Comparison of Beach Volleyball Team Performance Parameters After a Reduction in the Court's Dimensions

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The aim of this study was to assess the changes that were observed in the performance of beach volleyball (BV) teams after a reduction in the dimensions of the court. Five semi-final and 11 final games of the Hellenic Championship (HC) were recorded, in a court of 8 x 8m (HC8x8) and 9 x 9m (HC9x9). The following performance parameters were analyzed: (1) serve reception and (2) attack. Kill percentage and efficiency of attack were analyzed according to the type of attack (spikes - shots). An independent samples t-test was used for the comparison of the above parameters at the two different court sizes. Statistically significant differences ($p < .01$) were found in serve reception percentage ($\_{HC8x8} = .979$, SD = .026, in relation to $\_{HC9x9} = .931$, SD = .052), in-target serve reception percentage ($M_{HC8x8} = .695$, SD = .116, in relation to $\_{HC9x9} = .500$, SD = .154), and in reception errors percentage ($\_{HC8x8} = .018$, SD= .024, in relation to $\_{HC9x9} = .062$, SD = .048). Even in the HC8 x 8m court, the players used 49% spikes and 51% shots, whereas in the HC9 x 9m court they used 53% spikes and 47% shots ($p < .05$). The hitting efficiency of attack had no significant difference ($p < .05$). A statistically significant difference ($p < .05$) was found in the percentage of attacks just after reception ($\_{HC8x8} = .068$, SD = .096, in relation to $\_{HC9x9} = .009$, SD = .106). The reduction in dimensions of the court produced better conditions for the execution of attacks, resulting from better serve reception. Efficiency of attack did not present any improvement. The smaller the dimensions of the court, the fewer the number of reception errors, while the *over-on-two* attacks number increased, revealing a new element in the attack offensive tactics of the teams.

Key Words: beach volleyball, team performance, rally scoring, side-out

El propósito de este estudio fue evaluar los cambios observados en el rendimiento de equipos de voleibol de playa (VP) ante la reducción de las dimensiones de la cancha de juego. Cinco semifinales y 11 partidos finales del Campeonato Helénico (CH) fueron grabados en una cancha de 8 x 8m (CH8x8) y 9 x 9m (CH9x9). Los siguientes parámetros de rendimiento fueron analizados: (1) recepción del servicio y (2) ataque. El porcentaje de eficiencia en el remate y la eficiencia del ataque se analizaron de acuerdo al tipo de ataque (remates - colocadas). Una prueba de t para muestras independientes se utilizó para la comparación de los parámetros mencionados en los dos tamaños de cancha. Se encontraron diferencias significativas ($p < .01$) en la recepción del servicio ($\_{CH8x8} = .979$, DE = .026, en relación a $\_{CH9x9} = .931$, DE = .052), en el porcentaje de recepción del servicio ($M_{CH8x8} = .695$, DE = .116, en relación a $\_{CH9x9} = .500$, DE = .154), y en los errores en la recepción del servicio. ($\_{CH8x8} = .018$, DE = .024, en relación a $\_{CH9x9} = .062$, DE = .048). Aún en la cancha CH8 x 8m, los jugadores usaron remates el 49% del tiempo y colocadas el 51% del tiempo, mientras que en la cancha CH9 x 9m usaron remates 53% del tiempo y colocadas el 47% del tiempo ($p < .05$). No hubo diferencia significativa en la eficiencia del ataque ($p < .05$). Se encontró diferencia significativa ($p < .05$) en el porcentaje de ataques luego de la recepción ($\_{CH8x8} = .068$, DE = .096, en relación a $\_{CH9x9} = .009$, DE = .106). La reducción en las dimensiones de la cancha produjo mejores condiciones para la ejecutoria del ataque como resultado de una mejor recepción del saque. No hubo mejora en la eficiencia del ataque. Las dimensiones más pequeñas, el número menor de errores en la recepción del servicio, y la finalización del intercambio en dos turnos de ataque aumentó, indicando un elemento nuevo en las tácticas ofensivas de los equipos.

Palabras Claves: voleibol de playa, equipo rendimiento de equipo, sistema anotación de puntos, cambio de servicio

INTRODUCTION

After the 2000 Olympic Games in Sydney, Australia, the Federation Internationale de Volleyball (FIVB, 2001) effected radical changes to the rules of beach volleyball (BV). The most important of these rules was the change in score recording from the rally point system (nRS), where a team that receives the serve and wins the rally is awarded the serve without scoring a point (side-out) (SO), to the rally point score system (RS), where every rally is a point for the team that wins, and the reduction in the court dimensions from 9 x 9m (HC9x9) to 8 x 8m (HC8x8). One additional change that came with the RS was that the team that wins two sets wins the match, in comparison with the nRS, whereby a one-game match is won by the team that wins a single game.

