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ORIGINAL RESEARCH

# The effect of ball compression and scale court sizes on learning tennis skills of beginner adult tennis players

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**Abstract**

**Background:** Numerous studies have demonstrated the positive impact of scaled equipment on the playing performance of young tennis players. Nonetheless, there is a need for further research to explore the impact of scaled equipment on the skill development of beginner adult tennis players. **Objective:** This study aimed to assess the effects of ball compression and scale court sizes on the learning of tennis skills of beginner adult tennis players. **Methods:** Twenty-four beginner players (age 20.9 ± 1.2 years) were randomly divided into a regular ball group (RB, $n$ = 12) and a low-compression ball group (LCB, $n$ = 12) on-court training twice per week for six weeks. The RB played with standard yellow tennis balls, while the LCB used low-compression balls (red, orange, and green) during the intervention. Pre and post-tests included the Tennis-Specific Skills Test (TSST) and the International Tennis Number test (ITN). **Results:** The results demonstrated that the LCB showed higher technical characteristics after training ($p$ < .05, $\eta_p^2$ between .18 and .36) except for the mobility assessment ($p$ > .05, $\eta_p^2$ = .02) and the TSST scores in terms of forehand, backhand, and rally length ($p$ < .05, $\eta_p^2$ = .16–.19). **Conclusions:** This study indicates that the LCB might be more suitable equipment to improve technical skills and hitting performances. Practitioners can use the LCB to design an effective training plan, especially for young and adult beginner tennis players.

**Keywords:** racket sports, modified equipment, traditional approach, skill acquisition, scale equipment

## Introduction

The performance in tennis consists of complex and difficult-to-perform skills for young players or beginners of various age categories. Therefore, tennis needs to be made easier and simpler so that it can reach wider audiences and can be played by everyone of all ages (Buszard, Oppici, et al., 2020; Tennant, 2010). Changes in tennis equipment and rules have been made to facilitate tennis training, learning tennis skills easily and decrease the rate of injury. In addition to these changes, significant changes have occurred in tennis learning procedures and methodology in recent years. The game-based approach (i.e., Play and Stay) has become increasingly popular, emphasising the importance of learning through play and exploration rather than traditional drills and exercises. Overall, these changes in equipment, teaching methodologies, and approaches have significantly impacted the game of tennis and helped make it more dynamic and exciting than ever before (Crespo & Cooke, 1999; Crespo et al., 2004). The first time, arrangements were made to enable tennis learning, such as short-game matches, low-compression tennis balls, and smaller court and racquet sizes. These changes in the learning process are to improve the physical, mental, and skill capacities of the players compared to the past (Declercq, 2010; Schmidhofer et al., 2014; Unierzyski & Crespo, 2007).

In recent years, many experts around the world have studied especially young tennis players with modified equipment (ball compression and racquet length) and different court sizes, net heights, and rules (Buszard et al., 2014a, 2014b; Declercq, 2010; Farrow & Reid, 2010; Hammond & Smith, 2006; International Tennis Federation, 2010; Kachel et al., 2015; Larson & Guggenheimer, 2013; Lee et al., 2014; Schmidhofer et al., 2014; Timmerman et al., 2015). These studies were supported by a campaign (Play and Stay) designed to promote children's tennis by the International Tennis Federation using different sizes of rackets, balls, nets, and courts (International Tennis Federation, 2010; Pankhurst, 2016). The main idea of these studies is to make the strokes and movements of young tennis players more effective, more accessible, and injury free. Generally, when adapting the game for children, variables such as hitting performance, hitting technique, and children's racket/ball preference are considered. From a practical point of view, modifying equipment has many potential benefits.

Current research evaluating scaling tennis equipment demonstrated potential benefits for children with lower compression balls on smaller courts and smaller racquets (Buszard et al., 2014a, 2014b; Farrow & Reid, 2010). In a study supporting this, in children, the smallest scale

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combination (small racket/red ball) produced significantly higher hitting performance compared to all other racket/ball combinations (Buszard et al., 2014a; Tennis Xpress, 2013). Moreover, the low-compression ball called red (75% slower than a regular ball) was found to have the most significant positive effect on hitting performance. In general, a lower compression ball moves slower and allows children to hit the ball with more force (Buszard et al., 2014a).

