< .008 (.3)**	**< .001 (.5)**	< .023 (.3)
SE (%)	8.00 5.00-11.00	7.00 5.00-9.00	8.00 5.00-12.00	6.00 4.00-8.00	< .090	< .327 (.1)	< .587 (.1)	< .087 (.2)	< .093 (.2)	< .327 (.1)	< .026 (.3)
OwS	5.58 5.00-6.56	6.35 5.17-7.33	5.52 5.00-6.67	6.83 5.33-8.67	**< .005**	< .132 (.2)	< .691 (.0)	**< .007 (.3)**	< .044 (.3)	< .117 (.2)	< .003 (.4)
OpS	6.33 5.33-7.22	5.61 5.00-6.78	6.00 5.06-7.29	5.67 5.00-7.96	< .547	< .141 (.2)	< .501 (.1)	< .378 (.1)	< .401 (.1)	< .767 (.0)	< .788 (.0)
OpE/OwE	1.11 0.94 – 1.32	0.90 0.72-1.21	1.12 0.87-1.55	0.75 0.63-1.22	< .013	< .036 (.3)	< .995 (.0)	**< .003 (.4)**	< .100 (.1)	< .265 (.3)	< .029 (.3)

(Q1) Quartile 1, (Q3) Quartile 3, (S) Senior category, (U20) Under 20 category, (U18) Under 18 category, (ESr) effect size r Rosenthal, (APS) Attack Points/Set, (BPS) Block Points/Set, (SPS) Serve Points/Set, (AE) Atack Effectiveness, (BE) Block Effectiveness, (SE) Serve Effectiveness, (OwS) Own Errors/Set, (OpS) Opponent Errors/Set, (OpE/OwE) Opponent Errors/Own Errors. The variables with significant differences are highlighted in bold (p< .008).

Table 5. Analysis by level of performance in U18 category of the final actions of the game and their relative values.

Variables	Level 1 Median Q1-Q3	Level 2 Median Q1-Q3	Level 3 Median Q1-Q3	Level 4 Median Q1-Q3	Sig. Kruskal Wallis	Diff. Between levels P values (ESr)					
						1 vs. 2	1 vs. 3	1 vs. 4	2 vs. 3	2 vs. 4	3 vs. 4
APS	10.00 8.61-11.06	9.33 8.25-11.75	9.89 7.42-11.18	9.61 7.71-10.75	< .702	< .989 (.0)	< .638 (.1)	< .273 (.1)	< .522 (.1)	< .375 (.1)	< .633 (.1)
BPS	2.67 1.83-3.33	2.33 1.24-3.00	1.75 1.29-2.54	1.33 0.75-2.13	**< .002**	< .301 (.1)	< .030 (.5)	**< .001 (.5)**	< .356 (.1)	< .012 (.3)	< .046 (.2)

SPS	2.50 1.83-3.00	1.75 1.50-3.33	2.13 1.44-2.71	1.75 1.29-2.58	< .228	< .572 (.1)	< .146 (.2)	< .044 (.3)	< .572 (.1)	< .262 (.1)	< .456 (.1)
AE (%)	35.00 30.00-41.00	34.00 30.00-38.00	33.00 25.00-38.00	30.00 27.00-35.00	< .057	< .509 (.1)	< .070 (.2)	< .012 (.3)	< .350 (.1)	< .052 (.2)	< .648 (.1)
BE (%)	19.00 15.00-27.00	15.00 11.00-23.00	14.00 9.00-19.00	13.00 8.00-17.00	**< .001**	< .033 (.3)	**< .003** **(.4)**	**< .001** **(.5)**	< .509 (.1)	< .059 (.2)	< .188 (.2)
SE (%)	11.00 8.00-12.00	8.00 7.00-14.00	9.00 7.00-12.00	8.00 6.00-12.00	< .694	< .690 (.1)	< .375 (.1)	< .173 (.2)	< .891 (.0)	< .773 (.0)	< .653 (.1)
OwS	8.17 6.33-9.00	8.00 6.33-10.00	7.76 6.71-9.13	8.83 7.25-10.83	< .298	< .630 (.1)	< .984 (.0)	< .070 (.2)	< .690 (.1)	< .309 (.1)	< .107 (.2)
OpS	8.94 7.61-10.39	8.75 7.40-10.00	8.33 7.25-9.13	7.56 6.29-9.00	< .041	< .572 (.1)	< .139 (.2)	< .009 (.3)	< .283 (.1)	< .030 (.3)	< .259 (.1)
OpE/OwE	1.12 0.93-1.43	1.12 0.73-1.37	1.04 0.85-1.41	0.91 0.69-1.13	< .042	< .429 (.1)	< .334 (.1)	**< .005** **(.4)**	< .842 (.0)	< .061 (.2)	< .070 (.2)

