

Active and non-active time during elite men and women Sitting Volleyball matches

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Abstract

This paper aims to determine and sort the rally and break-time duration (including the rest time) in elite men's and women's Sitting Volleyball matches. The sample of study comprises 9195 rallies were retrieved from 68 (34 men and 34 women) Sitting Volleyball matches (corresponding to 224 sets) of the 2019 European Sitting Volleyball championship which monitored and recorded. Inter-rater and intra-rater reliability coefficients were estimated using Cohen's kappa coefficient. The results of the study showed that the total average attempts in the block of serve, setting, attack, block and defence are higher in men compared to women ($p \leq .001$). Also, the duration of the rally was longer in men, 5.98s, compared to 4.98s of women ($p \leq .001$). The non-parametric Kruskal-Wallis test demonstrated that in both genders the highest average rally length was recorded in the 5th set (7.42s for men and 5.4s for women, respectively) and in the 3rd period of that set for men (6.22s) and the 1st period for women (5.06s). For both genders, the highest average break-times were recorded in the 5th set (28.23s for men and 27.73s for women) and, in particular, the 3rd period of that set (23.75s for men and 25.14s for women). According to the study result, one of the reasons contributing to the higher rally length in men's matches is the higher number of attempts for all Sitting Volleyball skills that men performed comparing to women. The results of this study can be used by players, coaching staff, teams and federations for the organization, design, planning and managing of workouts and matches.

Key Words: Sitting Volleyball, Active time, Non-active time.

Introduction

Sitting Volleyball (SV) is one of the most impressive sports for athletes with disabilities due to its fast attack and defence. It requires fast-moving on the floor using the hands, which needs a great amount of strength in the upper body and it is commonly considered an effective rehabilitation intervention (Silva, 2013), as well as a successful reintegration practice for people with physical disabilities (Wieczorek et al., 2007; D'Isanto, 2020). As for SV athletes, on the basis of achieved research results, it was concluded that the morphological-motor relation of SV players suits the morphological-motor relation of Volleyball players (Bratovčić et al., 2017). The SV regulations are an amendment to those of Volleyball (Molik et al., 2017). In terms of the number of players, it is the same as that of Volleyball. Each team consists of six players, who compete with their opponents on a smaller field (10m × 6m) using a lower net (1.15m for men and 1.05m for women) comparing to Volleyball. The smaller dimensions of the court make SV faster than Volleyball, demanding physical condition and rapid decision making (Silva, 2013). The active time between the serve and the end of the play is called a "rally" and in Volleyball usually lasts from 7 to 10 seconds (Sánchez-Moreno et al., 2015). Researchers in different sports (Andrzejewski et al., 2012; Ben Abdelkrim et al., 2010) attempted to assess appropriate match loads by measuring the time of rallies and intervals between rallies, types of actions, and so on. In general, rally length is considered an indicator of performance that contributes to the success or improved performance in net and wall games (Hughes & Bartlett, 2002). The sum of the rallies' duration comprises the total active time of the match. The sum of the rest time (the time between subsequent rallies), the coach time outs, the time to change court sides between sets and the time to change players comprise the non-active time of a match. Besides the actual duration of the active and non-active time, it is of particular interest the active to non-active time ratio, which indicates the influence that the structure of the game imposes on the physical burden of the players (Vescovi, 2002).

During a rally, the technical skills that can take place are serve, block of serve (only in SV), reception, setting, attack, block and defence. These actions are usually grouped into game complexes (Ks) so that the structure and dynamics of the game can be understood more easily (Rodriguez-Ruiz et al., 2011). More specifically, each type of complex differs from the others based primarily on the initial defensive action (Hileno & Buscà, 2012). Complex I (KI), for instance, starts with the block of serve and continues with the reception, the set and the attack. Complex II (KII) starts with the serve and continues with block, defence, setting and counterattack (Hileno et al., 2020) and Complex III (KIII) is the continuation of the other two complexes.

