

The middle blocker in volleyball: A systematic review

ANTONIO MILLÁN-SÁNCHEZ¹ ✉, JUAN CARLOS MORANTE RÁBAGO², AURELIO UREÑA ESPA¹

¹Department of Physical Education and Sport, University of Granada, Granada, Spain

²Department of Physical Education and Sport, University of León, León, Spain

ABSTRACT

The objectives of this systematic review were to verify the existing scientific literature published in electronic databases about middle players in volleyball, and to describe a profile middle players should fulfill in order to achieve the highest possible level. The PRISMA protocol was followed. A search of the literature was carried out in electronic databases (ISI Web of Science™, Scopus and SPORTDiscus). Of the 1266 initial results, 41 articles were selected, comprised between 2003 and 2016. The main topics studied about middle blockers are: match analysis, technique, physical effort, muscle strength, injuries, body measures and mental skills. Overall, middle blockers tend to be the tallest and heaviest players with an ectomorph somatotype, and present the largest reach when jumping. Blocking and attacking (i.e. first tempo attack) are their main functions, thus they should dominate them. They present a higher risk of injury, particularly in their knees and fingers. Mentally, they seem to show less toughness and resiliency than other playing positions. **Keywords:** Team sports, Playing position, Player role, Player function.

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✉ **Corresponding author.** Department of Physical Education and Sport, Faculty of Sport, University of Granada, Granada, Spain.

E-mail: amilans@ugr.es

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INTRODUCTION

In high-level sport, there are seldom differences between teams of the same competitive level; however, within teams, differences can be found related to the playing position in sports such as football, handball or volleyball (Beniscelli & Torregrosa, 2010; Bradley et al., 2009; C. González et al., 2005; Póvoas, 2009). This is a consequence of a process of specialization, which takes place ever since players are young and classified into different tactical positions according to their abilities and anthropometric conditions. This differentiation can be detected in several variables. Therefore, a general counting of data might lead to a loss of relevant information (Häyrinen et al., 2004). As a consequence, it appears necessary to separate the study of different player roles in order to know what the game demands for each one of them.

The playing position or player role usually delimits the in-game functions of the players. In volleyball, they are commonly divided into 5 positions, referred to as: setter, outside hitter, opposite, middle player and libero (Afonso et al., 2012; Marcelino et al., 2014; Millan-Sanchez et al., 2015). The regulation changes in 1998 included the libero as a defensive specialist, starting to substitute middle players (most often) in their back row positions (C. González et al., 2005). This alteration caused a higher specialisation of the central players, who did not have to receive or defend any more. As a consequence, their functions are limited mostly to the front row, namely the block (Araújo et al., 2010) and the attack (Sapena Peiro et al., 2016) plus the serve (Afonso et al., 2012). Middle blockers play in the centre of the net during their front row positions (Costa et al., 2016), usually performing first-tempo attacks, quick hits where they jump near the setter and before or during the set action (Afonso et al., 2010). Quick tempo attacks provoke a higher uncertainty in the opposing team than slower tempo attacks, resulting in higher likelihood of success (Afonso et al., 2010; Asterios et al., 2009). Regarding the middle blocker location, Marcelino et al. (2014) established it as one of the basic variables in order to predict the attack of the team, thus highlighting the strategic relevance of these players.

There exists investigation that has approached player roles, in general, and the middle hitter position, in particular, from different perspectives. The most studied topic in relation to player role is anthropometric measures, such as height and weight (Palao et al., 2014; Sterkowicz-Przybycien et al., 2014), somatotype (Duncan et al., 2006; Toledo Fonseca et al., 2010) and reach (Ciccarone et al., 2008; Y. González et al., 2014).

The physical effort has been addressed too, both during training sessions and formal competition. It has been assessed through variables such as the number and type of jumps performed (Bahr & Bahr, 2014; Sheppard et al., 2009; Vilamitjana et al., 2008), the duration of the points (Sánchez-Moreno et al., 2016), the distances covered (Mroczek et al., 2014) or the heart rate and blood lactate concentration (C. González et al., 2005).

Concerning biomechanics, investigations focus mainly on the technique of the central blockers when performing their main actions, namely the block (Janssen et al., 2013; Lobietti & Merni, 2006) and the attack (Lobietti et al., 2010).

Other works approach the player role field from the match analysis or performance analysis, observing the actions that take place during the matches. By doing so, they can find relevant relationships between the different playing positions and the success of the teams (Araújo et al., 2010; Marcelino et al., 2014; Millan-Sanchez et al., 2015; Sapena Peiro et al., 2016).

Therefore, the aims of this systematic review are 1) to verify the existing scientific literature published in electronic databases about middle players in volleyball, and 2) to describe a profile middle players should fulfill in order to achieve the highest possible level.

METHODS

This systematic review was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol (Moher et al., 2009).

After an exploratory reading, the following search terms were defined, in combination with the keyword "Volleyball": "middle hitter", "middle", "hitter", "middle blocker", "blocker", "central hitter", "central", "central blocker", "player role", "player function", "player position", "playing position", "jump*". Besides, the keywords "male*", "men*" were added and the keyword "beach volleyball" was excluded. Within each group, the boolean operator OR was used, and the groups of keywords were combined using AND.

The inclusion criteria were: (1) original articles from scientific journals (no impact factor considered); (2) written in English, Spanish or Portuguese; (3) full texts available.

Articles were excluded if: (1) they did not mention the middle blocker or any of the actions most usually performed by middle blockers (i.e. first tempo attack, double/triple block); (2) they were not, total or partially, about volleyball; (3) they did not include, total or partially, a male sample.

A search of the literature was carried out in three different databases: ISI Web of Science™, Scopus and SPORTDiscus.