(Q1) Quartile 1, (Q3) Quartile 3, (S) Senior category, (U20) Under 20 category, (U18) Under 18 category, (ESr) effect size r Rosenthal, (APS) Attack Points/Set, (BPS) Block Points/Set, (SPS) Serve Points/Set, (AE) Atack Effectiveness, (BE) Block Effectiveness, (SE) Serve Effectiveness, (OwS) Own Errors/Set, (OpS) Opponent Errors/Set, (OpE/OwE) Opponent Errors/Own Errors. The variables with significant differences are highlighted in bold (p< .008).

4. Discussion

The aim of this study was to determine which performance indicators show significant differences in relation to the category and level of the teams in women's international volleyball competitions, played in 2019, by considering the final actions of the game. The lack of significance shown in the interaction of the two factors proposed (age category and level) in the regression study determined that the relationship of the performance variables proposed with age category and level was carried out separately.

From the results obtained in this study, it can be said that the U18 category is characterized by more errors and effectiveness in the serve, and in the U20 category there is a huge leap in quality, with maximum values of blocking, an increase in attack performance and a decrease in errors and effectiveness of the serve. In the Senior category, there is a decrease in block effectiveness and an increase in attack performance. On comparing levels, more differences were found for the levels that had teams more further apart in the ranking, and attack effectiveness and block effectiveness stood out as the most relevant indicators.

Differences according to category - The biggest differences between women's categories were found when comparing the Senior and U20 with the U18 category. As explained in previous studies, it could be due to the conjunction of the physical maturation of the players, the greater number of hours of practice and the experience that players acquire over the years (García-Alcaraz et al., 2016; Montoro-Escano & Hernandez-Mendo, 2014). Specifically, we identified improvements in attack and block effectiveness, as well as in points obtained by these actions during the set. These data coincide with those found by García de Alcaraz et al. (2017) in men's volleyball who found that the older the age, the more attacking and blocking points were produced. We also observed a decrease in errors as the categories advanced, as well as a reduction in the serve effectiveness. This last observation coincides with previous studies that indicated that the older and higher the level, the better the reception systems are, and less effective the serving actions (García-Alcaraz et al., 2020). Therefore, after comparing these results with previous studies on men (García-Alcaraz et al., 2020; García-Alcaraz & Marcelino, 2017), it can be assumed that in this case there are no obvious differences between the sexes.

Furthermore, it was observed that the performance variables improved greatly in the transition from the U18 to the U20, but not so much in comparison between the U20 and Senior categories. In the comparison between U20 and Senior, higher values with moderate and large effect size were only found in the attack point/set (+1.3 for Senior) and in block effectiveness (+10% for U20). The large difference found in block effectiveness proved to be an interesting and applicative finding, identifying a peak in

block effectiveness performance in U20. This information is interesting as it differs from data found in the literature, especially in comparison with men, where it is has been found that the older the age, the higher the blocking performance (García-Alcaraz et al., 2016). These disagreements between studies could be explained by the gender differences, taking into account anthropometric and conditional factors that provide greater force in the final actions of men's volleyball (Drikos et al., 2020).

To sum up, the U18 category presented a greater number of errors and more serve effectiveness just as García de Alcaraz et al. (2014) found for men. Moving on to the U20 category, performance increased considerably, establishing performance indicators very similar to those in the Senior category. Specifically, there is a peak in block performance, with 25% effectiveness, as well as an increase in attacking performance, and a decrease in errors and serve effectiveness. In addition, in the women's Senior category, a decrease was found in block effectiveness and an increase in attacking performance compared with the U20 category.

These contributions make it possible to establish a performance evolution throughout the formative stage of women players (Figure 1), giving indicative values for performance variables associated with each category in order to guide learning processes (Drikos et al., 2018). It is, therefore, possible to observe which variables are outside recommended average values so as to adjust training processes.

Differences according to level - We observed that each category shows a different trend, and that within each of them differences between levels show particularities, although there is a tendency for specific performance indicators to predominate. Furthermore, as Drikos et al. (2019) found, the comparison between levels tends to be greater, the further apart the teams are in the rankings, with worse values for performance variables in lower-ranked teams.

