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PULMONARY FUNCTION TEST AMONG OBESE AND NON-OBESE ADULT POPULATION OF KERALA: A COMPARATIVE CROSS-SECTIONAL STUDY

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ABSTRACT

Background: The objective of this study was to assess the impact of obesity on pulmonary functions, such as FEV1/FVC ratio, PEFR, and MVV, in adults aged 26 to 55, comparing those with abdominal obesity against non-obese individuals.

Materials and Methods: Over one year, the present cross-sectional study was carried out at the Academy of Medical Sciences in Pariyaram. The study comprised 200 non-obese patients and 200 subjects with abdominal obesity, including both males and females. The study sample comprised individuals between the ages of 26 and 55. Spirometry measurements were conducted on all subjects while they were seated, following the procedures advised by the American Thoracic Society. A proficient technician conducted a spirometry examination in the morning. The pulmonary functions that were evaluated include the FEV1/FVC ratio, PEFR, and MVV. The BMI was determined by recording the weight and height. The statistical analysis was conducted using IBM SPSS for Windows (Version 26.0). An Unpaired t-test was employed to evaluate the PFT of those classified as non-obese and those with abdominal non-obesity. A p-value of less than 0.05 was deemed statistically significant.

Results: The participants were categorized into three distinct age groupings, namely 26-35 years, 36-45 years, and 46-55 years. BMI cut-off values of more than 25 kg/m^2 were used to divide the participants into two groups: those with abdominal obesity and non-obese. In the abdominal obesity group, 49.5% of the 200 participants were men and 50.5% were women. In the group of non-obese individuals, there was an equal distribution of males and females. The study sample revealed a statistically significant difference in the average FEV1/FVC ratio between individuals with abdominal obesity and non-obese across all age categories. The study observed a decline in mean PEFR levels as individuals aged in both groups. The participants with abdominal obesity and non-obese showed a statistically significant difference in mean PEFR values ($p < 0.01$). The abdominal obesity group aged 46-55 years exhibited an MVV of 69.58±12.56 L/min. The statistical analysis revealed a significant difference in the average MVV values between individuals with abdominal obesity and non-obese in the age ranges of 26-35, 36-45, and 46-55 years.

Conclusion: The results of the study indicated that there was a consistent decrease in lung function measures as individuals aged in both groups. The abdominal obesity group exhibited a notable decrease in FEV1/FVC, PEFR, and MVV when compared to the non-obese group.

Keywords: Abdominal obesity, Body mass index, Maximum voluntary ventilation, Peak Expiratory Flow Rates, Pulmonary function tests.

INTRODUCTION

Obesity is caused by a multitude of interactions between environmental and hereditary variables. It is characterized by the atypical or excessive buildup of adipose tissue, which arises from an inequilibrium between energy consumption and usage. The average incidence of obesity in India varies between 10% and 50%, with morbid obesity impacting approximately 5% of the nation's population.[1] Obesity has been linked to various health outcomes, encompassing diabetes, hyperlipidemia, hypertension, ischemic heart diseases, obstructive sleep apnea, cerebrovascular accident, premature mortality, osteoporosis, respiratory system dysfunction, and a decline in general well-being. The majority of studies utilize pulmonary function tests (PFT) to examine the impact of obesity on the function of the lungs. The outcomes of PFT are typically influenced by various factors, including age, gender, height, ethnic background, and obesity.[2]

The body mass index (BMI) has historically been employed as a means of classifying individuals into two categories: obese and non-obese.[3] A BMI falling within the range of 25 to 30 kg/m2 should be regarded as clinically significant and indicative of potential remedial intervention.[4] The pulmonary parameters that are frequently utilized in clinical studies that indicate the correlation with lipid distribution are forced expiratory volume in one second (FEV1) and forced vital capacity (FVC).[5] One of the significant measures in PFT is Peak Expiratory Flow Rates (PEFR), which has emerged as a clinical instrument for diagnosing respiratory disorders caused by airflow restrictions, their severity, and deviations. The PEFR is a non-invasive conventional method used in clinical studies to assess the quantitative and qualitative estimates of pulmonary function.[1]

The maximum voluntary ventilation (MVV) is contingent upon both the inflow and outflow of air in the lungs during sustained maximal exertion over a predetermined period. It is a useful test that offers a comprehensive evaluation of the respiratory system's effort, coordination, and flow-resistive characteristics.[6] Obesity in adolescents and adults is linked to the deterioration of lung function. Research findings have indicated a notable decrease in various respiratory parameters, including FVC, FEV1, PEFR, MVV, expiratory reserve volume (ERV), and functional residual capacity, among individuals with morbid obesity. Adult obesity has been linked to reductions in pulmonary function to the waist-to-hip ratio.[6,7]

The most crucial technique for clinically assessing PFT in humans is the spirometric examination. The inclusion of population-specific benchmarks is important to uphold the credibility of pulmonary function assessment.[3,4] Several studies from various countries across the globe, including India, have published standards for lung function. The observed variations in these attributes can be ascribed to the biological, environmental, and ethnic disparities within the group under investigation.[8] While several studies have been conducted on obese adults to investigate the impact of obesity on pulmonary function, there is a lack of consistency among these research. Adiposity in general is regarded as a significant indicator of pulmonary functional state, while abdominal obesity is projected to have a mechanical impact on pulmonary function through alterations in lung compliance, respiratory effort, and elastic recoil.[1] The objective of this study was to assess the impact of obesity on pulmonary functions, such as FEV1/FVC ratio, PEFR, and MVV, in adults aged 26 to 55, comparing those with abdominal obesity against non-obese individuals.