Giatsis and Zetou (2003) compared different dimensions and the score recording system in all the BV games of the FIVB World Tour and of the Hellenic Championship (HC) during the 2000 and 2001 seasons and found that 59 percent of the games with RS had a set with a minimum difference of two points. With nRS, however, this minimum difference of two or one point was observed in 12.8 percent of the games. Assuming that an exciting set can also qualify a match as exciting, this percentage was increased by 46 percent. This increase showed that the final result was judged by the details of the last phases of the game.

The BV is divided, as for indoor volleyball (IV), into two basic phases: in the SO, where a team tries to win the right to perform

the service, and in the counter attack, where a team tries to win a point after performing the serve. In each rally, there are three to four continuous skill plays (Hare & Anderson, 1997; Selinger & Ackermann-Blount, 1986). The SO phase includes three basic skills – receiving the serve, set and attack in a hierarchical order. The counter-attack includes defense, set and attack.

Eom and Schutz (1992a), in a study about the assessment of the parameters relating to performance in IV and success, found that the most important differentiations were observed in the skills of block and spike. In another study by Eom and Schutz (1992b), a significant correlation was found between pass-set, set-attack and pass-attack.

The significance of serve reception in BV has been widely dealt with in the literature, as it gives the possibility of establishing better conditions for the efficiency of attack (Hare & Sanderson, 1997; Homberg & Papageorgiou, 1995; Kiraly & Shewman, 1999; Stevenson & Obstfeld, 1989).

In BV, the players use the spike and shot in their offensive tactics due to the uncovered playing area which is created, since there is only one defensive player and one blocker (Kiraly, 1993 June; Kiraly and Shewman, 1999; Smith, 1994 August). Homberg and Papageorgiou (1994) reported that in BV championships of the Association of Volleyball Professionals (AVP) and of the German Championship, spikes prevail in percentage over shots, representing 65.5 percent and 52.8 percent of the overall attacks, respectively.

It appears that there have been no related studies published on the comparative assessment of performance after the reduction in the court's dimensions from 9 x 9m to 8 x 8m.

The aim of this study was two-fold: (1) to record and assess the changes in the quality of serve reception, and in the efficiency of attacks made in BV after the reduction in court dimensions; and (2) to investigate the type and efficiency of attack used.

METHODS

The information for the analysis of the technical data was collected from the matches of 2000 and 2001. In 2000, the championship was conducted on a court of 9 x 9m (HC9x9), while in 2001, on a court of 8 x 8m (HC8x8). In both championships, the RS point system was used. The games were videotaped with a digital camera. The sample of the study included 16 games, five of which were semi-finals and 11 of which were finals. The six final games were from the HC 2000, while five semi-finals and five finals were from HC 2001. All other games were from the top level of HC (master's tournaments). From the 16 games, 22 teams, 33 sets and 1,521 points were analyzed. In every game, the following elements were recorded for serve reception: a) total attempts, b) in-target attempts, c) out-of-target attempts, d) errors; and for attack: a) total attempts, b) kills, c) zero attacks and d) errors. For attacks, the following were also analyzed: a) kill percentage and b) hitting percentage (efficiency). Finally, the type of attack was recorded (spike and shot), as well as the kill percentage and efficiency of each type. The recording of all the above data was made only for the SO phase, so no data were recorded in case the game was continuing after the opponent's defense. Also, the element that was analyzed was the overall performance of teams and not the individual performance of each player.

Recording definitions for the quality and the efficiency of the technical skills.

To quantify the quality or the effectiveness of each skill performance, a three-point numerical rating scale was used (Homberg & Papageorgiou, 1995; Gozansky, 2001; NCAA, 2002).

Serve Reception

The definitions for in-target serve reception were stipulated according to international literature (Hare & Sanderson, 1997; Homberg & Papageorgiou, 1995; Kiraly & Shewman, 1999; Stevenson & Obstfeld, 1989) and evaluated by the first author. Intra-rater reliability was .97.

Serve Reception scale: Score (+): In-Target Serve Reception. It means the landing area of reception, which is the space of 4m x 2.5m delimited by the net. Score (0): Average Serve Reception, which means the serve reception out of the target that permits attack. Score (-): Serve Reception Error. It is an ace service and point for the opposing team or forces the receiving team to give the opponents a free ball.

Serve Reception Percentage: Good and average receptions divided by all reception attempts.

