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Game phases performance in men's volleyball: from initial to top-level categories

Rendimiento de las fases de juego en voleibol masculino: desde la iniciación hasta las categorías de alto rendimiento

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Abstract

This study aimed to analyze the evolution of the game phases performance and the way of scoring points throughout different age groups and levels of competition in male volleyball. The sample was 53,320 game phases performed in 299 sets from five competition categories (national under-14, national under-16, national under-19, senior national and senior international). An observational design was used. The variables were: competition category, game phase performance, and way that points were scored. The higher the category, the higher the points in attack and side-out phase (from 48.37% -U14- to 69.61% -senior international-) and the lower points by the serving team (from 51.63% -U14- to 30.39% -senior international-). The opponent errors decreased as move to higher categories. The greater differences were observed between initial stages (under-14, under-16, and under-19) and senior categories. The cause of these results is related to the increase of the points scored by the attack in the side-out phase. The contributions of the different actions change through the developmental process from initial to top-level categories. This information may be useful to understand the technical-tactical training progression and to evaluate the long term athlete development of male volleyball players.

Keywords: team sports; performance; match analysis; player development.

Resumen

Este estudio trató de analizar la evolución del rendimiento de las fases de juego y la forma de puntuar a lo largo de diferentes grupos de edad y niveles de competición en voleibol masculino. La muestra fue de 53.320 fases de juego realizadas en 299 sets en cinco categorías de competición (nacional sub-14, nacional sub-16, nacional sub-19, senior nacional y senior internacional). Se empleó un diseño observacional. Las variables fueron: categoría de competición, rendimiento de la fase de juego, y forma de puntuar. A mayor categoría de competición, se registraron más puntos de ataque y salida de recepción (desde 48.37% -sub-14- hasta 69.61% -senior internacional-), y menos puntos para el equipo sacador (from 51.63% - sub-14- to 30.39% -senior internacional-). Los errores del oponente disminuyeron conforme se avanzó a categorías superiores. Las mayores diferencias se observaron entre las categorías iniciales (sub-14, sub-16, y sub-19) y las categorías senior. La causa de estos resultados se relaciona con el incremento de puntos anotados en ataque y en la fase de salida de recepción. La contribución de las diferentes acciones de juego varía a lo largo del proceso de desarrollo que hay entre las etapas de iniciación y las categorías de máximo nivel. Esta información podría ser de utilidad para comprender la progresión en el entrenamiento técnico-táctico y para evaluar el desarrollo del deportista a largo plazo en jugadores de voleibol masculino.

Palabras clave: deportes de equipo; rendimiento; análisis del juego; desarrollo del jugador.

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Introduction

Volleyball is a net sport in which both teams play in separate courts (FIVB, 2016). Therefore, the possession of the ball changes cyclically during the rally. There is not an attack and defense phases. The possession or not of the serve establishes the actions that teams and players do. When a rally starts, the team which performs the serve tries to difficult and to neutralize the attack of the opponent team and to organize their counter-attack to score and maintain the serve possession. Otherwise, the team which performs the reception tries to organize a successful attack or difficult the opponent counter-attack, with the goal to score and to get the serve possession (Palao, Santos, & Ureña, 2006). The performance of the game phases varies in a dynamic way according to player characteristics (physical features, technical level, maturity state, etc.), rule changes, and environmental factors (Travassos, Davids, Araújo, & Esteves, 2013). The causes of these changes could be due to changes on players' specialization/role and team systems (Millán-Sánchez, Morante, Álvarez, Femia, & Ureña, 2015; Nikolaidis et al., 2015), players' anthropometric and technical development (García-de-Alcaraz, Valadés, & Palao, 2017; Grgantov, Katic, & Jankovic, 2006), players' physical improvement (speed, jump, etc.) (Sheppard, Chapman, Gough, McGuigan, & Newton, 2009), or the rules change (increase in the net height starting under-16). Based on the above, the game phases performance could change due to the players and team development.