In Beach or indoor Volleyball, the profile of the active and non-active time as well as their ratio are recognized as effective indices of the Volleyball match structure (Sánchez-Moreno et al., 2016; Vescovi, 2002), the players' physical and psychological burden (Ferreira, et al, 2014) and the level of competition (Ferreira et al., 2014; Medeiros et al., 2014). Furthermore, the active and non-active time, as well as their ratio, are associated with the players' gender. Moreover, Beach and indoor Volleyball showed evidence of different technical and tactical characteristics as well as sex-specific differences in anthropometric and physiological parameters that may affect the rally length (João et al., 2010). The fact that women produce less power in the spike (Bishop et al., 1987) could result in numerous consecutive exchanges of the ball between the two teams and promote higher continuity in attack and defence. In specific, in the 2018-2019 Volley Nations League (VNL) indoor Volleyball tournament, a shorter active time was recorded for men (5.65s) than women (7.13s) while no data was provided about the non-active time (F.I.V.B., 2019). On the contrary, in Beach Volleyball matches, Palao et al. (2014, 2015) reported longer active time in men's game (active time = 7.26s, non-active time = 20.08s, 1:4.6 ratio, 84 matches) than women's (active time = 6.46s, non-active time = 22.69s, 1:5 ratio, 43 matches).

The existing literature highlights the importance of the active and non-active time profile for a successful Volleyball performance as well as their gender differentiation (F.I.V.B., 2019; Ferreira et al., 2014; Medeiros et al., 2014; J.M. Palao et al., 2014; José Manuel Palao et al., 2015). Nevertheless, the relevant information about SV appears rather limited (Molik et al., 2017). Thus, the purpose of the study is to provide reference data for the active and non-active time in elite men and women SV matches.

Materials & methods

Data collection

A systematic observation (Anguera, 2013) was applied for the analysis of 34 men and 34 women SV matches using the official video recordings of the 2019 European Sitting Volleyball Championship. Nine thousand, one hundred and ninety-five rallies (N=9195) were retrieved from 68 matches (corresponding to 224 sets – 112 sets per gender). The number of all attempts of SV skills (serve, block of serve, reception, setting, attack, block, defence) per match was recorded. The analysis aimed to determine the duration of the active and non-active time incidents in each set and each set period of the match. Winning a SV match (as also in Volleyball) presupposes the win of 3 sets (25 points each set, provided a 2-point difference in each set). A maximum of 5 sets is allowed with the 5th set having a winning limit of 15 points (provided a 2-point difference). Every set is divided into 3 sections that are called “periods”. In the initial 4 sets, the periods are defined as following: 1st period = 1st – 10th point, 2nd period = 11th – 20th point, 3rd period = 21st - last point of the set. Concerning the 5th set, the periods are defined as following: 1st period = 1st – 5th point, 2nd period = 6th – 10th point, 3rd period = 11th - last point of the set. The active time (rally duration) and non-active time (sum of time: between subsequent rallies, coach time outs, court change and player change) were determined per set, per set period and total match (Sánchez-Moreno et al., 2016). Also, the ratio between active and non-active time was calculated.

All videos were analyzed by two experienced and trained observers. The reliability of the observations was assured by the inter-observer and intra-observer agreement within a 15-day interval. Ten per cent (10%) of the total observations were analysed, according to the minimum value given in the literature (Tabachnick & Fidell, 2007). Inter-rater and intra-rater reliability coefficients were estimated using Cohen's kappa coefficient. The coefficient was 0.88 for inter-rater and 0.91 for intra-rater reliability, indicating very high consistency in the assessment procedure.

Statistical analysis

A descriptive analysis was carried out separately in men and women. According to the Kolmogorov - Smirnov criterion, the mean values did not follow a normal distribution while Levene's test indicated standard deviation heterogeneity. Thus, a non-parametric comparison was applied for skill attempts and match total time differences using the Mann-Whitney U test and for the set and set period differences, using the Kruskal-Wallis criterion, followed with post hoc pairwise comparisons when the chi-squared (χ^2) indicated a statistical significance (Katz & McSweeney, 1980). The SPSS 25.0 was used for all analyses and the level of significance was set at $p < 0.05$.

Results

Table 1 presents the overall skills' attempts per match for both genders. The total serves and receptions attempts were more in men (138.03 and 108.97, for serve and reception, respectively) than women (132.50 and 105.97 for serve and reception, respectively), but with no statistical difference ($z = -1.375$, $p = .169$ and $z = -.227$, $p = .820$ for serve and reception, respectively). In contrast, for the other skills, men performed a statistically higher number of attempts per match compared to women. More specifically, men attempted for the block of serve 18.26 vs 11.44 times for women ($z = -4.102$, $p \leq .001$), men set the ball for 163.19 attempts vs 108.88 for women ($z = -4.367$, $p \leq .001$), men performed 205.26 attacking attempts vs 137.97 for women ($z = -4.220$, $p \leq .001$), men blocked the attack for 89.27 attempts vs 47.71 for women ($z = -5.613$, $p \leq .001$) and attempted for defence 149.00 vs 105.06 times for women ($z = -3.515$, $p \leq .001$).

