"Analysis of the cardio-respiratory endurance in swimmers and non-swimmers in age group of 18-25 years by using 6-minute walk test"

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Abstract

Background:- The present study cross sectional in design was conducted on 60 swimmers and 60 non swimmers and analysis of the cardio-respiratory endurance in swimmers and non swimmers in age group of 18-25 years was done by using 6 minute walk test. **Results:-**The mean age of case group was 21.68 years and of control group was 21.63 years which means that mean age of case group and control group subjects was comparable. The mean heart rate taken immediately after six minute walk test in swimmers was 75.86 BPM and in non swimmers was 83.16 BPM, which was statistically significant. In our study we also found that, systolic and diastolic blood pressure taken immediately after six minute walk test in swimmers was lesser (129 mmHg) than in non swimmers was (138.76 mmHg). In our study, we found that respiratory rate taken immediately after six minute walk test in swimmers was 22.4per minute and in non swimmers was 25.75per minute. In our study, we also found that rate of perceived exertion taken immediately after six minute walk test in swimmers as 2.93 and in non swimmers was 3.11. The present study showed that mean walked distance taken immediately after six minute walk test in swimmers was 529.75meters and in non swimmers was 496.17meters. Conclusion:- We conclude that, regular swimming produces a positive effect on cardio vascular and respiratory endurance of individuals.

Keywords: - Cardiovascular, endurance, swimmers , non-swimmers , 6 minute walk test.

Introduction

Swimming is one of the most popular sports and is rated to be the best exercise for all round development of the body. Aquatic exercises (swimming) with resistance, improve physical strength factors, along with endurance. These exercises do not only improve the functions of the respiratory system and the circulatory system, they also help develop muscular strength, endurance, and flexibility, effectively affecting changes in one's body composition.[1]

Swimming as an aerobic exercise performed regularly for minimum three months duration increases cardio-respiratory endurance.[6] Endurance refers to a person's ability to continue doing a stressful activity for an extended period of time.

Regular swimming produces a positive effect on the lung by increasing pulmonary capacity and thereby improving the lung functioning [7]. There are many physiological changes taking place in the human body, when a person continuously swims [8]. Almost all muscle groups are used during swimming and therefore O_2 utilization for the muscle is higher in swimmers as compared to non swimmers.[7]

Regular swimming induces significant adaptations both at rest and during swimming in a variety of dimensions related to cardiovascular regulatory system such as cardiac autonomic function. Swimming performed regularly for minimum three months duration strengthens cardiovascular system, increases cardiovascular endurance overall strength and stamina. Regular swimming builds endurance, muscle strength and cardio-vascular fitness. Swimming works both the upper and lower body with little impact and is considered as one of the best cardiovascular modes of exercise. To make the best use of exercise time, it is important to train at the right intensity. [6]

The individual response to exercise is an important clinical assessment tool since it provides a composite assessment of the respiratory, cardiac and metabolic systems. The current gold standard for assessing one's aerobic exercise response is the maximum incremental cardiopulmonary exercise test. However, most daily activities are performed at sub-maximal levels of exertion, thus using sub-maximal functional tests that would provide one's physical capability.[10] There are many clinical tests used for evaluation of cardio-respiratory endurance. The ATS Guidelines in March 2012 have given several modalities for the objective evaluation of functional exercise capacity. The modality used should be chosen based on the clinical test to be addressed and on available resources.

A recent review of functional walking tests concluded that the 6 minute walk test (6 MWT) is easy to perform with better acceptability by participants, and provides a better

reflection of activities of daily living than other walk tests. Due to paucity of data on swimmers endurance, this study aims "to study the cardio-respiratory endurance in Swimmers and Non Swimmers in age group of 18-25 years by using 6 minute walk test." And objectives are to analyze the cardio respiratory endurance of Swimmers, Non Swimmers and comparison in both the group using 6 minute walk test.

