The effects of body mass index on respiratory parameters

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Abstract

Objective: To assess the correlation of body mass index (BMI) and respiratory parameters determined by spirometry.

Methods: A cross-sectional descriptive study was conducted at Medicine OPD of GP Koirala National Centre for Respiratory Disease, Dulegaunda, Tanahun from December 2021 to February 2022. A total of 95 underweight, normal, overweight, and obese participants, aged between 40 to 73 years were included in the study. BMI was determined by measuring the height and weight of individual patients. Spirometry was performed to determine different respiratory parameters.

Results: Mean age of participants was 56.7 ± 16.4 years with female population constituting 54% of the total population. Most of the study population were of normal weight (n=40) and pre-obese (n=41). An insignificant correlation between BMI and respiratory parameters was determined.

Conclusion: An insignificant correlation between BMI and respiratory parameters was determined in this study.

Keywords: Age, body mass index, respiratory parameters, spirometry

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a significant lung ailment that is a leading cause of long-term morbidity and mortality worldwide [1]. Many people have died as a result of this illness or its repercussions [2]. Furthermore, it is the world's third leading cause of death, and its prevalence and mortality are predicted to climb in the future years and decades [3].

WHO defines obesity as an abnormal or excessive fat accumulation that presents a health risk. In adults, a body mass index (BMI) over 30 is recognized as obese [4]. Physical activity and diet profoundly determine the obesity risk in an individual [5].

Body Mass Index (BMI) is a measure of body fat based on height and weight which is profoundly used to evaluate obesity, overweight, normal weight, and even underweight [6]. The BMI score marks the risk of comorbidity associated with every individual due to their fat content [7].

Obesity is the gateway to various disorders that can affect the quality of life of an individual. Most importantly, an individual’s efficiency is severely affected by obesity which leads to the loss of productivity in a long run [8]. It has been known that people who are obese are more prone to multiple disorders, especially respiratory disorders like asthma, COPD, atopy, etc [9]. Obese people often report the feeling of shortness of breath while carrying out physical activity even without prior pulmonary disorders [10].

Various lung function tests are key to identifying the capacity of the lungs in an individual. American Lung Association (ALA) recognizes spirometry as the basic test to measure the air-holding capacity of the lungs along with the expiration threshold of an individual [11]. Other tests such as Functional Residual Capacity (FRC), Expiratory Reserve Volume (ERV), Total Lung Capacity (TLC), Forced Expiratory Volume (FEV1), Forced Expiratory Flow (FEF), Forced Vital Capacity (FVC) and Peak Expiratory Flow (PEF) is very significant in determining the lung function [12]. Obesity renders various lung function tests to a decreased value, which signifies depletion in an individual's lung function [13].

The values of several PFTs also depend on certain variables like age, sex, height, gender, race, etc [14]. It has been found that TLC and ERV in males are larger than in females [15]. Demographic and geographic variations also play an important role in bringing about variation in the data obtained for PFTs [16].

The prevalence of increased BMI in developing and developed countries is prominent that affects the lives of people in many ways [17]. The causative factors for increased BMI include lack of nutritional awareness, intake of processed foods, high-calorie diets, mechanical transportation, and a sedentary lifestyle. It has been estimated that over 30 years or so, the prevalence rate of obesity has doubled or even quadrupled in several countries [8].

In the context of Nepal, not much data has been gathered that could be consensual but the available data shows a potential increment in the prevalence rate of obesity in near future [18]. The prevalence rate of overweight children was 14.6% whereas of those obese children was 11.3% [19]. This study aims to understand and add evidence to the relation between Body Mass Index (BMI) and respiratory parameters among Nepalese nationals.

Methodology

A cross-sectional descriptive study was conducted at Medicine OPD of GP Koirala National Centre for Respiratory Disease, Dulegaunda, Tanhun – a national respiratory specialized hospital. The data collection period was for three months from December 2021 to February 2022 including all the working days of the hospital.

Ethical clearance was also obtained from Institutional Review Committee (IRC), Pokhara University Research Center (PURC), Pokhara University, Kaski, Nepal on 23rd September 2019 (Reg No.: 98/076/077) & with written permission to conduct the study was also obtained from GP Koirala National Centre for Respiratory Disease (Reg No.: 69/078/079). Verbal consent was taken from the study participants before the collection of data. Privacy and confidentiality of the obtained information were maintained as per the ethical guidelines.

The Census sampling technique was applied for the data collection fulfilling the inclusion criteria included in the study.

Inclusion criteria

- Patient attending to the chest OPD at GP Koirala National Centre for Respiratory Disease Hospital
- Availability of complete pulmonary function test
- Patient willing to participate in the study

Exclusion criteria:

- Patient not willing to take part in the study
- Patient without complete pulmonary function test
- Pregnant and comorbid patient

Data management & analysis:

Data entry was carried out using EpiData version 3.1 software. Collected data was exported to Statistical Package for Social Science (SPSS) version 25 for its analysis and interpretation. Descriptive analysis was done using a frequency table when necessary. Numeric values were placed as mean values ± SD. Correlation coefficients were calculated to determine the correlation between different parameters. The tests were considered significant with a *P* value of less than 0.05.

Results

A total of 95 patients participated in the study with approximately 54% female population. The mean age of the participants was 56.7± 16.4 years. Study participants were then classified into different groups based on BMI (underweight, normal weight, pre-obesity, obesity class I, and obesity class II) and their respective ages were determined (**Table 1**).

