

## The setter's attack in high-level volleyball Ataque del colocador en voleibol de alto nivel

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**Abstract.** The aim of the present study was to improve the understanding of the use of the setter's attack in top level competitions. All the matches from the Tokyo 2020 Olympic Games were analyzed, totaling 218 actions of setter's attack. For data analysis, Pearson's Chi-square and an analysis of ROC curves were used. The setter's attack obtained more points and created less errors when performed after an excellent pass to the setter ( $X^2=15.53$ ;  $p=.004$ ). In the female category, the attack by the setter was used more frequently than in the male category, after an excellent quality pass ( $X^2=14.35$ ;  $p=.001$ ), using a one hand tip ( $X^2=12.53$ ;  $p=.002$ ) and after receiving a serve ( $X^2=9.55$ ;  $p=.023$ ); while in the male category, the attack after an acceptable pass ( $X^2=14.35$ ;  $p=.001$ ), the attack with a spike ( $X^2=12.53$ ;  $p=.002$ ), and the attack after attack coverage ( $X^2=12.53$ ;  $p=.002$ ) were used more frequently than in the female category. Also, in general, when the spike was used, the ball was more frequently sent to the back row of the court, while the tip was used more frequently in the front areas, especially the one-hand tip on D2-3. In conclusion, a recommendation is made for the setter to attack after an excellent quality pass, and an assumption of greater prominence of the attack by the setters in the team's attack systems, as a means of increasing their variability and their attack options, especially in the female category.

**Keywords:** Sport performance, spike, tip, volley, role, complex.

**Resumen.** El objetivo del presente estudio fue mejorar la comprensión acerca del uso del ataque del colocador en competiciones de alto nivel. Se analizaron todos los partidos de los Juegos Olímpicos de Tokio 2020, registrando un total de 218 acciones de ataque del colocador. Para el análisis de los datos se empleó Chi-cuadrado de Pearson y un análisis de curvas ROC. El ataque del colocador obtuvo más puntos y creó menos errores cuando se realizó después de un excelente envío al colocador ( $X^2 = 15.53$ ;  $p = .004$ ). En categoría femenina, el ataque del colocador fue utilizado con mayor frecuencia que en categoría masculina después de una calidad de envío al colocador excelente ( $X^2=14.35$ ;  $p=.001$ ), empleando finta con una mano ( $X^2=12.53$ ;  $p=.002$ ) y después de una recepción ( $X^2=9.55$ ;  $p=.023$ ); mientras que en categoría masculina, se empleó con mayor frecuencia que en categoría femenina el ataque después de un pase previo aceptable ( $X^2=14.35$ ;  $p=.001$ ), el ataque con remate ( $X^2=12.53$ ;  $p=.002$ ), y el ataque después de realizar cobertura de ataque ( $X^2=9.55$ ;  $p=.023$ ). Además, cuando se ejecutó un remate, la pelota se envió con mayor frecuencia a la zona zaguera del terreno de juego, mientras que la finta se empleó con mayor frecuencia en las zonas delanteras, especialmente la finta a una mano en la zona D2-3. En conclusión, se recomienda que el colocador ataque después de un envío excelente y se propone un mayor protagonismo del ataque de los colocadores en los sistemas de ataque de los equipos, como medio para aumentar su variabilidad y opciones de ataque, especialmente en categoría femenina.

**Palabras clave:** Rendimiento deportivo, remate, finta, rol, complejo.

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### Introduction

Volleyball is considered a sequential nature sport (Carrero, Fernández-Echeverría, González-Silva, Conejero, & Moreno, 2017) with six basic technical skills that correspond to the serve, reception, set, spike, block, and dig (Eom & Schutz, 1992). These abilities are habitually repeated cyclically (Stutzig, Zimmermann, Büsch, & Siebert, 2015) in a continuous transition from defense to attack (Beal, 1991), shaping structured game phases that are called complexes.

The complexes, as game phases shaped by various actions, are determined by the actions of the rival who tries to defend, and have been defined by Molina & Salas (2009) as: K1, the phase in which game is created, starting with the defense from the serve, K2, starting with the defense from the spike, K3, starting from the defense against a Free ball or down-ball, and K4, starting with the defense from a rebound coming from a spike from the team after blocking from the rival. During the development of all the complexes, it is common for the second contact to be performed by the setter (Millán-Sánchez, Parra-Royón, Benítez, & Espa, 2020). The setter position comes with a

great cognitive influence, and its main responsibility is to organize the game based on tactics, options, the possible consequences, and its own technical skill; choosing to which attacker the ball will be sent, to create more advantageous situations with regard to blocking formation and defense (Afonso, Mesquita, Marcelino, & Da Silva, 2010; Bergeles & Nikolaidou, 2011; Bordini & Marques, 2019; Fatahi, Molla, Drikos, Alriyami, & Jadidoleslam, 2022; Fortin-Guichard, Laflamme, Julien, Trottier, & Grondin, 2020; Mesquita & Graça, 2002; Michalopoulos, Sotiropoulos, Drikos, Barzouka, & Angelonidis, 2020; Patsiaouras, Moustakidis, Charitonidis, & Kokaridas, 2011; Raab, Gula, & Gigerenzer, 2012; Tsavdaroglou, Sotiropoulos, & Barzouka, 2018). At the same time, setters utilize different types of sets as a strategic option to reduce their predictability, which is a key aspect for success (Afonso et al., 2010; Marcelino, Afonso, Moraes, & Mesquita, 2014; Nascimento et al., 2023; Peña & Casals, 2016). The setter, then, assumes critical decisions for the success of the team (Patsiaouras, Moustakidis, Charitonidis, & Kokaridas, 2010), becoming one of the most valuable components of the volleyball team (Bordini & Marques, 2019; Hernández, Ureña, Martínez, & Oña, 2003). Also, the setters' making

of decisions can be influenced by contextual variables related with each moment of the match (López-Serrano, Moreno, Mon-López, & Molina, 2022; Nascimento et al., 2023). Thus, some studies indicate that some teams vary their technical-tactical behaviors and the level of risk assumed as a function of the scoreboard, during the set, and the competition load of the set, with greater risks assumed in situations of unbalance scoreboards or sets (Drikos & Vagenas, 2011; Marcelino, Mesquita, & Sampaio, 2011; Marcelino, Sampaio, & Mesquita, 2012), which may influence the setter's choices.

