COMPARATIVE ANALYSIS OF THE TECHNICAL-TACTICAL SKILLS OF ELITE MALE BEACH VOLLEYBALLTEAMS

Sophia D. Papadopoulou, George Giatsis, Efstratios Billis, Athanasios Giannakos and Panteleimon Bakirtzoglou

Aristotle University of Thessaloniki, Department of Physical Education & Sport Science, Laboratory of Evaluation of Human Biological Performance, Greece

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Abstract

The aim of the study was to perform a comparative analysis of the technical-tactical skills of elite male beach volleyball teams in the Olympic Games, Athens 2004. In total, thirty-four games (n=34) of the first eight top teams were studied, and 3484 game actions were videotaped. The study was conducted with the use of the 'Sportscout' video-analysis program. The efficiency and type of serves, sets and attacks were examined and assessed. The data were analysed and processed with the use of the statistical package SPSS 25.0, and more specifically the Crosstabs command. The non-parametric Chi-square test (x^2) was used to identify statistically significant differences. The statistical analysis of results showed significant differences among the teams in the efficiency of ace serves, the type of jump serve, the efficiency of perfect sets and the type of set, as well as in the efficiency of kill attacks (p<0,05).The Brazilian team, who won the Olympic gold medal, was significantly superior to the other teams with regard to all the above skills although they used overhand set to a lower extent (p<0,05). As a conclusion, the technical-tactical skills that result directly in points, such as ace serves and kill attacks seem to play a crucial role in the final outcome of a top-level men's beach volleyball game, and, therefore should be taken into serious account during training planning.

Key words: *beach volleyball, elite teams, performance, video analysis, efficiency.*

Introduction

Beach Volleyball (BV) was first played in Hawaii in 1914 (Couvillon, 2002). It took approximately the form it has today in the early 30s in California, USA, and became widely known in the 90s (Homberg & Papageorgiou, 1995). BV was officially introduced as an Olympic sport in the 1996 Olympics in Atlanta. Having witnessed unprecedented growth over the last decades, BV has had a positive impact on the volleyball world and, as a result, a great number of athletes worldwide are professional BV players. Video analysis in team sports has been proven a valuable tool for the analysis and assessment of technical-tactical skills, providing highly significant feedback on both the individual and team level (O'Donoghue, 2006; Shattuck, 1994). Moreover, video analysis substantially contributes to the personal development of players (Hughes, 1994) and the improvement of technical-tactical skills through observation. In Indoor Volleyball, the assessment of technical-tactical skills with the use of video analysis has proven that both serve and attack are crucial factors for the distinction of the winning team (Cox, 1974; Eom & Schutz, 1992a; 1992b; Hayrinen, Hoivala & Blomqvist, 2004; Palaoetal., 2004; 2005; Tsivika & Papadopoulou, 2008). In BV, Giatsis et al. (2003) used video analysis to study differences in the quality of serve reception and attack efficiency following the reduction in BV court dimensions from 9x9 to 8X8m. They also studied the type and efficiency of individual attack actions. According to the results of their study, the quality of serve reception improved after the reduction of court dimensions resulting in the creation of more favourable conditions for successful attacks.

In another study, Michalopoulou et al. (2005) investigated and assessed the efficiency of technical and tactical skills among winning and losing teams in the Greek BV Championship in 2000. The study demonstrated that the efficiency of serve and attack actions are two technical-tactical elements that primarily determined the game outcome between the winning and defeated teams. Significant differences were found in the serve failure rate between the two teams, as well as in the attack success rate ending in winning points.

Giatsis and Zahariadis (2008) compared winning and losing teams in world elite male BV games to identify differences in serves, attacks and blocks, and found that the winning teams were superior with regard to almost all elements; more specifically, the attack errors of the opposite team were found to be the most important determinant for the outcome of the game. In FIVB and CEV BV games it was shown that, the complete attack rate was 51,6% (Giatsis, Lopez Martinez & Gea García, 2015). The study by Koch and Tilp (2009) demonstrated that in the World Tour FIVB the jump serve rate (46,9%) was higher than the jump float (24,4%) and float serve rate (28,7%). Yet, jump serves had the highest error rate. Jump serves had the highest rate also in the Olympics in Atlanta (49,6%) (Urena, 1998) and in Sydney (58,9%) (Palao et al., 2004). According to the literature, the analysis and assessment of technical-tactical skills in BV play a major role in the outcome of the game. The aim of this study was to perform a comparative analysis of technical-tactical skills of elite male BV teams in the Olympic Games, Athens 2004.

