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Original Research Article

PULMONARY FUNCTION VARIATIONS IN ABDOMINAL OBESITY: A COMPARATIVE STUDY

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Abstract

Background: The objective of this study was to investigate the alterations in pulmonary function among those with normal weight and those with abdominal obesity across several age cohorts. **Materials and Methods:** The study was carried out from January to December 2012 at the Academy of Medical Sciences, Pariyaram. The Institutional Ethics Committee granted ethical approval. Before their inclusion in the study, the participants were duly informed about the research and provided with signed consent. A total of 400 people were included in the study, with 200 suffering from abdominal obesity and 200 having a normal weight. The subjects were selected from several age categories, specifically 25-35 years, 35-45 years, and 45-55 years. The assessment of pulmonary function in these groups was conducted using a portable computerized spirometer. The unpaired t-test was employed to contrast the data of the obese and non-obese groups using IBM SPSS software for Windows. Both the groups were compared based on age, BMI, WC, HC, and Pulmonary function measures. **Result:** The mean age of the obese and non-obese groups was 36.8±1.37 and 36.77±1.4 years, respectively (p>0.05). The group with obesity had an average HC of 96.5±11.5 cm, while the group without obesity had an average hip circumference of 73.3±5.78 cm (p>0.001). The mean waist circumference in the obese and non-obese groups were 88.15±13.25 cm and 64.3±7.7 cm, respectively (p>0.001). The obese sample exhibited an average BMI of 29.4±4.12 kg/m^2, in contrast to the comparison group (19.51 ± 1.23 kg/m^2) with p<0.001. The mean vital capacity (VC) in the current study was 2.95±0.48 in 45-55 years, 3.68±1.61 in 25-35 years, and 3.11±0.44 in 35-45 years for participants with normal weight. The study observed a consistent decrease in force vital capacity (FVC) values with advancing age, with the most pronounced reduction observed in those between the ages of 45-55 years. This decline was shown to be statistically significant (p<0.01). Statistically significant differences in the mean values of forced expiratory volume in one second (FEV1) were observed between normal-weight individuals and those with abdominal obesity across all age categories (p<0.001). **Conclusion:** The age group of 25-35 years exhibited the greatest values for VC, FVC, and FEV1 among the participants with normal weight. As individuals grow older, there is a consistent decrease in pulmonary function parameters. Significant reductions in VC, FVC, and FEV1 were observed in abdominal obesity groups in comparison to normal-weight patients within the same age groups.

INTRODUCTION

The worldwide incidence of abdominal obesity is on the rise due to the increasing urbanization of communities in developing countries, which is accompanied by a decline in physical activity and an upsurge in caloric consumption. No empirical data suggests that this occurrence will reach a plateau. Lack of physical activity is well recognized as a significant worldwide health issue and is widely acknowledged as the main risk indicator for chronic illness and mortality.[1] The global prevalence of overweight among adults exceeds one billion, with a minimum of 300 million individuals classified as significantly obese, a condition referred to as a "global epidemic" by the World Health Organisation (WHO).[2]

The prevalence of abdominal obesity is increasingly recognized as a significant contributing factor to the decline of lung function among the general populace. The potential association between abdominal obesity and reduced lung capacity is likely attributable to the compression exerted by the abdominal cavity on the diaphragm.[3] In comparison to general adiposity, abdominal adiposity indicators such as waist-hip ratio (WHR) and waist circumference (WC) have the potential to impact breathing capacity by impeding the descent of the diaphragm and constraining lung expansion.[4] Clinical investigations have assessed the correlation between waist-to-hip ratio (WHR) and waist circumference (WC) with impaired respiratory performance in individuals who are both slightly obese and severely obese.[5]

The presence of abdominal obesity can directly impact respiratory health due to its association with heightened oxygen use and carbon dioxide generation. Simultaneously, the mechanical requirement for respiration is intensified.[1] The evaluation of lung size, flow rates, and diffusing capacity of the lungs is a standard practice in pulmonary function testing (PFT). The examination has the potential to yield significant insights into the existence of ventilatory abnormalities, the extent of pulmonary dysfunction, the efficacy of treatment, and potential impacts on the process of gas exchange. The history of PFT is extensive, and the tests that are carried out frequently are generally well-standardized.[6]

