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Effect of sport-specific circuit training in semi-professional freestyle swimmers

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Abstract

Aim: To study the effect of sport-specific circuit training on shoulder muscle endurance and swim performance in semi-professional freestyle swimmers. **Purpose:** To determine whether a sport-specific circuit training will improve shoulder muscle endurance and swim performance in semi-professional freestyle swimmers between age 15-25 years. **Study Design:** Randomized control trial. **Procedure:** Ethical approval was taken from the committee. 30 subjects were selected to execute sport-specific circuit training of which 27 subjects completed the study. Approval and written consent was taken from the subjects. Subjects (14 control, 13 experimental) were randomly assigned to control and experimental group. Experimental group completed a 6-week sport-specific circuit training. The outcome measures were 90° push-up test and 50m speed test. The outcome measures of both the groups were taken before and after training. **Result:** The data collected was statistically analysed by paired t-test and un-paired t-test. From the result of the statistics, the endurance and speed of the experimental group ($p=0.0001$ and $p=0.05$) was increased significantly. **Conclusion:** This study concludes that sport-specific circuit training is more effective in improving shoulder muscle endurance and swim performance compared to regular training group in freestyle swimmers.

Keywords: Semi-professional freestyle swimmers, age 15-25 years, shoulder muscle endurance, swim performance, randomized control trial

Introduction

Swimming is a well-known sport which consists of 4 strokes i.e., Freestyle, Breaststroke, Backstroke and Butterfly stroke. However, freestyle stroke also known as “front crawl” is the most commonly used stroke by swimmers and is considered as ‘fastest swimming stroke’. An average competitive swimmer swims approx 60,000m to 80,000m per week with a typical count of 8-10 strokes per 25m lap^[10]. Each shoulder performs 30,000 rotations each week^[10]. Research has proved that 47-80% of competitive freestyle swimmers suffers from shoulder injuries^[3] such as:

- Rotator cuff injury,
- Bicipital tendinitis,
- Shoulder laxity,
- Subacromial impingement,
- Bursitis and
- Repetitive overuse injury.

It is due to improper technique, lack of strength, power and endurance. The research has also proved co-relation of swim performance with strength and endurance^[11]. Also, it has been observed through various studies that endurance of the shoulder muscles plays an important role in the efficiency of the swimmers^[15]. In freestyle swimmers, the great number of stroke repetitions and force generated through the upper extremity is the main cause of shoulder injury; also resulting in poor performance^[10]. The most of the studies are done on the gross strength training. However, there are lesser studies done with sport-specific circuit training in freestyle swimmers. Hence making it important to design a specific protocol for them.

Materials and Methodology

Materials

- Stop-watch.

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- Record sheet.
- Yoga mats.

Methodology

- Number of samples: 30
- Study design: Randomized control trial.
- Location: Sports club, Pune.
- Sampling type: Purposive sampling.
- Sampling method: Simple random sampling.
- Study duration: 6-weeks.

Procedure

Ethical approval was taken from Ethical committee to proceed the study further. Before starting study, all subjects received verbal and written information about the study including the method, aim and the criteria for participating. A written consent form was given to the subjects which they had to signed to participate in the study. Total 30 subjects (n=30) between age of 15-25 participated in the study out of which 27 subjects (n=27) completed the study and 3 subjects dropped out in between the study. The subjects included in study were young male semi-professional swimmers who have participated in any competition of minimum school or club level swimmers between the ages 15-25, who have been trained or coached for at least two years.

The subjects were then divided randomly into two groups,

Group A: Control Group and **Group B:** Experimental Group.

Testing procedure was explained as well as demonstrated to the subjects so that they become familiar with the tests. 90° Push-up test and 50m speed test was used to asses shoulder muscle endurance and swim performance. 90° Push-up test: After a standard warm-up, the subjects being tested has to lie face down on the floor with the hands placed under the shoulders, fingers pointed forward and elbow pointed backward along the sides of the body. The person pushed up to full arm extension, keeping the body straight and then lowered himself until all of the body touched the floor. A stop-watch was set for one-minute and the subject had to do as many push-ups as he can in one-minute. Best of 3 value was finalized. 50m speed test: After a standard warm-up all the swimmers performed 50m maximal test in freestyle stroke. The assessment was done in 50m outdoor pool and the time was recorded by therapist and coach with the help of stopwatch and was measure in milliseconds.