Materials and methods

Sample
The sample comprised the first eight top BV male teams of the 2004 Olympics in Athens, who were studied in thirty-four games (n=34), and 3484 game actions that were videotaped. The first eight winning teams were the following in rank order: Brazil (BRA), Spain (ESP), Switzerland 1 (SWI 1), Australia (AUS), Canada (CAN), Germany (GER), Switzerland 2 (SWI 2)and USA (USA). The study was conducted in accordance with the ethical guidelines of the Aristotle University.

Measurement Process
Thirty-four BV games (n=34) were videotaped and analysed based on the personal researcher's observation. The study was conducted with the use of the 'Sportscout' computer software programme for the analysis of the videotaped games of the sample. 'Sportscout' is a database system with an advanced search engine for multiple game scenes that is applied in various sports (Tsimpiris et al., 2006). A protocol for the observation and videotaping of the technical-tactical elements was designed with the aim of recording, analyzing and assessing the efficiency and type of serves, sets and attacks. The video camera was placed in the center of the court.

Statistical analysis
Data were analysed and processed with the use of the statistical package SPSS 25.0, and more specifically the Crosstabs command. The non-parametrical Chi-square (x^2) test was applied to determine the statistically significant differences. Statistical significance was set at $p<0,05$.

Functional definitions

Serve efficiency
1. *Successful serve:* serve that successfully crosses over the net into the opponent's court and the rally game actions continued.
2. *Ace serve*: serve that results immediately in a point for the serving team, without the opposite team being able to react in the reception phase.
3. *Serve errors:* unsuccessful serve in which the ball lands out of bounds or falls on the net and does not crossover the net into the opponent's court.

Types of serve:
1. *Jump serve*: the serving player tosses the ball with a spin, and hits it high in the air rotating it forward with topspin.
2. *Jump float serve:* the serving player jumps and tosses the ball in the air making it 'float' (without spinning).
3. *Float serve:* the serving player stands and tosses the ball in the air making it 'float' (without spinning).

Set Efficiency:
1. *Perfect set*: set performed close to the net creating the ideal conditions to attack.
2. *Good set:* set performed less close to the net creating good conditions to attack.
3. *Poor set:* set performed far from the net not creating the best conditions to attack.
4. *Set errors:* set that is technically wrong and, as a consequence, is whistled by the referee as fault and cannot be attacked.

Sets were assessed with the use of the Set Skill Test (Zetou, Giatsis, &Tzetzis, 2005).

Type of set:
1. *Overhand or hand set*: Technique of setting or passing the ball with two hands and fingers spread during contact with the ball (FIVB, 2019).
2. *Bump:* Technique of playing the ball by using forearms, two hands together used as a set (FIVB, 2019).

Attack Efficiency:
1. *Kill attack:* attack giving a point to the attacking team in any way.
2. *Unsuccessful attack:* attack resulting in a point for the defending opposite team in any way (attack error or attack blocked by opponents or successful opponent's defense and the rally game actions continued.

Type of attack:
1. *Spike:* Technique that involves hitting the ball hard with an open hand on a downward trajectory from above the top of the net (FIVB, 2019).
2. *Shot:* A relatively soft attack technique used to place a ball into an undefended area of the opponent's court. "Common shots used in BV include: roll shots, in which the attacker puts a lot of topspin on the ball so that it has an arcing trajectory that will go over the block then drop quickly; cut shots, in which the shot crosses the net at sharp angles; pokeys, in which the ball is contacted with the attacking player's knuckles; and dinks, in which the ball is directed very softly low over the net" (FIVB, 2019).