Material and methods

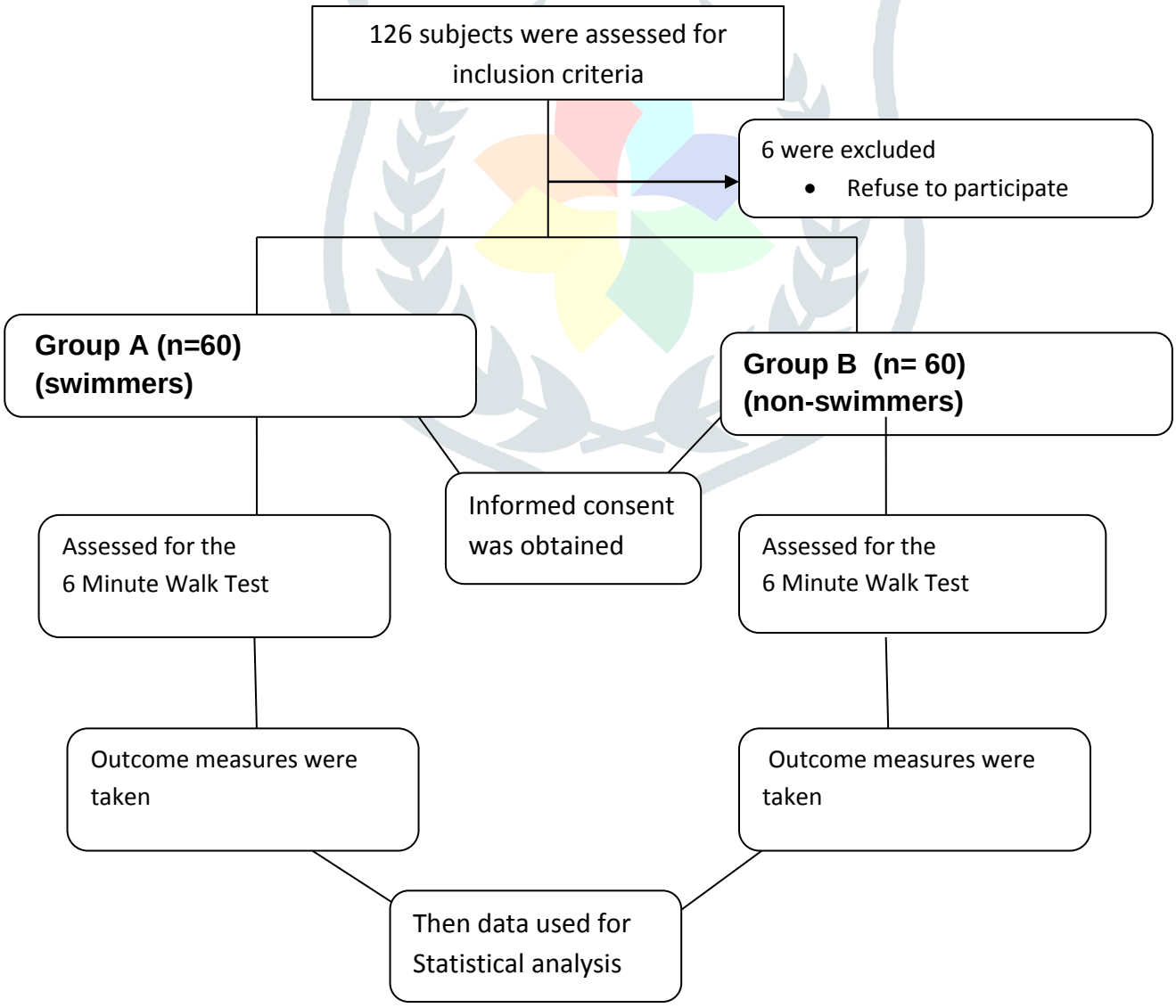
This was a cross sectional comparative observational study conducted at the outpatient Physiotherapy set up of Govt. Medical College, Nagpur from August 2015 to December 2016. Participant were selected on the basis of inclusion criteria**,** for Swimmers normal healthy Individuals **undergoing** Swimming for minimum

1yr duration 5 days in a week for 1 hr in the age group of 18 to 25 years and with normal BMI(range18.5-24.99).And for non-swimmers normal healthy Individuals in the age group of 18 to 25 years with normal BMI(range18.5-24.99). **Exclusion criteria for the participant were no** any h/o cardio-respiratory diseases, neuromuscular conditions and individuals involved in any other active sports.

Sample size:

Sample size was calculated statically on the basis of previous published study to determine the mean resting systolic & diastolic blood pressure in swimmers was significantly lower than in non-swimmers, there was mean difference of 8 units for power 90% and 95% confidence interval in both the groups. Estimated sample size was 120 healthy individual of age 18-25years. so the minimum sample size for both group (cases and control) was 60.

