Tabata Exercise Increased Endurance of Primary School Basketballers

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ABSTRACT

Basketball is a popularity sport in world. It has gained overwhelming popularity as one of the four major professional sports in the United States. Many people worldwide play it, and the FIBA (International Basketball Federation) sponsors the World Basketball Championships every four years. Basketball has gained worldwide popularity and fascinated players and spectators with its dynamic characteristics as a team sport. Basketball players need to improve their oxygen uptake to maintain maximum intensity throughout the game. The sport is characterized by frequent high-intensity periods and changes in activity every 2-3 seconds. **Objective**. This study is to investigate the effects of 12 weeks Tabata program on primary basketball players endurance. **Method.** 24 male (n=12) and female (n=12) from primary school were selected to the Tabata Training group (EG) and control group (CG). EG group involved Tabata Training three times per week for 12 weeks. **Results.** Body Mass Index (BMI) shown no significant differences between the control and experimental groups after 12 weeks of intervention. However, for others test of cardiovascular endurance, muscle endurance and flexibility of the primary basketball players shown that there is a significant difference in the endurance scores between the CG and the EG after the Tabata training program. Since the ($P<0.05$), we reject the null hypothesis and conclude that the variances are significantly different.

Keywords: Tabata Training, basketball, endurance, primary basketball players

INTRODUCTION

Basketball, invented in the United States in 1891, has become one of the four major professional sports in the country, alongside baseball, American football, and ice hockey. Its popularity extends globally, with the International Basketball Federation (FIBA) sponsoring the World Basketball Championships every four years. The sport's dynamic nature, characterized by multidirectional movements such as running, dribbling, and jumping, captivates both players and spectators. Endurance is a critical attribute for basketball players, enabling them to maintain high performance levels throughout the game. During a 40-minute game, players cover approximately 4500–5000 meters, engaging in various high-intensity activities. Basketball's intermittent nature involves frequent changes in speed and direction, especially following rule modifications in May 2000. The sport demands a combination of anaerobic exercises for explosive power and aerobic exercises for endurance.

Basketball players need to improve their oxygen uptake to maintain maximum intensity throughout the game. The sport is characterized by frequent high-intensity periods and changes in activity every 2-3 seconds (Ben Abdelkrim et al., 2007; McInnes et al., 1995; Scanlan et al., 2011). Neuromuscular abilities, including power, strength, and speed, are heavily taxed during matches, with jumping performance and quick changes in direction being key components (McInnes et al., 1995; Scanlan et al., 2011; Ziv & Lidor, 2010). Both aerobic and anaerobic mechanisms are activated to provide energy during play (Ziv & Lidor, 2009). Sprinting and change of direction are critical physical demands in basketball, influencing athletic performance (Sheppard & Young, 2006; Spiteri et al., 2014). High sprint and change of direction performance are particularly important for basketball players (Spiteri et

al., 2015; Stojanovic et al., 2019).

High-Intensity Interval Training (HIIT), such as Tabata training, has gained recognition for improving endurance. Named after Dr. Izumi Tabata, this training regimen involves short bursts of intense exercise followed by brief rest periods. Studies have shown that Tabata training significantly enhances both aerobic and anaerobic capacities, making it an ideal training method for basketball players (Prakash et al. 2024). Competitive basketball requires well-developed aerobic and anaerobic fitness. Players perform repetitive sprints, jumps, and varying intensity runs, necessitating comprehensive training in strength, power, and endurance. Effective training programs incorporate aerobic conditioning for endurance, anaerobic training for speed, and strength training for muscle development. Additionally, specialized training enhances flexibility, agility, reflexes, and psychological resilience. Endurance, a critical attribute for basketball players, enables sustained performance under fatigue and supports significant training loads. It is defined as the ability to perform work over time, resisting fatigue. General endurance involves long-term activities engaging major muscle groups in aerobic metabolism, indirectly benefiting sports specialization.