Results

Based on the results in Table 1 the mean values and standard deviations of Serves, Sets and Attacks rates are presented. With regard to ace serves, statistically significant differences were found among the teams ($p<0,05$). The BRA team that won the gold medal (8,7%) had statistically significant higher performance in ace serves than the teams of ESP ($x^2=6,19$, $p=0,01$), SWI 1 ($x^2=5,76$, $p=0,01$), AUS ($x^2=4,78$, $p=0,02$) USA ($x^2=5,15$, $p=0,02$) (Figure 1). Statistically significant differences were also found among the teams in the type of serve ($p<0,05$) (Figure 2).

More specifically, the following statistically significant differences were found in jump serve: a. BRA vs ESP ($x^2=72,86$, $p=0,00$), SWI 1 ($x^2=19,79$, $p=0,00$), AUS ($x^2=75,00$, $p=0,00$), CAN ($x^2=49,05$, $p=0,00$), GER ($x^2=32,28$, $p=0,00$), SWI 2 ($x^2=41,22$, $p=0,00$), USA ($x^2=65,01$, $p=0,00$), b. SWI 1 vs ESP ($x^2=20,58$, $p=0,00$, AUS ($x^2=21,94$,

p=0,00), CAN (x^2=7,68, p=0,00), SWI 2 (x^2=4,50, p=0,03), USA (x^2=15,85, p=0,00), c. GER vs ESP (x^2=10,90, p=0,00), AUS (x^2=11,95, p=0,00), USA (x^2=7,40, p=0,00), d. SWI 2 vs ESP (x^2=6,36, p=0,01), AUS (x^2=7,19, p=0,00).

Table 1. Percentage of Serves, Sets and Attacks, Mean Values (M) and Standard Deviations (SD).

Technical-tactical elements		M	SD
Serve efficiency	Successful	91,7	3,4
	Aces	2,9	2,5
	Errors	8,3	3,4
Type of Serve	Jump Serve	30,2	20,1
	Jump Float	30,1	18,7
	Float	39,7	23
Set efficiency	Perfect	57,6	8
	Good	32,5	5,5
	Poor	7,7	2,5
	Errors	2,2	0,7
Type of Set	Overhand	55,6	24,9
	Bump	44,4	24,9
Attack efficiency	Kill	59,8	5,4
	Unsuccessful	40,2	5,4
Type of Attack	Spikes	56	4,6
	Shots	44	4,6

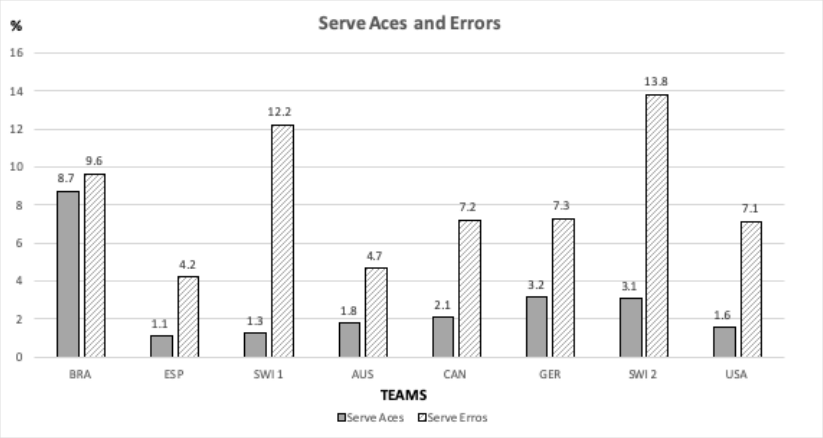

Figure 1.Percentage of serve aces and errors.

