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Original Research Article

A Cross-Sectional Study of Pulmonary Impairment Pattern in Adults With Central Obesity

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ABSTRACT

Background: Obesity impacts the respiratory system through various mechanisms, with numerous studies investigating the relationship between BMI and respiratory function. However, only a limited number of studies have utilized waist circumference as an indicator of adiposity. Furthermore, the findings regarding whether obesity leads to restrictive or obstructive alterations in lung function remain uncertain. **Objectives:** To determine the predominant pattern of pulmonary impairment associated with central obesity. **Methods:** A comparative cross-sectional study enrolled ninety non-smoking adults aged 20-40 years. The study group consisted of forty-five individuals with waist circumference ≥ 90cm in males and ≥ 80cm in females, while the control group comprised forty-five gender and age matched subjects with waist circumference < 90cm in males and < 80cm in females. Dynamic lung function parameters, including FEV_1, FVC, FEV_1/FVC ratio, PEFR, and FEF_{25-75}, were assessed using the spiro module of the MEC PFT system in both groups. Statistical analysis employed the Independent Student's t-test. **Results:** In centrally obese adults, there were significant reductions observed in FEV_1 ($P = 0.04$) and FVC ($P = 0.01$). However, there were no significant differences noted in the FEV_1/FVC ratio, PEFR, and FEF_{25-75} between the two groups. **Conclusion:** Our findings indicate a restrictive pattern of pulmonary impairment in centrally obese adults. This study aims to emphasize the impact of increasing waist circumference on pulmonary function, thereby advocating for appropriate intervention measures to reduce obesity and its associated health risks.

INTRODUCTION

Obesity stands as a global health issue that continues to rise in prevalence worldwide[1]. Currently, India is experiencing a rapid epidemiological transition from under-nutrition, which was common in the past due to poverty, to a rising tide of obesity. This transition is primarily attributed to declining levels of physical activity and the adoption of unhealthy dietary habits[2]. Obesity stems from a complex interplay of genetic predispositions, behavioral choices, environmental factors, cultural influences, and socio-economic disparities. These influences disrupts the balance between energy intake and expenditure, ultimately contributing to the development of obesity[3].

The correlation between obesity and its influence on respiratory function has been acknowledged for an extensive period[1]. The primary respiratory challenges associated with obesity encompass increased ventilation requirements, heightened respiratory effort, inefficiency of respiratory muscles, and reduced respiratory compliance[4]. Obesity impacts the respiratory system through various mechanisms, including direct mechanical alterations stemming from fat accumulation in the chest wall, abdomen, and upper airway, alongside systemic inflammation[1].

While body mass index (BMI) is commonly utilized as an obesity indicator due to its simplicity in calculation, it lacks the ability to provide insights into fat distribution across the body, which is crucial for understanding the physiological impact of obesity, particularly on respiratory function[5,6]. In contrast, waist circumference (WC) serves as a measure of adiposity that considers the accumulation of abdominal fat[7].

Despite numerous studies investigating the relationship between BMI and respiratory function, there has been limited exploration utilizing WC as an indicator of adiposity. Therefore, the aim of this study was to assess the impact of obesity, as measured by WC, on spirometric parameters among adults in South India. Spirometry, being the most commonly performed lung function test, plays a crucial role in evaluating the state of respiratory function[2,8].

Brazzalle et al. emphasized the significance of spirometry assessment in confirming obstructive alterations in the respiratory physiology of obese individuals, whereas Melo et al. concluded that the majority of obese subjects are prone for developing a restrictive pattern. Conversely, certain studies have indicated normal spirometric results in obese individuals[9]. Consequently, the findings regarding the specific alteration (restrictive or obstructive) in lung function in obesity remain a matter of dispute. Therefore, the objective of present study was to determine the predominant pattern of pulmonary impairment associated with central obesity.

Subjects & methods:

A cross-sectional observational study was undertaken following approval from the Institutional Ethical Committee. The research was conducted at the Life Style Laboratory in the Department of Physiology. Sample size determination utilized the formula: Sample Size (n) = [(Zα + Z(1-β))^2 σ^2]/d^2, where Zα represents the Alpha Error, Z(1-β) denotes the Beta Error, σ signifies the Standard Deviation, and d represents the Effect Size.

