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Original Article

Influence of body mass index on pulmonary function tests in young Punjabi population

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Abstract:

Background: Increasing respiratory problems in youngsters, due to lifestyle and eating habits, have raised an alarming situation. To combat such health hazards, interest has peaked in the investigation of body mass index (anthropometric index) and its impact on pulmonary functions.

Objectives: Aim of this study was to analyze relationship between pulmonary functions and body mass index (BMI) of subjects/participants in the Punjabi population (youngsters only).

Material and Methods: This study was carried out at Punjab Institute of Medical Sciences Jalandhar, for which, the database of 234 medical students belonging to the age group of 18-25 years was investigated. A medspiror computerized spirometer was used to procure information about their pulmonary functions, in terms of the forced vital capacity (FVC), peak expiratory flow rate (PEFR) and maximum voluntary ventilation (MVV).

Results: All the subjects were segregated into two major categories based on gender, and these were further subdivided based on their BMI status in subgroups as underweight, normal, overweight and obese. A significant reduction (p-value < 0.05) in the pulmonary functions was observed in case of the obese subjects in comparison to the subjects exhibiting normal BMI with best results. Moreover, authors inferred that BMI had a substantial negative correlation with the pulmonary function test values (p-value < 0.05).

Conclusions: The underweight, overweight and obese subjects/participants may encounter respiratory problems irrespective of gender, which need to be investigated further in different scenarios like seasonal changes and under the influence of different diseases like asthma. The authors suggest that the weight needs to be controlled for normal BMI to maintain good lung functions.

Key Words: Respiratory disorders, body mass index, pulmonary functions

Introduction

Respiratory disorders are one of the commonest causes of hospital visits, which are found to be responsible for morbidity as well as mortality worldwide. Pulmonary function tests are usually carried out for assessing the functional impairments and to make diagnosis. It is due to the fact that the lungs are generally affected in case of multisystemic diseases. However, the pulmonary functions may also differ in normal people because of ethnic origin, physical activities, environmental conditions, altitude, age, height, gender, socioeconomic status and based on the level of tobacco consumption. [1]

In addition, there are a number of other anthropometric measurements that can influence the functioning of lungs, such as body mass index (BMI), waist circumference and waist-hip ratio. [2] Undoubtedly, the obesity is a global health problem due to changing lifestyle, which is exaggerated by the alleviated level of physical activities and the elevated

intake of highly processed food stuffs. Unfortunately, overweighing and obesity may lead to some inevitable health hazards, like diabetes (type-II), hypertension, cardiovascular diseases, some types of cancers and premature mortality. [3]

It is a well-known fact that overweighing and obesity are closely associated with an increased level of BMI. Some researchers have reported a substantial reduction in the forced vital capacity (FVC), forced expiratory volume in the first second and the peak expiratory flow rate (PEFR) in adolescent boys with high BMI status.[4] Therefore in the presented research work, we focus on the effects of body mass index on the pulmonary function tests in young subjects/individuals, in the Punjabi population.

Material and Methods

The ethical/research approval for this study, done within the Physiology Department, was granted by the Institutional Committee of the Punjab Institute of Medical Sciences (PIMS) Jalandhar (affiliated to Baba Farid University of Health Sciences, Faridkot, India). As per the protocol, the participation was voluntary, and the subjects/participants were informed about the purpose and nature of the research.

The study was conducted on 234 randomly selected subjects aged between 18 to 25 years belonging to the Punjabi population. A written consent was obtained from all subjects, and whole procedure was explained to them, which involved Medspiror computerized spirometer. A detailed review of their medical history and physical examination were exercised. Subjects with known respiratory, cardiovascular, neuromuscular diseases, or suffering from thoracic skeletal deformities, diabetes mellitus, thyroid dysfunction and/or with history of any drug intake were excluded from the research data collection. The height of each subject was calculated in the standing and erect posture by using a standard measuring tape. Their weight was recorded by using a standard weighing machine. Body mass index was attained by utilizing the Quetelet index i.e., weight in kilogram per square of height in meters. All the subjects were segregated into following two groups based on the gender.