Attack

Attack Scale: Score (+): Kill Attack that results in a point. Score 0: Zero Attack when attacked ball remains in play. Score (-): Attack error that results in a point for the other team.

Attack Hitting Percentage (Efficiency): Total number of kills minus the errors divided by the total attempts.

Kills Percentage: Total number of kills divided by the total attack attempts.

Spikes - Shots

The attack was further divided according to the type of strike in spike and shot. The so-called "pockie" also belongs in the category of shots (Timmons, 1993 July), i.e., the set that results in a point, as well as the serve reception that results in a point (NCAA, 2002). For the assessment of spikes and shots, the same procedure with that of the attack assessment was used.

For validity and reliability of measurement, a pilot study in two games (79 phases) was conducted; a second pilot study followed in the same games after three days. The following correlation coefficients were determined for reception and attack: $r(79) = .919$, $p < .001$, and $r(79) = 1.000$, $p < .001$, respectively.

Statistical analysis

The statistical analysis was made with the statistics software SPSS 11.0. Independent samples t-test was used to evaluate the differences between the two courts, HC8 x 8m and HC9 X 9m, as per serve reception, attack, spikes and shots. The statistical significance was set up at the .05 level.

RESULTS

Out of 16 games, 11 ended with a score of 2-0 set and five with a score of 2-1. Table 1 (see page 4) shows a descriptive analysis of serve reception, attack, spikes and shots. In the HC8 x 8m court, the average of in-target receptions, spike errors, total and zero shots and over-on-two attacks was found to be higher, while in the HC9 x 9m court, all the other descriptive elements were found to be higher. Table 2 (see page 4) presents the average percentages

Table 1. Attacks, Spikes, Shots and Serve Reception on HC8 x 8m and HC 9 x 9m

Skill	HC8x8 M±*SD*	HC9x9 M±*SD*
Serve Reception		
Total Receptions	39.3 ± 7.7	39.3 ± 7.7
Reception Errors	0.8 ± 1.1	0.8 ± 1.1
In-Target Receptions	27.2 ± 6.8	27.2 ± 6.8
Out-of-Target Receptions	11.3 ± 5.0	11.3 ± 5.0
Attacks		
Total Attempts	37.2 ± 7.4	40.0 ± 8.7
Kills	20.5 ± 4.4	22.9 ± 6.0
Zero Attacks	10.8 ± 4.7	11.0 ± 4.3
Attack Errors	6.0 ± 2.5	6.1 ± 2.5
Spikes		
Total Attempts	18.1 ± 6.3	21.0 ± 6.7
Kills	10.8 ± 4.5	12.6 ± 5.2
Zero Spikes	3.0 ± 2.7	4.1 ± 2.4
Spike Errors	4.3 ± 2.1	4.3 ± 1.5
Shots		
Total Shots	19.1 ± 5.2	19.0 ± 6.5
Kills	9.7 ± 4.4	10.3 ± 4.6
Zero Shots	7.8 ± 1.4	6.9 ± 3.8
Shot Errors	1.7 ± 1.4	1.8 ± 0.9
Over-on-Two Attacks	3.0 ± 2.9	0.9 ± 1.0

of receptions, spikes and shots. The reception percentage was higher in the HC8x8 court in relation to the HC9x9 court, as opposed to the serve reception errors percentage, which was higher in the HC9x9 court in relation to the HC8x8 court. Furthermore, in the HC8 x 8m court, the percentage of over-on-two attacks was increased in relation to the HC9 x 9m court.

The t-test analysis revealed that there were statistically significant changes in the percentages of serve reception, $t(30) = 3.51$, $p = .001$, of target reception, $t(30) = 4.07$, $p < .001$, of serve reception errors, $t(30) = 3.49$, $p = .002$, and of over-on-two attacks, $t(30) = 2.09$, $p = .045$. No statistically significant differences were found in the percentages of attack efficiency, $t(30) = .38$, $p = .708$, spikes, $t(30) = .23$, $p = .818$, and shots, $t(30) = .327$, $p = .694$.

DISCUSSION

The results of the study revealed that the reduction in court dimensions brought changes to the quality of the technical skills of reception. The reception percentage and the in-target reception

Table 2: Means and Standard Deviations of Attack, Spike, Shot and Serve Reception Percentage of HC8 x 8m and HC9 x 9m.