Each subject provided informed written consent after receiving a thorough explanation of the study protocol. Subsequently, all participants underwent a comprehensive history-taking and relevant clinical examination. A total of 90 non-smoking adults aged 20–40 years were selected using a simple random sampling method, adhering to predetermined eligibility criteria. Exclusion criteria encompassed individuals exhibiting gross clinical abnormalities of the vertebral column and thoracic cage, neuromuscular diseases, known cases of bronchial asthma, tuberculosis, chronic obstructive pulmonary disease, any allergic or endocrine disorders, nasolaryngeal disorders, history of occupational lung diseases, excessive daytime sleepiness, daytime fatigue, or a history of snoring

Height, weight, and waist circumference were meticulously measured during the study. A constant tension non-stretchable measuring tape was employed to determine waist circumference, with measurement taken at the midpoint between the iliac crest and the lowermost margin of the ribs at the end of a normal expiration. Individuals with waist circumference measurements equal to or exceeding 90 cm in males and 80 cm in females were included in the study group, totaling 45 subjects. Additionally, 45 gender- and age-matched participants with waist circumference measurements below 90 cm in males and 80 cm in females were selected for the control group[10].

Recording of dynamic lung function parameters: Dynamic lung function parameters were recorded for all participants in accordance with the guidelines by the American Thoracic Society/European Respiratory Society (ATS/ERS).[11] Using the Spiro Module (Pocket-Spiro 12C) of the MEC PFT System (Medical Electronic Construction, Brussels, Belgium; Model No. - B1070), FEV_1, FVC, FEV_1/FVC ratio, PEFR, and FEF_{25-75} were measured. Prior to the spirometry session, participant details such as name, date of birth, gender, ethnic group, height, and weight were entered into the instrument. Participants were then briefed on the procedure and maneuvers were demonstrated. They were instructed to utilize a nose-clip during the measurement of all respiratory parameters and to ensure a tight seal around the mouthpiece provided. The forced spirometry maneuver, involving a deep inspiration followed by a forceful maximum expiration lasting for 6 seconds, was performed to record FEV_1, FVC, FEV_1/FVC ratio, PEFR, and FEF_{25-75}. Three recordings were taken with a 5-minute interval between each, and the best recording out of the three was selected for analysis. All recordings were conducted with participants in a seated position, and measurements were taken during the morning hours to minimize potential diurnal variations.

The selection and interpretation of spirograms followed the guidelines outlined by the American Thoracic Society (ATS) and the European Respiratory Society (ERS) in 2005. The Lower Limit of Normal (LLN) served as the cutoff for adults, defined as the 5th percentile of a healthy, non-smoking population. LLN was calculated using the formula LLN = Mean – (1.645 * SD), where Mean represents the mean value and SD denotes the standard deviation[12]. Subsequently, the pattern (normal/obstructive/restrictive/mixed) was identified as shown in Figure 1.[13].

Statistical Analysis: In this study, both descriptive and inferential statistical analyses were conducted. Continuous measurements are reported as mean ± standard deviation (SD). A two-tailed Independent Student's t-test was employed to compare the two groups, with statistical significance set at a p-value of less than 0.05. LibreOffice Calc software was utilized for statistical analysis and table generation.