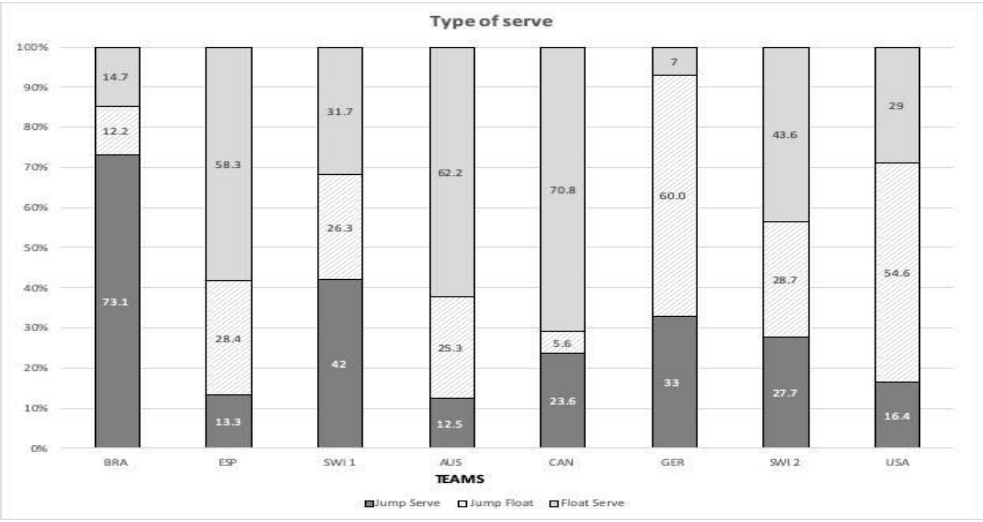

Figure 2. Percentage of the type of serve.

Statistically significant differences were found among the teams in set efficiency (p<0,05) (Figure 3). More specifically, the following statistically significant differences were found in perfect sets (overhand or bump): BRA vs GER (x^2=7,39, p=0,00), b. SWI 1 vs ESP (x^2=4,28, p=0,03), AUS (x^2=5,71, p=0,01), GER (x^2=13,73, p=0,00), USA (x^2=4,34, p=0,03), c. CAN vs GER (x^2=8,52, p=0,00), d. SWI 2 vs GER (x^2=5,58, p=0,01).

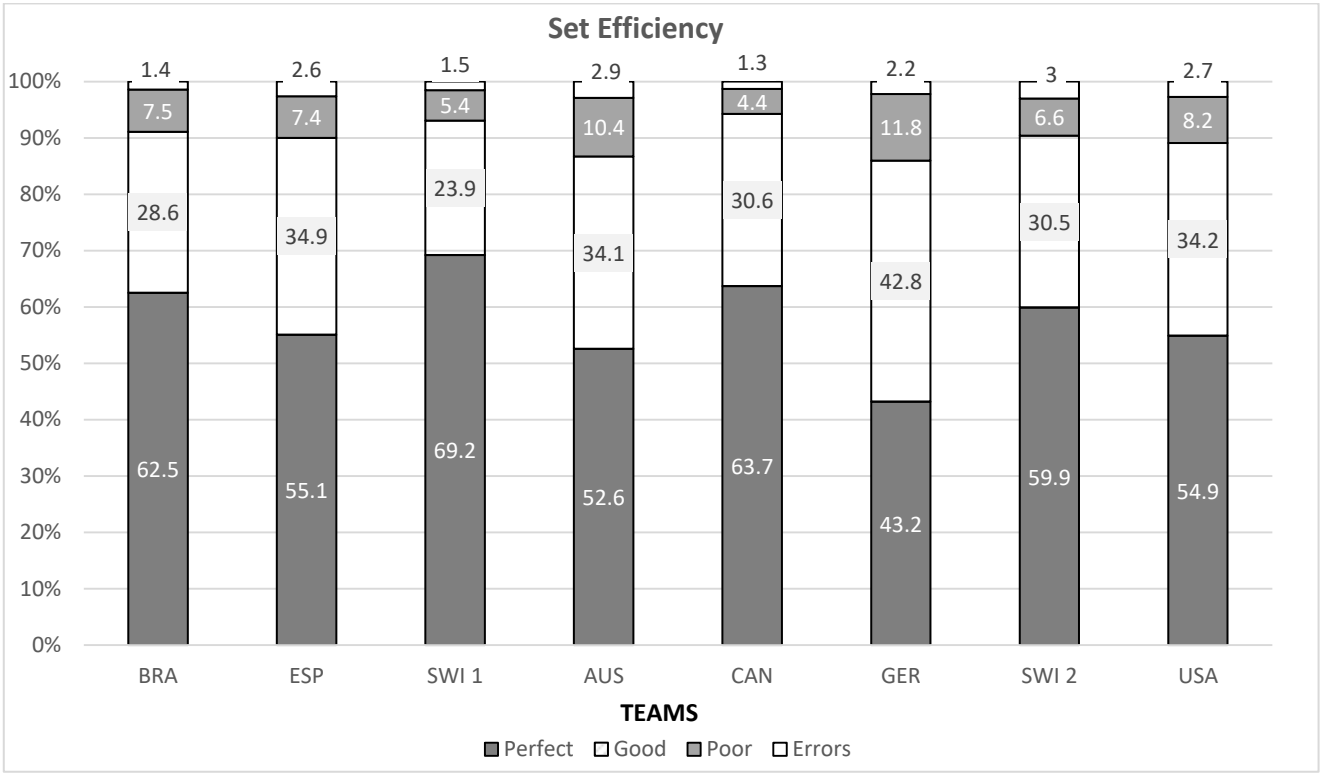

Figure 3. Percentage of set efficiency.

Statistically significant differences were found among the teams in the type of set used by the players (overhand and bump) ($p<0,05$) (Figure 4).

Regarding overhand set, the following statistically significant differences were found: a. BRA vs GER ($x^2=5,72$, $p=0,01$), b. ESP vs BRA ($x^2=39,73$, $p=0,00$), GER ($x^2=68,78$, $p=0,00$), SWI 2 ($x^2=4,23$, $p=0,03$), c. SWI 1 vs BRA ($x^2=42,03$, $p=0,00$), GER ($x^2=71,57$, $p=0,00$), SWI 2 ($x^2=5,08$, $p=0,02$), d. AUS vs BRA ($x^2=23,61$, $p=0,00$), GER ($x^2=48,36$, $p=0,00$). e. CAN vs BRA ($x^2=55,79$, $p=0,00$), GER ($x^2=87,82$, $p=0,00$), AUS, ($x^2=8,24$, $p=0,00$), SWI 2 ($x^2=11,26$, $p=0,00$), f. SWI 2 vs BRA ($x^2=19,23$, $p=0,00$), GER ($x^2=42,43$, $p=0,00$), g. USA vs BRA ($x^2=38,18$, $p=0,00$), GER ($x^2=66,89$, $p=0,00$). Also, significant differences were found in bump set: a. BRA vs ESP ($x^2=39,73$, $p=0,00$), SWI 1 ($x^2=42,03$, $p=0,00$), AUS ($x^2=23,61$, $p=0,00$), CAN ($x^2=87,82$, $p=0,00$), SWI 2 ($x^2=19,23$, $p=0,00$), USA ($x^2=38,18$, $p=0,00$), b. AUS vs CAN ($x^2=8,24$, $p=0,00$), c. GER vs ESP ($x^2=68,78$, $p=0,00$), SWI 1($x^2=71,57$, $p=0,00$), AUS ($x^2=48,36$, $p=0,00$), CAN ($x^2=87,82$, $p=0,00$), SWI 2 ($x^2=42,43$, $p=0,00$), USA ($x^2=66,89$, $p=0,00$), d. SWI 2 vs ESP ($x^2=4,23$, $p=0,03$), SWI 1 ($x^2=5,08$, $p=0,02$), CAN ($x^2=11,26$, $p=0,00$).

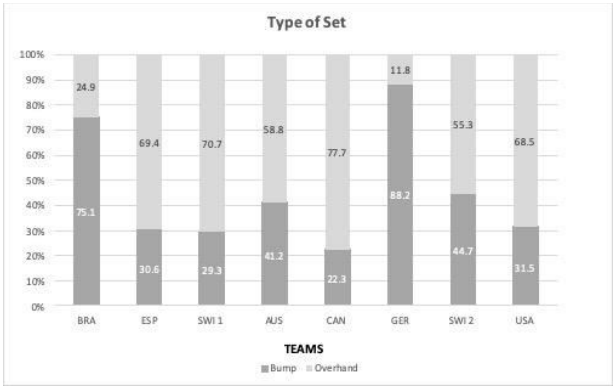

Figure 4. Percentage of the type of set.

Statistically significant differences were found among the teams and more specifically in kill attacks ($p<0,05$) (Figure 5). The mean value of the teams in kill percent was 59,8% (Table 1). More specifically, statistically significant differences were found in BRA vs AUS ($x^2=4,77$, $p= 0,02$), CAN ($x^2=5,72$, $p=0,01$), GER ($x^2=5,72$, $p=0,01$). On the contrary, no statistically significant differences were found among the teams in the type of attack ($p>0.05$) (Figure 6).

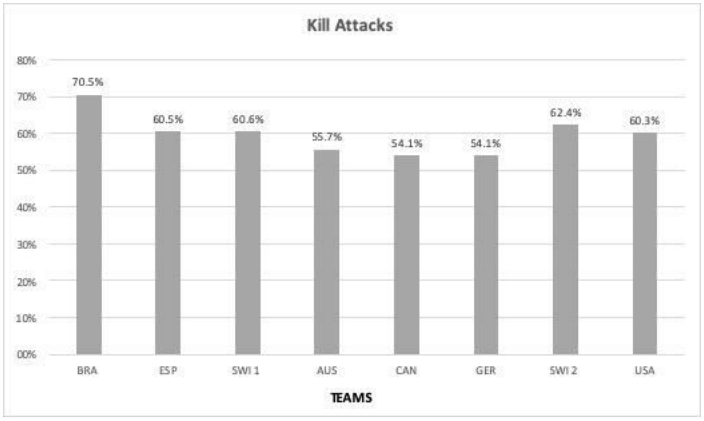

Figure 5. Percentage of total kill attacks.

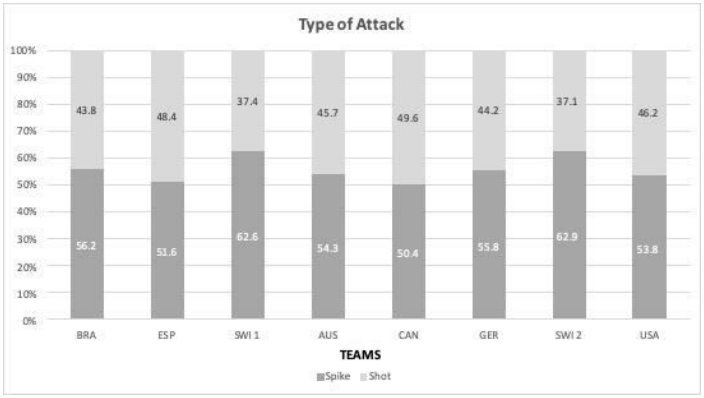

Figure 6. Percentage of the type of attack.

Discussion

The aim of the study was to perform a comparative analysis of technical-tactical skills of the elite male BV teams in the Olympic Games in Athens 2004. According to the results, statistically significant differences were found among the teams with regard to: a) the efficiency of serve (serve aces), b) the type of serve (jump serve), c) the efficiency of set (perfect set), d) the types of set (overhand and bump set), and e) the efficiency of attack (kill attack). More specifically, the serve success rate was 91,7%, a finding that comes in contradiction to the respective finding of Hömberg & Papageorgiou (1995) who mention that the successful serve rate hardly reaches 79%. However, the results of our study come in line with those of Ronglan & Grydeland (2006), who present a serve success rate of 90,9% in one of their studies. The same authors believe that most of the teams preferred not to risk the execution of service, probably due to the smaller size of the court (from 9x9 to 8x8), a finding which is in line with the results of our study. Giatsis and Tzetzis (2003) claim that probably easy serves are used more because of the new point-scoring system, according to which unsuccessful serves give points to the opposite team. This may also explain the high serve success rate that all teams presented in this study. Of the types of serve examined in our study, most frequently performed were the float serve (39,7%), the jump serve (30,2%) and the jump float serve (30,1%). Researchers who have studied different types of serve in BV games of various top-level tournaments report a 22% rate of float serve usage by American professional players (Kiraly, 1993), while others report that the float serve rate was 30% (Hömberg & Papageorgiou, 1995). On the contrary, in their study within the context of the BV World Championships for ages under 18 and 21 years old, Tilp et al. (2006) demonstrated an even higher float serve rate (36%), which comes in agreement with the findings of the present study. Similar results were found by Buscà et al. (2012) in an FIVB tournament where the float serve rate was 37,8%. As for jump serve, Kiraly (1993) reports a rate of 74% in AVP games, while Hömberg and Papageorgiou (1995) report a 57% rate. It is worth mentioning that the above surveys carried out before 2001 were conducted in BV courts with dimensions 9x9m. In the present study that was conducted in 8x8m courts, the jump serve rate was lower (30,2%), as in the study by Buscà et al. (2012) where the corresponding rate was 45%. In addition, Tilp et al (2006) found an overall 74% rate of jump serve and float jump serve, while the overall rate of these two types of serve in our study amounts to 60,3%. Buscà et al. (2012) found an even higher rate of these two types of serve (82,8%) in FIVB games. The reasons for these differences may lie in every team's special particularities, the wind force and the importance of the games. In the present study, significant differences were found among the teams with

