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A Comparative Study of Oxygen Saturation (Spo2) At Rest and after 6-Minutes Walking Test in Young Adults with Variable BMI

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Abstract

Background: Exercise affects every system of the body and cause several changes in them and respiratory changes are most important. Changes in blood levels of oxygen are very vital during exercise. The respiratory system is most efficient in young adults and undergoes various anatomical, physiological and immunological changes with age and hence blood levels of oxygen during exercise is more affected in elderly as compared to young adults.. But increased body mass index affects respiratory system of even young adults so there blood levels of oxygen are more compromised as compared to normal BMI young adults during exercise.

Objective: Under normal circumstances in the blood there is a reserve of oxygen. However, when doing exercise, the body requires oxygen in large quantities to meet the need for energy. If the level of oxygen in the blood decreases beyond the normal limit, it will be very dangerous for the body. Health risks are associated with obesity, including its effects on respiratory function. Respiratory muscle weakness in obesity has been linked to muscle weakness as a result of decreased compliance of the chest wall or reduced lung volume or can occur both.

Aim: Is to study the effect exercise on SpO2 in young adults with variable BMI.

Method: A comparative cross-sectional analytical study was conducted on 106 young adults in Medical College in North India. Data was collected by using self-administered questionnaire followed by anthropometric measurement. Body Mass Index (BMI) was calculated by Quetelet's index. Oxygen saturation at rest and after 6-minutes walking test was recorded by using pulse oximeter. Data analyzed on SPSS version 20.0 and various statistical tests were applied to find the correlation and significance.

Results: The students with high BMI show negative correlation with oxygen saturation (SpO2) at rest and after 6-minutes walking test. This correlation is statistically significant.

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Conclusion: There is more decrease in oxygen saturation (SpO2) in students with high BMI after 6-minutes walking test as compared to students with normal BMI. Weight management is recommended to young adults in order to prevent early impact of increased BMI on respiratory system.

Keywords: Body mass index (BMI), Quetelet's index, 6- minutes walking test, Obesity, oxygen saturation (SpO2)

Introduction

During exercise, cells may need to use over six times the oxygen used during rest. Aerobic exercise is also limited by the ability of the cardiovascular system to deliver oxygenated blood to the muscles. [(1)] Exercise will cause several changes in the body, one of which is the oxygen level in the blood. Under normal circumstances in the blood there is a reserve of oxygen. However, when doing exercise, the body requires oxygen in large quantities to meet the need for energy. If the level of oxygen in the blood decreases beyond the normal limit, it will be very dangerous for the body.[(2)]Among the different systems affected by obesity, the respiratory system deserves special attention, as obesity can cause changes in respiratory function, exercise tolerance, pulmonary gas exchange, respiratory pattern and strength and endurance of the respiratory muscles.[(3)] Health risks associated with obesity, including its effects on respiratory function. Respiratory muscle strength can experience weakness in obesity, where there is a decrease in maximal inspiratory pressure in obese subjects compared to subjects for normal body weight. Respiratory muscle weakness in obesity has been linked to muscle weakness as a result of decreased compliance of the chest wall or reduced lung volume or can occur both. [(4)]

The amount of oxygen carried depending on haemoglobin in the blood is named as SpO2 and this forms the main mechanism for the transportation of oxygen to the cells. Measurement of oxygen saturation gives information about hypoxia.[(5)] Peripheral capillary oxygen saturation (SpO_2) is commonly measured by pulse oximetry, which provides an indirect measurement of arterial oxygenation (SaO_2) based on the differential absorption of light by oxygenated and deoxygenated blood during pulsatile blood flow.[(6)] The oxygen saturation (SaO2) is the statistical average of the entire oxygen bound to haemoglobin. In healthy individuals SaO2 is 96%-98 %.[(7)]

Blood gas analysis was the optimal technique for detecting hypoxemia in critically ill patients for many years, but it has potential complications and is unable to provide a continuous measurement. [(8)] Oxygen requirements can be determined using pulse oximetry, instead of arterial blood gas sampling. Pulse oximetry is a technique used to measure oxygen saturation (SpO2) non-invasively. [(9)]

Material and Methods

A comparative cross-sectional analytic study was conducted in Medical College in North India. After explaining the procedure of the study to be conducted, an informed consent was obtained from the subjects. A total of 106 subjects were selected. Apparently healthy undergraduate medical students, aged between 18 -24 years, non-smokers, consenting for study were included in study. The history was also obtained from every individual prior to the study in which their personal details, medical record, family background, socio-economic status, diet and physical activity and history of smoking was asked. Students with any medical problem or on any medication, smokers, not consenting for study were excluded from the study.