With regard to the women's Senior category, generally attack effectiveness increased with the level, as was also observed in the men's category (Drikos et al., 2019). Specifically, these differences ranged from + 2% (between 2 and 3) to + 8% (between 1 and 4). Block effectiveness also appeared as a significant indicator especially in the comparisons between levels 1 and 2 with 3 and 4. These findings are in line with those obtained by Palao et al. (2004) who observed this tendency in men's volleyball but not so much in women. This may be due to the evolution that has occurred in women's volleyball from 2004 till now, when one considers women's physical, anthropometric and biotype characteristics that show that female players tend to be taller, faster and stronger than before (Fernandez et al., 2017). Regarding error variables, the variable own errors/set and the opponents' errors/own errors ratio were significant in the comparison between levels 1 and 2, and between levels 3 and 4, demonstrating that error variables can make differences between contiguous levels. Finally, there were no significant differences in the serve, which is in line with previous studies (Drikos et al., 2019; Miskin et al., 2010).

For the U20 category, the most significant variables were also the attack effectiveness with values from + 4% (between 1-3) and + 11% (between 1-4), and the block effectiveness with values from + 4% (between 1-3) and + 11% (between 2-4). In contrast to Seniors, variables related to serving started to appear as significant in some of the comparisons, such as serve point per set (between 1-4, and 3-4) and serve effectiveness (between 3-4), in line with the findings of Silva et al. (2014) in men's international competition, which associated serve effectiveness with success. In addition, greater differences were identified between higher levels with level 4 (Drikos et al., 2019), even in the direct comparison with level 3, an aspect that did not occur in such a pronounced way in Seniors.

In relation to the U18 category, the most repeated performance indicators were block effectiveness and attack effectiveness,

as it was in Seniors and U20, showing the importance of these two performance variables throughout the full age evolution training process of the game. This is in line with the findings of Patsiaouras et al. (2011) and Palao et al. (2004) in the Senior men's category, so establishing the importance of these variables regardless of the gender. Curiously, and unlike that of the U20 category, it is interesting to highlight that the differences between adjacent levels decreased only to block variables, reflecting the equality present in this category. In addition, indicators related to error were only found between levels 1 and 2 with 4, in line with previous studies that found that errors decrease with increased level (Palao et al., 2004).

Finally, a general tendency was observed in all categories to find more differences in the performance indicators when teams are further apart in the ranking, just as in previous research into men's volleyball (Drikos et al., 2019), as well as the predominance of two performance indicators, attack and block effectiveness. This result was reinforced with the regression analysis that showed no interaction between ranking position and team category, and these two performance indicators as important explanatory variables. The importance of attack and block effectiveness has been demonstrated in different studies (Campos et al., 2014; Palao et al., 2004; Patsiaouras et al., 2011) in both male and female categories, where it has been shown that attack effectiveness is associated with the teams' victories (Campos et al., 2014; Palao et al., 2004; Patsiaouras et al., 2011) and that block effectiveness increases with the higher level of the teams (Palao et al., 2004).

Among the particularities found within each women category, it was observed that serve performance presents differences between the U18 and U20 levels, possibly due to the greater inaccuracies in receiving the serve in these two categories (García-Alcaraz et al., 2020). In addition, a considerable increase in quality was identified between level 4 and 3 in U20, and a tendency towards equality between adjacent levels in U18, possibly due to the fact that all teams are at the beginning of their players' training process, so making it more difficult to find these types of difference.

The data of the current study can provide recommendations on the quality of improvement needed for a given performance indicator so as to reach the values of higher levels teams, so allowing coaches to establish clear objectives for reaching the next level (Palao et al., 2004). As an example, Figure 2 shows the differences between adjacent levels by category.

5. Practical Applications and Limitations

Research focused on sport performance is aimed at the practical application of its findings in the day-to-day lives of athletes. This transfer of knowledge is vital for the evolution of sport performance and is what brings the most value to the studies. In this sense, one of the most important applications of this research is to offer the possibility of establishing operational objectives based on the descriptive values of the variables that showed significant differences. In this way, the information becomes more concrete and valuable, allowing coaches and players to focus their attention on specific relevant aspects (Drikos et al., 2021; Filipcic et al., 2021).

The study of the differences by category allows us not only to know the operational objectives of the significant variables by category, but also to know how the performance of the athletes evolves over time. This information is of great interest for establishing, modifying, or proposing models to guide the learning of volleyball players from the formative categories (U18-U20) to the senior category (García-Alcaraz et al., 2016).