Table 2 presents the match statistics for each pair of the men's and women's teams. The total match duration was longer in men (67.69min) than in women (62.19min) but with no statistical difference ($t_{66}=1.052$, $p=.297$). Figure 1 presents the mean active time in men's matches being 13.75min, which was significantly longer than 10.99min in women's matches ($z=-3.097$, $p=.002$). The mean non-active time in men's matches was 53.94min, which was not significantly longer than 51.93min in women's matches ($z=.448$, $p=.654$). However, the percentage of mean active and non-active time in men's matches was 20.38% and 79.62%, which was significantly higher than 17.59% and 82.41%, respectively in women's matches ($z=-4.845$, $p\leq.001$). The overall ratio of active/non-active time was 1:3.96 for men, which was significantly lower than 1:4.75 for women ($z=-4.845$, $p\leq.001$).

Table 1. Overall skills statistics for the men and the women SV matches during the 2019 European Sitting Volleyball Championship

Skills variables	Men		Women	
	Mean	Sd	Mean	Sd
Serve	138.03	29.83	132.50	29.29
Block of Serve	18.26	7.92	11.44	3.26
Reception	108.97	29.11	105.97	24.36
Setting	163.19	58.17	108.88	33.11
Attack	205.26	65.92	137.97	40.79
Block	89.27	32.09	47.71	18.04
Defence	149.00	53.39	105.06	32.00

Table 2. Overall game statistics for the men and the women SV matches during the 2019 European Sitting Volleyball Championship

Game variables	Men		Women	
	Mean	Sd	Mean	Sd
Match duration(min)	67.69	20.37	62.91	16.85
Active time (min)	13.75	4.11	10.99	2.75
Non-active time (min)	53.94	16.56	51.93	14.40
Active time (%)	20.38	2.06	17.59	1.87
Non-active time (%)	79.62	2.06	82.41	1.87
Ratio Active/Non- active	3.96	0.50	4.75	0.62

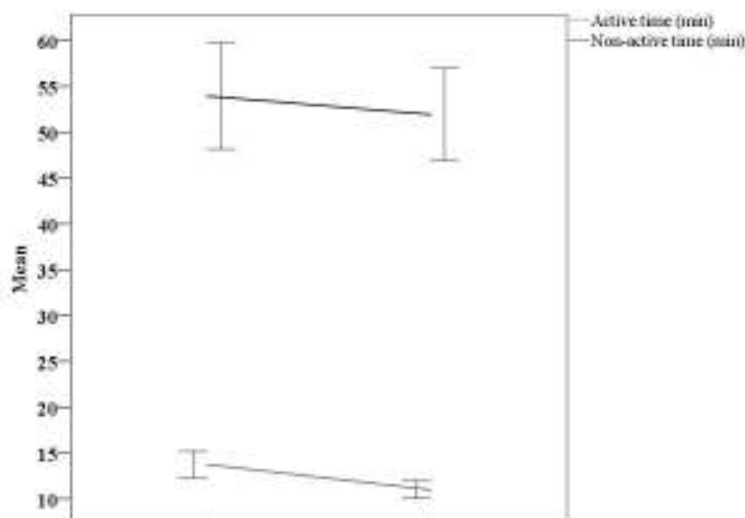


Figure 1. Mean rally length and error bars 95% C.I. of active and non-active time in the men and the women SV matches during the 2019 European Sitting Volleyball Championship.

Table 3 presents the count (N) and Figure 2 Figure 3 present the mean (Sd) of the active and the non-active time incidents in each set and each set period for the men's and women's matches. Concerning each set for men and women, the longest active and non-active times were both observed in the 5th set. The Kruskal Wallis test indicated a significant set difference in the active time ($\chi^2=12.107$, $p=.017$) and the non-active time

of men ($\chi^2=95.493, p\leq.001$). The posthoc comparisons concerning active time yield pairwise statistical differences for the 4th set comparing to the 1st and 2nd set ($p\leq.001$, for both comparisons), and concerning non-active time yield pairwise statistical differences between all the sets ($p\leq.001$) except between 2nd and 3rd set.