Skill	HC8x8 M (‰) ± *SD*	HC9x9 M (‰) ± *SD*	Sig
Serve Reception	.979 ± .026[a]	.931 ± .052[a]	.009**
In target Reception	.695 ± .116[a]	.500 ± .154[a]	.001**
Reception Errors	.018 ± .024[b]	.062 ± .048[b]	.002**
Attack Efficiency	.398 ± .144	.415 ± .072	.708
Spike Efficiency	.365 ± 0,227	.382 ± .123	.818
Shot Efficiency	.411 ± .180	.434 ± .106	.694
Kills / Attacks	.562 ± .107	.570 ± .070	.836
Kill Spikes / Spike Attempts	.600 ± .137	.588 ± .090	.794
Kill Shots / Shot Attempts	.507 ± .158	.536 ± .114	.576
Over on Two Attacks	.068 ± .096[c]	.009 ± .018[c]	.045*
Spike Attempts	.485 ± .130	.532 ± .115	.311
Shot Attempts	.515 ± .130	.468 ± .115	.311

(a) HC8x8 showed significantly higher values in Reception and In-Target Reception than HC9x9 ($p < .01$)

(b) HC8x8 showed significantly lower values in Reception Errors than HC9x9 ($p < .05$)

(c) HC8x8 showed significantly higher values in Over-on-Two Attacks than HC9x9 ($p < .05$)

percentage presented a statistically significant increase.

The improvement of serve reception is eventually due to athletes on smaller courts having to cover a smaller space, which justifies the lower reception errors percentage on the HC8 x 8m court. Despite the improvement of reception on a smaller court, the efficiency of attack (hitting percentage) in the sideout phase was not differentiated in relation to the HC9 x 9m court, eventually for different reasons. According to our study, this could be probably attributed to the fact that in the 8 x 8m court, the attackers find it difficult to finish the rally due to the smaller area of the court by 17m^2, despite the fact that reception improved significantly. On the other hand, the similar attack efficiency percentage in the 9 x 9m court may be due to the lower target reception percentages and to the higher reception errors percentage.

The teams used almost the same quantity of spikes and shots in both sizes of courts. These results appear to be similar with those of the German Championship, but differ from the AVP, where spikes prevail (Homberg and Papageorgiou, 1995). Based on this study, the kill percentage and efficiency of spikes and shots were not significantly different from one court size to the other.

Another important element that was revealed by the results was the increase in the percentage of over-on-two attacks in the HC8 x 8m court. This is due to two factors. The first involves the player who does not receive the ball and has a closer starting position in relation to the net and to a teammate. These conditions probably provide better opportunities for the deployment of such attacks. The second one involves the increase in difficulty of obtaining points from the attack, which is eventually due to the decreased dimensions of the court. The element of increase of the over-on-two attack number in the HC8 x 8m court may be con-

sidered as particularly positive, since the over-on-two attack makes the organization of the opponent's defense more difficult (Fontana, 1994; Youngs, 2002). Furthermore, this attack could be considered as an important alternative solution for offensive team tactics because it can take the opponent by surprise (Walsh, 2002).

CONCLUSION

Generally, the smaller dimension of the court, the more improved was serve reception, increased the number of in-target receptions and decreased the reception errors without increasing the efficiency of ace attacks. This fact also justifies the choice for the FIVB to change the rules, since the reduction in aces from serve increased the rallies of the game. The best quality of serve reception and the smaller distance of the setter from the net increased the over-on-two attacks percentage, giving an additional offensive weapon, which will probably contribute to the upgrading of the game for the world's elite teams (Youngs, 2002).

IMPLICATIONS FOR COACHING

The smaller dimensions of the court oblige beach volleyball teams to apply more complex offensive tactics. Attackers should take more advantage of the over-on-two attack in order to deceive the opposing defense, since most of the teams have a specialized blocker who is obliged to go for blocking after performing the serve. For the implementation of multiple offensive tactics, BV coaches should pay particular attention to the quality of reception, mostly the in-target receptions. They should also give more importance to serve practice in order to decrease good reception percentage by the opponents. A harder serve will be able to decrease the opponent's possibilities of developing multiple offensive tactics.