Spirometry is the pulmonary function test that is most frequently conducted. The main objective of conducting this examination within an outpatient environment is to identify restrictive and/or obstructive lung abnormalities.[7] Extensive research has been conducted in the past five decades to investigate the pathophysiology of abdominal obesity and its impact on lung function. By examining the degree to which abdominal obesity reduces lung function parameters, we can enhance our comprehension of the association between abdominal obesity and lung function.[8] Therefore, this study aimed to raise awareness regarding the relationship between BMI, hip circumference (HC), and WC with variations in lung function. It is important to recognize the pulmonary issues associated with abdominal obesity. The objective of this study was to investigate the alterations in pulmonary function among those with normal weight and those with abdominal obesity across several age cohorts.

MATERIALS AND METHODS

The study was carried out from January to December 2012 at the Academy of Medical Sciences, Pariyaram. The Institutional Ethics Committee granted ethical approval (IEC/ACME/25-11-13). Before their inclusion in the study, the participants were duly informed about the research and provided with signed consent. A total of 400 people were included in the study, with 200 suffering from abdominal obesity and 200 having a normal weight. The subjects were selected from several age categories, specifically 25-35 years, 35-45 years, and 45-55 years. The assessment of pulmonary function in these groups was conducted using a portable computerized spirometer.

The individuals underwent a thorough screening process by providing a comprehensive medical history as outlined in the proforma. The age of the majority of the subjects was verified by acquiring their date of birth. A comprehensive physical examination was conducted, and exclusions from the current study also included smokers, those with systemic diseases, and chronic cough. The participants who were chosen were taken to the examination rooms located in the outpatient clinics. During these visits, physical parameters included height in centimeters, weight in kilogram, and WC and HC in inches were examined. The height of the individual was measured while they were standing upright barefoot against a wall, and wearing light clothing. The measurement was taken using a measuring tape with a precision of 5mm or greater. The weight was determined by employing a weighing apparatus in the absence of footwear and while wearing lightweight attire. The body mass index (BMI) was determined using the formula weight (kg)/height in meter square units. The WC measurement was conducted while wearing lightweight clothing, with feet positioned 25-30 cm apart. The weight was evenly distributed, and a measuring tape was used in a plane perpendicular to the long body axis at the level of the umbilicus. The skin was not compressed, and the measurement was taken with a precision of 0.1 cm. According to the recommendations set by the World Health Organisation (WHO) Asia Pacific, WC exceeding 90 cm in men and 80 cm in women was classified as abdominal obesity. The measurement of HC was conducted while wearing lightweight clothing, namely across the greater trochanter, with the legs and feet together. This was accomplished with a measuring tape, ensuring that the skinfold was not compressed. Next, the participant was instructed to assume an upright position, with their feet solidly grounded on the floor. The patient's nose should then have a nose clip applied and the patient was instructed to inhale completely, firmly grasp the mouthpiece, and exhale rapidly and extensively. Then, inhale again with maximum force and to the maximum extent. The process of demonstrating the manoeuvre to the subject is crucial in attaining satisfying outcomes as it effectively addresses 90% of experienced issues. The act of observing and providing support for the subject's performance is of utmost importance.

The present investigation employed a handheld computerized spirometer called 'Medicaid'. The central component of the system is the intelligent flow meter, which is linked through the serial port established by ISO 13485 in 2003. The system consists of several components, including the turbine flow meter, the measurement and data validation device, the communication cable, and the software package. Medicaid automatically corrects BTPS values when ambient circumstances are provided. The utilization of this method guarantees a straightforward evaluation of lung function information obtained from laboratories that operate under varying environmental temperatures and altitudes.

The participant was instructed to exhale calmly and regularly using the mouthpiece. This procedure guarantees that the individual is in a state of relaxation and produces the resting end-expiratory level, which acts as the baseline for the measurement that follows. Subsequently, the participant was instructed to execute a maximal slow inhalation, succeeded by a maximal slow exhalation. During the final stage of expiration, the individual was motivated to prolong the expiration process to the greatest extent feasible. The parameters were computed using the best result from three consecutive assessments. Comparably, Forced Expiratory Volume (FEV1) pertains to the quantity of air that an individual is capable of expelling during a deliberate lung contraction within a span of one second.

