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Anthropometric measurements and indicators of body fat distribution in patients with bronchial asthma

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Abstract

Background: Previous studies repeatedly demonstrate a higher prevalence of bronchial asthma (BA) in subjects with high as well as low body mass index (BMI). This U-shaped associations between BMI and BA raise a question whether indicators of body fat distribution are helpful to predict BA prevalence and symptom control. The aim of this study was to evaluate anthropometric measurements and indicators of body fat distribution in asthmatic patients.

Materials and Methods: One hundred and twenty asthmatic patients were recruited from chest refer clinics - Military Hospital, Khartoum, Sudan and served as the test group. Another 59 non–asthmatic subjects were recruited from co-patients, University students/employees and served as the control group. Following clinical and spirometric evaluation of the studied subjects, the following were measured: body weight, height, waist circumference (WC), hip circumference (HC), triceps (TSF), biceps (BSF), subscapular (SSSF) and suprailiac (SISF) skinfolds thicknesses and the ratio between waist and hip circumferences (WHR). Body fat percent (BF %) and BMI were calculated. Based on BMI, studied subjects were categorized into four classes: underweight, normal weight, overweight, and obese.

Results: Although BMI, HC, TSF, BSF, SSSF, SISF and BF% were higher in asthmatic patients compared to non-asthmatic subjects, the difference of each of these parameters did not reach statistical significance. WC and WHR were significantly higher in asthmatic patients (88.50 (78.00- 101.75), 83.00 (78.47- 90.17)) compared with non-asthmatic subjects (81.00 (72.00- 92.00), 80.00 (75.67- 85.10), P = 0.004, 0.003). Presence of BA in underweight subject was comparable to normal BMI subjects (OR=1.05). However, presence of BA increases steadily in overweight (OR=1.46) and obese subjects (OR=2.67) compared with normal BMI subjects. Presence of symptoms at the time of the study increases in underweight (OR=3.55), overweight (OR=2.13) as well as obese (OR=3.43) compared to normal BMI subjects.

Conclusion: The results of the present study provide further evidence for the association between BA and obesity. Although all indicators of body fat distribution were higher in asthmatic patients compared to non-asthmatic subjects, only WC and WHR reached statistical significance, which points to the importance of abdominal obesity in the pathophysiology of BA.

Keywords: Anthropometric measurements, bronchial asthma, obesity.

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Introduction

Previous studies demonstrate a close relationship between bronchial asthma (BA) and obesity (1-7). From physiological standpoint, adipose tissue releases a group of cytokines which synergistically enhance airways mucosal inflammation associated with BA (8). In addition, obesity induces restrictive ventilatory defect, increases elastic work of breathing and consequently oxygen demands (9). This may explain the augmented perception of dyspnea in patients with already compromised lung like those suffering from BA (6, 10). Several studies were able to demonstrate higher prevalence of BA in patients with high as well as low body mass index (BMI) (2, 11, 12). The predominance of BA in both extremes of BMI raises a question whether indicators of body fat distribution e.g. waist circumference (WC), hip circumference (HC), the ratio between waist and hip circumferences (WHR), triceps (TSF), biceps (BSF), subscapular (SSSF) and suprailiac (SISF) skinfolds thicknesses would be helpful to predict BA prevalence and symptom control. The aim of this study was to evaluate anthropometric measurements and indicators of body fat distribution in patients suffering from BA.

Materials and Methods

This study received ethical approval from the Ethical Review Committee - Al-Neelain University Board, Khartoum, Sudan. All studied subjects signed informed consents before being enrolled in the study. The study was conducted in the Military Hospital - Sudan during the period June 2016 –January 2017. One hundred and twenty asthmatic patients were recruited from chest refer clinics - Military Hospital, Khartoum, Sudan and served as the test group. Another 59 non–asthmatic subjects were recruited from co-patients, University students/employees and served as the control group. Asthmatic patients were defined as self-reported, physician diagnosed BA cases for at least two years. Cigarette smoking, pregnancy, age below 20 years or above 40 years and chronic diseases like diabetes mellitus and hypertension were excluded in all studied groups.

Medical history, clinical examination, results of lung function tests and anthropometric measurements were collected using a prearranged data collection sheet. The examined anthropometric measurements were body weight, height, waist circumference (WC), hip circumference (HC), triceps (TSF), biceps (BSF), subscapular (SSSF) and suprailiac (SISF) skinfolds thicknesses. The ratio between waist and hip circumferences (WHR) was calculated for each subject. BMI was calculated using the formula: BMI = body weight (kg)/height^2 (m^2) (13). Based on BMI, studied subjects were categorized into four classes: underweight (< 18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), and obese (> 30 kg/m^2) (14). The body fat was calculated from the four measured skinfold thicknesses using Durnin-Womersley formula (15). Body fat percent (BF %) was calculated using the formula: BF% = (fat mass/body weight) X100.

