Journal of Human Kinetics volume 62/2018, 111-121 DOI: 10.1515/hukin-2017-0163
Section III – Sports Training

DE GRUYTER OPEN

What are the Most Widely Used and Effective Attack Coverage Systems in Men's Volleyball?

by

Raúl Hileno[1], Antonio García-de-Alcaraz[2,3], Bernat Buscà[4], Cristòfol Salas[1], Oleguer Camerino[1]

In volleyball, attack coverage is one of the play actions most neglected in coaching and research. The purpose of this study was to find out which attack coverage systems are used by high-level men's teams in different game situations and the characteristics of the most effective systems. We analysed 15 matches from the 2010 Men's Pan-American Volleyball Cup, with a total of 1,415 coverage actions. Chi-square tests for independence, adjusted residuals analysis and calculations of standardised mean difference were performed. The results show that high-level men's volleyball uses many coverage systems other than the traditional 3-2-0 and 2-3-0. At this level of play, the most frequent systems were 1-3-1 and 1-2-2, which occurred significantly often at the culmination of a third-tempo attack at the wing. The most effective systems consisted of three coverage lines, with fewer than five players covering the spiker and at least one player in the first coverage line, in both the attack and counterattack phases. Given the large number of coverage systems identified in different game situations, we recommend flexible, loosely structured training in these systems, based on a set of guiding principles that all players on a team must internalise for the specific position they are playing. Regarding the systems' efficacy, the main watchword is that on each coverage line there should always be at least one player, but the first line should not be exposed.

Key words: *performance analysis, game patterns, collective behaviour, team sports.*

Introduction

Since its founding in 1947, the International Volleyball Federation (FIVB) has made multiple changes to the official rules in order to make play more continuous and spectacular. Hence the FIVB's famous motto, "Keep the ball flying!", which reflects one of volleyball's main aims: to keep the ball from touching the ground (Kessel, 2015). Nonetheless, over the past decade, several studies have shown that some of these rule changes have had just the opposite effect on continuity of play, making points short and unspectacular. One example was the introduction of libero players in 1998. This defensive specialist position was originally conceived to generate longer points, but over time the libero's participation in the game has had a stronger impact on reception quality than on defence quality, and thus boosted the receiving team's chances of ending the point more than it boosted the defensive team's chances of keeping the ball in play (João et al., 2006; Mesquita et al., 2007).

As Selinger and Ackermann-Blount (1986) rightly indicated, the solution to discontinuous play may not depend only on changing the rules, but also on better coaching and studying the defensive and continuity actions that keep the opposing team from winning the point.

[1] - *National Institute of Physical Education of Catalonia (INEFC), University of Lleida, Lleida, Spain.*
[2] - *Faculty of Health Sciences. University Isabel I, Burgos, Spain.*
[3] - *LFE Research Group. Faculty of Physical Activity and Sport Sciences-INEF. Technical University of Madrid, Madrid, Spain.*
[4] - *Faculty of Psychology, Education Sciences and Sport Blanquerna, Ramon Llull University, Barcelona, Spain.*

Authors submitted their contribution to the article to the editorial board.
Accepted for printing in the Journal of Human Kinetics vol. 62/2018 in June 2018.

According to those authors, however, improving defensive play is not an easy task, as it requires much time, dedication and, above all, a changed mindset among coaches and researchers. Rather than primarily studying terminal actions such as serves, attacks and blocks (Marcelino et al., 2008; Rodríguez-Ruiz et al., 2011), they must also analyse continuity actions such as defence and attack coverage (Jäger and Schöllhorn, 2007; Laporta et al., 2015a, 2015b).

According to Papageorgiou and Spitzley (2003), attack coverage is the tactical area of volleyball most neglected in coaching. The past thirty years' worth of volleyball technical/tactical training manuals are proof of this. The vast majority recommend only two coverage systems to cover the team's own attack: the 3-2-0 and 2-3-0 systems, consisting of five players and two coverage lines (Fraser, 1988; Selinger and Ackermann-Blount, 1986; Papageorgiou et al., 2002). Today, though, two recent studies on attack coverage conducted by Laporta et al. (2015a, 2015b) have shown that many systems other than the traditional 3-2-0 and 2-3-0 exist in high-level men's and women's volleyball, and can consist of fewer than five players and of one, two or three coverage lines. These studies have also determined that the formal structure of coverage systems is strongly related to the attack tempo and the attack zone. On the other hand, it is moderately or even weakly related to the game complex, the setting zone and the effect of attack coverage. Yet these studies have a downside as they analysed attack coverage systems only when an offensive block occurred (a block that makes the ball fall directly onto the opponent's court) and not every time an attack occurred on the third hit with opposition by a blocker from the other team, as Hileno and Buscà (2012) suggested in a study that introduced the first version of an observational instrument to analyse attack coverage in volleyball.