The comparison by levels within each category makes it possible to identify the variables that are most influential in determining the final classification of the teams in the competitions. In this way, the significant differences of each variable by level are established, creating performance indicators that guide coaches and technical

staff in the evolution and performance of their teams (Palao et al., 2004). These data make it possible to know how much improvement is needed in each performance indicator to reach the values of teams at higher levels.

The limitations of this study include the impossibility of unifying the competition formats to establish the same number of matches per team, category, and level, and the robustness of the data could not be tested. Furthermore, the data obtained from the competitions made it impossible to distinguish the type of error depending on the technical action performed, and it was also not possible to know how other performance indicators could influence the game, such as the quality of serve reception or setter distribution. It should also be noted that from the authors perspective, individual competitive experience could be an influential factor in age and level comparison in international competitions that was not be considered in this research.

Furthermore, as women's volleyball is in continuous evolution, it would be interesting for future research to determine whether the results obtained in this research are repeated in subsequent years or whether, on the contrary, different trends are observed in the performance indicators proposed. Also, it would be interesting to determine the biomechanical or tactical reasons that explain the decrease of block effectiveness from the U20 category to the Senior category.

6. Conclusions

The results of the current study determine performance indicators for each category and level in women's international volleyball by considering final actions of the game. With this information coaches and technical staff will be able to establish specific objectives per variable in trainings and competitions for the team's improvement and success.

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References

Akarçeşme, C. (2017). Is it Possible to Estimate Match Result in Volleyball: A new Prediction Model. Central European Journal of Sport Sciences and Medicine, 19. https://doi.org/10.18276/cej.2017.3-01

Alfonso, J., Mesquita, I., Marcelino, R., & da Silva, J. A. (2010). Analysis of the Setter's Tactical Action in High-Performance Women's Volleyball. / Analiza Taktickih Akcija Vrhunskih Dizačica U Odbojci. Kinesiology, 42(1). http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=52950512&lang=es&site=ehost-live&scope=site

Araújo, R., Mesquita, I., & Marcelino, R. (2009). Relationship between Block Constraints and set outcome in Elite Male Volleyball. International Journal of Performance Analysis in Sport, 9(3), 306–313. https://doi.org/10.1080/24748668.2009.11868487

Ávila, F., Chirosa Ríos, L., Ureña-Espa, A., Lozano, D., & Ulloa Díaz, D. (2018). Evaluation of tactical performance in invasion team sports: A systematic review. International Journal of Performance Analysis in Sport, 18, 1–22. https://doi.org/10.1080/24748668.2018.1460054

Barris, S., & Button, C. (2008). A review of vision-based motion analysis in sport. Sports Medicine (Auckland, N.Z.), 38(12), 1025–1043. https://doi.org/10.2165/00007256-200838120-00006

Calero-Morales, S. C. (2011). Significant Influential Variables in Set Volleyball Performance. Revista Internacional De Medicina Y Ciencias De La Actividad Fisica Y Del Deporte, 11(42).

Calero, S. (2010). Análisis de las ecuaciones de una variable influyente utilizadas internacionalmente para procesar el rendimiento técnico-táctico del voleibol. / Equation analysis of an influential variable applied to process the technical and tactical

performance in volle. Revista Kronos, 9(17). http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=57276582&lang=es&site=ehost-live&scope=site

Campos, F. a. D., Stanganélli, L. C. R., Campos, L. C. B., Pasquarelli, B. N., & Gómez, M.-Á. (2014). Performance Indicators Analysis at Brazilian and Italian Women's Volleyball Leagues According to Game Location, Game Outcome, and Set Number. Perceptual & Motor Skills, 118(2). https://doi.org/10.2466/30.25.PMS.118k19w4

Collet, C., do Nascimento, J. V., Ramos, V., & Stefanello, J. M. F. (2011). Construction and validation of a technical-tactical performance evaluation instrument in volleyball. Revista Brasileira de Cineantropometria e Desempenho Humano, 13(1). https://doi.org/10.5007/1980-0037.2011v13n1p43

Drikos, S., Apostolidis, N., & Ntzoufras, I. (2018). Bayesian Analysis of Skills Importance in World Champions Men's Volleyball across Ages. International Journal of Computer Science in Sport, 18. https://doi.org/10.2478/ijcss-2019-0002