Table 1: Classification of the participants based on BMI and their respective ages.

Classification of BMI (kg/m^2)	Participant information	
	No. of patients (%)	**Age (mean±S.D.) (years)**
Underweight (< 18.5)	3 (3.2)	50.6±31.5

Normal weight (18.5-22.9)	40 (42.0)	56.4±17.8
Pre-obesity (23-24.9)	41 (43.2)	57.9±14.7
Obesity class I (25-29.9)	9 (9.5)	56.0±12.5
Obesity class II (≥30)	2 (2.1)	51.5±27.6

Spearman's Rank correlation coefficient between age and BMI presented a very weak correlation coefficient (0.17) with a significance of 0.868 (2-tailed). A similar weak correlation coefficient was obtained for gender and BMI, with a correlation coefficient and significance (2-tailed) of 0.010 and 0.926, respectively.

In terms of spirometric tests (pre-test and predicted), the correlation between age and spirometry results was poor or non-existent, except predicted FEF value (-0.708), which indicated a substantial negative association. The pre-test spirometric values of FVC, FEV1, FEV1/FVC ratio, PFP, and FEF were -0.224, -0.283, -0.106, -0.115, and -0.708 respectively. Likewise, for predicted FVC, FEV1, FEV1/FVC ratio, PFP, and FEF correlation coefficient were -0.412, -0.524, -0.417, -0.345, and -0.708 respectively (**Table 2**).

S.N.	**Test**	**Correlation coefficient**	**P**
1	Age& Predicted FVC	-0.412	0.000**
2	Age& Pretest FVC	-0.224	0.029*
3	Age& Predicted FEV1	-0.524	0.000**
4	Age& Pretest FEV1	-0.283	0.05*
5	Age& Predicted FEV1/FVC	-0.417	0.000**
6	Age& Pretest FEV1/FVC	-0.106	0.306
7	Age& Predicted PEF	-0.345	0.001**
8	Age& Pretest PEF	-0.115	0.268
9	Age& Predicted FEF	-0.708	0.000**
10	Age& Pretest FEF	-0.246	0.017*

Table 2: Correlation between age and respiratory parameters.
*, **- significant

Spearman rank correlation was computed to assess the relationship between BMI and spirometric pre-test and predicted results. There was no significant correlation obtained between BMI and either the pre-test or predicted results. Based on the statistical results, pre-test FVC, FEV1, FEV1/FVC ratio, PFP, and FEF coefficient of 0.021, 0.061, 0.183, 0.066, and 0.088, respectively, with a corresponding p-value of 0.84, 0.56, 0.08, 0.52, and 0.40. Likewise, the statistical results for predicted FVC, FEV1, FEV1/FVC ratio, PFP, and FEF were -0.14, -0.13, -0.11, 0.04, and -0.05, where none had a significant P-value (**Table 3**).

Table 3: Correlation between BMI and respiratory parameters.

S.N.	Test	Correlation coefficient	p
1	BMI & Predicted FVC	-0.140	0.177
2	BMI & Pretest FVC	0.021	0.841
3	BMI & Predicted FEV1	-0.132	0.203
4	BMI & Pretest FEV1	0.061	0.560
5	BMI & Predicted FEV1/FVC	-0.111	0.283
6	BMI & Pretest FEV1/FVC	0.183	0.076
7	BMI & Predicted PEF	0.044	0.672
8	BMI & Pretest PEF	0.066	0.527
9	BMI & Predicted FEF	-0.054	0.609
10	BMI & Pretest FEF	0.088	0.401

Discussion

The mean age of the patients included in the study was 56.7 ± 16.4 years with respective ages for male and female patients as 57.8 ± 16.9 and 55.7 ± 15.9 years. A deterioration in lung function is expected in the elderly population and the obtained results for age correlate with these observations [20]. The number of pre-obese (n = 41) and normal weight (n = 40) patients under the BMI classification were found to be the highest. Studies have demonstrated higher wheezing and exertion as respiratory symptoms in obese patients [21, 22]. Fat deposition over the diaphragm, abdomen and intercostal muscles results in respiratory function impairment and reduction in lung expansion. Generally, total lung capacity (TLC) and vital capacity (VC) remain normal but may be decreased by ≥30%, if obesity is severe [23]. Another study reported higher FEV1 among obese patients in comparison to lean patients [24] whereas another study explains the inverse relationship between BMI and the FEV1 [25].

Based on the results an alternate hypothesis is true suggesting no correlation between genders and body mass index; and age and body mass index which can be attributed to other different predictors of BMI [26]. A significantly higher BMI in males was reported in different studies [27, 28] which was not evident in this study.

The correlation of BMI between the pretest and predicted FVC, FEV1, FEV1/FVC, and PEF was found to be insignificant ($p>0.05$). A significant association between lung functions and BMI was found in a retrospective study [29]. Various studies have explained the increase in FEV1 with BMI [30, 31]. Studies have shown the negative association of FVC with BMI [32, 33]. But no such significant correlations between BMI and respiratory parameters were observed in our study attributable to different factors including the sample size, population type, age, daily activities, and others. Nearly 42% of the total patients were of normal weight and this might have led to an overall insignificant correlation between BMI and respiratory parameters.

Conclusion

Cumulatively, results from this study demonstrate no significant correlation between body mass and respiratory parameters. However, further similar studies including larger population size and larger geographic region are warranted.

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