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Influence of small ball training on the serve reception performance of male university volleyball players

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ABSTRACT

Purpose：The purpose of this study was to investigate the volleyball players' ability and efficacy in serve reception, and whether it can be effectively improved after serve receive training with a small ball. **Methods：**In this study, twenty male volleyball players in Level 1 from Taiwan's University Volleyball League were recruited as research participants. The participants were divided into two groups by stratified sampling to undergo a six-week training program: 10 in the small ball training group (SBTG), and 10 in the normal ball training group (NBTG). The volleyball machine was used in the experiment and the ball speed (from the volleyball machine) was 38 mph (= 61.16 km/h, = 16.98 m/s). The time interval was set at 8 seconds for each reception. The serve reception performance of both groups was evaluated before the training (Week 0), at third week (Week 3) and at the sixth week (Week 6) of the training. A two-way analysis of variance (group x weeks) was applied to analyze the data. If a significant interaction between the factors was found, the simple main effect would be assessed. If the interaction was not significant, the main effects would be assessed. **Results：**The results revealed a significant difference between two groups ($p < .001$). The results of the analysis also showed that the serve reception efficacy of participants in both groups gradually improved as the number of weeks increased, while SBTG achieved significantly greater results than NBTG at Week 6. After six weeks of training, the scores of the two groups increased by 20.40% (SBTG) and 6.01% (NBTG), showing that the training were effective indeed. **Conclusion：**The main finding was that both small ball and normal ball training had a positive effect on serve reception, while the influence of small ball training was more significant.

Keywords: Volleyball machine, Ball speed, Learning effects

1. Introduction

Volleyball is a sport in which two teams of players separated by a net compete against each other with a ball. Six major volleyball skills are spiking, blocking, serving, receiving, setting, and digging the serve. In modern volleyball, attacking is often the key to scoring points, and is highly correlated with winning (Yiannis, & Panagiotis, 2005; Marcelino & Mesquita, 2006). Even ineffective attacks can put the opposing team in unfavorable situations, resulting in an unstable defensive structure (Papadimitriou, Pashali, Sermaki, Mellas, & Papas, 2004). This means that points scored by attacking contribute significantly to the final result. However, the prerequisite for a team to create a great opportunity for effective attacks is success in serving and receiving the serve. Therefore, the serve reception is particularly important for scoring.

The purpose of the serve reception is to receive the ball from opponent and accurately and steadily pass the ball the setter through an overhand or an underhand pass at a strategic position. Preparation for receiving a serve mainly includes the following five steps: extending the hands forward, keeping the eyes on the ball, predicting the ball's landing point, checking team members' positions, and receiving the ball. Therefore, it is important to first establish a correct understanding of serve reception training and then adjust athletes' stability in action control with structured and systematic training methods. Repeated training allows the body to establish the habit of motion control over time. The habit then produces a (muscle-use method similar to the) synergistic effect, which promotes control of the musculoskeletal network and learning effect (Loeb, 2021). In general, common serve reception drills include

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receiving without a net, receiving circuit training, serving the ball on a raised platform, or increasing the difficulty of receiving a serve. With the development of scientific training methods in recent years, various training methods can be adopted to yield good results in a short time. For example, serve and serve receive training can be conducted by using a volleyball machine that is programmed based on the collected data of speed and styles of serves. Training with a volleyball machine can not only provide athletes with a good stimulation but also improve their efficacy of serve reception (Palao, 2014). As suggested by the above studies, the adoption of different sports equipment may lead to success in training.

Schmidt and Lee (2005) reported that changes in human behavior are based on changes in external factors. From the perspective of sports training and learning, adjusting equipment is an effective way to help athletes develop correct movements and techniques, and to improve the consistency of their actions. A sport consists of four major elements (apart from athletes): other participants, the court, sports equipment, and duration of play. Changes in any of the elements will have a great impact on the sports mode and control (Parlebas, 1999). In light of this, many scholars have made attempts to achieve greater training results with innovative methods. In Pellett, Henschel-Pellett, and Harrison (1994), a lighter ball (75% weight) was used in the training of the set and underhand serve techniques. After a short 16-day practice, the participants' athletic performance significantly improved. More substantial improvement has been achieved by using different balls in training young athletes. Arias, Argudo, and Alonso (2012) investigated the influence of basketballs of different mass on 9–11-year-old children's abilities of dribbling, passing, and pass reception. Their results showed that the best training results were achieved by using a lighter basketball (440 g), while the results with a regulation ball (485 g) and with a ball of greater mass (540 g) were not as satisfactory.

