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Original Article

Effect of Tabata resistance training program on body capacities and 50m sprint performance of intermediate swimmers

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Abstract:
Background: The search for an efficient training program remains paramount in swimming. **Purpose**: This experimental study was designed to test the efficacy of the Tabata resistance training program in comparison to conventional training. **Methods:** Twenty intermediate swimmers were evenly divided into two groups: the experimental and control groups. Both groups participated in pre- and post-field tests using valid and standard procedures of body capacity tests and 50m sprint performance. The Shapiro-Wilk test was performed to assess the normality of the distribution and all variables displayed normal data. The mean difference between groups in baseline and post-tests was assessed with an independent sample t-test to examine group differences. A paired sample t-test was used to identify significant differences within the groups' baseline and post-tests. The change ratio (Δ) was utilized to verify differences within groups between baseline and post-tests. Statistical significance was accepted at $p \leq 0.05$. Cohen's *d* effect size (ES) was computed to display the magnitude of differences between variables. **Results:** There is a large significant difference in anaerobic capacity(1RM, fatigue index, peak power, and average power), aerobic capacity (VO_{2max}), and 50m sprint performance (freestyle, butterfly, backstroke, and breaststroke) in favor of the experimental group at $p \leq 0.001$. **Conclusion:** The results demonstrate a significant effect of the Tabata resistance training program on intermediate swimmers' performance compared to conventional training. The study encourages coaches, trainers, and swimmers to consider the use of Tabata resistance training since it is beneficial in augmenting muscle engagement and strength gains, thereby contributing valuable insights for optimizing swimmer performance.
Keywords*:* resistance loads, HIIT, endurance, strength, swimming

Introduction

In swimming, the pursuit of an effective training program stands as the highest objective. Competitive swimming is a dynamic sport that demands a methodological approach to training, as recognized by coaches and athletes (McNarry et al., 2020). Maximizing performance in swimming requires a training design that addresses the physical demands of the sport and integrates elements of stroke correction, and strategic periodization. Athletes strive to improve their performance through a continuous quest for developments in training methodologies, training innovations, and programs suited to their present ability (Rothwell et al., 2020).

The Tabata protocol is widely applied across various sports disciplines, including taekwondo (Mischenko et al., 2021), badminton (Nugroho et al., 2021), gymnastics (Kokareva et al., 2023), and cycling (Viana et al., 2019). Upon reviewing the literature, numerous subsequent studies have employed the original Tabata protocol (Viana et al., 2019; Logan et al., 2016; Scribbans et al., 2014). Conversely, some literature has introduced a diverse array of Tabata-like protocols (Viana et al., 2019), modifying the original structure with alternative activities such as running, calisthenics, and resistance exercises (Logan et al., 2016). Similarly, elite soccer players exhibited notable enhancements in aerobic and anaerobic capacities through a sprint training program spanning 9 weeks, incorporating four repetitions of 30-second high-intensity runs (Helgerud et al., 2007). A study by Tjønna et al. revealed a 10% improvement in cardiorespiratory fitness in nonathletes who engaged in a single, intense, 4-minute treadmill bout at 90% of their peak heart rate three times a week for 10 weeks, without adverse effects (Tjønna et al., 2013). Several studies comparing endurance exercise and high-intensity interval training consistently favored the latter, demonstrating an increase in cardiorespiratory fitness (Tabata et al., 1996; Trapp et al., 2008; Helgerud et al., 2007). Relevant literature claimed that the incorporation of the Tabata protocol in swimming programs has significant effects and advantages in improving performance and overall fitness among athletes. Tabata protocol, first introduced in 1996 by Izumi Tabata and colleagues, is a type of workout used for high-intensity interval training, which compels you to work out at a very high intensity for a brief period (Tabata et al., 1996). Tabata protocol is characterized by short bursts of intense effort followed by brief rest periods, which is suited to competitive swimming. The use of the Tabata protocol improves cardiovascular endurance and anaerobic capacity which is critical for sprint events in swimming. This program also can efficiently engage both aerobic and anaerobic energy systems proving beneficial for swimmers seeking an effective training program (Rebold et al., 2013).

