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Original Article

Temporal aspects and physical behavior of U-21 female beach volleyball players: a study performed of the FIVB World Championship

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Abstract:
Introduction: Volleyball is a dynamic sport in which athletes often use jumps and small displacements during rallies. However, temporal aspects and physical behaviors (e.g., jumps per set and specific movements per set) have not yet been investigated by considering the competition phase and role. Objective: This study aimed to compare temporal and physical indicators by considering the competition phase, set result, and role when possible. Methods: The observed matches were from FIVB Beach Volleyball U21 World Championships 2019. A total of 8 matches, 16 sets, and 556 rallies were observed. The observed parameters showed great intra- and inter-reliability for qualitative and quantitative variables [Kappa ≥ 0.85 - Level of Agreement: strong; intraclass correlation coefficients (ICC ≥ 0.90)]. The sets were split into the phase of the competition (group or final), result of the set (winner or loser), and roles (blocker or defender). The temporal variables (i.e., rally, rest time between rallies, total work time, total rest time, duration of the set, duration of the match, TRT: TWR ratio, and the number of rallies) were compared by considering the competition phase; physical variables (jumps per set, jumps per set in the attack, and specifics movements) were compared by considering the competition phase, set result, and roles. In addition, rallies are classified as short (≤3 s), medium (4–7 s), and long (≥8 s), and the association of the types of rallies with the competition phase was confirmed. Results: Medium rallies are more frequent than other types (~58%). Blockers jump more times per set ($p = 0.003$) and have more digs with movement ($p < 0.001$). Conclusions: The competition phase seems to slightly increase the temporal and physical indicators. Moreover, blockers are more physically required.
Key Words: **sand sports, team sport, match analysis, young athletes, athletic performance**

Introduction

Beach volleyball is a team sport played in pairs with intermittent characteristics [i.e., periods of effort and pause with intensity variations (Medeiros et al., 2014)]. Magalhães et al. (2011) observed the heart rate and blood lactate concentration during the match. The results allow us to define that the aerobic system is predominant, but the matches' determinant actions depend on the ATP-PC system (anaerobic alactic). Moreover, players can assume the role of blockers or defenders. This specialization is important because determine physical and match strategies (Jimenez-Olmedo et al., 2016; Natali et al., 2017).

Temporal analysis is a means of studying the density of the game and is useful for increased specificity of training prescriptions (Costa et al., 2018; Medeiros et al., 2014; Reilly et al., 2009). In brief, these dates enable us to determine the effort : pause ratio (Andreato et al., 2016). In beach volleyball, these are commonly used as temporal indicators: rally duration, rest time between rallies, total work time, total rest time, duration of the set, duration of the match, and rallies per set (Palao & Manzanares, 2009). These parameters were previously checked in young elite (Pérez-Turpin et al., 2019) and professional (Natali et al., 2017) players, but it was not investigated if the competition phase changed these parameters. Usually, the effort : pause ration or rally : rest time between rallies is ~1:3 (Medeiros et al., 2014; Natali et al., 2017).

Within the range of the rally, athletes generally use jumps to perform various match's actions. For example, blocking, attacking, and some types of serves often use jumps (Buscá et al., 2012; López-Martínez et al., 2020; Turpin et al., 2008). Moreover, Batista et al. (2008) determined that the jump's height is a determinant of the athletes' competitive level, similar to that observed in volleyball indoor (Sattler et al., 2015). In this sense, the role assumed by athletes determines several aspects of physical behavior. Block is "a move performed at the net to prevent the ball from passing into one's court" (Perez-Turpin et al., 2009), and the player who performs 80% of that action during the match is considered a blocker (Giatsis et al., 2011). This role appears to determine

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the higher number of jumps made by the blocker than the defender [i.e., the specific player in defense (Natali et al., 2017; Palao et al., 2014)].

Moreover, some displacements are characteristic of each role. For example, when blockers serving need to dislocate to the net to perform the block action or get out of the net and return to a defensive position (i.e., pull of the net). This set of factors (jump and displacements) indicates that the blocker role becomes more stressful. Analyzes of the GPS, heart rate (Nunes et al., 2020), and testosterone: cortisol ratio (Costa et al., 2020) confirmed this information. Also, the direction of the displacements was associated to match fundamentals indicating a predominance of advance movements (Perez-Turpin et al., 2009). Besides, sand surface modifies biomechanical parameters and increases physiological responses (Binnie et al., 2013; Bishop, 2003; Giatsis et al., 2017), making jumping and displacements difficult.