The above studies suggest that bigger or lighter balls can be used to improve athletic performance. According to sports biomechanics, the speed of a bigger ball will be affected when it is flying in the air owing to greater air resistance (Takeuchi, Kobayashi, Hiruta, & Yuza, 2002). With a ball of greater mass, the loading will be higher on strength training for athletes (Kirk, 2004). However, few studies have investigated the influence of small ball training in volleyball, and the benefits of its adoption for specialized athletes need to be further explored. To this end, the present study intended to explore whether volleyball players' ability and efficacy in serve reception can be effectively improved through serve receive training with a small ball. The results of the study may provide a reference for coaching or training for other similar sports in the future.

2. Methods

2.1 Research participants

Twenty male volleyball players in Level 1 from Taiwan's University Volleyball League were recruited as research participants. Their average height, weight, age, and years of experience playing volleyball were 181.61 ± 5.36 cm, 75.37 ± 6.5 kg, 21.32 ± 2.5 years, and 9.52 ± 2.68 years, respectively. According to their player positions (spikers and liberos), the participants were divided into two groups by stratified sampling: 10 in the small ball training group (SBTG), including five chief spikers, three quick-set spikers, and two liberos, and 10 in the normal ball training group (NBTG), including five chief spikers, three quick-set spikers, and two liberos. Table 1 presents the basic profiles of the study participants.

2.2 Instrument and court setup

The following tools were used in this study: an experimental ball (MIKASA MVA-430 leather volleyball with a circumference of 62–64 cm), an assessment and general training ball (MIKASA MVA-200 leather volleyball with a circumference of 65–67 cm), the Total Attack Volleyball Training Machine (Sports Attack), and a target stand for assessing the players' serve reception ability. The outer frame of the machine was trapezoid-shaped, 400 cm in width, 400 cm in length, and 160 cm/243 cm in height.

Table 1 Basic profile of (research) participants

	Average	Standard deviation
Participant	20	
Height (cm)	181.61	5.36
Weight (kg)	75.37	6.50
Age (yrs)	21.32	2.50
Years of experience (yrs)	9.52	2.68

2.3 Operational definition

(1) Evaluation of serve reception ability

In this study, the standard used for assessing participants' serve reception ability was based on the evaluation and scoring standards for serve reception developed by Afonso et al., (2012). Based on their study, the height of the volleyball machine was adjusted to 215 cm, and the elevation angle was set to 20°. It was located 3 m behind the service area and 2.25 m from the right-side line. After the adjustments, the serving speed of the volleyball machine was 38 mph (= 61.16 km/h = 16.98 m/s). The target frame was placed at Position 3 (center forward) in the front zone of the court. The serve reception performance of each participant was evaluated

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for 20 balls (in the test zone), and the cumulative score of the 20 balls was taken as the overall score of the test. The followings are the scoring rules for the evaluation: 5 points for reception within Zone 1 or contacting the upper edge of the stand in Zone 1; 3 points for reception within Zone 2 or contacting the upper edge of the stand in Zone 2; 2 points for reception within Zone 3 or contacting the upper edge of the stand in Zone 3. No point was scored if the player failed to receive a serve or pass the ball to the target stand.

(2) Experimental zone(area)

The present study was mainly concerned with the ability of the volleyball player to receive a straight spike. Therefore, the area behind the end line of Position 1 was set as the serve zone, and the training area was located at Position 5 in the opponent's back zone. The layout of the court for training and evaluation is shown in Fig. 1.

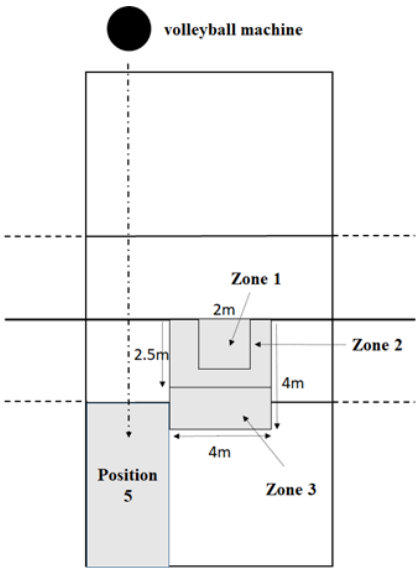

Figure 1. The experimental zone(area) set up.

2.4 Procedures

At the beginning of the experiment, the serve reception ability of all the participants were tested (Week 0). Both groups received basic team training as usual. In addition, participants in SBTG was arranged to receive serve reception training for six weeks, five days a week. Each participant was required to practice 120 balls per day, with an 8 s interval between each ball. Ten participants in NBTG received the same amount of training but with a normal ball. The serve reception performance of both groups was evaluated again at the third week (Week 3) and the sixth week (Week 6).