The individual was instructed to breathe normally for a short while before being asked to exhale as quickly, violently, and thoroughly as they could. The program verifies the satisfaction of the ATS requirements and, if accomplished, presents the calculated values on the screen. After that, the "stop key" was tapped. The evaluation of the performance involved a thorough examination of the graphic results, which was subsequently repeated if deemed required.

Statistical analysis:

The unpaired t-test was employed to contrast the data of the obese and non-obese groups using IBM SPSS software (Version 25.0) for Windows. Both the groups were compared based on age, BMI, WC, HC, and Pulmonary function measures.

RESULTS

The investigation was carried out on a sample size of 400 participants, consisting of 200 individuals with normal weight and 200 individuals with abdominal obesity. The mean age of the obese and non-obese groups was 36.8±1.37 and 36.77±1.4 years, respectively ($p>0.05$). The group with obesity had an average HC of 96.5±11.5 cm, while the group without obesity had an average HC of 73.3±5.78 cm ($p>0.001$). The mean WC in the obese and non-obese groups were 88.15±13.25 cm and 64.3±7.7 cm, respectively ($p>0.001$). The obese sample exhibited an average BMI of 29.4±4.12 kg/m^2, in contrast to the comparison group (19.51 ± 1.23 kg/m^2) with $p<0.001$.

The mean vital capacity (VC) in the current study was 2.95±0.48 in 45-55 years, 3.68±1.61 in 25-35 years, and 3.11±0.44 in 35-45 years for participants with normal weight. The greatest VC was observed in individuals aged 25-35, and it exhibited a consistent decrease as age progressed. The most substantial decrease was observed in the age group of 45-55 years and was shown to be statistically significant ($p<0.01$). The average VC of the abdominal obesity group was found to be 2.86±0.4 in the age group of 25-35 years, 2.67± 0.5 in the age group of 35-45 years, and 2.26 ± 0.4 in the age group of 45-55 years (Table 1). The VC exhibited a consistent decrease as age progressed, with the most significant reduction noticed in the 45-55-year age group ($p<0.01$).

The average forced vital capacity (FVC) value in the normal weight subjects was 3.27±0.31 in the 25-35 years age group, 3.07±0.45 in the 35-45 years age group, and 2.74±0.3 in the 45-55 years age group. The maximum FVC was observed in the age group of 25-35 years, whereas as age increased, there was a decrease in FVC levels. The greatest reduction was observed in the age group of 45-55 years, and this reduction was statistically significant ($p<0.01$). In this investigation, the average FVC value in the abdominal obesity group was 3.07±0.35 in the 25-35 age group, 2.85±0.31 in the 35-45 age group, and 2.37±0.38 in the 45-55 age group (Table 2). The study observed a consistent decrease in FVC values with advancing age, with the most pronounced reduction observed in those between the ages of 45-55 years. This decline was shown to be statistically significant ($p<0.01$). Statistically significant differences in the mean values of FEV1 (Table 3) were observed between normal-weight individuals and those with abdominal obesity across all age categories ($p<0.001$).

Table 1: Comparison of vital capacity of normal weight subjects of various age groups with abdominal obesity subjects of same age groups

	25-35 yrs	**35-45yrs**	**45-55yrs**
Without abdominal obesity (Mean±SD)	3.68±1.61	3.11±0.44	2.95±0.48
With abdominal obesity (Mean±SD)	2.86±0.4	2.67±0.5	2.26±0.4
Unpaired t-test (p-value)	<0.05	<0.05	<0.05

Table 2: Comparison of Forced Vital Capacity of subjects with abdominal obesity of various age groups with normal weight subjects of same age groups

	25-35 yrs	**35-45yrs**	**45-55yrs**
Without abdominal obesity (Mean±SD)	3.27±0.31	3.07±0.45	2.74±0.3
With abdominal obesity (Mean±SD)	3.07±0.35	2.85±0.31	2.37±0.38
Unpaired t-test (p-value)	<0.05	<0.05	<0.01

Table 3: Mean FEV1 of subjects with abdominal obesity of various age groups with normal weight subjects of same age groups

