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EFFECT OF AGE AND LEVEL OF COMPETITION ON EVOLUTION OF OFFENSIVE ACTIONS' EFFICACY AND ITS EFFECT ON THE GAME IN WOMEN'S VOLLEYBALL: A PILOT STUDY

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ABSTRACT

PURPOSES: The purpose of this study was to determine the effect of age and level of competition on the evolution of the offensive actions' efficacy and its effect on the game in women's volleyball. **METHODS:** The sample was six teams (two from the Spanish junior national level, two from the Spanish senior national level, and two from the senior international level). The variables studied were: level of competition (junior national, senior national, and senior international), game phase, reception performance, set performance, attack performance, type of attack, number of players blocking, and result of the play. **RESULTS:** The evolution between different ages and levels of competition correlates with a reduction of errors, an increase in the actions that allow teammates optimal actions, and increased speed in the game. **CONCLUSION:** The article discusses how analyzed teams build their offense in the different phases and the implications of the data on understanding game dynamics and training.

Keywords: match analysis, performance, volleyball, attack

INTRODUCTION

In sports, players' and teams' interactions affect other's actions. Additionally, the execution of the different actions of the game is influenced by the interacting aspects in this complex dynamic system: task, environment, and subjects (Glazier, 2010; Newell, 1986). In volleyball, these interactions between the game actions can be observed, because the execution of the different actions of the game is directly affected by the previous one (Eom & Schutz,

1992a; 1992b). This effect between actions has been studied in peak performance volleyball (e.g., Bergeles, Barzouka, & Nikolaidou, 2009; Bergeles & Nikolaidou, 2011). The strength of this relationship is stronger in the first part of the rally, and it is weaker when the ball goes over the net several times (Palao, Santos, & Ureña, 2006, 2007).

In the review done, how these relationships change in the different stages of the players' formation has been not found. For senior players, the team's level influences this relationship between actions (Marcelino, Mesquita, & Sampaio, 2010). However, it is not clear how differences in maturation or development (Malina, Bouchard, & Bar-Or, 2004), years of experience (e.g., practice and competition) (Gabbett et al., 2006), etc., of the different age groups affect the relationship between actions.

Not all the actions have the same effect on the game. The spike is the game action that correlates most with the final result (Drikos, & Vagenas, 2011; Palao, Santos, & Ureña, 2004; Peña, et al., 2013; Zetou, et al., 2007). This tendency is observed in international senior and U-19 women's volleyball (Inkinen, Häyrynen, & Linnamo, 2013). The spike efficacy varies in the different phases of the game (Palao, Santos, & Ureña, 2007). The attack executed after the reception is more efficacious than the attack executed after a court defense (Eom & Schutz, 1992b; Palao, Santos, & Ureña, 2007). Some of the possible reasons for these differences include the ball's trajectory and the speed or time that receivers and defenders have to neutralise the serve and attack. A better previous situation allows the setter to build the offense under better conditions (Araujo et al., 2010; Costa et al., 2011). Another aspect to consider in the study of spike efficacy is the manner of execution and the phase of the game (Palao, Santos, & Ureña, 2007).

In women's volleyball, only one study has been found that analyzed the relationship between the previous actions and the spike efficacy in different age groups. Palao and Echeverria (2008) found that the use of the jump set increased spike efficacy, and its use was higher among senior players than U-18 players. They hypothesized that the reasons for these results were the use of the jump set

and the situation that surrounded its use, such as better reception performance. No studies have tested this hypothesis. Inkinen, Häyrynen, and Linnamo (2013) found better reception, set, and attack performance in national teams than in under-18 national teams.

In men's volleyball, it has been found that the older the players are in the formation stages the better they are at neutralizing the opponent's serve and better organise their offense (Garcia-Alcaraz, Palao, & Ortega, 2014). Therefore, it is not clear how players' reception skills or ability to build their offense evolve in different age groups and levels of competition in women's volleyball. The lack of information about how players develop limits the correct understanding of the training process of a sport. If only data or criteria from the peak performance level are considered, it is possible that coaches are using unrealistic values to guide the formation process of their players. The purpose of this study was to assess the effect of age and level of competition on the evolution of the offensive actions' efficacy and its effect on the game in women's volleyball.