Task constraints, such as scaling equipment, have facilitated children's success and acquisition of necessary tennis skills and promoted their movement development. Additionally, utilizing smaller rackets and slower balls during matches has helped them concentrate on their next hit (Buszard et al., 2014a, 2014b; Farrow & Reid, 2010; Larson & Guggenheimer, 2013). In many studies in the literature, scaled equipment provided the most benefit for children playing with small rackets and low-compression balls, both in terms of hitting performance and technique (Buszard et al., 2014a). Thus, current information in the literature supports the conclusion that children prefer to play with equipment scaled to adult equipment (Farrow & Reid, 2010). Although the use of modified equipment for children has increased in recent years, scientific researches for beginner adults are very limited.

In the last few years, several campaigns have started to promote skill development (Tennis Xpress) for adults who play tennis. However, in training for beginner adults, more evidence is needed to use optimal scale equipment and to plan for progress. Therefore, this study aimed to assess the effects of ball compression and scale court sizes on the learning of tennis skills of beginner adult tennis players. We hypothesized that adult players would present better learning tennis skills performance (strokes most accurately and with better technique) using different low-compression balls and scale court sizes compared to standard balls and courts.

## Methods

### Participants

Twenty-four male university student players (age 20.9 ± 1.2 years, body mass 74.1 ± 5.1 kg, body height 176.7 ± 6.2 cm, body mass index 23.7 ± 1.9 kg/m$^2$) were randomly divided into two groups, the low compression ball group (LCB, $n$ = 12) and the regular ball group (RB, $n$ = 12). All participants had no previous experience playing tennis or other racquet sports. Before signing the informed consent form, players were notified of the research benefits, requirements, procedures and potential risks. Then they all provided written consent for participation. The present study was approved by the Local Ethics Committee (Malatya Clinical Research Ethics Committee, protocol code: 20-13/86), and was conducted in accordance with the Declaration of Helsinki.

### Study design

A parallel matched-group design was used to compare technical skills in adult beginner tennis players (Buszard et al., 2014a; Gimenez-Egido et al., 2020). The current study design lasted eight weeks, consisting of one week of tests (pre-test), six weeks of tennis training (low-compression ball – scale court size vs. regular tennis ball – full court size) interventions, and one week of tests (post-test). All participants completed pre-and post-testing, which consisted of the International Tennis Number test, the tennis-specific skills test, and rally length. Both training interventions and testing were performed two times a week, and training sessions and tests were separated by at least 48 hours to avoid any possible effects of physical fatigue. During the study, the participants were not involved in any physical activities except for walking. All training and tests in the same order were practised between 09:00 a.m. and 12:00 a.m. on the standard indoor hard court.

The pre and post-test were recorded using two cameras (Sony HDR-CX240 Full HD; Sony, Tokyo, Japan) positioned 2 m from the side of the court at the level of the service line and approximately 6 m above the court (Kilit & Arslan, 2017). A specialized movement-specific analysis program (Kinovea Version 0.8.15; www.kinovea.org) was used to analyze the results from the two tests. By way of video replay enabled (frame to frame) for the qualitative assessment scale, the same experienced tennis coach analysed all the tests (Farrow & Reid, 2010; Fitzpatrick et al., 2018; Kilit & Arslan, 2017). All tests were played on a full-size tennis court with a standard tennis ball (Wilson US Open; Wilson Sporting Goods, Chicago, IL, USA).

### Testing procedures

Before performance tests, a standardized (not including tennis-specific skills) 10-minute warm-up protocol consisting of jogging and dynamic stretching (upper- and lower-body exercises) was provided.

### International Tennis Number test

The International Tennis Number test (ITN) consists of serve, groundstrokes (depth and accuracy), volley depth, and mobility assessment. The test is a frequently used test in the literature to determine the game characteristics on-court (Baiget et al., 2014; International Tennis Federation, 2004; Kilit & Arslan, 2019). The participants utilized fundamental tennis techniques to hit 42 shots precisely at targeted areas inside the tennis court during the ITN test. This test consists of five phases:

1. groundstroke depth assessment – participants perform 10 hits with 5 forehands and 5 backhands alternately on the balls (maximum score 90),
2. groundstroke accuracy assessment – participants perform 12 strokes with 6 forehands and 6 backhands alternately on the ball (maximum score 84),
3. volley depth assessment – participants make 8 hits, 4 forehand volleys and 4 backhand volleys, alternately on the balls (maximum score 72),
4. serve assessment – participants make a total of 12 serves, 6 each, to both parts of the field (maximum score 108),
5. mobility assessment – the participants carry 5 tennis balls placed at the intersection points of the lines between the serving line and the baseline, one by one,

to the centre point in the shortest time possible (maximum score 76).