Medium and high level teams massively utilize the functional 5:1 system, which implies the use of a single setter in the court (Paulo, Zaal, Fonseca, & Araújo, 2016). The use of a single setter creates six different formations or rotations: three with the forward setter, and three with the setter at the back. With the six rotations understood as differential contexts, the systems of attack must be adapted to the different interactions that occur in each of them (López, Díez-Vega, & Molina, 2022; López, Molina, Díaz-Bento, & Díez-Vega, 2023; Molina-Martín, Díez-Vega, & López, 2022).

Although the main function of setters is to set the ball to facilitate the attack by their teammates, there is also the possibility of the setter performing an action of attack with the second contact from the team, without completing the habitual game sequences of three contacts of the complex. This action aims to surprise the defense structure of the rival, especially the blockers, starting with the initial position of setting and sending the ball to the opponent's side through a spike or a tip (Denardi et al., 2017). Therefore, setters can be part of the attack systems of teams, executing ending actions, especially when found in a forward position (Palao, Santos, & Ureña, 2005), which allows them to send the ball over to the opposing side by hitting it over the top edge of the net (FIVB, 2021).

In a study conducted by Denardi et al. (2017) with players from the 1<sup>st</sup> Division of the Paulista Championship, the authors found that the setters attacked with tipping with a greater frequency when they were close to the net (<0.79m), received fast passes, and moved in short distances that brought them closer to the net. This distance to the net, within which the setters tipped more frequently, also corresponded with the distance of less than 1m to the net described by Mercado-Palomino et al. (2022), in which the placement of the setters allowed for more effective attacks.

With the understanding that the attacks by the setters can improve the systems of attacks of their teams, by increasing their response options and variability, the aim of the present study is to improve our knowledge on the attack by setters in a high-level competition, by describing its impact and effectiveness, and by associating it with behavioral or contextual variables that could have an effect on its execution.

## Methods

### Methodology

This study was carried out by using an observational methodology with interpretation objectives. A categorical system that meets the requirements of completeness and mutual exclusivity was utilized, allowing for the recording of all observed cases with a null degree of reactivity. A follow-up observation was carried out, with a nomothetic criterion and a multidimensional response level (Anguera, Blanco-Villaseñor, Luis, & Portell, 2018).

This study was performed according to the Declaration of Helsinki, and was approved by the research committee from the Universidad Europea de Madrid (CIPI 22.004).

### Sample

The sample was composed by all the volleyball games played at the 2021 Olympic Games (Tokyo). A total of 38 senior male games and 38 senior female games were watched, from the group phases until the finals. A total of 218 actions were recorded; 130 setter attacks in female games, and 88 in male games.

### Variables

The variables used in this study were:

*Competition Gender (CGD)*- According to the two official categories: Male and female.

*Game set analyzed (GSA)*- Set number according to López, Gea-García, et al. (2023): 1, 2, 3, 4 and 5.

*Set moment (SMM)*- According to Fernández-Echeverría et al. (2013): Initial moment (0-8 points); Half moment (9-16 points); Final moment (17-25 or more points).

*Scoreboard status (SST)*- According to Marcelino, Sampaio, & Mesquita (2011): High disadvantage'' (-11 to -5 points); Moderate disadvantage (-4 to -1 points); Balanced (0 to 1 point); Moderate advantage (2 to 5 points), and high advantage (6 to 12 points).

*Sets Classification (SCL)*- According to López, Gea-García, et al. (2023) for the competition in high level volleyball in 2021: Balanced when the difference was  $\leq 6$  for the male category, and  $\leq 7$  for the female one; Unbalanced when these values were higher.

*Rotation attack team (RAT)*- Six categories according to the setter's position in the moment of serve (López et al., 2022): R1, R2, R3, R4, R5 and R6.

*Rotation defense team (RDT)*- Six categories according to the setter's position at the moment of the serve (López et al., 2022): RD1, RD2, RD3, RD4, RD5 and RD6.

*Game complex (GCP)*- Game phase according to Molina & Salas (2009): K1: phase that deals with the reception of the serve; K2: phase that deals with the defense from a spike; K3: phase that deals with the defense from a free-ball or downball; K4: phase that deals with the reception of the spike against the rival's block.

*Setter's attack technique (SAT)*- Hitting technique used by the setter to attack: Spike, tip with one hand and tip with two hands.

**First contact zone (FCZ)**- Zone of origin of the ball, adapting the 6 zones established by official regulations (FIVB, 2021), the front reception areas were expanded by one meter up to four meters away from the net (López et al., 2022): Z1, Z2, Z3, Z4, Z5 and Z6.

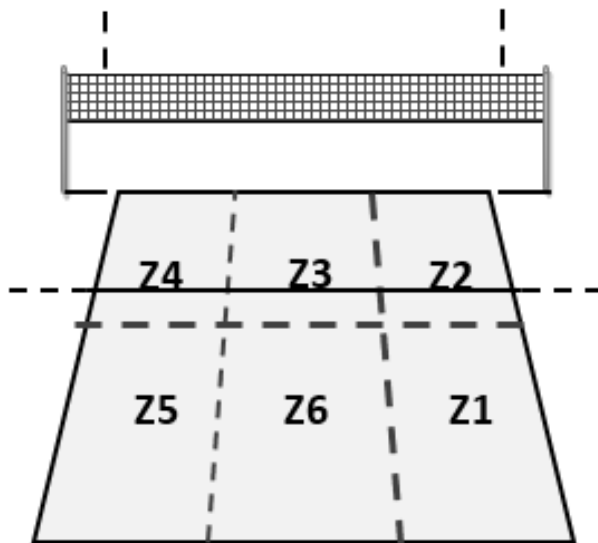


Figure 1. First contact zone.

