

A spatiotemporal analysis of gender differences in volleyball attack coverage complex

M. LAMPROGEORGOU¹, K. SOTIROPOULOS², S. DRIKOS³, K. BARZOUKA⁴

^{1, 2, 3, 4} School of Physical Education and Sport Science, National and Kapodistrian University of Athens, GREECE

Published online: December 30, 2024

Accepted for publication: December 15, 2024

DOI:10.7752/jpes.2024.12315

Abstract

While volleyball consists of six fundamental action complexes (K0-KV), most research has primarily focused on complexes I and II, often incorporating elements from other complexes. This focus can result in the oversight of specific actions in the less-studied complexes. Setting, a crucial skill in volleyball, is particularly under-researched, especially in relation to the attack coverage complex (KIV). This study aimed to analyse the types and spatiotemporal characteristics of setting actions within KIV, identify the most common and effective setting techniques, explore potential gender differences in setting performance, and assess the impact of setting quality on attack performance. The study sample included 48 matches (24 male, 24 female) from the 2022 World Championships. A total of 762 setting actions were recorded and analysed. Intra- and inter-rater reliability, assessed using Cohen's Kappa coefficient, was excellent (0.92 and 0.89, respectively). Descriptive statistics and chi-square tests were employed to analyse the data. Statistical significance was set at $p < 0.05$, and data analysis was performed using SPSS v.29 and Statgraphics v5.1. The findings revealed that the overhead setting with a jump towards zones 2 and 4 was the predominant setting type observed. Additionally, setters exhibited a higher propensity for perfect sets to zones 3 and 4. Notably, male setters tended to utilise faster setting tempos to these zones, which correlated with a higher percentage of perfect sets than female setters. The overall ratio of excellent sets was significantly higher for male athletes (16.8%) than for female athletes (6.5%). This disparity was reflected in attack success rates, with male attackers converting 40.5% of attacks compared to 28.8% for female attackers. This study provides valuable insights into the nuances of setting within the attack coverage complex. By focusing on this understudied area, the research contributes to a more comprehensive understanding of volleyball performance and offers practical implications for coaches and athletes. Future research may explore the impact of different setting techniques on specific attacking strategies and the role of advanced statistical analysis in evaluating setting performance.

Key Words: match analysis, elite level, KIV, defensive organization, attack performance

Introduction

Volleyball is one of the most popular sports in the world. According to FIVB (Fédération Internationale de Volleyball), over 800 million people play volleyball worldwide. Volleyball is a high-intensity interval sport, characterized by multiple short action periods with intense movements, separated by brief rest and recovery periods (Vujmilović & Karalić, 2013). These active and non-active times are called game episodes and breaks. The structure of the game and the constant changes between defence and offence led researchers and coaches to distinguish them into different phases, called complexes. This distinction helped them to facilitate a more in-depth analysis of the game.

Initially, the game was divided into two complexes: KI (side-out), where teams aim to win the serve, and KII (side-out transition), where teams aim to keep the serve (Valladares et al., 2016). In 1998, the point system changed, resulting in a new distinction in six primary complexes (K0-KV). K0 or serve can be identified as a separate complex, despite having only one action, because it can result in a point for the serving team, KI or side-out is the complex in which players can attack in faster tempos and win more points for their team (Palao et al., 2007). KII, or side-out transition, is the answer to KI and is known as a defensive complex (Afonso et al., 2005). KIII or transition, is similar to KII, although there are some differences regarding the setting conditions, attacking zones, and attack tempo (Laporta et al., 2021). KIV, or attack coverage, is characterised by the attacking reorganisation of the team after a blocked spike. KV or freeball and downball, includes all the situations in which the opponent team cannot perform an attack (Hurst et al., 2016; Loureiro et al., 2017). Some recent research also added a seventh complex called KU or undefined complex, which includes all those phases that can't be categorised into any of the other complexes (Hileno et al., 2020).

