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Effects of Game-Based Training Approach on Physical Abilities in Male Youth Volleyball Players

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ABSTRACT

The study aimed to determine the effects of a game-based training approach on the physical abilities of male youth volleyball players. A two-way mixed design was used. Forty young male volleyball players (age: 15.49±1.36 years old; height: 175.50±0.02 cm; weight: 65.50±1.32 kg; experience: 3.39±1.27 years old) participated in this study. Participants were randomly assigned into two equal study groups, a Traditional Training Group (TTG; n = 20) and a Game-based Training Group (GTG; n = 20). TTG uses a traditional training program in which coaches coach athletes, give individual feedback, and perform technique-focused workouts. GTG follows a 12-week simple volleyball game-based training program. Before and after 12 weeks of training, both groups measured their agility, endurance, power, and speed. A two-way mixed design (2 × 2) ANOVA was used to compare the differences between subjects and repeated measure variables. All coefficients are considered significant at $p \leq .05$. As a result, significant differences were found within-subject and between groups in male youth volleyball players' physical abilities. In conclusion, the 12-week game-based training approach effectively improved the physical performances of male youth volleyball players. To support this notion, an additional study is necessary.

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INTRODUCTION

Athletes worldwide constantly strive for excellence in their respective sports (Durand-Bush & Salmela, 2002). Therefore, coach-led standardized training facilitates and enhances the development of athletes capable of meeting the demands of the competitive environment (Hodges & Franks, 2002). However, sport is a global phenomenon developed through an impact on the moral culture of societies performed for competition, recreation, self-enjoyment, skill development, and improvement of the lives of socially vulnerable people (Super et al., 2014). Furthermore, sport is a highly structured human activity, emphasizing physical exertion, skill development, and social interaction (Bilohur & Andriukaitiene, 2020).

Volleyball is a popular sport involving short, focused, and repetitive movements (Gabbett et al., 2007). However, physical ability with a unique combination of technical, tactical, and psychological attributes is a factor in success as a volleyball player (Gabbett, 2008). Furthermore, volleyball players are more likely to succeed if they have strong upper- and lower-body muscles and good hamstring flexibility (Hedrick, 2008). Players perform short bursts of high-intensity activity followed by low-intensity exercises such as jumping, diving, and lateral movements (Purkhús et al., 2016).

Around the world, different training methods are used depending on the country, the coach, and the situation. Young athletes often have difficulty maintaining traditional exercise routines due to a lack of enjoyment and experience with this type of exercise (Wall & Côté, 2007). In addition, conventional coaching methods are focused on developing technical skills and do not accurately reflect real-world gameplay (Ford et al., 2010). This approach is treated as necessary for players to improve their sporting skills and tactical knowledge (Serra-Olivares et al., 2015). However, advances in coaching, especially team coaching, have brought rewards and enjoyment to teams and athletes (Harrison et al., 2015).

Recently, game-based training approaches have been proposed to contextualize learning through games and game-like interactive activities for successful team sports (Light, 2004). Those using game-based training have been shown to improve physical performance in athletes (Hall & Smith, 2006). Performance is thought to be higher when exercise stimulation is matched to the metabolic and technical demands of the actual game (Gabbett, 2008). Additionally, game-based training helps volleyball players make decisions and improve their physiological needs (Gabbett et al., 2008).

Game-based training is often viewed as an ideal environment for players to develop physical prowess, skills, team building, and playing style (Pritchard et al., 2008). A previous

study has shown that game-based training activities are reflected in higher trait homogeneity among elite athletes (Sheppard et al., 2009). The rationale for the game-based approach is therefore based on the assumption that game tasks are not only technical skill applications but also problem-solving grounds (Rosa et al., 2010). Recently, game-based training approaches have been developed that combine skill and conditioning elements cooperatively (Broek et al., 2011). Moreover, previous studies have shown that game-based training can improve physical performance, technical skills, and tactical awareness in sports teams (Trajković et al., 2012).

Moreover, game-based coaching methods require a switch from coach facilitator to facilitate opportunities for player interaction and reflection (Cushion, 2013). As a result, game-based coaching has recently received attention as a new way to improve an athlete's physical performance (Harvey & Jarrett, 2014). According to various kinds of literature on traditional and game-based volleyball-specific training, we hypothesized that a 12-week game-based training program significantly affected agility, endurance, power, and speed. Therefore, this study aimed to determine the impact of a game-based training approach on the physical performance of young male volleyball players.