2.5 Data processing

The statistical analysis of the collected data was performed by using SPSS Statistics 20.0 for Windows (Version 20.0; SPSS Inc., Chicago, IL, USA). The test results were described with descriptive statistics and analyzed by using a two-way analysis of variance (*group* x *weeks*). If a significant interaction between the factors was found, the simple main effect would be assessed. If the interaction was not significant, the main effects would be assessed. The significance level of this study was set at $\alpha = .05$.

3. Results

After a six-week training, the reception scores of participants in SBTG at week 0, week 3, and week 6 were 44.6 ± 8.1, 49.4 ± 7.2, and 53.7 ± 5.8 points, respectively. In comparison, the reception scores of participants in NBTG at week 0, week 3, and week 6 were 44.9 ± 8.0, 45.4 ± 6.6, and 47.6 ± 5.9 points, respectively. According to the two-way analysis of variance, both the factor group ($F_{1, 18} = 950.545$; $p < .001$; power = 1.000) and the factor weeks were statistically significant ($F_{2, 36} = 82.440$; $p < .001$; power = 1.000). The interaction between the factors (group x weeks) was also statistically significant ($F_{2, 36} = 25.120$; $p < .001$; power = 1.000). Therefore, a simple main effect was assessed. The results showed that there was no significant difference between the two groups at Week 0 ($F_{1, 18} = 0.007$; $p = .934$; power = 0.051) and at Week 3 ($F_{1, 18} = 1.657$; $p = .214$; power = 0.230). A significant difference was found between the two groups at Week 6 ($F_{1, 18} = 5.397$; $p = .032$; power = 0.594). Moreover, SBTG showed a significant difference in the training effect within the group ($F_{1, 9} = 92.125$; $p < .001$; power = 1.000). The training effect from high to low was Week 6 > Week 3 > Week 0; in comparison, a significant level of difference in the training effect was also reached within NBTG ($F_{1, 9} = 11.293$; $p = .008$; power = 0.848). The results of the analysis showed that the serve reception efficacy of participants in both groups gradually improved as the number of weeks increased, while SBTG achieved significantly greater results than NBTG at Week 6. In addition, the intra-group results showed that SBTG made a significant improvement in their performance at Week 3 and further improvement at Week 6, while the performance of players in NBTG only significantly improved at Week 6.

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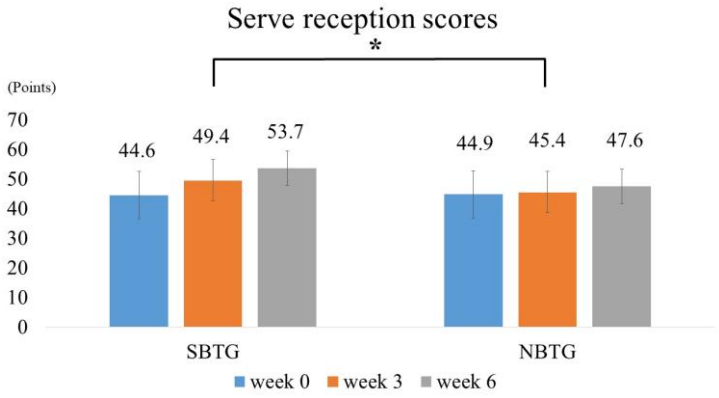

Figure 2. Comparison of the serve reception performance scores of the two groups.

4. Discussion

This study investigated whether volleyball training with balls of different sizes would have a positive influence on the player's ability to receive a serve. The main finding was that both small ball and normal ball training had a positive effect on serve reception, while the influence of small ball training was more significant. After six weeks of training, the scores of the two groups increased by 20.40% (SBTG) and 6.01% (NBTG), showing that the training were effective indeed. Furthermore, the results of skill migration and retention in this study were consistent with previous researches' findings (Burcak, 2015). In the face of more difficult training in the learning stage, athletes need to obtain additional cognitive information, which is very important for skill transfer and retention. In that case, training itself should be difficult enough for the players, irrespective of the ball size. Given the above, more difficult training (e.g., training with smaller ball) should be considered together with the complexity of the action when designing a training method for fostering skill transfer and retention. According to Wulf and Shea (2002), if the action is difficult enough, then it is not beneficial to further increase the difficulty of training.

In this sense, training with balls of different sizes may result in additional requirements of motion(abilities) such as movement time (predicting ball trajectories and movements of lower limbs), and magnitude of force (control of the ball), thereby enhancing skill transfer and retention. After six weeks of training, significant differences were observed both in the inter- and intra-group statistics, indicating that these motion(abilities) requirements in training may be related to ball size. In this study, the amount of time for practice was regulated by the total volume of work (number of repetitions). However, regular skill learning usually places an emphasis on the amount of time, rather than on the total volume of work. However, to avoid the variations caused by training repetitions, each serve reception training includes 120 balls (per day), with an 8 s interval between every ball, to limit the influence of the number of repetitions on trainings. Previous studies (van den Tillaar & Marques, 2013; Raastad, Aune, & van den Tillaar, 2016) have found that an increasing amount of practice in the learning stage, rather than ball size, plays a key role in developing skill transfer ability. Therefore, there was no significant difference between the two groups that were trained by using balls of different sizes.