Procedure:



Outcome measures are Heart Rate, Blood Pressure, Respiratory Rate, Rate of perceived exertion (Modified Borg's scale) and Walked Distance.

Data Analysis:

Data entry was done using Microsoft excel 2007.

Statistical Analysis: Descriptive statistics was used to summarize baseline characteristic of the study subjects. Various data obtained asking the subjects were noted. Various pre test and post test parameters were noted. All the data obtained for various parameters were tested for their statistical significance. Statistical analysis were summarized in the form of mean, standard deviation and the difference in means were compared by non parametric 'un-pair t'. P value <0.05 was considered significant.

Observations and Results

The present study was cross sectional comparative observational study and has been carried out on 60 swimmers and 60 non swimmers at Department of physiotherapy, Medical College, during august 2015 to December 2016.

We have compared cardiovascular and respiratory endurance in swimmers and non swimmers by using six minute walk test.

Table No. 1: AGE wise distribution of cases and control i.e Normal healthy Individuals undergoing Swimming and non-swimmers.

	Age in years (mean)
Swimmers	**21.68**
Non-Swimmers	**21.63**

Table no. 1 shows that out of total 120 study subjects, age of all the subjects were between 18 to 25 years. A total 60 (Swimmers) and 60 (Non- swimmers) were studied. In this study, mean age of case group was 21.68 years and of control group was 21.63 years which means that means age of cases group and control group subjects was comparable.

Table No. 2: Showing pre-test & post-test immediate HEART RATE in six minute walk test for Swimmers and Non-Swimmers.

	Swimmers		Non-Swimmers	
	Pre	Post	Pre	Post
Mean systolic Blood pressure (mm of Hg)	117	129	122.33	138.76
P Value	<0.0001		<0.0001	
P Value	< 0.0001			
P Value summary	pairing was significantly effective			

Table no. 2 shows the immediate heart rate in swimmers and non-swimmers after the 6 minute walk test. The mean heart rate in pre test was 72.11 for swimmers and 74.98 for non-swimmers. The mean heart rate in post test was 75.86 for swimmers and 83.16 for non-swimmers. The p value for both swimmers and non-swimmers were < 0.0001.

Table No. 3: Showing comparison of pre-test & post-test immediate SYSTOLIC BLOOD PRESSURE in six minute walk test for Swimmers and Non-Swimmers.

	Swimmers		Non-Swimmers	
	Pre	Post	Pre	Post
Mean Heart rate (beat per minute)	72.11	75.86	74.98	83.16
p Value	< 0.0001		< 0.0001	
p Value	< 0.0001			
P Value summary	pairing was significantly effective			

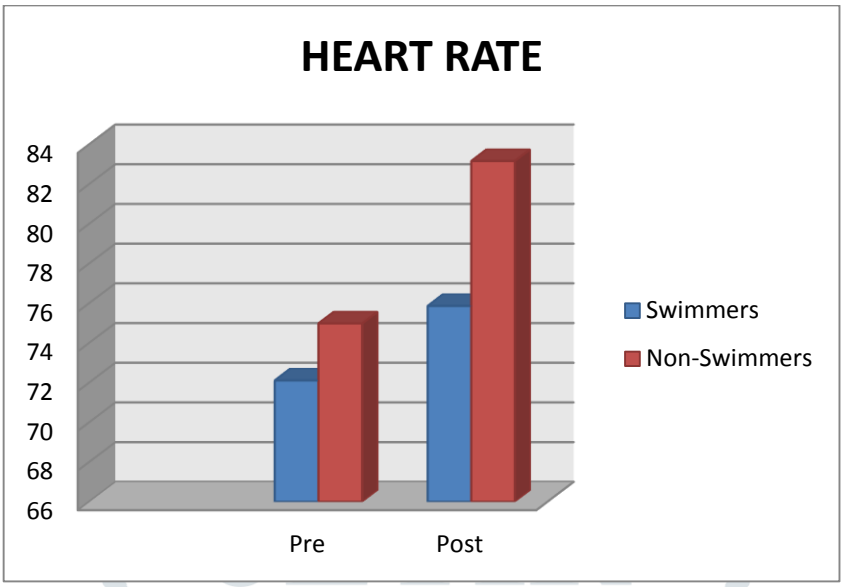
Table no. 3 showed the immediate systolic blood pressure in swimmers and non-swimmers after the 6 minute walk test. The mean systolic blood pressure in pre test was 117 mmHg for swimmers and 122.33mmHg for non-swimmers. The mean systolic blood pressure in post test was 129mmHg for swimmers and 138.76mmHg for non-swimmers. The p value for both swimmers and non-swimmers were < 0.0001. There was statistically significant p value for swimmers and non-swimmers immediate systolic blood pressure.