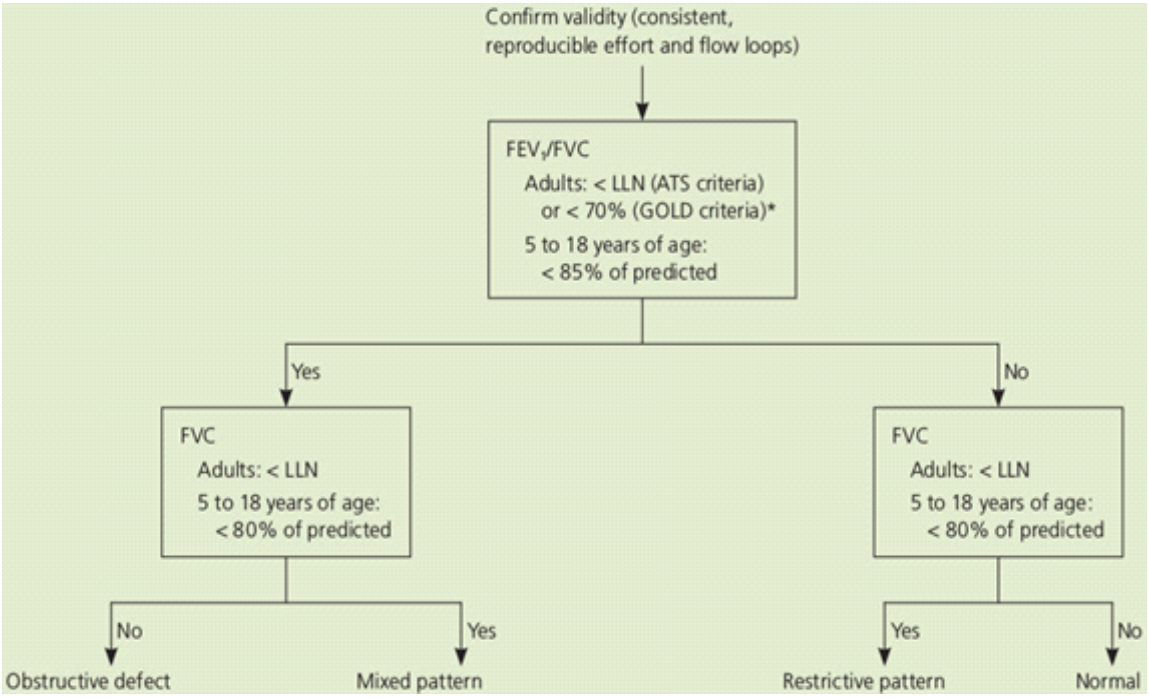

Figure 1: Interpretation of dynamic lung function parameters

The severity of the defect was graded using FEV_1 percent predicted as depicted in Figure 2.[13]

American Thoracic Society Grades for Severity of a Pulmonary Function Test Abnormality

Severity	*FEV_1 percentage of predicted*
Mild	> 70
Moderate	60 to 69
Moderately severe	50 to 59
Severe	35 to 49
Very severe	< 35

Figure 2. Grading of severity

RESULTS

Baseline characteristics of the subjects are summarized in Table 1. There were no significant differences observed in terms of age or height between the two groups, suggesting homogeneity in these variables. The study group comprised 22 males and 23 females, while the control group consisted of 23 males and 22 females. As anticipated, weight, BMI, and waist circumference were notably elevated in the study group compared tothe control group, with statistical significance, P-value < 0.0001.

Table 1: Baseline characteristics of the subjects

	Study Group	Control Group	P-Value
Age (years)	24.69 ± 3.27	24.29 ± 3.09	0.55
Weight (kg)	75.78 ± 14.34	60.5 ± 10.82	**0.0001 ***
Height (cm)	165.49 ± 9.18	165.5 ± 9.97	1
BMI (kg/m^2)	27.53 ± 3.54	21.98 ± 2.68	**0.0001***
Waist Circumference (cm)	90.87 ± 8.88	73.41 ± 8.63	**0.0001***

Table 2 presents a comparison of dynamic lung function parameters between the two groups. Significantly reduced values were observed in both FEV_1 (P = 0.04) and FVC (P = 0.01) in the study group compared to the control group. However, there were no significant differences noted in the FEV_1/FVC ratio (P = 0.24), PEFR (P = 0.23), and FEF_{25-75} (P = 0.25) between the two groups

Table 2: Comparison of dynamic lung function parameters of study group and control group

	Study Group	Control Group	P-Value
FEV_1 (L)	2.55 ± 0.63	2.79 ± 0.42	**0.04***
FVC (L)	2.85 ± 0.73	3.19 ± 0.53	**0.01***
FEV_1/FVC (%)	89.05 ± 6.2	87.54 ± 5.9	0.24
PEFR (L/s)	6.14 ± 1.86	5.7 ± 1.55	0.23
FEF_{25-75} (L/s)	3.39 ± 1.02	3.15 ± 0.87	0.25

Within the study group, 24 subjects (53.3%) exhibited a restrictive pattern, while the remaining 21 displayed a normal pattern according to the ATS-ERS 2005 recommendations. Statistical analysis using chi-square indicated a highly significant difference (P < 0.0001). None of the participants in the study group demonstrated an obstructive or mixed pattern. All subjects in the control group exhibited a normal pattern.

Among the 24 subjects in the study group who had restrictive pattern, 18 had mild (75%) and 6 had moderate (25%) restriction as graded on the basis of FEV_1 % predicted (ATS-ERS 2005 recommendations)

DISCUSSION

The current study demonstrated decline in certain dynamic lung function parameters among centrally obese individuals. Importantly, both groups were meticulously matched for gender and age, and all participants shared a common South-Indian ethnic origin. Therefore, the key distinguishing factors between the groups were weight, BMI, and waist circumference. Additionally, subjects were divided into study and control groups based on their waist circumference measurements. Thus, it is plausible to suggest that central obesity may be the contributing factor responsible for the observed reductions in lung function parameters within the study group.