Previous researches have shown that at elite senior level, the team in reception has more efficacy than serving team (65% vs. 35%) (Laios & Kountouris, 2010, 2011; Palao 2004). The causes of this imbalance could be related to the "*lower*" contextual interference occurred in side-out of the team in reception, in comparison with the "*higher*" contextual interference occurred in the actions of the serving team. For the team in reception, the ball come from an action executed far of the net (serve) by one player. For the serving team the ball comes from an action executed close to the net (attack) by several players (Castro, Souza, & Mesquita, 2011). These allow higher performance in reception than in dig (Palao, Manzanares, & Ortega, 2009), which affect the frequency of use and performance of attack and counter-attack actions according to the attack tempo (Costa et al., 2011; García-de-Alcaraz, Ortega, & Palao, 2015; Palao, Santos, & Ureña, 2007). However, in developmental stages, the reception efficacy is lower than in top-level categories (Durkovic, Marelic, & Resetar, 2008, 2009; García-de-Alcaraz, Ortega, & Palao, 2016; Stamm, Stamm, & Koskel, 2008), leading theoretically to lower performance of the reception team (García-de-Alcaraz, Palao, & Ortega, 2014).

These previous studies focused on the analysis of what actions have more correlation with the performance and not in the weight of each action or phase of the final result (Marcelino, Mesquita, Castro, & Sampaio, 2008; Palao, Santos, & Ureña, 2004; Rodríguez-Ruiz et al., 2011; Stamm et al., 2008). Also, other studies have analyzed the evolution of the game considering the different actions done in the game from an isolated perspective. To our knowledge, it is unknown the evolution of the different actions on the performance through the different game phases. Besides, reference values are absent for the different game phases and game situations at the different age groups and levels of competitions. This lack of knowledge difficulties the establishment of objective criteria and goals to guide players and team development for training or competition phase. This information could be useful to guide the training and competition process. These reference values should be also useful to analyze the evolution of the players and teams properly through the different stage of their development. This study aimed to analyze the evolution of the performance of the game

phases and the way of scoring points throughtout different age groups and levels of competition in male volleyball.

Method

Sample

The sample was composed by 53,320 game phases played for 99 teams in 299 sets. Sample was obtained from the Spanish National Championships (under-14, under-16, and under-19 categories), the Spain's first division – senior national category, and the 2008 Olympic Games - senior international category (Table 1). All game phases from the first to fourth sets (sets of 25 points) were included in the study. The fifth set (set of 15 points) was not included due to its different structure (FIVB, 2016). For each category, sets were first stratified in terms of the ranking achieved by a team at the end of the competition (high, middle, and low classified teams), and the quality of opposition (six possible confrontations based on teams' performance level: high vs. high; high vs. middle; high vs. low; middle vs. middle; middle vs. low; and low vs. low). Then, ten sets for each confrontation and category were randomly selected; excepted for the lower confrontation in senior international category were nine sets available were analyzed. The study complied with the ethical principles of the Declaration of Helsinki.

Table 1. *Sets and game phases analyzed according to competition category*

Category	Sets	Game Phases	Season
Under-14 (U14)	60	10,172	2008/2009
Under-16 (U14)	60	10,592	2008/2009
Under-18 (U14)	60	10,644	2008/2009
Senior national	60	11,000	2008/2009/2010
Senior international	59	10,912	2008
Total	299	53,320	-

Design

An observational design was implemented (descriptive, punctual, intrasessional, nomothetic, and multidimensional) (Anguera, 2003). The variables were: a) *category of competition*: under-14 (U14), under-16 (U16), under-19 (U19), senior national, and senior international; b) *game phase performance*: percentage of points scored by teams in reception or serving. For the team in reception it could be found: the total points winning in reception phase (total receiving team), the points winning after a reception (no serving errors are considered) until the end of the rally (side-out + counterattack -*SO*+*C*-), and the points winning from the attack after reception (side-out -*SO*-). For the serving team it could be found: the total points winning in serving phase (total serving team), and the points winning after defending an opponent's attack until the end of the rally (serve + counterattack -*S*+*C*-); and c) way of *scoring points*: points scored in serve, attack, block, or counter-attack, and errors in serve, attack or counter-attack, or other errors (consecutive contacts, touch the net, etc.).