But what is attack coverage? Is this a pre-contact defensive action or one involving contact with the ball? It is very important to answer these two questions correctly, because a study of attack coverage, and especially its sample size, will be totally different depending on the answers. On the one hand, authors such as Papageorgiou et al. (2002) consider attack coverage to be a pre-contact defensive action simultaneous to the same team's attack hit, in which the players not culminating the attack are placed around their team's spiker in case the spiked ball rebounds when blocked and returns again to the court of the attacking team with a chance of winning the point. On the other hand, authors such as Palao et al. (2004) consider coverage to be a defensive contact action following the other team's offensive block, in which a player on the attacking team manages to volley the blocked ball before it lands on their own playing court (this player may be any member of the attacking team, including the spiker). Because of this conceptual controversy, Hileno and Buscà (2012) define *attack coverage* as the pre-contact defensive action that coincides with the team's own attack hit, and define *offensive block defence* as the contact defensive action after the other team's offensive block.

Therefore, after defining what attack coverage is and justifying its importance in the game, this study aimed to find out which attack coverage systems are used by high-level men's teams in different game situations and to identify the most effective systems' characteristics. Laporta et al. (2015a, 2015b) already achieved that goal from a systemic angle based on dynamic systems theory (Thelen, 2005; Walter et al., 2007), but they understood coverage as a contact defensive action after the other team's offensive block and not as a pre-contact defensive action that coincides with the team's own attack hit. The present study uses the latter meaning.

Methods

Participants

We observed 15 matches (57 sets) that took place at the 2010 Men's Pan-American Volleyball Cup. The teams we studied were Argentina, Brazil, Canada, Colombia, the Dominican Republic, Mexico, Puerto Rico, the United States and Venezuela. All the teams used a 5-1 offensive system, a two- or three-player serve reception system and a player-back defensive system (USA Volleyball, 2009). In all, 1,415 attack coverage actions were documented, of which 248 culminated in an offensive block defence. An attack coverage action was included in the sample whenever an attack occurred on the third hit with opposition by a blocker from the other team. Moreover, an offensive block defence action was added whenever a completed block occurred and

the blocked ball was returned to the attacking team's court with a chance to score a point, regardless of whether this ball touched the floor directly or was defended by some player on the attacking team. Given the way the video was shot, observation was limited to the attack coverage actions and offensive block defence actions that occurred on the court nearest the camera.

Measures

The following variables were measured: *offensive gameplay*, *attack tempo*, *attack zone*, *attack coverage system* and *quality of offensive block defence*. However, following the example of Afonso et al. (2010), the *attack tempo* and *attack zone* were combined into a new variable called *attack tempo and zone* in the data-analysis phase. According to these authors, "the setter's tactical action consists in [*sic*] a set, which comprises two interdependent parameters: *attack zone* and *attack tempo*".

Offensive gameplay is the offence process in which the attack coverage system is formed. Like Eom and Schutz (1992), we distinguished between two offensive phases of play: the attack phase (offensive process consisting of setting and the attack, which begins with the serve reception) and the counterattack phase (offensive process consisting of setting and the counterattack, which begins with the attack defence, the counterattack defence, the freeball or downball defence, or the offensive block defence).

Attack tempo is the time between the setting touch and the attack hit (Buscà and Febrer, 2012). In all, we distinguished between three attack tempos: first tempo (quick attack of 0.3 to 0.5 s culminated by a middle hitter), second tempo (fast attack of 0.6 to 1.2 s culminated by an outside or opposite hitter) and third tempo (high attack greater than or equal to 1.3 s culminated by an outside or opposite hitter). The time thresholds of these three attack tempos were determined years ago by Zimmermann (1993) and confirmed recently by Hileno et al. (2012) in a study on the relationship between the attack tempo and block cohesiveness in high-level men's volleyball.