Data was collected by using self-administered questionnaire based on review of similar studies. The questionnaire contains several anthropometric data included information of age, gender, height and weight. Pulse oximetry was done to know the oxygen saturation. Height was determined using a stadiometer and weight was measured using kg weight scale. The BMI was calculated by Quetelet's index i.e. BMI is weight (kg)/height $(m)^2$ .BMI was classified in to three groups as per new classification for Asian Indians as {Undernourished: <18.0 kg/ m^2Normal weight: 18-22.9 kg/m^2Overweight: 23-24.9 kg/m^2Obese: >25 kg/m^2}**(10).**

Oxygen saturation (SpO2) was estimated by digital pulse oximeter at rest. Pulse oximetry is a relatively simple, feasible, non-invasive and

inexpensive method. The team was instructed to avoid measuring oxygen saturation at the fingers with any nail polish or dye, as they can interfere with accurate measurements. Readings for oxygen saturation after 30 s of the pulse oximeter being attached to the subjects' fingers were taken at rest. Another reading of SPO2 was taken after 6-minutes walking test.

6-Minute walking test; -The six minute walking test (6MWT) was developed by the American Thoracic Society and it was officially introduced in 2002. It is a sub-maximal exercise test used to assess aerobic capacity and endurance and has proved to be reliable, inexpensive, safe and easy to apply.

The subjects were asked to do 6 minutes walking test and pulse oximeter was placed on the index finger during the test and SpO2 was noted immediately after 6-minutes walking test.

Data entry and analysis was done using Statistical Package for Social Sciences (SPSS). Chi-square was used for categorical data analysis and a P value of ≤0.05 was regarded as statistically significant.

Results

Table 1: Gender Distribution

	Frequency	Percent	Cumulative Percentage
Female	66	62.3	62.3
Male	40	37.7	100.0
Total	106	100.0	

Table 2: BMI Distribution

BMI	Gender		Total
	Female	Male	
<18.5	2(1.9%)	2(1.9%)	4(3.8%)
18.5-24.9	48(45.3%	30(28.3%)	78(73.6%)
25-29.9	13(12.3%)	7(6.6%)	20(18.9%)
>30	3(2.8%)	1(0.9%)	4(3.8%)
Total	66(62.3%)	40(37.7%)	106(100%)

Table 3: BMI and SPO2 (Crosstabulation)

BMI	Spo2 rest				Total	
	>98	97-98	95-96	<95		
<18.5	0 (0%)	1 (25%)	2 (50%)	1 (25%)	4 (100%)	Pearson's R=0.113 Spearman correlation=0.104 P Value =0.000 (p<0.005)
18.5-24.9	46 (58.9%)	20 (25.7%)	12 (15.4%)	0 (0%)	78 (100%)	
25-29.9	0 (0%)	4 (20%)	16 (80%)	0 (0%)	20 (100%)	Statistically Significant
>30	0 (0%)	0 (0%)	1 (25%)	3 (75%)	4 (100%)	
Total	20	51	31	4	106	

Table 4. BMI and SPO2 (after 6-minutes spot exercise)

BMI		spo2Eercise				Total	
		>98	97-98	95-96	<95		
	<18.5	0 (0%)	0 (0%)	4 (100%)	0 (0%)	4 (100%)	Pearson's R=0.124 Spearman correlation=0.96
	18.5-24.9	28 (35.9%)	34 (43.6%)	16 (20.5%)	0 (0%)	78 (100%)	P Value=0.000
	25-29.9	0 (0%)	3 (15%)	17 (85%)	0 (0%)	20 (100%)	(p<0.05)
	>30	0 (0%)	0 (0%)	1 (25%)	3 (75%)	4 (100%)	Statistically
Total		28	37	38	3	106	Significant

Discussion

Many cardiovascular and respiratory mechanisms must operate in an integrated fashion if the O2 needs of the active tissue are to be met and the extra CO2 and heat removed from the body during exercise. Circulatory changes increase muscle blood flow while maintaining adequate circulation in the rest of the body. In addition, there is an increase in the extraction of O2 from the blood in exercising muscles and an increase in ventilation. [11]