Table 3. Count (N) and mean (SD) of active and non-active time in men and women SV matches. Chi-squared (χ^2) indicates the significance of the set and period differences.

	MEN				WOMEN			
	Active		Non-active		Active		Non-active	
	N	Mean (Sd)	N	Mean (Sd)	N	Mean(Sd)	N	Mean (Sd)
Overall	4691	5.98 (4.4)	4652	23.64 (29.3)	4504	4.98 (3.5)	4470	23.70(30.01)
SETS								
1	1423	5.89 (4.4)	1420	23.84 (34.1)	1356	5.13 (3.6)	1356	24.54 (33.9)
2	1427	5.96 (4.4)	1426	25.00 (33.0)	1352	4.96(3.5)	1352	25.29 (35.5)
3	1425	5.91 (4.3)	1398	27.76 (20.7)	1407	4.85 (3.5)	1380	21.20 (20.4)
4	361	6.47 (4.5)	355	24.14 (20.8)	312	4.88 (3.4)	308	23.24 (23.0)
5	55	7.42 (5.6)	53	28.23 (20.2)	77	5.40 (3.8)	74	27.73 (22.5)
χ^2	12.107		95.493		5.645		35.052	
Sig.	.017		$\leq.001$.227		$\leq.001$	
Sets Pairwise comparisons	1 st -4 th		1 st -2 nd		1 st -4 th		1 st -4 th	
	2 nd -4 th		1 st -3 rd		1 st -5 th		1 st -5 th	
			1 st -4 th		2 nd -4 th		2 nd -4 th	
			1 st -5 th		2 nd -5 th		2 nd -5 th	
			2 nd -4 th		3 rd -4 th		3 rd -4 th	
			2 nd -5 th		3 rd -5 th		3 rd -5 th	
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			3 rd -5 th					
PERIODS								
1	1824	6.01 (4.3)	1808	23.50 (27.9)	1843	5.06 (3.6)	1828	23.19 (28.3)
2	2040	5.85 (4.3)	2026	23.74 (31.2)	1864	4.87 (3.5)	1812	23.58 (28.8)
3	826	6.22 (4.8)	760	23.75 (27.2)	750	5.05 (3.6)	719	25.14 (36.3)
χ^2	3.120		4.921		4.066		1.963	
Sig.	.210		.085		.131		.375	

Regarding women, the Kruskal Wallis test indicated a significant test difference only in non-active time ($\chi^2=35.052, p\leq.001$), while the post-hoc comparisons yield pairwise statistical differences ($p\leq.001$, for all comparisons) for all the pairs formed by the first three sets of a match (1st, 2nd, 3rd) and the last two (4th, 5th).

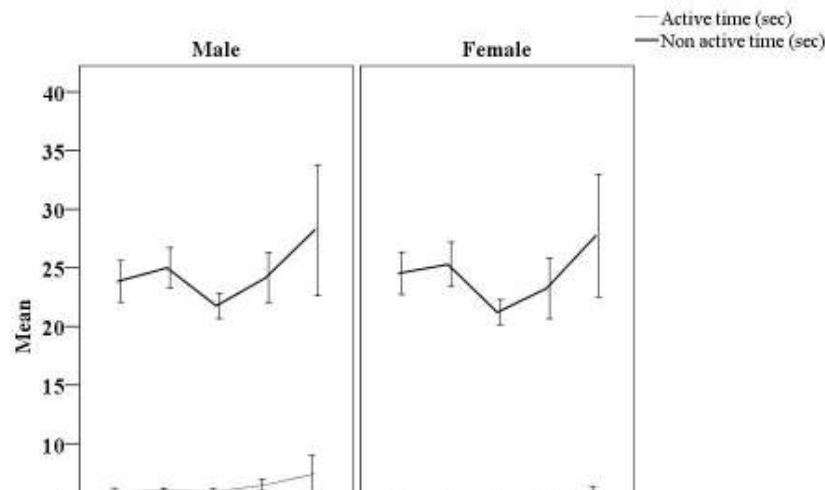


Figure 2. Mean rally length and error bars 95% C.I. of active and non-active time in the men and the women SV sets during the 2019 European Sitting Volleyball Championship.