Evaluation of the ITN Test: The participant's scores from each section are added, and the participant's tennis skill level is found (assessment highest possible score = 430 points). ITN test levels for male players: ITN-10 (score 75–104) starting to play tennis between ITN-1 (363–430) pro-tennis players. Before the test, all participants watched the ITN test protocols video, and then two attempts were made, and the best test score was recorded (Kilit & Arslan, 2019). A ball machine (Tennis Tutor Plus, Sports Tutor, Burbank, CA, USA) was used to feed balls to the tested players.

### Tennis-Specific Skills Test

In the Tennis-Specific Skills Test (TSST) protocol adapted from the study of Farrow and Reid (2010), randomly matched players (each group within itself) were fed the ball by the coach (one ball is fed to start the rally) and the participants were instructed to hit as many strokes (forehands and backhands) as possible in their natural playing rhythm. A second chance is given if a participant fails to respond more than once in the first rally attempt. The total number of consecutive hits was recorded as rally-length points. Each participant was given three trial opportunities, and the highest trial score was recorded (consecutive hits were considered successful for each successful attempt). In addition, participants' technical analysis assessed four aspects of stroke production for forehands and backhands, respectively:

1. preparation (intra-class correlation coefficient [ICC] = .93),
2. backswing (ICC = .85),
3. ball impact and follow-through (ICC = .86),
4. recovery (ICC = .92), using a 7-point scale (1 – very poor, 2 – poor, 3 – slightly poor, 4 – average, 5 – slightly above average, 6 – good, 7 – very good) producing a maximum achievable score of 28 points per stroke (Farrow & Reid, 2010; Fitzpatrick et al., 2018).

Reliability, a pre and post-test analysis calculation was performed again with three-day intervals for each subject. The ICC between analyses was defined as excellent (ranged between .85 and .93).

### Training interventions

All groups completed twice a week 90-min technical practice session per week for six weeks. The RB group worked with standard tennis balls (yellow – Wilson US Open; Wilson Sporting Goods, Chicago, IL, USA) in full court sizes, and the LCB group performed with low-compression, slower, tennis balls (red 75% slower than the yellow ball, orange 50% slower than the yellow ball, green 25% slower than the yellow ball) and different scale court sizes (Buszard et al., 2014a; Buszard, Oppici, et al., 2020; Cortela et al., 2019; Crespo et al., 2004; Lee et al., 2014; Miley, 2010; Newman, 2010; Tennis Xpress, 2013). Tennis training (for both groups) was applied by three experienced (3 tennis courts and 12 participants per session) coaches (Turkey Tennis Federation level 3–4, 10–15 years' experience). The traditional learning model was applied to both study groups. This model in tennis typically involves a technique-based approach that emphasizes the development of specific strokes and techniques (i.e., forehand, backhand or serve) through repetitive drills and exercises (Crespo et al., 2004). Standard exercises (repetitive practice drills) were used to get away from the random effects of randomized training (opened or game-based approach) and to be the perfect technique (Lee et al., 2014; Unierzyski & Crespo, 2007).

Participants were trained in a traditional teaching method environment where the main technical components of serve, forehand, backhand, volleys, and smash were more prominent. Thus, facilitating might provide early skill acquisition during practice while players learn the basic movement pattern (Buszard et al., 2014a, 2014b; Crespo & Cooke, 1999; Crespo & Miley, 1998; Crespo et al., 2004; Reid et al., 2007). Traditionally, rally with a partner or with a coach feeding, with four players on one court, two rallies occurred at the same time to consistency (keep the ball in play) and targets in the court either cross or line (moving the opponent; Ayvazo, 2009; Farrow & Reid, 2010). The hitting technique of all participants (all players were right-handed) was acceptable (forehand, double-handed backhand, volley, serve) during six weeks of the tennis learning program. Semi-Western grip was used for forehand hitting in strokes; for a double-handed backhand, right-handed Eastern-backhand, and left-handed Semi-Western; Continental grip was used for serve and volley strokes (Crespo & Miley, 1998; Genevois et al., 2015). General daily training program:

1. warm-up (10 min) general and tennis-specific skills warm-up,
2. main part (30 min work, 10 min rest, 30 min work) learning of the basic tennis technical skills in forehand, backhand, forehand volley, backhand volley, smash, serve and return (left and right service box), coach feeding from basket and rally among players (closed situation: down the line or cross-court),
3. cooldown (10 min) stretching, summary (Crespo & Miley, 1998; Crespo et al., 2004; Tennis Xpress, 2013; Unierzyski & Crespo, 2007).