Table No. 4: Showing comparison of pre-test & post-test immediate DIASTOLIC BLOOD PRESSURE in six minute walk test for Swimmers and Non-Swimmers.

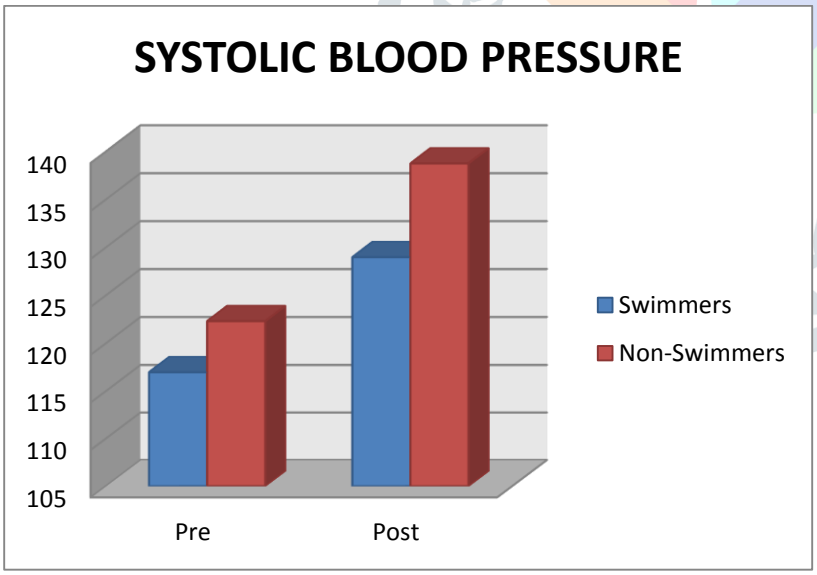
	Swimmers		**Non-Swimmers**	
	Pre	Post	Pre	Post
Mean Diastolic (mm of Hg)	79.16	89.3	82.133	90.43
P Value	<0.0001		<0.0001	
P Value	< 0.037			
P Value summary	pairing was significantly effective			

Table no. 4 showed the immediate diastolic blood pressure in swimmers and non-swimmers after the 6 minute walk test. The mean diastolic blood pressure in pre test was 79.16 for swimmers and 82.133 for non-swimmers. The mean diastolic blood pressure in post test was 89.3 for swimmers and 90.43 for non-swimmers. The p value for both swimmers and non-swimmers were < 0.037. There was statistically significant P value for swimmers and non-swimmers immediate diastolic blood pressure.

Graph 1 : Showing pre-test & post-test immediate HEART RATE in six minute walk test for Swimmers and Non-Swimmers.



Graph 2. : Showing comparison of pre-test & post-test immediate SYSTOLIC BLOOD PRESSURE in six minute walk test for Swimmers and Non-Swimmers



Graph 3 : Showing comparison of pre-test & post-test immediate DIASTOLIC BLOOD PR ESSURE in six minute walk test for Swimmers and Non-Swimmers.

