Original Article

A study to compare the physiological effect of aging on respiratory functions in sedentary individuals to the professional swimmers

P Sambasivarao[1], Balla Sriramulu[2], Mohd Rasheeduddin Imran[3*]

[1]Assistant Professor, Department of Physiology, SVS Medical College, Mahboobnagar. Andhra Pradesh, INDIA.
[2]Associate Professor, Department of Physiology, Rajiv Gandhi Institute of Medical Sciences, Srikakulam, Andhra Pradesh, INDIA.
[3]Assistant Professor, Department of Physiology, Bhaskar Medical College, Telangana, INDIA.
Email: dr.imran1980@gmail.com

Abstract

Background: Pulmonary function tests are of significance in assessing the functional status of lungs in different age groups exposed to varied conditions of physical activity and to predict the clinical outcome. **Aims**: A study has been conducted to evaluate and compare the physiological effects of aging on respiratory functions in sedentary individuals to the professional swimmers. **Settings and Design:** This cross-sectional study was conducted in clinical lab of physiology department on 75 healthy male sedentary subjects and 75 healthy male professional swimmers in the age range of 26 to 70 years divided further into three groups, 26 to 40 years, 41 to 55 years and 56 to 70 years. **Materials and Methods:** FVC, FEV1, FEV1%, and PEF 50% were spirometric parameters used to evaluate the pulmonary function and differences between groups. Lung Function Test was performed using– computerized spirometer "Medspiror". All the values were recorded and comparison tables were derived after statistical analysis using SPSS statistical software version 20.0 and the results were analyzed. **Results and Conclusion:** The Pulmonary Function values derived were compared between the study groups. In the present study the professional swimmers were having higher mean value of FVC, FEV1, FEV1%, and PEF 50% as compared to sedentary group. Sedentary age group III (56 to 70 years) has significantly least mean values for the lung function variables compared to all other groups suggesting decline in lung function with age. The professional swimmers have higher mean values than all the sedentary groups suggesting that regular swimming has improved the lung function.
Keywords: lung function test, age, lifestyle.

***Address for Correspondence:**
Dr. Mohd Rasheeduddin Imran, Assistant Professor, Department of Physiology, Bhaskar Medical College, Telangana, INDIA.
Email: dr.imran1980@gmail.com
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INTRODUCTION

Aging process has effect on the respiratory system affecting the mechanics of breathing and also the lung volumes. There is increased work of breathing with the changes occurring in the lungs with age. Respiratory function is also related to physical exercise and also to healthy lifestyle. The changing lifestyle with unhealthy food and sedentary habit has decreased the working capacity and also productive lifespan. Sedentary lifestyle is an important cause of obesity and thus an important modifiable cause of many diseases. The effects of aging on the mechanical behavior of the human lung have been well described in relation to its P-V behavior[2,11]. Morphometric studies in human[9,22] and dog[6] lungs showed that alveolar mean linear intercept (or alveolar diameter) increases, whereas alveolar surface area decreases with age. This behavior is associated with an increase in lung tissue elastin and little change in collagen content[15,16]. The lung parenchyma becomes more resistant to both uniform expansion and shear deformation with increasing age.[21] Both tissue and surface forces contribute to tension in alveolar walls. Surface forces that arise from the alveolar air liquid interface are modified by pulmonary surfactant[19,20]. The contribution of tissue forces to the elastic constants can be measured by studying the lung filled with saline[4]. The most important