All participants used the same tennis racquets (Wilson US OPEN BLX 100; length = 68.58 cm, head size = 645 $cm^2$, weight = 283 g; Wilson Sporting Goods, Chicago, IL, USA), see Table 1.

### Statistical analyses

Data were represented as mean ± standard deviation. Group differences in tennis skill tests on rally performance and ITN test between pre- and post-test results were assessed using a 2 (group: RB, LCB) × 2 (time: pre, post) mixed-model analysis of variance. The ICC was used to determine the test-retest reliability of the performance tests.

Effect sizes ($\eta_p^2$ for interaction effect and Cohen's *d* for pairwise comparison) were also calculated for each dependent variable. $\eta_p^2$ was considered small (.01–.06), moderate

(.06–.14) or large (> .14). Cohen's *d* was considered trivial (< 0.2), small (0.2–0.6), moderate (0.6–1.2), large (1.2–2.0), very large (2.0–4.0), and extremely large (> 4.0; Hopkins et al., 2009). Statistical analyses were performed with SPSS (Version 21.0 for Windows; SPSS, Chicago, IL, USA). The significance level was determined as $p < .05$.

## Results

Significant interactions were found in ITN test scores in groundstroke depth ($p = .003$, $\eta_p^2 = .336$), groundstroke accuracy ($p = .026$, $\eta_p^2 = .207$), volley depth ($p = .040$, $\eta_p^2 = .178$), serve ($p = .037$, $\eta_p^2 = .184$), and total score ($p = .002$, $\eta_p^2 = .365$). Pairwise comparison showed an increase in both groups from pre-testing to post-testing. No significant interactions were found in the mobility measurements when comparing the effect of the LCB and RB groups ($p = .543$, $\eta_p^2 = .017$; Table 2).

Significant interactions were found in TSST scores in forehand ($p = .034$, $\eta_p^2 = .188$), backhand ($p = .046$, $\eta_p^2 = .169$), and rally length ($p = .044$, $\eta_p^2 = .171$). Pairwise comparison showed an increase in both groups from pre-testing to post-testing (Table 3).

## Discussion

This study examined the learning tennis skills performance of different court sizes and low-compression tennis balls in

Table 1 Tennis intervention program

| Session | Court and ball | | Training program |
|---|---|---|---|
| | RB | LCB | |
| Pre-test | standard test size and yellow ball | | ITN and TSST test (test session description, demonstration, and application) |
| Week 1 | full-size court and yellow ball | 12.8 x 6.1 m court size and red ball | *Warm-up (10 min):* general and tennis-specific skills<br>*Main part 1 (30 min):* learn to rally – basic tennis techniques, coach feeding from basket<br>- forehand and backhand (down the line & cross court)<br>(e.g., the coach is on the other side at the baseline and feeding with a racquet 5 balls to the left and to the right, respectively for a forehand and for a backhand strokes)<br>*Rest (10 min):* water and sitting<br>*Main part 2 (30 min):* rally among players, players count and try to get the longest rally<br>- forehand and backhand (down the line and cross court)<br>(e.g., forehand to forehand play in pairs or forehand to backhand play in pairs or backhand to backhand play in pairs)<br>*Cool down and closing (10 min):* static stretching, summary of the training |
| Weeks 2–3 | full-size court and yellow ball | 18.29 x 8.23 m court size and orange ball | *Warm-up (10 min):* general and tennis-specific skills<br>*Main part 1 (30 min):* develop a consistent groundstroke rally, coach feeding from basket<br>- forehand, backhand, forehand volley, backhand volley, smash (down the line and cross court)<br>*Rest (10 min):* water and sitting<br>*Main part 2 (30 min):* rally among players, players count and try to get the longest rally and players in the group change pairs every 5 min<br>- forehand, backhand, forehand volley, backhand volley, smash (down the line and cross court)<br>- serve (left and right service box)<br>(e.g., every player performs 10 serves – serve box 5 to the left and 5 to the right respectively)<br>*Cool down and closing (10 min):* static stretching, summary of the training |
| Weeks 4–6 | full-size court and yellow ball | full-size court and green ball | *Warm-up (10 min):* general and tennis-specific skills<br>*Main part 1 (30 min):* groundstroke depth and accuracy rally, coach feeding from basket<br>forehand, backhand, forehand volley, backhand volley, smash (down the line and cross court)<br>*Rest (10 min):* water and sitting<br>*Main part 2 (30 min):* rally among players, players count and try to get the longest rally and players in the group change pairs every 5 min<br>- forehand, backhand, forehand volley, backhand volley, smash (down the line and cross court)<br>- serve (left and right service box)<br>- serve and return (left and right service box)<br>- serve, return and rally (get the longest rally)<br>(e.g., each player after the service, the return and controlled rally)<br>*Cool down and closing (10-min):* static stretching, summary of the training |
| Post-test | standard test size and yellow ball | | ITN and TSST test (test session description, demonstration, and application) |