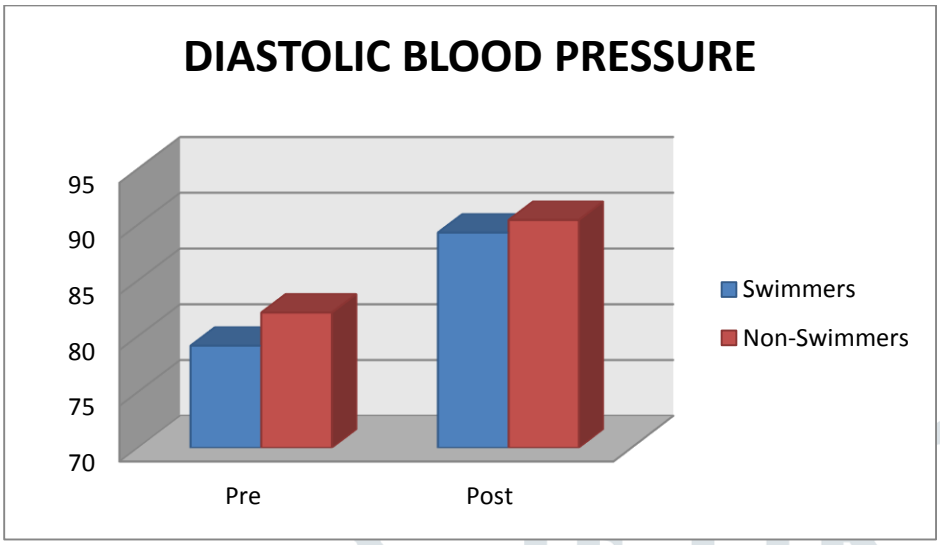


Table no 5 : Showing comparison of pre-test & post-test immediate RESPIRATORY RATE in six minute walk test for Swimmers and Non-Swimmers.

	Swimmers		Non-Swimmers	
	Pre	Post	Pre	Post
Mean (Per minute)	15.13	22.4	18.766	25.73
P Value	<0.0001		<0.0001	
P Value	< 0.0001			
P Value summary	pairing was significantly effective			

Table no. 5 showed the immediate respiratory rate in swimmers and non-swimmers after the 6 minute walk test. The mean respiratory rate in pre test was 15.13 for swimmers and 18.766 for non-swimmers. The mean respiratory rate in post test was 22.4 for swimmers and 25.73 for non-swimmers. The T ratio was 37.11 in swimmers and was 39.90 for non-swimmers. The p value for both swimmers and non-swimmers were <

0.0001. There was statistically significant P value for swimmers and non-swimmers immediate respiratory rate.

Graph 4: Showing comparison of pre-test & post-test immediate RESPIRATORY RATE in six minute walk test for Swimmers and Non-Swimmers.

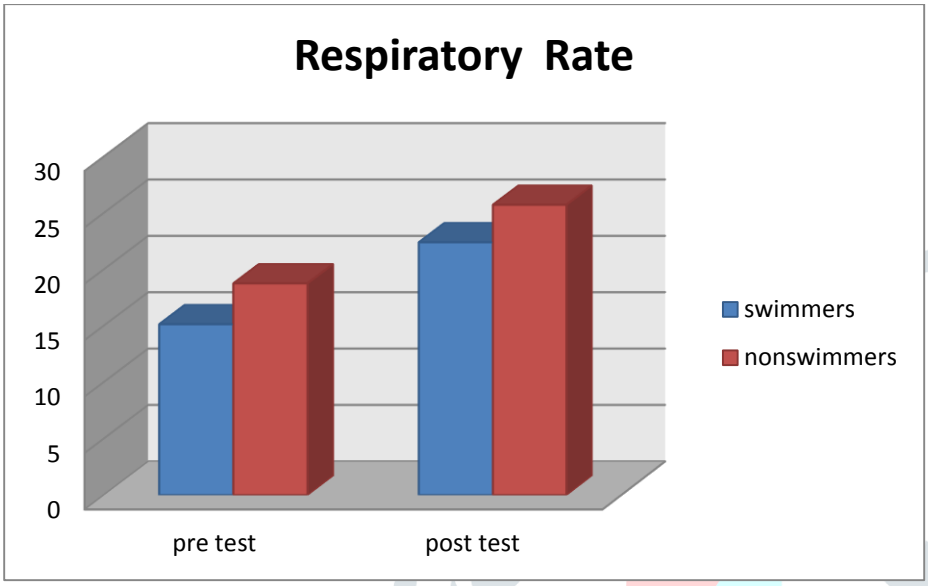


Table No. 6: Showing comparison of pre-test & post-test immediate RPE ON BORGS SCALE in six minute walk test for Swimmers and Non-Swimmers.

	Swimmers		Non-Swimmers	
	Pre	Post	Pre	Post
Mean	0	2.93	0.1	3.11
P Value	<0.0001		<0.0001	
P Value	< 0.160			
P Value summary	pairing was not significantly effective			

Table no. 6 showed the immediate RPE (rate of perceived exertion) on Borge scale in swimmers and non-swimmers after the 6 minute walk test. The mean RPE on Borge scale in pre test was 0 for swimmers and 0.1 for non-swimmers. The mean RPE on Borge scale in post test was 2.93 for swimmers and 3.116 for non-swimmers. The p value for both swimmers and non-swimmers were < 0.160. There was statistically significant P value for swimmers and non-swimmers immediate RPE on Borge scale.