METHOD

The sample was composed of the actions of six women's teams (two under-18 teams, two Spanish first division teams, and two national teams). The teams that were selected were the first- and second- ranked teams in their competition (2002 under-18 Spanish National Championship, 2004-2005 Spanish first division, and 2002 World Championship), and the matches that were selected were the finals of the competitions. A total of 289 rallies from four sets of under-18, 374 rallies from four sets of the Spanish first division, and 374 rallies from five sets of the World Championship division were analyzed. The video recordings of the matches were obtained from the researchers' own

recordings and the Spanish National Federation.

The variables analyzed were: level of competition (under-18 Spanish national championship, Spanish first division, and Olympic Games), phase (side-out (KI), side-out defense phase (KII), and counter-attack defense phase (KIII)), reception performance, set performance, attack performance, type of attack (1st tempo, 2nd tempo, 3rd tempo, attack from back row, or second contact), number of players that block, and result of the play (win or lose, for the attacking team). The unit of analysis was the phase of the rally.

The actions' performance was evaluated in relation to the success of the action and the options it gave the opponent (Coleman et al., 1969). Five levels for attack actions were distinguished (error, maximum opponent attack options or no attack options, opponent limited attack options or team limited attack options, no opponent attack options or maximum team attack options, or point). Four levels for continuous actions (reception and set) were distinguished (error, no attack options, team limited attack options, or team attacked or counter-attacked with all attack options). Only the actions where players contacted the ball were registered. With the categories of reception, set, and attack performance, an efficacy coefficient (sum of the attempts per category multiplied by the value of the category and divided by the total attempts) was calculated (Coleman et al., 1969).

The matches were analyzed through systematic observation by two observers who were trained using the methodology described by Anguera (2003). The matches were recorded from a posterior view. Inter- and intra-reliability of observers were calculated. An inter-reliability index of 0.85 and an intra-reliability index of 0.97 were found (intra-class correlation coefficient and Kappa index). Descriptive and inferential analyses of the

different variables were carried out (count, percentage, chi-square test, and likelihood ratio), using SPSS software with statistical significance set at $p < 0.05$.

RESULTS

The reception performance improved from the under-18 level to the international level through a reduction in the errors and an increase in the actions that allow all attack options as well as in the efficacy coefficient (Table 1). The court defense performance does not present a clear tendency. For the counter-attack defense phase, the under-18 teams presented more digs that allowed all attacks options, and the international teams presented more digs that allowed an attack. No significant differences were found for the dig performance in the defense phase.

From a descriptive analysis, the set performance increased from the under-18 level to the international level; through a reduction of the errors (side-out phase) and actions that limited attacks options, and an increase of the actions that allow all attack options and efficacy coefficient (Table 2). No significant differences were found in the set performance in the counter-attack defense phase.

The attack performance in the side-out improved from the under-18 level to the international level, through a decrease in errors and increases in the attack points and the efficacy coefficient (Table 3). No significant differences were found in the defense phase or the counter-attack defense phase regarding the attack performance.

The use of the different type of attack in the side-out changed between levels of competition studied (Table 4). In under-18 teams, there was a significantly higher use of slow attack (3rd tempo and back-row attacks). In Spanish first division teams, there was a significantly higher use of quick attacks (first

tempo). In World Championship teams, there were a significant lower use of slow attack (3rd tempo) and a higher use of second tempo attacks. No significant differences were found in the other game phases (KII and KIII).

Regarding the numbers of blockers, senior international teams had a significantly higher use of the block of three players in the side-out and defense phase (Table 5). No significant difference was found in the numbers of blockers in the national under-18 teams, and senior national teams.

A significantly higher number of loss side-out in under-18 national teams were found (Table 6). No significant differences were found in senior national teams and senior international teams.

Table 1. Reception and dig performance according to phase of the game and level of competition.

