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Original Research Article

Cross-sectional study of effect of adiposity and hypertensive states on airway dynamics

Kunal Kishor Gautam, Deepak Saxena*, Arvind Kanchan, Nisar Ahmad, Rahul Saini, Naushi Mujeeb

Department of Physiology, Hind Institute of Medical Sciences, Barabanki, Uttar Pradesh, India

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***Correspondence:**
Dr. Deepak Saxena,
E-mail: physiologyhimsbbk@gmail.com

ABSTRACT

Background: Adiposity and hypertensive states are major burden for community. It causes many health-related issues, including problems related to respiratory system. It is proposed that pulmonary functions can be affected in obese hypertensive and obese normotensive adults compared to non-obese normotensive adults. The objective of the study was to find out the effect of adiposity and hypertensive states on the airway dynamics.
Methods: About 30 male obese normotensives and 30 male obese hypertensive subjects were selected as study participants. 30 age-controlled non-obese, normotensive males were selected as controls. All participants were in the age group of 40 to 60 years. The pulmonary functions measured were FVC, FEV1, FEV1% and PEFR. All the participants performed 3 attempts of spirometry and maximum among the three recordings were used for analysis. ANOVA followed by Post hoc analysis to find out any significant differences between these groups. Spearman's rank correlation was used.
Results: There was a statistically significant differences in BMI between the group I and group II and III. There was a significant difference in SBP and DBP between obese normotensive (group II) and obese hypertensive (group III) subjects. There were significant decline in % predicted values of PFT parameters, on comparing obese normotensive and obese hypertensive when compared to non-obese normotensive participants. There were statistically significant negative correlations between age and FEV1 as well as BMI and PEFR.
Conclusions: There was a significant decrease the pulmonary functions in obese normotensive and obese hypertensive adults in comparison to non-obese normotensive adults. It can be concluded that body weight and adiposity as well as high blood pressure creates deleterious effect on airway dynamics.

Keywords: Adiposity, Airway dynamics, Hypertension, Pulmonary function

INTRODUCTION

Adiposity and hypertension are global public health problems. The prevalence of adiposity is increasing nowadays in all the geographical regions. Adiposity is considered as a root cause of many diseases like type 2 diabetes mellitus, osteoarthritis, hypertensive states, ischemic heart diseases, gall stones etc.[1] Hypertensive states is in itself a major health issue in adults and elderly population. Adiposity and hypertensive states are very common cause of morbidity and mortality with increasing age. These are because of interaction between varieties of genetic, endocrine and metabolic disorders. The stress, sedentary lifestyle and fast- food culture are equally contributing factors.[2]

Obese and hypertensive persons are on increased risk of problem related to respiratory system, such as dyspnea, especially due to physical exertion and involvement in various exercises. Adiposity and hypertension have a probability to have its deleterious effect on respiratory functions. It increases O_2 utilization and CO_2 formation. It considerably increases the work of breathing by hardening the walls in bronchial airway as well as by changing the mechanics of ventilation.[3] Persons with increased body fat and increased body mass index (BMI) have decreased cardiac as well respiratory capability and they become hypo ventilated. This is shown by exercise intolerance and decreased aerobic capacity (evidenced by reduced VO_2 max in obese adults).[4]

Previous research studies have inconsistent findings about the impact of adiposity and hypertensive states on airway dynamics.[5-7] In present study, authors attempted to compare the objective parameters of airway dynamics (pulmonary function test) in obese normotensive, obese hypertensive with non-obese normotensive adults. The objective of the study was to find out the effect of adiposity and hypertensive states on the airway dynamics.

METHODS

This study was carried out in department of physiology, Hind Institute of Medical Sciences, Safedabad, Barabanki, Uttar Pradesh, India, which is a tertiary care teaching hospital situated in rural area. This research study was done during October 2017 to December 2018. Ethical clearance was obtained from the institutional ethical committee. The study design was observational, cross sectional and comparative.

About 30 male obese normotensives and 30 male obese hypertensive subjects were recruited as study participants. Obesity was considered when the participants' BMI was $\geq$30kg/m^2; hypertensive state was considered when BP $\geq$140/90mmHg. 30 age-controlled non-obese, normotensive males attending the outpatient department for general check-up were recruited as controls. All the subjects participated in this study has given informed written consent. All participants were in the age group of 40 to 60 years.

The dietary history, history of past medical illness, drug history, personal habits of the participants were noted. Participants suffering from ischemic heart disease, any known respiratory illness, any skeletal abnormalities and smokers were excluded from the study. Then, their general physical examination was done.

Body height (height) was measured using a standardized stadiometer, body weight (weight) was measured using an electronic weighing machine. BMI was calculated as weight in kg divided by square of Height in meter. Blood pressure (BP) was recorded after 15 minutes of resting in supine position using an aneroid sphygmomanometer and the recordings were represented in terms of mm of Hg. Pulmonary function test (PFT) was done using as a computerized spirometer with nostrils closed using a nose-clip. PFT was done providing standard conditions of laboratory temperature and pressure in sitting position. The laboratory area where the recordings were done was kept silent. All the recordings were done between 9:00 am to 11:00 am in order to avoid any effect due to circadian rhythm. Each participant had performed PFT with 3 full efforts as per recommendations of American thoracic society.[8] The best of the three values of forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1% and peak expiratory flow rates (PEFR) were considered for evaluation.