Graph 5: Showing comparison of pre-test & post-test immediate RPE ON BORGS SCALE in six minute walk test for Swimmers and Non-Swimmers.

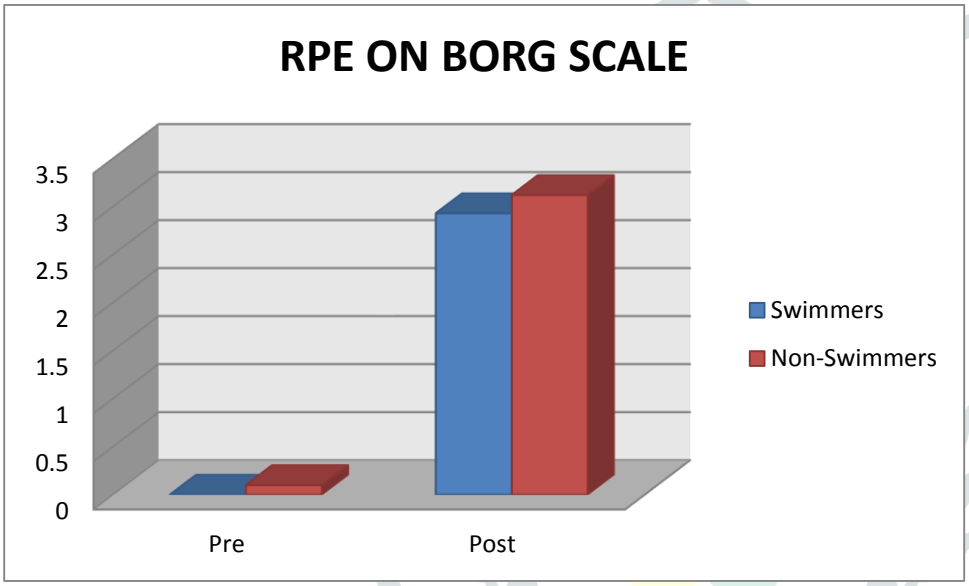


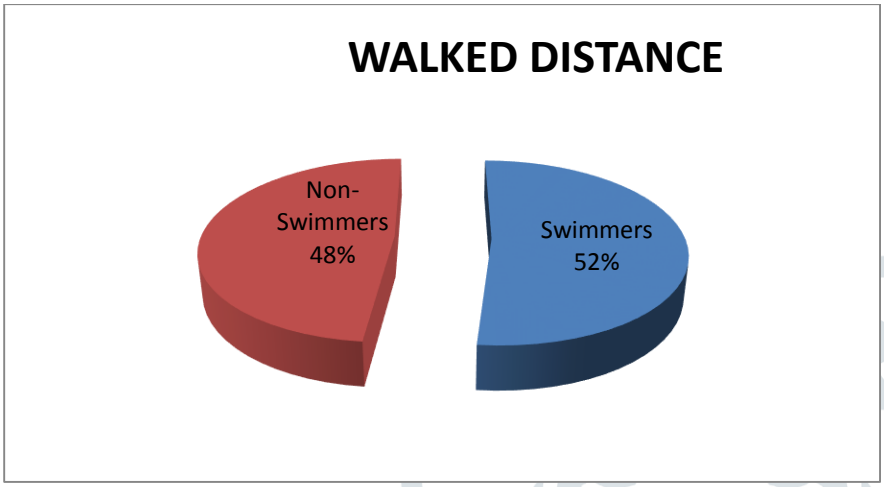
Table No. 7: Showing comparison of WALKED DISTANCE in six minute walk test for Swimmers and Non-Swimmers.

	Swimmers	Non-Swimmers
Mean (in meters)	529.75	496.17
Mean difference	33.58	

Table no. 7 showed the walked distance in swimmers and non-swimmers after the 6 minute walk test. The mean walked distance in swimmers was 529.75 meters. The walked distance in non-swimmers was

496.17meters. The mean difference after six minute walked distance of swimmers and non swimmers was 33.58 meters. As swimmers has more endurance compare to non-swimmers.

Graph No. 7: Showing comparison of WALKED DISTANCE in six minute walk test for Swimmers and Non-Swimmers.