KIV is characterised by the attack coverage and the attacking retraining of the team when the ball, after the attack comes back to the attackers' side following contact with the opposite block. The most common

systems of attack coverage are 2-3-0 and 3-2-0, while recent research showed that structuring the coverage in three defensive lines can be more effective. For that reason, systems 1-3-1 and 2-2-1 are commonly used to cover attacks, especially from zones 2 and 4 (Hileno et al., 2018). According to Hurst et al. (2017), in a study focused on the KIV, teams that successfully attack after attack coverage, usually attack at slower tempos from zone 4. In the same study, the researchers surprisingly found that the second most common attacking zone was zone 3. A study of the Estonian national championships found that attack coverage was more effective in women than in men. As a result, women had a longer playing time. Although women were more effective in attack coverage, men had a higher ratio of successful attacks following coverage (Stamm et al., 2016). Attack coverage (KIV) occurs in 3.8% of the men's games and 4.1% of women's games, with 28% of the attack coverage in men's games resulting in a winning point, compared to 23.5% in women's games (Laporta et al., 2015b, 2015a). According to Gasparatou et al. (2023), the incidence rates of the KIV were even lower, with attack coverage occurring in 2.3% of the men's games and 2.6% of women's games; in contrast, success rates were higher, with 31% of the attack coverage in men's game and 29.7% in women's resulting in a winning point. While these numerical differences may appear marginal, their significance is magnified in the context of high-level volleyball, where individual points can drastically influence the outcome of a match. Furthermore, existing research has established the counterattack phase as a critical determinant of match success, with teams demonstrating superior performance in this phase exhibiting a higher likelihood of victory (Đurković et al., 2009; Rentero et al., 2015).

During gameplay, a cyclical interplay of skills occurs, wherein one skill influences the subsequent one (Bergeles et al., 2009; Palao et al., 2004; Papadimitriou et al., 2004). Numerous studies have emphasised the impact of each skill on its successor (Bergeles et al., 2009). Specifically, the quality of the initial touch significantly affects the subsequent touch, and both collectively influence the third touch. Superior performance in the first touch is correlated with enhanced attacking performance in both male and female players (Afonso & Mesquita, 2011; Bergeles et al., 2009; Silva et al., 2013). A volleyball team's offensive strategy is contingent upon successful reception and defense. Setting, a skill that significantly influences subsequent actions, plays a pivotal role in determining match outcomes. The setter, responsible for approximately one-third of a team's ball contacts, is considered as a crucial player (Vujmilović & Karalić, 2013). Setters must be able to correct a poor first touch of the ball, either a serve reception, defence or even more an attack coverage, and turn it into an effective setting that will lead to a successful attack. They must also be able to perform the pass regardless of their position on the court. The setter is the one who decides what kind of setting is suitable for every game episode and, together with the coach, determines the defensive plan of the team. Choosing the right direction and type of the setting depends on some factors. These factors are: a) where is the weak point of the opponent's block, b) in which zone are the most influential attackers, c) what type of setting every attacker prefers, and d) how can the best attacker attack against the least effective block (Stork, 1992). One of the factors that influence a team's offensive plan is reception. Reception is the starting point for every offensive strategy. A successful reception helps the team to develop its tactics fully. On the other hand, a poor reception automatically gives the advantage to the opponent, as the quality of the setting and the setter's options are reduced. Studies have shown that in both genders the higher the performance of the first touch, the higher the performance of the attack (Bergeles et al., 2009). Also, the quality of the setting depends on the setting zone on the court and the technique used by the setter (González-Silva et al., 2016). Research that studied the Men's Greek Volleyball League showed that setters use overhead setting with a jump after a successful reception. That type of pass increases their options, confuses the opposing block, and helps teams maintain a faster attack tempo. Also, they found that the most preferred attack tempos were the first and second tempos (Palao & Ahrabi-Fard, 2014; Papadimitriou et al., 2004). Attack tempo is defined by the time difference between the set and the attack hit. After a good reception, setters used quick attacking tempos; after a poor reception, they mostly used third-tempo attacks. This study also showed that setters could correct poor receptions, as most of their passes were successful (Papadimitriou et al., 2004; Sotiropoulos et al., 2019). In high-level volleyball, teams use all lengths of the net to attack and they attack at different tempos, reducing the predictability of their game (Ramos et al., 2017).