Drikos, S., Barzouka, K., Balasas, D. G., & Sotiropoulos, K. (2021). Effect of quality of opposition on game performance indicators in elite male volleyball. International Journal of Sports Science & Coaching, 17479541211013700. https://doi.org/10.1177/17479541211013701

Drikos, S., Kountouris, P., Laios, A., & Laios, Y. (2009). Correlates of Team Performance in Volleyball. International Journal of Performance Analysis in Sport, 9(2), 149–156. https://doi.org/10.1080/24748668.2009.11868472

Drikos, S., Sotiropoulos, K., Barzouka, K., & Angelonidis, Y. (2020). The contribution of skills in the interpretation of a volleyball set result with minimum score difference across genders. International Journal of Sports Science & Coaching, 15(4), 542–551. https://doi.org/10.1177/1747954120930307

Drikos, S., Sotiropoulos, K., Papadopoulou, S., & Barzouka, K. (2019). Multivariate analysis of the success factors in high-level male volleyball: A longitudinal study. 26, 177–185. https://doi.org/10.23829/TSS.2019.26.4-6

Fernandez, J. A., Rubiano, P. A., & Hoyos, L. A. (2017). Morphological Profile of Elite Women Volleyball Players. Review Article. Revista Internacional De Medicina Y Ciencias De La Actividad Fisica Y Del Deporte, 17(68), 775–794. https://doi.org/10.15366/rimcafd2017.68.012

Fernandez-Echeverria, C., Gil, A., Moreno, A., Claver, F., & Perla Moreno, M. (2015). Analysis of the variables that predict serve efficacy in young volleyball players. International Journal of Performance Analysis in Sport, 15(1), 172–186.

Filipcic, A., Leskosek, B., Crespo, M., & Filipcic, T. (2021). Matchplay characteristics and performance indicators of male junior and entry professional tennis players. International Journal of Sports Science & Coaching, 16(3), 768–776. https://doi.org/10.1177/1747954120988002

Franks, I. M., & Goodman, D. (1986). A systematic approach to analysing sports performance. Journal of Sports Sciences, 4(1), 49–59. https://doi.org/10.1080/02640418608732098

Garcia-Alcaraz, A., Palao, J. M., & Ortega, E. (2014). Perfil de Rendimiento Técnico-Táctico de la Recepción en Función de la Categoría de Competición en Voleibol Masculino. / Technical-tactical performance profile of reception according to competition category in men volleyball. Revista Kronos, 13(1). http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=97447065&lang=es&site=ehost-live&scope=site

García-Alcaraz, A., & Marcelino, R. (2017). Influence of match quality on men's volleyball performance at different competition levels. International Journal of Performance Analysis in Sport, 17(4). https://doi.org/10.1080/24748668.2017.1348058

García-Alcaraz, A., Ortega, E., & Palao, J. M. (2015). Effect of age group on male volleyball players' technical-tactical performance profile for the spike. International Journal of Performance Analysis in Sport, 15(2). https://doi.org/10.1080/24748668.2015.11868823

García-Alcaraz, A., Ortega, E., & Palao, J. M. (2016). Effect of Age Group on Technical-Tactical Performance Profile of the Serve in Men's Volleyball. Perceptual & Motor Skills, 123(2). https://doi.org/10.1177/0031512516660733

García-Alcaraz, A., Ortega, E., & Palao, J. M. (2016). Technical-tactical performance profile of the block and dig according to competition category in men's volleyball. Motriz. Revista de Educacao Fisica, 22(2). https://doi.org/10.1590/S1980-6574201600020013

García-Alcaraz, A., Ortega, E., & Palao, J. M. (2020). Game phases performance in men's volleyball: From initial to top-level categories Rendimiento de las fases de juego en voleibol masculino: Desde la iniciación hasta las categorías de alto rendimiento. RICYDE. Revista Internacional de Ciencias Del Deporte, 16(61). http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=144780357&lang=es&site=ehost-live&scope=site

Hughes, M. D., & Bartlett, R. M. (2002). The use of performance indicators in performance analysis. Journal of Sports Sciences, 20(10), 739–754. https://doi.org/10.1080/026404102320675602

Kountouris, P., Drikos, S., Angelonidis, Y., Laios, A., & Kyprianou, M. (2015). Evidence for Differences in Men's and Women's Volleyball Games Based on Skills Effectiveness in Four Consecutive Olympic Tournaments. Comprehensive Psychology, 4, Article 9. https://doi.org/10.2466/30.50.CP.4.9