Our study revealed significant reductions in FEV_1 and FVC among subjects with central obesity compared to controls. This finding aligns with the observations of Soundariya K et al. and Baruah K et al., who similarly reported significant reductions in FEV_1 and FVC among obese subjects[8,14]. However, in contrast to these studies, Ajmani S et al. reported no significant changes in FEV_1 and FVC among obese subjects[15].

Furthermore, our study indicated no significant difference in the FEV_1/FVC ratio between the two groups, consistent with the findings reported by Soundariya K et al. and Baruah K et al[8,14]. However, this result contrasts with the findings of Ajmani S et al., who reported a reduction in the FEV_1/FVC ratio among obese subjects. It is worth noting that the study conducted by Ajmani S et al. involved sedentary subjects who had been working in air-conditioned environments for a minimum of six years and they grouped subjects based on their BMI[15].

Additionally, our study revealed no significant differences between the two groups in terms of PEFR and FEF_{25-75} values. This observation aligns with the findings of Paralikar S J et al., although their study specifically focused on adolescent boys[16]. In contrast, Soundariya K et al. reported decreased PEFR in obese subjects compared to controls, diverging from our study's findings[8].

The observation of reduced FEV_1 and FVC with a preserved FEV_1/FVC ratio suggests that both FEV_1 and FVC were similarly affected by central obesity. Reduction in FVC and FEV_1 without affecting FEV_1 / FVC ratio indicates a restrictive pattern of impairment. In addition, the lack of significant differences between obese subjects and controls in terms of flow rates (PEFR and FEF_{25-75}) is also suggestive of a non-obstructive pattern of impairment.

In our study, 53.3% of obese subjects exhibited a restrictive pattern, with none displaying an obstructive or mixed pattern. This observation is consistent with the findings of Melo et al., who also reported a prevalence of restrictive respiratory pattern among obese subjects[17]. Conversely, Supriyatno B et al. observed that the most common abnormality in obese subjects is a mixed pattern, followed by restrictive and obstructive patterns. It's important to note that their study was conducted in Indonesia, with a different ethnic group, and focused on obese adolescents aged 10-12 years[18].

Obesity exerts its impact on the respiratory system through various mechanisms[1]. One potential mechanism involves the mechanical constraints imposed on chest expansion during the forced vital capacity (FVC) maneuver. The increased mass around the abdomen may hinder the descent of the diaphragm, consequently elevating thoracic pressure[19]. This interference with pulmonary mechanics can restrict breathing, leading to reduced respiratory volumes such as FEV_1 and FVC. This mechanical effect is particularly pronounced if central obesity is considered instead of overall or peripheral fat[20]. Additionally, abdominal adiposity is likely to diminish expiratory reserve volume by compressing the lungs and diaphragm, further contributing to lower FVC measurements[19].

Moreover, inflammatory changes associated with obesity can induce airway inflammation, contributing to impaired lung function[21]. Visceral adipose tissue plays a role in modulating circulating concentrations of various cytokines, including interleukin-6, tumor necrosis factor-alpha, leptin, and adiponectin. These cytokines may promote systemic inflammation, thereby exerting negative effects on pulmonary function. Studies have reported an inverse relationship between serum leptin concentrations and FEV1, alongside elevated levels of markers of systemic inflammation such as C-reactive protein, leukocytes, and fibrinogen. Thus, inflammation serves as another potential mechanism linking visceral obesity to pulmonary function[16].

However, Van de Kant et al. did not observe evidence of airway inflammation based on the fraction of exhaled nitric oxide, suggesting the need for further research to validate data regarding airway inflammation in obese patients[9]. While obesity is recognized as a risk factor for pulmonary morbidity, it's noteworthy that not all obese adults experience pulmonary impairment. Nevertheless, the factors underlying pulmonary impairment in specific obese individuals remain unclear. Further investigations are warranted to elucidate these factors.

Considering our findings pointing towards a potential link between obesity and restrictive pulmonary function, it underscores the importance of maintaining an ideal body weight to prevent such dysfunctions. Given that many respiratory function abnormalities observed in obesity stem from the mechanical burden of adipose tissue and subsequent deconditioning, it is logical to anticipate that weight reduction could lead to improvements in these physiological disturbances[22]. Doing regular exercise and adopting a balanced diet have been shown to effectively decrease weight and enhance respiratory function[2].

