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A Study Of Pulmonary Functions In Male Swimmers – A Cross Sectional Study

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Abstract: -
Introduction: *Swimming is an aerobic exercise which also increases the strength of Respiratory muscle as well as elastic recoil of lungs as immersion in water increased pressure over lung & heart.*
Objective: *Our main aim is to know whether short duration of swimming (six months to one year) can significantly change the pulmonary functions in swimmers compare to sedentary subjects.*
Materials and Method*: This present study was designed as a cross-sectional study and was proposed to study Pulmonary function test (Parameters of Spirometry: FVC, FEV1, FEV1/FVC%, PEFR, $FEF_{25-75\%}$, MVV) in male swimmers and sedentary controls. For this purpose, we randomly selected 90 cases (swimmers) and 90 healthy sedentary controls and age between 18 – 25 years with matched anthropometric parameters. Approval of the Institutional Ethics Committee was taken prior to the study.*
Results*: The mean value of FVC, FEV1, PEFR, FEF25-75 % & MVV was significantly increased in swimmers as compared to sedentary control. The mean value of FEV1/FVC% of swimmers and sedentary control was compared and the difference was statistically non-significant.*
Conclusion: *Various pulmonary functions parameters were markedly increased in the youths who undertake a couple of hours of swimming in short duration of six months to one year.*
Key Wards: *pulmonary function tests, spirometry, comparison, male, sedentary, swimming*

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I. Introduction

Physical training in athletes also helps in developing greater endurance in respiratory muscles. The ability of the individual to inflate and deflate the lungs depends on the strength of the thoracic and the abdominal muscles, the posture of the individual and elasticity of lungs. Lung recoil and chest elasticity with co-ordinated neuromuscular functions, maintenance of breathing effort together with thoracic and abdominal muscle strength play a key role in most of the pulmonary functions.

Swimming also changes various anthropometric parameters of our body. Average body fat is also reduced in swimmers. So swimming may also help to reduce obesity, which is a burning issue in our society today[1].

Swimming is an aerobic exercise which helps to train the subjects in control breathing. Respiratory muscle strength might also increase(respiratory muscle composed of Diaphragm, External & Internal intercostals, Parasternal, Sternomastoid, Scalene, Internal oblique muscle) [2].

Long-term Swimming may also increase both static and dynamic function of lungs [3]. Whereas the people having sedentary lifestyle may be associated with less efficient pulmonary functions[4].

But most of the study design was done in swimmers who are performing swimming for a longer duration. But in our study, we have selected a group of swimmers who are swimming for as short as last six months to one year, regularly. Our main aim is to know whether the short duration of swimming can significantly change the pulmonary functions and cardiopulmonary efficiency in swimmers in comparison to sedentary subjects.

By measuring PFT data in swimmers and sedentary subjects we can evaluate, whether short duration exercise as a form of swimming can make difference in the pulmonary functions significantly or not.

II. Aim And Objectives

Aim:
To know whether pulmonary functions are different in swimmers as compare to sedentary subjects.

Objectives:
1)To study pulmonary functions in swimmers.
2)To study pulmonary functions sedentary subjects.
3)To compare pulmonary functions between swimmers and sedentary subjects.

III. Materials And Method:

Study design: The study was planned as a cross-sectional study**.**

Study place:
1) Tertiary health carecenter in central India.
2) Municipal Swimming Pool, Wardha.

Study period: Present study was conducted over a period of 18 months from 1st January 2016 to 30th June 2017 at Mahatma Gandhi Institute of Medical Sciences (MGIMS), Sevagram, Maharashtra.

Study population
Cases: Swimmers (male) aged between 18-25 years were considered as case

Inclusion criteria:
Swimmers (male) aged between 18-25 years old, practicing swimming 2-3 hours per day at least 5 days in a week regularly for six months to one year.

Exclusion criteria:
1)Smoker.
2)Chronic respiratory disease.
3)Cardiac disease.
4)A systemic disorder affecting the respiratory system.

Control:
Non-swimmer healthy male person aged between 18 – 25 years and not engaged in any kind of sports or yoga considered as Sedentary and was selected as control

Sample size:
Sample size was estimated, using OpenEpi software with following assumptions with previous study knowledge[5]. We recruited 90 cases and 90 controls to have adequate power for the study.

Data collection:
Approval of the Institutional Ethics Committee was taken prior to the study. Prior written informed consent was taken from every participant which was voluntary in nature.
Case record form was filled with all cases and controls. A relevant clinical history was taken. Clinical examination was done. Individuals' identity was kept confidential.