*Note.* RB = regular ball; LCB = low compression ball; ITN = International Tennis Number test; TSST = Tennis-Specific Skills Test.

Table 2 Results of the International Tennis Number test

| Variable (points) | Regular ball (*n* = 12) | | | | Low compression ball (*n* = 12) | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-test | Post-test | Change | *d* | Pre-test | Post-test | Change | *d* |
| Groundstroke depth | 16.75 ± 4.97 | 25.64 ± 4.19* | 8.89 | 1.93 | 19.33 ± 4.27 | 32.67 ± 2.96*† | 13.34 | 3.63 |
| Groundstroke accuracy | 14.67 ± 5.25 | 21.08 ± 6.53* | 6.41 | 1.08 | 13.25 ± 4.41 | 32.00 ± 4.71*† | 18.75 | 4.11 |
| Volley depth | 6.75 ± 2.63 | 15.67 ± 3.31* | 8.92 | 2.98 | 5.75 ± 2.18 | 21.25 ± 4.05*† | 15.50 | 4.76 |
| Serve | 13.25 ± 3.60 | 21.92 ± 5.25* | 8.67 | 1.93 | 12.75 ± 2.95 | 29.25 ± 4.39*† | 16.50 | 4.41 |
| Mobility | 28.25 ± 5.24 | 29.83 ± 5.97 | 1.58 | 0.28 | 27.33 ± 5.48 | 28.00 ± 6.47 | 0.67 | 0.11 |
| Total score | 79.67 ± 11.10 | 114.17 ± 7.72* | 34.50 | 3.61 | 78.42 ± 9.41 | 143.17 ± 14.14*† | 64.75 | 5.39 |

*Note. d* = Cohen's *d;* *statistically significant difference between pre- and post-test. †statistically significant difference between groups.

Table 3 Results of the Tennis-Specific Skills Test

| | Regular ball (*n* = 12) | | | | Low compression ball (*n* = 12) | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Pre-test | Post-test | Change | *d* | Pre-test | Post-test | Change | *d* |
| Forehand (points) | 18.16 ± 2.65 | 23.16 ± 1.74* | 5.00 | 2.23 | 17.91 ± 2.19 | 26.50 ± 1.16*† | 8.59 | 4.90 |
| Backhand (points) | 17.91 ± 2.31 | 22.16 ± 2.48* | 4.25 | 1.77 | 17.58 ± 2.10 | 25.50 ± 2.31*† | 7.92 | 3.59 |
| Rally length (strokes) | 3.66 ± 1.66 | 7.66 ± 2.38* | 4.00 | 1.95 | 3.33 ± 1.43 | 11.08 ± 3.05*† | 7.75 | 3.25 |

*Note. d* = Cohen's *d;* *statistically significant difference between pre- and post-test. †statistically significant difference between groups.

beginner adult players. The findings show that the learning tennis skills of both the RB and LCB groups improved after the 6-week training period. In addition, beginner adults had higher ITN, TSST, and rally performance scores after training with a low-compression ball than with standard ball training. Thus, the LCB group was more successful in controlling the ball's hitting technique, speed, and direction.

Considering our study results, the ITN test scores of the LCB group are higher than the RB group in terms of accuracy, groundstrokes, volleys and serves hits. Thus, these tennis skills, related to the match performance, might improve in the LCB group. Furthermore, the TSST scores, such as rally performance and forehand and backhand strokes, also are significantly higher than the RB group. In other words, training with modified materials, namely the LCB group, provided stability in the strokes and technical proficiency. In this respect, using modified materials provide a faster game rhythm and more accurate technique to teach the game of tennis. The findings of this study suggest that training with scaled equipment can positively impact the learning of tennis skills in beginner adult players. One possible explanation is that the low-compression balls have a slower speed and a lower bounce; it gives the players more time to adjust their positions to hits. Therefore, this may provide more controlled and accurate shots and having better control of the ball's hitting technique, speed, and direction. Another possible reason for the improved performance of the LCB group could be attributed to the different court sizes used in training. The smaller court size may have forced players to focus on shot placement and control, which could have contributed to their improved tennis-specific skill performances.