Many studies have focused on analysing the skill of setting because of its importance in the game (González-Silva et al., 2016; Palao et al., 2004). Many of these studies have tried to find potential differences between men and women (Sotiropoulos et al., 2019; Tsavdaroglou et al., 2018). In sports like volleyball, the reasons for differences between genders are the structure of the game, the technique and tactic used, the player's strength, and their anthropometric and psychological characteristics (Palao et al., 2004).

While the skill of setting has been extensively researched, the specific focus on the complex nature of attack coverage remains relatively limited. Most studies concentrate on KI and KII, often incorporating K0, KIII, KIV, and KV within KII, leading to a potential neglect of certain specific information. A comprehensive analysis of a volleyball game necessitates consideration of all complexes to fully understand its intricacies. Despite their lower occurrence, studying and analyzing lower-level complexes can significantly contribute to a team's success. This study aimed to investigate potential gender differences in setting performance for high-level volleyball players, specifically examining the setting type and spatiotemporal characteristics within KIV. The research also sought to explore the impact of setting on attack effectiveness. The hypothesis was that analyzing the spatiotemporal characteristics of the setting during KIV would reveal gender-based differences in offensive play.

Material & methods*Data collection*

Forty-eight games (24 male-24 female) from the World Championships 2022 were analysed. Fifteen female teams and sixteen male teams took part in the research, and the games that were studied were from the finals, semifinals, quarterfinals, and the phase of 16, as well as selected games from the pool phase, but only from the teams that advanced through the later stages of the tournament. A total of N=762 phases were analysed. Three hundred eighty-seven (N=387) phases were from male teams, and three hundred seventy-five (N=375) were from female teams.

The 5-point rating scale of Eom and Schutz (1992) was used to evaluate every skill. This rating scale evaluates the effectiveness of the performance of every skill within a point range from 0 to 4. Each incorrect action was given a score of 0, a bad/poor action a score of 1, an average action a score of 2, a good action a score of 3, and an excellent/perfect action a score of 4. Two experienced and trained observers, ex-volleyball players and MSc students, analysed all the videos. The inter-observer and intra-observer reliability were assured by a test-retest procedure within a 15-day interval, on 10% of the games, which aligns with the minimum value recommended in the literature (Tabachnick et al., 2019). The researcher's intra and inter-observer reliability was evaluated using Cohen's Kappa index, which showed values of 0.92 and 0.89 respectively. All data were collected by systemic observation. The observers categorised the setting type according to four different setting types. Those were the forearm pass, the overhead pass, the overhead pass with a jump, and the emergence (EMR) situations. They also observed and categorised the direction of the set, according to zones of the volleyball court 1-6, and the setting tempo, according to categories: 1st tempo, 2nd fast tempo, 2nd slow tempo, and 3rd tempo. In the 1st tempo or quick attack, the attacker jumps while the setter touches the ball. In the 2nd fast tempo, the attacker starts their move as soon as the ball leaves the setter's hands. In the 2nd slow tempo, the attacker begins their approach when the ball is halfway up to its trajectory. In the 3rd tempo, the attacker starts their approach when the ball reaches its highest trajectory point (Michalopoulos et al., 2020).

Statistical analysis

Descriptive statistics and inferential analysis with the chi-square(χ^2) test were used to analyse the variables and examine their relationship. The statistical analysis used was the chi-square test of independence between "setting performance" and "gender" for each category and the total spatiotemporal variables of the skills in KIV. Fisher's exact test was used for expected values less than five. The cross-tabulation method was used to calculate the proportions and frequencies. Furthermore, a pairwise comparison between genders was conducted for each level of setting performance. To statistically compare the proportions, a z-test for the equality of proportions was conducted under the assumption of normality. The effect size index Cramer's V was computed to assess the magnitude of the association between the variables. Values of 0.1, 0.3, and 0.5 indicate small, medium, and large effect sizes, respectively (Cohen, 1988). SPSS v.29 and Statgraphics v.5.1 were used for all analyses. The significance level was set at $p < 0.05$.