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Another strategy for improving the total performance of swimmers is the use of resistance training equipment like ankle weights and resistance bands (Crowley et al., 2017; Park et al., 2019). This strategy adds an extra layer of challenge to traditional swimming movements, fostering enhanced muscle engagement and strength development (Crowley et al., 2017). Resistance training targets the muscle groups involved in swimming which increases power and endurance. These tools are used for stroke-specific training that enables swimmers to correct their technique. The resistance creates drag during execution, supporting the progress of streamlined body positions and better-quality propulsion. Moreover, incorporating resistance equipment training expands workouts and is effective in injury prevention, as it helps build muscular balance and adaptability. Substantial scientific studies on Tabata training impact the overall health and sports performance of athletes across the field of sports. However, based on my knowledge, there are no studies focused on the integration of resistance bands and ankle weights in the Tabata swimming program to enhance the athletes' body capacities and sprint performance. Thus, this study examines the effect of the Tabata resistance training program on body capacities and 50m sprint performance of intermediate swimmers.

Methods

Participants

Participants comprised 20 physical education majoring students (8 male (40%), 12 female (60%)) under SPECPE14: swimming and aquatic course at one state university in the Philippines on the first semester of the academic year 2023 to 2024, who are considered as intermediate swimmers (Table 1). Participants were randomly assigned into two equal groups: an experimental group (EG) and a control group (CG). Two conditions were considered in selecting the participants: (i) have no existing medical problem; and, (ii) can perform 50m freestyle, butterfly, breaststroke, and backstroke well. The study obtained permission from the participants in the form of written consent. Approval for conducting the study was secured from the recommending committee of the Sorsogon State University.

Table 1. Characteristics of participants between groups

	Experimental Group (n = 10)		Control group (n = 10)		*p*
	Average	CV	Average	CV	
Height (cm)	165.6 ± 1.26	0.76	166.0 ± 1.25	0.75	0.967†
Body mass (kg)	55.1 ± 1.43	2.59	56.9 ± 1.60	2.81	0.251†
Age (year)	21.9 ± 0.74	3.38	21.8 ± 0.63	2.89	0.749†

Abbreviation: n = sample size; CV = Coefficient of Variation; † = No Statistical difference between groups; $p \leq 0.05$

Study design

The researcher conducted a nonrandomized trial study with two groups, employing pre-and post-tests. The study timeline comprised three phases: (i) a week for pre-test and familiarization with the training program; (ii) eight weeks of training; and (iii) a week for post-testing. The same procedures were used in both pre-and post-tests.

Test procedure

Two places (dryland and in water) were utilized to evaluate the participants' performance at 24-hour intervals, respectively. Both the dryland (fitness gym) and in-water (25m swimming pool/short course) measurements were conducted on two separate days. Participants were instructed to abstain from exercise 48 hours before testing and to avoid soda, caffeinated drinks, and large meals.

Dryland measurements

Anaerobic capacity was evaluated using the vertical jump test to measure the explosive power of the legs and the bench press 1RM test to measure the upper body strength. A 15-minute warm-up before the start of vertical jump tests was performed by the subjects. The researcher explains while demonstrating the reach height and jump height for clear instructions. The test was conducted on a flat surface with a mat and foam wall padding for safety. Participants performed three times at 5-minute intervals. The distance (cm) difference between the standing reach height and the jump height was recorded using a measuring tape. The average score and peak score were collected and converted into power, using the formula: peak power (W) = (61.9 x jump height (cm)) + (36 x body mass (kg)) + 1822; and, average power (W) = (21.2 x jump height (cm)) + (23.0 x body mass (kg)) – 1393. This test is valid and reliable (Harman et al., 1991; Canavan & Vescovi, 2004; Gajewski et al., 2018).