In the studies carried out, the competition phase and set result (i.e., win and lost) were not considered. Besides, most were performed with professional or male athletes, making extrapolation difficult for application in young female athletes, and specifics movements (e.g., serve-net, pull off the net) are not investigated. Therefore, this study aimed to compare temporal and physical indicators considering the competition phase, set result, and role when possible. We hypothesize that the match duration increases without changing the effort : pause ratio; blockers make more jumps, especially the winners; and more defenses with movement are performed.

Materials & methods

Participants

Sixteen female athletes (8 teams= Brazil, Russian, Spain, Germany, Mexico, Czech Republic, and Morocco) that competed in FIVB Beach Volleyball U21 World Championships 2019 participated. A total of 8 matches, 16 sets, and 556 rallies were observed. Two groups were created: Group [one match each finalist in group phase (n= 4 matches)], and Final [semi-final, final and third place (n= 4 matches)]; This procedure was adopted to ensure the same number of sets in groups (Costa et al., 2018). The third set was not analyzed because they have unique characteristics. The roles are split into two groups: blocker and defender [athlete who participates less than 20% of the blocking actions (Giatsis et al., 2011)]. Finally, the result of the set was considered to classify winners and losers. This research followed the ethical recommendations indicated in the Declaration of Helsinki and was approved by the Ethics Committee.

Data collection procedures

The observed matches were recorded by the official organization [Federation International of Volleyball (FIVB)]. All games had the camera positioned behind the court with a view of the entire game space. Subsequently, 13% of the games were analyzed by two observers with experience in beach volleyball (coaches with over 10 years of experience) and repeated observation after 15 days (Landis & Koch, 1977). This procedure ensured reliability Intra and Entre observers, tested by Kappa Coefficient to the number of jumps per set and specific movement per set [K ≥0.85 - Level of Agreement: strong (McHugh, 2012)] and intraclass correlation coefficients to temporal variables [(ICC ≥ 0.90 – excellent reliability (Koo & Li, 2016)] associated with a mean difference of less than 5% between observers, allowing to continue with the analysis of the other matches.

Temporal variables

The time was measured using the digital chronometer from software VLC Media Player 3.0.11 for Windows (Free Software Foundation, Inc. Boston, MA, EUA). The observers registered the duration of the rally (the period between the start -server's ball hit- and the end of a rally -referee's whistle signal-) in Microsoft Excel 2013 as suggested by Palao and Manzanares (2009), and the other variables are automatically calculated.

Thus, it was adopted as temporal variables: rally duration, rest time between rallies (the period between the end -referee's whistle signal- and the beginning -server's ball hit- of a rally); total work time (sum of the duration of all rallies in a set); total rest time (sum of the duration of all rest time between rallies in a set); duration of the set (the period between the first serve and the end of the last rally in a set); duration of match (sum of the duration of 1st and 2nd set); rest time : work time ratio (TRT : TWT Ratio); and the number of rallies (points played per set). Interruptions (technical timeouts and timeouts) were not excluded from the analysis. Furthermore, the rally duration was classified using two-step cluster analysis [distance measure: log-likelihood; clustering criterion: Schwarz's Bayesian criterion; the number of clusters fixed at three (Sánchez-Moreno et al., 2015)]. The short rallies were ≤ 3 seg; medium 4 – 7 seg; and long ≥ 8 seg.

Number of jumps per set

The jump is classified in service jumps (jumps in the action of serve), jump attack (jump to hit the ball), jump defender (jumps in defensive actions), block jump (jump near the net to prevent opponent attack), and other jumps (any action outside the categories). Thus, two indicators are calculated: a) sum number of jumps per set; and b) sum jumps in attack per set.

Specific movement per set

Each role's specific movements were verified: blocker (a) Serve-net: movement after service to reach the net to block; (b) pull of the net: blocker movement to get out of the block to assume a defensive position. Defender (a) dig with movement: the athlete had to move after the attack to dig; (b) dig without movement: the athlete did not have to move after the attack to dig.

