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Effects Of Strength Training On 3 Strokes Time, Stroke Rate, and MMT In Swimmers

Nayyab Kanwal[1]
Riphah International University

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Abstract

Aim: The study aims to determine the effectiveness of strength training on 3-stroke time, stroke rate, and MMT in swimmers.

Methodology: A randomized controlled trial study was done among national-level swimmers, with data collected from Punjab International Swimming Complex, Lahore. Informative meetings were held before training, and pre-tests were applied to both groups. Twenty competitive swimmers participated. Individuals performed exercises for 6 weeks, 3day/w and post-tests were applied to both groups to evaluate outcome measures at the end of training. Control group: only participate in their yearly swimming training. Experimental group: strengthening training with regular practice. Strengthening exercises of the upper limb and lower limb were performed with thera-band. Tools were utilized, and the stroke rate was recorded with a DSLR camera. The latissimus dorsi, Serratus anterior, Upper trapezius, Flexors of the hip, Extensors of the hip, and Plantar flexors muscles were tested in manual muscle testing. SPSS version 24.0 was used for data entry and analysis.

Results: There were 9 participants allocated in each group, control and experimental; experimental groups showed more improvement in stroke rate time, stroke rate, and upper and lower limb strength measured by manual muscle testing with P-value (< 0.05). In between-group analyses, independent sample t-tests were applied post-intervention. All muscles of U.L and L.L showed significant differences. A paired sample t-test was used for within-group analyses, which showed all muscles showed significant improvement except serratus anterior, hip extensors, and ankle plantar flexors, which showed no significant differences (p> 0.05).

Conclusion: The study's findings underscore the significant impact of muscle strengthening exercises on the stroke rate time, stroke rate, and upper and lower limb muscle strength of swimmers, as measured by manual muscle testing. This knowledge is crucial for enhancing training methods and improving performance, particularly in the context of competitive swimming.

Key Words: Strengthening, thera-band, 3 Strokes time, Stroke Rate, Swimmers

Introduction

Swimming is a sport performed underwater and is accompanied by repeated motion of the upper and lower limbs to complete the defined space[1]. It can be done using various techniques known as 'strokes'[2]. There are four categories of swimming: freestyle, breaststroke, backstroke, and butterfly[3]. The freestyle stroke is fast-moving, and this style has a massive implementation in swimming. There are three phases of freestyle stroke: 1st (glide), 2nd (pull through), and 3rd (recovery). The glide phase starts when the right hand penetrates water with the elbow slightly higher than the hand. Pullthrough has three divisions: early, mid, and late. The WHO officially termed coronavirus disease 2019 (COVID-19) on February 11, 2020. Chinese researchers quickly identified a SARS-CoV-2 from a patient on January 7, 2020, and then sequenced the virus' DNA[3].

***Corresponding Author: Dr. Nayyab Kanwal**
Email: kanwalnayab1230@gmail.com
Contact: +971563827756

When the second phase pulls through and ends, it converts into the primary differentiation is that the overland games use the floor for motion, and swimmers don't utilize it; hence, swimmers must apply force with their core for motion. Due to this, swimmers need to have robust and strengthened cores for successful careers[7]. Many studies demonstrate that muscle-strengthening activities are essential to many swimming training programs. Increasing the work of the stabilizing muscles can help you generate additional strength in your limbs. Controlling one's body position during swimming and the initial jump and turn increases efficiency and reduces the distance traveled. Swimming ability depends on the muscles necessary for optimal body positioning to be adequately strengthened. The position of each body part, including the head, shoulders, torso, pelvis, and legs, must be correct. The body will experience less resistance from the water if these muscles are positioned in a roughly linear arrangement when swimming. Excellent core muscle action is required given the unsettled environment in which the swimmer's body is placed, and a lack of stable stability suggests a muscular deficiency, which can lead to significant time costs. In addition to minimizing resistance, a correct high and solid body position maximizes the force of the upper and lower limbs[8]. Injury prevalence in swimmers is (ankle and foot 19%, knee 28%, shoulder 37%)[9]. There are 2 Components liable for moving forward in the reaction of a flutter kick: Extension of the ankle (PF) and the power of muscles engaged in flutter kicking.