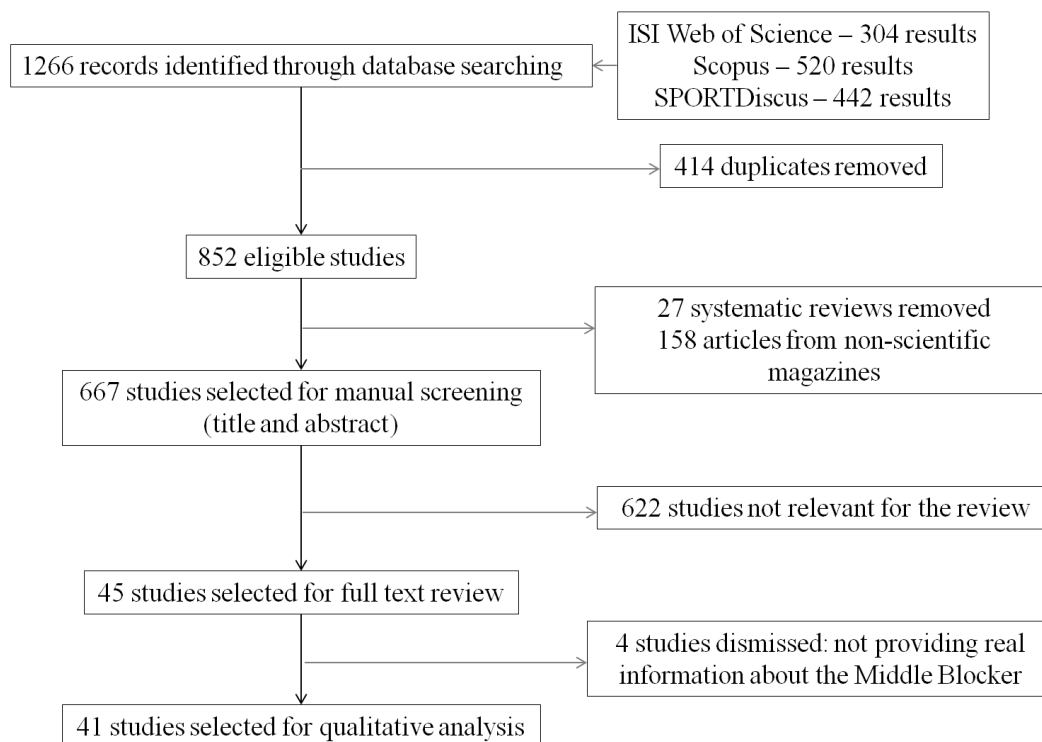


Figure 1. Flow chart of the management and selection of studies

The search offered a total of 1266 studies, which were imported to the reference manager software EndNote X7 (Thomson Reuters, Philadelphia, PA, USA). After removing 414 duplicates, 852 articles were left. 185 studies did not match the inclusion criteria, leaving a total of 667 for manual screening. After revising titles and abstracts, 622 were dismissed for not being relevant for the topic of the review. 45 studies were selected for full-text review, ultimately discarding 4 which did not provide actual information about the middle blocker, remaining 41 articles for the systematic review (Figure 1).

In order to organise the results, the articles were classified according to the main research topics addressed, which emerged from their analysis: match analysis, technique, physical effort, muscle strength, injuries, anthropometry and body measures, and mental skills. Besides, information about the comparison between male and female players was added when the studies included in the review contained results of both sexes.

RESULTS

A total of 41 articles were finally selected for further analysis. Their details are described in Table 1.

Table 1. Articles selected for the systematic review

Article	Objective	Sample	Denomination	Results
Afonso et al. (2012)	To examine predictors of the setting zone in elite-level men's volleyball.	5117 rallies from 31 matches of the 2007 Men's World Cup.	Middle-attacker; Middle-player	Middle-attackers exhibit a more effective serve, reflected upon the difficulties posed to the serve-reception.
Agostini et al. (2013)	To analyze the postural sway of volleyball players in bipedal quiet stance.	46 volleyball players (26 males and 20 females) from Italian teams (9 from professional leagues and 37 from regional leagues). 16 middle blockers.	Hitter (mixed with receivers and opposites)	Hitters may have longer reaction times than defenders due to training, which makes them have a different postural stability.
Araújo et al. (2010)	To examine the relationship between the opponent block, (the blockers starting points and the number of blockers) compared to the hitter chosen by the setter to attack.	4531 game actions of 97 sets from the final phase of the 2007 men's World Cup.	Central blocker; Central attacker	Downward trend in the attack from the middle hitter with pinched block; Middle hitters show high tendency to attack against individual block; Wing attackers (opposites and receivers) usually attack against 2 or 3 blockers.
Augustsson et al. (2006)	To examine the prevalence of injury and the extent of preventive actions in elite Swedish volleyball players.	225 volleyball players who played in the elite Swedish division during the 02/03 season.	Center; Blocker	73% of the injuries were related to a specific court position: the three front players (attackers and blockers).
Bahr and Bahr (2014)	To examine interindividual and sex differences in jump frequency during training and matches in young elite volleyball players.	26 16-18 year-old volleyball players in the Toppvolley Norge volleyball program during 4993 training jumps and 2202 match jumps.	Middle blocker	Setters performed more jumps in both training and matches, followed by middle blockers.
Beneka et al. (2009)	To record the injury incidence in all age categories in male volleyball players and clarify the role of age in injury occurrence.	407 Greek male volleyball players participating in all Volleyball	Middle hitter	Outside hitters and middle hitters presented more injuries than the other players.

		Championships in Greece.		
Beneka et al. (2007)	To record prospectively the injury incidence rate among elite and local division players in Greece and compare them in terms of their injury profile.	649 Greek male and female volleyball players participating in the Greek Volleyball championships involving first division and local division in the 2005-2006 period.	Middle hitter; Middle blocker	There were no differences between injured and not injured in any of the playing positions.
Bere et al. (2015)	To describe the risk and pattern of injuries among world-class players.	Injuries reported by the FIVB ISS (International Surveillance System) throughout 4 years of major tournaments (2010-2014), male and female.	Middle blocker; Centre player	Injury incidence was greater for centre players; No injury patterns were statistically observed for middle blockers.
Castro et al. (2011)	To identify performance indicators predicting attack efficacy in volleyball's game phase denominated Complex II.	680 complex II actions from 100 sets from 28 games of the 2007 World Cup.	Not mentioned	Attack tempo 1 increased the probability of an attack point; The high frequency of two and three blockers reflected the difficulty of efficient attack during Complex II.
Ciccarone et al. (2008)	To compare anthropometric parameters and jumping ability in a group of elite male volleyball players in relation to technical skills required by player position.	36 elite male volleyball players from the Italian 1st and 2nd Division Championship.	Middle hitter	Middle hitters had higher values for height, reach with dominant arm and reach with both arms than either the setters or the liberos; Middle hitters and outside hitters had statistically higher specific jumping abilities than setters and liberos.
Cieśla (2015)	To determine incidence of sports injuries reported by Plus League volleyball players, as well as to identify their most common types and causes.	90 Plus League (Poland 1st division) players in the 2010/2011 season.	Middle blocker; Middle hitter; Centre	No data was found for injury rates depending on the playing position; Middle blockers presented the highest mean values for height, weight, block and spike reach.
Ciuffarella et al. (2013)	To investigate the serving techniques in male top level volleyball, especially the tactical and spatial behavior of the servers and receiving opponents focusing on the pros and cons of the different serving techniques.	4552 serves from 28 matches of the 08-09 regular season of the Italian male Top League.	Middle blocker	No statistical relationship was found between the role of the server and the outcome of the serve.
Costa et al. (2016)	To analyze the game practiced by the middle attacker in the complex I of the 2014/2015 National Men's Brazilian Championship (Superliga).	5350 receptions, sets and attacks carried out by middle spikers from 142 games of the 2014-2015 Brazilian Men's Superliga.	Middle attacker; Middle spiker; Central blocker	There was association between: 1. Reception effect and attack type. 2. Setting type and attack type. 3. Setting type and attack effect. Powerful attacks were the most used. Tips were the less widely used; Attack score positively associated with positive and negative attack and negatively with back one and inside shoot set; Attack error positively associated with inside shoot set and negatively to negative attack.