After the completion and recording of pre-assessment, Group-A continued with the routine training whereas Group-B started with the sport-specific circuit training which included 8 exercises. All the participants of Group-B was trained for 6-weeks. After 6-weeks post-assessment was done and the values were recorded in the record sheet.

Outcome Measures

- Push-up test to assess endurance (r=0.94).
- 25mx2 test to assess speed performance [7, 8].

Sr. No	Exercise	No. of repetitions/ time of exercise			Rest interval	No. of sets	Frequency/week
		Week 1-2	Week 3-4	Week 4 -6			
1.	Push-Ups	12	16	20	30 secs	3	3
2.	Triceps Dips	12	16	20	30 secs	3	3
3.	Pull-Ups	12	16	20	30secs	3	3
4.	Bridging	30 secs	45 secs	1 min	30secs	3	3
5.	Prone Plank	30 secs	45 secs	1 min	30secs	3	3
6.	Squats	12	16	20	30 secs	3	3
7.	Lunges	12	16	20	30 secs	3	3
8.	Step Up-Step Down	12	16	20	30 secs	2	3

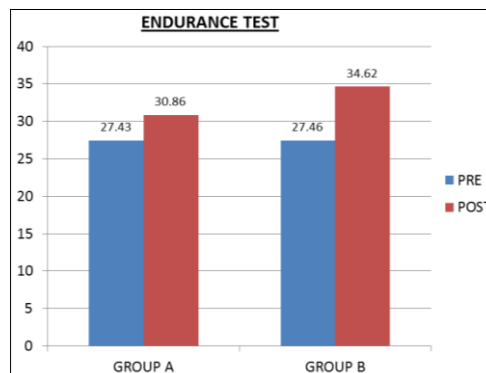
Rest interval between each exercise is 90 seconds.

Results and interpretation

Endurance test

Table 1: Paired T-Test used in Group-A & Group-B for pre & post value for Endurance Test.

		Paired-t test					
		N	Mean	Standard deviation	Mean difference	P-value	T-ratio
Group-a	Pre-training	14	27.43	4.309	3.429	0.0001	8.000
	Post-training	14	30.86	4.555			
Group-b	Pre-training	13	27.46	4.754	7.154	0.0001	17.628



Graph 1: Comparison of Mean between Pre and Post Training Of Control and Experimental Group.

Graphical Interpretation

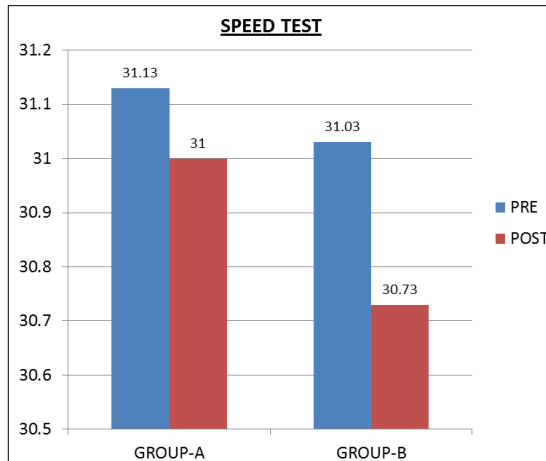
This graph shows changes in post values of endurance compared with pre values of GROUP-A (control group) and GROUP-B (experimental group). Y-axis show the difference in endurance and X-axis shows control (GROUP-A) and experimental (GROUP-B) groups.

Graphical Result: The result obtained for endurance test of experimental group is extremely significant with $p=0.0001$ and $t=17.628$ and shows statistical significance than control group.

Speed Test

Table 2: Paired T-Test used in Group-A & Group-B for pre & post value of Speed Test.