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physiological changes associated with ageing are of respiratory system depicting the decrease in static elastic recoil of the lung, in respiratory muscle performance, and in compliance of the chest wall and respiratory system, resulting in increased work of breathing. (Janssens, 2005)[7]. Normal aging results in changes in pulmonary, mechanics, respiratory muscle strength, gas exchange and ventilatory control. Increased rigidity of chest wall and a decrease in respiratory muscle strength with aging result in an increased closing capacity and a decreased forced expiratory volume in first second or FEV1 (Knudson *et al*, 1983)[10]. Significant variables affecting the standards for ventilatory function include age, height, sex, size of the sample tested, racial and ethnic composition, criteria for normality, tobacco smoking, environmental conditions, altitude of residence, apparatus and techniques. Since master athletes train as vigorously as they possibly can, and withdraw from competitions when they become sick or otherwise impaired, they constitute a unique population to study age-related changes without (or with very little) contribution of two usual confounders of old age, namely sedentarism and co-morbidity (Rittweger *et al*. 2004)[17]. Some studies reported a positive correlation between physical activity and physical fitness and lung capacity[3,12,23], while others do not[1]. A study has been conducted to evaluate and compare the physiological effects of aging on respiratory functions in sedentary individuals to the professional swimmers. The aim of the present cross-sectional study was therefore to evaluate and compare the physiological effects of aging on respiratory function in professional swimmers and sedentary control people. We hypothesized that there is decline in lung function with age and that the professional swimmers would have better ventilatory function than age-matched sedentary population[22]. The study is being done to signify the benefits of dynamic exercise such as swimming that improves the lung function and general health condition.

MATERIALS AND METHODS

This cross-sectional study was conducted in clinical lab of physiology department on 150 healthy male subjects in the age range of 26 to 70 years. The subjects were further divided into three groups of age range, (group I:- 26 to 40 years, Group II:- 41 to 55 years and Group III :- 56 to 70 years).

Each age group consists of 25 healthy male sedentary individuals and 25 healthy male professional swimmers.

Group	Age range	Sedentary subjects	Swimmers
Group I	26 – 40 years	25	25
Group II	41 – 55 years	25	25
Group III	56 – 70 years	25	25

After obtaining informed written consent, the procedure was explained to all the subjects. Detail history, physical examination and anthropometric measurements were done in all subjects. In the present study, sedentary individuals were defined as individuals who have less than 20 minutes of physical activity in a day. Professional swimmers were defined as subjects who practiced swimming daily for two or more hours for more than 2 year.

Inclusion Criteria

1. Healthy subjects,
2. Male subjects,
3. Age range of 26 – 70 years,
4. Non-hypertensive and non-diabetic.

Exclusion Criteria

1. Tobacco chewers and smokers.
2. Respiratory or other systemic diseases,
3. On medication,
4. On diet restriction,
5. Alcoholics

METHOD

The lung function tests were carried on all the subjects as per the standards mentioned by M.R Miller *et al*[13]. The tests were carried out using computerized spirometer "Med-Spiror". The subjects were familiarized with the instrument and the technique used. During this time period the laboratory was staffed by a technologist and a trained medical officer. The readings were taken in standing position. Age, height and body weight were recorded. Each subject was given two trials and three tests runs for each test and best of the three test readings was taken. The parameters studied from the records were Forced Vital Capacity (FVC), Forced Expiratory Volume in 1second (FEV1), FEV1% and Peak expiratory flow rate (PEF 50%).

Statistical Analysis

Commercially available software was used for statistical computations. Data analysis was done using IBM SPSS statistics version 20.0 Data are reported as mean, standard deviation and standard error of mean. Mean values were compared between two different groups using unpaired t test for the difference in the mean scores. A 2-tailed P value of less than 0.05 was considered significant and less than 0.001 as highly significant.

RESULTS

The mean age and mean anthropometric measurements of the groups is summarized in table 1 which suggests that the three groups differed significantly only in age and are comparable.

Table 1

Variables	Study groups			P value
	Group I	Group II	Group III	
Age (years)	34.0 (5.0)	48.2 (5.2)	62.4 (4.5)	S
Weight (kg)	56.2 (8.6)	55.3 (8.3)	54.2 (8.5)	NS
Height (m)	1.63 (7.2)	1.64 (6.8)	1.62 (7.0)	NS
BMI	25.58 (1.8)	24.96 (2.2)	25.15 (1.6)	NS

Anthropometric measurements of participants

The parameters considered in this study are: FVC, FEV1, FEV1%, and PEF 50%. Comparison table showing lung function changes with age in sedentary group. The descriptive results of spirometric pulmonary functions (mean±SD) are summarized in Table 2.