Study tools:
Anthropometric profile:
Pulse rate (per minute), Respiratory rate (per minute), Blood pressure (systolic and diastolic), Age (in years), Height (in meter), Weight (in kg), Body mass index (BMI) & Body surface area (BSA) were measured and calculated.
BMI was calculated according to the following formula [6]:
BMI= weight in kilogram / height in meter^2 and
BSA was calculated by Dubois and Dubois formula[7]
BSA (m^2) = $0.007184 \times \text{weight (kg)}^{0.425} \times \text{height (cm)}^{0.72}$

2) Pulmonary functions:
Pulmonary functions were studied by computerized portable Spirometer (MIR spirolab III).
The subject was instructed to inhale maximally and then exhale as rapidly and completely, as long as possible in sitting position. A soft nose clip was put over the nose to occlude the nostrils and disposable mouthpieces were used to minimize cross infection. Three readings were taken and highest of the three readings was recorded for statistical analysis.

Following are the parameters used in the study [8]

1) **FVC (forced vital capacity)**: the maximum volume of air forcefully exhaled after a maximal inspiration.
2) **FEV1 (forced expired volume in the first second)**: the volume expired in the first second of maximal expiration after a maximal inspiration.
3) **FEV1/FVC**: the FEV1 expressed as a percentage of the FVC, useful index of airflow limitation.
4) **PEFR (peak expiratory flow rate)**: is the maximal expiratory flow rate achieved and this occurs very early in the forced expiratory maneuver.
5) **FEF25-75% (Litre/sec)**: this is the forceful expiratory flow over the middle half of the FVC curve.
6) **MVV (Maximum Voluntary Ventilation).** It is a maximum volume of air that inhaled and exhaled within one minute. The subject was instructed to breathe as deep and fast as possible for 10 to 15 seconds. The result is extrapolated to 60 seconds and reported as litres per minute.

Data analysis:

We analyzed the results by using formula, Student's unpaired T-tests and by using Microsoft Excel 2013. **"**p**"** value <0.05 was considered as significant.

IV. Results And Observations:

This is the study aims to evaluate the status of pulmonary function test (PFT) in swimmers and sedentary normal individuals and compare PFT within these two groups. The study consists of two groups' viz. swimmers and non-swimmers, each consists of 90 subjects based on inclusion and exclusion criteria.

In present study, anthropometric profile of swimmers & non-swimmers was measured and shown in the following Table 1

Table 1. Anthropometric profile of swimmers and non-swimmers

Parameters	Swimmers Mean ± SD	Non swimmers Mean ± SD	p value
Age(years)	20.46±2.36	20.48±2.70	0.9535(NS)
Height(meter)	1.69±0.06	1.69±0.05	0.9496(NS)
Weight (Kg)	64.39±6.89	65.84±7.56	0.1811(NS)
BMI(Kg/m^2)	22.67 ± 2.13	23.18 ± 2.34	0.1302(NS)
BSA(m^2)	2.00 ± 0.15	2.02 ± 0.14	0.4115(NS)
Student's unpaired t-test was used for analysis. p-value < 0.05 considered significant. NS – Non-significant, BMI – Body Mass Index, BSA – Body Surface Area			

Table 2. Vital Parameters of swimmers and non-swimmers

Parameters	Swimmers Mean ± SD	Non swimmers Mean ± SD	p value
Pulse rate (per minute)	74.67 ± 3.61	81.6 ± 5.92	0.0001**
Respiration rate (per minute)	14.76 ± 1.55	16.18 ± 1.10	0.0001**
Systolic BP (mmHg)	116.16 ± 3.74	117.13 ± 4.13	0.0996(NS)
Diastolic BP (mmHg)	75.69 ± 4.46	76.04 ± 4.71	0.6059(NS)
Student's unpaired t-test was used for analysis. p-value < 0.05 considered significant. NS – non-significant. ** - Highly significant. BP – Blood Pressure			

Further using Computerised Spirometer, we have measured pulmonary functions in swimmers & non-swimmers and it is shown in following table 3 and Figure 1