Tabata training requires players to perform exercise at near-maximal efforts at 85-95% of maximum heart rate, for 20 seconds, followed by 10 seconds of rest. This cycle is repeated for four minutes, resulting in a highly efficient workout that improves maximal oxygen uptake (VO2max) and overall endurance (Prakash et al, 2024). The benefits of Tabata training extend beyond physical fitness, as it also enhances mental toughness and the ability to perform under pressure (Izumi Tabata, 2019). Research highlighted the effectiveness of Tabata-style exercises in developing endurance and performance in young basketball players, particularly in skills such as the lay-up shot (Ahmed Ghassy et al. 2021). These findings underscore the importance of incorporating Tabata training into the regimen of primary basketball players to enhance their endurance and overall performance.

Incorporating Tabata training into the regimen of primary basketball players can significantly improve their endurance, allowing them to sustain high-intensity performance throughout the game. This training method not only boosts physical capabilities but also prepares young athletes for the demands of competitive basketball. Thus, this study aim to investigate the effects of Tabata program on primary basketball players endurance through a 12 weeks of intervention. The hypothesis posited that Tabata Training Program might increase the endurance among the primary basketball players.

METHOD

Participants

Participants comprised 12 male basketball players and 12 female basketball players selected from primary school, who had participated in the competition before. They were well-trained on the basketball skills before starting the study. They were assigned into two equal groups: an experimental group (EG) and a control group (CG). All of the following conditions were fulfilled for inclusion: all samples, (i) were enthusiastic about the opportunity and stuck with the training; (ii) had no pre-existing illnesses or musculoskeletal problems that might compromise their performance; and (iii) They have the ability and skill to perform the basketball skills as well. All the tests are conducted by the basketball coach in the school.

Study Design

This study is investigate to effect of the Tabata Training Program on the endurance of primary basketball players. The study included 24 primary basketball players (12 males and 12 females) aged 8-12 years, selected through convenience sampling from local schools. Participants underwent an 12-week Tabata training program. Participants in both groups, who were players of the same team, continued their regular training (4 days per week). In addition, Experimental Group players applied Tabata Training for 12 weeks at the end of regular training 3 days a week. They performed a set of the exercise, which consisted of 8 different movements and lasted for 4 minutes. with sessions held three times per week. Each session consisted of 20 seconds of high-intensity exercise followed by 10 seconds of rest, 4 minutes of the duration training.

In this study, cardiovascular endurance, muscle endurance, flexibility and body mass index (BMI) were measured to investigate the effect of the Tabata Training Program among the primary basketball players. Cardiovascular endurance was measured using The Intermittent Recovery Level 1 Children's Test (YYIR1C), muscle endurance was measured using The Plank Test, Modified back saver sit-and-reach test (MBSSRT) used to measure the flexibility of the players and BMI calculated by the formula given. Score of the test was taken before the intervention, and post-intervention assessments were conducted at the end of the 12-week period. Data were analyzed using SPSS Statistics version 23 software. Independent samples t-test were used to compare pre- and post-intervention endurance levels. Statistical significance was set at $p < 0.05$.

Intervention Assessment

The intervention was held to increase the endurance among the primary basketball players. Experimental Group players applied Tabata Training for 12 weeks at the end of regular training 3 days a week. They performed a set of the exercise, which consisted of 8 different movements and lasted for 4 minutes. Tabata Training consisting of 8 stations was applied in the form of 20 sec working and 10 sec active recovery interval method shown as Table 1.