METHODS

Research Design

A two-way mixed design (2 × 2) was used to compare the differences between data sets that included intersubject and repeat measure variables. It is considered a parametric test and is only suitable for parametric data. Thus, a researcher not only looks at potential differences between two or more separate groups of participants but also evaluates changes individual members of each group over time.

Study Group

Forty male youth volleyball players (age 15.49±1.36 years; height 175.50±.02 cm; weight 65.50±1.32 kg; playing experience 3.39±1.27 years) participated in this study (Table 1). Study participation was voluntary. All participants were selected from the two project volleyball players in Awi zone, Amhara region, Ethiopia. Participants were randomly formed into two equal study groups, a Traditional Training Group (TTG; n = 20) and a Game-based Training Group (GTG; n = 20). Randomization ensures groups are the same age, playing experience, and performance (Merton et al., 2003).

The study included male youth volleyball players aged 15–17 years and those who trained for five consecutive years from 2018–2022. Athletes who had no musculoskeletal injury

for ≥ 6 months and participated in > 95% of training sessions were included. Also, players under the age of 15 were excluded. All participants were informed about the possible risks and benefits of the study. Since the participants are under 18, written consent forms were obtained from the athlete's parents or legal guardians at the beginning of the study. The ethical principles of the Helsinki Declaration conducted the study. In line with this, the study was approved by the local institutional review board or the research ethics review committee of the sports academy of Bahir Dar University (Protocol No. SAD-1148/22).

Table 1
Demographic Characteristics of the Subjects

Variables	TTG (n = 20) Mean±SD	GTG (n = 20) Mean±SD
Age (Years)	15.46±1.29	15.52±1.42
Height (Cm)	175±0.01	176±0.03
Weight (Kg)	65.00±1.30	66.00±1.34
Experience (Years)	3.23±1.24	3.54±1.29

Abbreviations: Cm = centimeter, GTG = game-based training group, Kg = kilogram, n = number of subjects, SD = standard deviation, TTG = traditional training group.

Training Program

In this study, a 12-week game-based and traditional training program was administered by qualified volleyball coaches during preseason (2022-23) in Table 2. All participants completed 120-minute exercise programs three times a week. The training goal was to incorporate volleyball drills and skills while increasing the intensity of sport-specific training. To this end, a game-based training approach was chosen based on previous experience and pilot studies proposed by previous authors (Gabbett, 2008). The TTG used traditional training methods in which coaches coached athletes, provided individualized feedback, and performed technique-oriented drills while the GTG played a simple volleyball game. Both groups emphasized a didactic approach to age-appropriate exercise, with differences in training content, method, and format (Hakman et al., 2017).

The TTG (n = 20) practiced a 20-minute adequate warm-up (10-minute walk and jog, arm circles, high reaches, toe touches, side bends, hand claps, knee raises, hip swirls, 5-minute static and dynamic stretching, 5-minute accelerated running, shaping, and balance exercises (each exercise had ten repetitions). The main training session was 80 minutes of technical skill and tactical development of volleyball elements (each exercise repeated ten times).

Under the guidance of a coach, players practice running, shaping activities with and without the ball, drills performed individually, focusing on skill improvement, and learning volleyball techniques by working in pairs against a wall or partner in a closed or non-

competitive atmosphere. All skills were taught in block practice before proceeding to the next skill (Gabbett, 2008). Lastly, a cool down with a 20-minute walk, side stretch, toes touch, butterfly stretch, quad stretch, and calf stretch (each exercise had ten repetitions).

The GTG (n = 20) practiced a 20-minute adequate warm-up (10-minute walk and jog, arm circles, high reaches, toe touches, side bends, hand claps, knee raises, hip swirls, 5-minute static and dynamic stretching, 5-minute accelerated running, shaping, and balance exercises (each exercise had ten repetitions). The main training session was 80 minutes of volleyball drills with ball practice and game use (each exercise had ten repetitions). It consists of 10-minute small group single-element drills such as serves, passes, and sets for low-intensity activities and 10-minute combination drills such as blocks, spikes, and digging for high-intensity. In addition, it involves 30-minute small field games (2 vs. 2, 3 vs. 3, and 4 vs. 4) where the volleyball field is divided into two smaller courts (9 x 4.5 m) with 5-minute breaks. This is a modified version due to a high-intensity match (60-80%) and 30-minute volleyball competitive matches (6 vs. 6). When a team reaches 15 points, the players rotate and take a 2-minute break after each rotation. Lastly, a cool down with a 20-minute walk, side stretch, toes touch, butterfly stretch, quad stretch, and calf stretch (each exercise had ten repetitions).

