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ORIGINAL ARTICLE

EFFECTS OF STRENGTH TRAINING ON FREESTYLE SWIMMING PERFORMANCE, KICKING AND CORE MUSCLES STRENGTH IN SWIMMERS

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ABSTRACT:

Sports that are carried out under water are accompanied by repeated motion of the upper limb as well as the lower limb to complete the defined space. Swimming is a sport that can be done using a variety of techniques, known as 'strokes. **Methods:** It was a randomized controlled trail study done among national level swimmers data collected from Punjab international swimming complex, Lahore. Informative meeting was done before trainings; pre-test was applied on both groups. There were 20 competitive swimmers participated Individuals performed exercises for 6 weeks, 3day/w and posttest applied on both groups for evaluation of outcome measures at the end of training. Control group: only participate in their yearly swimming trainings. Experimental group: strengthening training with regular practice. For core First 2-week simple strengthening exercises, Next 4-week stability ball exercises were performed. Tools were utilized 50 m swimming, 50-meter kicking, core muscles strength test determined with stopwatch, 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 50 m freestyle swimming time, 50 m kicking time, core muscle strength with p-value (<0.05). **Conclusion:** The study concluded that of core muscle strengthening exercises are more effective in 50m freestyle swimming time, 50 m kicking time, core muscle strength. **Key Words: Core Strength, Free Style, kicking, Stroke Rate, Stability Ball.**

INTRODUCTION:

Sports which carry out under water accompanied by repeated motion of upper limb as well as lower limb to complete the define space(1). Swimming is a sport that can be done in a variety of techniques, known to as 'strokes,'(2). Swimming may be divided into four categories: freestyle, breaststroke, backstroke, and butterfly (3). Freestyle stroke is fast moving and in swimming there is the huge implementation of this style. There are three phases of freestyle stroke 1st(glide),2nd (pull through) 3rd (recovery). Glide phases starts when right hand penetrates in water by elbow a bit upper than hand. Pull through have further three divisions: early, mid and late. When the second phase pull through come to the end it converts into recovery phase, elbow extant a bit in flexion in such a way it leaves the water earlier than hand. In freestyle stroke the recovery phase goes through considerable small period then second phase due to no resistance of water which reduce the speed of motion of arm(4). Recent research has utilized computational fluid dynamics to investigate many technical aspects of dolphin kick and freestyle swimming strokes. The simulation of dolphin kicks was conducted using the well-established finite-volume flow solver Fluent. The intention was to assess the impacts of various frequencies and amplitudes of kicking, as well as the recovering of vortices. An incorporated limit stream solver was used to survey the viability of dolphin kicking and recognize critical stream structures. The Smoothed Molecule Hydrodynamics procedure was utilized to look at the impacts of kick recurrence and lower leg adaptability on dolphin kick (5). In swimming-related activities, physical power and strength are important factors of success. Effective training process seems to be significantly influenced by proper abdominal and torso exercise. The primary objective of a swimming competition is to achieve the prescribed distance in the shortest feasible duration. This is mostly achieved by adopting correct body positioning in the water and reducing competition. Many studies demonstrate that core muscle strengthening activities are an important feature of many swimming training programmers. Increasing the work of the stabilizing muscles can help you generate additional strength in your limbs. Various sources guarantee that center muscles, which involve the rectus abdominis, latissimus dorsi, gluteus maximus, and trapezius muscles are going through transformative changes. Keeping up with exact body situating while swimming, as well as executing the underlying jump and turn, improves proficiency and thus diminishes the distance covered. Swimming skill relies upon the muscles that are vital for ideal body situating being appropriately reinforced. The position of each individual 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. The swimmer's body must exhibit strong core muscle activation to compensate for the unstable environment. A lack of stability indicates a muscular weakness, which can result in large time penalties. Aside from reducing resistance, maintaining a proper elevated and stable body posture allows individuals to optimize the strength exerted by their upper and lower extremities (6). Paul pao yen wu et al. done research in 2021 in which they investigated prediction model for the 4x200-meter freestyle