A bench with a safety bar, barbell, and various free weights were used in the bench press 1RM test. A 15-minute warm-up starts with shoulders and wrists dynamic stretches. The researcher first demonstrated a proper technique and execution, and then the participants followed. The researcher serves as the spotter. If the lift is successful, the participants rest for two minutes then increase the load by 5-10%, and attempt another lift. If the participant fails to perform the lift with the correct technique, they must rest for two minutes and attempt a weight 2.5-5% lower. The weight increases and decreases until a maximum lift (1RM) is performed. The 1RM in the bench press test is considered the gold standard for assessing muscle strength in non-laboratory situations (Kim et al., 2012).

The aerobic capacity was evaluated using the 12-minute run test on a 50m flat surface back and forth. Primarily, participants were instructed to execute warm-up stretching, 10 min. easy jog, 5 min. running with increasing pace and 3 x 100m fast pace starting every minute then rest for 10 minutes before the actual run test. At a standing stance, the participants started to run after the command of a sharp whistle sound (Fox 40 Pealess, US), and the clock started. The participants stop running when 12 minutes have elapsed, and the total distance completed is recorded (km). The VO_2max was calculated using the formula: (22.351 x km) - 11.288. This test is valid and reliable (Cooper, 2013; Conley et al., 1991; Huse et al., 2000).

In-water measurements

Special endurance was evaluated using the sprint recovery test to determine the fatigue index comprising 6 maximal intensity sprints of 25m (6 x 25m) with 20 secs. rest interval. The participants were instructed to present themselves at 7:30 am. A 5-minute stretching followed by 400m swim, 200m drills, 200m kick, and 400m pull (4-2-2-4) were performed by the participants to warm up and rest for 10 mins before the start of the actual test. During the test, the participants assumed a preparatory diving stance on the diving board before the takeoff. On the command of a sharp whistle sound (Fox 40 Pealess, US), the clock starts, and participants dive and swim at maximum intensity sprint.

The cycle continues until the completion of 6 sprints. Time is recorded to the nearest 0.01s using a manual stopwatch (TYR Z-200, US). Four scores were calculated: average time of the first 3 sprints, and average time of the last 3 sprints. The fatigue index (%) was calculated by taking the average time of the first three sprints and dividing it by the average time of the last three trials. This test is considered valid and reliable (Pyne et al., 2008; Veronese da Costa et al., 2012; Lavoie et al., 1985).

The 50m performance was evaluated using 3 maximal intensity sprints of 50m (3 x 50m) sprinting test of 4 competitive strokes (freestyle, butterfly, breaststroke, and backstroke). The participants were instructed to return at 2:30 pm for the final evaluation. The subjects performed the same warm-up in the morning before the start of the tests. The participants were in a diving position on the diving board except for backstroke and waited for the command of a sharp whistle sound before the takeoff and swam at maximum intensity sprint. The participants were allowed to perform any turns. Each 50m sprint has an interval of 2 minutes before the start of the second sprint. Time is recorded to the nearest 0.01s using a manual stopwatch (TYR Z-200, US). The lowest time was recorded.

Training intervention

The training program started on September 4, 2023. For eight weeks, the experimental group engaged in 24 sessions, with each session occurring three times a week and lasting for 1 hour and 30 minutes. A recovery period of at least 48 hours was observed between swimming sessions. The participants started the sessions with a 5-minute warm-up involving stretching and 5 minutes of easy swimming. Subsequently, they followed a 20-minute Tabata resistance training protocol. The main training session extended for 45 to 50 minutes, finishing with a 10-minute cool-down period. The control group followed a regular training routine throughout the same duration.