Table 2
Twelve-Week Game-Based Training Program during the 2022-2023 Seasons

Goal: 12-Weeks Game-Based Training Program (March-May)						
Days: (Monday, Wednesday, and Friday)						
Exercises	**Groups**		**Rules**			
	TTG (n = 20)	**GTG (n = 20)**	**F**	**I**	**T**	**R**
Warm-up	General: walking, jogging, running, and stretching. Specific: drills with ball.	General: walking, jogging, running, and stretching. Specific: drills with ball.	10x	Low	20′	2′
Main-part	Traditional training Drills against a wall. Drills with a partner. Drills without competition. Skills taught in a block.	Game-based training Competition drill (6 vs. 6). Small-sided game drill (2 vs. 2, 3 vs. 3, 4 vs. 4) Technique drills.	10x	High	80′	5′
Cool-down	Walking, slow jogging, and stretching the muscle groups.	Walking, slow jogging, and stretching the muscle groups.	10x	Low	20′	No

Abbreviations: F = frequency, GTG = game-based training group, I = intensity, n = number of subjects, R = rest, T = time, TTG = traditional training group.

Data Collection Tools

Standard fitness tests such as agility (T-test), endurance (30-second jump test), power (vertical jump), and speed (30-meter sprint test) were chosen for this study. Researchers spoke

to five volleyball and fitness experts to get information about the specificity and applicability of each test. Each test was fine-tuned to ensure relevant, informative, controllable, and accessible data collection (Currell & Jeukendrup, 2008).

Agility Test

Volleyball players need to accelerate, decelerate, and change position quickly. Subject agility was assessed using the T-test (Hoffman, 2006). The T-test was set to an inverted T with four cones (4.57 and 9.14 meters) apart. A volleyball player should always keep their body forward and direct them to run as fast as to touch each cone with their hand. The player's agility performance was measured within 0.01 seconds. The fastest value in two trials measures a player's agility performance.

Endurance Test

The 30-second jump test assesses endurance. The player jumps with both feet, lands with both feet, then jumps back to overcome the obstacle. The first movement triggers sync. Depending on the level of competition, a volleyball match can last up to 90 minutes. Players require sufficient endurance to recover from strenuous activity (Viitasalo, 1987). Endurance is assessed by the player's total number of successful jumps in 30 seconds and the best time of two successful jumps.

Power Test

Volleyball players require high levels of muscle power to perform spike, block, and jump tasks commonly performed during the game. Muscle power was therefore estimated using the metric bar measured with an accuracy of 1 cm (Osborne, 2002). It was calculated as the distance between the highest points reached while standing and the highest point reached during the vertical jump. Players were asked to stand on the ground and extend their hands to mark the standing height. After squatting, each subject was instructed to jump up and touch the highest point on the scale. The highest score of the two trials determined the player's power performance.

Speed Test

Volleyball players require the ability to move quickly to position themselves to receive a pass, block, or shot from an opponent. The running speed of players was evaluated with a 30-meter sprint effort. This speed test requires the participant to sprint as fast as 30 meters. The correct sprint test version was explained and demonstrated to all participants (Castro-Piñero et al., 2010). Players were instructed to run as quickly as possible along the 30-meter distance from a standing start. To measure the exact time of participants, a mechanical

stopwatch with an accuracy of ± 1.0 seconds per 30 minutes was used. An accurate 30-meter run time with the fastest value obtained from two trials was measured for the analysis.

Data Collection Procedure

The researcher provided brief information about the data collection for the participants before each test. All participants performed a special warm-up guided by a volleyball coach, which consisted of walking and jogging. Each participant was measured for agility, endurance, power, and speed performances before and after 12 weeks of game-based volleyball training. To guarantee the consistency of the test, measurements were taken in the morning from the same participants under the same environmental circumstances with the same researchers. All participants were given trials before testing to familiarize themselves with the test protocol. Verbal encouragement was used throughout all tests to achieve maximum effort.