The *attack zone* is the area of the court in which the spike or attack hit occurs. Like Palao et al. (2007), we distinguished between six attack zones: zone 4 (front-left), zone 3 (front-centre), zone 2 (front-right), zone 5 (back-left), zone 6 (back-centre) and zone 1 (back-right).

The *attack coverage system* is the spatial structure made up of the players that cover the spiker at the moment of their teammate's attack hit. Following the example of Laporta et al. (2015a), coverage systems were described using three digits. Reading the digits from left to right, they represented the number of players in the first, second and third coverage line, respectively (e.g. the 2-3-0 system means two players provide coverage in the first line, three in the second and none in the third). To identify the players' coverage lines, we divided the playing court into 36 zones of 1.5 m^2 each, and observed the zone where these players were in relation to the attack zone so that the players in the same zone or one zone away from the spiker were deemed to be in the first coverage line; and those who were 2 to 3 and 4 to 5 zones away in the second and third coverage line, respectively (Figure 1). To determine whether a player was not covering the spiker when the attack hit occurred, we observed whether this player was performing some other action (e.g. a spike approach), whether the player was not facing the spiker or an opposing blocker (e.g. if the player's back was to the spiker), or was outside the bounds of the playing court (i.e. in the free zone).

Quality of offensive block defence is a quality scale assessing the outcome of a defensive action that counters the opposing team's offensive block. Within this quality ranking variable, five numerically coded categories were identified: 0 (a very poor defence that does not contact the blocked ball), 1 (a poor defence that contacts the blocked ball but does not allow either team to continue play), 2 (a mediocre defence that does not let the defensive team counterattack but does let the blocking team counterattack), 3 (a good defence that lets the defensive team counterattack, but without having the full range of attacking options) and 4 (a very good defence that lets the defensive team counterattack and have the full range of attacking options).

Design and Procedures

The matches were recorded with a digital video camera (Sony Handycam DCR-SR52E, Sony Corp., Tokyo, Japan) located in the centre of the stand at the end of the hall. Software used to view the recorded video files was Kinovea v. 0.8.24 (Joan Chartman and contributors, Free Software Foundation, Inc., Boston, MA). Among other things, this free and open source video analysis

software allowed us to insert an on-screen chronometer to time the attack tempo and a 36-zone perspective grid to identify players' location on the playing court (Picture 1). The data were entered into Microsoft Excel 2007 (Microsoft Corp., Redmond, WA) and were analysed in the programs IBM SPSS Statistics v. 23.0 (SPSS Inc., Chicago, IL), Microsoft Excel (Hopkins, 2007), and GraphPad Prism v. 7.0a (GraphPad Software, Inc., San Diego, CA).

To verify the reliability of the recorded data, 282 randomly selected coverage actions from the analysed competition (20% of the total sample) were observed in advance. In terms of both intraobserver agreement (observer 1 vs. observer 1 bis) and interobserver agreement (observer 1 vs. observer 2), we obtained kappa values greater than or equal to 0.85 for all the variables analysed. Therefore, all the Cohen's kappa coefficients calculated achieved *almost perfect* strength of agreement (Landis and Koch, 1977). The research study complied with the ethical principles stated by the Declaration of Helsinki.

Statistical analysis

Firstly, we calculated the percentage distribution of the variable *attack coverage system* with the total for the sample (N = 1,415). Based on the results of this descriptive analysis, a two-step cluster analysis was performed (defined number of clusters: 2; distance measure: log-likelihood) to classify the attack coverage systems into two groups: (a) frequent systems and (b) rare systems.

Secondly, looking only at the frequent systems (n = 1,029), we performed the following statistical analyses: (a) we calculated the percentage distribution of these systems for each offensive phase of play and compared their proportions using the z-test, to seek significant differences ($p < 0.05$) between the attack and counterattack phases; (b) we calculated the Pearson chi-square (χ^2) and the corrected contingency coefficient (C_{corr}) to verify whether there was a significant ($p < 0.05$) and strong ($C_{corr} > 0.70$) relationship between the *attack tempo and zone* variable and the *attack coverage system* variable, both in the attack phase and in the counterattack phase; and (c) we calculated the adjusted residuals (z) and their associated p-values to detect positive ($z > 1.96$) and significant ($p < 0.05$) relationships among the variables analysed.