Table 2 Tabata protocol intervention

Workout	Composition	Materials
1	4 x 20 secs. freestyle 4 x 20 secs. underwater freestyle kick 10 secs. recovery time	A stationary swim trainer is used for each swimming stroke A 0.75lb ankle-weight bag is used for each underwater swim
2	4 x 20 secs. butterfly 4 x 20 secs. underwater dolphin kick 10 secs. recovery time	
3	4 x 20 secs. breaststroke 4 x 20 secs. underwater breaststroke 10 secs. recovery time	
4	4 x 20 secs. backstroke 4 x 20 secs. underwater kick on back 10 secs. recovery time	

Table 3 Eight-week Tabata protocol program

Duration	Week 1			Week 2			Week 3			Week 4			Week 5			Week 6			Week 7			Week 8		
Sessions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Workout	1,2	1,3	1,4	2,1	2,3	2,4	3,1	3,2	3,4	4,1	4,2	4,3	1,1,2	1,1,3	1,1,4	2,2,1	3,3,1	4,4,1	1,2,3,4	2,3,4,1	3,4,1,2	4,1,2,3	1,2,3,4	2,3,4,1
Max no. of breath allowed in every stroke and underwater	4			4			3			3			2			2			1			1		
Workout Duration	4 x 2 = 8 mins.												4 x 3 = 16 mins.						4 x 4 = 20 mins.					
Recovery time	10 secs.																							
Rest between Workout	2 mins.																							

Tabata protocol

The experimental group performed Tabata resistance workouts, where each workout is composed of 4 x 20 secs. swim stroke and 4 x 20 secs underwater swim with 10 secs. recovery time. The 4 x 20 secs. swim (freestyle, butterfly, breaststroke, and backstroke) was performed using a stationary trainer (Stationary Swim Trainer S121-StrechCordz®, USA) attached to both sides of the pool lines and the 4 x 20 secs. underwater swim was performed using 0.75lb weight bags on both ankles (Neo Ankle Weight, One Swim, USA) (Table 2). The 10 secs. recovery time was allotted for 5 secs. easy swim and 5 secs. of bubbling. Two workouts were completed in the first 4 weeks, and 3 workouts for the fifth and sixth weeks, while 4 workouts in the two final weeks. Participants are allowed to breathe 4 times in every swim and underwater in the first and second weeks, 3 times in the third and fourth weeks, 2 times in the sixth and seventh weeks, and 1 in the 2 final weeks. A sharp whistle sound (Fox 40 Pealess, US) was used to signal the start of the workout and an electronic underwater LED light (LED pool return light with remote control, The Pool Factory, USA) was used to signal the participants at the end of 20 secs. The interval was 2 minutes between workouts (Table 3).

Statistical Analysis

Data are presented as mean ± standard deviation for continuous variables. The Shapiro-Wilk test was performed to assess the normality of the distribution and all variables displayed normal data. The mean difference between groups in baseline and post-tests was assessed with an independent sample t-test to examine group differences. A paired sample t-test was used to identify significant differences within the groups' baseline and post-tests. The change ratio (Δ) was utilized to verify differences within groups between baseline and post-tests. Statistical significance was accepted at $p \leq 0.05$. Cohen's *d* effect size (ES) was computed to display the magnitude of differences between variables and interpreted as trivial (0-0.19), small (0.20-0.49), medium (0.50-0.79), and large (≥0.80) (Cohen, 1988). The statistical analysis was performed using IBM SPSS version 29 (IBM company, Armonk, New York, USA).

Results

Baseline data

No statistically significant differences in the baseline variables between the experimental and controlled group during the pre-tests (peak power 6967.26 ± 367.47 vs 7081.15 [W]; $p \geq 0.424$; average power 931.63±160.91 vs 993.04±88.97[W];$p \geq 0.305$; strength 93.60±5.51 vs 89.10±6.26[1RM]; $p \geq 0.158$; fatigue index 84.90±2.93 vs 84.32±3.28[%]; $p \geq 0.682$; aerobic capacity 47.83±3.24 vs 45.15±2.26[VO_2max]; $p \geq 0.550$; 50m freestyle 35.52±1.23 vs 35.25±1.32[sec]; $p \geq 0.646$; 50m butterfly 40.34 ± 2.14 vs 40.65 ± 1.68 [sec]; $p \geq 0.726$; 50m breaststroke 39.98±2.48 vs 41.19±2.02[sec]; $p \geq 0.245$; 50m backstroke 35.39±0.55 vs 35.69±0.32[sec]; $p \geq$ 0.636 (Figure 1). All participants attended the eight-week training duration with 100% attendance.