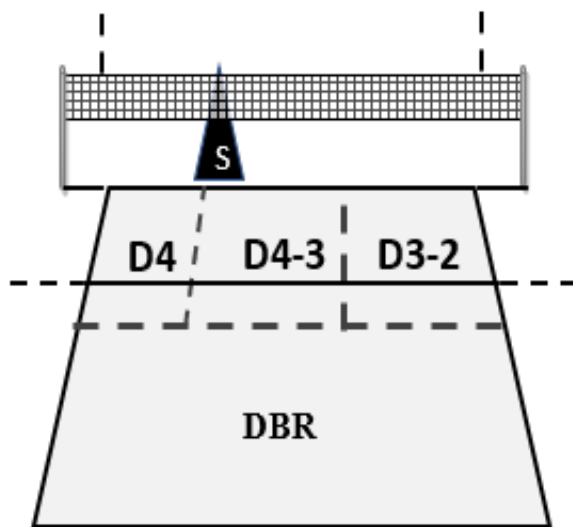


Figure 2. Destiny attack zone.

**Pass Quality (PQT)**- According to Sotiropoulos et al. (2022), performance obtained during the previous pass (reception, dig, free ball or attack coverage). Rating scale used according to López et al. (2021): Bad: the pass quality does not allow the elaboration of a sequence with setting and spike; Acceptable: the pass quality does not allow setting first times; Good: the pass quality allows setting first times with risk; Excellent: the pass quality allows playing any type of setting in optimal conditions.

**Destiny attack zone (DAZ)**- The zones in the back row (DBR) were grouped into a single zone, while the forward zones were expanded to four meters away from the net and

their width modified to try to adapt them to the reference position of the setter, considering that setters tend to be positioned in front of zone 4 on their side (Millán-Sánchez et al., 2020), and with the space between zones 2 and 3 traditionally considered as excellent setting zones (Afonso, Esteves, Araújo, Thomas, & Mesquita, 2012; Marcelino et al., 2014; Paulo, Davids, & Araújo, 2018): D4, D4-3, D3-2, DBR.

**Attack performance (APF)**- According to the Volley Information System established by the FIVB (FIVB, 2015) to calculate points scored by individual volleyball skills: Attack error: The attack leads to an error or a direct block; Attack continuity: the attack sent to the opposite side is controlled by the defending team; Attack point: the attack sent to the opposite side becomes a point.

### Approach and Procedure

Two observers received specific training to review the actions of this study (Medina & Delgado, 1999). Afterwards, the actions were reviewed by the principal observer (with national top-level certification and experience in performance evaluation). One month after finishing the recording of the sample, and in order to confirm intra-observer reliability, several matches were randomly selected to reach 10.0% of the sample actions (Tabachnick & Fidell, 2007). The values achieved with Cohen's Kappa (range: .855 to 1) were higher than .75 (Fleiss, Levin, & Paik, 2003).

Once the viewing of all actions has been made by the main observer, the second observer (with national top-level certification, international level II coach's certification and experience in performance evaluation), analyzed several matches that were randomly selected to reach 11.25% of the sample actions to calculate the inter-observer reliability test (range: 0.846 to 1). One month later the same matches were re-analyzed to calculate the intra-observer reliability value (range: 0.942 to 1). In both cases, Cohen's Kappa values were above 0.75, considered almost perfect (Landis & Koch, 1977).

For the data recording, LINCE PLUS sport observation and analysis software was used (Soto, Camerino, Iglesias, Anguera, & Castañer, 2019).

### Statistical analysis

The descriptive data for the different variables studied are presented through their values of mean (M) and standard deviation (SD). The Kolmogorov-Smirnov test was used to verify the normality of the data, and Levene's test was used for variance homogeneity. Subsequently, the Pearson's Chi-Square ( $\chi^2$ ) analysis was applied, through a post-hoc comparison of 2xn tables through the statistical contingency coefficient (CC) to obtain the possible differences between each of the variables studied. In addition, for the cases in which the variables showed frequency problems in the Pearson's Chi-Square cells, a Chi square likelihood ratio ( $G^2$ ) test was performed (Ferrán, 1996). Also, in these types of analysis, through contingency tables, a value of

$\pm 1.96$  of the corrected residuals was considered as the cut-off value for the existence or not of a significant association between the variables studied (Haberman, 1978). In addition, an ROC (Receiver Operating Characteristic) curve analysis was performed to determine the cut-off point of the different variables object of study as a function of their grouping, according to the attack technique chosen, its efficacy, and the gender of the teams analyzed. The precision of classification for each set of cut-off points was assessed through weighed statistics, the sensitivity, specificity, and the area under the curve (AUC) from the ROC. An area of one represents a perfect classification, while an area of 0.50 indicates a lack of classification precision. The ROC-AUC values  $>0.90$  were considered excellent,  $0.80-0.89$  good, and  $0.70-0.79$  acceptable, and  $<0.70$  poor (Metz, 1978).

Lastly, in all cases, to determine the relationships between these variables, the Rho ( $\rho$ ) statistic by Spearman was used. The mediation analysis was performed through the PROCESS macro for SPSS (Hayes, 2013), model 4 (SPSS, Inc., Chicago, Illinois). In this process, the bootstrap resampling procedure of 10,000 samples was used for the non-parametric sample (Preacher & Hayes, 2008). Lastly,

the classical method of stepwise regression by Baron and Kenny (1986), was used for the non-parametric samples. The statistical meaning of the effect of the mediation was analyzed with the Sobel test (Sobel, 1982). When the independent variable was not associated with the dependent variable after the mediation had been controlled for, it was considered a complete mediation. When the association between the independent and the dependent variables was reduced but did not disappear after the effect of the mediation was controlled, it was considered a partial mediation. When the z-value was greater than 1.96, and the p-value was less than 0.05, the mediating effect was accepted. The analysis of data was performed with the SPSS program (IBM Corp., Armonk, NY, USA) for Windows, version 24.0, and MedCalc 14.12.0 (Mariakerke, Belgium) was utilized for the ROC curves. The level of statistical significance was set at 0.05 for all the statistical comparisons.