Duncan et al. (2006)	To investigate the anthropometric and physiological characteristics of junior elite volleyball players.	25 elite junior volleyball players (16-19 years-old) during a summer training camp held by the English Volleyball Association.	Centre	The only measures influenced by playing position were the sit and reach test and the mesomorphic and ectomorphic components of somatotype; For centres, sit and reach was not significantly defining, only somatotype; Centres tend to be ectomorphic-mesomorpha.
Fattahi et al. (2013)	To determine relationship between anthropometric properties with vertical jump on 40 male elite volleyball players.	40 male elite volleyball players with at least 4 years of experience in Iran Premier League.	Spiker (includes middle blockers, opposites and receivers)	There were significant differences between vertical jump of spikers and liberos; There are no significant differences between vertical jump of spikers and setters.
Fellingham et al. (2013)	To examine the relationship of the speed of a set in volleyball with the outcome of the attack.	19 home matches of a United States university men's volleyball team during 2 years.	Middle blocker; Middle hitter	No trends were seen with sets delivered to hitters that were closer to the setter.
González et al. (2005)	To determine the intensity of effort in competition of the libero and central players by measuring heart rate and blood lactate.	30 players from 10 teams of Spanish national level (10 liberos, 10 principal central and 10 secondary central players)	Central player	When on court there are more demands placed on central players and therefore more intensity in their game (given their high levels of heart rate recorded). High levels of blood lactate concentrations recorded especially the central players.
Gonzalez-Silva et al. (2016)	To analyse the variables that predicted setting efficacy in complex I (KI) in volleyball, in formative categories and depending on gender.	5842 game actions carried out by 34 male and female teams (36 sets each) during the U16 Spanish National Championship.	Middle attacker; Middle player	In U16 males there is no relationship between the role of the server and the setting efficacy; In U16 females the middle player carries out the serve more often and the role of the server is significantly related to the setting efficacy.
Gradinaru et al. (2014)	To establish the defining elements of a central hitter parameter dynamics.	Middle hitters from the 2012 London Olympic Games.	Central hitter	The mean values of height (203.8 cm) and weight (94 kg) are relevant in establishing the final hierarchy in a world level (Olympic Games).
Hadzic et al. (2010)	To evaluate the differences in quadriceps and hamstring strength, strength ratios and bilateral strength asymmetry among age groups, playing positions and playing levels.	127 male volleyball players from the Slovenian 1st and 2nd division.	Blocking	Quadriceps and Hamstring muscle function of male professional players is independent of their playing position.
Hadzic et al. (2014)	To evaluate shoulder strength asymmetry and a history of shoulder injury in a sample of professional volleyball players of both sexes across different playing positions and skill levels.	183 volleyball players (99 men) from the Slovenian 1st and 2nd division.	Blocker	The likelihood of an abnormal strength ratio (external rotators / internal rotators) was not associated with playing position; The frequency of an abnormal strength ratio was highest among the blockers, opposites, and receivers; The likelihood of strength asymmetry of either the external rotators or internal rotators

					was not associated with the playing position.
Li and Kang (2015)	To study if there are differences of will among high level volleyball players of different genders, positions, exercise levels, and exercise ages.	254 Chinese Super League Volleyball players (130 male and 124 female) in the 2010-2011 season.	Blocker		There is difference in toughness between auxiliary setter and ace spiker and blocker ($p < .05$); Toughness of libero player is higher than ace spiker, blocker, and setter ($p < 0.01$); The auxiliary setter is more resilient than the ace spiker and blocker; The libero player is more resilient than the ace spiker, blocker, and setter.
Lian et al. (2003)	To examine the leg extensor characteristics in a larger cohort of players by using a more comprehensive jump- and strength-testing program.	47 amateur players from the Norwegian Leagues.	Middle blocker		The prevalence of patellar tendinopathy was higher among outside hitters (12 of 18, 67%) and middle blockers (9 of 14, 64%), compared to utility players (1 of 6, 17%) or setters (2 of 9, 22%); The body weight of the players with jumper's knee was also greater.
Lobietti and Memi (2006)	To determine tendencies in lateral footwork techniques used by volleyball players when blocking.	15 male and 16 female matches from the 04/05 Italian Professional League.	Middle blocker		Middle blockers tend to use the single cross and the single slide; When moving to 4 and 2, they use the single cross step, and less often the single slide step; They do not use the slide-cross-slide; Middle blockers use the slide and double slide more when they are moving to the left, while the cross and slide-cross when moving to position 2.
Lobietti et al. (2010)	To compare different jumping activities during official men's and women's volleyball games.	48 male and 48 female volleyball players from 12 professional matches (6 each) of the 04-05 Italian league.	Middle blocker; Middle attacker		The frequency of landings on one foot was related to court position; Men landed first with the ipsilateral foot (right foot when moving to the right, left foot when moving to the left) 76% of the time and in both directions; Male middle blockers landed significantly more when attacking in the middle on two feet.
Marcelino et al. (2014)	To analyse probabilistic relationships predicting the outcomes relating to attack players in elite-level men's volleyball.	19 matches from the 2006 men's World Championship	Middle blocker; middle player; Middle attacker; Middle hitter		The selection of the attack player showed is predictable and can be anticipated by analysing visual cues previous to the attack. Namely, an interaction between setting zone, position and type, as well as the reception player and the positioning of the middle hitter.
Marques et al. (2009)	To investigate the anthropometric and strength characteristics of elite male volleyball athletes and to determine if differences exist in these characteristics according to playing position.	35 full-time professional male team volleyball players from different nationalities.	Middle blocker		No significant differences were detected between the middle blockers and opposite hitters for body mass, being both of them significantly higher than the other playing positions in body mass and height; Middle blockers and opposite players presented higher

				values of bench press strength than liberos and setters.
Milavić et al. (2013)	To validate the Competitive State Anxiety Inventory on a larger sample of male and female volleyball players; To use this questionnaire to determine gender, age and positional differences, as well as differences in situational efficacy of male and female young volleyball players in competitive state anxiety.	286 (180 female and 106 male) volleyball players (average 16 years old) in the Croatian championship competitions.	Middle blocker	No significant differences were found in the level of competitive anxiety and self-confidence by analysis of variance between different player roles.
Millan-Sanchez et al. (2015)	To determine the probability of success of the different players who execute the terminal actions according to their role and location on the court.	5790 terminal actions from the 2010 men's World Championship and 7640 terminal actions from the 2011 men's European Championship.	Middle blocker	The opposite is the player with a higher rate of success in his terminal actions, followed by the receiver, the middle blocker and the setter; At an European level the middle blocker increases his probability of winning points with respect to the World Championship.
Mostafa and Mansour (2016)	To assess and compare players' positions mental skills of Iran men's national junior volleyball team in year 2015.	16 Iran men's national junior volleyball players.	Speed spiker	There were significant differences between positions in cognitive skills; There were no significant differences between positions of the junior national volleyball players in: goal setting, confidence, commitment, psychosomatic skills and cognitive skills.
Mroczek et al. (2014)	To assess motor activity of volleyball players using an original video recording method developed by the authors.	28 male professional players from the Polish National Volleyball League.	Middle blocker	Middle blockers covered less distance ($p < .005$) than setters, defenders, spikers, and liberos in a match and in a set; There was a tendency to lengthen the distance by the players in the final sets, which is indicative of the extended time of individual rallies.
Notarnicola et al. (2012)	To evaluate the influence of age, gender, dominant arm, role and number of years activity on rotator cuff tendon strain, with the aim of developing strategies to improve peripheral perfusion in volleyball players.	80 volunteer (16 males and 64 females) elite volleyball players in Italian professional teams.	Middle hitter	Different levels of rotator cuff tendons vascularization were found in players according to their role in the team: from setter through middle hitter, libero, opposite hitter to outside hitter, who had the statistically significantly highest oxygenation values.
Palao et al. (2014)	To study the ranges in height, weight, age, spike reach, and block reach of volleyball players in relation to the player position and the level of their respective teams in peak performance.	1454 male and 1452 female players from the Olympic Games and World Championships from 2000 to 2012.	Middle blocker; Middle-blocker	Middle-blockers and opposites had the highest spike and block, followed by outside-hitters, setters and liberos.
Rodríguez-Ruiz et al. (2014)	To evaluate the normalized response speed of the knee musculature in high competitive	83 male and 83 female professional players	Middle blocker	Normalized response speed differences seem to be larger in

	level volleyball players using tensiomyography; To analyze the muscular response of the vastus medialis, rectus femoris, vastus lateralis, and biceps femoris in accordance with the specific position of the players.	from the Spanish Superleague.			setters, liberos and outside players compared to middle blockers.
Sapena Peiro et al. (2016)	To determine whether the distance between the setter, the middle hitter, and the second tempo attacker can predict the attack zone in Complex I in elite men's volleyball.	23 matches of the third stage of the 2010 Men's World Championship (3936 rallies).	Middle hitter		In elite male volleyball, middle hitter is mainly placed near and in front of the setter, which means that instead of MH having a fixed location, he moves according to the variation of setter position.
Sattler et al. (2012)	To determine the reliability and factorial validity of 2 volleyball-specific jumping tests (the block jump test and the attack jump test), relative to 2 frequently used and systematically validated jumping tests (the countermovement jump test and the squat jump test); To establish volleyball position-specific differences in the jumping tests and simple anthropometric indexes.	95 male volleyball players from the Slovenian First and Second Division.	Middle; Middle blocker; Middle player		No statistical association was found for the middles regarding the jumping capacity; Middles were the tallest and heaviest players; No significant differences were found for BMI between positions.
Sattler et al. (2015)	To explore the overall vertical jump performance of elite volleyball players of both sexes; To explore the differences in vertical jump performance among different competition levels and different playing positions; To evaluate the sex-related differences in the role of the arm swing and 3-step approach with arm swing on the jump height.	113 male and 140 female volleyball players from the Slovenian First and Second Division.	Blocker: Central blocker		Position-related differences in VJ performance were observed in male players CMJs between receivers and setters, but not in blockers.
Sheppard et al. (2009)	To investigate the physiologic demands, physiologic characteristics and jumping ability of different playing positions in elite male volleyball players.	Study 1: 8 matches from the 2004 Olympic Games and 8 international test matches; Study 2: 142 subjects from the national teams of Argentina, Australia, Canada, Australia U-21, Brazil U-21 and Brazil U-19.	Middle; Middle blocker; Middle player		<i>Physical effort.</i> Middles carried out more block jumps ($p < .001$) than setters and outsides; Attack jumps were performed more frequently by middles than setters and outsides ($p < .001$); Middles playing for the winning side performed jump serves more frequently than those from the losing side ($p < .01$); <i>Body measures.</i> Middles were taller and had a higher standing reach and body mass than outsides and setters; <i>Muscle strength.</i> Both middles and outsides had a higher countermovement vertical jump than setters, but when expressed relative to standing reach (relative countermovement vertical jump),

				no differences existed between them; Both middles and outsides had a higher spike jump than setters, but when expressed relative to standing reach (relative spike jump), outsides were superior to setters and middles; Absolute jumping ability was not different between the development national team and the senior national team middles.
Toledo Fonseca et al. (2010)	To determine the anthropometric characteristics of the Brazilian U-16 national team players according to the playing position.	16 players (16-18 years old) of the U-19 Brazilian national team participating in the South American 06 championship.	Central (Spanish); Middle	Middles were the tallest and heaviest players, finding significant differences with liberos; Middles and opposites presented the highest values of fat percentage, with no significant differences; The somatotype was independent of the playing position.
van der Worp et al. (2012)	To determine the risk factors for patellar tendinopathy in a large representative sample of basketball and volleyball players.	1561 volleyball players (male and female, 18 to 35 years old) from the Dutch Volleyball Association in 2008.	Middle blocker; Middle hitter	Playing as outside hitters or middle blockers is a risk for patellar tendinopathy compared with playing as setters.
Vilamićjana et al. (2008)	To determine a jumping profile of elite volleyball male players by field positions during a competitive season.	23,862 volleyball jumps of 12 Argentinian professional players during 55 official matches.	Middle blocker	The work-rate profile does not vary significantly according to field position in the game, but there are differences in the percentage of jump types performed; Middle blockers and wing attackers performed similar number of jumps (1.35 j/m vs.1.33 j/m), but the former used the blocking (46.5 %) and spiking approach (23.8 %) more compared to the latter and others positions (except blocking with receiver attackers); Wing attackers and receiver attackers used spike jumps more than middle blockers.

The first paper was published in 2003 and the last one in 2016. Most of them were published in the period between 2012 and 2016 (25, 61%), reaching the peak of production in 2014 (7, 17% of the total) (Figure 2).

The majority of them were carried out on professional subjects (29, 71%), but also on U19 players (5, 12%), a mixed population (4, 10%), U16 players (1, 2%), university students (1, 2%) or amateurs (1, 2%) (Figure 3).

Regarding the topic of study, as can be seen in Figure 4, both *Match analysis* and *Anthropometry/Body measures* comprised the 24% of the total (10 papers each), followed by *Muscle strength* and *Injuries* (7, 17% each), *Physical effort* (6, 15%), *Mental skills* (3, 7%) and *Technique* (2, 5%). It must be taken into consideration that some studies cover more than one field.

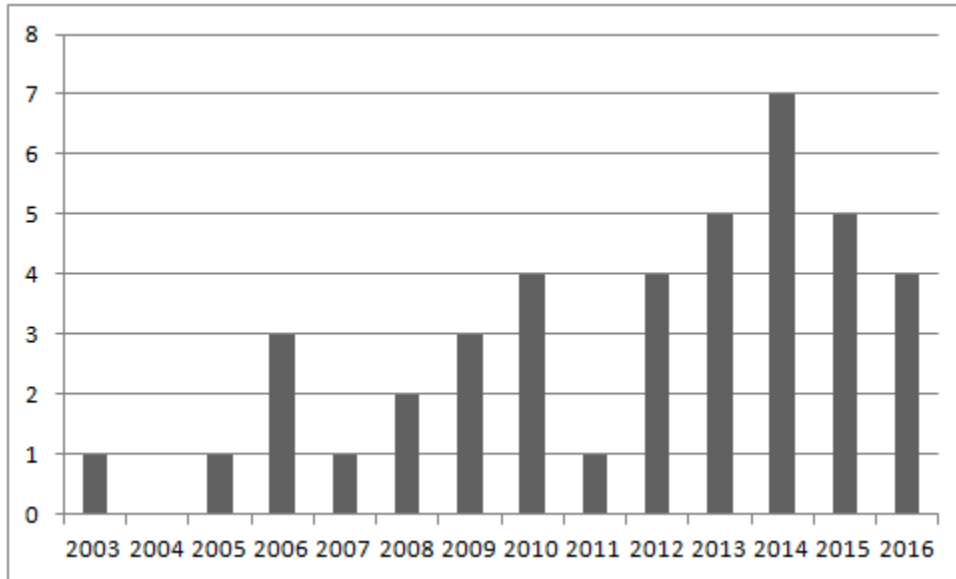


Figure 2. Number of studies published per year

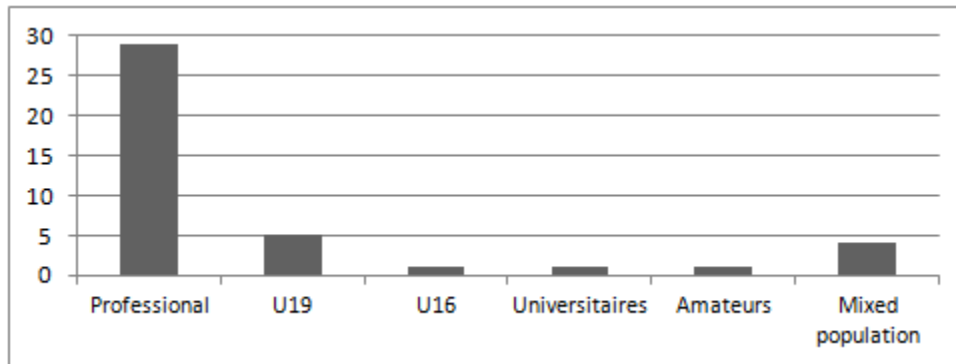


Figure 3. Type of samples used in the articles

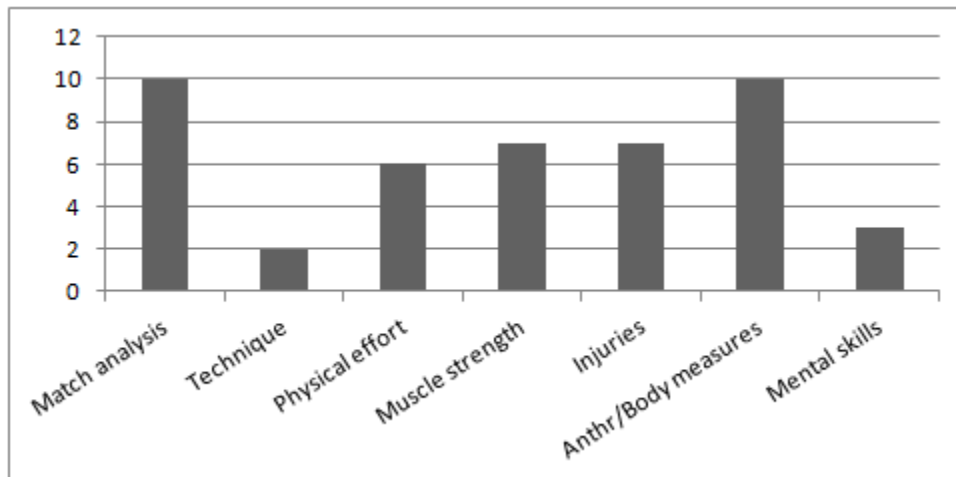


Figure 4. Number of studies per topic of research

Concerning the denomination of the playing position (Figure 5), the most common word to address this player is *Middle* (28, 68%), both by its own or in combination with *player*, *attacker*, *blocker*, *hitter* or *spiker*. It is

followed by *Central/Centre* (10, 24%), both by its own or in combination with *player*, *attacker*, *blocker* or *hitter*. Then there is *Blocker* (5, 12%), *Hitter/Spiker* (mixed with other positions; 2, 5%), *Speed spiker* (1, 2%) or not mentioned (1, 2%). In view of this data, from this point it will be used the denomination *Middle blocker*.

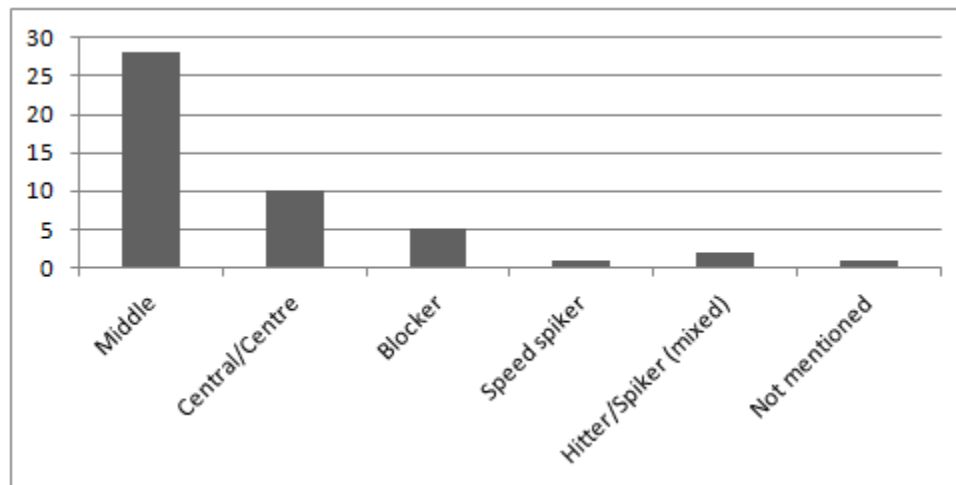


Figure 5. Distribution of the denominations of the playing position

DISCUSSION

Match Analysis

The reliability of the selected Match Analysis papers was not regarded.

Serve

Regarding the serve, different studies have come to opposite conclusions. Whereas, in the elite level, Afonso et al. (2012) seemed to find that middle blockers presented a more harmful serve, according to the difficulties caused to the reception (differences with opposite ($p < .001$), receiver [$p < .001$] and setter [$p < .01$]), Ciuffarella et al. (2013) detected no statistical relationship between the role of the server and the serve's outcome. With an U16 sample, Gonzalez-Silva et al. (2016) did not find relationship either between the role of the server and the setting efficacy in males. However, in females the middle blocker carried out the serve more often (32.3%) and the role of the server was significantly related to the setting efficacy ($p < .05$).

Block

One of the main responsibilities of the middle blockers is the block. It is the first action that teams have in order to stop the opponent's attack (Selinger & Ackermann-Blount, 1986), and middles must complete it in as many opponent's attacks as possible, alongside the 9 metres of the net. For instance, middle blockers perform 45.5% of the block jumps of a team, whereas the position 4 and 2 blockers only 27.0% and 27.5%, respectively (Lobietti & Merni, 2006). For this reason, when studying the block, it must be assumed the involvement of the middle blocker, even when it is not specifically mentioned (i.e. "double block").

In this respect, Araújo et al. (2010) discovered the zone-blocking system (where the initial position of the middle blocker is the centre of the net, independently of the location of any opponent player) to be associated with the double and triple block ($p < .001$), that is, including the participation of the middle blocker. Given that the more players composing the block, the higher difficulty performing attacks efficiently (Araújo et al., 2010; Castro et al., 2011), the zone-blocking system seems to be the most efficient.

Attack

Middle blockers usually execute a special type of attack, called first tempo or tempo 1 attack. In this action, the attacker jumps in the exact moment the set is made (Selinger & Ackermann-Blount, 1986), creating a time pressure on the opponent's block (Araújo et al., 2010) and being able to perform a surprising attack, in case the ball is set to him.

In this regard, and considering that tempo 1 attack increased the probability of an attack point (Castro et al., 2011), it might be assumed that when middle blockers attack the likelihood of winning the rally increases.

Focusing on the different types of first tempo attacks, there are different denominations depending on the study. Fellingham et al. (2013) describe the quick as an attack performed close to the setter, either in front of or behind him, and the gap as an attack executed approximately 3 metres from the left sideline. On the other hand, Costa et al. (2016) divide the quick by Fellingham et al. (2013) into three different possibilities: positive (in front of the setter, contacting the ball on the right side of the body), negative (in front of the setter, contacting the ball on the left side of the body), back one (behind and close to the setter); and refer to the gap as inside shoot. Nevertheless, these differences apply to the findings of both studies as well. Whereas Fellingham et al. (2013) found no data indicating differences of success depending on the type of first tempo attack, Costa et al. (2016) found that positive and negative sets were associated ($p < .001$) with attack score (obtaining a point), and inside shoot sets were associated with attack error (losing a point) and a poor reception ($p < .001$). Additionally, the tip was associated ($p < .001$) with inside shoot and back one set. Regarding directions of the first tempo attack, negative sets were associated ($p < .001$) with attacks for position 5 and 1, whereas positive, back one and inside shoot sets with attacks for position 6.

Overall success

Despite the higher likelihood of success of the middle blocker when it comes to the attack, if all terminal game actions are included in the analysis (serve, reception, set, attack, block and defence), Millan-Sanchez et al. (2015) found that opposites had a higher rate of success in their actions ($p < .001$), with middle blocker presenting 55% (OR = 0.553) of probability compared to them in a World Championship sample (61%; OR = 0.612 for an European Championship sample).

Middle blocker positioning

Marcelino et al. (2014) seemed to detect the location on court of the middle blocker (amongst others, such as the setting zone and the reception player) as a key visual cue when predicting the selection of the attack player ($p < .01$).

In another study (Sapena Peiro et al., 2016), the authors discovered that the middle blocker is most often placed close (1 or 2 m) to and in front of the setter when performing his attacks ($p < .01$). That entails that middles do not always have fixed positions alongside the net, but they move depending on the position of the setters.

Technique

Two studies regarding blocking technique and footwork are presented in this review, referring both of them to professional players from the Italian top-level division.

Lobiatti and Merni (2006) described seven different blocking footwork techniques: Slide step, Cross step, Slide-cross, Slide-cross-slide, Repeated slide, Running steps and Vertical jump. They found out the Cross step (38.5%) and Slide step (25.9%) to be the most frequently performed (not reporting significance) by

middle blockers, independently of the opponent's type of set. However, significant differences ($p < .001$) were found with women, who preferred a combination of steps (slide-cross-slide [30.9%] and double slide [21.5%]).

Nevertheless, there exist differences when moving towards the extremes of the net (positions 4 and 2). Middles use the Slide step and Repeated slide more when they are moving to the left (position 4) (14% each), while the Cross step and Slide-cross when moving to the right (position 2) (63% and 7%, respectively).

Hence, the cross step is the most executed technique by middle blockers (Lobiatti & Merni, 2006). This technique consists of crossing the foot which is further from the blocking place, close to the net, and then the second foot closes the movement, pushing both up for the jump. Nevertheless, in a later study out of this review (Janssen et al., 2013), the authors set the lateral stop-jump technique (similar to the Slide step) as the experimental task, because it was the movement most usually performed by middles.

According to Lobiatti and Merni (2006), middle blockers do not use the Slide-cross-slide, which would allow them to reach further. A possible explanation is the time pressure and speed of the game, which prevent them from including a third step in the footwork sequence.

Regarding the landing technique, Lobiatti et al. (2010) found out that it was related to court position, both when attacking ($p = 0.001$) and blocking ($p = 0.001$). Middle blockers landed quite frequently with both feet (75.8% of the landings) when performing their attacks (not significantly different from women), whereas when blocking the landing was executed with the ipsilateral foot (right foot when moving to the right, left foot when moving to the left) 76% of the time (no significant differences were found between block directions). Nevertheless, female middle blockers landed more often on the ipsilateral foot when blocking to the left (77%) than to the right (61%), being these data significantly different from those of men ($p = 0.001$). According to the authors, this is a consequence of the lateral component of blocking jumps.

Physical effort

Jumping profile

Among 16-18 year-old players, it was detected a difference in jump frequency between player functions in training jumps ($p = .008$), with middle blockers jumping 45.9 times per hour of training (less than setters [63.9] but more than opposites [26.8], receivers [23.2] and liberos [14.5]). Female middle blockers performed 12.3 jumps/hour, which is considerably less than men ($p = .002$). However, this difference between positions decreased when measuring the frequency of match jumps, not reaching significance; setters performed 15.7 jumps per set, followed by middle blockers (13.0), opposite players (9.1), receivers (7.1) and liberos (0.3). This reduction in jump frequency during the matches approximated the data from male (13.0) and female (10.2) middle blockers, but still was significant ($p < .05$) (Bahr & Bahr, 2014). These results agree with those obtained by Lobiatti & Merni (2006), who found that male and female middle blockers have similar percentages of block jumps, but male middle blockers jump without moving more often than women (22.2% vs 17.7%) The differences between male and female players was significant ($p < .001$). With professional players, Vilamitjana et al. (2008) established a Work Rate Profile based on the number of jumps performed per minute. Their results did not show statistical differences among playing positions for Work Rate Profile and were similar to those obtained in lower categories, with middle blockers and opposite attackers performing similarly in number of jumps performed (1.35 vs. 1.33), being both below setters (1.62).

In addition, differences were found among playing positions according to the specific jump ability in elite players. Sheppard et al. (2009) found that the mean frequency of block jumps per game for middles (11.0) was significantly higher ($p < .001$) than for outsides (6.5) and setters (6.25). Along the same lines, attack jumps

were performed significantly more ($p < .001$) by middles (7.75) than by outsiders (5.75) and setters (0.38). Similar results were found by Vilamitjana et al. (2008), with middle blockers using the blocking (46.5 % of total jumps) and spiking approach (23.8 %) significantly more ($p < .05$) than the other positions (except blocking with receivers). In contrast, they found opposites and receivers to use spike jumps significantly more ($p < .05$) than middle blockers. Besides, middles playing for the winning side performed jump serves more frequently (4.58; $p < .01$) than middles from the losing side (3.54) (Sheppard et al., 2009).

Physiological profile

During the time the middle blockers are on court there are more demands placed on them and therefore more intensity in their game than in the liberos' ($p < .001$), according to the heart rates recorded by González et al. (2005), (148.5 (average of the two middle hitters) Vs 137 bpm). In the same study blood lactate was measured, being different statistically ($p < .001$) between central players (4.12 mmol·l⁻¹ [average]) and liberos as well (3.23 mmol·l⁻¹).

Distance covered

Middle blockers of a professional level covered significantly less distance ($p \leq .005$) during a game (788 m; 266 m) than setters (1,630 m; 552.25 m), defenders (1,448 m; 488.5), spikers (1,383 m; 499.5 m), and liberos (1,372 m; 459.25 m) both in a match and in a set (average of sets shown), respectively (Mroczek et al., 2014).

Muscle strength

Postural stability

In the study by Agostini et al. (2013), middles, receivers and opposites were classified as hitters, whereas setters and liberos were defined as defenders. Their results showed that hitters had a different postural stability than defenders, not reaching statistical significance. A possible explanation, according to them, is that hitters are usually trained to respond to a single playing scheme and may have longer reaction times than defenders.

Lower limbs

Quadriceps and hamstring muscle strength of professional players were calculated by Hadzic et al. (2010) through a 15-second stretch, as well as the Hamstring-to-Quadriceps Ratio (HQ Ratio), defined as the maximal hamstring strength relative to maximal quadriceps strength (Aagaard et al., 1998). They found no differences neither between the playing positions, which means that knee flexor and extensor muscles strength of professional players is independent of their playing position, nor between sexes.

Still on the quadriceps and hamstring, Rodríguez-Ruiz et al. (2014) studied the normalized response speed (V_{rn}) of both muscle groups on players from the Spanish top level division, finding differences between the musculature responsible for the knee extension (vastus medialis, rectus femoris and vastus lateralis) and flexion (biceps femoris) ($p < .01$). Furthermore, middle blockers presented the lowest NRS among all playing positions (51.27 mm/ms; $p = .002$), followed by opposites (53.46 mm/ms; $p = .035$), outside hitters (54.27 mm/ms; $p < .001$) and setters/liberos (56.38 mm/ms; $p < .05$), meaning that middle blockers' knee muscles can respond more rapidly to stimuli. However, no differences were found when analysed depending on sex.

Regarding jumping performance, Ciccarone et al. (2008) conducted the vertec test on elite players as a means of measuring jumping ability for both attack (Vertec test with run, similar to Spike Jump [SpJ]) and block (Vertec block, similar to Block Jump [BJ]). They found significant differences ($p < .001$) in both spike (vertec attack) and block (vertec block) jump between the middles (345.6 cm; 321.3 cm) and the outside hitters (344.1 cm; 319.4 cm) above those of the setters (329.9 cm; 307.1 cm) and the liberos (333.7 cm;

309.3 cm). Agreeing with these results are those obtained by Sheppard et al. (2009), who found that both middles (343.2 cm) and outsides (341.3 cm) had a higher SpJ than setters (328.1 cm) ($p < .001$). Anyway, when expressed relative to standing reach, outsides were superior to setters and middles ($p < .05$).

Concerning the Vertical Jump (VJ) and Countermovement Jump (CMJ), some studies have been conducted on elite-playing level athletes. Several results showed no differences in VJ and CMJ performances between middle blockers and other positions, only between receivers and setters ($p < .05$) (Sattler et al., 2015; Sattler et al., 2012). These differences were not found between women (Sattler et al., 2015). Notwithstanding, according to previous results obtained by Sheppard et al. (2009), both middles (324.0 cm) and outsides (319.8 cm) presented a higher CMJ than setters (308.5 cm) ($p < .001$), but when expressed relative to standing reach, no differences existed between the groups of setters, middles and outside players. Along the same lines, Fattahi et al. (2013), including wing and middle attackers as one (spikers), found significant differences between the VJ of spikers and setters with respect to that of the liberos ($p < .05$).

As regards the different playing levels, absolute jumping ability (including SpJ, relative SpJ, CMJ and relative CMJ) was not different between Development National Team (players competing for their age group National Team) and Senior National team (players competing for a National team) middles (Sheppard et al., 2009).

Upper limbs

As with the Quadriceps and Hamstring strength, Hadzic et al. (2014) calculated the strength ratio between the external and internal rotators of the shoulder in professional players. They reported a higher frequency of an abnormal strength ratio (external rotators/internal rotators) among the blockers, opposites, and receivers, but it was not statistically associated with playing position, regardless of previous shoulder injury status. Furthermore, separately, the likelihood of strength asymmetry of either the ERs or IRs was not associated with playing position either.

Still on the rotators, different levels of rotator cuff tendons vascularization were found in players according to their role in the team. The player with the highest perfusion values was the outside hitter (62.7%), followed by the setter (56.2%), although there were no significant differences between them. However, statistical differences ($p < .05$) were found with opposites (55.5%), liberos (54.4%) and middle blockers (53.7%) (Notarnicola et al., 2012).

Regarding pectoral strength, middle blockers and opposite players of elite level presented higher values ($p < .05$) than setters and liberos (Marques et al., 2009). It was measured through a 4 repetition maximum bench press. Middles reported 96.11 kg, opposites 94.00 kg, setters 78.33 kg and finally liberos 76.25 kg.

Injuries

Overall, the studies about injuries in volleyball have found middle blockers as the players with a higher risk of injury, along with outside hitters ($p < .05$), both in elite and underage players (Beneka et al., 2009; Bere et al., 2015; van der Worp et al., 2012), or at least that 73% of the injuries were related to the three front row positions (attackers and blockers), noting that 24% of all injuries registered happened during blocking (Augustsson et al., 2006). However, there is one exception to these findings (Beneka et al., 2007), where no statistical differences between injured and not injured in any of the playing positions were discovered, although the majority of injuries for both elite and local division players occurred in middle blockers and universals. Another study (Ciesla et al., 2015) does not report data for injury rates depending on the playing position for professional athletes, but indicates that players with higher BMI and vertical jump present an increased risk of injury. According to their results, they might refer to middle blockers and opposites, who

presented the largest spike and block reach. A similar finding is reported by Lian et al. (2003), with Norwegian amateur players, stating that the body weight of players with jumper's knee was also greater.

Specific body areas injured

Middle players presented a lower proportion of injured fingers/thumbs than liberos (13% vs 22%) and shoulder/clavicle than receivers (9% vs 4%) (Bere et al., 2015), but these results refer to data from mixed age groups and sexes, so they should be dealt with carefully.

Concerning knee injuries, van der Worp et al. (2012) quantified the likelihood of patellar tendinopathy for outside hitters and middle blockers compared to setters as 2.8 times larger (OR = 2.8; $p < .005$). These results are in agreement with those of Lian et al. (2003), who established the prevalence of patellar tendinopathy was larger in outside hitters (67%) and middle blockers (64%) than in utility players (17%) and setters (22%).

Anthropometry and body measures

Height and body mass

Overall, middles tend to be the tallest and heaviest players in their teams, regardless the competitive level, both in men (Ciesla et al., 2015; Marques et al., 2009; Palao et al., 2014; Sattler et al., 2012; Sheppard et al., 2009; Toledo Fonseca et al., 2010) and women (Palao et al., 2014).

However, depending on the study, significant differences were found in body mass between elite middle players and other playing positions. For Ciccarone et al. (2008) and Sattler et al. (2012), the significant differences for the middles ($p < .001$ and $p < .05$, respectively) were with setters and liberos; for Sheppard et al. (2009), they were different ($p < .001$) from outsides and setters; Toledo Fonseca et al. (2010) found significant differences between middles and just liberos ($p < .01$), although they carried out their work with the U19 Brazilian national team. Nevertheless, Sheppard et al. (2009) included opposite players and receivers as wing attackers; others, who did not differentiate, found these same disparities between middles and all the rest of players, except for opposites ($p < .001$) (Marques et al., 2009; Palao et al., 2014).

Closely related to the weight is the Body Mass Index (BMI). This index is calculated as the quotient of the body mass in kilograms and the body height in square metres ($BMI = kg \cdot m^{-2}$). Regarding this indicator, no significant differences were found among playing positions in professional men (Sattler et al., 2012), although middles presented the lowest values (Palao et al., 2014). On the contrary, female middles presented significantly higher BMI than liberos ($p < .003$) (Palao et al., 2014).

When it comes to different competitive levels, for adult volleyball players, Gradinaru et al. (2014) compared the heights of Olympic-level middle blockers with those of the University of Timisoara team (no playing level indicated). Olympic middle blockers were 203.8 cm tall, whereas Timisoara players were 191.3 cm tall.

In any case, it appears not necessary to compare between such different groups, according to the results obtained by Palao et al. (2014). In this study, middle blockers of level 2 (5th-8th in the final standings) were significantly heavier (93.9 kg) than those of level 3 (9th-last) (90.9 kg) ($p < .001$). However, in female volleyball, no differences were found between middle blockers from separate levels of play.

Somatotype

Regarding the somatotype, there is some disparity in the results of the two papers reviewed, both of them with a 16-19 year-old sample. Whereas Duncan et al. (2006) found that middles tend to be ectomorphic mesomorphs, Toledo Fonseca et al. (2010) on their part obtained a ectomorph-endomorphic somatotype.

All this results are in line with the higher values of fat percentage presented by middle blockers and opposites, although not significantly (Toledo Fonseca et al., 2010).

Reach

The reach is defined as the height at maximal extension of the arm or arms (Ciccarone et al., 2008). Different types of have been defined: reach with dominant arm (Ciccarone et al., 2008; Sheppard et al., 2009), reach with both arms (Ciccarone et al., 2008), spike and block reach (height reached when performing a spike or block jump, respectively [Ciccarone et al., 2008; Palao et al., 2014]).

Reviewing all the studies, middle blockers tended to present the highest reach among all the playing positions in professional players, with differences according to the study. Significant differences were found between middle blockers and both setters and liberos ($p < .001$) according to Ciccarone et al. (2008). Sheppard et al. (2009) (who included receivers and opposite players as outsiders), found a significantly higher standing reach for middles than either outsiders ($p < .001$) and setters ($p < .001$).

With regard to jumps reach (i.e. spike and block reach), the players with the highest reach were middle blockers and opposites, followed by outside-hitters and then setters and liberos, both for men (Ciesla et al., 2015; Palao et al., 2014) and women ($p < .05$) (Palao et al., 2014).

Mental skills

Mental capacities have been studied in different age groups. Li & Kang (2015) observed aspects such as will or resiliency in the Chinese Super League Volleyball players, whereas Milavić et al. (2013) and Mostafa & Mansour (2016) assessed younger players (16 years old and 16-18 years old, respectively) abilities like anxiety, self-confidence, goal-setting or commitment.

According to Li & Kang (2015), middles were worse than setters ($p < .05$) and liberos ($p < .01$) in toughness and also presented lower resiliency than auxiliary setters and liberos.

In younger samples, overall findings agree that there are no significant differences between playing positions in psychological aspects such as competitive anxiety, self-confidence (Milavić et al., 2013; Mostafa & Mansour, 2016), goal setting, commitment, relaxation, fear control, activation, imagery, mental practice or competition plan (Mostafa & Mansour, 2016). However, Mostafa & Mansour (2016) did find significant differences in cognitive skills as focusing (between setters and all other playing roles) and re-focusing (between setters/liberos and the rest of positions) ($p < .05$).

These differences could be explained, as Li & Kang (2015) indicate, by the requirements of the different player roles as a consequence of specialisation.

Regarding the comparison between sexes, male players are better in self-control ($p < .05$), while female players are tougher ($p < .05$) (Li & Kang, 2015), but no playing position was taken into consideration for this analysis.

CONCLUSIONS

The middle blocker, as is most commonly referred to, must lead his team in terms of physical attributes overall: height, weight, reach, spike reach and block reach, which could be explained by the lowest BMI values showed.

In addition, middle blockers present the largest jump heights, both when spiking and blocking. They do not only jump higher, but also more often than any of their team mates regarding block and spike jumps. These data could explain the higher physical intensity required for middle blockers, despite covering less distance than anyone during a match, as a consequence of their substitution during the back row positions.

They must dominate the serve, although it could be something acquired in the professional level. Likewise, middle blockers should start their blocking actions from the centre of the net (zone-blocking system) and perform first tempo attacks with success, particularly those near to and in front of the setter. However, overall they are not the most successful player in their teams.

Furthermore, they should be able to perform fluently the cross step and slide step blocking footwork technique. The slide-cross-slide could be more successful, but is unused because of the time pressure.

When landing from their jumps, middle blockers should do it with both feet, either attacking or blocking, in order to avoid injuries, which they seem to present a higher risk of, mainly in their knees, but also in their fingers.

Regarding mental skills, middle blockers seem to present demands that make them score less than their team mates in resiliency and toughness.

Future research should continue to delve into playing positions in volleyball. A standardization of the denominations of playing positions seems to be required, since many different names are assigned to the different roles, not only middle blockers. More investigation should be conducted on technique from an injuries point of view; there is plenty of work about injuries, but it is seldom associated with the specific techniques that might be causing them.

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