Knee extensors are involved in this action (RF, VM, VL, VI, and Sartorius)[10]. Lower extremities don't have propulsion power. However, a balanced torso location allows roughly 9% elevation of swimming speed[11]. Swimming is highly based on strengthening muscles and the force of muscles and significantly correlates with swimming. Consequently, enhancement in the power of arm outcomes elevates stroke max force and, afterward, elevates swimming speed[12]. Swimming is highly nonidentical to any other game because of the preparation required for prone posture and using both upper and lower limbs to move forward. Upper limbs provide 90% of propulsion force[7]. Functional fitness is the ability to execute typical daily activities comfortably and safely without becoming overly tired. In swimming-related activities, physical power and strength are essential factors of success[13]. Proper abdominal and torso training appears to be one of the critical factors affecting the effectiveness of the training process. The main goal of a swimming competition is to complete the designated distance in the least amount of time possible. This is done mainly by correctly placing one's body in the water and minimizing competition[8]. Many academics prefer "functional fitness" over "physical fitness" since it encompasses well-being, independence, and physical functioning. This is especially important for populations like the elderly and people with impairments or persistent health problems. Significant components of functional fitness for the health and well-being of any demographic group include cardio-respiratory endurance, muscular endurance and strength flexibility, balance, functional ability, and optimal body structure. Lack of functional fitness makes it harder to live independently and without sickness[13]. Numerous researches have been conducted to identify the factors that affect swimming performance. In association studies, it was discovered that muscle strength was a crucial element in enhancing swimmers' stroking phase performance. Swimming velocity and muscular strength are closely related, with stronger muscles producing faster swimming velocity. The relationship between upper extremity strength and swim efficiency is relatively high since swimmers must exert significant pushing power with each stroke. Researchers studied the importance of stroke biomechanics in swimming performance and learned more about how muscular strength affects swimming performance. For instance, it has been demonstrated that stroke length (SL) is a good predictor of swimming performance and speed and that stroke rate (SR) is closely related to sprinting performance. The blood lactate content ([Lac]) increases at the beginning of any moderate exercise. It has also been noticed that swimmers with a higher SR and the upkeep or extension of SL have superior performance and create more thrust force[14].

More literature on observational and interventional studies on Pakistan's professional and non-professional swimmers must be published. Moreover, Strength training programs and their effects on 3 stroke time, stroke rate, and manual muscle testing in swimmers, particularly in Asian and Pakistani countries, have not been studied. The results of this study will help people perform better in the water. This research enables us to determine the effectiveness of strengthening exercises in improving the performance of professional swimmers in Pakistan. Through these sports, physiotherapists, instructors, and coaches would know the importance of enhancing upper and lower limb protocols in a swimmer's performance. They will train swimmers on different body-strengthening protocols in the future. Due to this, our swimmers will perform well at the national and international levels in the future.

Methodology

Randomized controlled trials and non-probability convenient sampling were used to acquire the data. Data was collected from the Punjab International Swimming Complex in Lahore. Inclusion criteria were competent swimmers, Gender: Male, Age range: 15 to 32, and swimming experience of at least a year, and exclusion criteria were Individuals who have neuromuscular diseases and any damage to the lower limbs and swimming experience of no more than a year. Spinal cord injuries have been excluded from the study. According to inclusion criteria, individuals were registered for this work. Inform consent was taken before the collection of data. All individuals were taught about the primary features of the study. Each subject had permission to discontinue training at any time. Eighteen individuals were randomly registered after screening the participants. There were 2 groups: Group a (experimental) and Group B (control). Informative meetings and pre-tests were applied to both groups. After grouping, the Stroke rate was first calculated, and the time needed to complete three 3 stroke cycles with the help of a camera. Then, the stroke rate was evaluated using this formula.SR= 60 × 3/tSR (SR- Stroke Rate, tSR- time taken of 3 cycles), which DSLR15 notices. MMT evaluated U.L and L.L power. In manual muscle testing, the latissimus dorsi, Serratus anterior, Upper trapezius, Flexors of the hip, Extensors of the hip, and Plantar flexors muscles were tested[16]. sAfter that, the Interventional group performed training with their regular swimming practice, and the non-interventional group just performed their regular practice. This training was given 3d/w for 6 weeks. Post-tests were applied to both groups to evaluate outcome measures at the end of training. Treatment protocols were that the control group only participated in their yearly routine swimming training, and the experimental group performed strengthening exercises of the Upper Limb and Lower Limb with 10 reps of each with green color TheraBand. U.L. exercises were performed on latissimus dorsi, Serratus anterior, and Upper trapezius muscles, and L.L. exercises were performed on hip flexors, extensors of the hip, and plantar flexors.

In the data analysis procedure, the Normality of data distribution was determined using the Shapiro-Wilk test. Shapiro-Wilk test range for Stroke rate time, stroke rate, core muscle strength test and MMT of upper limb muscles including serratus anterior, upper trapezius, latissimus dorsal and lower limb muscles including flexors of hip (Iliopsoas), extensors of hip (Gluteus Maximus and Hamstrings) and ankle plantar flexors (Gastrocnemius and Soleus) was more significant than 0.05 so data was normally distributed. Parametric tests were applied and analyzed using SPSS version 24.0.