Table 1. Tabata Training for a week

	Tabata Training Method	Set/ Repetition
1	Push-ups	The duration of training 4 minutes, with each movement session lasted 20 seconds and 10 seconds active rest.
2	Squat	
3	Plank	
4	Burpee	
5	Biceps curl	
6	Skipping rope	
7	Shoulder press	
8	Sit-ups	

Body Mass Index (BMI)

Body mass index (BMI) is a value derived from the mass (weight) and height of a person. The BMI is defined as the body mass divided by the square of the body height, and is expressed in units of kg/m2, resulting from mass in kilograms (kg) and height in metres (m). The test is calculated by the formula as shown in Figure 1. According to the American Center for Disease Control and Prevention (CDC) and the World Health Organisation (WHO) the Classification of the BMI in children are shown in Figure 2.

$$BMI = \frac{\text{Weight in kilogram}}{\left(\text{Height in meter}\right)^2}$$

Figure 1. Formula of Body Mass Index (BMI)

Group	BMI (kg/m^2)			
	8–9 years old	9–10 years old	10–11 years old	11–12 years old
Obese				
Boys	> 22.0	> 22.5	> 22.9	> 23.5
Girls	> 21.0	> 21.6	> 21.6	> 23.1
Normal-weight				
Boys	19.3–15.0	19.7–15.2	20.3–15.4	21.0–15.8
Girls	18.8–14.6	19.3–14.9	20.1–15.2	20.9–15.8

BMI body mass index.

Figure 2. Classification of the BMI

The Intermittent Recovery Level 1 Children's Test (YYIR1C)

The Intermittent Recovery Level 1 Children's Test (YYIR1C) was conducted in a basketball court setting, 2 × 16 meters shuttle runs (rather than 2 × 20m) and 2 × 4 meters for active recovery (rather than 2 × 5m) in 10 seconds as shown in Figure 3. The increase in speed was controlled by audio bleeps (Mohr & Krustrup, 2013). The scoring process involved tallying the total count of levels and successful returns achieved by participants.

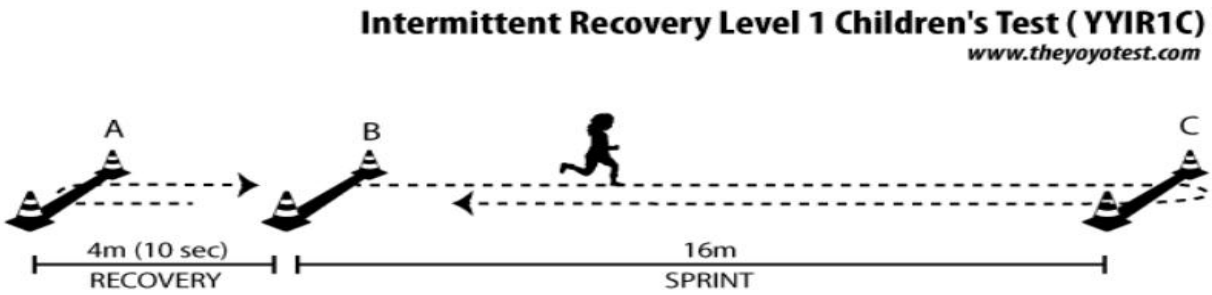

Figure 3. The Intermittent Recovery Level 1 Children's Test (YYIR1C)

Plank Tests

The Plank Test assesses the control and endurance of the core stabilizing muscles, including the abdominals, back, and shoulders. The test starts with the upper body supported off the ground by the elbows and forearms, and the legs straight with the weight taken by the toes. The hip is lifted off the floor creating a straight line from head to toe. As soon as the subject is in the correct position, the stopwatch is started. The head should be facing towards the ground and not looking forwards. The test is over when the subject is unable to hold the back straight and the hip is lowered. Table 2 below is used to scores the test for children age 6 to 12. According to National Youth Fitness Survey (NYFS) these adjusted scores take into account the physical development and endurance levels typical of younger children. It's important to ensure that children maintain proper form throughout the test to avoid injury and get accurate results.