Results

Table 1 presents the setting performance according to setting type. There were, in total 762 settings in KV. Three hundred eighty-seven (387) of them were carried by women and three hundred seventy-five (375) by men. Most settings were carried out using an overhead pass with a jump (339) or an overhead pass (271). Regardless of the setting type, 16.8% of the men's and 6.5% of the women's settings were excellent. In male teams, there were 375 settings in KIV. One hundred ninety-two (192) of them were made by jumping. Of the total number of settings found in men's teams, 61.3% were classified as average. There were 387 settings in female teams, with the majority being an overhead pass (150). Most of the women's settings were average (70.5%). The analysis showed a statistically significant difference between genders and setting performance in the two most common setting types. Regardless of the setting type, men were more qualitative and presented more frequent perfect settings than women, but they also made more frequent errors ($z=4.44$, $p<0.001$ and $z=2.12$, $p=0.03$). On the other hand, the women had bad and average settings more often ($z=-1.92$, $p=0.05$ and $z=2.12$, $p=0.007$). Specifically, men had better settings using overhead passes ($z=2.70$, $p=0.007$). In addition, when setters used overhead passes, men had more frequent perfect ones ($z=2.31$, $p=0.02$), while women had more frequent good ones ($z=-2.18$, $p=0.03$). Cramer's V was used to determine effect size, showing a value of 0.194, which represents a moderate effect.

Table 1.**Setting performance of men and women in relation to setting type in KIV**

Setting type	Gender	Setting performance					Sum (N)	χ^2 Value sig.
		0	1	2	3	4		
		%(N)	%(N)	%(N)	%(N)	%(N)		
Forearm pass	M		8.9(4)	75.6(34)	6.7(3)	8.9(4)	45	6.657
	W		19.4(12)	77.4(48)	1.6(1)	1.6(1)	62	.075
	<i>z</i>		-1.50	-0.22	1.37	1.77		
	<i>p</i>	ns	ns	ns	ns	ns		
Overhead	M	1.7(2)	5.0(6)	82.6(100)	4.1(5)	6.6(8)	121	10.750

pass	W	0.0(0)	7.3(11)	86.0(129)	6.0(9)	0.7(1)	150	.020
	z		-0.78	-0.77	-0.70	2.70		
	p	ns	ns	ns	ns	0.007		
Overhead	M	2.1(4)	1.6(3)	50.0(96)	20.3(39)	26.0(50)	192	10.013
pass with	W	0.0(0)	0.7(1)	61.9(91)	21.8(32)	15.6(23)	147	.031
jump	z		0.75	-2.18	-0.34	2.31		
	p	ns	ns	0.03	ns	0.02		
EMR	M	5.9(1)	88.2(15)	0.0(0)	0.0(0)	5.9(1)	17	5.649
	W	3.6(1)	75.0(21)	17.9(5)	3.6(1)	0.0(0)	28	.205
	z	0.36	1.07					
	p	ns	ns	ns	ns	ns		
Sum	M	1.9(7)	7.5(28)	61.3(230)	12.5(47)	16.8(63)	375	28.540
	W	0.3(1)	11.6(45)	70.5(274)	11.1(43)	6.5(25)	387	<.001
	z	2.12	-1.92	-2.68	0.60	4.44		
	p	0.03	0.05	0.007	ns	<0.001		

Note: M=men, W=women

Table 2 presents the performance of men and women in the setting according to the direction of the setting. One of the factors examined in KIV was the setting performance in relation to setting direction. Most settings for both genders were towards zones 4 (380) and 2 (165). Out of all settings in both genders, most were towards zone 4. Specifically, 177 men's and 203 women's settings were directed to the attackers of zone 4. The statistical analysis showed a significant difference between the setting performance of men and women and setting zones. Specifically, women presented more frequent average settings towards zone 1 ($z=-2.08$, $p=0.03$), while men presented more frequent excellent settings towards zone 2 ($z=2.84$, $p=0.004$). Also, there was a significant difference when setters directed the ball toward zone 3. Male teams had more frequent excellent settings ($z=2.46$, $p=0.01$) than females with more frequent average settings ($z=-2.09$, $p=0.03$).