Data analysis

The data were presented by mean, standard deviation, relative, and absolute frequency. The chi-square test was used to verify the difference in rally types of frequency distribution between the competition phases. Temporal indicators, jump indicators, and specifics movements showed a normal distribution verified by the Shapiro-Wilk test. Thus, temporal indicators are compared by Student's t-test; sum jump per set, sum jumps in attack per set by Anova three-way (competition phase, result, and roles); movement specifics are compared by Anova two-way (Serve-Net and Pull of the net: phase and result); and digs by Anova three-way (competition phase, result and, movement).

When Anova showed a significant difference, the post hoc Bonferroni is utilized for pairs comparison. Besides, Cramer's V is presented with effect size to chi-square test; partial eta squared to Anova (η_p^2) and Cohen's d (d) for pairs comparison (Cohen, 1988). The magnitude of effect size is interpreted (Hopkins et al., 2009): <0.2 (trivial), >0.2 to 0.6 (small), >0.6 to 1.2 (moderate), >1.2 to 2.0 (large), >2.0 to 4.0 (very large), >4.0 (extremely large). The analyzes were performed using the SPSS 20.0 software (IBM Corp., Armonk, NY, EUA), with a significance level of $p \leq 0.05$.

Results

The Pearson Chi-squared analysis did not show a difference in the distribution in the rally duration classification between competition phases [Table 1 ($p \leq 0.05$)]. Furthermore, medium rallies are the most frequent in the group (56%) and final (60.8%) phase.

Table 1. Frequency distribution according to the competition phase and classification of the rally duration

Competition phase		Short (≤3s)	Medium (4s – 7 s)	Long rallies (≥8s)
Group	n (268)	58	150	60
	%	21.6	56.0	22.4
	AD	0.6	-1.1	0.8
Final	n (288)	56	175	57
	%	19.4	60.8	19.8
	AD	-0.6	1.1	-0.8
Total	n	114	325	117
	%	20.5	58.5	21.0

AD: Adjusted Residual; Pearson Chi-squared= 1.317; p= 0.516. Cramer's V= 0.049; p= 0.961.

There was no difference between the time indicators between the competition phases [Table 2 ($p \leq 0.05$)]. The time between rallies, total rest time, duration of the set, and duration of the match showed a moderate effect size.

Table 2. Comparison of temporal indicators between the group and the final phase.

		Mean (±DP)	P	d
Rally (s)	Group (n= 8)	05.76 (00.47)	0.968	-0.033 (trivial)
	Final (n= 8)	05.74 (00.71)		
Rest time between rallies (s)	Group (n= 8)	20.27 (01.59)	0.173	0.640 (moderate)
	Final (n= 8)	21.43 (02.01)		
Total work time (min:seg)	Group (n= 8)	03:12 (00:33)	0.362	0.485 (small)
	Final (n= 8)	03:26 (00:24)		
Total rest time (min:seg)	Group (n= 8)	11:03 (02:29)	0.221	0.742 (moderate)
	Final (n= 8)	12:27 (00:59)		
Duration of set (min:set)	Group (n= 8)	14:15 (02:58)	0.184	0.695 (moderate)
	Final (n= 8)	15:53 (01:11)		
Duration of match (min:seg)	Group (n= 4)	28:31 (06:03)	0.363	0.727 (moderate)
	Final (n= 4)	31:47 (01:20)		
TRT : TWT Ration	Group (n= 8)	03.43 (00.39)	0.260	0.568 (small)
	Final (n= 8)	03.66 (00.42)		
Number of rallies (points)	Group (n= 8)	33.50 (05.45)	0.291	0.587 (small)
	Final (n= 8)	36.00 (02.56)		

TRT : TWT Ration: Rest time : work time ratio

There was no difference between the number of jumps per set along the competition [F(1.00 5.00)= 4.863; p= 0.079; $\eta_p^2 = 0.493$], result [F(1.00 5.00)= 1.251; p= 0.314; $\eta_p^2 = 0.200$] and interactions (Table 3).

However, had a significant difference among roles [F(1.00 5.00)= 29.212; p= 0.003; η_p^2 = 0.854]. Thus, blocker jump more times per set than defender (24.78 ±7.82 Vs. 17.19 ±6.41; p= 0.003; d=1.062, moderate effect).

Table 3. Comparison jumps per set between game role, set result, and competition phase.