Table 2. Plank Test Score

Score Category	**Time Held**
Excellent	> 2 minutes
Very Good	1.5 - 2 minutes

Above Average	1 - 1.5 minutes
Average	45 seconds - 1 minute
Below Average	30 - 45 seconds
Poor	15 - 30 seconds
Very Poor	< 15 seconds

Modified back saver sit-and-reach test (MBSSRT)

Modified back saver sit-and-reach test (MBSSRT) is a variation of the traditional Sit-and-Reach Test designed to measure the flexibility of the lower back and hamstrings. In this test, the participants performed a single-leg sit-and reach on a wooden bench on which the measuring tape was placed. The untested leg was placed on the floor with knee at approximately 90°. The participant aligned the sole of the foot of the tested leg with the 50-cm mark on the measuring tape. Thereafter, participants were asked to reach forward as far as possible while maintaining the knees, arms, and fingers fully extended, and keeping the two hands on top of each other (tips of the middle fingers even) and palms down as shown in Figure 4. They were asked to hold this position shortly two seconds. The score was recorded as the most distant point on the bench contacted by the middle fingertip. A qualified physiotherapist recorded the average of the three trials on each leg.

Figure 4. Modified Back Saver Sit-And-Reach Test (MBSSRT)

Statistical Analysis

The data were analyzed using an independent paired t-test to compare the results obtained before and after the 12-week Tabata training program. The results are presented as the mean and standard deviation. The independent paired t-test was employed to determine the statistical significance of the differences in endurance levels measured at the start and end of the training period. The analyses were conducted with a 95% confidence interval, and statistical significance was set at $p \leq 0.05$. This means that any p-value less than or equal to 0.05 was considered statistically significant, indicating a high likelihood that the observed differences were not due to chance.

The statistical analyses were performed using SPSS Statistics version 23. This software was used to calculate the mean, standard deviation, and p-values for the pre- and post-training endurance measurements. The independent paired t-test allowed for the comparison of the two sets of data, providing insights into the effectiveness of the Tabata training program in improving the endurance of primary basketball players. The results of the analysis showed significant improvements in the endurance levels of the participants, as indicated

by the mean differences and corresponding p-values. These findings support the hypothesis that the Tabata training program effectively enhances the aerobic and anaerobic fitness of young basketball players.

RESULT

The results are presented as the mean and standard deviation. The normality of the distribution with the Shapiro Wilk test was determined. The independent samples t-test was used to compare two sample means from control group (n=12) and experimental groups (n=12). It also used to combine the results obtained from the tests before the start of the specific training, and at the end of it, after twelve weeks. The analyses were performed with 95% confidence interval and $p \leq 0.05$. The statistical analyses were performed with SPSS Statistics version 23 shown as Table 3.

Table 3. Mean and standard deviation of four variables.

Variables	Group	Mean		SD	
		Pre	Post	Pre	Post
Body Mass Index (BMI)	Control	17.87	17.51	5.13	4.81
	Experimental	21.30	20.16	6.42	5.36
The Intermittent Recovery Level 1 Children's Test (YYIR1C)	Control	12.91	13.53	0.65	0.48
	Experimental	12.81	15.17	0.82	1.15
Plank Test	Control	0.71	0.76	0.42	0.40
	Experimental	0.63	1.30	0.40	0.35
Modified back saver sit-and-reach test (MBSSRT)	Control	16.17	18.58	4.63	4.87
	Experimental	15.75	23.67	4.94	3.63

Body Mass Index (BMI)

Based on the data Body Mass Index (BMI) indicated no significant differences between the control and experimental groups. The pre-test data for Body Mass Index (BMI) showed no significant differences between the control group and the experimental group. The control group had a mean BMI of 17.8667 (SD = 5.12735, N = 12), while the experimental group had a mean BMI of 21.3000 (SD = 6.41674, N = 12). The independent samples t-test showed no significant difference in mean BMI scores between the groups ($t(22) = -1.448$, $p = 0.162$), with a mean difference of -3.43333. The post-test data for BMI showed no significant differences between the control group and the experimental group. The control group had a mean BMI of 17.5083 (SD = 4.80520, N = 12), while the experimental group had a mean BMI of 20.1583 (SD = 5.35545, N = 12). The independent samples t-test showed no significant difference in mean BMI scores between the groups ($t(22) = -1.276$, $p = 0.215$), with a mean difference of -2.65000.