About the set periods, for both men and women, the longest active and the longest non-active time were observed in the 3rd period. The Kruskal Wallis test indicated no significant difference in the non-active time for both genders ($\chi^2=4.921$, $p=.085$ and $\chi^2=1.963$, $p=.375$ for men and women, respectively) and for the active time ($\chi^2=3.120$, $p=.210$ and $\chi^2=4.066$, $p=.131$, for men and women, respectively)

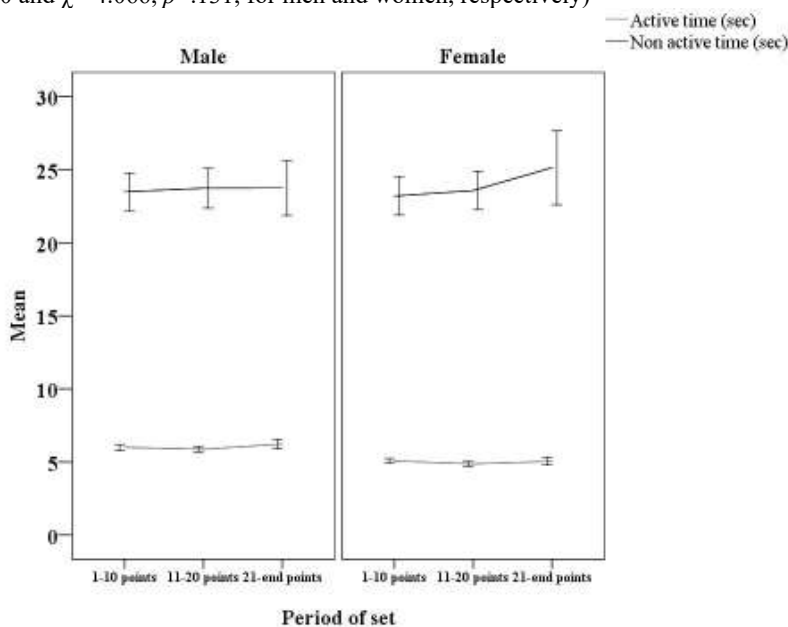


Figure 3. Mean rally length and error bars 95% C.I. of active and non-active time in the men and the women SV sets during the 2019 European Sitting Volleyball Championship.

Discussion

The purpose of this study was to analyze the duration of the active and non-active time in elite men and women SV matches. The rationale of the study was to provide reference data as the relevant information about SV is rather limited, although these indices have been extensively analyzed in Volleyball.

Active time. The men's and women's active time in the present study is within the values reported in previous indoor (F.I.V.B., 2019; Mroczek et al., 2014; Sánchez-Moreno et al., 2015) or Beach Volleyball studies (Medeiros et al., 2014; J.M. Palao et al., 2014; José Manuel Palao et al., 2015). Sánchez-Moreno et al. (2015) classified the rally duration as short (<6s), medium (6-10s) and long (>10s). Thus, the active time of men's (5.98s) and women's game (4.98s) could be classified as short. Previous studies in Volleyball reported shorter active times in men than in women (F.I.V.B., 2019), which is in contrast with the shorter active time in women than men found in the present study. In specific, for indoor Volleyball, shorter active times were found for men than for women in the 2016-2017 championships (5.73s and 6.86s, respectively) (F.I.V.B., 2019). Shorter active time in men's than in women's game are also found in Beach Volleyball (6s and 8s, respectively) (Medeiros et al., 2014). Nevertheless, there are Beach Volleyball studies that report longer active time for men (7.26s) than for women (5.5s) (J.M. Palao et al., 2014; José Manuel Palao et al., 2015). In SV, this study found that men performed a higher number of game actions in all SV skills than their women counterparts and, consequently, the active time was greater for men compared to women. Possibly, this may be attributed to the men's anthropometric locomotion advantage since they are taller, heavier, leaner and had greater standing reach height, speed, agility, muscular power and estimated maximal aerobic power than female players (Gabbett & Georgieff, 2007). Also, studies have shown that men have greater strength than women in their upper body (Bishop et al., 1987; Majstorovic et al., 2020). Thus, the greater stature and longer limbs advantage may be lessened either due to the form of locomotion (Sitting Volleyball) or due to the surface characteristics (Beach Volleyball).