However, our study had few limitations. Firstly, the findings were derived from cross-sectional analyses, meaning that waist circumference and dynamic lung function parameters were measured at a single time point. As such, the cross-sectional study design does not offer insights into the temporal sequence of exposure-outcome relations. Secondly, the study involved South-Indian adults, potentially limiting the generalizability of the findings to other populations or ethnic groups. Therefore, further longitudinal studies are necessar, encompassing a larger and more diverse sample of subjects spanning various age groups and socioeconomic backgrounds from different ethnicities and regions. Additionally, longitudinal investigations should extend to children and adolescents to verify the effects in these age groups.

CONCLUSION

Our study revealed a notable decrease in FEV_1 and FVC among subjects with central obesity. However, there were no significant differences observed in the FEV_1/FVC ratio, PEFR, and FEF_{25-75} between the two groups. These findings indicate a restrictive pattern in centrally obese adults. This study is an attempt to highlight the effects of increasing WC on pulmonary function so that appropriate intervention measures can be instituted to reduce obesity and its related diseases.

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A Comparative Cross-Sectional Analysis

Assessment of Airway Resistance and Specific Airway Conductance in Centrally Obese Adults

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ABSTRACT

Background: Obesity's systemic consequences impact pulmonary function, with central obesity exerting a more significant influence on pulmonary mechanics than peripheral obesity. Waist circumference (WC) emerges as a crucial parameter, yet research focusing on its specific impact on airway mechanics is limited. ***Objectives:*** The study aims to assess whether centrally obese adults exhibit distinct airway resistance and specific airway conductance compared to gender and age-matched controls using cross-sectional study. ***Methods:*** A total of ninety individuals between the ages of 20 and 40 took part in the study. The research group consisted of forty-five individuals who were selected based on their waist circumference (WC) being equal to or more than 90 cm in males and 80 cm in women. The remaining 45 individuals were allocated to the control group according to their waist circumference (WC) being below 90 cm in men and 80 cm in females. A body plethysmograph was used to assess airway resistance and conductance. The statistical methodology employed was appropriate, utilizing the Independent Student's t-test to compare the groups. ***Results:*** The findings showed that the group that participated in the research had a higher airway resistance (P = 0.03) than the control group. No significant disparity in specific airway conductance was observed between the two groups, following the application of suitable statistical tests for mean comparison (P = 0.99). ***Conclusion:*** Centrally obese adults experience increased airway resistance attributable to diminished lung volumes rather than intrinsic airway obstruction. This heightened respiratory effort underscores the importance of maintaining a normal waist circumference to mitigate potential respiratory challenges associated with central obesity.

Introduction

The abnormal or excessive accumulation of fat that characterizes obesity may have detrimental consequences on health. Obesity is well recognized as a worldwide occurrence that leads to higher rates of illness and shorter lifespans[1]. The cause of obesity is complex and involves several causes, resulting from the interplay between genes and the environment, lifestyle, and emotional aspects. Due to the absorption of western culture, urbanization, and sedentary lifestyle, the prevalence of obesity has grown substantially in India, where it is now a major health problem for a considerable section of the population[2-4].

Obesity may be categorized as either central or peripheral. Central obesity refers to an accumulation of fat over the thorax, abdomen, and visceral organs. In contrast,peripheral obesity involves fat deposits mostly in the thighs, hips, and leg areas. Pulmonary function and mechanics are more significantly impacted by central obesity than to peripheral obesity [5, 6]. Studies have demonstrated that, regardless of body mass index (BMI), abdominal obesity, which may be estimated by measuring waist circumference (WC), can affect respiratory mechanics [7, 8]. Waist circumference measurement and interpretation are simple procedures that are highly correlated with visceral fat. Research is accessible that demonstrates the impact of body weight and BMI on airway resistance. However, there is a scarcity of material that illustrates the impact of waist size on airway mechanics [9-11].

Lung function may be adversely affected by a number of systemic consequences resulting from chronic obesity. Furthermore, the thoracic

wall and diaphragm may have difficulty in moving due to the accumulation of adipose tissue in the chest and abdomen. The mechanical pressures placed on the diaphragm cause a reduction in both the expiratory volume and the functional residual capacity, or the quantity of air left in the lungs following a typical expiration. As a result, this leads to decreased flexibility and ease of breathing (respiratory compliance). Obese persons have the challenge of dealing with both the elastic load and higher airway resistance caused by reduced lung capacities related to obesity.