## Results

Table 1 shows the results of the different variables that showed an association or were of special interest as they were related with the variable attack by the setter.

Table 1.  
Distribution of the effectiveness of the attack by the setter in the variables that showed an association.

Attack effectivity	Error n (%)	Continuity n (%)	Point n (%)	Total	$\chi^2$	p
Pass Quality					15.33	.004**
Acceptable	6.70% (n=1)	80.00%*(n=12)	13.30%*(n=2)	6.90%(n=15)		
Good	20.70%*(n=6)	44.80%(n=13)	34.50%(n=10)	13.30%(n=29)		
Excellent	5.70%*(n=10)	45.40%(n=79)	48.90% (n=85)	79.80%(n=174)		
Gender					.22	.894
Female	8.50% (n=11)	46.90%(n=61)	44.60%(n=58)	59.60%(n=130)		
Male	6.80% (n=6)	48.90%(n=43)	44.30%(n=39)	40.40%(n=88)		
Attack technique					5.17	.270
Spike	14.30%(n=5)	42.90%(n=15)	42.90%(n=15)	16.10 % (n=35)		
1 hand tip	6.60% (n=9)	45.30%(n=62)	48.20%(n=66)	62.80%(n=137)		
2 hands tip	6.50% (n=3)	58.70%(n=27)	34.80%(n=46)	21.10% (n=46)		

Note: n=number of actions; p=significant difference; \*  $p<0.05$ ; \*\*  $p<0.01$ .

Associations were found in pass quality between the acceptable category and the excellent category, with a  $p=.05$ ; with the acceptable category obtaining a frequency that was higher than expected in pass continuity, and a lower frequency in points scored. With a good pass, the frequency of errors was higher than expected. In contrast, with an excellent pass, less attack errors than expected were committed,

and the frequency of point scoring was significantly higher.

When relating the variable performance of attack by the setter with other variables such as gender or attack technique, no significant differences were obtained.

Table 2 shows the results from the different variables that showed an association or were of special interest when relating them with the variable gender of the competition.

Table 2.  
Setter attack distribution as a function of gender of the competition.

	Female	Male	Total	$\chi^2$	p
Technique				12.53	.002**
Spike	10.00 %* (n=13)	25.00%* (n=22)	16.10% (n=35)		
Tip-one hand	63.10% (n=82)	62.50% (n=55)	62.80% (n=137)		
Tip-two hands	26.90%* (n=35)	12.50%* (n=11)	21.10% (n=46)		
Complex				9.55	.023*
K1	63.80 %* (n=83)	44.30 %* (n=39)	56.00% (n=122)		
K2	17.70% (n=23)	26.10% (n=23)	21.10 % (n=46)		
K3	11.50% (n=15)	13.60 % (n=12)	12.40% (n=27)		
K4	6.90%* (n=9)	15.90%* (n=14)	10.60% (n=23)		
Pass Quality				14.35	.001**
Acceptable	1.50%* (n=2)	14.80%* (n=13)	6.9% (n=15)		
Good	13.80% (n=18)	12.50% (n=11)	13.30% (n=29)		
Excellent	84.60%* (n=110)	72.70%* (n=64)	79.80% (n=174)		
Moment in the set				5.23	.073

Initial	47.70% (n=62)	34.10% (n=30)	42.20% (n=92)
Middle	29.20% (n=38)	43.20% (n=38)	34.90% (n=76)
Final	23.10% (n=30)	22.70% (n=20)	22.90% (n=50)

Note: F=female category; M= male category; n=number of actions; Complex=game complex; K1=Complex 1; K2=Complex 2; K3=Complex 3; K4=Complex 4; p=significant difference; \* p<0.05; \*\* p<0.01.

As observed in Table 2, significant differences were detected in the attack technique for both male and female categories ( $p=.002$ ;  $CC=.23$ ). In the female category, the number of spikes recorded was less than expected (10.00%), while the number of tips executed with both hands was higher than expected (26.90%). In the male category, the analysis showed an inverse behavior, with a higher percentage of spikes than expected (25.00%), and a percentage of tips executed with both hands lower than expected (12.50%).

When comparing the use of the setter's attack in different games complexes as a function of the category, significant differences were found ( $p=.023$ ;  $CC=.20$ ). In the female category, the percentage of attacks in K1 was significantly higher than expected, comprising 63.80% of the attacks, while in K4, it was less than expected (6.90%). In the male category, an inverse behavior was observed, with a

percentage of attacks in K1 lower than expected (44.30%), and a percentage of attacks in K4 higher than expected (15.90%).

With respect to the attack by the setter as a function of pass quality ( $p<.001$ ;  $CC=.25$ ), in the female category, a percentage of attacks with an acceptable pass that was lower than expected was recorded (1.50%), while a higher percentage was recorded with an excellent pass (84.60%). On the contrary, in the male category, a higher percentage of attacks with an acceptable pass defense was recorded (14.80%), while a lower percentage to the expected was recorded with an excellent pass (72.70%).

Lastly, when relating gender with the variable set moment, no associations were found between variables.

Table 3 shows the results obtained when relating the attack technique utilized with other variables.

Table 3.

Distribution of variables as a function of the attack technique of the setter.

	Spike	1 hand tip	2 hands tip	Total	$\chi^2$	G <sup>2</sup>	p
Complex							
K1	.80%* (n=1)	79.50%* (n=97)	19.70% (n=24)	56.0% (n=122)	77.56	27,61	.000**
K2	19.60% (n=9)	56.50% (n=26)	23.90% (n=11)	21.1% (n=46)			
K3	37.00* (n=10)	33.30%* (n=9)	29.60% (n=8)	12.4% (n=27)			
K4	65.20%* (n=15)	21.70%* (n=5)	13.00% (n=3)	10.6% (n=23)			
Total	16.10% (n=35)	62.80% (n=137)	21.10% (n=46)	100% (n=218)			
FCZ							
Z1	8.00% (n=2)	68.00% (n=17)	24.00% (n=6)	11.6% (n=25)	30.77	68,30	.001**
Z2	8.30% (n=1)	58.30% (n=7)	33.30% (n=4)	5.6% (n=12)			
Z3	47.60%* (n=10)	23.80%* (n=5)	28.60% (n=6)	9.7% (n=21)			
Z4	22.90% (n=8)	54.30% (n=19)	22.90% (n=8)	16.2% (n=35)			
Z5	12.5% (n=4)	62.50% (n=20)	25.00% (n=8)	14.8% (n=32)			
Z6	8.80%* (n=8)	75.80%* (n=69)	15.40% (n=14)	42.1% (n=91)			
Total	15.30% (n=33)	63.40% (n=137)	21.30% (n=46)	100% (n=216)			
DAZ					84.99	68,30	.000**
D2-3	3.50%* (n=3)	75.60%* (n=65)	20.90% (n=18)	39.4% (n=86)			
D3-4	7.10%* (n=5)	62.90% (n=44)	30.00%* (n=21)	32.1% (n=70)			
D4	8.70% (n=2)	73.90% (n=17)	17.40% (n=4)	10.6% (n=23)			
DBR	64.10%* (n=25)	28.20%* (n=11)	7.70%* (n=3)	17.9% (n=39)			
Total	16.10% (n=35)	62.80% (n=137)	21.10% (n=46)	100% (n=218)			

Note: F=female category; M= male category; n=number of actions; FCZ=first contact zone; Complex=game complex; K1=Complex 1; K2=Complex 2; K3=Complex 3; K4=Complex 4; (DAZ) Destiny attack zone=destiny zone of the attack performed by the setter; p=significant difference; \* p<0.05; \*\* p<0.01.

When analyzing the type of spike used by the setters without differentiating by gender, as a function of the game complex, significant differences were observed ( $p<0.05$ ;  $CC=0.51$ ). More specifically, it was observed that in K1, the percentage of spikes was lower than expected, while for K3 and K4, this percentage was higher than expected, as compared with the rest of the game complexes. On the other hand, when considering the one hand tip, an inverse behavior was observed, or what is the same, for K1, this action was observed in a higher percentage than expected (79.50%). For the same one hand tip action, in K3 and K4, the percentage of actions through this technique was lower than expected (33.30% and 21.70%).

In second place, when examining the first contact zone (FCZ), significant differences were observed for the spike

actions used by the setter ( $p<0.05$ ;  $CC=0.53$ ). For the spike action, Z3 (47.60%) obtained a percentage that was higher than expected, while Z6 obtained spike percentages that were lower than expected (8.80%). For this same FCZ variable, the action of attack through a one-handed tip showed a behavior that was the opposite from the spike, with a lower percentage than expected in Z3 (23.80%), and much higher than expected in Z6 (75.80%). Lastly, significant differences were found when examining the destiny attack zone (DAZ) as a function of the type of attack by the setter ( $p<0.05$ ;  $CC=0.53$ ). For the spike action to zones D2-3 and D3-4, the percentage obtained was lower than expected; while in the DBR zone, the spike actions obtained a higher than expected percentage (64.10%). In addition,

for the one-hand tip to C2-3, a higher than expected percentage was observed (75.60%), while for the DBR, the percentage was lower than expected. Lastly, for the two-hand tip attack, the percentage of actions directed to D4 was higher than expected, as compared to the remaining actions of attack possible, while this same action was inferior for the DBR zone.

Next, through the analysis of the ROC curves, the cut-off point was determined for the different variables analyzed in relation with the attack technique of the one-hand tip and scoring a point, in both male and female categories. Table 4 shows the results obtained after the analysis of the ROC curves for the female teams.

Table 4. ROC analysis as a function of the use of the tip as the attack technique and the scoring of a point for the female teams.

	Attack technique used by the setter							Efficiency of the attack by the setter				
	Complex		DAZ		Female teams			Complex	FCZ	S_CL		
	n=130	S_CL BAL n=83	n=130	S_CL BAL n=83	n=130	S_CL BAL n=83	n=130	n=69	S_CL BAL n=43	S_CL BAL n=43	n=69	
	Tip	Tip	Tip	Tip	Tip	Tip	Tip	Point	Point	Point	Point	
AUC	.84	.86	.83	.81	.68	.70	.62	.66	.73	.70	.67	
SE	.05	.06	.08	.09	.07	.08	.06	.08	.08	.09	.06	
95% CI	.77 to .90	.77 to .93	.76 to .89	.70 to .88	.60 to .76	.56 to .77	.53 to .70	.54 to .77	.57 to .85	.54 to .83	.55 to .78	
p	<.001**	<.001**	<.001**	<.001**	.006**	.03*	.04*	.04*	.007**	.03*	.002**	
YI	.62	.63	.71	.66	.45	.4	.23	.38	.5	.32	.34	
P_C	≤1	≤2	≤3	≤3	>4	>4	≤0	≤1	≤1	>5	≤0	

Note= n=number of sets analyzed; DAZ= destiny attack zone; FCZ= first contact zone; S\_CL=classification of the set; BAL=Balanced set; Complex= game complex; AUC=area under the curve; SE=standard error; p=significant difference; CI=Confidence interval; YI=Youden index; P\_C=cut-off point; \* p<0.05; \*\* p<0.01.

In first place, in order to discriminate the setter’s attack as a function of the technique utilized, it was observed how, for the variable game complex, a good discriminatory capacity (AUC=.84) was found for the use of the tip, with the cut-off point set at 1 (K1), while for the classification of the set (S\_CL) with the balance set (BAL), this point was less than 2 (K2 and K1; AUC=.86). For the DAZ variable, the cut-off point was set to 3 in a generalized manner as a function of S\_CL for the BAL or lower, (Zone D4, Zone D4-3, Zone D3-2), with a good discriminatory capacity observed for the use of the tip during the attack in these zones (AUC=.83; .81). When examining the FCZ, a low value was obtained in relation with its discriminatory capacity on the use of the tip (AUC=.68), slightly increasing to acceptable for the S\_CL in the BAL (AUC=.70). Lastly, based on its S\_CL, a cut-off value of 0 was able to be obtained (non-

balanced set), but with a low capacity for discriminating the use of the attack through a tip (ABC=.63).

In second place, when examining the discrimination in scoring a point with the setter’s attack, it was observed that in general, the variable game complex showed a low discriminatory capacity, and an acceptable one as a function of the S\_CL (AUC=.66; .73), with the cut-off value set at 1 (K1). On the other hand, for the variable FCZ, the cut-off point was set to >5 (zone 5 and zone 6), thereby obtaining an acceptable discriminatory capacity (AUC=.70) for scoring a point. Lastly, for the variable S\_CL, the cut-off point was set at 0 (non-balanced set), with a low discriminatory capacity (AUC=.67) for scoring a point.

Below, table 5 shows the results obtained from the analysis of ROC curves in the different variables studied, during the male team games.

Table 5. ROC analysis as a function of the use of the tip as the attack technique and the scoring of a point for the male teams.

	Attack technique used by the setter					Efficiency of the attack by the setter				
	Complex		DAZ		Male teams			PQ	FCZ	SS
	n=88	S_CL BAL n=63	n=88	S_CL BAL n=63	n=45	S_CL BAL n=35	n=45	S_CL BAL n=35	n=45	S_CL BAL n=45
	Tip	Tip	Tip	Tip	Point	Point	Point	Point	Point	Point
AUC	.86	.87	.84	.87	.75	.75	.81	.84	.84	.76
SE	.04	.04	.05	.04	.09	.11	.13	.06	.07	.09
95% CI	.77 a .92	.76 a .94	.75 a .91	.76a .94	.58 a .88	.60 a .87	.64 a .92	.70 a .93	.67 a .94	.61 a .88
p	<.001**	<.001**	<.001**	<.001**	.005**	.02*	.02*	<.001**	<.001**	.004**
YI	.59	.61	.58	.59	.48	.51	.62	.65	.66	.44
P_C	≤1	≤2	≤3	≤2	≤1	>3	>3	>4	>4	>.1

Note= n=number of sets analyzed; DAZ= destiny attack zone; PQ= pass quality; FCZ= first contact zone; S\_CL=classification of the set; BAL= Balanced set; Complex= game complex; SS= Scoreboard status; AUC= area under the curve; SE=standard error; p=significant difference; CI=confidence interval; YI=Youden index; P\_C=cut-off point; \* p<0.05; \*\* p<0.01.

In first place, to discriminate the attack by the setter as a function of the technique utilized, it was verified that for the variable game complex, the cut-off point showed a good discriminatory capacity (AUC=.86) for the use of the tip,

with a cut-off value of 1 established (K1), while for the S\_CL with the BAL, this value was set to 2 (K2) and K1 (AUC=.87). The DAZ showed a general good discriminatory capacity for the use of the tip technique (AUC=.84),

with a cut-off value of 3 or less (D4, D4-3, D2-3). Meanwhile, as function of the S\_CL for the BAL, the cut-off value was 2 (D3-4, D2-3), with a good discriminatory capacity for the use of the tip (AUC=.87).

In second place, when examining the discrimination in the efficacy of the setter's attack, the variable game complex showed an acceptable discriminatory capacity for scoring a point (AUC=.75), while the analysis as a function of S\_CL showed a good discriminatory capacity for scoring a point in BAL (AUC=.81); with both of them obtaining a cut-off value of 1 (K1). The variable DP showed an acceptable discriminatory capacity in general, and a good one in the BAL for scoring a point (AUC=.75; .81), with a cut-off value higher than 3 (acceptable, good, or excellent). The variable FCZ showed a high discriminatory capacity for scoring a point (AUC=.84), with a cut-off point higher than 4 (zone 4, zone 5, and zone 6), in general and in BAL. Lastly, for the variable SS, a good discriminatory capacity was found in the action as a point (AUC=.76), when the action was performed when the executing team was losing by -1 point, tied, or winning.

Next, table 6 shows the results for the variables studied that showed a correlation with the attack technique utilized by the setter. As observed in the results obtained, an inverse and statistically significant correlation was found between the variables technique, game complex, and DAZ ( $p < .01$ ). Meanwhile, for the variable game complex and DAZ, the relationship was direct and significant ( $p < .01$ ).

Table 6. Bivariate correlations between attack technique and the variables game complex and destiny attack zone in the male team games

	1	2	3
1. Attack technique	1		
2. Game complex	-0.421**	1	
3. Destiny attack zone	-0.427**	0.46**	1

Note: \*\*  $p < 0.01$ .

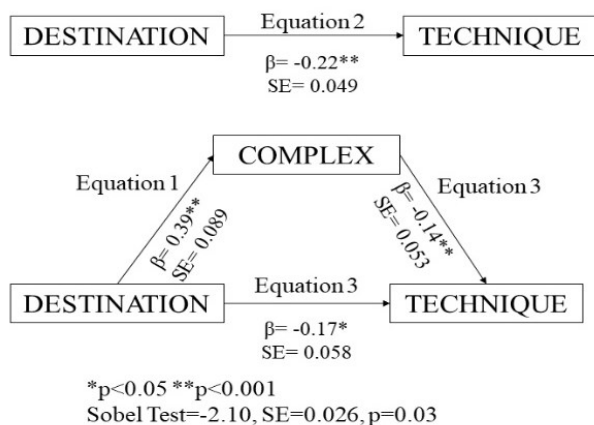


Figure 3. Mediation of the destination and technique by complex of game.

Lastly, as shown in figure 3, for the male volleyball teams, the attack technique used by the setters was associated with the DAZ ( $R^2=.19$   $F=10.47$ ,  $\beta=-.22$ ,  $SE=.049$ ,  $t=-4.52$ ,  $p=.000$ , 95% CI=-.32 to -.13) and the game complex ( $R^2=.24$ ,  $F=13.66$ ,  $\beta=-.14$ ,  $SE=.058$ ,  $t=-2.39$ ,

$p=.01$ , 95% CI=-.26 to -.002). Also, the result obtained in the game complex was associated with the destiny attack zone  $R^2=.18$ ,  $F=19.24$ ,  $\beta=.39$ ,  $SE=.089$ ,  $t=4.39$ ,  $p=.000$ , 95% CI=.21 to .57). In addition, an analysis was performed to verify if the game complex had a mediating effect on the association between the DAZ and the attack technique used by the setters. After including the variable game complex in the technique used by the setters in the equation, the association between DAZ and the attack technique used by the setters was still significant, but its effect was reduced ( $R^2=.24$ ,  $F=13.66$ ,  $\beta=-.17$ ,  $SE=.053$ ,  $t=-3.18$ ,  $p=.002$ , 95% CI=-.28 to -.06), allowing us to identify game complex as a mediating variable with a partial effect. The analysis of the mediation showed a significant direct and indirect effect with a significant value in the Sobel test ( $z=-2.10 \pm .026$ ,  $p=.03$ ).

### Discussion

The objective of the present study was to improve our understanding about the use of the attack by setters in a high level competition, by describing its importance and effectiveness, and by seeking to find a relationship between the variables that could affect its execution.

When analyzing the effectiveness of the setter's attack, it was observed that it was conditioned by the quality of the pass prior to it. With a low frequency of actions (6.90%), the setters used their attack in not very favorable situations with an acceptable quality pass, perhaps trying to surprise the rival team. However, they scored less points than expected (13.3%), with a greater continuity of actions in the opposing teams' court (80.00%). However, with an excellent quality pass, and despite not being able to generate as much surprise on the rival defense, they scored a greater percentage of points (48.90%) with a lower percentage of errors (5.70%). This result is in agreement with that proposed by other studies in medium and high level competitions, which found a relationship between the quality of the reception or the previous defense, and the effectiveness of the attacks of the teams (Araújo, Tosini, Freire, Costa, & Meira, 2020; Costa et al., 2018; Fatahi et al., 2022; González-Silva, Fernández-Echeverría, Conejero, & Moreno, 2020). This relationship was found despite the expert setters being able to convert regular or low quality passes into good placements (Marcelino et al., 2014; Patsiaouras et al., 2010), partially reducing the effect of the quality of the first contact on the performance of the attack in the third contact. Nevertheless, the analysis showed that in the male category, the setters attacked more frequently with acceptable quality passes (male: 14.80%; female: 1.50%), while in the female category, the setters attacked more frequently with passes of excellent quality (female: 84.60%; male: 72.70%).

Although in the male category more attacks were performed with acceptable passes, when analyzing the effectiveness of the attacks of the setters as a function of gender,

no significant differences were found. Almost identical values were obtained in the percentage of points obtained in both categories (female: 44.60%; male: 44.30%), and very similar ones in the errors (female: 8.50%; male: 6.80%). These scoring percentages were lower than those published by Palao et al. (2007) with a sample from the 2000 Olympic Games, with respect to the attack with the second contact of the team, for both the female category (K1: 51.2%; Counter attack: 46.2%), as well as the male one (K1: 51.5%; Counter attack: 57.7%); also showing an error rate with the attack in the second contact that was higher in the female category (K1: 7.3%; Counter attack: 23.1%), which was similar in the male one (K1: 5.1%; Counter attack: 7.7%). However, the study by Palao et al. (2007) assessed the attack with the second contact of the team, and although most of them were performed by the setters, they could also be performed by the other team members in game sequences that did not use the 3 contacts allowed by the regulations. In fact, the percentage of attacks performed in the second contact was slightly higher (2%), to that obtained in our study. In another study published by Denardi et al. (2017), in which authors analyzed the attack by the setters in the Paulista league, they found, just as in our study, a medium efficacy that was identical for both genders, although with a slightly higher percentage in scoring (48%).

When comparing the results of the present study with the values published by the official statistics of the tournament in a descriptive manner, with respect to the effectiveness of the attack without differentiating the game role (FIVB, 2023), we found that in the female category, the attack by the setters was slightly more efficient than the mean of the rest of the players combined (41.05%), with less errors committed (17.61%), and entailing 1.55% of the attacks performed; while in the male category, the attack by the setter was slightly less efficient than the mean of the rest of the players (50.53%), making less errors, and entailing 1.16% of the attacks performed. The fact that more attacks were performed by the female setters may be due to their percentages of scoring being slightly higher than the mean of the attacks by the rest of the team; and that in high level female volleyball, it is common to see less players involved in the system of attack than in male volleyball, as less attackers are involved in the back row (Costa et al., 2016; Matias, González-Silva, Moreno, & Greco, 2021).

Although no significant differences were found in the effectiveness of the attack by the setter as a function of gender, differences were observed in the technique used in the attack. The attack through two-handed tipping was more frequently employed than expected by the female category (26.90%), and less than expected by the male category (12.50%); while the spike was used with a higher frequency than expected by the male category (25.00%) with a lower frequency than expected observed in the female one (10.0%). The more frequent use of the spike attack by the male setters coincides with the results obtained in other studies, which defined the greater offensive power of the