Procedures

Video cameras located at the end of the court and at a height above that of the net were used to record the matches. Lateral and back views were used for Olympic Games matches. In all cases, a full view of the official court area was filmed. The recording and observational process did not affect the spontaneous behaviour of players/teams due to it is a common and widely used system in this sport. Observation analysis was recorded by an observer using

Data Volley 2007 software (Data Project Sport Software, Bologna, Italy). The observer had a degree in sport sciences, the highest volleyball coaching certification in the country, and over ten years' experience in coaching and performance analysis in volleyball. The data of the game actions were calculated with Data Volley 2007 software using its internal spreadsheet and exported from there. A consistency analysis (Cohen's Kappa) was conducted with two observers with more than two years' experience in performance analysis in volleyball and in the use of the observational software used in this study. A 25% of sets from the senior national category were randomly selected for inter-observer reliability analysis. A 20% of sets from each category of competition were randomly selected for intra-reliability analysis. Results over 0.96 were obtained for all variables. The final data-variables were analyzed with SPSS v.21.0. (Statistical Package for the Social Sciences, SPSS Inc) and GraphPad Prism 7.0a (GraphPad Software, Inc., San Diego, CA).

Statistical analyses

Descriptive and inferential analyses were done in order to compare the efficacy of game phases and scoring actions among categories. The Mann Whitney U procedure with Bonferroni post hoc ($p < .01$) was used to compare performances among categories. Besides, standardized differences in means at 95% of confidence intervals (CIs) were calculated to measure the magnitude change between the performance from each category to the next one. The magnitude threshold was set as: 0-0.2 trivial, > 0.2-0.6 small, > 0.6-1.2 moderate, > 1.2-2 large, and > 2 very large (Holpkins, Marshall, Batterham, & Hanin, 2009).

Results

In higher categories, the performance of team in reception (total receiving team), side-out + counterattack and side-out increased significantly, while the performance of the team in serve (total serving team) and serve + counterattack decreased significantly. No statistical significant differences for these game phases efficacy between senior categories (national and international) were observed. Overall, the higher the category, the greater the difference between team in reception and serving team (Table 2).

The magnitude of differences between the efficacy of an age-group category and the higher one showed the major (small or moderate) and a whole of differences between U19 and senior national category (Figure 1). Minor differences were found between senior categories (national to international). In order to the game phases, the total receiving team showed small increases from U14 to U16 category (0.27±0.23) and from U16 to U19 category (0.27±0.25), and a moderate increase between U19 and senior national category (0.98±0.22); the side-out + counterattack phase exhibited small increases from U14 to U16 (0.50±0.23) and moderate increases between U19 and senior national category (0.99±0.20); and the side-out phase showed small increases from U14 to U16 category (0.50±0.24) and from senior national to international category (0.25±0.23), and a moderate increase between U19 and senior national category (1.08±0.22).

Contrarily, the serving team (total serving team) presented a small decrease from U16 to U19 category (-0.27±0.29) and a moderate decrease between U19 and senior national category (-1.01±0.27). Finally, the serve + counterattack phase showed a moderate decrease between U14 and U16 (-0.78±0.28) and a small decrease between U19 and senior national category (-0.38±0.26).

Table 2. Performance efficacy of game phases in different age-group categories.