Providing adequate treatment for this expanding patient population requires a thorough understanding of the relationship between obesity and respiratory disorders as well as ensuring that there are enough medical resources available. Spirometry is the most reliable and widely accepted tool for assessing lung function in clinical settings. Nevertheless, the spirometry test lacks the ability to accurately identify peripheral airways illness in individuals who are fat. Using volume-corrected respiratory mechanics measurements, like specific airway conductance, may shed more light on the underlying causes of fat people's airway mechanics. However, only a small number of researches have investigated airway resistance and specific airway conductance in persons who are centrally obese. This is despite the fact that a number of studies have demonstrated the influence that obesity has on basic pulmonary function tests. The objective of this study was to examine if there are significant disparities in airway obstruction and specific airways conductance among people with central obesity and their counterparts who are comparable in terms of age and gender. A body plethysmograph is used for the quantification of airway resistance and specific airway conductance. Our hypothesis is that people who have central obesity would have increased airway resistance compared to control subjects who are similar in terms of gender and age.

MATERIALS & METHODS

Study Design: Cross-sectional Observational Study.

Study Site: Department of Physiology, Bangalore Medical College and Research Institute, Bengaluru.

Study Duration: 6 months

Sampling Technique: Simple Random Sampling

Sample Size: The sample size was calculated by using the following formula which was as follows:

$n = [(Z_\alpha + Z_{(1-\beta)})^2 \sigma^2]/d^2$

where, n is the required minimum sample size

Z_α = level of significance, $Z_{(1-\beta)}$ = power of test,

σ = Standard Deviation & d = Effect Size.

n = 45

Therefore, the sample size for the study consists of 45 study subjects in study group and 45 study subjects in control group.

Inclusion Criteria: Participants between the age of 20 and 40 years, participants willing to provide informed consent for participation in the study, **g**enerally healthy individuals without significant persistent respiratory disorders (e.g., asthma, chronic obstructive pulmonary disease) or cardiovascular diseases and participants with no history of smoking are included in the study.

Exclusion Criteria: Individuals below 20 or above 40 years of age, pregnant individuals due to potential confounding factors affecting airway dynamics, individuals with evident clinical anomalies in the thoracic cage and spinal column, neuromuscular ailments, documented cases of any allergy or endocrine abnormalities, TB, chronic obstructive pulmonary illness, bronchial asthma, chronic bronchitis, nasolaryngeal disorders, a past medical history of occupational lung diseases, excessive daytime sleepiness, smoking, daytime fatigue, or snoring are excluded from the study.

Data collection methods and Procedures: Clear instructio--ns on the procedures were provided to all participants. The study design included the collection of patient history, conducting a clinical examination, obtaining anthropometric measures (such as height, weight, and waist circumference), and recording airway resistance and specific airway conductance.

Research group and control group were formed based on waist circumference. A measuring tape that does not stretch was used to determine the waist circumference. The waist circumference was measured exactly midway between the iliac crest and the lowest margin of the ribs, at the end of normal expiration. 45 study subjects were taken in the study; all had waist circumference 90 cm or larger in men and 80 cm or larger in women. For this study, we used 45 controls, all of whom were age and gender matched and had a waist circumference of less than 80 cm for women and 90 cm for men.

The body plethysmograph module of the MEC PFT System (Medical Electronic Construction, Brussels, Belgium; Model No. - B1070) was used to assess the specific airway conductance and airway resistance. This is derived from Boyle's Law, which asserts that while the temperature and quantity of gas molecules remain constant, product of pressure and volume remains constant. The whole body plethysmograph comprises a rigid chamber where the patient sits and breathes via a pneumotachograph. The variable pressure plethysmograph operates on the core idea that alterations in plethysmograph pressure may be used to deduce variations in alveolar pressure. This is accomplished by the use of a shutter mechanism, which is located near the mouth in the plethysmograph. The shutter may be closed to temporarily block the airway. Voluntary respiratory attempts are made while the shutter is closed, and the change in alveol-

-ar pressure is determined by measuring the change in mouth pressure. The correlation between alveolar and plethysmographic pressure, which is determined while exerting respiratory efforts against a closed shutter, is then applied to dynamic events during spontaneous breathing in order to assess airway resistance.