Category	Phase	Error		No attack		Limited attack		All attack options		Total		Efficacy coefficient
		n	%	n	%	N	%	n	%	n	%	
Under-18	KI	18 ⁺	11.32	24 ⁺	15.09	69	43.40	48 ⁻	30.19	159	53.5	1.92
	KII	0	0.00	10	15.87	40	63.49	13	20.63	63	21.2	2.05
	KIII	0	0.00	11 ⁺	14.67	33 ⁻	44.00	31 ⁺	41.33	75	25.3	2.27
	Total	18	6.06	45	15.15	142	47.81	92	30.98	297	100	2.04
Spanish first division	KI	9	5.33	12	7.10	81	47.93	67	39.64	169	53.7	2.22
	KII	1	1.79	10	17.86	32	57.14	13	23.21	56	17.8	2.02
	KIII	0	0.00	4	4.44	56	62.22	30	33.33	90	28.6	2.29
	Total	10	3.17	26	8.25	169	53.65	110	34.92	315	100	2.20
World Championship	KI	0 ⁻	0.00	11 ⁻	6.36	74	42.77	88 ⁺	50.87	173	55.1	2.45
	KII	0	0.00	4	6.78	31	52.54	24	40.68	59	18.8	2.34
	KIII	0	0.00	5 ⁻	6.10	64 ⁺	78.05	13 ⁻	15.85	82	26.1	2.10
	Total	0	0.00	20	6.37	169	53.82	125	39.81	314	100	2.33

⁺ or ⁻ Positive or negative statistical significance between levels of competition (p<.001).

Table 2. Set performance regarding phase of the game and level of competition.

Category	Phase	Error		No attack		Limited attack		All attack options		Total		Efficacy coefficient
		n	%	n	%	N	%	n	%	n	%	
Under-18	KI	2 ⁺	1.77	8	7.08	50 ⁺	44.25	53 ⁻	46.90	113	50.4	2.36
	KII	2	3.92	1	1.96	33 ⁺	64.71	15 ⁻	29.41	51	22.8	2.20
	KIII	1	1.67	3	5.00	25	41.67	31	51.67	60	26.8	2.43
	Total	5	2.23	12	5.36	108	48.21	99	44.20	224	100	2.34
Spanish first division	KI	0	0.00	5	3.45	40	27.59	100	68.97	145	53.5	2.66
	KII	1	2.33	2	4.65	15	34.88	25	58.14	43	15.9	2.49
	KIII	0	0.00	2	2.41	33	39.76	48	57.83	83	30.6	2.55
	Total	1	0.37	9	3.32	88	32.47	173	63.84	271	100	2.60
	KI	0 ⁻	0.00	3	1.86	29 ⁻	18.01	129 ⁺	80.12	161	54.9	2.78

World	KII	0	0.00	1	1.82	13-	23.64	41 ⁺	74.55	55	18.8	2.73
Championship	KIII	0	0.00	1	1.30	35	45.45	41	53.25	77	26.3	2.52
	Total	0	0.00	5	1.71	77	26.28	211	72.01	293	100	2.70

⁺ or ⁻ Positive or negative statistical significance between levels of competition (p<.000).

Table 3. Attack performance regarding phase of the game and level of competition.

Category	Phase	Error		Allows all attack		Limits attack		No attack		Point		Total		Efficacy coefficient
		N	%	n	%	n	%	n	%	n	%	n	%	
Under-18	KI	27 ⁺	23.08	14	11.97	36	30.77	5	4.27	35 ⁻	29.91	117	50.0	2.06
	KII	8	15.09	7	13.21	12	22.64	3	5.66	23	43.40	53	22.6	2.49
	KIII	10	15.63	12	18.75	15	23.44	5	7.81	22	34.38	64	27.4	2.27
	Total	45	19.23	33	14.10	63	26.92	13	5.56	80	34.19	234	100	2.21
Spanish first division	KI	26	17.57	22	14.86	30	20.27	15 ⁺	10.14	55	37.16	148	53.0	2.34
	KII	8	17.78	8	17.78	9	20.00	3	6.67	17	37.78	45	16.1	2.29
	KIII	16	18.60	15	17.44	25	29.07	3	3.49	27	31.40	86	30.8	2.12
	Total	50	17.92	45	16.13	64	22.94	21	7.53	99	35.48	279	100	2.27
World Champ	KI	24 ⁻	14.81	34 ⁺	20.99	29	17.90	7	4.32	68 ⁺	41.98	162	55.1	2.38
	KII	11	20.00	6	10.91	13	23.64	2	3.64	23	41.82	55	18.7	2.36
	KIII	15	19.48	11	14.29	22	28.57	2	2.60	27	35.06	77	26.2	2.19
	Total	50	17.01	51	17.35	64	21.77	11	3.74	118	40.14	294	100	2.33

⁺ or ⁻ Positive or negative statistical significance between levels of competition (p<.002).