	U14		U16		U19		National		International	
	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Team in reception										
Total receiving team	48.37	13.99	51.79	12.27	55.20$^{\#}$	13.06	68.47$^{\#*}$†	11.27	69.61$^{\#*}$†	10.68
SO+C	29.08	14.68	37.12$^{\#}$	14.72	39.65$^{\#}$	16.04	58.71$^{\#*}$†	12.80	60.96$^{\#*}$†	12.88
SO	20.52	13.92	26.70$^{\#}$	12.17	28.28$^{\#}$	14.27	46.00$^{\#*}$†	12.89	49.35$^{\#*}$†	13.02
Serving team										
Total serving team	51.63	13.99	48.21	12.27	44.80$^{\#}$	13.06	31.53$^{\#*}$†	11.27	30.39$^{\#*}$†	10.68
S+C	36.34	13.91	31.07$^{\#}$	11.47	26.80$^{\#}$	10.59	23.30$^{\#*}$†	9.34	22.52$^{\#*}$†	9.40

Note. SO+C: side-out + counterattack; SO: side-out; S+C: serve + counterattack;$^{\#}p < .01$ when compared to U14. $^{*}p < .01$ when compared to U16. †$p < .01$ when compared to U19.

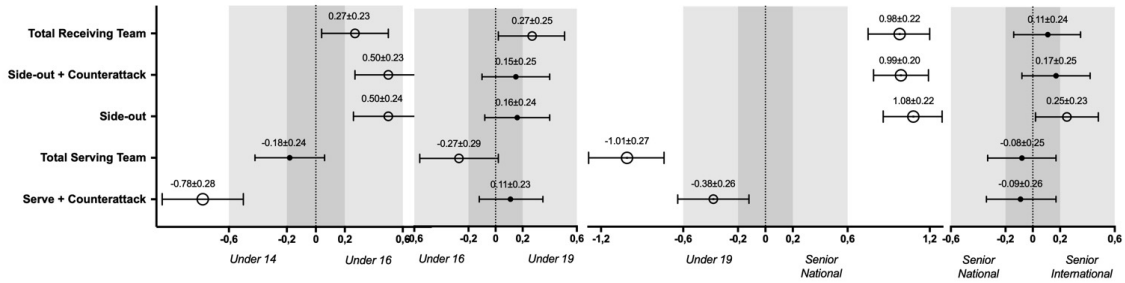

Figure 1. Standardized mean differences (ES) and confidence intervals (95%) for game phases performance when compare one category with the higher.

Within each competition category, the contribution of the different technical-tactical actions to score a point (Table 3) showed a statistical significant increase of points scored by attack and block, and a statistical significant decrease of points scored by serve and counterattack in higher competitions. Regarding the points scored by opponent errors, a statistical significant decrease was observed at senior categories. A statistical significant decrease was found in attack, counter-attack and other errors (rule violations). A statistical significant increase in serve errors was found. A statistical significant increase of the total of rallies played and the points scored from the own team was found as move to top-level categories.

Regarding the magnitude of the changes, the major changes were found between U19 and senior national category (Figure 2). Between U14 and U16, a moderate decrease in attack errors was found (-0.86±0.27). Between U19 and senior national category, a moderate increase was found in attack (1.07±0.22). Between U19 and senior national, a moderate decrease was found in attack error (-0.62±0.27), in other errors (-0.74±0.28), and in points scored by opponent errors (-1.05±0.25). Between U19 and senior national, a moderate increase in points scored was found (0.83±0.20).

Table 3. Number of rallies per set (n) and percentage of winning and losing points (%) scored by serve, block, attack, counter-attack, and other errors