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swimming for the selection of teams. In the middle of 2010 and 2018 the race statistics via 716 finals relay of 4×200-meter freestyle swimming from fourteen international competitions were examined. They came to the conclusion that linear regression in performance and machine learning were applied to people in the 4 x 200-meter swimming freestyle relay events(7). In 2020, Dennis-Peter Born et al. conducted research to assess the performance of competitive male and female junior swimmers' freestyle sprint starts after undergoing training for maximal strength or vertical leap. Both groups were subjected to identical training loads. Implementing a training schedule of 16 hours per week, together with two sessions of intense strength training, resulted in improved sprint start performance among a specific group of swimmers under the age of 17. A comparison was made between the performance of the sprint start in freestyle swimming and vertical jump training, both before and after 6 weeks of practicing at maximum capacity. A total of 21 junior swimmers, consisting of 9 men and 12 females, underwent training for vertical leaps and engaged in two weekly sessions of maximal strength. Before and during the instructional meeting, they used a beginning block outfitted with force plates that were synchronized with a 2-layered movement catch framework to evaluate run start execution. They inferred that there was no general impact. They encouraged the strength and molding educators to begin showing greatest strength preparing to kids while they were youthful(8). Jakub Karpinski1 et al. conducted study in 2020 to determine the effect of six week exercising plan designed for the strengthening of core muscles to develop the advantages of swimming in licensed swimmers. The research involved 16 male national swimmers. Individuals were randomly assigned in two groups. Interventional group (n=8) and non-interventional group (n=8). In pool both groups had done same regular swimming practice. Interventional group done core muscles strengthening training as well. The individuals were given 50-meter free style pool to complete swimming, which was recorded by camera. The interventional group showed in analysis remarkable improvement in 50 m free style swimming duration. The results of the previous research showed that the complete strengthening of core muscles is favorable along with regular swimming practice(6). Ika Novitaria Marani et al conducted a study in 2019 on core training for the strengthening of swimmer's muscles there were 20 individuals. They did validity as well as feasibility test. There were thirty-three models of core strengthening attained. And for the strengthening of core in swimmers the swill ball was mostly utilized(9). I Mujika and E Crowley conducted a study in 2019 on strengthening training in professional swimmers on dry land and in pool. World championship occasions time around 21s in males 50m front crawl, 5h 15mins in females 25km open water swimming. Hence it is important to improve their professional swim performance by strengthening their muscles as well as aerobic stamina(10). There is lack of literature of both observational and interventional studies on the professional and non-professional swimmers in Pakistan. Moreover, Strength training programmers and their effects on freestyle swimming performance with core muscle strength 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 would be helps us to determine the effectiveness of strengthening exercises on the performance enhancement of professional swimmers in Pakistan. Through this sports physiotherapist, instructors and coaches would be aware about the importance of core strengthening in swimmer's performance. They would train swimmers by different core strengthen protocols in future. Due to this our swimmers will perform well at national and international level in future.

METHODS:

It was Randomized controlled trial and non-probability convenient sampling was used to acquire the data. Data was collected from Punjab international swimming complex Lahore. Inclusion criteria was competent swimmers, Gender: Male, Age range: 15 to 32 and swimming experience of at least a year and exclusion criteria was 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 in the study According to inclusion criteria individuals were registered for this work. Inform consent was taken before collection of data. All individuals were teaching about primary features of study. Each subject had permission to discontinue training at any time. 18 individuals were randomly registered after screening the participants. They were 2 groups; Group a (experimental) and group b (control). Informative meeting and pre-test were applied on both groups. After grouping core muscle strength test were used for assessment of core strength.50M freestyle swimming measured by stop watch, 50M kicking was performed by kick board and measured by stop watch. After that Interventional group was performed training with their regular swimming practice and non-interventional group just performed their regular practice. This training was given 3d/w for 6 wks. Post-test applied on both groups for evaluation of outcome measures at the end of training. Treatment protocols were control group only participated in their yearly routine swimming trainings and experimental group performed strengthening exercises of core with10 reps and 3 sets of each which are following: Prone plank(10 sec hold)(11),side plank(8 sec hold),bridging(8 sec hold)(12),bird dog(10 reps,3 sets),leg drop(10 reps, 3 sets)(13),dying bug with their regular swimming practice. First 2 weeks simple strengthening exercises were practiced. Next 4 weeks exercises were performed with stability ball. Dying bug without stability ball was practiced.