regard to jump serve. More specifically, the Olympic gold medal team of Brazil (73,1%) presented significant differences from all other teams, while the Australian team made the least use of this type of serve (12,5%). It is noteworthy to mention that the rate of the Brazilian team that was found in our study was the highest rate in the literature in studies conducted in 8x8m BV courts.

Out of all successful serves in this study, the ace-serve rate was 2,9%. According to Hömberg & Papageorgiou (1995), approximately 6% ace serves were performed in the German National Championship, which is almost twice the rate found in the present study. Also, Tilp et al. (2006) and Buscà et al. (2012) found higher rates in their studies (4,1 and 7,6% respectively). Regarding the ace serve rate of every team in the present study, Brazil presented a significantly higher rate (8,7%) compared to Spain 1,1%, Switzerland I 1,3% etc.

Although the jump serve is considered to be of great difficulty and has a significantly higher failure rate, it has nevertheless been observed that in many cases teams using it scored more points (aces), indicating that some teams may choose to risk, such as the Brazilian team in the present study. On the contrary, teams using the other types of serves that are considered to be of less difficulty and risk than jump serve presented higher serve success rate, but the ace serve rate was lower (e.g. Spain with 86,3% and 1,1%, respectively). It is likely that, instead of risking the serve, these teams preferred to target the player who they wished to perform the attack, in order to make it more difficult and reduce the chances of the opponent scoring through the attack (Giatsis & Tzetzis, 2003). Michalopoulou et al. (2005) agree with this view and report that in BV, the biggest differences between winners and losers are related to the service. When performing more difficult serves, the winning teams do not allow the opponents to attack even under ideal conditions, whereas performing easier serves allows the opponents to develop optimal attack.

Concerning the type of set (overhand and bump set), there was a tendency found in our study of using more overhand sets (54,6%). This rate was less than the 72% overhand serve rate reported by Homberg & Papageorgiou (1995), and higher than the 45% and 42% rates reported by Kiraly (1993) and Tilp et al. (2006) respectively. Regarding bump set, the present study showed a rate of 44,4%. The same above mentioned researchers (Homberg & Papageorgiou, 1995; Kiraly, 1993; Tilp et al., 2006) report that the bump set rates presented in their studies were 26%, 55%, 58% respectively. The differences in the results of the above studies regarding the type of set may be justified by the more flexible/ lenient or strict application of the regulation related to overhand set concerning catch or double contact and by the lower quality of reception in 9x9m courts. This may also be due to the lower quality of reception in 9x9m squares. The strict interpretation of the regulation concerning overhand set may be the reason for the more frequent use of the bump set technique in these studies. As for overhand set, the present study showed significant differences among the teams and in particular from the German team who presented the lowest rate (11,8%). Regarding bump set, there were significant differences among the teams. In addition, Brazil that won the gold medal used the bump set (75,1%), as opposed to almost all the other teams, indicating that the Brazilian team had probably trusted more the bump set and therefore chose using only this type of set in their game. Moreover, other important factors that play a role in choosing which type of set to use are environmental factors (wind, sun), as well as the position of the setting player (steady position, moving position). Homberg & Papageorgiou (1995) hold the same view claiming that BV players are constantly trying to use overhand set, since this technique allows for greater accuracy. In particular when there is no wind or under moderate wind conditions, the overhand set is more accurate. Also, the same researchers support that strong winds may lead to technical errors when performing an overhand set. In addition, the bump set should be used whenever the player cannot achieve a well-balanced position to perform the overhand set. It becomes clear from the above that the bump set technique is of crucial significance in BV.