Statistical evaluation was performed using SPSS (version 20, Chicago, SPSS Inc. USA). Normal

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distribution of variables was examined using Shapiro-Wilk test. The normally distributed variables were described with mean and standard deviation (SD). Studied variables with abnormal distribution were described with median and 25^{th}–75^{th} interquartile (Q1–Q3). Unpaired T-test was used to assess statistical difference of the mean for normally distributed variables. Alternatively, significant statistical differences of abnormally distributed variables were assessed by comparing median (25^{th}–75^{th} interquartile) and giving the P value of Mann-Whitney U test. $P < 0.05$ was considered significant for all statistical tests.

Results

Distribution of age and gender were comparable in the studied groups, table 1. In contrast, FEV1% and PEFR were significantly lower in asthmatic patients compared to the control group, table 1.

Table 1: Characteristic of the studied groups

	Non-asthmatic N = 59 Median (25^{th} – 75^{th} Quartile)N (%)	Asthmatic N = 120 Median (25^{th} – 75^{th} Quartile)N (%)	P
Age (Years)	28.00 (25.00- 33.00)	28.00 (24.00- 36.00)	0.674
Male N (%)	30 (50.85%)	58 (48.33%)	0.752
FEV1%	82.99 (74.26- 88.07)	75.60 (67.63- 82.46)	< 0.001
PEFR (L/min)	410.0 (350.0- 510.0)	300 (242.5- 360.0)	< 0.001

The indicators of body fat distribution in the studied groups is shown in table 2. Although BMI, HC, TSF, BSF, SSSF, SISF and BF% were higher in asthmatic patients compared to non-asthmatic subjects, the difference of each of these parameters did not reach statistical significance in the studied groups, $P > 0.05$.

WC and WHR were higher in asthmatic patients (88.50 (78.00- 101.75), 83.00 (78.47- 90.17)) compared with non-asthmatic subjects (81.00 (72.00- 92.00), 80.00 (75.67- 85.10), P = 0.004, 0.003), table 2

Table 2: Indicators of body fat distribution in the studied groups

	Non-asthmatic N = 59 Mean (SD)Median (25^{th} – 75^{th} Quartile	Asthmatic N=120 Mean (SD)Median (25^{th} – 75^{th} Quartile)	P
Weight (Kg)	67.60 (58.70- 79.00)	73.72 (17.31)	0.106
Height (m)	1.67 (0.09)	1.67 (0.09)	0.503
BMI	24.13 (20.48- 27.77)	26.22 (21.73- 30.75)	0.060
WC (mm)	81.00 (72.00- 92.00)	88.50 (78.00- 101.75)	0.004
HC (cm)	101.00 (95.00- 110.00)	106.00 (95.00- 116)	0.217
WHR	80.00 (75.67- 85.10)	83.00 (78.47- 90.17)	0.003
TSF (mm)	18.00(10.00- 25.00)	17.00 (9.25- 24.00)	0.719
BSF (mm)	9.00(5.00- 14.00)	10.00 (6.00- 20.75)	0.078
SSSF (mm)	18.00 (12.00- 22.00)	18.00 (12.25- 26.00)	0.594
SISF (mm)	19.00 (12.00- 22.00)	19.00 (12.0- 24.75)	0.622
BF %	25.40 (20.40- 33.70)	27.10 (19.40- 35.55)	0.905

As shown in figure 1, presence of BA in underweight is comparable to normal BMI subjects (OR=1.05, 95% CI: 0.35−3.03). However, presence of BA increases steadily in overweight (OR=1.46, 95% CI: 0.68−3.12) and obese subjects (OR=2.67, 95% CI: 1.07−6.63) compared with normal BMI subjects. Presence of symptoms at the time of the study increases in underweight (OR=3.55, 95% CI: 0.41−31.00), overweight (OR=2.13, 95% CI: 0.66−6.86) as well as obese (OR=3.43, 95% CI: 0.87−13.54) compared to normal BMI subjects, figure 2.