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Effects of Reduction in Dimensions of the Court on Timing Characteristics for Men's Beach Volleyball Matches

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In 2001, the Federation Internationale de Volleyball (FIVB) changed the dimensions of beach volleyball (BV) courts from 9 x 9m to 8 x 8m. The purpose of this investigation was to record and compare the timing characteristics of work and rest of BV games in 8 x 8m and 9 x 9m courts. Sixteen matches (36 sets, 1,454 rallies) were observed and compared from the finals and semi-finals of the BV Hellenic Championship (HC). The data were classified as work (W), work alone (WA) (without aces and service errors), total rest (R) (without time-out), rest alone (RA) (without time-out, intervals between sets and court switches) and court switches (CS). The frequency of rallies, time-outs, total intervals and court switches was also recorded. A significant difference was found, $t(1452) = 4.30$. $p < .001$, on W between 8 x 8m ($M = 7.54$, $SD = 3.79$ s) and 9 x 9m ($M = 6.69$, $SD = 3.54$ s). Additionally, a significant difference was found in WA, $t(1266) = 2.67$, $p < .01$, between 8 x 8m and 9 x 9m ($M = 8.1$, $SD = 3.59$ s, and $M = 7.6$, $SD = 3.26$ s, respectively). No significant differences in TR, $t(1,372) = .64$, $p = .520$, between 8 x 8m ($M = 17.12$, $SD = 6.14$) and 9 x 9m ($M = 17.34$, $SD = 6.56$) were found. By reducing the size of the court to 8 x 8m, the W:R ratio decreased to 1:2.3 compared to 1:2.6 on the 9 x 9m court. A smaller W/RA ratio was also observed for the 8 x 8m = 1:1.9 vs. 9 x 9m = 1:2.1. The distribution of rally duration was varied, with a 7.0% reduction in the number of aces and service errors on the 8 x 8m court and a 7.6% increase in the number of rallies lasting between 8 and 14s. The reduction in court dimensions increased rally duration, decreasing the work-to-rest ratio, while increasing metabolic demands for the players.

Key Words: beach volley, work-rest ratio, rally scoring, side-out training

En 2001, la Federation Internationale de Volleyball (FIVB) cambió las dimensiones de la cancha de juego del voleibol playa (VP) de 9 x 9m a 8 x 8m. El propósito de esta investigación fue anotar y comparar las características temporales de trabajo y descanso en el voleibol playa en canchas de 8 x 8m y 9 x 9m. Dieciséis partidos (36 sets, 1,454 intercambios) de las fases semifinales y finales de VP de los Campeonatos Helénicos (CH) fueron observados y comparados. Los datos fueron clasificados como trabajo (TT), trabajo solo (TS), sin ases o errores en el servicio), descanso total (DT) (sin tiempos de descanso), descanso solo (DS),(sin tiempos de descanso , intérvalos entre sets, y cambios de cancha)), y cambios de cancha (CC) La frecuencia de los intercambios, tiempos de descanso, total de intérvalos y cambios de cancha fueron anotados. Se encontró una diferencia significativa para (T), $t(1452) = 4.30$. $p < .001$, entre las canchas de 8 x 8m ($M = 7.54$, $DE = 3.79$ s) y 9 x 9m ($M = 6.69$, $DE = 3.54$ s). En adición se encontró una diferencia significativa para (TS), $t(1266) = 2.67$, $p < .01$, entre 8 x 8m y 9 x 9m ($M = 8.1$, $DE = 3.59$ s, y $M = 7.6$, $DE = 3.26$ s, respectivamente). No se encontró diferencia en TT, $t(1,372) = .64$, $p = .520$, entre 8 x 8m ($M = 17.12$, $DE = 6.14$) y 9 x 9m ($M = 17.34$, $DE = 6.56$). Con la reducción en el tamaño de la cancha a 8 x 8m, la proporción de TT:DT disminuyó de 1:2.3 a 1:2.6 comparada don la cancha de 9 x 9m. También se encontró una proporción menor de TT/DS 8 x 8m = 1:1.9 vs. 9 x 9m = 1:2.1. La distribución de los intercambios disminuyó también, con un 7.0% menos en el número de ases en el servicio en la cancha de 8 x 8m y un incremento de 7.6% en el número de intercambios con duración entre 8 y 14segundos. La reducción en las dimensiones de la cancha aumentó la duración de los intercambios y disminuyó la proporción de trabajo a descanso; mientras que incrementó y aumentó los requerimientos metabólicos de los jugadores.

Palabras Claves: voliplaya, proporción de trabajo-descanso, punto por jugada, cambio de servicio, entrenamiento

INTRODUCTION

After the 2000 Olympic Games in Sydney, Australia, the Federation Internationale de Volleyball (FIVB) radically changed beach volleyball (BV) regulations. These modificatons included changing non-continuous scoring (non Rally Score System) (nRS) to continuous scoring (Rally Point Score System) (RS), and reducing court size from 9 x 9m to 8 x 8m (FIVB, 2001). Such changes may affect the main aspects of the BV game, such as the work-to-rest ratio (W:R).

