

Changes in spirometric parameters with position in asymptomatic Egyptian young males with central obesity

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ABSTRACT

Background: Central obesity is a chronic condition that can contribute to impairments in lung functions. