

Original article (short paper)

Technical-tactical performance profile of the block and dig according to competition category in men's volleyball

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Abstract—The aim of this study was to analyse the technical-tactical performance profile of blocking and court defence actions for various age groups and categories of competition in men's volleyball. The sample comprised 16,454 blocks and 8,321 digs performed in 299 sets in several categories of competition (from U-14 to Olympic Games). A descriptive and correlational inter- and intra-group observational design was used. The variables studied were: category of competition, opponent's spike tempo, and block and dig performance. The results showed a significant increase in the percentage of blocks and digs derived from fast attacks and a significant improvement in performance of these actions to counteract slow attacks. Thus, improving in blocking and digging performance was observed at higher categories when the attack is performed slowly. This paper discusses various reasons for the evolution in defensive performance and the effects on the training process for various categories of competition in volleyball.

Keywords: team sports, performance, match analysis, volleyball

Introduction

In a volleyball play, the defending team tries to neutralise or restrain the opponent's offense through defensive actions such as blocking and court defence. The block is a team's first line of defence, and it aims to intercept, stop, or restrain the opponent's offensive actions (Selinger & Ackermann-Blount, 1985). The main objective of court defence is to control the ball that was attacked by the opponent to send it to the setter and, thus, counterattack (Stone, 2002). Block and court defence performance depend on how an opponent's spike (e.g. attack tempo, distance from the ball, previous displacements) is performed (Selinger & Ackermann-Blount, 1985) as well as on variables that determine the opponent's offense (e.g. setter's zone, available hitters, attack area) (Afonso & Mesquita, 2011). The interaction of various game actions determines the performance of defensive actions such that performance may vary according to the age group and/or competition level. These changes are determined by players' maturity (e.g. greater height, weight, reach) (Malina & Bouchard, 1991), progress in the training process (e.g. higher speed, better technical execution), and changes in game regulations (e.g. net height, libero), which may occur as players progress from one category to the next.

Block performance is associated with players' anthropometric features (e.g. height, weight, etc.), and behavioural and psychological abilities (e.g. reaction time) (Stamm, Stamm, & Thomson, 2005). One reason for this association is the fact

that the height reached over the net is crucial (Grgantov, Katic, & Jankovic, 2006; Stanganelli, Dourado, Oncken, Mancan, & Costa, 2008), as it enables an appropriate technical-tactical execution. On the other hand, court defence performance requires the development of physiological factors (e.g. strength, flexibility, etc.), technical-tactical factors (hand-eye coordination, etc.), and psychological factors (optimal activation for a quick reaction to the opponent's attack) (Stone, 2002). Most of these performance factors are limited when the opponent's spike is carried out quickly. These quick attacks force defenders to react and move in the shortest possible time. Thus, quick attacks have greater efficiency (Bergeles & Nikolaidou, 2011; Castro, Souza, & Mesquita, 2011; Costa *et al.*, 2011; Palao, Santos, & Ureña, 2007) on account of the conditions in which the block is performed (Afonso, Mesquita, Marcelino, & Silva, 2010) and limited defensive movements.

Despite the relationship between the spike and defensive actions, there is a lack of reference values in the scientific literature pertaining to technical-tactical performance of the block and court defences that take into consideration the opponent's spike tempo according to the various categories of competition. Reference values may be helpful in guiding training process and improving the performance of these actions. This study is the first step in establishing a technical-tactical performance profile of blocking and court defence. The aim was to assess technical-tactical performance profiles of blocking and court defence for various categories of competition in men's volleyball.

Method

Population and sample

The sample was made up of teams and players participating in matches and sets in Spain's U-14, U-16, and U-19 men's championships (2008-2009 season), Spain's first division (national senior category, 2008-2009 and 2009-2010 seasons), and the 2008 Olympic Games (international senior category). The analysed actions comprised 16,454 blocks and 8,321 digs. These actions were played by 99 teams in 299 sets. Fifty-nine sets were randomly selected from the Olympic Games, while sixty sets were randomly selected from the other categories. The sets were stratified in terms of "performance level" (one of three rankings) and "quality of opposition" (six different options according to rival's level of performance). Given the different structure of the fifth set (FIVB, 2008), it was not included in the sample.

All matches were video recorded after the organizing committee had given consent. In the case of the Olympics, matches were not filmed, but downloaded from open online channels such as NBC. The process did not affect players' and teams' spontaneous behaviour, as filming is a common, non-invasive procedure typically used by coaches. This study complied with

the Bioethics Commission of the University of Murcia (Spain) and with the ethical principles stated by the Declaration of Helsinki.

Design

A descriptive, correlational, observational (nomothetic, intrasessional, and multidimensional) design were implemented through of a category system (Anguera, 2003). The study's variables were: a) category of competition (U-14, U-16, U-19, national senior, and international senior); b) attack tempo (first, second, or third tempo); and c) the performance of the block and dig. A first, second, or third tempo block or dig was an action or attempted action responding to a first, second, or third tempo spike, respectively. Block and dig performance were measured in terms of the defending team's ability to counterattack under the best possible conditions. The performance of the block was measured in terms of the opponent's ability to continue the play when the ball is returned to their court or in terms of the defending team's ability to continue the play when the ball remains in their court (Table 1). Performance of the dig was measured in terms of the defending team's ability to continue the play (Table 2).

Table 1. Variables for block performance.

Value	Category	Description
0	Error	Block error. Point is lost after block contact
0	Error (fault)	Block error. Point is lost because blocker commits a fault (touching the net, penetration, etc.)
1	Negative block	Block continuity. The blocking team cannot set up a counterattack, but when the ball is in the opponent's court, the opposing team can counterattack
3	Positive block	Block continuity. The blocking team can set up a counterattack, and if the ball remains in the opponent's court, the opponent cannot counterattack
4	Point	Block point. The player who blocks sends it to the court on the other side of the net

Table 2. Variables for dig performance.

Value	Category	Description
0	Error	Dig error. Point is lost after dig contact
1	Negative dig	Dig continuity. The digging team continues the play but is not able to set up a counterattack, or the ball is sent to the opponent's court after digging
3	Positive dig	Dig continuity. The digging team continues the play and maintains the possibility of setting up a counterattack

Procedure and instruments

Competitions were recorded on video cameras placed at the end of the court and at a height higher than the net, except for the matches from the Olympic Games where filming took place from the sides and back of the court. It was ensured that the official court area (18 x 9 m) would be recorded, at a minimum, to allow clear viewing of all actions. Regular video cameras positioned on tripods and plugged in with extension cords were used. For the national senior category, matches were also downloaded from an official website.

Technical-tactical actions were observed by a single observer, who was licensed in sport science, was a volleyball coach with the highest coach certification in Spain, and had over ten years of experience in volleyball training and performance analysis. To assess the adequacy of data coding and variables, a training process which included analysing twelve national senior-category matches was undertaken before starting the research study. The videos were observed in the month after the end of each tournament. The consistency analysis (Cronbach's Alpha) was conducted with two observers who were volleyball coaches with over two years of experience in performance

analysis, and in the use of the observational software used in this study, and who held the highest national coach certification. For the inter-observer reliability analysis, 25% of sets from the national senior category were randomly selected and observed. Analyses showed a reliability of 0.865 for blocking and 0.820 for court defence. For intra-reliability analysis, 20% of sets from each category of competition were randomly selected and observed. Analyses showed a reliability of 0.872 for blocking and 0.864 for court defence.

While observing, variables were recorded with the Data Volley software (Data Volley 2007, Data Project Sport Software, Bologna, Italy). Recorded actions were then synchronised with video images by means of Data Video (Data Video 2007, Data Project Sport Software, Bologna, Italy), so that the quality of the data could later be analysed. The data were collected and exported from Data Volley 2007 software using the observation tool's internal spreadsheets. Each spreadsheet contained players' and teams' performance during sets. All spreadsheets were merged into a single matrix in which contextual variables (category, team level, type of match, set result, game system, initial line-up, substitutions, and role of players) were added. SPSS 15.0.0 (Statistical Package for the Social Sciences, IBM, Armonk, United States) was used for descriptive and inferential analyses. The sample size was analysed in order to check the stability of data (Hughes & Daniel, 2003). For all tested categories, stability occurred starting at the 17th set, in the case of the block, and starting at the 10th set, in the case of court defence.

Statistical analysis

A descriptive analysis for the various actions and types of actions in every category of competition was performed. Frequency (number of actions or type of actions), relative frequency (relative measure for frequency), mean actions (team's

mean value for the entire set), coefficient (mean value of performance of an action or type of action), efficacy (percentage of maximum performance of an action or type of action), efficiency (percentage of maximum value of an action when subtracting errors), and ratios (block point-to-error or positive-dig-to-negative-dig) were calculated. Coefficient, efficacy, efficiency and ratio were calculated using players' mean values per set. The following inferential tests were performed: a) Kolmogorov-Smirnov test to analyse normality of data; b) Kruskal-Wallis test ($p < 0.05$) to identify differences among categories; c) Wilcoxon test ($p < 0.05$) to analyse differences within each category; and d) Mann Whitney U procedure with post hoc Bonferroni ($p < 0.01$) to analyse specific differences between categories.

Results

Results showed that at the initial stages (U-14, U-16, and U-19), the percentage of blocks with ball contact was significantly lower than the percentage of blocks with no ball contact (Table 3). These differences were not significant at later stages. At higher categories, the percentage of ball contacts increased significantly. Beginning with the U-14 category, the percentage of attack situations in which there were no block actions decreased significantly. The percentage of block attempts decreased significantly starting in the U-19 category. Regarding the tempo utilised to block, a predominance of third tempo blocks was observed in initiation stages (U-14, U-16 and U-19), and a predominance of second tempo blocks was observed in the senior stage. In higher categories; however, first and second tempo blocks increased significantly, while third tempo blocks decreased significantly. Starting at the U-16 category, all changes were significant, except for first and third tempo blocks, which changed significantly starting at the U-19 category.

Table 3. Number of blocks, mean team blocks per set, percentage of blocks per player per set, and statistically significant differences among categories.

	U-14			U-16			U-19			National			International		
	n	Mean	%	n	Mean	%	n	Mean	%	n	Mean	%	n	Mean	%
Attempted blocks	1710	14.25	56.58 ^A	1887	15.73	54.31 ^A	1769	14.74	50.91 ^{1A}	1636	13.63	49.38 ^{1*}	1445	12.25	46.15 ^{1*1}
1 st tempo	37	0.31	2.22	98	0.82	5.26 [†]	360	3.00	20.72 ^{1*}	397	3.31	24.20 ^{1*}	351	2.97	23.94 ^{1*}
2 nd tempo	0	0.00	0.00 ^a	56	0.47	2.80 ^{1a}	125	1.04	7.33 ^{1a}	771	6.43	47.57 ^{1*1a}	834	7.07	58.02 ^{1*1a}
3 rd tempo	1673	13.94	97.78 ^{ab}	1733	14.44	91.94 ^{†ab}	1284	10.70	71.95 ^{1*ab}	468	3.90	28.24 ^{1*1b}	260	2.20	18.03 ^{1*1ab}
Contacted blocks	642	5.35	20.70	1172	9.77	33.04 [†]	1347	11.23	38.39 ^{1*}	1541	12.84	46.19 ^{1*1}	1516	12.85	47.82 ^{1*1}
1 st tempo	37	0.31	6.63	76	0.63	6.34	231	1.93	17.82 ^{1*}	315	2.63	20.34 ^{1*}	242	2.05	16.28 ^{1*}
2 nd tempo	0	0.00	0.00 ^a	34	0.28	2.40 ^{1a}	88	0.73	6.61 ^{1*a}	755	6.29	49.30 ^{1*1a}	831	7.04	54.96 ^{1*1a}
3 rd tempo	605	5.04	93.37 ^{ab}	1062	8.85	91.27 ^{ab}	1028	8.57	75.57 ^{1*ab}	471	3.93	30.36 ^{1*1ab}	443	3.75	28.76 ^{1*1ab}
No blocks	660	5.50	22.72 ^B	443	3.69	12.65 ^{1AB}	350	2.92	10.19 ^{1*AB}	149	1.24	4.43 ^{1*1AB}	187	1.58	6.04 ^{1*1AB}
Total	3012	25.10	100	3502	29.18	100	3466	28.88	100	3326	27.72	100	3148	26.68	100

Note. [†] $p < .01$ when compared to U-14. ^{*} $p < .01$ when compared to U-16. ¹ $p < .01$ when compared to U-19. ¹ $p < .01$ when compared to national category. ^ASignificant differences when compared to "Contacted blocks".

^aSignificant differences when compared to "Attempted blocks". ¹Significant differences when compared to "1st tempo block". ^bSignificant differences when compared to "2nd tempo block".

When analysing the performance of first tempo blocks (Table 4), a predominance of block points in the U-14 category and of block errors in the other categories were observed. Block errors increased significantly beginning in the U-19 category, while block errors due to faults decreased significantly starting at U-16. When analysing the performance of second tempo blocks (Table 4), a predominance of block errors in all categories was found, except for the U-14 category in which there were no such attacks. A statistically

significant increase in positive blocks was detected when comparing senior categories (national and international) with U-19. As to the performance of third tempo blocks (Table 4), a predominance of block errors in all categories was observed. Regarding the national category, the evolution of performance of third tempo blocks showed a statistically significant decrease in errors due to faults and negative blocks. In contrast, a statistically significant increase in block points was found.

Table 4. Performance of contacted blocks with regard to spike tempo, and statistically significant differences between categories.

		U-14			U-16			U-19			National			International		
		n	Mean	%	n	Mean	%	n	Mean	%	n	Mean	%	n	Mean	%
1 st tempo block	Error	4	0.03	11.67	21	0.18	25.98	73	0.61	30.07 [†]	113	0.94	37.02 [†]	105	0.89	42.88 ^{†*}
	Error (rule)	6	0.05	16.67	1	0.01	1.09 ^{†a}	10	0.08	3.82 ^a	8	0.07	2.08 ^a	4	0.03	2.18 ^{†a}
	Negative block	7	0.06	16.67	22	0.18	24.60 ^b	54	0.45	20.91 ^b	77	0.64	21.90 ^{ab}	34	0.29	15.00 ^{ab}
	Positive block	8	0.07	25.00	18	0.15	24.96 ^b	47	0.39	23.33 ^b	63	0.53	20.25 ^{ab}	61	0.52	25.00 ^{abc}
	Point	12	0.10	30.00	14	0.12	23.37 ^b	47	0.39	21.87 ^b	54	0.45	18.74 ^{ab}	38	0.32	14.94 ^{abd}
Total		37	0.31	100	76	0.63	100	231	1.93	100	315	2.63	100	242	2.05	100
2 nd tempo block	Error	0	0.00	-	13	0.11	41.12	36	0.30	49.28	358	2.98	46.36	393	3.33	48.62
	Error (rule)	0	0.00	-	0	0.00	0.00 ^a	2	0.02	1.90 ^a	16	0.13	2.36 ^a	13	0.11	1.83 ^a
	Negative block	0	0.00	-	8	0.07	22.89 ^b	14	0.12	16.42 ^{ab}	118	0.98	16.92 ^{ab}	105	0.89	12.78 ^{ab}
	Positive block	0	0.00	-	6	0.05	19.69 ^b	15	0.13	11.33 ^{ab}	140	1.17	18.19 ^{‡ab}	162	1.37	18.78 ^{‡abc}
	Point	0	0.00	-	7	0.06	16.30 ^b	21	0.18	21.06 ^{ab}	123	1.03	16.17 ^{ab}	158	1.34	18.00 ^{abc}
Total		0	0.00	-	34	0.28	100	88	0.73	100	755	6.29	100	831	7.04	100
3 rd tempo block	Error	225	1.88	38.01	359	2.99	33.90	359	2.99	36.70	157	1.31	33.87	140	1.19	32.10
	Error (rule)	35	0.29	6.26 ^a	71	0.59	7.29 ^a	55	0.46	5.87 ^a	12	0.10	2.81 ^{†*‡a}	6	0.05	1.36 ^{†*‡a}
	Negative block	119	0.99	17.89 ^{ab}	211	1.76	18.44 ^{ab}	229	1.91	20.27 ^{ab}	83	0.69	17.14 ^{ab}	68	0.58	15.14 ^{‡ab}
	Positive block	123	1.03	21.49 ^{ab}	243	2.03	22.47 ^{abc}	235	1.96	22.49 ^{ab}	92	0.77	18.30 ^{ab}	117	0.99	25.24 ^{bc}
	Point	103	0.86	16.35 ^{ab}	178	1.48	17.90 ^{abd}	150	1.25	14.68 ^{abcd}	127	1.06	27.88 ^{†*‡bcd}	112	0.95	26.15 ^{‡bc}
Total		605	5.04	100	1062	8.85	100	1028	8.57	100	471	3.93	100	443	3.75	100

Note. [†] $p < .01$ when compared to U-14. ^{*} $p < .01$ when compared to U-16. [‡] $p < .01$ when compared to U-19. [§] $p < .01$ when compared to national category. ^a Significant differences when compared to “error”. ^b Significant differences when compared to “rule error”. ^c Significant differences when compared to “negative block”. ^d Significant differences when compared to “positive block”.

As for statistical parameters of total blocks (Table 5), a statistically significant decrease in the block point-to-error ratio between U-14 and senior categories (national and international) and a statistically significant increase in this same variable between U-14 and U-19 were found. Also, a statistically significant increase in efficacy starting at the national senior category was found. When analysing statistical parameters of first and second tempo blocks, there was a significant increase in the block point-to-error ratio as of the national senior category. Furthermore, there was a significant increase in the percentage of errors in first tempo blocks between the U-16 and international senior categories. Regarding the third tempo block, an increase in the coefficient, efficacy, and efficiency beginning with the senior

national category was observed, while a statistically significant decrease in percentage of error (between the initiation categories and the international senior category) and in the block point-to-error ratio (beginning with U-19) was also observed.

For court defence (Table 6), there was a significant predominance of digs with ball contact versus digs without ball contact throughout all categories. From the senior category upwards, a significant decrease in the percentage of digs with ball contact and a significant increase in the percentage of digs without ball contact were observed. For both types of dig, a predominance of third tempo actions at initial stages (U-14, U-16 and U-19) and of second tempo actions at senior stages (national and international) were found. A statistically

significant increase in digs for first and second tempo attacks and a statistically significant decrease in digs for third tempo attacks were observed. These changes were significant

beginning with U-16, except for first and third tempo digs with ball contact, which increased significantly from the U-19 category upwards.

Table 5. Block performance values and statistically significant differences between categories.

Type of block	Statistical data	U-14		U-16		U-19		National		International	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total Blocks	Coefficient	1.51	0.85	1.59	0.58	1.50	0.48	1.54	0.43	1.57	0.52
	Efficacy (%)	17.28	17.90	18.14	14.42	15.98	11.70	20.02↓	11.39	19.72↓	11.61
	Error (%)	43.80	27.41	40.17	16.64	41.11	16.67	43.35	12.92	45.32	15.53
	Efficiency (%)	-26.52	38.53	-22.03	24.54	-25.13	22.93	-23.33	20.60	-25.60	23.21
	Point:error	1:2.35	1.78	1:2.34	1.79	1:2.45↑	2.01	1:2.18↑	1.90	1:2.15↑	1.82
1st tempo block	Coefficient	2.12	1.60	1.93	1.46	1.78	1.24	1.58	1.15	1.50	1.16
	Efficacy (%)	30.00	44.72	23.37	40.28	21.87	31.24	18.74	28.19	14.94	26.41
	Error (%)	28.33	42.92	27.07	39.55	33.89	35.29	39.10	35.41	45.06*	37.27
	Efficiency (%)	1.67	73.68	-3.70	65.67	-12.02	56.09	-20.36	53.55	-30.13	52.75
	Point:error	1:0.83	0.32	1:1.57	0.60	1:1.77	0.96	1:2.24↑	1.05	1:2.87↑	0.73
2nd tempo block	Coefficient	.	.	1.47	1.13	1.35	1.38	1.36	0.69	1.41	0.73
	Efficacy (%)	.	.	16.30	19.84	21.06	31.54	16.17	15.20	18.00	16.97
	Error (%)	.	.	41.12	38.41	51.19	42.10	48.72	20.94	50.45	20.09
	Efficiency (%)	.	.	-24.82	46.93	-30.13	66.62	-32.55	30.95	-32.45	32.95
	Point:error	.	.	1:1.86	0.66	1:1.81	0.68	1:3.04↓	1.70	1:2.57↓	1.64
3rd tempo block	Coefficient	1.48	0.87	1.58	0.58	1.46	0.59	1.84↑*↓	0.94	1.95↑*↓	1.03
	Efficacy (%)	16.35	17.83	17.90	14.83	14.68	13.14	27.88↑*↓	24.66	26.15↓	27.36
	Error (%)	44.27	28.34	41.19	17.80	42.57	20.71	36.68	26.05	33.46↑*↓	28.59
	Efficiency (%)	-27.92	39.59	-23.29	25.05	-27.89	27.91	-8.80↑*↓	44.13	-7.31↑*↓	47.64
	Point:error	1:2.52	1.80	1:2.42	1.82	1:2.76↑	1.69	1:1.33↑*↓	0.95	1:1.30↑*↓	1.08

Note. †*p* < .01 when compared to U-14. **p* < .01 when compared to U-16. ‡*p* < .01 when compared to U-19. †*p* < .01 when compared to national category.

Table 6. Number of digs, mean team digs per set, percentage of digs per player per set, and statistically significant differences between categories.

	U-14			U-16			U-19			National			International		
	n	Mean	%	n	Mean	%	n	Mean	%	n	Mean	%	n	Mean	%
Non-contacted dig	344	2.87	18.42 ^A	389	3.24	20.68 ^A	362	3.02	22.01 ^A	500	4.17	34.19 ^{†*†A}	544	4.61	38.73 ^{†*†A}
1 st tempo	19	0.16	5.72	54	0.45	13.35 [†]	94	0.78	25.67 ^{†*}	182	1.52	37.74 ^{†*†}	175	1.48	31.39 ^{†*}
2 nd tempo	0	0.00	0.00 ^a	14 ^w	0.12	3.96 ^{†a}	31	0.26	6.91 ^{†a}	221	1.84	43.64 ^{†*†}	306	2.59	57.28 ^{†*†a}
3 rd tempo	325	2.71	94.28 ^{ab}	321	2.68	82.69 ^{†ab}	237	1.98	67.42 ^{†*ab}	97	0.81	18.61 ^{†*†ab}	63	0.53	11.32 ^{†*†ab}
Contacted digs	1592	13.27	81.58	1481	12.34	79.32	1256	10.47	77.99	998	8.32	65.81 ^{†*†}	855	7.25	61.27 ^{†*†}
1 st tempo	114	0.95	6.80	115	0.96	7.68	258	2.15	20.81 ^{†*}	218	1.82	22.21 ^{†*}	172	1.46	20.19 ^{†*}
2 nd tempo	0	0.00	0.00 ^a	38	0.32	2.33 ^{†a}	72	0.60	6.28 ^{†a}	444	3.70	44.67 ^{†*†a}	448	3.80	51.44 ^{†*†a}
3 rd tempo	1478	12.32	93.20 ^{ab}	1328	11.07	89.99 ^{ab}	926	7.72	72.90 ^{†*ab}	336	2.80	33.13 ^{†*†ab}	235	1.99	28.37 ^{†*†ab}
Total	1936	16.13	100	1870	15.58	100	1618	13.48	100	1498	12.48	100	1399	11.86	100

Note. †*p* < .01 when compared to U-14. **p* < .01 when compared to U-16. ‡*p* < .01 when compared to U-19. †*p* < .01 when compared to national category. ^A Significant differences when compared to “Contacted digs”. ^a Significant differences when compared to “1st tempo dig”. ^b Significant differences when compared to “2nd tempo dig”.

When analysing first tempo digs (Table 7), predominance of positive digs in U-14, U-16, and U-19 and of dig errors in the senior national and international categories were observed. An increase in errors beginning at U-19 and a statistically significant decrease in negative and positive digs starting at the national

senior category were found. Concerning second tempo digs (Table 7), there was a predominance of dig errors in all categories, except for U-14 as no data were recorded. There were no differences between categories for the evolution of performance of this action, yet a decrease in negative digs and an increase in positive digs

were observed. Regarding the analysis of third tempo digs (Table 7), a predominance of positive digs in all categories was observed. There was a significant decrease in dig errors (between the U-14 and international senior categories) as well as in negative digs (starting with the U-19 category). On the other hand, an increase in positive digs beginning with the U-16 category was observed.

When analysing the statistical data of the total number of digs and first tempo digs (Table 8), there was a significant increase in the percentage of error and in the positive-dig-to-negative-dig ratio as well as a significant decrease in the coefficient, efficiency, and effectiveness. All

these changes were significant starting at the national senior level, except for the first tempo defence ratio variable, which showed a significant increase in the beginning at the U-19 category. For the second tempo dig, a significant increase in the positive-dig-to-negative-dig ratio between the national category and U-16 was observed. For the third tempo defence, there were an increase in the coefficient, efficiency (starting at U-19), and efficiency (starting with the national category) and decrease in the percentage of errors (for the international senior category) and in the ratio (starting at the national category).

Table 7. Performance of contacted digs with regard to spike tempo, and statistically significant differences between categories.

		U-14			U-16			U-19			National			International		
		n	Mean	%	n	Mean	%	n	Mean	%	n	Mean	%	n	Mean	%
1 st tempo dig	Error	22	0.18	17.63	29	0.24	21.64	79	0.66	30.48 [†]	118	0.98	55.15 ^{*†}	89	0.75	53.83 ^{*†}
	Negative dig	2	0.24	25.72	27	0.23	23.23	63	0.53	23.55	32	0.27	13.72 ^{‡a}	15	0.13	7.87 ^{*†a}
	Positive dig	63	0.53	56.64 ^{ab}	59	0.49	55.13 ^{ab}	116	0.97	45.98 ^b	68	0.57	31.13 ^{*†ab}	68	0.58	38.30 ^{†b}
Total		114	0.95	100	115	0.96	100	258	2.15	100	218	1.82	100	172	1.46	100
2 nd tempo dig	Error	0	0.00	-	14	0.12	40.08	37	0.31	54.97	227	1.89	52.66	222	1.88	48.47
	Negative dig	0	0.00	-	13	0.11	36.31	13	0.11	21.78	70	0.58	14.31 ^a	58	0.49	13.87 ^a
	Positive dig	0	0.00	-	11	0.09	23.61	22	0.18	23.25	147	1.23	33.03 ^{ab}	168	1.42	37.65 ^b
Total		0	0.00	-	38	0.32	100	72	0.60	100	444	3.70	100	448	3.80	100
3 rd tempo dig	Error	405	3.38	30.11	351	2.93	25.77	238	1.98	27.26	89	0.74	28.39	52	0.44	25.60 [†]
	Negative dig	408	3.40	26.58	329	2.74	24.60	203	1.69	20.29 ^{‡a}	47	0.39	13.31 ^{*†a}	20	0.17	7.81 ^{*†a}
	Positive dig	665	5.54	43.31 ^{ab}	648	5.40	49.63 ^{†ab}	485	4.04	52.45 ^{†ab}	200	1.67	58.29 ^{†ab}	163	1.38	66.59 ^{*†ab}
Total		1478	12.32	100	1328	11.07	100	926	7.72	100	336	2.80	100	235	1.99	100

Note. [†]*p* < .01 when compared to U-14. ^{*}*p* < .01 when compared to U-16. [‡]*p* < .01 when compared to U-19. [§]*p* < .01 when compared to national category. ^a Significant differences when compared to “error”. ^b Significant differences when compared to “negative dig”.

Table 8. Dig performance values and statistically significant differences among categories

Types of court defence	Statistical data	U-14		U-16		U-19		National		International	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total dig	Coefficient	1.59	0.51	1.72	0.48	1.69	0.52	1.37 ^{*†}	0.55	1.50 [*]	0.62
	Efficacy (%)	44.33	17.80	48.90	17.82	49.31	19.18	41.24 ^{*†}	19.06	46.55	21.65
	Error (%)	29.31	18.52	26.33	15.35	29.93	17.22	45.40 ^{*†}	19.86	42.74 ^{*†}	20.88
	Efficiency (%)	15.07	33.73	22.57	30.52	19.29	33.84	-4.11 ^{*†}	36.62	3.78 ^{*†}	40.56
	Positive:error ratio	1:0.59	0.76	1:0.55	0.84	1:0.57	1.03	1:1.05 ^{*†}	1.23	1:0.91 ^{*†}	1.22
1 st tempo dig	Coefficient	1.96	1.06	1.89	1.16	1.61	1.03	1.07 ^{*†}	1.08	1.23 ^{**}	1.17
	Efficacy (%)	56.65	43.30	55.12	45.15	45.98	38.95	31.11 ^{*†}	36.87	38.29 [†]	39.88
	Error (%)	17.62	31.68	21.65	37.30	30.43 [†]	35.22	55.17 ^{*†}	40.94	53.84 ^{*†}	41.86
	Efficiency (%)	39.01	65.48	33.50	73.40	15.49	66.35	-24.01 ^{*†}	72.89	-15.53 ^{*†}	78.42
	Positive:error ratio	1:0.35	0.45	1:0.49	0.61	1:0.68 [*]	0.55	1:1.74 ^{**}	1.01	1:1.31 [*]	0.86
2 nd tempo dig	Coefficient	.	.	1.07	1.02	0.92	0.95	1.13	0.79	1.27	0.89
	Efficacy (%)	.	.	23.62	37.65	23.23	31.96	33.03	27.86	37.65	31.30
	Error (%)	.	.	40.05	42.79	54.97	43.29	52.67	29.23	48.48	30.61
	Efficiency (%)	.	.	-16.43	68.69	-31.73	66.45	-19.64	52.98	-10.83	58.67
	Positive:error ratio	.	.	1:1.27	0.47	1:1.68	1.61	1:1.54 [*]	1.27	1:1.32	0.92
3 rd tempo dig	Coefficient	1.57	0.53	1.74	0.47	1.78 [†]	0.61	1.88 [†]	0.98	2.08 ^{*†}	1.03
	Efficacy (%)	43.35	18.67	49.65	18.19	52.48 [†]	22.46	58.30 [†]	35.26	66.61 ^{*†}	36.02
	Error (%)	30.12	19.18	25.81	15.57	27.29	20.12	28.40	32.43	25.57 [†]	34.44
	Efficiency (%)	13.19	35.17	23.88	29.97	25.16	39.44	29.94 [†]	63.86	40.97 ^{*†}	67.65
	Positive:error ratio	1:0.61	0.99	1:0.54	0.79	1:0.49	0.88	1:0.45 ^{*†}	0.54	1:0.32 ^{*†}	0.45

Note. [†]*p* < .01 when compared to U-14. ^{*}*p* < .01 when compared to U-16. [‡]*p* < .01 when compared to U-19. [§]*p* < .01 when compared to national category.

Discussion

This study demonstrates the technical-tactical performance profile of blocking and court defence depending on attack tempo at various age groups and categories of competition in men's volleyball. As the category increases, there is a significant increase in block and court defence for first and second tempo spikes and a significant decrease in these actions for third tempo spikes, with or without contact with the ball. Regarding performance, only the block and court defence for third tempo spikes showed increased efficiency (block points and digs which allow a team to set up their counterattack).

An increase in contacted blocks when progressing to higher categories may be related to players' anthropometric development and physical abilities (Grgantov *et al.*, 2006). Physical improvements would restrain the spike; thus increasing the percentage of contacted blocks. However, players' development may not be enough to prevent a decline in the percentage of contacted digs which occur when the ball avoids a block and heads toward the opponent's court. When comparing blocks and digs, the percentage of ball contacts for digs is greater than the percentage of ball contacts for blocks throughout all categories. This could be related to a shortage of time to set up a block depending on how close one is to the opponent's spike. Thus, the proximity of blockers to the spike would hinder their perception and interception of the ball and its path, while defenders would have more time to identify and respond to it (Selinger & Ackerman-Blount, 1985).