To develop a scientifically-based conditioning program, knowledge of energy demands of the sport is vital to successful beach performance. Beach volleyball, like indoor volleyball (IV), requires activities with short duration and extremely high power output (Scates & Linn, 2003). For this reason, the development of anaerobic ability should be the focus of the conditioning program (Alejo, 1995). Furthermore, since only two players can participate in beach volleyball, players are forced to perform continuous actions under difficult conditions such as high temperature and high humidity. Also, moving on sand increases energy utilization compared to moving on solid ground (Lejeune, Willems, & Heglund, 1998; Zamparo, Perini, Orizio, Sacher, & Ferretti, 1992). The aforementioned characteristics make BV a sport with increasing demands for anaerobic and aerobic capacity (Ferretti and Zeppill, 1987). Many investigations have been conducted in indoor volleyball concerning the work-to-interval ratio. (Vescovi, 2001; Vescovi, 2002; Viitasalo, Rusko, Pajala, Rahkila, Ahila, & Montonen, 1987). The above investigations examined the work-to-rest ratio (W:R), either on the basis of total intervals or on the basis of intervals, which did not include the rest time due to time-outs and substitutions. According to an investigation carried out in the BV championships of the Association of Volleyball Professionals (AVP), mean rally duration of the game in the 9 x 9m court was 7.5 s, while rest time between the rallies was 20 s (Homberg & Papageorgiou, 1994). According to the above timing characteristics, the W:R ratio was 1:2.7. The work and rest time following the reduction in the court size, however, have not been investigated.

METHODS

The purpose of the investigation was to record and compare the timing characteristics of work and rest of BV games on 8 x 8m and 9 x 9m courts. The information used for time analysis characteristics was collected from 2000 and 2001 Hellenic Championship (HC) matches. In 2000, the championship took place on 9 x 9m courts (9 x 9), while in 2001, they were on 8 x 8m courts (8 x 8). RS was used in both the 2000 and 2001 championships. The investigation sample included 16 matches in total, 5 of which were semi-finals and 11 of which were finals. The 6 final matches were from the 2000 HC, while 5 semifinals and 5 finals were from the 2001 HC. All matches were top-level. The matches were videotaped using a digital video camera JVC GR-DVL 9600 EG (Victor Company, Japan). The digital camera clock timed the duration of all work and rest. Work and rest times were defined according the AVP clock time procedure (AVP Rules, n.d.; Vescovi, 2002) that has been used in volleyball matches. In particular, work is defined as the time from when a player contacts the ball for service until the referee blows the whistle concluding the rally. Rest is defined as the time from when the whistle is blown from the preceding rally to the next serve. The data were classified as work (W), work alone (without aces and service errors) (WA), total rest (without time-out) (R), rest alone (without time-out, intervals between sets and court switches) (RA) and court switches (CS). The number of rallies (R), time-outs (TO), intervals (I) and court switches (NCS) were also recorded. Six ball shaggers were used from the Hellenic Federation during matches for quicker transfer of the ball to the players.

A student's t-test was used to compare the differences between 8 x 8 and 9 x 9 courts. Statistical significance was set at .05 level. SPSS 11.0 was used to analyze the data.

Table 1

Frequency Characteristics of

Different Court Dimensions (Values are Numbers).

	8x8m	9x9m
	(N)	(N)
Matches	10	6
Sets	24	12
Rallies	893	561
Total Intervals	879	549
Court Switches	80	54
Rest Alone	737	460
Time-outs	62	35

RESULTS AND DISCUSSION

Table 1 illustrates the frequency of matches, sets, rallies, total intervals, court switches, rest alone and time-outs. Figure 1 shows mean and standard deviations of work (W), work alone (WA), rest (R) and rest alone (RA). A 10.7%