	25-35 yrs	35-45yrs	45-55yrs
Without abdominal obesity	2.72±0.29	2.46±0.35	2.12±0.22
With abdominal obesity	2.44±0.33	2.21±0.28	1.69±0.25
Unpaired t-test (p-value)	<0.05	<0.05	<0.01

DISCUSSION

Changing lifestyle and behaviour can lead to abdominal obesity, which are an undesired consequence and a reversible risk factor for the onset of serious disabling conditions. The accumulation of adipose tissue in the abdominal region can potentially result in a reduction in the respiratory system's compliance and resistance, hence elevating the energy requirements associated with respiration. The resistance and reactance of the airway are significantly influenced by lung volume and can be impacted by any decrease in lung function. Obstructive sleep apnea, obese hypoventilation syndrome, chronic obstructive illnesses, and cardiovascular diseases might arise as a consequence of a gradual decline in pulmonary function. The Baltimore Longitudinal Study investigated the correlation between obesity trends and the decrease in lung volumes and capabilities in men and women across different age groups.[9]

Krishnan and Vareed (2010) also demonstrated a decrease in VC with advancing age. The study specifically focused on individuals aged 18 to 65 years.[10] The decline in performance observed with advancing age can be attributed to the limited expansion of the lungs, resulting from the replacement of elastic tissue by fibrous tissue. Schmidt and Thwes,[11] Vague et al,[12] and Sue et al.[13] also reported a comparable decrease in pulmonary parameters. The detrimental impact of abdominal obesity on lung function is probably facilitated by direct influences on the rib cage or a decrease in pulmonary compliance. Compression in the abdominal viscera caused by localized fat may also transfer blood to the thoracic compartment, resulting in a decrease in VC.

The current observations on FVC revealed a substantial drop in the pulmonary values among the abdominal adiposity groups as opposed to the normal-weight patients across all three age groups, and this decline was statistically significant. Similar findings were observed in studies conducted by Al Bader et al.,[14] Attaur–Rasool et al,[15] and Jubber et al.[16] The potential cause may be attributed to restricted respiratory impairment in those who are obese, resulting from an accumulation of body fat that reduces the compliance of the chest wall. This is mostly due to the accumulation of adipose tissue around the chest and in the abdominal region. The decrease in FVC values exhibited similarities to the findings reported by Vijayan et al,[17] and Verma et al,[18] within the age range of 15-40 years.

A statistically significant reduction in FEV1 was found in the abdominal obesity group in comparison to the normal weights throughout the three age groups ($p<0.01$). The findings of Shinohara et al,[19] and Sood et al,[20] in comparable age cohorts were consistent with the outcomes of the present investigation. An increase in abdominal fat accumulation is associated with a decrease in thoracic volume. The presence of abdominal fat directly impacts the downward motion of the diaphragm, resulting in a decrease in lung volumes and capacities. The deterioration in pulmonary function and the hastened drop in pulmonary function parameters associated with aging can be altered by modifying the lifestyle of those who are currently negligent in their dietary habits and have a preference for consuming high-calorie processed foods, as well as adopting automated work patterns.

According to Morris et al,[21] there is a consistent decline in pulmonary function as individuals age, even in the lack of respiratory disorders, cigarette smoking, or atmospheric pollution-induced dysfunction. The implementation of spirometry as a tool for screening for the general population and the timely identification of mid-decline pulmonary function characteristics can contribute to raising public awareness about the health hazards linked to abdominal obesity. These initiatives have the potential to mitigate the long-term negative consequences associated with abdominal obesity, leading to a reduction in both morbidity and death rates. As individuals get older, the lung thoracic system has a decline in its elastic characteristics, resulting in restrictions on both dynamic and static ventilatory activities.

CONCLUSION

The age group of 25-35 years exhibited the greatest values for VC, FVC, and FEV1 among the participants with normal weight. As individuals grow older, there is a consistent decrease in pulmonary function parameters. Significant reductions in VC, FVC, and FEV1 were observed in abdominal obesity groups in comparison to normal-weight patients within the same age groups. The study observed a statistically significant decrease in pulmonary function measures among individuals aged 45-55 years with abdominal obesity, in comparison to other age cohorts.

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