The Intermittent Recovery Level 1 Children's Test (YYIR1C)

The results presented that there is no significant difference in the cardiovascular endurance scores between the control and experimental groups before the implementation of the Tabata training program. The t-test compares the means of the two groups. From the data, the variances of the two groups are equal. Since the p-value (Sig.) is greater than 0.05. The p-value (Sig. (2-tailed)) is 0.744, which is greater than 0.05, indicating that there is no statistically significant difference between the means of the control and experimental groups. Based on the data, it appears that there is no significant difference in the cardiovascular endurance scores

between the control and experimental groups before the implementation of the Tabata training program.

The post-test data shown that the Tabata training program significantly increased the cardiovascular endurance of the primary basketball players in the experimental group compared to the control group. The post-test of the control group with mean=13.5250, sd=0.47697 and experimental group with mean= 15.1667, sd= 1.14838. From the data p-value is 0.000, which is much less than 0.05. This means that there is a significant difference in the endurance scores between the control group and the experimental group after the Tabata training program. Since the p-value (Sig.) is less than 0.05, we reject the null hypothesis and conclude that the variances are significantly different.

Plank Tests

From the data collected of the Plank Test shown that pre-test of control group with mean score of 0.7083 (SD= 0.4225) and experimental group with mean score of 0.6342 (SD=0.40325). In this study the p-value (Sig. (2-tailed)) is 0.664, which is greater than 0.05, indicating that there is no statistically significant difference between the means of the control and experimental groups before the Tabata training program. The small effect sizes indicate that the difference between the groups is minor. The post-test data for the plank test revealed significant differences between the control group and the experimental group. The control group had a mean score of 0.7625 (SD = 0.39811, N = 12), while the experimental group had a mean score of 1.3083 (SD = 0.34761, N = 12). However, the independent samples t-test showed a significant difference in mean scores between the groups ($t(22) = -3.578$, $p = 0.002$), with a mean difference of -0.54583.

Modified back saver sit-and-reach test (MBSSRT)

The result for the Modified Back Saver Sit-and-Reach Test (MBSSRT) showed no significant differences between the control group and the experimental group. The control group had a mean score of 16.167 (SD = 4.6286, N = 12), while the experimental group had a mean score of 15.750 (SD = 4.9383, N = 12). The independent samples t-test showed no significant difference in mean scores between the groups ($t(22) = 0.213$, $p = 0.833$), with a mean difference of 0.4167. Based on the post-test data for MBSSRT revealed significant differences between the control group and the experimental group. The control group had a mean score of 18.583 (SD = 4.8703), while the experimental group had a mean score of 23.667 (SD = 3.6265). However, the independent samples t-test showed a significant difference in mean scores between the groups ($t(22) = -2.900$, $p = 0.008$), with a mean difference of -5.0833.

DISCUSSIONS

The results of this study indicate that the Tabata Training Program significantly improves the endurance and overall fitness of basketball players. Specifically, the program led to notable enhancements in cardiovascular endurance, muscle endurance, body mass index (BMI), and flexibility. These findings suggest that the high-intensity interval training (HIIT) structure of Tabata is effective in addressing multiple aspects of physical fitness, which are crucial for athletic performance. The findings of this study are consistent with previous research on the benefits of HIIT and Tabata training. Studies have shown that HIIT can improve cardiovascular and muscular endurance more effectively than traditional moderate-intensity continuous training (MICT). Short bursts of high-intensity exercise followed by rest periods were more effective at increasing VO2 max and overall endurance than longer, steady-state cardio sessions (Gibala et al., 2012). Additionally, HITT could lead to significant reductions in abdominal fat, which is a key factor in improving BMI and overall health. The improvements in BMI and flexibility observed in this study align with research indicating that HIIT can promote fat loss and enhance overall body composition (Boutcher, 2011). Furthermore, Tabata training has been recognized for its efficiency in boosting both aerobic and anaerobic capacity, making it a valuable training method for athletes (Paulo Gentil, 2018).