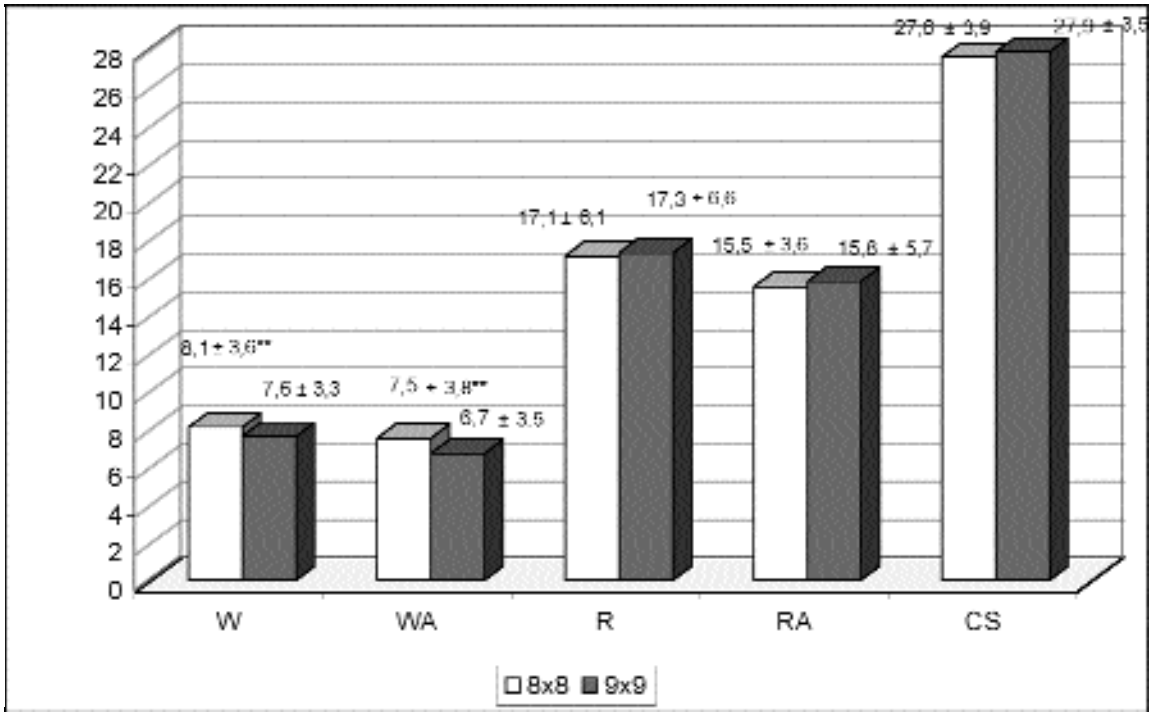

Figure 1. Comparison of work (W), work alone (WA), rest (R) and rest alone (RA) between the 8 x 8m and 9 x 9m court dimensions. Values are means ± *SD*; ** p<.01.

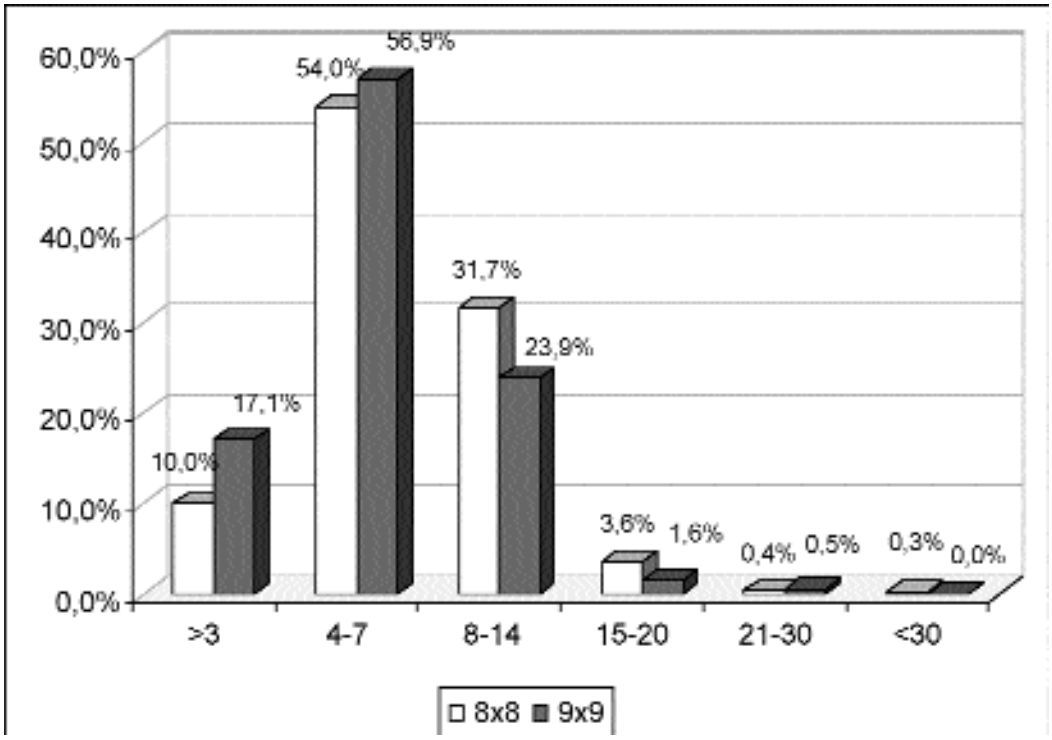

Figure 2. Comparison of the distribution of work duration (values are percentages).