		Paired-t test			Mean difference	P-value	T-ratio
		N	Mean	Standard deviation			
Group-a	Pre-training	14	31.13	3.754	0.1271	0.032	0.324
	Post-training	14	31	3.754			
Group-b	Pre-training	13	31.03	3.007	0.3392	0.0001	4.673
	Post-training	13	30.73	3.003			



Graph 2: Comparison of Mean between pre and post training of control and experimental group for speed test

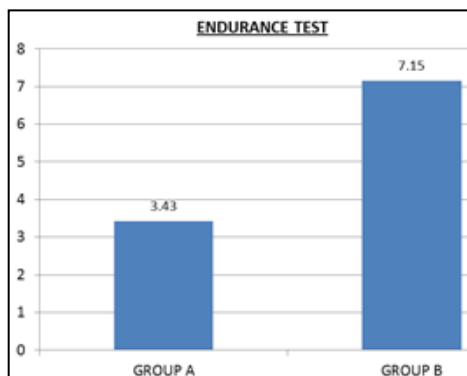
Graphical Interpretation: This graph shows changes in post values of speed test compared with pre values of Group-A (control group) and GROUP-B (experimental group). Y-axis shows the difference in speed and X-axis shows control (Group-A) and experimental (Group-B) groups.

Graphical Result: The result obtained for endurance test of experimental group is extremely significant with $p=0.0001$ and $t=4.673$ and shows statistical significance than control group.

Endurance test

Table 3: Unpaired T-Test Used in Group-A & Group-B for Endurance Test

		Unpaired-t test		Mean difference	P-value	T-ratio
	N	Mean	Standard deviation			
Group-a	14	3.429	1.604	3.725	0.0001	6.289
Group-b	13	7.154	1.463			



Graph 3: comparison of endurance between group-a and group-b.

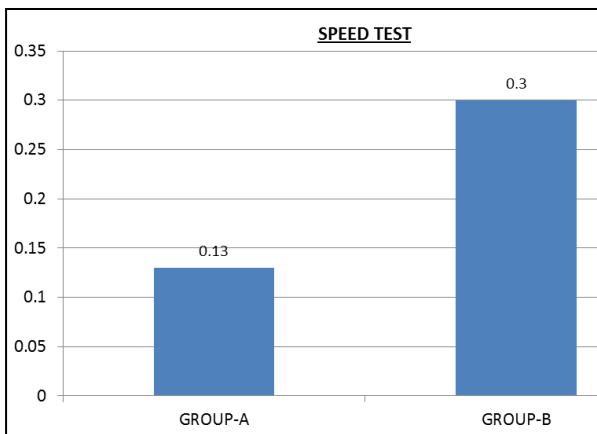
Graphical Interpretation: This graph shows difference between Group-A and Group-B. Y-axis shows the difference in endurance and X-axis shows control (GROUP-A) and experimental (Group-B) groups.

Graphical Result: The shows an significant difference between GROUP-A and Group-B with Group-B having $p=0.0001$ and $t=6.289$

Speed Test

Table 4: Unpaired T-Test Used In Group-A & Group-B for Speed Test.

Unpaired-t test						
	N	Mean	Standard deviation	Mean difference	P-value	T-ratio
Group-a	14	0.1271	0.1979	0.1682	0.050	2.055
Group-b	13	0.2954	0.2273			

**Graph 4:** Comparison of Speed between Group-A and Group-B

Graphical Interpretation: This graph shows difference between Groups-A and Group-B. Y-axis shows the difference in speed and X-axis shows control (GROUP-A) and experimental (GROUP-B) groups.

Graphical Result: The shows a significant difference between Group-A and Group-B with GROUP-B having $p=0.05$ and $t=2.055$.

Discussion

As we all know that the strength, endurance and power are the key elements of muscle performance. Any impairment in one or more of these areas can lead to functional limitations and disability or increased risk of dysfunction¹². The purpose of this study was to design a 6-week sport-specific circuit training programme for semi-professional freestyle swimmers between the ages of 15-25 years and to investigate its effect on shoulder muscle endurance and swim performance. We chose 90° push-up test to assess the endurance of shoulder muscles and 50m speed test to assess swim performance as outcome measures. The result of this study showed that there was statistically significant increase in shoulder muscle endurance and swim performance in experimental group as compared to the control group post 6-weeks assessment. The graphs for endurance test and speed were plotted which showed the significant increase after six weeks of training having $p<0.05$ and $p=0.05$ (Table 3 & 4).