In the learning stage, it is essential to understand the learner's degree of mastery of the skill. For beginners, training with simpler methods can enhance the effect of skill transfer and retention in the learning stage. On the other hand, more difficult training should be adopted to improve the effect of skill transfer and retention in experienced athletes (Wulf & Shea, 2002). Guadagnoli and Lee (2004) proposed a challenge point hypothesis. Their hypothesis suggests that in the learning stage, the difficulty of the training of a functional task must be adjusted to the learner's skill level (Guadagnoli, Molin, & Dubrowski, 2012). In volleyball, this means that if the learner reaches a stable level, the difficulty of the training must be increased to seek further improvement. Based on the challenge point hypothesis, the difficulty of the task should be systematically increased (Porter & Magill, 2010; Porter & Saemi, 2010). In the present study, the volleyball players recruited all had professionally trained for a long time. Basic serve reception training was a part of their daily training. Given the characteristics of the participants, the difficulty of the serve reception training was systematically increased by reducing the ball size, without huge variations, and hence, making a positive adaptation to training.

When receiving a serve, the receiver has to predict the direction of the ball before reacting. It is a very fast process from the serve to the reception. As the receiver approaches the ball, the player may only be able to take a small step to receive the ball. If the player wants to receive the ball outside the zone, big steps and diving are not avoidable. In that case, the quality of the reception may not be good, even if the player receives the ball. Therefore, the player's reaction, judgment, and speed are very important for a successful serve reception. In this study, the six-week training included 30 days of training, each lasting 16 minutes. Multiple sets were organized for serve

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reception training. Training with high repetition strengthened the training effects on (muscle) stimulation and actions. A key issue worth noting is that motion skill learning is not a linear process. Rather, such skills are gradually developed over time. This means that to improve skill level, repetition is necessary to further promote skill mitigation and retention.

In serve reception, body movements should be accompanied with corresponding arm movements. After receiving the signal to serve, the player needs to quickly move the body to the reception zone and then move the arms to pass the ball in a stable posture. This are the basic movements in serve reception. When it comes to a float serve, the player has a little more time to prepare and move the body and arms. However, the body movement may not be quick enough to ensure stable posture(arm movements) in dealing with a strong jump serve. In this case, the player usually has no other choice but to block the ball as high as possible. Though this is not a standard method in serve reception, it is at least so in the assessment of elite players.

5. Conclusion

The results of this study show that six-week serve-reception training with a small ball can significantly improve the serve reception efficacy of volleyball players. The influence of different practice methods on skill acquisition, transfer, and retention has gained attention in the area of motor skill learning, given the coaches' and trainers' pursuit of the most effective methods for teaching skills. In fact, in modern volleyball, players often encounter strong jump serves that stop them from properly preparing themselves in a steady position for reception. Such situations should be addressed with suitable training methods so that players can properly pass the serve to the setter.

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小球體接發球訓練對大專男子排球選手接發球成效影響之研究

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摘要

目的：本研究目的為探討大專男子排球選手使用不同尺寸的排球練習後，對接發球技能的影響。**方法：**本研究以中華民國大專男子排球公開一級 20 名選手為受試對象，以分層隨機取樣法 (Stratified Sampling) 區分成小球體接發球訓練組 10 名 (small ball training group, SBTG) 及一般接發球訓練組 10 名 (normal ball training group, NBTG)，進行六周的訓練計畫。以排球發球機進行接發球訓練，球速設定為 16.98m/s，每球間隔時間為八秒。在訓練前 (week 0)、第 3 週 (week 3) 及第 6 週 (week 6) 進行接發球技巧測驗。統計方法採用二因子變異數分析 (group x weeks)，若二因子作用達顯著水準，則進行單純效果考驗，若交互作用未達顯著水準，則以主要效果考驗。**結果：**經由分析後的結果顯示，兩組別都隨著周數的增加而逐步改善接發球的技巧，而 SBTG 在 week-6 時更是顯著的優於 NBTG。兩組在經過 6 周的訓練後分別提升了 20.40% (SBG)與 6.01% (NBTG)，這顯示出隨著時間的推進的確產生了學習效應。**結論：**主要發現為，SBTG 和 NBTG 都能夠對接發球測驗有正面的影響，且 SBTG 的成效顯著的較佳。

關鍵詞：發球機、球速、學習效應

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