Lastly, the *quality of offensive block defence* (n = 186) was analysed using standardised mean differences (effect size), with a confidence interval of 90%. The study analysed: (a) the number of coverage lines (three or fewer lines); (b) the number of players giving coverage (five or fewer players); and (c) the number of players providing coverage in the first line (no player vs. one or more players). Comparisons differentiated between the attack and counterattack phases of offensive play. Differences were deemed to be trivial [0.0, 0.2], small (0.2, 0.6], moderate (0.6, 1.2], large (1.2, 2.0], or very large (2.0, +∞) (Hopkins et al., 2009).

Results

In all, 41 different attack coverage systems were observed, classified into frequent versus rare systems (Table 1). The 11 most frequent systems were used by the teams 72.7% of the time (n = 1,029), while the other 30 were used 23.7% of the time (n = 335). Only 3.6% of the time (n = 51) did these teams not form any system, with one player or no player covering the spiker. As for the traditional systems, 2-3-0 was observed 0.5% of the time and 3-2-0 was not observed on any occasions.

Looking only at the group of frequent systems, the 1-3-1, 0-4-1 and 2-2-1 structures (systems of 5 players and 2 or 3 coverage lines) were used in larger proportions in the counterattack phase than in the attack phase; the 1-2-0, 1-1-0 and 0-2-0 structures (systems of 2 or 3 players and 1 or 2 coverage lines) were used more in the attack phase than in the counterattack phase; and the 1-2-2, 1-2-1, 0-3-2, 0-3-1 and 1-1-2 structures (systems of 4 or 5 players and 2 or 3 coverage lines) were used a similar percentage of the time in both phases (Figure 2).

Calculating the chi-square and the coefficient of contingency revealed a significant strong relationship between the *attack tempo and zone* and *attack coverage system* variables, in both the attack phase ($\chi^2 = 744.62$, $p < 0.001$, $C_{corr} = 0.78$) and the counterattack phase ($\chi^2 = 489.47$, $p < 0.001$, $C_{corr} = 0.79$). Calculating the adjusted residuals, meanwhile, identified 20 positive significant relationships among the different categories of these variables, 15 of which were detected in both offensive phases of play, though the adjusted

residual had a different absolute value (Table 2). Basically, these relationships show that the 1-2-0, 1-1-0 and 0-2-0 systems (which have 2 or 3 players and 1 or 2 coverage lines) were formed significantly often at the culmination of a first- or second-tempo attack at the centre of the net (z = 1.99 to 12.49, $p < 0.05$); the 1-2-1, 0-3-1 and 1-1-2 systems (which have 4 players and 2 or 3 coverage lines) at the culmination of a second-tempo attack at the left wing (z = 2.70 to 5.73, $p < 0.01$); the 0-4-1 and 0-3-2 systems (which have 5 players and 2 coverage lines) at the culmination of a second- or third-tempo attack at the right wing (z = 2.23 to 6.78, $p < 0.05$); and the 1-3-1, 1-2-2 and 2-2-1 systems (which have 5 players and 3 coverage lines) at the culmination of a third-tempo attack at the right or left wing (z = 2.38 to 6.10, $p < 0.05$).

According to the quality of the offensive block defence (Figure 3), we observed that systems with three coverage lines, fewer than five players covering the spiker and at least one player in the first coverage line, were more effective in both the attack phase and the counterattack phase, though the latter showed higher values in all cases.

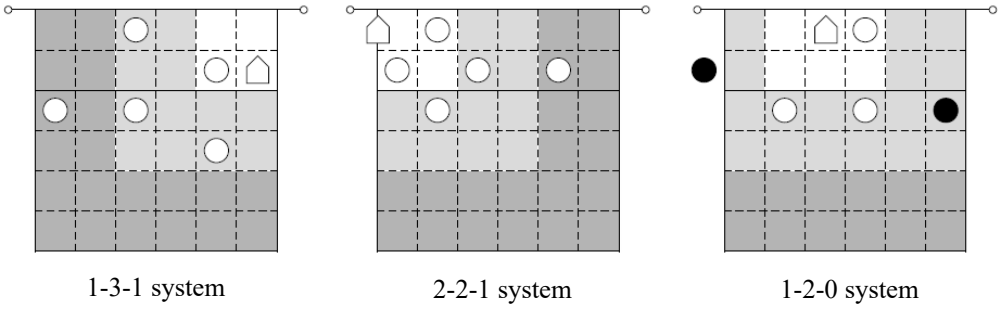

Figure 1

Procedure for identifying attack coverage systems. Arrows represent the attack zone; black and white circles represent players covering and not covering the spiker, respectively; and the white, light-grey and dark-grey zones are the first, second and third coverage line, respectively.