		Group	Final	Interactions	
[a]Blocker	Winner	20.38 (±7.71)	29.17 (±4.79)	Phase*Result	F(1.00 5.00)= 5.292; p= 0.070; η_p^2= 0.514
	Loser	23.50 (±11.78)	27.14 (±2.79)	Phase*Role	F(1.00 5.00)= 0.143; p= 0.721; η_p^2= 0.028
Defender	Winner	12.88 (±6.13)	19.83 (±4.96)	Role*Result	F(1.00 5.00)= 0.405; p= 0.553; η_p^2= 0.075
	Loser	18.33 (±7.45)	18.86 (±5.58)	Phase*Result*Role	F(1.00 5.00)= 0.374; p= 0.567; η_p^2= 0.070

[a]Blocker Vs. Defender p≤ 0.05.

Regarding the jumps performed specifically in hits, there was no difference between of roles [F(1.00 5.00)= 5.576; p= 0.065; η_p^2= 0.527], phase competition [F(1.00 5.00)= 5.035; p= 0.075; η_p^2= 0.502], set result [F(1.00 5.00)= 1.833; p= 0.234; η_p^2= 0.268] and interactions (Table 4).

Table 4. Comparison jumps in the attack between game role, set result, and competition phase.

		Group	Final	Interactions	
[a]Blocker	Winner	8.13 (±3.98)	10.00 (±2.53)	Phase*Result	F(1.00 5.00)= 1.106; p= 0.341; η_p^2= 0.181
	Loser	8.67 (±3.93)	11.00 (±3.87)	Phase*Role	F(1.00 5.00)= 0.449; p= 0.533; η_p^2= 0.082
Defender	Winner	7.75 (±5.18)	8.83 (±3.76)	Role*Result	F(1.00 5.00)= 0.004; p= 0.951; η_p^2= 0.001
	Loser	9.50 (±5.39)	8.43 (±4.83)	Phase*Result*Role	F(1.00 5.00)= 1.672; p= 0.252; η_p^2= 0.251

[a]Blocker Vs. Defender p≤ 0.05.

Finally, there was no significant difference in serve-net between phase competition [F(1.00 4.00)= 0.103; p= 0.764; η_p^2= 0.025], set result [F(1.00 4.00)= 2.078; p= 0.223; η_p^2= 0.342] and interaction (Table 5). In relation to pull of the net, there was no significant difference in phase [F(1.00 6.00)= 0.381; p= 0.560; η_p^2= 0.060], result [F(1.00 6.00)= 0.665; p= 0.449; η_p^2= 0.098] and interaction (Table 5). In movement specifics of defender, there was no significant difference between dig in phase [F(1.00 4.00)= 0.492; p= 0.522; η_p^2= 0.110], result [F(1.00 4.00)= 3.440; p= 0.137; η_p^2= 0.462] and interactions (Table 5), but there was a significant difference in movement [F(1.00 4.00)= 297.593; p< 0.001; η_p^2= 0.987. Thus, there was more digs with movement (4.50 ±2.80) than without movement (1.05 ±0.95), p< 0.001; d= -1.650, effect large.

Table 5. Comparison between specific movements of blockers and defenders between phases of the competition and the result of the set.

		Blocker			
	Result	Group	Final	Interaction	
Serve-Net	Winner	8.20 (±2.16)	6.00 (±3.16)	Phase*Result	[F(1.00 4.00)= 4.785; p= 0.094; η_p^2= 0.545]
	Loser	4.60 (±3.50)	5.60 (±1.81)		
Pull of the net	Winner	4.50 (±2.81)	3.20 (±2.54)	Phase*Result	[F(1.00 6.00)= 0.446; p= 0.529; η_p^2= 0.069]
	Loser	2.83 (±2.54)	2.86 (±3.29)		
		Defender			
	Result	Group	Final	Interaction	
[a]With movement	Winner	4.40 (±2.51)	2.80 (±1.64)	Phase*Moviment	[F(1.00 4.00)= 0.383; p= 0.570; η_p^2= 0.087]
	Loser	4.60 (±4.77)	6.20 (±1.30)	Result*Moviment	[F(1.00 4.00)= 1.308; p= 0.317; η_p^2= 0.246]
Without movement	Winner	0.40 (±0.894)	1.80 (±0.83)	Phase*Result	[F(1.00 4.00)= 1.030; p= 0.367; η_p^2= 0.205]
	Loser	0.60 (±0.54)	1.40 (±0.89)	Phase*Result*Moviment	[F(1.00 4.00)= 1.530; p= 0.284; η_p^2= 0.277]

[a]With movement Vs. Without movement= p <0.001.