The purpose of this study was to investigate the correlation of SpO2 (%) with pre- and post- induction of short term exercise (6-minutes walk test) in young, non-athletes undergraduate male and female medical students with an age ranging from 18-24 years with variable BMI. Our study included 106 students with 62.3% females and 37.7% males. Among these 3.8%were underweight with BMI <18.5, 78% were with normal BMI 18.5-24.9, 20% were overweight with BMI 25-29.9 and 3.8% were obese with BMI of >30. The percentage of obese and overweight female students were more than male students.

At rest oxygen saturations(SpO2) of >97 were in 84.6% students with normal BMI (18.5-24.9),80% overweight students (BMI 25-29.9) were having SpO2 levels of 95-96 while as obese students (BMI >30) with SpO2 levels <95 were 25% and 95-96 were 75%.

Table 3. shows that at rest students with higher BMI have lower SpO2 levels, high BMI is negatively correlated with SpO2 levels. The correlation between BMI and SpO2 levels at rest was statistically significant with p=0.000 (p=<0.05), Spearman correlation 0.104 and Pearson's R=0.113.

Similar studies were conducted by Vishesh K Kapur et al. [12] which showed that obesity Is Associated with a Lower Resting Oxygen Saturation in the Ambulatory Elderly. A study by Monica Linea Vold et al [13] showed that low FEV1, smoking history, and obesity are factors associated with oxygen saturation decrease in an adult population cohort.

After 6-minutes walking test, the SpO2 levels of >98, in students with normal BMI were 35.9%, 97-98 SpO2 in 43% while as overweight students with SpO2 of 95-96 were 85% and in obese students SpO2 levels were <95 in 75% and 95-96 in 25%. After exercise SpO2 levels decreased as compared to SpO2 levels at rest and this decrease was more in students with high BMI. The correlation between BMI and SPO2 levels after 6-minutes walking test was statistically significant with p=0.000 (p<0.05).

These results are in line with the results of research conducted by Eroglu et al. 2018, [14] which concluded that aerobic exercise performed acutely can reduce oxygen saturation. Barcroftet al [15] and Penaloza et al [16] also indicated that there was a decrease in oxygen saturation of arterial blood during exercise. Onder Daglioglu et al. 2013 [17] also studied that short-term exercise reduces the oxygen saturation but regular exercise doesn't affect the

change in oxygen saturation. In a study conducted on 117 patients, it was found that oxygen saturation decreased after aerobic exercise (Talvar et al., 2018). [18] In another study conducted on patients (patients without cystic fibrosis), it was found that oxygen saturation decreased after the 6-min walk test (HSIEH, et al., 2017). [19]

Under normal circumstances there is a reserve of oxygen in the blood. However, when doing exercise, the body requires large amounts of oxygen to meet the energy needs for muscle contraction, thus causing oxygen stores in the body to decrease. The decrease in oxygen storage causes a decrease in oxygen saturation, so that the exercise group tends to have lower oxygen saturation compared to the control group. [20]

Obesity is one of the independent contributors to a low SpO2, with its effects comparable to or greater than other factors which are commonly associated with lower oxygen saturation. This suggests that the obesity or overweight affects lung function by diminishing oxygen exchange. The prognostic implications of this finding with regards to long-term outcomes are unclear and require further prospective evaluation.

Conclusion

In conclusion, we can say that SpO2 becomes lower despite the same partial pressure of oxygen during exercise, as supported by the relevant literature and this SpO2% become even more decreased in subjects with high BMI. Since obesity affects all systems of body including respiratory system. Keeping in view multisystem diseases and dysfunctions related to overweight and obesity especially in young adults, National Medical council (NMC) has introduced sports activities in revised curriculum to be implemented in every medical college.

Based on the results of the study it is recommended to do further research by comparing treadmill exercises with several kinds of exercise intensities like mild, moderate and severe to study the changes in oxygen saturation. Also weight management is recommended to young overweight and obese adults in order to prevent early impact on respiratory system and to increase the endurance.

Limitations

We did not independently verify the accuracy of our SpO2 measurements using arterial blood gases and relied on the long-term accuracy of the pulse oximeters due to invasive nature of arterial blood gas sampling.

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