Picture 1

Screenshot of Kinovea v. 0.8.24.

Table 1

Percentage distribution of the attack coverage system variable over the total sample (N = 1,415), and classification of coverage systems into two groups: frequent and rare.

Group	Attack coverage systems (percentage in parentheses)
Frequent systems	1-3-1 (13.4), 1-2-2 (10.9), 1-2-1 (7.3), 0-4-1 (6.9), 0-3-2 (6.1), 2-2-1 (5.8), 1-2-0 (5.4), 0-3-1 (4.7), 1-1-0 (4.5), 0-2-0 (4.1), 1-1-2 (3.6)
Rare systems	0-3-0 (2.5), 0-2-2 (2.5), 2-1-2 (2.2), 1-3-0 (2.2), 0-2-1 (2.0), 1-1-3 (1.6), 0-2-3 (1.6), 1-1-1 (1.2), 2-1-1 (1.0), 0-1-1 (0.8), 0-4-0 (0.8), 2-3-0 (0.5), 2-2-0 (0.5), 1-4-0 (0.4), 0-1-3 (0.4), 0-1-2 (0.4), 2-1-0 (0.4), 1-0-1 (0.4), 3-1-1 (0.3), 3-0-2 (0.3), 2-0-2 (0.3), 2-0-3 (0.2), 1-0-3 (0.2), 1-0-2 (0.2), 0-5-0 (0.2), 0-1-4 (0.2), 3-0-1 (0.1), 1-0-4 (0.1), 3-1-0 (0.1), 0-0-2 (0.1)

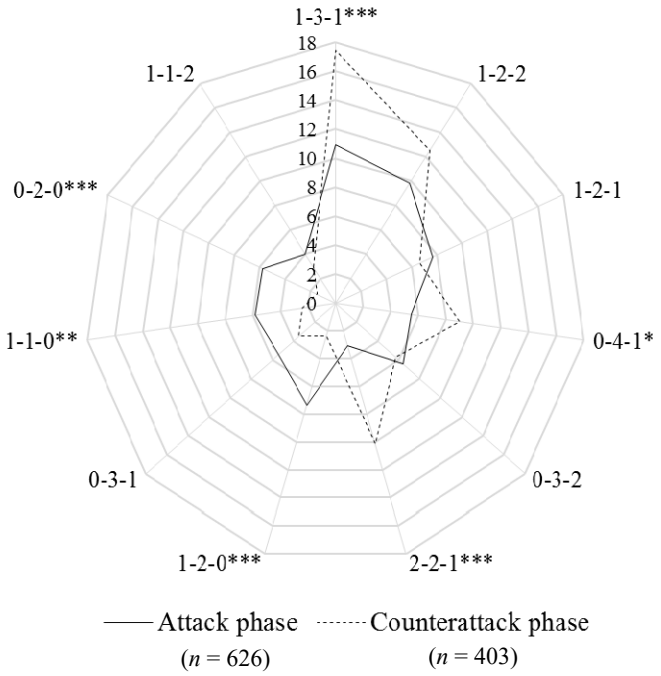

Figure 2

*Percentage distribution of the most frequent attack coverage systems based on the offensive phase of play, and z-test comparison of proportions. Significant differences: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 2

Positive, significant adjusted residuals detected in the attack and counterattack phases, correlating tempo and attack zone with the frequent attack coverage systems.

Attack tempo and zone	Attack coverage system	Attack phase (n = 626)	Counterattack phase (n = 403)
1st tempo in zone 4	1-2-0	2.83**	2.96**
	1-1-0	2.25*	
	0-2-0	9.00***	8.06***
1st tempo in zone 3	1-2-0	10.05***	4.51***
	1-1-0	12.38***	12.49***
	0-2-0	6.61***	7.79***
2nd tempo in zone 4	1-2-1	4.97***	2.63**
	0-3-1		2.70**
	1-1-2	5.73***	5.13***
2nd tempo in zone 2	0-4-1	3.37***	2.88**
	0-3-2	3.03**	
2nd tempo in zone 6	1-2-0	3.65***	3.26**
	1-1-0	3.42***	5.17***
	0-2-0		1.99*
2nd tempo in zone 1	0-4-1	6.78***	2.23*
	0-3-2	2.51*	2.72**
3rd tempo in zone 4	1-2-2	6.10***	3.78***
	2-2-1	2.60**	
3rd tempo in zone 2	1-3-1	2.38*	2.04*
3rd tempo in zone 1	0-3-2	4.92***	3.25**

*Significant associations: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

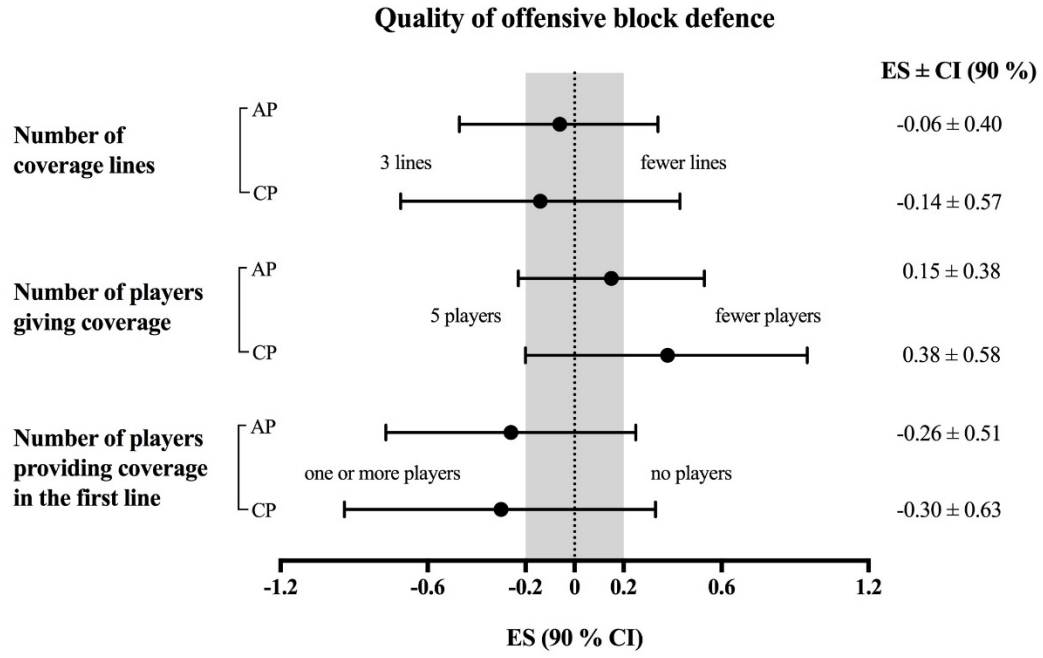

Figure 3

Quality of offensive block defence according to the number of players and lines in the system, and the number of players in the first coverage line. AP = attack phase; CP = counterattack phase; EF = effect size; CI = confidence interval.

Discussion

For this project, a total of 41 attack coverage systems were observed in men's volleyball, while Laporta et al. (2015a) found a total of 23 systems among men. The results show that real-world play uses many more coverage systems than the traditional 3-2-0 and 2-3-0. In other words, as Laporta et al. (2015a) put it, "attack coverage systems traditionally depicted in technical and/or pedagogical books were misleading and did not even approach the complexity and diversity of the game". Fraser (1988) had already warned years ago that these traditional systems were far from easy to implement in competitive play, mainly because defensive actions such as attack coverage are generally taken with little time to spare. That said, though, the reason the present study identified more coverage systems than the study by Laporta et al. (2015a) may be that the latter, in discussing one- and two-line coverage systems, did not specify the exact line the players covering the spiker were in. This means that, for example, for the 2-3 system, they did not specify whether these players were in the first and second line (2-3-0), the first and third line (2-0-3), or the second and third line (0-2-3).

The coverage systems most used by the teams in this study were the three-line systems 1-3-1 (13.4%) and 1-2-2 (10.9), while in Laporta et al. (2015a), the two-line systems 2-3 (18.4 %) and 2-2 (12.1%) were the most frequently used. Note that those authors did not specify the exact process they used to record the formal structure of the coverage systems, whereas the present study did so in the methods section. Regardless of this, as an innovative contribution, this study found that some systems were proportionally more frequent

in the attack phase (1-2-0, 1-1-0 and 0-2-0) and others in the counterattack phase (1-3-1, 0-4-1 and 2-2-1). According to Castro and Mesquita (2010), in the attack phase, offensive play is generally faster and more unpredictable than in the counterattack phase, since the first hit in the reception phase is generally of greater quality than in the defence phase. In turn, Nelson and Compton (1997) noted that "when fast plays are used, coverage becomes less defined because the players simply do not have time to position [themselves] properly before the ball is hit".

The results of the present study and those of Laporta et al. (2015a) showed a strong significant relationship between the *attack tempo and zone* and *attack coverage system* variables, and identified more than 17 positive significant relationships between categories. Laporta et al. (2015a) analysed the variables *attack tempo* and *attack zone* separately, yet in a study of the setter's tactical action in high-level women's volleyball, Afonso et al. (2010) recommended that they be analysed as a single combined variable, as we have done it in the present study. This methodological approach favours the application of these data to specific situations in training and competition, making the data useful for volleyball coaches.

Regarding the efficacy of attack coverage systems, the most frequent systems proved more effective in the counterattack phase than in the attack phase. This may be due to the increased speed of play in the attack phase, especially in high-level competitions (Garcia-de-Alcaraz et al., 2015), since during fast play, it becomes harder to arrange players in the coverage systems (Nelson and Compton, 1997). As for the systems' characteristics, the results revealed that it is very important to have at least one player on the first coverage line. According to Papageorgiou et al. (2002), first-line players are in charge of defending blocked balls that drop close to the net; however, second- and third-line players are responsible for blocked balls that fall in the centre and back of the court, which, given their higher trajectory, are less difficult to defend than those that fall close to the net. Besides this first-line characteristic, the results also showed that using three coverage lines was a key component of team's efficacy. Surprisingly, it was found that coverage by fewer than five players was less effective than coverage with five. Nonetheless, putting at least one player both on the first line and on the other lines seems sufficient to boost the efficacy of the attack coverage.

Practical Implications

Considering the large number of coverage systems identified in different game situations, we encourage coaches to work on these systems in a flexible, loosely structured way, rather than in rigid, highly structured training, since many coverage situations are singular and unlikely to repeat within a given match. According to Laporta et al. (2015b), these flexible systems must arise from a set of guiding principles that team players must follow, such as the following general principle: "If you are near the attacker and not involved in other actions, try to cover the attack". We do not, however, see these principles as applying generically to all players on a high-level men's team, as they should be specific to each particular position, in other words, based on whether the players are setters, opposite hitters, outside hitters, middle hitters or liberos. Regarding the systems' efficacy, the main watchword is that there should always be at least one player on each coverage line, while not exposing the first line, as often occurs at the culmination of a second- or third-tempo attack at the right wing. This specific situation tends to give rise to ineffective systems, such as 0-4-1 and 0-3-2 (systems with five players and two lines, with no player on the first coverage line).

Acknowledgements

This study was conducted with support and funding from the National Institute of Physical Education of Catalonia (INEFC) and the Generalitat de Catalunya Research Group GRUP DE RECERCA I INNOVACIÓ EN DISSENYS (GRID). Tecnologia i aplicació multimedia i digital als dissenys observacionals [2014 SGR 971]. It also received support from two research projects of the Spanish government: (a) *Avances metodológicos y tecnológicos en el estudio observacional del comportamiento deportivo* [PSI2015-71947-REDT]; and (b) *La actividad física y el deporte como potenciadores de estilo de vida saludable: evaluación del comportamiento deportivo desde metodologías no intrusivas* [DEP2015-66069-P].

References

Afonso J, Mesquita I, Marcelino R, da Silva JA. Analysis of the setter's tactical action in high-performance women's volleyball. *Kinesiology*, 2010; 42(1): 82-89

Buscà B, Febrer J. Temporal fight between the middle blocker and the setter in high level volleyball. *Rev Int Med Cienc Ac*, 2012; 12(46): 313-327

Castro JM, Mesquita I. Analysis of the attack tempo determinants in volleyball's complex II - A study on elite male teams. *Int J Perf Anal Spor*, 2010; 10(3): 197-206

Eom HJ, Schutz RW. Statistical analyses of volleyball team performance. *Res Q Exercise Sport*, 1992; 63(1): 11-18

Fraser SD. *Strategies for competitive volleyball*. Champaign, IL: Leisure Press; 1988

García-de-Alcaraz A, Ortega E, Palao JM. Effect of age group on male volleyball players' technical-tactical performance profile for the spike. *Int J Perf Anal Spor*, 2015; 15(2): 668-686

Hileno R, Buscà B. Observational tool for analyzing attack coverage in volleyball. *Rev Int Med Cienc Ac*, 2012; 12(47): 557-570

Hileno R, Salas C, Buscà B. The influence of the attack tempo on the type of block in high-level men's volleyball. In: Sebastiani EM, Cabedo J (Eds.), *Together for physical education: Scientific communications of the 7th FIEP European Congress*. Barcelona: FIEP Catalunya, 185-188; 2012

Hopkins WG. A spreadsheet to compare means of two groups. *Sportscience*, 2007; 11: 22-24

Hopkins WG, Marshall SW, Batterham AM, Hanin J. Progressive statistics for studies in sports medicine and exercise science. *Med Sci Sports Exerc*, 2009; 41(1): 3-12

Jäger JM, Schöllhorn WI. Situation-orientated recognition of tactical patterns in volleyball. *J Sport Sci*, 2007; 25(12): 1345-1353

João P, Mesquita I, Sampaio J, Moutinho C. Comparative analysis between libero and priority receivers on the offensive organization, from the serve reception on the volleyball game. *Rev Port Cien Desp*, 2006; 6(3): 318-322

Kessel J. Sharing the passion. In: Reynaud C, ed. *The volleyball coaching bible: Volume II*. Champaign, IL: Human Kinetics, 3-14; 2015

Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*, 1977; 33(1): 159-174

Laporta L, Nikolaidis P, Thomas L, Afonso J. Attack coverage in high-level men's volleyball: Organization on the edge of chaos? *J Hum Kinet*, 2015a; 47: 249-257

Laporta L, Nikolaidis P, Thomas L, Afonso J. The importance of loosely systematized game phases in sports: The case of attack coverage systems in high-level women's volleyball. *Monten J Sports Sci Med*, 2015b; 4(1): 19-24

Marcelino R, Mesquita I, Afonso J. The weight of terminal actions in volleyball. Contributions of the spike, serve and block for the teams' rankings in the World League 2005. *Int J Perform Anal Sport*, 2008; 8(2): 1-7

Mesquita I, Manso FD, Palao JM. Defensive participation and efficacy of the libero in volleyball. *J Hum Movement Stud*, 2007: 52(2): 95-107

Nelson R, Compton F. Systems of play. In: Asher KS, ed. *Coaching volleyball*. Lincolnwood, IL: Masters Press, 117-128; 1997

Palao JM, Santos JA, Ureña A. Effect of team level on skill performance in volleyball. *Int J Perf Anal Spor*, 2004; 4(2): 50-60

Palao JM, Santos JA, Ureña A. Effect of the manner of spike execution on spike performance in volleyball. *Int J Perf Anal Spor*, 2007; 7(2): 126-138

Papageorgiou A, Spitzley W. *Handbook for competitive volleyball*. Oxford: Meyer & Meyer Sport; 2003

Papageorgiou A, Spitzley W, Christ R. *Volleyball: A handbook for coaches and players*. Oxford: Meyer & Meyer Sport; 2002

Rodríguez-Ruiz D, Quiroga ME, Miralles JA, Sarmiento S, de Saá Y, García-Manso JM. Study of the technical and tactical variables determining set win or loss in high-level European men's volleyball. *J Quant Anal Sports*, 2011; 7(1): 1-13

Selinger A, Ackermann-Blount J. *Arie Selinger's power volleyball*. New York, NY: St. Martin's Press; 1986

Thelen E. Dynamic systems theory and the complexity of change. *Psychoanal Dialogues*, 2005; 15(2): 255-283

USA Volleyball. *Volleyball systems & strategies*. Champaign, IL: Human Kinetics; 2009

Walter F, Lames M, McGarry T. Analysis of sports performance as a dynamical system by means of the relative phase. *Int J Comp Sci Sport*, 2007; 6(2): 35-41

Zimmermann B. Main characteristics of defense (block - court defense - counter-attack) in top volleyball. *Int VolleyTech*, 1993; 1: 9-15

Corresponding author:

Raúl Hileno
National Institute of Physical Education of Catalonia (INEFC), University of Lleida, Lleida, Spain
Address: Complex de la Caparrella s/n, 25192, Lleida, Spain
Phone: +34 973 27 20 22
Fax: +34 973 27 59 41
E-mail: rhileno@inefc.es