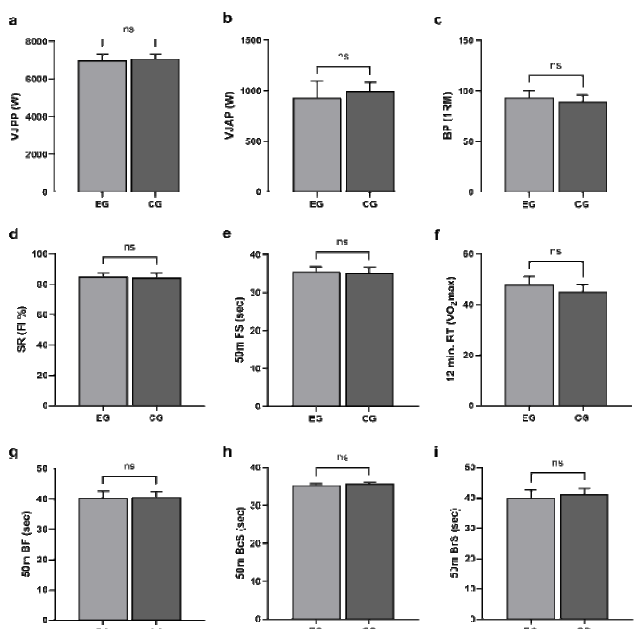

Figure 1. Baseline data

Abbreviations: VJP P≤vertical jump peak performance; VJA P≤vertical jump average performance; W = work; B P≤bench press; 1RM = 1 repetition maximum; SR = sprint recovery; PS = peak sprint; min = minutes; VO_2max = maximal oxygen consumption; 50m FS = 50 meters freestyle; 50m BF = 50 meters butterfly; 50m BcS = 50meters backstroke; 50m BrS = 50 meters breaststroke; EG = experimental group; CG = controlled group; ns = no significant differences; *p*-value set at ≤ 0.05.

The effect of eight-week training intervention

Anaerobic capacity

There is a significant difference in 1RM (bench press t = -3.57; *p*=0.002; ES = -1.25), fatigue index (sprint recovery t = -9.13; *p*≤0.000; ES = -1.33), peak power (vertical jump t = -4.71; *p*≤0.000; ES = -1.45), average power (vertical jump t = -4.17; *p*≤0.001; ES = -2.14) in favor of the experimental group. Both groups significantly increased 1RM (EG 63.10 ± 5.51 vs 70.00 ± 8.29 [1RM]; t = -3.689; *p*≤0.005; Δ = 14.42%; ES = -1.17/ CG 63.40 ± 6.26 vs 67.70 ± 8.58 [1RM]; t = -3.07; *p*≤0.13; Δ = 4.41%; ES = -0.93), fatigue index (EG 84.90 ± 2.93 vs 88.77 ± 2.46 [%]; t = -13.64; *p*≤0.000; Δ = 4.56%; ES = -4.31/CG 84.32 ± 3.23 vs 85.10 ± 3.67 [%]; t = -4.22; *p*≤0.002; Δ = 0.93%; ES = -1.34), peak power (EG 6967.27 ± 367.47 vs 7688.80 ± 305.24 [W]; t = -9.03; *p*≤0.000; Δ = 10.36%; ES = -2.86/CG 7081.15 ± 242.34 vs 7368.62 ± 185.53 [W]; t = -6.25; *p*≤0.000; Δ = 4.06%; ES = -1.94), and average power (EG 931.63 ± 160.90 vs 1008.75 [W]; t = -9.17; *p*≤0.000; Δ = 8.28%; ES = -2.90/CG 993.04 ± 160.91 vs 1022.74 ± 91.20 [W]; t = -3.88; *p*≤0.004; Δ = 2.99%; ES = -1.00) (Figure 2).