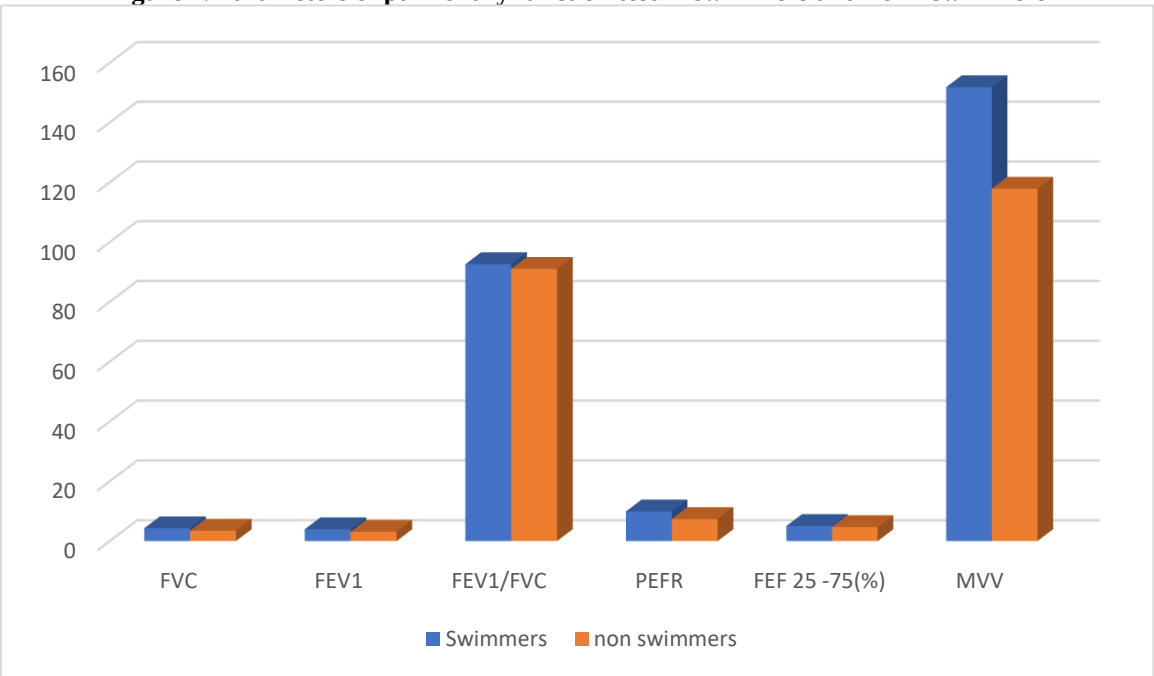
Table 3. Parameters of pulmonary function test in swimmers and non – swimmers

Parameters	Swimmers Mean ± SD	Non swimmers Mean ± SD	p value
FVC(Litres)	4.27 ± 0.53	3.44 ± 0.65	0.0001**
FEV1(Litres)	3.95 ± 0.48	3.11 ± 0.58	0.0001**
FEV1/FVC (%)	92.56 ± 4.98	90.99 ± 7.44	0.0979(NS)

PEFR(Litre/sec)	9.87 ± 1.08	7.36 ± 1.47	0.0001**
FEF 25-75(%) (Litre/sec)	5.01 ± 0.79	4.68 ± 0.72	0.003*
MVV (Litre/min)	151.81 ± 18.83	117.83 ± 17.95	0.0001**

Student's Unpaired t-test was used for analysis p-value< 0.05 considered significant.
NS-non-significant, * - significant, ** - Highly Significant
FVC – Forced vital capacity, FEV1 – Forced expiratory volume in the first second
PEFR – Peak expiratory flow, FEF25-75% - forced expiratory flow of mid-FVC,
MVV -Maximum voluntary ventilation

Figure 1. Parameters of pulmonary function test in swimmers and non - swimmers



V. Discussion

The anthropometric profile -The mean value of **Age**-(20.46 ± 2.36), **Height**-(1.69 ± 0.06) and **Weight**–(64.39±6.89) of swimmers compared with non-swimmers **Age (**20.48±2.70), **Height**1.68±0.05 in, and **Weight** in kg-65.84±7.56) and the difference ware found statistically non-significant. Similar findings were found by Doherty et al (1997) [9] Rumaka et al (2007) [10] Vaithiyanadane et al (2012)[11] Akhade et.al (2014)[5] where age height weight was matched. Whereas in the study published by Chhabra et.al. (2013) [12] mean difference of height and weight was significant which is not in accordance with our study.