Table 1: Grouping of Subjects

Group Number	Body Mass Index	Group Name
Group – 1a (Female) Group – 2a (Male)	00.00 < BMI < 18.50	Under-Weight (UNW)
Group – 1b (Female) Group – 2b (Male)	18.50 ≤ BMI ≤ 24.90	Normal-Weight (NOW)
Group – 1c (Female) Group – 2c (Male)	25.00 ≤ BMI ≤ 29.90	Over-Weight (OVW)
Group – 1d (Female) Group – 2d (Male)	30.00 ≤ BMI	Obese (OBW)

It is noteworthy fact that same spirometer was utilized throughout the study; and the tests were performed by the same technician. Minimum three readings were recorded for each subject, and the average of three was chosen for the analysis. The observed data was analyzed using the standard statistical techniques, based on N number of subjects/participants.

Results

We have calculated mean and standard deviation for the observations obtained corresponding to FVC, PEFR and MVV for both genders, which is

represented as Mean ± Standard Deviation in Table 2 and Table 3. It may be inferred from Table 2 that FVC, PEFR and MVV measured values are significantly (p-value < 0.05) lower in the group-1a (UNW), group-1c (OVW) and group-1d (OBW) in comparison to the group-1b (NOW) in case of the female data. It is apparent from Figure 1 that group-1d (OBW) subjects exhibit substantially lower pulmonary function test mean values (p-value < 0.05) as compared to other groups. However, the difference between test values of group-1a (UNW) and group-1c (OVW) is quite small (not significant).

Table 2: Statistics for Female Subjects

Measured Value	Group-1a (N1a = 100)	Group-1b (N1b = 32)	Group-1c (N1c = 22)	Group-1d (N1d = 08)
FVC	02.31 ± 00.34	03.20 ± 00.21	02.48 ± 00.38	01.90 ± 00.10
PEFR	03.82 ± 00.21	06.35 ± 1.17	03.53 ± 00.38	03.04 ± 00.04
MVV	65.20 ± 01.26	104.30 ± 14.13	73.81 ± 07.87	55.30 ± 01.10

Table 3: Statistics for Male Subjects

Measured Value	Group-2a (N2a = 06)	Group-2b (N2b = 30)	Group-2c (N2c = 30)	Group-2d (N2d = 06)
FVC	02.78 ± 00.07	03.79 ± 00.32	02.77 ± 00.30	01.98 ± 00.04
PEFR	04.85 ± 00.05	07.90 ± 00.52	05.89 ± 00.45	03.94 ± 00.07
MVV	69.50 ± 00.80	119.06 ± 04.18	76.80 ± 02.44	58.21 ± 02.90

Similar results are observed in case of male data based on the p-value test (p < 0.05), as shown in Figure 2 and Table 3. However from Figure 1 and Figure 2, it is clear that all the average pulmonary function test values (FVC, PEFR and MVV) in case of the males are higher than the average test values of females in all groups (i.e., when the data values in 2a, 2b, 2c and 2d groups are compared to the values in 1a, 1b, 1c and 1d groups respectively). However, BMI possesses negative correlation with these respiratory parameters.