Participants were directed to engage in a period of relaxation lasting 5-10 minutes before the commencement of procedure. Subsequently, the process was elucidated and the move was exemplified. Participants were directed to sit erect within the body box and maintain this position during the assessment. They were also told to wear a nasal clip. They were directed to firmly close their lips around the provided mouthpiece. Participants were instructed to do a panting maneuver inside a body plethysmograph with the door closed in order to evaluate airway resistance and specific airway conductance.

This research included both descriptive and inferential statistical analysis. The continuous values are reported as the mean value plus or minus the standard deviation. To comparethe two groups, we employed the Independent t-test (two-tailed). A statistically significant p-value was less than 0.05. R 3.4.1 was the version of software used to analyze the data.

RESULTS

Demographic information for the participants is summarized in **Table 1.** No notable distinctions in age or height were observed between the two groups. However, the research group exhibited significantly elevated values for weight, BMI, and waist circumference, with a p-value of 0.0001 ($p < 0.05$). The research group consisted of 22 males and 23 females, while the control group comprised 23 males and 22 females.

Table 2 provides a comparison of airway resistance and specific airway conductance between the two groups. The research group exhibited a statistically significant increase in airway resistance compared to the control group, as indicated by a p-value of 0.03 ($p < 0.05$). Conversely, no significant difference in specific airway conductance was observed between the two groups, with a p-value greater than 0.99.

Table 3 illustrates the correlation matrix which indicates relationships among variables in the study. Age and BMI show a positive correlation (0.28), suggesting a tendency for higher BMI with increasing age. Weight and BMI exhibit a strong positive correlation (0.85), highlighting their close association. Airway resistance and specific airway conductance display a strong negative correlation (-0.8), ind--icating an inverse relationship - higher airway resistance is associated with lower specific airway conductance.

Table 1: Demographic profile of participants.

Variables Name	Control Group	Research Group	P-Value
Age (years)	24.29 ± 3.09	24.69 ± 3.27	0.55
Height (cm)	165.5 ± 9.97	165.49 ± 9.18	1.000
Weight (kg)	60.5 ± 10.82	75.78 ± 14.34	**0.0001***
BMI (kg/m^2)	21.98 ± 2.68	27.53 ± 3.54	**0.0001***
Waist Circumference (cm)	73.41 ± 8.63	90.87 ± 8.88	**0.0001***

***statistically significant**

Table 2: Comparison of airway resistance and specific airway conductance of two groups

Variables Name	Control Group	Research Group	p-value
Airway Resistance (kPa/L/s)	0.3 ± 0.14	0.38 ± 0.1	**0.03***
Specific Airway Conductance (1/kPa/s)	1.54 ± 0.63	1.53 ± 1.27	0.99

***statistically significant**

Table 3: Correlation Matrix.

Parameters	Age	BMI	Airway Resistance	Specific Airway Conductance
Age	1	0.28	-0.12	0.07
Height	-0.02	0.2	0.05	-0.18
Weight	0.15	0.85	0.32	-0.25
BMI	0.28	1	0.42	-0.36
Waist Circumference	0.1	0.75	0.28	-0.22
Airway Resistance	-0.12	0.42	1	-0.8
Specific Airway Conductance	0.07	-0.36	-0.8	1

DISCUSSION

Our study showed increased airway resistance in centrally obese adults. But, specific airway conductance was comparable between two groups. Both the groups were gender and age matched; they varied significantly only for weight, BMI & waist circumference. As subjects were divided into 2 groups according to WC, increased waist circumference in centrally obese subjects might be the factor responsible for above observed findings.

Similar results were also observed in a study conducted by Zerah F et al. The study included a cohort of 46 individuals, who were categorized into three separate groups based on their body mass index. Body plethysmography facilitated the assessment of airway resistance. Based on their investigation , the researchers found that the severity of obesity did not impact the specific airway conductance. However, they observed a positive relationship between the amount of obesity and an increase in airway resistance [22-24]. Truncal obesity has a notable impact on airway resistance, as indicated by the research conducted by Abdel Halim H A and colleagues. A total of 102 participants participated in this study, and airway resistance levels were determined using im-

-pulse oscillometry [25].

In contrast, Arevalo A. P. and colleagues discovered that individuals who were obese saw a notable decrease in specific airway conductance (sGaw). This observation contradicts the findings presented in this study. However, the study included a group of thirty-six children and adolescents, ranging in age from six to twelve years. The participants were classified into two groups according to their body mass index (BMI): individuals with a normal weight and individuals with obesity[26, 27].