Table 2

Parameter Predicted %	Sedentary Group I: (26-40 YRS) N= 25 mean±SD	Sedentary Group II: (41-55 YRS) N= 25 mean±SD	Sedentary Group III: (56-70 YRS) N= 25 mean±SD	Comparison between groups (p-value)		
				Gp-I and Gp-II	Gp-I and Gp-III	Gp-II and Gp-III
FVC	4.467 ± 0.074	3.98 ± 0.04	2.39 ± 0.012	HS	HS	HS
FEV1	3.585 ± 0.051	2.934 ± 0.02	1.892 ± 0.032	HS	HS	HS
FEV1%	80.4 ± 0.68	73.79 ± 0.974	68.61 ± 1.801	HS	HS	HS
PEF 50%	4.104 ± 0.0789	3.239 ± 0.013	2.436 ± 0.097	HS	HS	HS

HS= highly significant (P <0.001), S=significant (P<0.05)

Comparison table showing lung function changes with age in professional swimmers. The descriptive results of spirometric pulmonary functions (mean± SD) are summarized in Table 3.

Table 3

Parameter Predicted %	Swimmer Group I: (26-40 YRS) N= 25 mean±SD	Swimmer Group II: (41-55 YRS) N= 25 mean±SD	Swimmer Group III: (56-70 YRS) N= 25 mean±SD	Comparison between groups (p-value)		
				Gp-I and Gp-II	Gp-I and Gp-III	Gp-II and Gp-III
FVC	4.98 ± 0.15	4.15 ± 0.09	2.49 ± 0.03	HS	HS	HS
FEV1	4.077 ± 0.115	3.254 ± 0.063	2.021 ± 0.024	HS	HS	HS
FEV1%	82.48 ± 0.441	78.6 ± 2.2	74.7 ± 0.65	HS	HS	HS
PEF 50%	4.462 ± 0.108	3.914 ± 0.043	2.908 ± 0.081	HS	HS	HS

HS= highly significant (P <0.001), S=significant (P<0.05)

Comparison table showing lung function in professional swimmers and sedentary individuals in Group I. The descriptive results of spirometric pulmonary functions (mean±SD) are summarized in Table 4.

Table 4

Parameter Predicted %	Swimmer Group I: (26-40 YRS) N= 25 mean±SD	Sedentary Group I: (26-40 YRS) N= 25 mean±SD	Combined Std deviation	Comparison between groups (p-value)	
				t value	p value
FVC	4.98 ± 0.15	4.467 ± 0.074	0.1182	15.342	<0.001
FEV1	4.077 ± 0.115	3.585 ± 0.051	0.0889	19.563	<0.001
FEV1%	82.48 ± 0.441	80.4 ± 0.68	0.573	12.832	<0.001
PEF 50%	4.462 ± 0.108	4.104 ± 0.0789	0.0945	13.391	<0.001

HS= highly significant (P <0.001), S=significant (P<0.05)

Comparison table showing lung function in professional swimmers and sedentary individuals in Group II. The descriptive results of spirometric pulmonary functions (mean± SD) are summarized in Table 5**.**

Table 5

Parameter Predicted %	Swimmer Group II: 41-55 YRS) N= 25 mean±SD	Sedentary Group II: (41-55 YRS) N= 25 mean±SD	Combined Std deviation	Comparison between groups (p-value)	
				t value	p value
FVC	4.15 ± 0.09	3.98 ± 0.04	0.0696	8.634	<0.001
FEV1	3.254 ± 0.063	2.934 ± 0.02	0.0467	24.222	<0.001
FEV1%	78.6 ± 2.2	73.79 ± 0.974	1.701	9.996	<0.001
PEF 50%	3.914 ± 0.043	3.239 ± 0.013	0.063	37.875	<0.001

HS= highly significant(P <0.001), S=significant (P<0.05)