	U14		U16		U19		National		International	
	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Number of rallies	42.38	4.62	44.13	4.98	44.35$^{/}$	4.53	45.83$^{/*}$	4.19	46.24$^{/*}$†	4.35
Scored points	60.95	13.96	62.56	12.97	60.59	13.43	73.40$^{/*}$†	8.91	72.86$^{/*}$†	9.64
Serve	15.57	8.43	8.96$^{/}$	6.54	5.84$^{/*}$	5.12	4.27$^{/*}$	4.30	4.06$^{/*}$†	4.07
Block	4.49	5.14	7.29$^{/}$	5.35	8.02$^{/}$	6.07	10.89$^{/*}$†	6.16	10.99$^{/*}$†	6.75
Attack	17.36	9.96	22.78$^{/}$	9.65	24.28$^{/}$	10.75	39.27$^{/*}$†	11.08	40.76$^{/*}$†	10.49
Counter-attack	23.52	11.43	23.53	10.04	22.44	11.30	18.98$^{/*}$	9.32	17.05$^{/*}$†	7.14
Opponent errors	39.05	13.96	37.44	12.97	39.41	13.43	26.60$^{/*}$†	8.91	27.14$^{/*}$†	9.64
Serve errors	12.27	7.41	12.20	8.40	11.78	8.21	13.59†	7.34	16.75$^{/*}$†$^{\backslash}$	7.32
Attack errors	7.90	8.32	9.37	7.45	11.49$^{/}$	8.44	5.80*†	5.71	5.27*†	4.96
Counter-attack errors	9.57	6.87	9.18	6.58	8.37	6.38	5.01$^{/*}$†	5.05	3.62$^{/*}$†	4.65
Other errors	9.32	6.81	6.69$^{/}$	6.26	7.77	6.96	2.20$^{/*}$†	3.13	1.50$^{/*}$†	2.83

Note. $^{/}p < .01$ when compared to U14. $^{*}p < .01$ when compared to U16. †$p < .01$ when compared to U19. $^{\backslash}p < .01$ when compared to senior national.

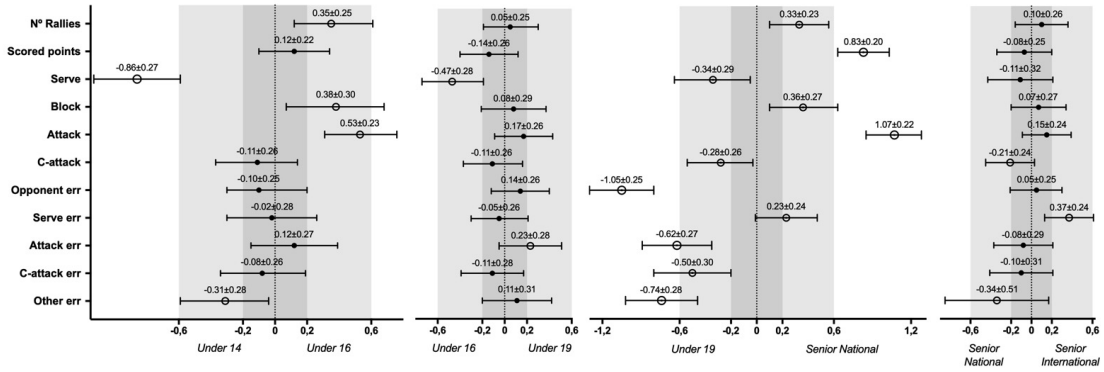

Figure 2. Standardized mean differences (ES) and confidence intervals (95%) for number of rallies per set and proportion of winning and losing points when compare one category with the higher.

Discussion

This study aimed to analyze the evolution of the game phases performance and the way of scoring points throughtout different age groups and levels of competition in male volleyball. When players moved to higher categories, there was an improvement on teams in reception, specifically in the side-out phase. These increases were due to the significant increase of the attack points. The increase on performance was higher between initial stages and senior age-groups categories. The increase of the attack performance may based on the improvement in the reception performance (Durkovic et al., 2008, 2009; García-de-Alcaraz et al., 2016; Stamm et al., 2008; Palao et al., 2009), setting efficacy (González-Silva, Moreno, Fernández-Echeverría, Claver, & Moreno, 2016; Palao & Martinez, 2013), and use of different techniques to increase the speed of the attack (Katsikadelli, 1995; García-de-Alcaraz et al., 2015; González-Silva et al., 2016; Palao & Martínez, 2013). The improvement of the reception could be related to different aspects, such as the increase of the net height at under-16 category, the inclusion of the libero (specialist players in reception and in defense) at under-16 category, and the higher experience, development and training of the players to

perceive and intercept the serve ball trajectory (García-Alcaraz, et al., 2014). The increase of the net height in under-16 and under-19 category, from 2.24 to 2.36m and from 2.36m to 2.43m respectively, did not affect the attack performance negatively probably due to incidence of serve trajectories and the increase of the jump ability of players (Sheppard et al., 2009).