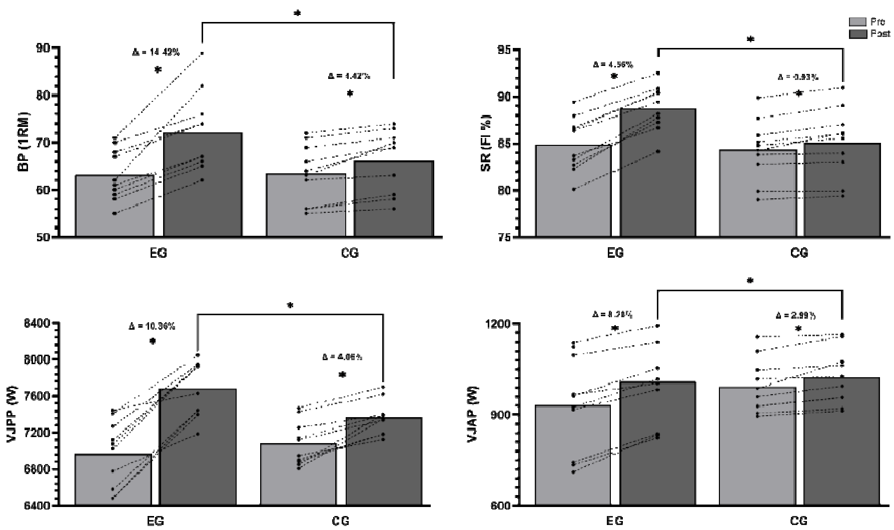

Figure 2. Effect of training intervention on 1RM, fatigue index and power

Abbreviation: * significant difference; B P≤bench press; SR = sprint recovery; FI % = fatigue index percent; VJP P≤vertical jump peak performance; VJA P≤vertical jump average performance; W = work; B P≤bench press; 1RM = 1 repetition maximum; SR = sprint recovery; Δ = change ratio; EG = experimental group; CG = control group. *p*-value set at ≤ 0.05.

Aerobic capacity

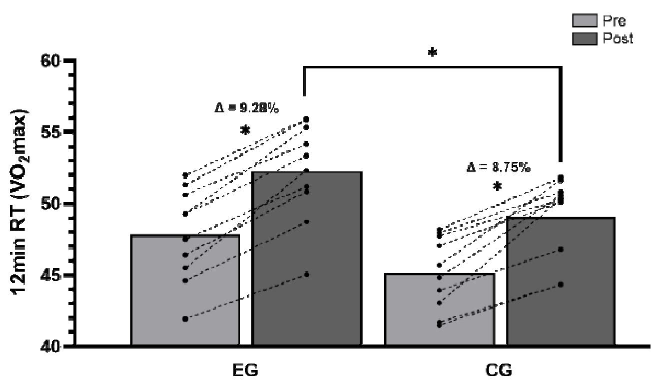

Figure 3. Effect of training intervention on VO_2max

Abbreviation: * significant difference; Δ = change in ratio; RT = running test; VO2max = maximal oxygen consumption; EG = experimental group; CG = control group. *p*-value set at ≤ 0.05.

There is a significant difference in VO_2max (12-min running t = -275; *p*≤0.035; ES = -2.91) in favor of the experimental group. Both groups increased VO_2max performance (EG 46.49 ± 3.16 vs 51.18 ± 3.77 [VO_2max]; t = -13.00; *p*≤0.000; Δ = 9.28%; ES = -3.86/CG 45.15 ± 2.57 vs 49.10 ± 2.87; t = -12.20; *p*≤0.000; Δ = 8.75%; ES = -2.30).