Liebermann, D. G., Katz, L., Hughes, M. D., Bartlett, R. M., McClements, J., & Franks, I. M. (2002). Advances in the application of information technology to sport performance. Journal of Sports Sciences, 20(10), 755–769. Scopus. https://doi.org/10.1080/026404102320675611

Marcelino, R., Mesquita, I., & Sampaio, J. (2011). Effects of quality of opposition and match status on technical and tactical performances in elite volleyball. Journal of Sports Sciences, 29(7). https://doi.org/10.1080/02640414.2011.552516

Michalopoulos, G., Sotiropoulos, K., Drikos, S., Barzouka, K., & Angelonidis, Y. (2020). Spatiotemporal analysis of setting per game complex and team rotation in junior volleyball. https://doi.org/10.23829/TSS.2020.27.3-4

Miskin, M., Fellingham, G., & Florence, L. (2010). Skill Importance in Women's Volleyball. Journal of Quantitative Analysis in Sports, 6, 5–5. https://doi.org/10.2202/1559-0410.1234

Montoro-Escano, J., & Hernandez-Mendo, A. (2014). Impact on competition level performance block female volleyball. Ricyde-Revista Internacional De Ciencias Del Deporte, 10(36). https://doi.org/10.5232/ricyde2014.03605

Nevill, A. M., Atkinson, G., Hughes, M. D., & Cooper, S. M. (2002). Statistical methods for analysing discrete and categorical data recorded in performance analysis. Journal of Sports Sciences, 20(10), 829–844. https://doi.org/10.1080/026404102320675666

Palao, J. M., & Hernández-Hernández, E. (2014). Game statistical system and criteria used by Spanish volleyball coaches. International Journal of Performance Analysis in Sport, 14(2), 564–573. https://doi.org/10.1080/24748668.2014.11868743

Palao, J. M., Manzanares, P., & Ortega, E. (2009). Techniques used and efficacy of volleyball skills in relation to gender. International Journal of Performance Analysis in Sport, 9(2), 281–293. https://doi.org/10.1080/24748668.2009.11868484

Palao, J., Santos, J. A., & Ureña-Espa, A. (2004). Effect of team level on skill performance in volleyball. International Journal of Performance Analysis in Sport, 4, 50–60. https://doi.org/10.1080/24748668.2004.11868304

Patsiaouras, A., Moustakidis, A., Charitonidis, K., & Kokaridas, D. (2011). Technical Skills Leading in Winning or Losing Volleyball Matches During Beijing Olympic Games. Journal of Physical Education and Sport, 11.

Paulo, A., Zaal, F. T. J. M., Seifert, L., Fonseca, S., & Araujo, D. (2018). Predicting volleyball serve-reception at group level. Journal of Sports Sciences, 36(22), 2621–2630. https://doi.org/10.1080/02640414.2018.1473098

Peña, J., Rodríguez-Guerra, J., Buscà, B., & Serra, N. (2013). Which skills and factors better predict winning and losing in high-level men's volleyball? Journal of Strength and Conditioning Research, 27(9), 2487–2493. https://doi.org/10.1519/JSC.0b013e31827f4dbe

Silva, M., Lacerda, D., & João, P. (2014). Game-Related Volleyball Skills that Influence Victory. Journal of Human Kinetics, 41, 173–179. https://doi.org/10.2478/hukin-2014-0045

Silva, M., Marcelino, R., Lacerda, D., & João, P. V. (2016). Match analysis in Volleyball: A systematic review. Montenegrin Journal of Sports Science and Medicine, 5(1), 35–46. Scopus.

Smith, R. M., & Loschner, C. (2002). Biomechanics feedback for rowing. Journal of Sports Sciences, 20(10), 783–791. Scopus. https://doi.org/10.1080/026404102320675639

Sotiropoulos, K., Drikos, S., Papadopoulou, S. D., & Barzouka, K. (2021). Characterizing adaptations of serve indicators in top-level male volleyball among seasons. International Journal of Sports Science & Coaching, 16(3), 784–792. https://doi.org/10.1177/1747954120978920

Ureña-Espa, A., Ferrer, R., & Pérez, C. (2002). Estudio de la recepción del saque en el voleibol masculino español de elite tras la incorporación del jugador libero. Revista Internacional de Medicina y Ciencias de La Actividad Física y Del Deporte, ISSN 1577-0354, No. 4, 2002