As regards set efficiency, the results showed significant differences. More analytically, the rates found according to set efficiency were as follows: 57,6% 'perfect' sets, 32,5% 'good' sets, 7,7% 'poor' sets and 2,2% 'set errors'. According to Kessel (1992) who conducted a study in American BV players, the 'perfect' set rate was approximately 56%, which comes in line with the findings of the present study. Also, all overhand sets in American players are either 'perfect' or 'good', while the bump set rate is 86% (Kiraly, 1993). In addition, concerning set efficacy, Tilp et al. (2006) reported a rate of 60% that is similar to the rate found in this study. As for the 'perfect' set rate in our study, it was found that the 'perfect' set rate in the teams of Brazil (62,5%), Switzerland I (69,2%), Canada (63,7%), and Switzerland II (59,9%) showed significant differences from Germany (43,2%); this is probably due to the fact that most teams used mostly the overhand set, as opposed to the German team who made more use of the bump set (88,2%). In terms of attacks, the kill attack rate was 59,8%. This finding is inconsistent with that of Hömberg and Papageorgiou (1995), who report that successful attacks in men account for 56% of all attacks. They also report that in American BV professional players (AVP), the rate of direct attack errors is about 15%. This comes in line with the results of Michalopoulou et al. (2005) and Giatsis and Zahariadis (2008), who report that winning teams perform more effective attacks (65,5% and 63,2% respectively) compared to losing teams (54,8%). Also, the same researchers argue that losing BV teams presented a significantly higher attack failure rate, as 1/3 of their attacks would result in a direct loss of point or in the opposite

team's counter-attack under good conditions. Ronglan and Grydeland (2006) share the same view, reporting a 60% kill attack rate. Concerning kill attacks, the results of the present study showed significant differences for Brazil (70,5%) compared to the other teams. More specifically, among the three medal teams, the Brazilian team (70,5%), who won the gold medal in the Olympic tournament, was clearly ahead of the second ranked team of Spain (60,5%) and the third ranked team of Switzerland I (60,6%). This high kill attack rate of Brazil may be attributed to the better attack ability of the Brazilian athletes. The kill attack rate of these three teams was higher than the respective 55% rate that was found in a study by Koch et al. (2009). Therefore, kill attacks seem to play a major role and are directly related to the success of BV teams, a finding which has also been supported by indoor volleyball researchers (Häyrinen et al., 2004; Palao et al., 2004).

Conclusions

Significant differences were found among the teams in terms of efficiency and type of serve. The Brazilian gold team dominated in ace-winning serves, and also executed more jump serves compared to the other teams. Therefore, it is confirmed that the serve, and particularly the jump serve, is a highly important weapon for every BV team. As for the type of the serve, significant differences were found among the teams in both overhand and bump sets. It is characteristic that six of the eight teams in the Olympic tournament made more use of the overhand set, whereas the other two teams performed more bump sets.

However, the gold medal winning Brazilian team performed primarily the bump set, probably because they had more confidence in the specific type of set. Significant differences were found among the teams in the efficiency of the attack. More specifically, the Brazilian team was in overall superior in terms of successful kill attacks. In combination with the high serve success rate, this superiority contributed significantly to Brazil's high distinction in the Olympics. As a conclusion, the technical-tactical skills that result directly in points, such as ace serves and kill attacks seem to be the key success factors for teams at the top men's BV level, and, therefore they should be taken into serious account during training planning.

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Correspondence to:
Sophia D. Papadopoulou
Associate Professor
Faculty of Department of Physical Education & Sport Science,
Aristotle University of Thessaloniki,
57001 Thessaloniki, Greece.
Email: sophpapa@phed.auth.gr