Figure 1 summarized the effect size (Cohen's d) in peer comparison (jump and specific movements). A moderate effect is observed in Blocker Vs. Defender (jumper per set); Winner Vs. Loser (movement blocker: serve-net); Group Vs. Final (digs without movement). Moreover, dig with movement Vs. without movement show a large effect size.

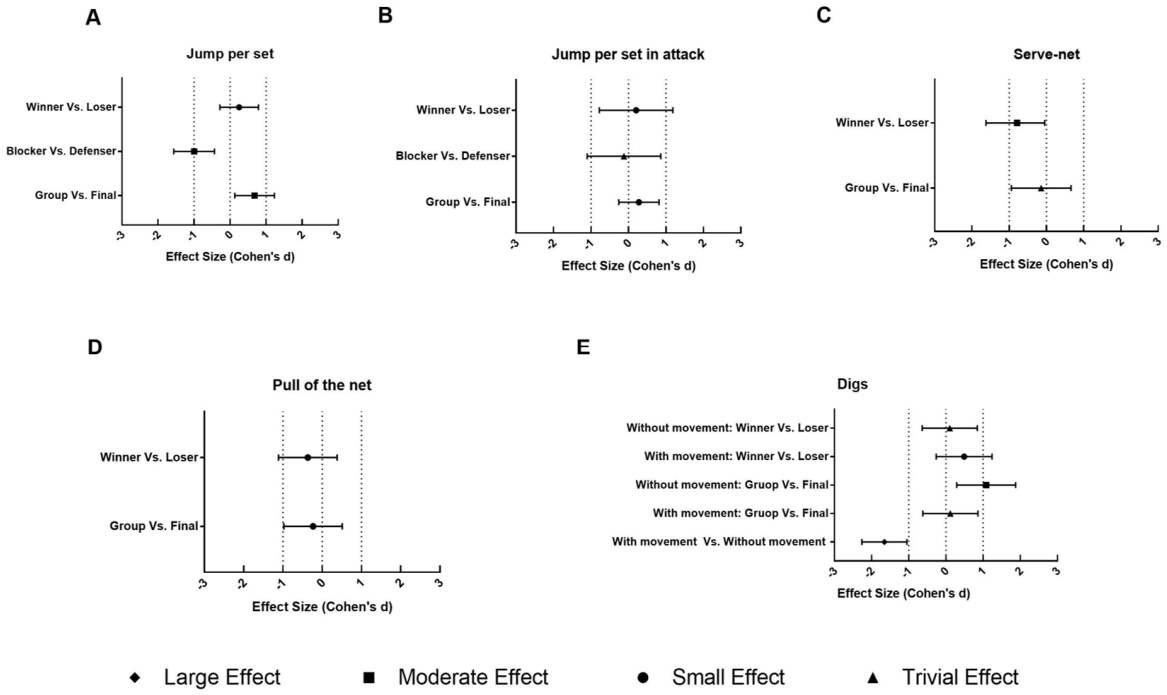

Figure 1. Effect size (Cohen's d) in peer comparison (jump and specific movements). A: Jump per set; B: Jump per set in the attack; C: Serve-net; D: Pull of the net; E: Digs.

Discussion

This study aimed to identify and compare physical indicators in female beach volleyball with young athletes. In general, medium rallies had a large distribution but is not affected by the competition phase. Moreover, the competition phase had a moderate effect on rest time between rallies, total rest time, total work time, and duration of the set. The blocker jumps more times per set than the defender but jumps in the attack are similar. Regarding specific movements, the serve-net (blocker's specific movements) seems more in winner than loser (moderate effect). Similar is observed by the defender's specific movements but had more digs with movements than without movements.