Table 2.

Setting performance of men and women in relation to setting direction in KIV

Setting direction	Gender	Setting performance					Sum (N)	χ^2 Value sig.
		0	1	2	3	4		
		%(N)	%(N)	%(N)	%(N)	%(N)		
Z1	M		7.0(3)	60.5(26)	18.6(8)	14.0(6)	43	6.279
	W		8.8(3)	82.4(28)	5.9(2)	2.9(1)	34	.101
	z		-0.29	-2.08	1.64	1.68		
	p		ns	0.03	ns	ns		
Z2	M	1.2(1)	4.9(4)	58.0(47)	11.1(9)	24.7(20)	81	10.805
	W	0.0(0)	6.0(5)	64.3(54)	21.4(18)	8.3(7)	84	.018
	z		-0.31	-0.83	-1.79	2.84		
	p	ns	ns	ns	ns	0.004		
Z3	M	3.8(2)	13.5(7)	17.3(9)	19.2(10)	46.2(24)	52	11.749
	W	0.0(0)	28.9(11)	36.8(14)	13.2(5)	21.1(8)	38	.121
	z		-1.80	-2.09	0.75	2.46		
	p	ns	ns	0.03	ns	0.01		
Z4	M	1.1(2)	4.5(8)	82.5(146)	7.3(13)	4.5(8)	177	6.262
	W	0.0(0)	7.9(16)	84.2(171)	5.9(12)	2.0(4)	203	.165
	z		-1.35	-0.44	0.55	1.39		
	p	ns	ns	ns	ns	ns		
Z5	M		100.0(3)				3	
	W		100.0(3)				3	
	z							
	p		ns					
Z6	M	10.5(6)	15.8(3)	10.5(2)	36.8(7)	26.3(5)	19	3.253
	W	4.0(1)	28.0(7)	24.0(6)	24.0(6)	20.0(5)	25	.565
	z	0.85	-0.95	-1.15	0.92	0.49		
	p	ns	ns	ns	ns	ns		
Sum	M	1.9(7)	7.5(28)	61.3(230)	12.5(47)	16.8(63)	375	28.540
	W	0.3(1)	11.6(45)	70.5(273)	11.1(43)	6.5(25)	387	<.001
	z	2.12	-1.92	-2.68	0.6	4.44		
	p	0.03	0.05	0.007	ns	<0.001		

Note: M=men, W=women, Z=zone

Table 3 presents the setting performance of men and women according to the setting tempo. Most settings were on a second slow tempo (276) and third tempo (252). Specifically, men used a second slow tempo on 126 attacks, while women used the same tempo on 150. The analysis revealed a significant difference between the performance of men and women and the setting tempo. Specifically, when setters used a first tempo setting, women had average settings ($z=-1.96$, $p=0.05$) more often, while men had more frequent excellent

settings when they used a second fast tempo ($z=2.14$, $p=0.03$). Also, men had excellent settings more often than women when they used a second slow tempo ($z=2.14$, $p=0.03$).

Table 3.