Data Analysis

Descriptive statistics such as mean and standard deviation (SD) were used in data analysis. The normality of the distribution was tested using the Shapiro-Wilk test. The homogeneity of variance was verified with Levene's test. Training effects were analyzed using a two-way (2 groups x 2 times) mixed ANOVA. The effect size (ES) was calculated using Cohen's (d) within each group and tested as follows: <0.2 = trivial; 0.2–0.6 = small; 0.6–1.2 = moderate; 1.2–2.0 = large; >2.0 = very large; and >4.0 = extremely large (Hopkins et al., 2009). Data analysis was performed with IBM SPSS (Statistical Package for Social Science) Statistics Version 26 for Windows in Armonk, New York, USA. All coefficients were considered significant at $p \leq .05$.

RESULTS

Table 3 presents descriptive statistics and Mixed ANOVA results for agility, endurance, power, and speed variables in GTG and TTG.

Table 3
Descriptive Statistics and the Mixed ANOVA Results

Variables	G	n	PT Mean±SD	POT Mean±SD	MD	ES (d)	Time, Group, and Interaction Effects
Agility	TTG	20	10.75±0.02	10.73±0.02	0.02	1.00	T: (F = 282.83, P = .00, η^2p = .88)
	GTG	20	10.74±0.02	10.33±0.02	0.41	20.50	G: (F = 24.59, P = .00, η^2p = .39)
	Total	40	10.745±0.04	10.53±0.04	0.22	10.75	I: (F = 18.28, P = .00, η^2p = .33)
Endurance	TTG	20	48.00±2.18	46.00±2.18	2.00	0.92	T: (F = 2.23, P = .05, η^2p = .14)
	GTG	20	47.00±2.18	50.00±1.49	3.00	1.61	G: (F = 5.74, P = .02, η^2p = .13)
	Total	40	47.50±4.36	48.00±3.67	0.50	0.12	I: (F = 4.37, P = .04, η^2p = .10)

Table 3 (Continued)

Variables	G	n	PT Mean±SD	POT Mean±SD	MD	ES (d)	Time, Group, and Interaction Effects
Power	TTG	20	48.00±2.18	46.00±2.18	2.00	0.92	T: (F = 4.32, P = .05, η^2p = .10)
	GTG	20	47.00±2.18	52.00±1.49	5.00	2.68	G: (F = 14.25, P = .001, η^2p = .27)
	Total	40	47.50±4.36	49.00±3.67	1.50	0.37	I: (F = 10.31, P = .003, η^2p = .21)
Speed	TTG	20	4.52±0.02	4.50±0.02	0.02	1.00	T: (F = .14, P = .004, η^2p = .72)
	GTG	20	4.50±0.02	4.42±0.02	0.08	4.00	G: (F = .37, P = .01, η^2p = .55)
	Total	40	4.51±0.04	4.46±0.04	0.05	1.25	I: (F = 1.30, P = .03, η^2p = .26)

Abbreviations: *ES (d) = Effect size, F = F test-statistic, G = Group, GTG = game-based training group, I = Interaction, MD = Mean difference, n = number of subjects, P = P test-statistic, POT = Post-test, PT = Pre-test, SD = Standard Deviation, T = Time, TTG = traditional training group, η2p = Partial eta squared. *p ≤ .05.*

As shown in Table 3, the mean agility was lesser for TTG (MD = 0.02, ES (d) = 1.00) than for GTG (MD = 0.41, ES (d) = 20.50). There was a statistically significant difference among subjects concerning agility (F = 282.83, p < .001, partial η2 = .88). There was also a statistically significant difference between groups on agility performance (F = 24.59, p < .001, partial η2 = .39). Moreover, there was a significant interaction effect between game-based training and agility (F = 18.28, p < .001, partial η2 = .33).

As shown in Table 3, the mean endurance was lesser for TTG (MD = 2.00, ES (d) = 0.92) than for GTG (MD = 3.00, ES (d) = 1.61). There was a statistically significant difference among subjects concerning endurance (F = 2.23, p = .05, partial η2 = .14). There was also a statistically significant difference between groups on endurance (F = 5.74, p = .02, partial η2 = .13). Moreover, there was a significant interaction effect between game-based training and endurance (F = 4.37, p = .04, partial η2 = .10).

As shown in Table 3, the mean power was lesser for TTG (MD = 2.00, ES (d) = 0.92) than for GTG (MD = 5.00, ES (d) = 2.68). There was a statistically significant difference within subjects concerning power (F = 4.32, p = .05, partial η2 = .10). There was also a statistically significant difference between-group on power (F = 14.25, p = .001, partial η2 = .27). Moreover, there was a significant interaction effect between game-based training and power performance (F = 10.31, p = .003, partial η2 = .21).