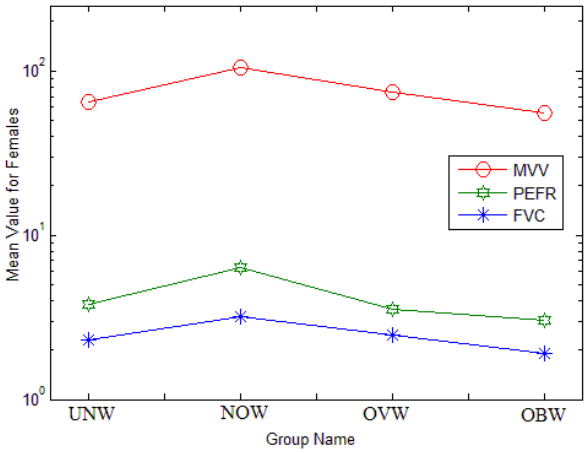

Figure 1: Female Data Analysis

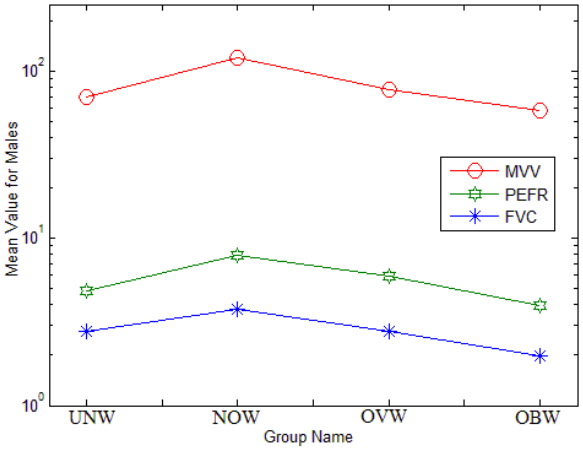

Figure 2: Male Data Analysis

Discussion

The aim of this study was to determine the influence of BMI on the pulmonary function tests, in young individuals of age group 18 – 25 years. Obesity or increase in BMI is generally found to affect the pulmonary function in a negative way.[5] The individuals with BMI lower and higher than normal weight groups exhibit lower values of FVC, PEFR and MVV, as show in Figure 1 and Figure 2, for both genders. However, it is evident from the previous studies that in individuals with a normal BMI, the pulmonary function increases in parallel with the weight gain, due to related increase in the muscle strength. [2]

Similar negative correlation between BMI and pulmonary function was reported by Sri Nageswari et al. in a group of obese children belonging to the mixed socioeconomic status in the Punjabi population, India. [6] They concluded that obesity is characterized by reduction in the chest wall compliance due to the increased amount of adipose tissue around chest and abdomen, which alleviates the pulmonary functions in children/subjects. The reduction in FVC, PEFR and MVV in OBW group can be explained by the mechanical restraint to the movement of thorax and abdomen. [2] The reduction in PEFR indicates the presence of peripheral airflow limitation and elevated airway resistance in the obese individuals. Hence, weight reduction may enhance the ventilatory function by reducing the mechanical constraints. Al-Jiffri et al. observed a substantial improvement in the ventilatory functions in the obese asthmatic children after the weight reduction. [7]

Raju et al. conducted a study to evaluate pulmonary functions that developed prediction equations in Indian girls for height, weight, sitting height, chest circumference and body surface area. They concluded that the variables like height, fat free mass and chest circumference or age had shown a very strong predictability of FEV1, FVC and PEFR. [8] Joshi et al. observed lower FVC as well as expiratory reserve volume in a group of overweight individuals. They correlated the fall in FVC in overweight individuals to the fall in expiratory reserve volume (ERV). However, ERV forms a component of FVC. This reduction was also attributed to the increase in body fat percentage with the increasing value of BMI, particularly in overweight individuals. [9]

However, underweight individuals exhibit lower values of pulmonary functions than the individuals with normal BMI. This can be due to the poor respiratory muscle strength because of the poor resources of body proteins causing wasting of skeletal muscles including the respiratory muscles in the underweight individuals. [10] A substantial negative correlation was also observed between BMI and all the measured test values/observations. Similar inference was reported by Saxena et al. and Dayanand. [11, 12]

Concluding Remarks

The study demonstrated that the pulmonary functions are substantially influenced by the body mass index (anthropometric index), in case of youngsters (Punjabi population).The recorded test values of FVC, PEFR and MVV were found to be lower in case of the females belonging to all the BMI subgroups (UNW, NOW, OVW, OBW), when compared with the male data under similar conditions. This can be justified by the greater respiratory muscle strength as well as greater compliance in males as compared to females. However, obesity can be reduced to improve the lung function and to combat the critical respiratory disorders, by changing eating habits. Usually age and height are utilized in the prediction equations for lung functions. Therefore, future work includes the usage of BMI in the prediction equations for lung functions in different seasons (for asthmatic patients). To conclude, since obesity is a lifestyle disorder that

affects all age groups, a bigger sample size with broader range of age distribution is required so that it represents the whole of Punjabi population. This is a small effort in this direction and we plan to continue this study in different age groups with a larger sample size and we hope to get some positive results.

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