The greater active time was noted in the 5th set for both men (7.42s) and women (5.40s). Given the fact that a 5th set was played only in 5 out of the 34 men and the 34 women matches, the longest duration of the 5th set could be associated with its critical importance for the outcome of the match (Sánchez-Moreno et al., 2015). It appears that, despite the inevitable physical and psychological fatigue, the players enhance their efforts to avoid losing the game. Sánchez-Moreno et al. (2015) found that winning a long than a short rally in initial sets increased the likelihood of winning the subsequent rally. Thus, long rallies could be considered a critical incident of the game. Sánchez-Moreno et al. (2015) showed that a longer active time length implies an increased likelihood of losing the point by the team on the side-out phase. The influence of active time length on winning a point appears to depend on the set order. Sánchez-Moreno et al. (2015) explain that it is important to take some risks in trying to win the first set and highlight the need to manage the degree of risk in the final sets. In agreement with Sanchez-Moreno (2015), the set period did not present any significant influence on active time length. A possible reason might be that the teams of the sample, composed of high-level athletes, do not vary

their style of play based on the importance of the set for the match result. Thus, the active time length seems to follow similar patterns regardless of the set period.

Non-active time. Concerning the non-active time, the highest values were recorded in the 5th set in both genders' matches. Taken into consideration that the 5th set was played only in two men matches and only in three of the women matches, their longer non-active time could be associated with the generation of tactical delays. In the latest sets, the greater difficulty for winning a point is expected due to the physical exhaustion of the players or due to an increase in the adaptation to the opponent's game style and patterns. Additionally, in men matches the 3rd set of the match, which is the last in 26 of the 34 matches under study, confirmed the trend of extending rest time in final sets. Thus, in line with Medeiros et al. (2014) some tactical delays could be intentionally generated in the final sets (e.g. by wiping the court, taking a time-out) in an attempt to gain some rest time or to break the pace of the opposing team. Such tactical delays may also explain the significant elongation of the non-active time in the 3rd period compared to the 1st and 2nd period, but also for the 2nd period comparing to the 1st one, for both genders.

Ratio of active vs non-active time. The active vs non-active time ratio provides information that could be incorporated in training planning so that training sessions include non-active times that best simulate the situation of an actual match, particularly concerning the gender specificities in the active vs non-active time ratios. The 1:4 men's ratio of the present study is similar to the ratio in men's Beach Volleyball (Medeiros et al., 2014; J.M. Palao et al., 2014). The 1:5 of the women's ratio is higher than the 1:2 ratio in women's indoor Volleyball (Vescovi, 2002) and similar to the 1:5 ratio for women Beach Volleyball (José Manuel Palao et al., 2015). The greater active vs non-active time ratio in women than men most likely highlight the gender differences in the physical demands due to the different game structure of SV compared to Volleyball. Palao et al. (2015) show that female players increase the rest time between subsequent rallies more than senior male players. As commented by Medeiros et al., (2014), who studied Under-21 and Under-18 male Beach Volleyball players, the senior players appeared to succeed in generating more rest time between subsequent rallies (i.e. most likely using their towels to clean off, to wipe off their sunglasses, etc.). Thus, as the rules for interruption of the play are the same in men's and women's Volleyball, the present results most likely show that female players may intentionally increase their non-active time to meet the physical demands of the game.

Conclusions

In conclusion, the present study showed that in elite men and women SV the active and non-active times are within the range reported in previous studies for men and women indoor and Beach Volleyball matches. The important finding of the study is, that compared to Volleyball, there is a gender reversal regarding the distribution of active and non-active time. In specific, in SV longer active time was found for men than women, while the opposite is observed for Volleyball. Moreover, men had a way higher number of attempts for setting, attack, block of serve or of attack and defence performed comparing to women.

A finding worth noting is also that the set period does not influence the non-active time in both men's and women's matches. To the best of our knowledge, this is the first study providing data regarding the active and non-active time for both elite men and women SV players, as the study of Molik et al. (2017) reported only for men. These data may be used as reference values for coaches, strength and conditioning trainers and researchers to plan their practices and to better understand the differences between a Sitting and a Volleyball game. Training should be adapted to the variable intensity of work and the relevance of long rallies should be considered as mentioned in the study of Sánchez-Moreno et al. (2015). Overall, the gender differences may help players, coaching staff, teams and federations in organizing, designing and managing the active and non-active time distribution in workouts and matches.

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Conflicts of interest: No conflict of interest

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