Epi tool calculator (42) was utilized to decide the sample size. The sample size needed for the trial was 18 (9 in each group). By considering the attrition rate of 10%, a total of 20 subjects were recruited 10 in each group for the study.

Sample size to detect a significant difference between two means

Inputs "Mean 1" "1.002"
"Mean 2" "4.003"
"Variance""5"
"Confidence level" "0.95"
"Power" "0.8"
"Tails" "2"
Results "Sample size"
"Sample size (per group):"9
"Total):" 18 (9)

Figure: 1.14 Weight Scale Figure: 1.15 Stop Watch

Data analysis procedure was the Normality of data distribution was determined by using Shapiro-Wilk test. Shapiro-Wilk test range for 50m free style swimming time, 50m kicking time, and core muscle strength test was larger than 0.05 so data was normally distributed and parametric tests were applied, was analyzed by using SPSS version 24.0.

RESULTS:

Tests used for analyses are following:

Differences between the groups: difference across the groups were analyzed by performing independent sample t-test.

Differences between pre and post treatment values: within the group analyses was performed by paired sample t-test.

Table-1: Region

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Region						
Groups			Frequency	Percent	Valid Percent	Cumulative Percent
Experimental	Valid	Lahore	9	100.0	100.0	100.0
Control	Valid	Lahore	5	55.6	55.6	55.6
		other	4	44.4	44.4	100.0
		Total	9	100.0	100.0	

Description: Showed region of both control group and experimental group, there were 9 participants recruited in each group, in experimental group 100% participants were from Lahore and in control group 55.6% participants were from Lahore and 44.44% from other cities

Table-2: Profession

Profession						
Groups			Frequency	Percent	Valid Percent	Cumulative Percent
Experimental	Valid	competitor national junior	9	100.0	100.0	100.0
Control	Valid	competitor national junior	5	55.6	55.6	55.6
		national swimmer	4	44.4	44.4	100.0
		Total	9	100.0	100.0	

Description: showed profession of both control group and experimental group, there were 9 participants recruited in each group, in experimental group 100% participants were national junior competitor and in control group 55.6% participants were national junior competitor swimmers and 44.44% participants were national swimmers

Table-3: Descriptive Statistics

Variable	Experimental			Control		
	Mean	**Median**	**Std. Deviation**	**Mean**	**Median**	**Std. Deviation**
Age	17.44	17.00	2.297	25.33	25.00	4.770
Weight	58.533	60.000	6.6978	68.778	70.000	13.4330
Height	5.5778	5.7000	.35277	5.7467	5.8000	.42376
Body Mass Index	20.5100	19.9100	3.83049	23.0822	21.5300	7.35907
Swimming Experience	7.33	8.00	2.958	8.44	8.00	4.065

Description: Descriptive Statistics showed that mean age of control group (mean 25.33,SD±4.77) and mean age of experimental Group (mean 17.44,SD±2.297), mean weight of control group (mean 68.78 SD ± 13.433) and mean weight of experimental group (mean 58.53,SD ± 6.698), mean height of control group (mean 5.75, SD ± 0.424) and mean height of experimental group (mean 5.58,SD± 0.353), mean BMI of control group (mean 23.08, SD ± 7.359) and mean BMI of experimental group (mean 20.51,SD± 3.83), mean swimming experience of control group (mean 8.44, SD ± 4.065) and mean swimming experience of experimental group (mean7.33,SD± 2.958) of participants.