MATERIAL AND METHODS

Over one year, the present cross-sectional study was carried out at the Academy of Medical Sciences in Pariyaram. It was approved by the Institutional Ethics Committee (I EC/ACME/25-11-13). Consent was obtained from each participant after a comprehensive explanation of the study's purpose. The study comprised 200 non-obese patients and 200 subjects with abdominal obesity, including both males and females. The study sample comprised individuals between the ages of 26 and 55. The study excluded individuals who were smokers, individuals with systemic disorders, and those with persistent coughs. The spirometer utilized was an ISO-certified Medicaid equipment. The researchers took into account many elements that contribute to the preciseness of spirometric evaluation, while also reducing potential sources of error. The primary objective was to obtain precise information that may be utilized to corroborate the clinical diagnosis.

Spirometry measurements were conducted on all subjects while they were seated, following the procedures advised by the American Thoracic Society (ATS). A proficient technician conducted a spirometry examination in the morning. The participants were instructed to inhale deeply and exhale forcefully into the mouthpiece of the device while wearing a nose clip. The validity of the test was confirmed following the ATS standards. The pulmonary functions that were evaluated include the FEV1/FVC ratio, PEFR, and MVV. The BMI was determined by recording the weight and height. According to the Asian Indian criteria, those with a BMI exceeding 25 kg/m2 were classified into the category of abdominal obesity.[9]

Statistical Analysis

The analysis was conducted using IBM SPSS for Windows (Version 26.0, Armonk, NY). The data are displayed using the mean, standard deviation, and percentages. An Unpaired t-test was employed to evaluate the PFT of those classified as non-obese and those with abdominal non-obesity. A p-value of less than 0.05 was deemed statistically significant.

RESULTS

The study comprised a cohort of 400 individuals aged 25-55 years who attended the outpatient services at the institution. The participants were categorized into three distinct age groupings, namely 26-35 years, 36-45 years, and 46-55 years. BMI cut-off values of more than 25 kg/m2 were used to divide the participants into two groups: those with abdominal obesity and non-obese.

Table 1 presents the demographic characterization of the study subjects. In the abdominal obesity group, 49.5% of the 200 participants were men and 50.5% were women. In the group of non-obese individuals, there was an equal distribution of males and females.

The study sample revealed that the 26-35-year cohort exhibited the greatest FEV1/FVC ratio. Table 2 reveals a statistically significant difference in the average FEV1/FVC ratio between individuals with abdominal obesity and non-obese across all age categories.

The study observed a decline in mean PEFR levels as individuals aged in both groups. The participants with abdominal obesity and non-obese showed a statistically significant difference in mean PEFR values (Table 3) ($p < 0.01$). The abdominal obesity group aged 46-55 years exhibited an MVV of 69.58±12.56 L/min. The statistical analysis revealed a significant difference in the average MVV values between individuals with abdominal obesity and non-obese in the age ranges of 26-35, 36-45, and 46-55 years. [Table 4]

Table 1: Descriptive statistics of mean age, gender and BMI among the study groups

		Mean age (Years)	BMI (Kg/m^2)	Gender		
				Males n(%)	Females n(%)	Total n(%)
Abdominal obesity group	26-35 yrs	27.7±1.5	27.8±3.98	33(48.5)	35(51.5)	68(34)
	36-45yrs	36.3±1.12	28.9±4.23	32(48.5)	34(51.5)	66(33)
	46-55yrs	46.4±1.58	31.5±4.09	34(51.5)	32(48.5)	66(33)
	Total	36.8±1.4	29.4±4.1	99(49.5)	101(50.5)	200(100)
Non-obese group	26-35 yrs	26.2±1.46	19.6±1.19	34(50.7)	33(49.3)	67(33.5)
	36-45yrs	36.9±1.26	19.7±1.31	33(49.3)	34(50.7)	67(33.5)
	46-55yrs	47.3±1.48	19.2±1.1	33(50)	33(50)	66(33)
	Total	36.8±1.4	19.5 ± 1.2	100(50)	100(50)	200(100)

Table 2: Comparison of FEV1/FVC (mean %) of different age groups among subjects with abdominal obesity and non-obese individuals