Statistical analysis

The actual and the predicted values of spirometry and the % predicted value were expressed as mean and standard deviation. The % predicted values in obese normotensive, obese hypertensive with non-obese normotensive participants were compared by analysis of variance followed by post hoc analysis to find out any significant differences between these groups. p-value less than 0.05 was considered statistically significant.

RESULTS

Table 1 shows the comparison of data between non-obese normotensive, obese normotensives and obese hypertensive subjects. The SBP and DBP were significantly raised in group III.

Table 1: Comparison of data between non-obese normotensive, obese normotensives and obese hypertensive subjects.

Study characteristics	Non-obese normotensive (group I) (n= 30)	Obese normotensive (group II) (n= 30)	Obese hypertensive (group III) (n= 30)	ANOVA (followed by post hoc analysis)
Age (in years)	46.70±7.60	47.82±11.34	51.34±14.43	NS
Body mass index (BMI)	21.69±2.35	31.04±2.46	33.89±2.98	I vs II; I Vs III
Systolic blood pressure (SBP)	121.91±12.14	129.85±14.28	146.76±17.40	I Vs III; II Vs III
Diastolic blood pressure (DBP)	76.90±8.66	84.60±9.01	96.90±10.42	I Vs III

Table 2 shows the comparison of change in percentage of pulmonary functions between non-obese normotensive, obese normotensive and obese hypertensive subjects. There were significantly higher values of FVC, FEV1 and PEF in group I as compared to group III.

Table 2: Comparison of change in percentage of pulmonary functions between non-obese normotensive, obese normotensive and obese hypertensive subjects.

PFT	Non-obese normotensive (group I) (n= 30)	Obese normotensive (group II) (n= 30)	Obese hypertensive (group III) (n= 30)	ANOVA (followed by post hoc analysis)
FVC (L)	92.62±13.27	86.45±12.75	78.60±11.38	I Vs III
FEV1(L)	94.52±16.29	88.35±16.48	79.65±17.62	I Vs III
FEV1%	100.49±17.85	98.47±20.61	102.10±12.78	NS
PEF (L/sec)	91.39±13.27	81.14±20.54	71.09±19.29	I Vs III

Table 3 shows the spearman's rank correlation between the change in percentage of pulmonary functions and age, BMI as well as BP. There were statistically significant negative correlations between age and FEV1 as well as BMI and PEFR.

Table 3: Spearman's rank correlation between the change in percentage of pulmonary functions and age, BMI as well as BP.

Spearman's rank correlation (r value)	Age	BMI	SBP	DBP
FVC (L)	-0.342	-0.259	-0.453	0.301
FEV1(L)	-0.289*	-0.378	-0.391	-0.256
FEV1%	0.245	0.317	-0.275	0.343
PEFR (L/sec)	-0.429	-0.167*	-0.330	0.412

*indicates p-value <0.05 (significant correlation).

DISCUSSION

In present study, authors compared the objective parameters of airway dynamics (pulmonary function test) in obese normotensive, obese hypertensive with non-obese normotensive adults. There was a statistically significant differences in BMI between the group I and group II and III. There was a significant difference in SBP and DBP between obese normotensive (group II) and obese hypertensive (group III) subjects. There were significant decline in % predicted values of PFT parameters, on comparing obese normotensive and obese hypertensive when compared to non-obese normotensive participants. There were statistically significant negative correlations between age and FEV1 as well as BMI and PEFR.

The findings in present study are similar to the previous studies by Lazarus R et al, and Chinn DJ et al, who had reported a negative correlation between adiposity marker like fat mass and distribution of abdominal fat with parameters of pulmonary functions.[6,7] Another important finding in present study suggested the restrictive and obstructive pattern of lung functions in the hypertensive participants with higher BMI. This observation is also consistent with a similar study showing the effects of body weight on airway caliber as decreasing trend of pulmonary volumes and capacities with obesity.[9]

There was a significant decrease in the airway dynamic functions in obese hypertensive participants as compared to non-obese normotensive participants. Some extent of decrease in pulmonary functions was also observed in obese normotensive participants as compared to non-obese normotensive participants. The decrease in airway dynamics in obese hypertensive participants suggest that higher blood pressure could negatively influence the pulmonary functions similar to the influence of obesity. The two principal mechanisms act behind this:(A). Increase in adiposity causes a rise in overall volume of blood volume as well as rise in the venous return and cardiac output. This may be because of increase in the metabolic activity and sympathetic over activity. Obese hypertensive individuals are found to have diastolic dysfunction and left ventricular hypertrophy (LVH) owing to overloads on cardiac muscles crated by high blood pressure and increased blood volume. These abnormalities can lead to increased resistance in airway precipitating as decline in lung functions.[10-11] (B). Increase in adiposity is also associated with deposition of adipose tissues in central regions of body, this cause difficulty in the natural recoil of diaphragm and movements of intercostal muscle creating mechanical restriction. This leads to decrease in the lung and thoracic wall compliance causing increase in the work of breathing because of greater inspiratory efforts. The decrease in the elasticity of airways also leads to decline in lung volume and capacities as well as flow rates.[12] Similar study done in larger sample size and in different age groups of persons in community can establish the impact of higher blood pressure and higher body mass index in decline of pulmonary functions.

CONCLUSION

There was a significant decrease the pulmonary functions in obese normotensive and obese hypertensive adults in comparison to non-obese normotensive adults. It can be concluded that body weight and adiposity as well as high blood pressure creates deleterious effect on airway dynamics.

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