Setting performance of men and women in relation to setting tempo in KIV

Setting tempo	Gender	Setting performance					Sum (N)	χ^2 Value sig.
		0	1	2	3	4		
		%(N)	%(N)	%(N)	%(N)	%(N)		
1 st tempo	M	2.3(1)	2.3(1)	14.0(6)	25.6(11)	55.8(24)	43	4.970
	W	0.0(0)	0.0(0)	34.8(8)	26.1(6)	39.1(9)	23	.290
	<i>z</i>			-1.96	-0.04	1.29		
	<i>p</i>	ns	ns	0.05	ns	ns		
2 nd fast tempo	M	2.2(2)	1.1(1)	41.3(38)	23.9(22)	31.5(29)	92	7.216
	W	0.0(0)	2.6(2)	47.4(36)	32.9(25)	17.1(13)	76	.125
	<i>z</i>		-0.73	-0.79	-1.29	2.14		
	<i>p</i>	ns	ns	ns	ns	0.03		
2 nd slow tempo	M	2.4(3)	10.3(13)	70.6(89)	9.5(12)	7.1(9)	126	9.606
	W	0.0(0)	14.0(21)	77.3(116)	6.7(10)	2.0(3)	150	.048
	<i>z</i>		-0.93	-1.27	0.85	2.07		
	<i>p</i>	ns	ns	ns	ns	0.03		
3 rd tempo	M	0.9(1)	11.4(13)	85.1(97)	1.8(2)	0.9(1)	114	2.268
	W	0.7(1)	15.9(22)	81.9(113)	1.4(2)	0.0(0)	138	.687
	<i>z</i>		-1.02	0.68	0.25			
	<i>p</i>	ns	ns	ns	ns	ns		
Sum	M	1.9(7)	7.5(28)	61.3(230)	12.5(47)	16.8(63)	375	28.540
	W	0.3(1)	11.6(45)	70.5(273)	11.1(43)	6.5(25)	387	<.001
	<i>z</i>	2.12	-1.92	-2.68	0.6	4.44		
	<i>p</i>	0.03	0.05	0.007	ns	<0.001		

Note: M=men, W=women

Table 4 presents the performance of the attack in both genders according to the setting performance. Most settings were average (503). Specifically, men had 273 average settings and women 230. The analysis revealed a significant difference between the attacking performance of men and women and the setting performance. Overall, men presented a statistically significantly higher proportion of excellent attacks ($p<0.001$) than women (40.5% vs 28.8%), regardless of setting performance. Specifically, when the setting was excellent, men had more frequent successful attacks ($z=2.11$, $p=0.03$), while women had more frequent lost attacks ($z=-2.80$, $p=0.005$). Also, when the second touch was average, men won more points than women ($z=1.98$, $p=0.05$), who presented average attacking actions ($z=-3.11$, $p=0.05$) more often. Cramer's V was used to determine effect size, showing a value of 0.159, which represents a moderate effect.

Table 4.

Attack performance of men and women in relation to setting performance in KIV

Setting performance	Gender	Attack performance					Sum (N)	χ^2 Value sig.
		0	1	2	3	4		
		%(N)	%(N)	%(N)	%(N)	%(N)		
1	M	3.6(1)	78.6(22)	10.7(3)		7.1(2)	28	1.594
	W	6.7(3)	84.4(38)	4.4(2)		4.4(2)	45	.661
	<i>z</i>	-0.56	-0.63	1.03		0.49		
	<i>p</i>	ns	ns	ns		ns		
2	M	16.5(38)	0.9(2)	28.7(66)	18.3(42)	35.7(82)	230	11.422
	W	15.8(43)	1.5(4)	42.1(115)	13.2(36)	27.5(75)	273	.022
	<i>z</i>	0.21	-0.60	-3.11	1.57	1.98		
	<i>p</i>	ns	ns	0.002	ns	0.05		
3	M	12.8(6)	0.0(0)	25.6(11)	23.4(8)	46.8(22)	47	2.583
	W	9.3(4)	2.3(1)	35.6(11)	9.3(4)	53.5(23)	43	.630
	<i>z</i>	0.53		-1.03	1.80	0.63		
	<i>p</i>	ns	ns	ns	ns	ns		
4	M	6.3(4)		17.5(11)	7.9(5)	68.3(43)	63	11.804
	W	28.0(7)		8.0(2)	20.0(5)	44.0(11)	25	.008
	<i>z</i>	-2.80		1.13	-1.61	2.11		
	<i>p</i>	0.005		ns	ns	0.03		
Sum	M	13.3(49)	6.5(24)	24.7(91)	14.9(55)	40.5(149)	368	19.009
	W	14.8(57)	11.1(43)	33.7(130)	11.7(45)	28.8(111)	386	<.001
	<i>z</i>	-0.60	-2.22	-2.71	1.30	3.38		
	<i>p</i>	ns	0.02	ns	ns	<0.001		