Table-4: Independent Sample t test Free Style Swimming (pre and post level)

Outcome	Groups	N	Mean	Std. Deviation	Mean Difference	P Value
Pre-Intervention:50m Free Style Swimming Time	Experimental	9	45.7778	8.22766	-.44444	.911
	Control	9	46.2222	8.30328		
Post- Intervention: 50m Free Style Swimming Time	Experimental	9	24.4444	8.39808	-10.00000	.020
	Control	9	34.4444	8.06398		

Description: Showed comparison between control group and experimental group for pre-intervention and post-intervention of 50m free style swimming time by independent sample t test. Pre-intervention value of control group (pre-mean 46.22, SD ± 8.33) and experimental group (pre-mean 45.77, SD ± 8.30) with p-value (0.911). P-value presented that there was no significant difference between control group and experimental group before intervention. Post-intervention value of control group (post-mean 34.44, SD ± 8.39) and experimental group (post-mean 24.44, SD ± 8.06) with p-value (0.020), which indicated that there was significant difference between both groups and according to mean values, experimental group showed more improvement in 50m free style swimming time compared to control group.

Table-5: Independent Sample t test 50m Kicking Time (pre and post level)

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Outcome	Groups	N	Mean	Std. Deviation	Mean Difference	P Value
Pre-Intervention: 50m Kicking Time	Experimental	9	65.1111	11.17413	-1.77778	.790
	Control	9	66.8889	16.27455		
Post-Intervention: 50m Kicking Time	Experimental	9	42.4444	11.10305	-14.66667	.047
	Control	9	57.1111	17.13508		

Description: Showed comparison between control group and experimental group for pre-intervention and post-intervention of 50m kicking time by independent sample t test pre-intervention value of experimental group (pre mean 65.11, SD ± 11.17) and control group (pre mean 66.8, SD ± 16.27) with p-value (0.790). P-value presented that there was no significant difference between experimental group and control group. Post-intervention value of experimental group (post-mean 42.44, SD ± 11.10) and control group (post-mean 57.11, SD ± 17.13) with p-value (0.047). Which indicated difference between both groups and according to mean values, experimental group showed more improvement in 50m kicking time compared to control group.

Table-6: Core muscle strength at pre and post interventional level compared with Wald Chi-Squared Test

		Experimental Group		Control Group		
		Frequency	Percentage	Frequency	Percentage	
Pre-Intervention: Core Muscle Strength Test	Good	3	33.30%	2	22.20%	0.599
	Poor	6	66.70%	7	77.80%	
Post-Intervention: Core Muscle Strength Test	Good	8	88.90%	3	33.30%	0.016
	Poor	1	11.10%	6	66.70%	

Description: showed results regarding core muscle strength at pre and post interventional level compared with Wald Chi-Squared Test showed equal strength in both groups without significant difference, p value 0.599 while at post-interventional strength to be significantly better in experimental group, P value 0.016.

Table-7: Paired Samples t Test of 50m free style, 50m kicking, and core muscle strength test within Control Group

Paired Samples T Test Within Control Group					
Pre-Post Outcome Variables	**Mean**	**Std. Deviation**	**t**	**df**	**Sig. (2-tailed)**
Pre-Intervention: 50m Free Style Swimming Time - Post-Intervention: 50m Free Style Swimming Time	11.77778	.83333	42.400	8	.000
Pre-Intervention: 50m Kicking Time - Post-Intervention: 50m Kicking Time	9.77778	3.34581	8.767	8	.000
Pre-Intervention: Core Muscle Strength Test - Post-Intervention: Core Muscle Strength Test	.111	.333	1.000	8	.347

Table-8: Paired Samples t Test of 50m free style, 50m kicking, and core muscle strength test within experimental Group

Paired Samples T Test Within Experimental Group					
Pre-Post Outcome Variables	**Mean**	**Std. Deviation**	**t**	**df**	**Sig. (2-tailed)**
Pre-Intervention: Free Style Swimming Time - Post- Intervention: Free Style Swimming Time	21.33333	1.41421	45.255	8	.000
Pre-Intervention: 50m Kicking Time - Post-Intervention: 50m Kicking Time	22.66667	.70711	96.167	8	.000
Pre-Intervention: Core Muscle Strength Test - Post-Intervention: Core Muscle Strength Test	.556	.527	3.162	8	.013