The decrease in functional residual capacity (FRC) has a considerable impact on measurements of airway function, such as resistance and reactance; since these metrics depend on the precise lung volume at which they are evaluated. "Specific airway conductance" is a volume corrected measure. The computation is obtained by dividing the airway conductance by the lung volume at the moment of measurement. So while airway resistance is increased in obesity, when correction is done for the decreased functional residual capacity with parameters such as specific airway conductance, the airway caliber appears normal [28, 29]. Consequently, the observation that both groups demonstrate--d comparable airway conductance suggests that the heightened airway resistance observed in centrally obese individuals is primarily due to a decrease in lung capacities rather than a genuine blockage of the airways. A bigger waist circumference may potentially impact pulmonary function by constraining the movement of the diaphragm and chest wall, leading to mechanical consequences. The impact of this mechanical effect becomes more apparent when specifically considering central obesity rather than overall or peripheral fat[30].

There is insufficient knowledge on the precise process that causes changes in airway mechanics due to obesity. Several variables, such as inflammation and the mechanical stress caused by fat accumulation around the abdomen are believed to be the underlying causes. Structural alterations occur as a result of excess adipose tissue in the chest wall, abdomen, and upper airways. These modifications lead to a decrease in lung volumes and capacities, namely in the expiratory reserve volume (ERV) and functional residual capacity (FRC) [31]. The decrease in lung capacity leads to a simultaneous rise in peripheral airway resistance. Hence, the accumulation of adipose tissue on the thoracic wall and abdominal region leads to reduced lung capacities during periods of inactivity and diminished total respiratory flexibility. This decrease in size may result in an increase in airway resistance, necessitating greater exertion for respiration. In obese persons, tidal breathing occurs in a less compliant position within their respiratory system, primarily due to their decreased functional residual capacity (FRC). As a consequence, they face increased airway resistance during tidal breathing.

Furthermore, adipose tissue is recognized for its metabolic activity and its ability to cause inflammation by releasing several chemicals, including as adipokines as leptin, resistin, and adiponectin. It is crucial to acknowledge that the receptors for these hormones are extensively dispersed throughout the body, specifically in the lungs [33]. The pro-inflammatory mediators cause an increase in airway inflammation and a decrease in lung viscoelasticity, leading to a loss of lung function. Leptin has been proposed to be involved in the reduction of airway function linked to obesity. The primary explanation for this is the direct impact it has on the smooth muscles of the airways, coupled with its pro-inflammatory properties. Additionally, it is possible that an intensified atopic reaction could result from an increased inflammatory condition triggered by fat which warrants further consideration[34].

Conversely, some investigations have demonstrated that obesity-induced decrease in lung volumes might result in a decrease in the diameter of the peripheral airways. Over time, this can lead to the dysfunction of smooth muscles, resulting in the obstruction of the airway and increased sensitivity. Our analysis did not address the duration of an individual's obesity. However, it is plausible that long-term obesity is the underlying cause of the previously stated process [35].

The current incidence of respiratory ailments and obesity in our culture amplifies the significance of our findings. Obesity rates are increasing worldwide, despite mounting evidence of increased health concerns and a decline in quality of life. Although genetic predisposition can contribute, there are several strategies that can be pursued to treat and prevent obesity, aiming to mitigate a range of medical and respiratory issues. Promoting a lifestyle characterized by enhanced dietary habits and elevated levels of physical activity are vital for public health. It is crucial for governments to work together with public health authorities throughout this endeavor. The respiratory issues linked to obesity can be effectively alleviated by achieving weight loss and participating in physical exercise[36, 37].

CONCLUSION

In conclusion, the findings of this comparative cross-sectional study demonstrate a heightened airway resistance in centrally obese adults, coupled with comparable specific airway conductance between the two groups under investigation. This suggests that the augmented airway resistance observed in centrally obese individuals is attributed to a reduction in lung volumes rather than intrinsic airway obstruction. Consequently, it is imperative to recognize that centrally obese adults experience an increased respiratory burden, emphasizing the critical importance of maintaining normal waist circumference as a preventive measure. These results contribute to our understanding of the respiratory implications associated with central obesity and underscore the significance of targeted interventions to

mitigate potential respiratory challenges in this population.

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ETHICS APPROVAL

All necessary approval including ethical approval has been taken before conducting this study.

AVAILABILITY OF DATA AND MATERIAL

Not Applicable.

CONFLICT OF INTERESTS

Authors declared that there is no conflict of interest.

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