50m sprint performance

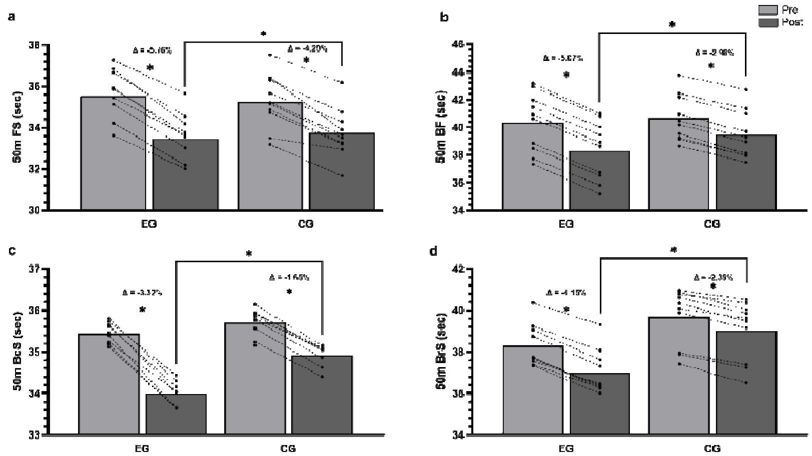

Figure 4. Effect of training intervention on 50m sprint time across competitive swimming strokes
Abbreviation: * significant difference; Δ = change in ratio; 50m = 50 meters; sec = seconds; FS = freestyle; BF = butterfly; BcS = backstroke; BrS = breaststroke; EG = experimental group; CG = control group. *p*-value set at 0.05.

There is a significant difference in the 50m freestyle (t = 2.94; $p \le 0.009$; ES = 3.71), butterfly (t = 17.81; $p \le 0.000$; ES = 1.90), breaststroke (t = 7.74; $p \le 0.000$; ES = 1.71) and backstroke (t = 10.78; $p \le 0.000$; ES = 1.82) sprint performances in favor of the experimental group respectively. Both groups significantly decreased the time in 50m sprint performance in freestyle (EG 35.52 ± 1.23 vs 33.27 ± 1.17 [sec]; t = 20.39; $p \le 0.000$; Δ = -5.76%; ES = 1.30/CG 35.25 ± 1.32 vs 33.74 ± 1.20[sec]; t = 10.06; $p \le 0.000$; Δ = -4.29%; ES = 1.04), butterfly (EG 40.34 ± 2.14 vs 38.40 ± 2.11 [sec]; t = 63.64; $p \le 0.000$; Δ = -5.07%; ES = 0.88/CG 40.65 ± 1.68 vs 39.43 ± 1.74 [sec]; t = 35.66; $p \le 0.000$; Δ = -2.98%; ES = 0.68), breaststroke (EG 39.98 ± 2.48 vs 37.00 ± 1.06[sec]; t = 29.45; $p \le 0.000$; Δ = -3.32%; ES = 1.05/CG 41.19 ± 2.02 vs 39.02 ± 1.44 [sec]; t = 11.46; $p \le 0.000$; Δ = -1.65%; ES = 0.47), and backstroke (EG 35.39 ± 0.55 vs 33.96 ± 0.29 [sec]; t = 29.34; $p \le 0.000$; Δ = -4.15%; ES = 1.84/CG 35.69 ± 0.32 vs 34.85± 0.29[sec]; t = 28.98; $p \le 0.000$; Δ = -2.35%; ES = 1.60) (Figure 5).

Discussion

The experimental group has significantly greater improvements than the control group in anaerobic capacity, aerobic capacity, and 50m sprint performance of 4 competitive strokes. The study's Tabata resistance training program had a substantial impact on enhancing both upper (ES = -1.17) and lower (peak ES = -2.86, average ES = -2.90) body strength compared to conventional workouts during the bench press and vertical jump tests. The experimental group demonstrated a 14.42% increase in upper body strength, 10.36% in peak, and 8.28% in average lower body strength, surpassing the control group's 4.42%, 4.06%, and 2.99% with lesser effect sizes (ES = -0.93; -1.94; -1.00), respectively (Figure 2). In general, there is a large effect size between the upper (ES = -1.25) and lower body strengths (ES = -1.45; ES = -2.14) between both groups. It is noteworthy that stationary resistance trainer in Tabata workouts intensifies muscle engagement and promotes an increase in strength in the upper body, while, the use of ankle weights challenges the lower body, allowing increased resistance during underwater workouts and enhancing the strength of leg muscles. This dual approach increases the muscular demand of the workout and triggers a specific and dynamic stimulus for upper and lower body muscles, leading to comprehensive strength gains in body regions. My study also shows relevance to the recent articles on the use of the Tabata aquatic program to improve swimmers' upper body (Isnaini et al., 2023) and leg muscle strengths (Gani et al., 2022). Moreover, the use of resistance kits in aquatic training further adds a significant effect on athletes' anaerobic capacities (Franco et al., 2021; Ravé et al., 2018; Alagöz et al., 2021).