	26-35 yrs	36-45yrs	46-55yrs
Non-obese group	83.03±3.76	79.90±2.35	77.44±5.2
Abdominal obesity group	79.51±6.39	77.77±6.79	71.99±10.52
p-value$^+$	<0.01	<0.01	<0.05

$^+$Unpaired t-test; p<0.01 = Highly significant

Table 3: Comparison of PEFR (L/sec) of different age groups among subjects with abdominal obesity and non-obese individuals

	26-35 yrs	36-45yrs	46-55yrs
Non-obese group	7.12±0.85	6.49±0.82	6.02±0.53
Abdominal obesity group	5.76±1.12	5.18±1.22	4.37±1.00
p-value+	<0.01	<0.01	<0.01

$^+$Unpaired t-test; p<0.01 = Highly significant

Table 4: Comparison of MVV (L/min) among study samples of different age groups

	26-35 yrs	36-45yrs	46-55yrs
Non-obese group	103.44±12.19	91.54±12.55	84.98±8.46
Abdominal obesity group	91.69±13.35	82.89±9.47	69.58±12.56
p-value+	<0.01	<0.01	<0.01

$^+$Unpaired t-test; p<0.01 = Highly significant

DISCUSSION

A drop in the FEV1/FVC ratio and MVV was identified as the primary pulmonary function deterioration observed among obese individuals. The utilization of these tests, in conjunction with a comprehensive assessment of respiratory symptoms, is expected to facilitate the prompt and precise identification of respiratory illnesses. Consequently, this could eventually result in improved medical care through the integration of a comprehensive understanding of the condition and the execution of appropriate exercise regimens.[10] The overall respiratory compliance is diminished, which could perhaps be associated with the elevated pulmonary blood volume observed in obese patients.[11] Nevertheless, compared to non-obese persons, total respiratory compliance is significantly decreased in obese individuals. The fall in compliance of the chest wall is the primary cause of this decline, but it may also be attributed to an upsurge in respiratory resistance.[12]

The association between fat distribution and lung function was studied by Harik-Khan et al.[13]

through the utilization of the waist/hip ratio. An inverse relationship was noticed between FEV1 and waist-hip ratio exclusively in males. Our study aligns with the findings of Ofuya et al,[14] who observed a reduction in PEFR among individuals with obesity. The detrimental impact of atypical metabolism and obesity on pulmonary function has been substantiated in numerous prior investigations.[15,16] Furthermore, the presence of visceral adipose tissue has an impact on the levels of interleukin-6, tumor necrosis factor-alpha, leptin, and adiponectin in the circulatory system. These cytokines have the potential to exert their effects on pulmonary function through systemic inflammation, leading to adverse consequences.[17,18] Researchers have documented a negative correlation between serum leptin levels and FEV1, along with elevated levels of C-reactive protein, leukocytes, and fibrinogen, which are indicative of systemic inflammation. Hence, it is plausible that inflammation serves as the potential association between visceral adiposity and lung function.[19]

PFTs are conducted to evaluate the performance of the lungs and are commonly employed in clinical settings. However, there is a limited number of studies that have set benchmarks for pulmonary function to age, particularly within the Indian population.[10] The findings of the current study were congruent with that of Bais et al. who observed a decrease in the PFT as individuals aged. This was also analogous and comparable to the older Indian population.[10,20] Even in individuals in good health, lung functions deteriorate as they age.[20] Itagi et al. observed a statistically significant association between basal metabolic rate (BMR) and various indices of lung function. Nevertheless, the study revealed a significant disparity in BMR between persons who are obese and those who are not, as BMR estimations rely directly on the weight of the participants. The study revealed that BMR is a more robust indicator of alterations in lung function in individuals with and without obesity. Consequently, when detecting initial changes in lung function, it is crucial to include BMR instead of solely relying on BMI. To confirm the presence of this connection, it is advisable to conduct a practical evaluation of BMR using direct measurement of oxygen consumption.[5]

This study revealed an additional health concern linked to obesity and emphasized the importance of actively reducing weight at an earlier stage in life. Conducting longitudinal research would be intriguing to more accurately evaluate the correlation between gaining body weight and lung functioning in individuals who are obese. Our study has limitations because of the moderate sample size. However, it may still be valuable to evaluate maximum inspiratory and expiratory pressures, which serve as indicators of diaphragm strength and abdominal or intercostal muscle strength, respectively. The utilization of PFTs, in conjunction with a comprehensive assessment of respiratory symptoms, is expected to facilitate the prompt and precise identification of respiratory-related illnesses. Consequently, this could culminate in improved disease treatment through the integration of a comprehensive understanding of the condition and the implementation of appropriate exercise regimens

CONCLUSION

The results of the study indicated that there was a consistent decrease in lung function measures as individuals aged in both groups. The abdominal obesity group exhibited a notable decrease in FEV1/FVC, PEFR, and MVV when compared to the non-obese group.

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