Result

Table No. I Descriptive Statistics

Variable	Experimental		Control	
	Mean	Std. Deviation	Mean	Std. Deviation
Age	17.44	2.297	25.33	4.770
Weight	58.533	6.6978	68.778	13.4330
Height	5.5778	.35277	5.7467	.42376
Body Mass Index	20.5100	3.83049	23.0822	7.35907
Swimming Experience	7.33	2.958	8.44	4.065

Table 2 Independent Sample t Stroke Rate (pre- and post-level)

Outcome	Groups	Mean	Std. Deviation	Mean Difference	P Value
Pre-Intervention: Stroke Rate (Time Of 3 Stroke Cycles)	Experimental	6.8889	1.45297	.77778	.333
	Control	6.1111	1.83333		
Post-Intervention: Stroke Rate (Time Of 3 Stroke Cycles)	Experimental	2.0000	1.11803	-2.00000	.024
	Control	4.0000	2.12132		
Pre-Intervention: SR=60×3/TSR	Experimental	413.3333	87.17798	46.666	.333
	Control	366.6667	110.00000		
Post-Intervention: SR=60×3/TSR	Experimental	120.0000	67.08204	-120.000	.024
	Control	240.0000	127.2792		

Table 3. Paired Samples t Test of stroke rate time and stroke rate within Control Group/Experimental

Paired Samples t Test Within Control and Experimental Group					
Pre-Post Outcome Variables	**Mean**	**Std. Deviation**	**t**	**df**	**X^2**
Pre-Intervention: Stroke Rate (Time Of 3 Stroke Cycles) Post-Intervention: Stroke Rate (Time Of 3 Stroke Cycles)	2.11111	.60093	10.539	8	.000
Pre-Intervention: SR= 60 × 3/TSR Post-Intervention: SR= 60 × 3/TSR	126.66667	36.05551	10.539	8	.000
Paired Samples t Test Within Experimental Group					
Pre-Intervention: Stroke Rate (Time Of 3 Stroke Cycles) Post-Intervention: Stroke Rate (Time Of 3 Stroke Cycles)	4.88889	.78174	18.762	8	.000
Pre-Intervention: SR= 60 × 3/TSR Post-Intervention: SR= 60 × 3/TSR	293.33333	46.90416	18.762	8	.000

Discussion

The purpose of the current study was to evaluate the impact of strength training on swimmers' freestyle swimming ability and core muscular strength. A randomized clinical trial was conducted for 1.5 months (6 weeks) to evaluate the effects of strengthening exercises performed with the band in the upper limb and lower limb on swimming performance, stroke time, stroke rate, and muscles of the upper limb and lower limb. Following screening, 18 participants were enrolled in the study. Many studies support the effectiveness of core muscle strengthening in enhancing swimmers' performance, and few don't. However, much literature recommends core muscle-strengthening protocols for improving swimming techniques.

Mu-Yeop JI et al. did another study in 2021 studied the effects of a 12-week dry-land core training program on the performance of adult swimmers. The results show no difference in isotonic maximum strength, anaerobic power, core muscular power, muscular endurance of limbs, or improvement in swim record ($P>0.05$)[17]. In the current study, it was stated that various muscles in the upper and lower limbs exhibited a substantial improvement in across-group comparisons while showing no significant changes within-group studies.

A prior study on dry-land resistance training by Jerzy Sadowski et al. in 2020 focused on boosting upper-limb muscle strength and power production. The significance level was established at p 0.05 when a two-way repeated measures ANOVA with Tukey HSD post hoc comparisons was utilized[18].

Ahmad Khiyami et al. did a previous study in 2022 and concluded results indicate that the experimental group showed improvement in 50m swimming time, swimming velocity, stroke rate, stroke length, stroke index, total strokes, and intergroup comparison also showed significance ($p < 0.05$;) by six weeks core training program[19]. However, the present study also showed significance in 3 stroke time and stroke rate with a p-value <0.05.

P. H. Boer conducted a study in 2020. They concluded that there were significant differences between the exercise and control group for body mass, body mass index, aerobic capacity, dynamic balance, muscular strength, 12-meter swim time, and

functional ability (P 0.05) after 8 weeks of training on the effect of 8 weeks of freestyle swim training on the functional fitness of adults with Down syndrome[13]. However, in the present study, healthy individuals were present, and they performed strengthening exercises with their regular swimming practice for 6 weeks and showed significant improvements with a p-value(<0.05).

Jakub Karpiński's study in 2020 examined how a 6-week core workout program affected the swimming performance of national-level swimmers. The swimmers had to do a 50-meter front crawl swim individually while having the kinematics of their start jump turns and strokes photographed. They concluded that there had been a statistically significant improvement in 50-meter front crawl swimming ($p = 0.001$)[8].

This is a principal study in which we determine the effectiveness of strength training on 3-stroke time, stroke rate, and MMT in swimmers. For swimmers' improvement in swimming parameters and performance enhancement, the strengthening exercises of the upper and lower limbs with the band, discussed in the current study, are ideal exercises for long-term goals.

Conclusion

The study concluded that 6 weeks (1.5 months) of strengthening exercises of the upper and lower limbs with the band are more effective in stroke time and stroke rate. All these outcomes significantly improved at per-post testing, as observed in the within-group analysis, except for a few of the muscle groups, which did not show significant improvement in this within-group analysis.

Author Contributions

Conception and design: *Nayyab Kanwal*
Collection and assembly of data: *Nayyab Kanwal*
Analysis and interpretation of the data: *Nayyab Kanwal*
Drafting of the article: *Nayyab Kanwal*
Critical revision of article for intellectual content: *Nayyab Kanwal*
Statistical expertise: *Nayyab Kanwal*
Final approval and guarantor of the article: *Nayyab Kanwal*
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