Discussion

Swimming is primarily an aerobic exercise due to the long exercise time, requiring a constant oxygen supply to the muscles, except for short sprints where the muscles work an-aerobically. As with most aerobic exercise swimming is believed to reduce the harmful effects of stress. Swimming can improve posture and develop a strong lean physique, often called a "swimmer's build." Swimming is a healthy activity that can be continued for a lifetime, and the health benefits swimming offers for a lifetime are worth the effort it takes to get to the swimming pool. It works practically all of the muscles in the body. Swimming can develop a swimmer's general strength, cardiovascular fitness and endurance. Regular swimming builds endurance, muscle strength and cardio-vascular fitness. It can serve as a cross-training element to your regular workouts. Swimming with increasing effort to gradually increase your heart rate and stimulate your muscle activity is easily accomplished in the water.

This study was cross sectional in design. It was undertaken to systematically examine and evaluate cardio-respiratory endurance in swimmers and non-swimmers. We compared endurance by

implementing six minute walk test and measured endurance in parameters like heart rate, SBP, DBP, RR, RPE and distance walked immediately after six minute walk test.

Overall the results from this study suggest that cardio-respiratory endurance of swimmers was more than non-swimmers and this result was similar to what clinical and epidemiological studies had suggested.

In this study, mean age of case group was 21.68 years and of control group was 21.63 years which means that mean age of case group and control group subjects was comparable.

In our study, the mean resting i e pre test heart rate in swimmers was 72.11bpm and in non swimmers was 74.98 bpm. The mean heart rate taken immediately after six minute walk test in swimmers was 75.86 BPM and in non swimmers was 83.16 BPM The p value was significant (p=0.001). This result was similar to the study carried out by Klaudia Palak and et al.[36] which showed that, compared to the controls, swimmers were characterized by significantly higher values of the Heart Rate Variability indices determined at rest. Another study of D.M. Patil and et al[37] suggest mean value of resting heart rate is lower in subjects of the swimming group (Mean resting heart rate 69.8± 0.9) as compared to non swimmers (Mean resting heart rate 82.8.8± 2.1) and they are statistically significant (p =0.000). The lowering of resting heart rate is mediated by alterations in the autonomic nervous system and by changes in the intrinsic mechanism of the sinus node and right atrial myocytes.

The mechanisms underlying the training induced increase in vagal activity are thought to consist of greater activation of the cardiac baroreceptors in response to the enlargement of blood volume and ventricular filling as well as changes in the opioid and dopaminergic modulation of parasympathetic tone. Lower intrinsic heart rate may be one adaptation mechanism after aerobic training. Subjects with enlarged heart have lower intrinsic heart rate. Therefore it has been hypothesized that cardiac enlargement caused by training accounts for the lower intrinsic heart rate. Another possible mechanism for reduced intrinsic heart rate is that atrial enlargement reduces the stretch-depolarization stimulus altering the resting regulation of heart muscle.[38]

In our study we also found that systolic blood pressure taken immediately after six minute walk test in swimmers was 129mmHg and in non swimmers was 138.76mmHg. Our study we also found that diastolic blood pressure taken immediately after six minute walk test in swimmers was 89.3mmHg and in non swimmers was 90.43mmHg The p value was significant (p=0.0037). The results of the present study have indicated statistically significant (p = 0.0037) difference in blood pressure in the case of the swimmers group compared to the non-swimmers. Swimming is often recommended by various authoritative groups as a mode of exercise for the prevention and treatment of hypertension and cardiovascular disease.[4,40] In the study done by D. Patil[6] it was seen that resting systolic and diastolic blood pressures of the students of the swimmers group have lower values (Mean systolic blood pressure 120.3±1.1 and Mean diastolic blood pressure of 79.9±0.7) compared to the non-swimmers group who have significantly higher values (Mean systolic blood pressure128±1.8 and Mean diastolic blood pressure of 85.6±2.2). The results of this study are similar to the results found out by Whelton (2002)[30], Zivkovic[31] (2005), Kokkinos[32] et. al. (1995), Kingwell and Jennings[33] (1993).

The changes that occurred in blood pressure are probably the result of the regular aerobic exercise which causes better cardiovascular adaptations. The precise mechanisms for how regular exercise lowers blood pressure remains unknown. Contributing factors include reduced sympathetic nervous system activity with training, possible normalization of arteriole morphology, decreased peripheral resistance to blood flow to lower blood pressure and altered renal function facilitates the kidney's elimination of sodium, which subsequently reduces fluid volume and hence blood pressure[34,35]. It has also been proven that regular aerobic exercise such as swimming, lowers both systolic and diastolic blood pressure significantly and it stays down if the exercise is continued.