In terms of anaerobic endurance, my study found a large effect (ES = -4.31) and increased by 4.56% in fatigue index during the repeated sprint test on the experimental group. This was greater than the control group's improvement by 0.93% and large effect size (ES = -1.34). In general, there is a large effect (ES = -1.33) on anaerobic endurance between groups (Figure 2). The significant increase is due to the challenge on muscles, combined with the high-intensity Tabata workout with breath holding, which enhances the ability to sustain power and performance across multiple trials with limited resting time. According to Megahed et al., the longer physiological stimulants of Tabata training can speed lactic acid transfer and elimination, delaying the start of fatigue (Megahed et al., 2023). The findings of this study support the claims of similar studies on the positive effect of Tabata workout on anaerobic endurance (Tabata, 2019; Karahan, 2012), especially in swimming (Oh, et al., 2016).

In line with aerobic capacity, my study found a large effect (ES = -3.86) during the 12min. running test and improved by 9.28%. This was greater than the control group improved by 8.75% and large effect (ES = -2.30). A large effect was also observed between groups (ES = -2.91) (Figure 3). This is due to the intense intervals of Tabata resistance training pushing the cardiovascular system, increasing oxygen consumption, and prompting adaptations for more efficient oxygen utilization. The metabolic changes contribute to enhanced calorie burning and cardiovascular fitness (Ljubojević et al., 2023). In addition, the underwater training with ankle weights component of the program requires the body to exert more effort while breath-holding. This result supports the recent studies on the effect of Tabata aquatic training on aerobic capacity (Viana et al., 2019; Viana et al., 2018; Popowczak et al., 2022)

In terms of 50m sprint time across competitive swimming strokes, the experimental group significantly decreased by -5.76% in freestyle, -5.07% in butterfly, -3.32% in breaststroke, and -4.15% in backstroke with large effect sizes (ES = 1.30; 0.88; 1.05; 1.84), respectively. This outperformed the control group with a large effect in freestyle (ES = 1.04) decreased by -4.29%, and -2.35% in backstroke (ES = 1.60), however, a medium effect on butterfly stroke (ES = 0.68) decreased by -2.98% and small effect (ES = 0.47) on breaststroke decreased by -1.65% was observed (Figure 4). The reductions of time (sec) in 50m sprint across swimming strokes in the experimental group, with large effect sizes, emphasize the effectiveness of the resistance. The outperformance of the experimental group, especially in freestyle and backstroke, underscores the program's efficacy in achieving significant gains compared to the control group. The observed medium and small effects in butterfly and breaststroke for the control group, respectively, indicate that regular training alone may not elicit as pronounced improvements in these strokes.

Conclusion

The findings of my study show a significant effect of the Tabata resistance training program on intermediate swimmers' performance compared to conventional training program. The experimental group significantly improved in anaerobic and aerobic capacities, and 50m sprint performance across all competitive strokes, surpassing the control group with larger effect sizes. The dual approach of using a stationary resistance trainer in Tabata workouts for upper body strength and ankle weights for lower body strength proved effective in intensifying muscle engagement and promoting comprehensive strength gains. The study contributes to the existing body of literature, aligning with recent articles on the Tabata aquatic program's positive effects on swimmers' upper and leg muscle strengths. The emphasis on breath-holding during high-intensity Tabata workouts contributes to enhancing anaerobic endurance, supported by similar studies. My study provides valuable insights into the advantages of Tabata resistance training in aquatic settings, offering a scientific approach to maximize the performance of swimmers.

Conflict of Interest

The author declares that there is no conflict of interest.

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