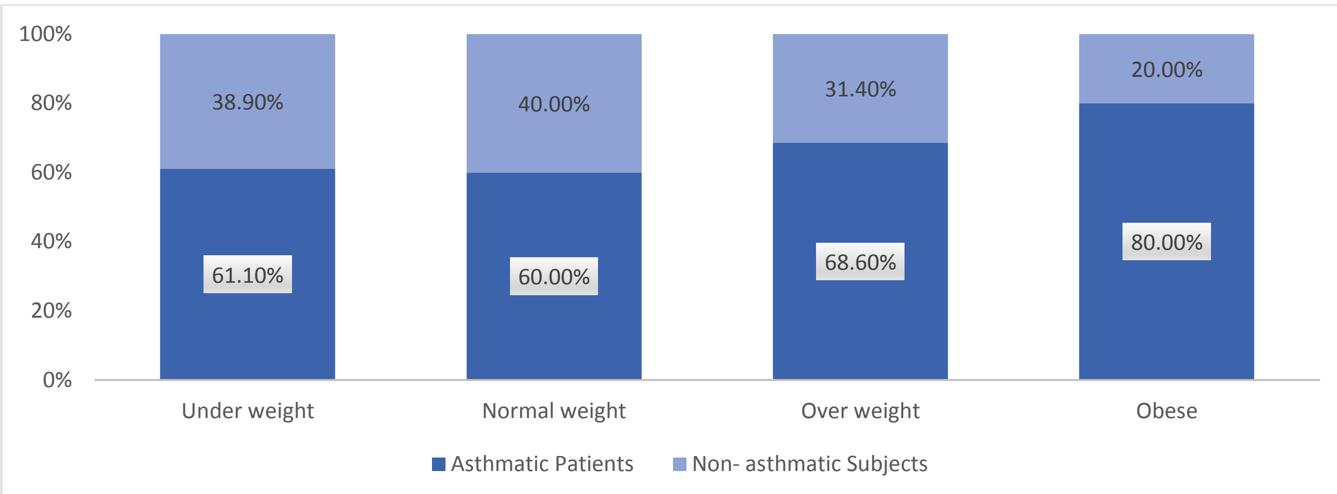

Figure 1: Percentage of BA among different BMI categories.

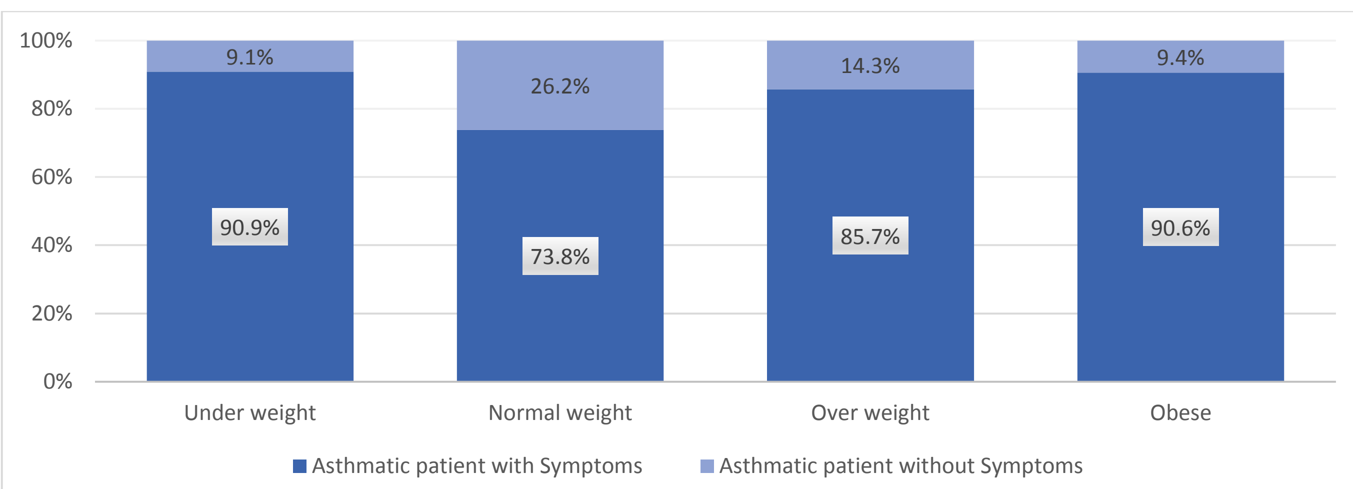

Figure 2: Distribution of symptoms among BA patients with different BMI

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Discussion

The results of the present study revealed three main findings: firstly, although all indicators of body fat distribution were higher in asthmatic patients compared to non-asthmatic subjects, only WC and WHR reached statistical significance. Secondly, presence of BA in underweight patients is comparable to normal BMI subjects, however the presence of BA increases steadily in overweight and obese subjects compared with normal weight subjects. Thirdly, presence of BA symptoms at the time of the study increases in underweight, overweight as well as obese subjects compared to normal BMI subjects.