The significant improvement of the side-out phase by the team in reception involved a significant reduction of the performance in the serving team. As higher was the category of competition, less the serve points, counter-attack points and the opponent errors points were obtained. The under-14 category was the only level of competition in which the serving team got more points than team in reception. From this category, the efficacy of the serving team went up, due principally the inability of serving teams to neutralize the side-out of the team in reception. The increase of the net height in under-14 and under-16 probably helped to balance the ability to attack and defense on the game (Lidor & Ziv, 2010), but reduced the serve points obtained (Durkovic et al., 2008, 2009; García-de-Alcaraz et al., 2016; Stamm et al., 2008). The inclusion of the libero in male volleyball in under-16 looks to have a higher contribution to increase the performance of team in reception and side-out than in floor defense. However, future studies are needed to confirm the contribution of the libero on the initial stages of the player development.

The findings show improvements in the attack and side-out points and a reduction of the errors through the different stages of the players' development. The serve was the only actions that show a reduction of points and increase in the errors. However, this tendency could be due to an increase in the serve risk with the goal of difficult the organization of the side-out (García-de-Alcaraz, et al., 2016). The block presented an increase of the points obtained through the different development stages, 6% from under-14 to senior categories. The increase in block performance could be explained by the increase in players' anthropometric characteristics, especially height and reach (Stamm, Stamm, & Thomson, 2005), and numbers of players in block (Afonso, Mesquita, & Palao, 2005). This increase compensated partially the increase of points obtained by attack and counterattack. Nevertheless, teams in reception also increase the speed of the game due to the increase of fast attacks (García-de-Alcaraz et al., 2015, 2017), used different attack options (Castro, Souza, & Mesquita, 2011; Costa et al., 2011), and used the jump set (Palao & Martinez, 2013) to reduce the block intervention. This data show how the game evolves from serve to the actions closed to the net (Stamm et al., 2005; Palao, et al., 2004).

Moreover, the results showed a non-progressive evolution from initial to top-level categories (non-linear way), especially when youth categories are compared to senior ones. These results demonstrate potential issues with youth volleyball players playing on senior elite teams with options to play (both when they play-up and when they are adults). The findings may show the need of elite teams to have second senior teams in lower categories that allow younger talents to continue their development until they are ready to incorporate to the first teams. Future researchers should study specifically the evolution of the youngest players in the second teams of the senior professional clubs or national teams. At international level, the FIVB organizes two World Championship for these specific stages of the development of the players (under-21, and under-23) in order to facilitate the transition of these players .

This study provides reference values for the different game phase and the points contribution of the different actions. This information could help to guide and to establish clear and coherent goals according to age-players development (cross-sectional or longitudinal). However, the reference values should be considered in perspective. Data was obtained from a

cross-sectional sample, and players' evolution was not followed from under-14 until they reach their senior level. The study analyzed the evolution of Spanish players, which may be not representing the reality of the developmental stages in other countries. Despite the limitations and delimitations, the findings showed objective values that allow coaches, researchers and other stakeholders involved in the analysis of the long-term athletic development of male volleyball players to guide their decisions and actions. Future studies should be carry out to know data from other competitions levels, analyzing the gender differences, and taking into consideration the influences of contextual variables (relationship between variables, level of confrontation, team strategies, etc.).

Conclusions

As higher is the level of the teams and players, teams in reception increase their performance and serving teams reduce the points obtained. The greater game evolution in these game phases performances occur between under-19 and senior national category. Regarding the way that points were scored through different levels of competition a significant increase in the attack points, block points and serve errors, and significant reduction of the serve points and counter-attack points were found. These reference values may be a useful guide for planning and designing training task, and to establish training and competition goals coherent with the players' and teams' development.

Disclosure statement

No potential conflict of interest was reported by the authors.

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