Table 4. Type of attack regarding phase of the game and level of competition.

Category	Phase	1 st tempo		2 nd tempo		3 rd tempo		Back-row attack		Second contact		Total	
		n	%	n	%	n	%	n	%	n	%	n	%
Under-18	KI	6 ⁻	5.45	20 ⁻	18.18	64 ⁺	58.18	20 ⁺	18.18	1	0.95	111	50.2
	KII	0	0.00	3	6.25	30	62.50	15	31.25	2	4.00	50	22.6
	KIII	4	6.78	8	13.56	32	54.24	15	25.42	1	1.79	60	27.1
	Total	10	4.61	31	14.29	126	58.06	50	23.04	4	1.90	221	100
Spanish first division	KI	36 ⁺	25.53	63	44.68	34 ⁻	24.11	8 ⁻	5.67	4	3.67	145	52.9
	KII	4	9.52	11	26.19	24	57.14	3	7.14	2	5.00	44	16.1
	KIII	10	12.05	25	30.12	34	40.96	14	16.87	2	2.67	85	31.0
	Total	50	18.80	99	37.22	92	34.59	25	9.40	8	3.57	274	100
World Championship.	KI	25	15.63	95 ⁺	59.38	29 ⁻	18.13	11	6.88	1	0.74	161	54.9
	KII	1	1.82	22	40.00	19	34.55	13	23.64	0	0.00	55	18.8
	KIII	1	1.30	24	31.17	40	51.95	12	15.58	0	0.00	77	26.3
	Total	27	9.25	141	48.29	88	30.14	36	12.33	1	0.38	293	100

⁺ or ⁻ Positive or negative statistical significance between levels of competition (p<.000).

Table 5. Number of blockers and attack performance regarding phase of the game and level of competition.

Category	Phase	No block		One blocker		Two blockers		Three blockers		Total		Coeff. efficacy
		n	%	n	%	n	%	n	%	n	%	
Under-18	KI	3	2.75	23	21.10	81	74.31	2	1.83	109	50.7	1.75
	KII	2	4.17	8	16.67	37	77.08	1	2.08	48	22.3	1.77
	KIII	3	5.17	21	36.21	32	55.17	2	3.45	58	27.0	1.57
	Total	8	3.72	52	24.19	150	69.77	5	2.33	215	100.0	1.71
Spanish first division	KI	0	0.00	51	36.69	87	62.59	1	0.72	139	54.3	1.64
	KII	1	2.44	9	21.95	29	70.73	2	4.88	41	16.0	1.78
	KIII	1	1.32	26	34.21	48	63.16	1	1.32	76	29.7	1.64
	Total	2	0.78	86	33.59	164	64.06	4	1.56	256	100.0	1.66
World Championship.	KI	4	2.52	49	30.82	98	61.64	8 ⁺	5.03	159	55.0	1.69
	KII	0	0.00	14	25.45	31	56.36	10 ⁺	18.18	55	19.0	1.93
	KIII	2	2.67	10	13.33	50	66.67	13	17.33	75	26.0	1.99
	Total	6	2.08	73	25.26	179	61.94	31	10.73	289	100.0	1.81

⁺ or ⁻ Positive or negative statistical significance between levels of competition (p<.017).

Table 6. Rally result regarding phase of the game and level of competition.

Category	Phase	Win		Lose		Total	
		n	%	n	%	n	%
Under-18	KI	84 ⁻	47.19	94 ⁺	52.81	178	56.3
	KII	35	55.56	28	44.44	63	19.9
	KIII	43	57.33	32	42.67	75	23.7
	Total	162	51.27	154	48.73	316	100
Spanish first division	KI	110	60.11	73	39.89	183	55.6
	KII	27	48.21	29	51.79	56	17.0
	KIII	51	56.67	39	43.33	90	27.4
	Total	188	57.14	141	42.86	329	100
World Championship	KI	118	62.11	72	37.89	190	57.2
	KII	32	54.24	27	45.76	59	17.8
	KIII	46	55.42	37	44.58	83	25.0
	Total	196	59.04	136	40.96	332	100

⁺ or ⁻ Positive or negative statistical significance between levels of competition ($p < .008$).