Previous investigations repeatedly demonstrate an intimate relationship between BA and obesity in women (5, 16-18), except for a few reports (4). The first report on the association between BA and obesity was probably in the mid-eighties of the last century. In 1986, data correlating BMI to health service consumption for over 20 years old Dutch adults demonstrated significant association between overweight and BA in women, but not for men (16). Several studies thereafter were able to confirm significant association between high BMI to BA in females (5, 17, 18). Camargo et al demonstrated that women who gained weight after age 18 were at higher risk of developing BA during the following 4 years (19). The association between BA and obesity was also demonstrated in the results of a study exploring the relationship between BMI and prevalence of common chronic diseases in Italian National Health Survey (20). According to a longitudinal cohort of the Tucson Epidemiologic Study of Airways Obstructive Diseases, BMI equal to or more than 28 Kg/m^2 increased the odds of BA diagnosis 2.1 times, irrespective of gender (5). Increased prevalence of BA among high BMI adults was also established in people from 1970 British Cohort Study (BCS70) when they were surveyed at the age of 26 years about past history of BA (18). After controlling for possible confounders, the odds ratio comparing uppermost with lowermost BMI quintile in BCS70 was 1.72. In addition, the association between fatness and BA was more evident in females (18).

Luder et al explored the association between BMI and BA in over 18 years old adults of diverse ethnic and socioeconomic background (2). The results showed that BA prevalence was significantly higher in women with a BMI 25 kg/m^2 or more. According to the same study, the prevalence of BA in men was increased in those with BMI less than 22 kg/m^2 as well as BMI equal to or more than 30 kg/m^2. This U-shaped association was more evident in the males with age range 18-49 years. In a separate large scaled cross-sectional study in Chinese adults, both extremes of BMI distribution were also associated with airway hyperresponsiveness (AHR) in both men and women (11). The same U-shaped associations between BMI and AHR were demonstrated in both gender when data from European Community Respiratory Health Survey were analyzed (12). In the present study, although presence of BA in underweight is comparable to normal BMI subjects, it increases steadily in overweight and obese subjects. In contrast, presence of BA symptoms at the time of the study is equally high in underweight and overweight asthmatic subjects. The predominance of BA in both extremes of BMI may explain why most indicators of body fat distribution failed to reach statistical difference when asthmatic patients were compared to non-asthmatic subjects in the present study.

Interestingly, WC and WHR were statistically higher in the studied asthmatic patients compared to non-asthmatic subjects. This finding points to the probable importance of abdominal obesity in pathophysiology of BA. In a large cohort of 88,304 female teachers, Von Behren et al examined the association between BA prevalence and WC as a measure of abdominal obesity (3). The study confirmed that large WC was associated with increased BA prevalence even among women with a normal BMI. According to the same report, the OR for BA was also higher among abdominally obese women compared to those with less WC. In a separate prospective study involving 23,245 subjects living in Nord-Trøndelag, Norway in 1995-2008 (HUNT study), abdominal obesity remained a risk factor for BA development after adjustment for BMI (1). The implication of HUNT study was reproduced by the North West Adelaide Health Study, which used WC and WHR as measures of central obesity (7).

Physiologically, obesity reduces respiratory system compliance and consequently lung volumes and capacities (9, 21) . Another consequence of restrictive ventilatory defect associated with obesity is increased elastic work of breathing and consequently higher oxygen cost of pulmonary ventilation (9). Increased oxygen demands give further burden on the already compromised lung in obese subjects as described above. This may explain augmented perception of dyspnea in obese asthmatic patients (6, 10). Recently, adipose cells were proved to express powerful endocrine function that recruit immune cells and enhance inflammatory responses (8), especially among those with central obesity (22). The endocrine role of adipocytes gives an explanation for the higher prevalence of BA among obese subjects as described in the present study and many other previous reports (5, 16-18).

Conclusion

The results of the present study provided further evidence for the association between BA and obesity. Although all indicators of body fat distribution were higher in asthmatic patients compared to non-asthmatic subjects, only WC and WHR reached statistical significance. This finding points to the importance of abdominal obesity in the pathophysiology of BA, as described in the literature. The present results also showed that presence of BA and intensity of symptoms increases steadily with BMI, possibly because of the mechanical and endocrine effect of obesity on the respiratory system.

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Abbreviations

AHR airway hyper-responsiveness; BA bronchial asthma; BF% body fat percent; BMI body mass index; BSF biceps skinfold thickness; FEV1% forced expiratory volume in the first minute percent; HC hip circumference; OR odds ratio; PEFR peak expiratory flow rate; Q1–Q3 25th–75th interquartile; SD standard deviation; SISF suprailiac skinfold thickness; SPSS Statistical package for the social sciences; SSSF subscapular skinfold thickness; TSF triceps skinfold thickness; WC waist circumference; WHR the ratio between waist and hip circumferences.

Ethics approval and consent to participate

The study received ethical approval from the Ethical Review Committee - Al-Neelain University Board, Khartoum, Sudan. All studied subjects signed informed consents before being enrolled in the study.

Consent for publication: Not applicable

Availability of data and materials: The data supporting the present findings are contained within the manuscript.

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