Many medium rallies are observed in this study (~58% | 4 – 7 seg). In male volleyball indoor with a different classified (Sánchez-Moreno et al., 2015), observed "short rallies" (73.6% | <6s); "medium rallies" (15.9% | 6s – 10s); and "long rallies" (10.5% | >10s). These data indicate a more balanced frequency distribution between rally types. This can be explained by the less variability of the sport indoors, allowing a better form of attack. Moreover, had a small tendency of associated medium rallies with final phase (AD=1.1), added moderate effect of phase competition in time between rallies, total rest time, duration of the set suggests a small tendency to increase the duration of the set and the game without large changing the TRT : TWT Ratio. Besides, the finalist teams better manage recovery time with strategies like described by Medeiros et al. (2014), causing a moderate effect on related variables.

The rally had a mean of duration (~6 sec) slightly lower than observed within male (6.9 sec) and female (7.1 sec) elite competition (Natali et al., 2017), and male (7.0 sec) under 19 and 21 (Medeiros et al., 2014). In other studies with female athletes, large number sets, and teams of different countries, Palao et al. (2015) verified a mean of rally 6.46 sec and 5.43 sec with female athletes under 21 (Pérez-Turpin et al., 2019). This set of evidence suggests that the rally lasts for ~6 sec in female beach volleyball and varies little between categories. The time between rallies (group= 20.27 sec; final= 21.43 sec) also is slightly lower than observed with female professional athletes [22.69 sec (Palao et al., 2015) and 23.0 sec (Natali et al., 2017)]. In addition to better rest time management by professionals (Medeiros et al., 2014), climatic conditions (i.e., wind speed, temperature, and relative humidity) can be an intervening factor.

Regarding sports roles, the blocker jumps more often than the defender (24.78 ±7.82 Vs. 17.19 ±6.41, moderate effect); the block action mainly explains this. Previously, it identified 39.7 jumps in blockers

professional female athletes (Natali et al., 2017). The difference may be related to technical-tactical skills and the lesser number of rallies played. The competition phase showed a moderate effect to increase the number of jumps (Figure 1 - A), and the mean is closer to professional athletes (Natali et al., 2017). Moreover, a progressive increase in jumps was observed concerning the under 19, 21, and senior male categories (Medeiros et al., 2014). The competition phase showed a trendy to increase the jumps in attack from group to final phase ($p= 0.075$), and blockers jumped slightly more than defenders in this action ($p= 0.065$), but the effect is trivial.

The competition phase does not seem to affect the blocker's movement. Koch and Tilp (2009) had already seen a low incidence of the pull off the net. Moreover, serve-net represents an additional effort to blocker, and the result shows a moderate effect. This was expected since winners need to serve more often. Concerning the defender, the digs with the movement were greater than the defenses without movement ($p< 0.001$; $d= 1.650$), this is corroborated by Koch and Tilp (2009). The authors also noted that women defend more "shot" attacks than spikes.

This study has the limitation of not having observed non-specialized pairs; however, this formation's low use makes it difficult to find a significant number of athletes to compose the research participants. Future investigations should verify the effect of the weather and the pair's formation (i.e., specialist or universal) on the match's physical aspects. Moreover, the intensity of the actions should be investigated in females and males.

Practical Application

The progression of the loads can leave the group to the final phase. In addition, the interval training prescription should increase the volume maintaining the effort : pause ratio, since the increase in the competitive level only resulted in moderate changes in the sum of the parameters. Moreover, the observed data demonstrate that blockers have a higher physical demand than defenders. In this way, the training must be specific for each role. Coaches can structure the training section to integrate the physical and technical loads, avoiding excessive external load. In this sense, it is recommended that the number of jumps is quantified daily. Finally, from a technical-tactical point of view serving on blockers can be interesting to increase physical demand during the match. Moreover, when there is a large difference in skill, adopting a universal formation can be useful to save the physical wear of the blocker for more important matches.

Conclusions

In conclusion, the competition phase seems to moderate increase the temporal indicators (total work time, total rest time, duration of the set), but the effort : pause ratio is not strongly altered. Regarding the physical aspects, blockers are more physically demanded than defenders. This is due to the greater number of jumps for a specific action (block). Moreover, players in this role still move a relatively long distance whenever they need to serve. This information is useful because it provides parameters for decision making by coaches. In this sense, using the data more specific training for female beach volleyball athletes (U-21) can be prescribed. Besides, coaches and teams should consider using universal formations in matches with an unbalanced technical level, as well as forcing the blocker to attack to gain some advantage at the end of the match due to fatigue.

Conflicts of interest

The authors report no conflicts of interest.

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