In freestyle swimming both strength and endurance plays a vital role during swimming performance. During the propulsive phase Latissimus dorsi and Pectoralis major plays major role. Whereas along with Latissimus dorsi and Pectoralis major, Biceps brachii, Triceps brachii and ulnar deviators helps to maintain speed¹¹⁶. However, the eccentric load is on Serratus anterior as plays an important role in the preparation for the next propulsive phase and shoulder joint stability hence all these muscles are at high risk of injury along with subscapular is¹¹⁶. It has been observed in a study that impaired muscular endurance has strong co-relation with the shoulder pain in competitive freestyle swimmers¹⁵. Hence it is important to implement endurance training in freestyle swimmers.

In this study, both the control and experimental group has shown the improvement in the endurance of shoulder muscles as the endurance training of 6-weeks increases ability of the muscles to utilize oxygen, increases slow-twitch muscle function and increased glycogen production and mitochondrial activity^{112, 141}. Endurance training also works on the slow twitch (type 1) fibers, and develops their efficiency and resistance to fatigue. It also increases the number of capillaries per area of muscle, thus increasing oxygen supply to the muscle^{112, 141}.

Previous studies have extensively studied about factors that affects the swimming performance. It depends on the amount of metabolic energy spent in transporting the body mass of the athlete and on the economy of locomotion¹²². And is also related to different anthropometrical, physiological and biomechanical parameters¹²¹. A study with an 8-weeks strength program combined with aerobic swim training only showed a slight improvement in 25m and 50m swim performance^{118, 111}.

During swimming, the energy system which comes under most strain is the aerobic system and improvement in performance comes from the development of the aerobic system¹¹⁹. For any swimmer to perform a higher training level, an increase in aerobic enzymes, muscle glycogen and the circulating blood volume is required.

The combined effects of lower intensity and longer duration training develops aerobic capacity which in turns helps for better swimming performance¹⁴¹. Both continuous as well interval training are effective as they maintain high VO_{2max} , high lactate threshold, high oxidative capacity of muscle and elevated fuel stores in muscle¹²¹. In 50m sprint freestyle swimmers, swimming performance depends on the balance between the propulsive force generated by the arms and legs and the resistance created by the drag. Therefore, making it more essential to train the specific group of muscles used in freestyle stroke.

During training a certain amount of rest interval is required for the recovery of ATP's and to allow the lactic acid to decrease at tolerable levels¹¹⁹. In my study we have selected 90 seconds rest interval in between the exercises as and short rest interval of 30-40 seconds in between the sets as 90% of the ATP and Phosphocreatine stores can be resynthesized in 1 minute by oxidative metabolism¹²².

An improvement in upper body muscular endurance increases the fatigue resistance which enables the swimmer to maintain effective technique therefore improving overall swim performance. Even though there was not that significant increase in swim performance, the 6-week training program had beneficial effect on swimmer's endurance and swim performance.

Conclusion

The conclusion drawn from the data analysis was:

The experimental group, achieved significant improvement in the shoulder muscle endurance and swim performance after the implementation of sport-specific circuit training when compared to control group.

Therefore, the result and data analysis concludes that a well-structured sport-specific circuit training improves the shoulder muscle endurance and swim performance in freestyle swimmers.

Clinical implications

1. The study can be used on regular basis throughout the year.

2. It can save the time of athlete and coach.
3. It can be used for Rehabilitation after sport injury for quick return back to sport.

Limitations

1. The main limitation was limited sample size
2. Fitness variables were limited such as strength, power aerobic and anaerobic capacities were not included.
3. The study was restricted only to the males.
4. Study was only limited to one stroke.

Further scope of study

1. The same study can be conducted with the larger sample size.
2. Other fitness parameters such as strength, power, aerobic and anaerobic capacities and breathing capacity could also be included.

Acknowledgement

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