DISCUSSION

The purpose of this study was to find out the effect of age and level of competition on the evolution of offensive actions efficacy and its effect on the game in women's volleyball. The data found show changes in the manner in which the offense is build and the efficacy of the actions involved regarding age and level of competition. Data show that at higher is the group age, higher is the reception, set, and attack performance. These results confirm the findings of previous studies in women and men volleyball (García-Alcaraz, Palao, & Ortega, 2014; Inkinen, Häyrynen, & Linnamo, 2013; Palao & Echeverria, 2008). Older and more experienced players neutralize better the opponent serve and they are more effective building their offense. This increase of efficacy was only found in the first part of the rally sequence (side-out) and no in the rest of the phases. These results confirm the relationship between the actions of the side-out found by previous research in senior population (Bergeles, Barzouka, & Nikolaidou, 2009; Bergeles & Nikolaidou, 2011; Palao, Santos, & Ureña, 2006). Side-out is a phase of the rally more structure, and organize for teams (teams' strategy plans).

Defense phases are more unpredictable

because the starting situation can vary a lot.

Comparing the differences between the levels of competition, data shows that under-18 teams do not have a strong side-out phase that correlates with winning the rally. The cause of this could be the lower reception, set and attack performance and the use of slow attacks. Senior international teams present a better performance in reception, set, and attack actions in the side-out and a lower use of slow attacks. These results are similar to previous studies done in elite women's volleyball (Palao, Santos, & Ureña, 2006, 2007). The current study shows how to evolve the team offense through under-18 to international level. The increase in the performance of the different actions are probability relationship between them. A better reception allows the setter to play in better conditions and to build quicker offense (Palao, Santos, & Ureña, 2006). These involve probably better conditions for the attackers, who obtain higher performance in their actions (Palao, Santos, & Ureña, 2007). The results confirm the findings of previous research done at the international level and show the way that offense is building and evolve from under-18 teams to senior teams.

The results show that women's volleyball at the international level (world championship) organize and control their offenses in the side-out phase. They have the ability to neutralize the serve and build organize offense. In under -18 teams, the ability to neutralize the serve is lower and it creates uncertainty in their game. These tendencies are similar to the found in women's and men's volleyball by previous research (García-Alcaraz, Palao, & Ortega, 2014; Inkinen, Häyrynen, & Linnamo, 2013). Data show teams, independently the age and the level, cannot control and manage with their blocks and digs the uncertainty of the offense (attack zone, tempo, direction, speed, etc.). These made that the relationship between the different actions are clear in the side-out phase, and cannot found in defense phases. These results differ from previous studies done in senior men's and women's volleyball regarding spike (Palao, Santos, & Ureña, 2006), but they are similar to previous research regard rally phases efficacy (Palao, 2004). More studies are needed to understand the success of the counter-attack offense and defense. At this level, it must consider that the women's volleyball players present lower jump and hit values (Palao & Valades, 2014; Palao, Valades, & Ortega, 2014). Therefore, although the net height, the women's spike is less effective in women's volleyball, and there is more continuity in the game than men's volleyball (Palao, Santos, & Ureña, 2006). This differences in the task (rule 2.1. height of the net, FIVB, 2012) and characteristics of the players affect the dynamic system (Palao, Valades, & Ortega, 2014). Therefore, results suggest women should have different reference values and criteria that men and it should not be establish the same criteria through different formation stage of the players. The lack of information about women's volleyball made that women's coaches are using data from men's volleyball, using subjective information, or trial-error

methods. The results show quantitative the changes in the performance of the actions and the use of different types of attacks from one category to other. These values can show how the game evolves and the aspects that must be considered in the formation stages. However, it must be considered that the present study is a pilot study, and more data is needed to confirm these findings.

CONCLUSIONS

The evolution between different levels of competitions involves a reduction of errors, an increase in the actions that allow the teammates optimal options, and an increase the speed in the game. There are differences between how teams handle different phases of the game regarding age and level. International teams control better the uncertainty of the game in the side-out phase (reception phase). Data show that teams at different levels have different ways and manner of playing, and they need specific reference values and goals in their training. Data must be carefully interpreted due to the reduce sample analyze in this study. However , the results show that more studies are needed to study how different sports evolve through the different stage of player's formation. Future studies must consider other variables related to offense, such as rotation, setter's position, or zone of executions.

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