From the study found that HIIT significantly improved VO2 max and anaerobic capacity in athletes (Buchheit et al., 2012). This shown that where the Tabata training program, a form of HIIT, led to significant improvements in endurance among primary basketball players. The short bursts of intense activity followed by brief rest periods, characteristic of the Tabata protocol, seem to enhance both aerobic and anaerobic endurance. Tabata training also tends to enhance recovery times, which is particularly beneficial in team sports like

basketball where quick recovery is crucial during intense gameplay. In this study's results align with the study of Drigny et al., (2015) which highlighted the positive impact of HIIT on reducing the time needed for athletes to recover from exertion, therefore improving their performance during the game. This implies that regular incorporation of Tabata sessions could help players better manage fatigue throughout the game and during subsequent training sessions. Based on the findings of Milanovic et al., (2015) have demonstrated that HIIT, such as Tabata, leads to significant improvements in both aerobic and anaerobic capacity. This is consistent with the findings of the current study, where players showed improved ability to maintain effort during longer periods and recover during short breaks in game situations.

The significant improvements in endurance and overall fitness observed in this study have important implications for the training of basketball players. Coaches and trainers can incorporate Tabata training into their athletes' workout regimens to enhance performance and reduce the risk of injuries. The comprehensive nature of Tabata training, which targets various aspects of physical fitness, makes it a valuable addition to traditional training methods. While this study provides valuable insights into the benefits of the Tabata Training Program, further research is needed to explore the most effective variations of Tabata protocols for primary basketball players. Future studies should investigate different exercise combinations, intensity levels, and training durations to optimize the program for this specific population. Additionally, research should focus on developing individualized training programs that consider the unique health conditions and fitness levels of each athlete.

This study has several limitations that should be acknowledged. The sample size was relatively small, which may limit the generalizability of the findings. Additionally, the study did not account for potential confounding variables such as diet, sleep, and other lifestyle factors that could influence the results. Future research should aim to address these limitations by including larger sample sizes and controlling for additional variables. In conclusion, the Tabata Training Program has demonstrated significant potential in improving the endurance and overall fitness of basketball players. The findings of this study support the use of Tabata training as a comprehensive and effective approach to enhancing athletic performance. By continuing to refine and personalize this training method, coaches and trainers can better support athletes in achieving their performance goals and maintaining long-term health. The potential of Tabata training extends beyond basketball, suggesting its applicability to other sports and fitness contexts, thereby contributing to the broader field of athletic training and performance enhancement.

CONCLUSION

The Tabata Training Program offers a promising and comprehensive approach to improving the endurance and overall fitness of basketball players. By continuing to refine and personalize this training method, coaches and trainers can better support athletes in achieving their performance goals and maintaining long-term health. The potential of Tabata training extends beyond basketball, suggesting its applicability to other sports and fitness contexts, thereby contributing to the broader field of athletic training and performance enhancement. The significant improvements in endurance observed in this study have important implication for the training of basketball players. Coaches and trainers can incorporate Tabata training into their athletes' workout regimens to enhance performance and reduce the risk of injuries. The comprehensive nature of Tabata training, which targets various aspects of physical fitness, makes it a valuable addition to traditional training methods.

In practical terms, incorporating Tabata training can lead to shorter, more efficient sessions that help players stay in top physical shape without requiring significant time investments. This is especially advantageous during the competitive season when time is constrained. Moreover, Tabata training can reduce the risk of overuse injuries by varying the intensity and exercises. Coaches can create sport-specific Tabata routines that replicate the demands of basketball, effectively translating fitness improvements into better performance on the court. Therefore, Tabata training program can be a highly effective method to improve endurance in primary basketball players.

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