Table 7 and Table 8 revealed within group comparison of treatment 50m Free Style Swimming Time. Control group showed (mean 11.77, SD ±.8333) and experimental group showed (21.33, SD ± 1.4142). P-value (<0.05) in both groups showed that results in both groups were statistically significant. Experimental groups improve the 50m free style within group, in 50m kicking time control group showed (mean 9.77, SD ± 3.34) and experimental group showed (mean 22.66, SD ± 0.70) with p-value (<0.05) in both groups showed that results in both groups were statistically significant experimental improve the 50m kicking time within group, In core muscle strength test control group showed (mean 0.11, SD ± 0.33) with p-value (0.34) showed that result in control group were non-significant and experimental group showed (mean 0.55, SD ± 0.52)

with p-value (<0.05) in experimental group showed that results in experimental were statistically significant experimental improve the core muscle strength within group.

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) with the primary objective of evaluating the effects of core muscle strengthening on swimming performance, 50m freestyle swimming, kicking, and core muscle strength. 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, a vast literature is available that recommends core muscle strengthening protocols for improving swimming techniques. In 2021, C. Jung et al. conducted a prior study in which swimmers engaged in an 8-week regimen of core muscle training, including movements for the bench, sideways bench, and Nordic hamstring. There was a considerable observable effect on muscular fitness, but no difference was seen across the groups (14)However, in the present study, swimmers performed core training exercises, including prone plank, bird dog, side plank, bridging, leg drop, and dying bug, and showed significant improvement in swimming performance and core muscle strength. Matthew Weston et al. did a prior study in which they compared an experimental group with a non-interventional group. The core-training intervention group showed a potentially significant improvement in 50-meter swimming time (13). Canan Gülbin Eskiyecek et al. did previous research Wilcoxon test was used for intra-group comparisons in earlier research on the effects of 8-week core exercises on swimming performance, and the Mann-Withney-U test was used for swimmer pre- and post-test-measurements. According to the study's findings, core training improves male swimmers' swimming performance, as evidenced by the striking difference in the experimental group's 50-meter time at the end of practice (p.05)(1). In the current study, paired sample t tests were used for analyses of swimmers' performance within groups and independent-sample t tests were used for analyses between groups. The results also demonstrated a significant improvement in swimmer performance with a p-value (0.05). Research was attempted by P. H. Boer in 2020. Following two months of preparing, it was resolved that there were remarkable variations between the activity bunch and the benchmark group as far as weight, weight file, oxygen consuming limit, dynamic equilibrium, strong strength, 12-meter swim time, and utilitarian capacity (P 0.05). This study zeroed in on the effect of about two months of free-form swim preparing on the utilitarian wellness of grown-ups with Down disorder (15).However, in present study healthy individuals were presents and they performed strengthening exercises with their regular swimming practice for 6 weeks and showed significant improvements with p-value(<0.05). Jakub Karpiński conducted study in 2020 examined how a 6-week core workout programmed 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 came to the conclusion that there had been a statistically significant improvement in 50-meter front crawl swimming (p = 0.001)(6). However, current study also finds 50m free style swimming time with the help of stop watch and after interventions 50m free style swimming also showed significant results. All in all, this is principal study in which we determine the effects of core muscle strengthening on free style swimming performance; it additionally revealed 50m kicking time, core muscle strength. For improvement in swimming parameters and performance enhancement of swimmers the core muscle strengthening exercises which were discussed in current study are ideal exercises for long term goals.

CONCLUSION:

The study concluded that 6 weeks (1.5 months) of core muscle strengthening exercises are more effective in 50m freestyle swimming time,50 m kicking time and core muscle strength All these outcomes significantly improved at per-post testing as observed in the 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*
Conflict of Interest: *None declared*

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