Note: M=men, W=women

Discussion

This study aimed to investigate potential gender-based differences in the performance of high-level volleyball setters, focusing on the types of sets performed and their spatiotemporal characteristics within Complex IV. Additionally, the research explored the relationship between setting performance and the effectiveness of subsequent attacks. The type of the set is one of the factors, along with the quality of the first touch, that plays a critical part in its quality (González-Silva et al., 2018). In attack coverage, the most common setting type was the overhead pass and the overhead pass with a jump. These findings corroborate previous research indicating that a well-executed first contact facilitates the implementation of overhead jump sets, which subsequently expand the setter's tactical options, disrupt the opposing team's blocking strategy, and accelerate the pace of play (Papadimitriou et al., 2004). The level of the teams that analysed in this study likely affected the most common type of touch. Higher-level teams use jump setting more frequently (Palao & Ahrabi-Fard, 2014) because it is the type of setting that decreases the ball's flight time (Buscà & Febrer, 2012). As a result, offensive play becomes faster, the opponent's reaction time decreases and teams can utilise all of their attack options (Palao & Ahrabi-Fard, 2014). Overhead passes, with or without a jump, are the type of setting that presents the highest number of perfect actions because they are the most reliable and effective form of setting, regardless of gender and skill level (González-Silva et al., 2018; Palao et al., 2009). Most settings in KIV were categorized as average, because of the unpredictable conditions during the first touch in the complex. The most common type of second touch in both genders was the overhead pass with a jump, with average settings prevailing in both men and women. There was only one significant difference between genders in setting performance according to the setting type. Men showed more frequent perfect passes with a jump, while women showed more frequent average actions.

Concerning the direction of the setting in KIV, this study showed that most settings were directed towards zone 4 and zone 2. These results align with previous research stating that in the counterattack phase, setters prefer to set the ball to zone 4 and the outside hitters or zone 2 and opposite hitters (Laporta et al., 2021). In addition, if the first touch is not good or perfect, setters give the ball to zone 4 (Grgantov et al., 2018). The same zones prevailed in both genders, as the difficulty during the first touch didn't allow setters to fully use all their attack options, especially the middle blockers from zone 3. The preference for outside hitters aligns with previous research (Sotiropoulos et al., 2019) that suggests outside hitters are the most influential attackers on the counterattack (Lima et al., 2021). Women's preference for zone 2 as the second most common option (Inkinen et al., 2014) is also confirmed. The fact that zones 4 and 2 are the most popular can be explained by the ability of outside and opposite hitters to attack effectively from both zones. Also, in women's games, attack from zone 2 from middle blockers using the one-leg approach is very common (Millán-Sánchez et al., 2017).

It is known that when male setters receive a perfect ball, they use all lengths of the net and exploit all of their attacking options (Sotiropoulos et al., 2019). This is not confirmed in the present study because of the difficulty of the first touch. As noted by Costa et al. (2012) and Loureiro et al. (2017), setters often receive suboptimal ball delivery during counterattacks. Specifically, subsequent to less-than-ideal ground-floor defensive performances, a majority of sets are categorised as average concerning their quality (Gonzalez-Silva et al., 2017). Gender disparities were observed in setting performance, contingent upon the specific setting direction. Males exhibited a higher frequency of successful sets to zones 2 and 3 compared to females. This discrepancy can be attributed to the faster rhythm of the offensive play, as a stable characteristic of male volleyball. The utilisation of fast attack tempos often catches opponent blockers off guard, particularly when attacks originate from zones adjacent to the setter (zones 2 and 3). This fast rhythm of the offensive play limits the reaction time of opposing blockers, hindering their ability to execute effective blocking attempts. In contrast, female volleyball tends to be more predictable in terms of attack patterns (Hurst et al., 2016). However, it should be noted that women try to reduce predictability by increasing their game speed and switching frequently between attacking tempos (Hurst et al., 2016). There were also some differences concerning the settings towards zone 1. Women had more average settings to zone 1 because they mostly used attacks from zone 1 as a safe option if their attack plan didn't work (Barzouka, 2018). Female opposite players playing in zone 1 received significantly lower quality settings in Complex I and Complex II compared to male players. Conversely, male players utilised attacks from Zone 1 as a core component of their offensive strategy (Barzouka, 2018).