men as the cause, based on jump height, hitting speed, and effectiveness of attack, as well as the assumption of a greater risk in the hits (Ciemiński, 2018; Oliveira, Moura, Rodacki, Tilp, & Okazaki, 2020; Pawlik & Mroczek, 2023; Sotiropoulos et al., 2022; Stamm, Stamm, Torilo, Thomson, & Jairus, 2016). With respect to the game complexes, it was found that women attacked in K1 to a greater degree (63.80%) as compared to the men (44.30%). As the K1 phase has a greater stability and organization than other complexes, it allows for a greater precision of the first contact (Castro & Mesquita, 2010), generating a higher percentage of excellent passes to the setter, especially for women (Millán-Sánchez et al., 2020). As previously indicated, the setters more frequently attack with excellent passes, which could explain this result. Also, in K1, a higher percentage of attacks through tipping (79.50) than expected was observed, with a lower percentage observed for the spike (0.80%). It is possible that the one-handed attack allows the setter to better hide the intentions of attack as compared to the spike, especially in a situation with more precise passes to the setter, and in which the rival blocks are better prepared, as it is performed at the start of the point without having executed previous actions. On this respect, Marcelino et al. (2011) proposed that the attacks by the elite setters did not surprise the rival defenders, took on a greater risk, and provoked a higher loss of points with the attacks. In the male category, the setters attacked in K4 to a higher degree (15.90%) than the female setters (6.90%). After analyzing both gender categories together, in K4, a much higher percentage than expected use of the spike was utilized (65.20%), while a lower percentage was observed for the tip (21.0%). In K4, one or more players from the same team may not be available to attack or may be temporarily limited after the attack, decoy, or performing attack coverage (Hileno, García-De-Alcaraz, Buscà, Salas, & Camerino, 2018; Laporta, Nikolaidis, Thomas, & Afonso, 2015), with the presence of a single available attacker being common in high level female volleyball, as Hurst et al. (2017) found in the 2015 Grand Prix. In this situation, the use of the attack by the setter could provide a solution in the system of attack. In addition, the attack with the second contact from the setter could take advantage of an unbalance in the blocking structures and defense of the rival, provoked by a previous action, and the movement needed to retake the initial positions. In this context of K4, the use of a higher percentage of spike attacks from the setter is coherent, despite it being more difficult to hide its execution as a surprising element, with respect to other attack techniques. Also, it was found that in the balanced sets, the use of the tip was more predictable as an attack technique, in both K1 and K2. It may be that the spike attack, in which more errors were recorded than the use of the tip, could be used by setters in unbalanced sets in which there is a clearer possibility of victory or defeat of the team.

Continuing with the attack technique, a relationship was also found between the zone of origin of the pass to the setter, and the technique utilized. Thus, the spike and the one-



handed tip were performed in a higher frequency than expected, when the ball originated from Z3 and Z6, located at the center of the court. The high level setters habitually ended the placement pass towards zone 4 (Peiró et al., 2016) and from zone 2-3 (Mercado-Palomino et al., 2022), with a change of orientation of the shoulders needed during the contact.

When the balls originated from the center aisle of the court (zone 3 and zone 6), the setters could take advantage of the change in shoulder and trunk orientation movement to more easily drive the one-handed tip attack or facilitate the turn needed in the spike, which would explain the higher frequency of these attacks. However, with balls originating from the right aisle (zone 2 and zone 1), the greater difficulty to see the location of the block and the greater turn necessary, could make its use difficult, and may explain the lack of significant differences in the technique utilized.

With respect to the destiny of attack zone, more spikes were performed on the DBR and less on the forward Z2-3 and Z3-4 zones. As the spike is performed with the highest power, sending the ball to the forward zones requires a higher hit area that creates the greatest angle of attack, assuming a greater risk for blocking. Therefore, in a spike action that is habitually performed by the setters without the power provided by an approach (Suhadi, Guntur, Kriswanto, & Nopembri, 2023), and which especially requires, for the right-handed setter, an important change of trunk orientation in the air, with setters not being players who stand out for their wingspan or jumping ability (Palao, Manzanares, & Valadés, 2014), it seems logical that more hits are performed towards the back of the court. On the contrary, less attacks were produced on the DBR with 1 or 2-hand tips, and more attacks on the zones closest to the net. As these actions are executed with less speed, the attacks on the DB could be easily defended against. The attack with a 1-handed tip was more frequent on Z2-3. Sending the ball towards Z2-3 could facilitate the arm's travel needed for the execution of the one-handed tip when it is performed with the arm that is away from the net, which would also allow overcoming the block facing the net in front of the setter. The 2-handed tips were more frequently destined to Z4, which implies sending the ball from behind the setter's head, not laterally or frontally, with a strong surprising character. As no other studies were found that detailed the destiny attack zones, a comparison was not possible.

With respect to the set moment and scoreboard status, the present study did not find differences at the general level, in the frequency or effectiveness of the setter's attack. However, the attack by the setter in the male category showed a greater discriminative capacity in scoring a point with a scoreboard status  $>-1$  point. This result is contradictory to a study with a sample from the 2007 Male World Cup, which reported a higher frequency of attack by the setters when the difference in the scoreboard was equal to or higher than 5 points (Marcelino, Mesquita, et al., 2011).

As practical applications, the setters should reduce the

use of the tip with an acceptable quality pass, and increase it with an excellent pass. Also, the setters must be considered as an interesting option that could increase the variability of the systems of attacks by high-level teams, without modifying the stability of the placement pass in height and speed, which provide better results at this level (Ramos, Coutinho, Silva, Davids, Guimaraes, et al., 2017; Ramos, Coutinho, Silva, Davids, & Mesquita, 2017). Despite the attacks by the setters being found in a low percentage within the attack actions of the teams, the actions of low occurrence could become a differentiating element in achieving victory (Hurst et al., 2017).

As for the limitations of the study, the low incidence of setter attack actions limited the options of analysis of the data. In future studies, it would be interesting to analyze the influence of the anthropometric characteristics of the setters with respect to the attack technique employed and its effectiveness, as well as the dynamics of the scoreboard in the points before the action, to record the performance of the attackers in the previous actions.

As conclusions from the study, the attack by the setters obtained more points and generated less errors when it was performed after an excellent quality pass to the setter. Although no performance differences were found as a function of the category, the women more frequently used a tip attack on game complex K1 than men; while in the male category, they more frequently used the spike on game complex K4 than women. Also, in general, when the spike was used, the ball was more frequently directed towards the back zone of the court, while the tip was more frequently utilized in forward zones, especially the one-handed tip on D2-3.

## Conflicts of interest

The authors declare that there is no conflict of interest.

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