In our study, we found that respiratory rate taken immediately after six minute walk test in swimmers was 22.4per minute and in non swimmers was 25.75per minute. The p value was significant (p=0.001). This confirmed the comparative similarity with previous studies that, respiratory endurance in swimmers was better compared to non swimmers. Another study showed comparison between swimmers

and effect of yoga in sedentary subjects showing end conclusion of better pulmonary functions in swimmers than even in yoga practices.

Swimming engages practically all muscle groups. Hence O2 utilization for the muscle is higher in swimmers. The water pressure on the thorax makes the respiration difficult. Breathing is not as free during swimming, as in most other types of exercise. Respiration during competitive swimming is synchronized with swimming strokes.[39] Swimming produces maximum effect on the lungs compared to any other sport[41]. Regular swimming produces a positive effect on the lung by increasing pulmonary capacity and thereby improving the lung functioning. Regular swimming practice may tend to alter the elasticity of the lungs and the chest wall which leads to improvement in lung functions in swimmers.[42] Good swimmers tend to be above average for lung capacity. Training during adolescence increases vital capacity and total lung capacity due to the development of a broad chest and long trunk and this increased vital capacity helps swimmers maintain their buoyancy [9].

Cardio respiratory Endurance reflects the condition of the heart, circulatory system and respiratory system. It is sometimes referred to as the aerobic component because it relates directly to how much oxygen can be used per minute. Cardio-respiratory fitness is the ability to deliver and use oxygen under the demands of intensive, prolonged exercise or work.

In our study, we also found that rate of perceived exertion taken immediately after six minute walk test in swimmers as 2.93 and in non swimmers was 3.11 and the p value was not significant (p=0.160). This statistically significant difference could be a result of more usage of anaerobic capacitry. The accumulation of ions of hydrogen in active muscle and blood, followed by the dissociation of lactic acid can cause a superior perception of efforts[43].

Swimming can develop a swimmer's general strength, cardiovascular fitness and endurance. Regular swimming builds endurance, muscle strength and cardio-vascular fitness. It can serve as a cross-training element to your regular workouts. Before adryland workout, you can use the pool for a warm-up session. Swimming with increasing effort to gradually increase your heart rate and stimulate your muscle activity is easily accomplished in the water.

The present study showed that mean walked distance taken immediately after six minute walk test in swimmers was 529.75meters and in non swimmers was 496.17meters. The difference between these mean walked distance may be because of increased cardio-respiratory endurance of regular swimmers as compared to non swimmers. Swimmers have greater pulmonary efficiency than non-swimmers which also acts as a predictor of performance.

Strengths and Suggestions

The study population was selected and recruited randomly from 2-3 swimmers club in case group and from comparable students in control group and carried out in department of physiotherapy thus there was no bias. Inclusion and exclusion criteria were specific. The size of sample was sufficient and was corresponding to earlier studies.

In our study we compared many new variables of cardio-respiratory endurance in swimmers and non-swimmers which was lacking in previous study.

We further suggest that, study on effect of swimming as an aquatic exercise in treatment of hypertension, pulmonary rehabilitation and obesity management etc needed.

Limitations of the study

There were many limitations of this study. This study being cross sectional in design cannot check follow up changes in cardio-respiratory endurance if it persists or not.

Also to calculate exact relationship of various parameters of cardio-respiratory endurance larger sample size will be needed. We have not included recovery time in all parameters measured for cardio-respiratory endurance.

Conclusion

Globally many studies have been conducted and documented between swimmers and non swimmers by using different methods, and standardized criteria. In this study, especially we selected swimmers i e case group who are regular swimmers from at least 1 year so that we could estimate

importance of regular swimming than that of irregular. The purpose of choosing swimmers instead of any other sports person was that previous studies have shown that swimming produces maximum effect on the heart and lungs compared to any other sport. Also we used six minute walk test which is reliable measure to evaluate and compare cardio-respiratory endurance in swimmers and non-swimmers.

The result obtained from this study showed significant difference in the means of various parameters measured. Overall, the results from this study suggest that cardio-respiratory endurance of swimmers was more than non-swimmers and this result was similar to what clinical and epidemiological studies had suggested.

Thus, we conclude that regular swimming produces a positive effect on cardio vascular and respiratory endurance of individuals. Our finding may have important implications for exercise prescription.

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