In high-level men's teams, the performance and the type of the first touch are two factors that influence the setting tempo (Castro & Mesquita, 2010). This study found that the unpredictable nature of the first touch during attack coverage led setters to predominantly select slower-setting tempos, with second and third tempos being the most frequent choices for both genders. In complex I, teams can use faster tempos (Afonso et al., 2005; Palao et al., 2007), showing a higher percentage of attacking efficiency (Palao et al., 2004, 2007). In counterattacks, setters use slower tempos, especially second and third tempos (Loureiro et al., 2017). Using first-tempo attacks can significantly increase a team's chances of winning a point (Costa et al., 2011). In addition, researchers have highlighted that during practice, setters must work on choosing faster setting tempos and taking advantage of all of their attacking options (Ramos et al., 2017). According to previous studies, men attack at a faster tempo than women (Barzouka, 2018; Stamm et al., 2016), and they also tend to use more 1st tempo attacks than women, surprising the opponent's block, which doesn't have enough time to form, resulting in more attacks against no or single block (Stamm et al., 2016). This is not confirmed in the present study. Although men

showed more fast tempo settings (1st and 2nd fast tempo), there were no statistically significant differences between genders. The only exception was when using a second slow tempo, they showed more perfect settings than women.

In addition, the performance of the attack was examined in relation to the performance of the setting, because it is known that attack and set have a significant correlation (Silva et al., 2013). There were some statistically significant differences between genders after excellent and average settings. Specifically, after average quality settings, men had more winning attacks compared to women, who had more average attacks. Also, when the setting was excellent, it was found that men were more efficient than women. The observed difference in zone 1 attack patterns between genders could be related to differences in physical strength and power (Forthomme et al., 2005). Also, women tend to use more positional hits and are more likely to attack against an organised double block.

Male participants exhibited a significantly higher rate of successful attacks compared to female participants. Their attack success rate was 40.5% compared to 28.8% for females. This finding for females aligns with previous research. Regardless of the setting performance, men had significantly more successful attacks than women. The percentages for women are similar to previous studies which reported a success rate of 29.7% (Gasparatou et al., 2023). However, the success rate for males in this study (40.5%) deviates from previous findings (31%) reported by Gasparatou et al. (2023). These results indicate a substantial margin for improvement in the overall attack efficiency of teams. The findings of this study are specific to high-level volleyball players and may not be generalisable to other skill levels or age groups. Future research is recommended to investigate attack efficiency in different competitive contexts, such as youth or recreational volleyball.

Conclusions

This study investigated gender-based differences in the performance of high-level volleyball setters. It was found that both genders primarily utilised overhead passes and overhead passes with jumps, particularly in Complex IV. However, men demonstrated a higher frequency of perfect jump sets compared to women. Regarding the direction of sets, both genders predominantly targeted zones 4 and 2, aligning with common attacking strategies. While men exhibited a higher frequency of successful attacks, especially after average sets, women tended to rely more on safe options, such as attacks from zone 1. The study also explored the relationship between setting performance and attack effectiveness. It was observed that both genders primarily utilised slower setting tempos in Complex IV due to the unpredictable nature of the first touch. While men tended to use faster tempos, no significant gender differences were found in this regard. In conclusion, this study provides valuable insights into gender-based differences in setting performance and attack strategies in high-level volleyball. Understanding these differences can inform coaching practices and player development programs to optimise performance.

Conflicts of interest: The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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