An increase in blocks and digs for first and second tempo spikes (contacted and non-contacted) demonstrates that the higher the category, the higher the speed of play. This is positively affected by an improvement in reception and court defence performance which occurs in higher ages and categories of competition (García-Alcaraz, Palao, & Ortega, 2014; Grgantov *et al.*, 2006). An increase in the speed of the game may reduce the time available for defensive actions, thus limiting both the number of players who may block (Afonso, Mesquita, & Palao, 2005) and the defensive moves (Afonso *et al.*, 2005, 2010; Selinger & Ackermann-Blount, 1985). This limitation of perception and execution on defensive actions is intended to counteract the increase in the height of the net (FIVB, 2008), the increase in the height of the players, and the development of players' physical abilities (e.g. jump, speed, etc.) (Grgantov *et al.*, 2006), which are variables that may favour the performance of defensive actions when progressing to higher categories.

Regarding the performance of the block and court defence, there was a significant improvement in performance for slow attacks when analysing higher categories. This may be related to the amount of time available for defenders to execute their defensive actions. Previous studies have demonstrated that a shortage in time determines players' defensive moves (Afonso *et al.*, 2010; Afonso *et al.*, 2005; Selinger & Ackermann-Blount, 1985), thus limiting the execution of a cohesive block (Bergeles & Nikolaidou, 2011) and the number of blockers (Afonso *et al.*, 2005). On the other hand, an increase in time for slow attacks fosters anticipation, decision-making, and players' moves when blocking and defending. This is because slow attack times are related to low-performance receptions (Papadimitriou, Paschali,

Sermaki, Mellas, & Papas, 2004), which limit the options for attacking and determine the setting zone, thus promoting the set-up of a block with a larger number of players (Afonso *et al.*, 2005). An improvement in performance of court defence in slow attacks may also be due to the relationship between court defence (i.e. the second line of defence) and the block (i.e. the first line of defence). Increasing the number of blockers (Afonso *et al.*, 2005), or setting up a more cohesive block (Bergeles & Nikolaidou, 2011), reduces the number of trajectories of attack aimed at areas not covered by defenders, thus facilitating the performance of court defence.

The significant improvement in performance of blocks and court defence for slow attacks may explain the significant decrease in the percentage of blocks and digs contacted in slow attacks. Regarding the block, this decline would be related to the spiker's performance, particularly in one's ability to avoid getting blocked. Thus, the increase in training and players' experience as they progress to higher categories would improve their ability to spike. In contrast, temporal limitations of the block in fast attacks would be an advantage for spikers, who may perform better when attacking against this limited block. In this regard, Rocha and Barbanti (2004) found an increase in the attack's efficacy when the ball contacts the block, although the attack tempo is not specified. As for defence, a significant increase in the percentage of contacted digs in fast attacks (first and second tempo) may be related to a decrease in the number of blockers (Afonso *et al.*, 2005), which promotes the increase in the number of balls headed toward diggers.

These results present the performance profile of blocking and court defence according to attack tempo in various categories of competition. The data provide reference values which may be useful when setting training and competition objectives for the various categories. Due to the relationship between defensive actions and attack tempo and between attack tempo and performance in previous actions (i.e. reception/defence and set) (Eom & Schutz, 1992), there is a need for further research on the effect of these variables on block and court defence performance. Thus, the attack that is set up upon receiving the ball is different in terms of offensive actions that are set up from a team's defence, mainly due to the setter's location and the spikers' availability to counterattack as quickly as possible (Castro & Mesquita, 2010). Variables such as spike direction distance between the point where the spiker hits the ball and the blocker positions his hands, ball speed, number of blockers, defence area, player role, set momentum, etc., may also need further analysis.

Conclusions

The results of this study show changes in the performance of the block and court defence depending on various age groups and competition level. When progressing to higher categories, there is a significant increase in the percentage of contacted blocks and digs with no ball contact, a significant increase in the percentage of defensive actions (i.e. blocks and digs) contacted in quick attacks (i.e. second and first tempo), and a significant improvement in performance in slow attacks (i.e. third tempo). These data may contribute to developing a technical-tactical performance profile of blocking and court defence in various

categories of competition. These values may help to develop training programs, assess performance in competition, and expand knowledge about variables that describe performance. Nevertheless, the complex interaction of defensive actions with other game variables, such as attack time, attack zone, height of block, etc., requires further study which would fulfil a gap in current knowledge of performance variables.

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