Comparison table showing lung function in professional swimmers and sedentary individuals in Group III. The descriptive results of spirometric pulmonary functions (mean±SD) are summarized in Table 6**.**

Table 6

Parameter Predicted %	Swimmer Group III: (56-70 YRS) N= 25 mean±SD	Sedentary Group III: (56-70 YRS) N= 25 mean±SD	Combined Std deviation	Comparison between groups (p-value)	
				t value	p value
FVC	2.49 ± 0.03	2.39 ± 0.012	0.022	16.06	<0.001
FEV1	2.021 ± 0.024	1.892 ± 0.032	0.0282	16.17	<0.001
FEV1%	74.7 ± 0.65	68.61 ± 1.801	1.353	10.215	<0.001
PEF 50%	2.908 ± 0.081	2.436 ± 0.097	0.0893	18.684	<0.001

HS= highly significant (P <0.001), S=significant (P<0.05)

The student t test compared different groups and a statistically highly significant difference was obtained in FVC, FEV1, FEV1%, and PEF50% among the three groups. Mean values of these spirometric measures were higher in professional swimmers in all age range groups compared to sedentary individuals. The mean values of the parameters were significantly reduced in the groups with the increasing age, with highest in group I and least in Group III.

DISCUSSION

The results of the present study conducted with an aim to explain the physiological effects of age in individuals with different lifestyle conditions including the sedentary life style and regular swimming on the functioning of the lungs and to signify the importance of regular dynamic exercise to improve the health. The study shows that the spirometric parameters decline with the increasing age within the groups and in comparision. The study shows that the individuals who have sedentary lifestyle has lung function values significantly lesser than the professional swimmers in all age groups. From this study, the evidence of changes in lung function with age is in accordance with current available data. The major finding of the study by Stephen J. Lai-Fook *et al*, is that both K (specific lung compliance) and m (shear modulus) of human lungs increase with age at constant Ptp (transpulmonary pressure.[21] Mittman *et al*. found a significant reduction in the compliance of the chest wall with age.[14] The 60-year-old subject would have to do 20 % more elastic work at a given level of ventilation than the 20-year-old, but he would expend 70 % of his total elastic work on the chest wall, whereas the comparable value for the 20-year-old would be 40%.[6] The study done by Hans Degens *et al*. concluded that the ventilatory function in master athletes was superior to that in age-matched controls in their study**.**[5] The study done by Rosemary Peter *et al*. has shown that both athletes and yogis had significantly better lung functions as compared to sedentary workers. People with sedentary lifestyles had lowest pulmonary function parameters.[18] Assessment of health by pulmonary function tests by simple spirometry if used routinely, permit early identification of abnormalities associated with many respiratory diseases. These tests would also provide valuable information in monitoring disease progression, response to treatment and rating disability due to occupational hazards. The results of this study agree with this fact that sedentary lifestyle is accompanied by significantly lesser lung function values compared to regular swimmers. There is much evidence that sedentary lifestyle is associated with indulging in unhealthy habits such as smoking and also that regular physical activity prevents individual from unhealthy habits. Smoking is one of the important reason for quitting the physical activities and participation in sports. The current study has shown that simple lifestyle modification by actively participating in physical activity such as swimming can improve lung function with increasing age and therefore there can be a lower lung function decline which improve and maintain general health condition and also decreases the risk of lung diseases compared to sedentary individuals even in the older age. In counseling patients who has sedentary life style, health professionals can provide abundant information on the improvement in lung function and general health condition following starting regular physical activity such as swimming. Since many previous studies has shown that the risk of development pulmonary and cardiovascular disease is reduced significantly in swimmers because of the physical activity, the clear public health message is that it is never too late to start physical activity. In summary, the present study shows significant lung function changes with age in both sedentary individuals and professional swimmers. However the changes are comparatively less in swimmers than sedentary individuals. Starting the swimming exercises in early ages in childhood prevents the deleterious effects of sedentary lifestyle on the respiratory function and also improves the general health condition.

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