As shown in Table 3, the mean speed was lesser for TTG (MD = .02, ES (d) = 1.00) than for GTG (MD = .08, ES (d) = 4.00). There was a statistically significant difference among subjects concerning speed (F = .14, p = .004, partial η2 = .72). There was also a statistically significant difference between-group on speed (F = .37, p = .01, partial η2 = .55). Moreover, there was a significant interaction effect between game-based training and speed (F = 1.30, p = .03, partial η2 = .26).

DISCUSSION

This study examined how a 12-week game-focused coaching program affects the physical performance of young male volleyball players. Gabbett and Georgieff (2006) explore the feasibility of a game-based approach to training the physical performance of young male volleyball players. Additionally, Gabbett (2008) concluded that game-based coaching improves game skills and agility in volleyball players. In addition, Purkhus et al. (2016) and Idrizovic et al. (2018) concluded that an effective game-based coaching program can improve the overall range of motion, lateral movement, and speed.

Game-based coaching programs have been particularly effective in altering various intermittent endurance markers because of the large-scale game. As a result, Buchheit et al. (2008) confirmed that the game-based coaching strategy was created to enhance volleyball players' endurance capabilities. Most importantly, players can benefit from this fun and engaging coaching method for understanding the volleyball game (Billaut et al., 2012). Coaches who utilized game-based training had higher physical capabilities and excellent heart rate measures than traditional skill practice (Miller et al., 2016; Nathan, 2017).

In support of the study, a game-based coaching approach is enhances power performances, increased efficiency and stability in game situations (Hill-Haas et al., 2007). Therefore, game-based training improves physical fitness, technical ability, and overall quality improvement in volleyball players (Gabbett et al., 2009). However, volleyball players require considerable leg power to perform hundreds of jumps to perform spikes and blocks during games and competitions (Sheppard et al., 2009).

Moreover, game-based coaching strategies appear to be an effective way to improve athletic performance in volleyball players (Trajković et al., 2012). However, increasing vertical jump success in volleyball matches requires explosive leg power (Martinez, 2017). As a result, game-based coaching methods are more physically demanding and may lead to performance adjustments (Kinnerk et al., 2018). Furthermore, Trajković et al. (2020) discovered that two months of volleyball practice reduced some risk factors and enhanced power.

Speed performance was significantly enhanced by the game-based coaching approach (Hill-Haas et al., 2007). In support of this, Gabbett (2008) concluded that a game-based coaching approach improves the playing abilities of young volleyball players. Furthermore, game-based training strategies have significantly impacted speed performance in volleyball players (Rodriguez-Ruiz et al., 2011; Chaouachi et al., 2014). Overall, volleyball players showed sufficient improvement in physical abilities during game-based coaching approaches

(Harvey & Jarrett, 2014). However, game-based training promotes a productive and meaningful training environment (Batez et al., 2021). Moreover, exposing athletes to an environment that resembles the tactical situations encounter in-game activities prepares them for competition (Ramos et al., 2021).

Limitations

The lack of a literature review on game-based training programs in youth male volleyball players makes it challenging to compare our findings with those of other studies. Results were also influenced by each participant's intelligence level, lifestyle, and dietary habits. However, similar tests and scoring systems are applied during research and development.

CONCLUSION

Based on the results of this study, we can conclude that game-based training appears to be an effective way to improve the physical abilities of young male volleyball players. There was a significant change in agility, endurance, power, and speed ability after 12 weeks of the game-based coaching program. Many coaches do not use the method described in this article because they fear not enough stimulation that game-based coaching can have in volleyball. However, more research is needed to determine whether physical ability improvement can be achieved after a similar training period.

PRACTICAL IMPLICATIONS

The researchers hope results will facilitate the assessment of athletes' physical performance by coaches, instructors, and other volleyball professionals. In addition, players who participated in game-based coaching methods also improved their overall game skills. Because this is promising research, sports scientists are encouraged to conduct research applying game-based training techniques to other sports.

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Authors' contributions

All authors contributed to this study together. The first author contributed to the conceptualization, methodology, design of the study, data collection, and writing process. The second (middle) author contributed to the validation of the methodology with review and editing of the original draft. The third (last) author contributed to this study by supervising

the overall work, critical reviewing of the original draft, as well as the approval of the final draft.

Declaration of conflict interest

No potential conflict of interest was reported by the author(s).

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