The anthropometric profile the mean value of **BMI** (Body mass index) and **BSA** (Body surface area) was matched and the difference was found statistically nonsignificant in between swimmers (BMI 22.67±2.13, BSA 2.00±0.15) & non-swimmers (BMI 23.18±2.34, BSA 2.02±0.14) in our study. Similar findings were also found by Vaithiyanadane et al (2012)[11] where age, height, weight was matched. Whereas in the study done by Chhabra et al (2013)[12] mean difference of BMI & BSA was significant which is not in accordance with our study.

The vital parameters: The mean value of pulse rate was 74.67±3.61 and respiration rate was 14.76±1.55 in swimmers and pulse rate was 81.6±5.92 and respiration rate was 16.18±1.10 in non swimmers and the differences were statistically highly significant.

The vital parameters: The mean value of systolic Blood pressure (in mmHg) was 116.16±3.74 and diastolic Blood pressure (in mmHg) was 75.69±4.46 in swimmers while systolic Blood pressure (in mmHg) was 117.13±4.13 and diastolic Blood pressure (in mmHg) was 76.04±4.71 in non swimmers and the differences were statistically non-significant.

Pulmonary function test of swimmers and non –swimmers:

1. FVC (Forced vital capacity): The mean value of FVC (Litre) was 4.27±0.53 in case of swimmers whereas it was 3.44± 0.65 in case of non -swimmers and the difference was statistically highly significant. Which is similar with the studies done by Doherty et al (1997)[9], Mehrotra et al (1998)[13] , Rumaka et al (2007)[10] ,Vaithiyanadane et.al (2012)[11] ,Chhabra et al (2013)[12]& Akhade et al (2014)[5]

2. FEV1(forced expiratory volume in the first second): The mean value of FEV 1 (Litre) was 3.95±0.48 in case of swimmers whereas it was 3.11 ± 0.58 in case of non –swimmers and the difference was statistically significant, which is similar with the studies done by Doherty et al (1997)[9], Mehrotra et al (1998)[13], Rumaka et al (2007)[10], Vaithiyanadane et al (2012)[11],Chhabra et al (2013)[12]& Akhade et al (2014)[5]

3. FEV1/FVC %(FEV1/FVC ratio in percentage): The mean value of FEV 1/FVC was 92.56 ±4.98 in case of swimmers whereas it was 90.99 ± 7.44 in case of non-swimmers and the difference was statistically non-significant, which is similar with the studies done by Doherty et al (1997)[9], Rumaka et al (2007)[10] , Vaithiyanadane et al (2012)[11] ,Chhabra et al (2013)[12] as shown in the following table .Whereas, in the study published by Akhade et al (2014)[5] observed that the FEV1/FVC ratio was increased significantly in swimmers as compared to non-swimmers which are not in accordance with the present study.

4. PEFR (peak expiratory flow rate): The mean value of PEFR (Litre/Sec) was 9.87±1.08 in case of swimmers whereas it was 7.36 ± 1.47 in case of non -swimmers. and the difference was statistically highly significant. which is similar to the studies done by Mehrotra et al (1998) [13], & Akhade et al (2014)[5] but not accordance with the study of Rumaka et al (2007)[10]& Chhabra et al (2013)[12]where PEFR was reduced in swimmers as compared with non-swimmers .

5. FEF25-75% (Average FEF rate over the middle 50% of the FVC): The mean value of FEF25-75 % (percentage) was 5.01±0.79 in case of swimmers whereas it was 4.68 ± 0. 72 in case of non -swimmers. and the difference was statistically significant, whereas Chhabra et al (2013)[12] published a study, where PEFR was reduced in swimmers as compared with non-swimmers.

6.MVV (Maximum voluntary ventilation): The mean value of MVV (litre/min) was 151.81±18.83 in case of swimmers whereas it was 117.83 ± 17.95 in case of non -swimmers. Thus, the mean value of MVVwas an increase in swimmers as compared to non-swimmers and the difference was statistically highly significant.

which is similar with the studies done by Vaithiyanadane et al (2012)[11]& Akhade et al (2014)[5]as shown in the following table.

VI. Conclusions

This study has demonstrated that exercise in the form of swimming for a short duration (6 months -1 year) produces a significant improvement in the pulmonary functions. The improvement in pulmonary functions can be due to increase in strength of respiratory muscles. So, swimming can be recommended to improve the lung functions of an individual, in case of a young adult also.

Simple changes in lifestyle by enhancing physical activity would go a long way.

Limitations Of The Study

This cross-sectional study was done for a period of 1½ years. These study findings cannot be generalized to the community because of following facts –

- Only male population was taken
- Study was done among members of one swimming pool only

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