These study results are in line with similar study designs performed on youth players' technical skills and performance responses. Tennis literature shows that the scaled equipment provides better game and shot performances compared to the standard equipment. Furthermore, using scaled equipment is a fun, easy and effective way to learn tennis-specific technical and tactical responses, especially for youth athletes (Buszard, Garofolini, et al., 2020; Buszard, Oppici, et al., 2020; Ion-Musat & Tupan, 2022; Schmidhofer et al., 2014). Generally, young players produce higher ball velocity with using low-compression balls during tennis training and matches. Therefore, this scaled equipment gives children greater force and more control, especially when deciding to perform a shot (Elliott, 1981; Hammond & Smith, 2006; Larson & Guggenheimer, 2013). Thus playing with a low-compression ball results in a similar game rhythm to a game of adult tennis matches (Buszard, Garofolini, et al., 2020; Kachel et al., 2015; Schmidhofer et al., 2014; Timmerman et al., 2015). Moreover, children playing on the smaller tennis court had higher skill accuracy and longer rallies than on the standard tennis court (Bayer et al., 2017; Buszard et al., 2014a, 2014b; 2016; Farrow & Reid, 2010; Fitzpatrick et al., 2017, 2018; Kachel et al., 2015; Timmerman et al., 2015).

However, beginner adult players have limited skills, so the game of tennis should be easier and simpler from the start. Low-compression balls are not just for kids but are available for beginner players of all ages. For example, the "Tennis Xpress" course, designed specifically for adults, focuses on scale equipment to make the game of tennis easy and fun (Buszard, Oppici, et al., 2020; Tennis Xpress, 2013). It is known that young adults have a higher level of skill proficiency than children. In addition, the skill development of adults can be gained in a shorter time (Flick, 2020). In this manner, adults can progress faster than children in tennis training/exercise, so the time spent in the red, orange, and green stages will be shorter (Flick, 2020; Koning, 2008; Miley, 2010). Based on this information, using slower balls for both child and adult beginner players can make their tennis game experience easy and fun. It can also result in low-compression balls (slower bounce), giving players more time to control, consequently more hits in rallies can be realized (Miley, 2010; Newman, 2010; Tennis Xpress, 2013). In addition, players are subject to lower loads due to this slow rally situation. Thus, players may be less likely to injure both their upper and lower extremities (Allen et al., 2018; Flick, 2020).

These results indicated that the use of scale equipment positively affects adults as well as children. Generally, scale equipment allows players to optimize the working environment according to their skill development. However, adults' skill levels and physical abilities are higher than children's; they may differ according to age, gender, and physical activity skills. There was no statistical difference in the pre-post test on mobility assessment (agility and change of direction running) comparison of both LCB and RB groups. The main reason may be that the participants were exposed to similar training programmes during the study, and they were also not involved in any physical activities. These variables need to be reviewed in detail, and the most appropriate training protocol developed. Despite the knowledge gained in the literature, the biggest challenge is determining how and when to move from scaled equipment to standard equipment for adults and children. However, given the little research on adults, more research using modified equipment is needed (Buszard, Garofolini, et al., 2020; Tennant, 2013; Tennis Xpress, 2013).

This study is limited to a relatively small sample size of only male young adult students. Also, a traditional (technical-based) study program was used gradually. Given this sample size and training stages (transition from scaled play to adult conditions), our study results may not generalize with all ages group adult players (Limpens et al., 2018). Further research is needed to investigate the effectiveness of scaled equipment in skill development for adults of different age groups. In addition, a traditional training program was applied to be less affected by technical development differences in the study. Also, the tennis skill tests for the LCB group were performed outside the red ball, orange ball and green ball stages. Finally, future applications can be made in combination with different training methods according to gender, physical fitness, and learning levels.

## Conclusions

Due to the fact that this study involved participants at the beginner level, both groups demonstrated technical improvement following the intervention. However, tennis skill scores in the ITN and TSST of beginner adult tennis players after training with a slow tennis ball were higher than those with standard tennis balls. These results support the use of modified equipment to accelerate the learning process, as do many studies on children in the literature. In addition, these results can benefit coaches in planning tennis training sessions suitable for adult beginner tennis players with modified materials.

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## Conflict of interest

The authors report no conflict of interest.

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