increase was found in W between 8 x 8 (M = 7.54, SD = 3.79) and 9 x 9 (M = 6.69, SD = 3.54), thereby resulting in a significant difference, t (1452) = 4.30. p <.001. There was also a significant difference in WA, t(1266) = 2.67, p < .01, (M8 x 8 = 8.1, SD = 3.59; M9 x 9 = 7.6, SD = 3.26). There were no statistically significant differences in R, t(1372) = .64, p = .520, between 8 x 8 (M= 17.12, SD = 6.14) and 9 x 9 (M = 17.34, SD = 6.56). By reducing the size of the court to 8 x 8, the W:R ratio decreased to 1:2.3 compared to 1:2.6 on 9 x 9 courts. The W:RA ratio was smaller, 1:2.1 and 1:2.4 on 8 x 8 and 9 x 9 courts, respectively. Without including aces and intervals, the WA:RA ratio remained lower on 8 x 8 with 1:1.9 compared to 1:2. on 9 x 9.

Court Switches

Figure 1 shows mean interval time during court switches. The mean court switch time was not significantly different, t (141) = .483, p > .05, in 9 x 9 (M = 27.89, SD = 3.49) compared to 8 x 8 (M= 27.58, SD = 3.94).

Distribution of Work

Figure 2 shows the distribution of rally time on both court dimensions. The majority of rallies used lasted 4 to 8 s. Each rally lasting less than 3 s was an ace or a service error. When the court size was reduced, the ace and service error percentage decreased by 7.1%. This percentage was added to rallies lasting from 8 to 15 s (7.8%) on the 8 x 8 court. The percentage between 4 to 7 s, which was the first stage of the rally, was 2.9% higher in the 9 x 9 court. On the 8 x 8 court, the percentage of rallies exceeding 16 s also increased by 2.1%.

Reduction in the court size affected the mean rally duration of the BV Hellenic Championship matches by significantly increasing the mean rally duration (Figure 1). Such increase was due to a higher percentage of service errors and aces (17.1%) recorded on the 9 x 9. The continuation of the rally contributed to the increase in the mean rally duration. Secondly, when service errors and aces were not included in the analysis, mean rally was again increased significantly on the 8 x 8. Rally percentage during which the serving team set up a counter-attack increased and as a result, mean rally duration also increased. Overall, mean work time increased considerably on the 8 x 8 court due to the greater number of rallies played. This fact supports the FIVB's choice to change the rules in order to make the game more spectacular by increasing rally duration. Mean rally duration in this investigation matches that established by the AVP (Homberg & Papageorgiou, 1994).

The R and RA mean intervals were quite similar. The use of the six shaggers who threw the ball quickly to players and enforcement of the rules by referees contributed to the balancing of the interval time between rallies on both court sizes.

The work-to-rest ratio was lowered after the reduction of court dimensions. On the 8 x 8 court, the ratio was lower in all cases of work and interval (8 x 8 = 1:2.3 vs. 9 x 9 = 1:2.6 using W/R; 8 x 8 =1:2.1 vs. 9 x 9 = 1:2.4 using W/RA and 8 x 8 = 1:1.9 vs. 9 x 9 = 1:2.1 using WA/RA).

Top-level players must train according to maximal demands they may encounter (Kiraly & Shewman, 1999). For this reason, a coach should include in a training program under ideal conditions during which rally intervals last 12 s (FIVB, 2001). Also, because only two players participate in the game, it is possible for one of the players to receive all balls and also serve as a specialized blocker. In this case, work demands increase greatly during the match and throughout the tournament.

Reduction of court dimensions, then, contributes to an increase in rally time, while intervals between rallies remain the same. The W:R was reduced on the smaller courts, thereby increasing metabolic demands of players.

IMPLICATIONS FOR COACHING

Since mean duration and distribution of W was changed and rest duration between rallies was decreased, metabolic demands for beach volleyball players will be increased. Therefore, conditioning programs should be changed and adapted to meet these increasing demands. Coaches should approach training according to specific demands of the sport as far as W:R is concerned following the change in the court size. Additionally, coaches should adapt rally duration during ball training according to percentages occurring during the match. This means that during the drills, the coach should use competitive games (Iams, 1993) focusing on the continuation of the rally in order to achieve the work times, which occur during matches. The work time should increase from time to time by setting up a third or fourth consecutive attack so that all work times occurring in BV matches are used. Intervals should be similar to intervals during the matches in order to achieve the correct work-to-rest ratio.

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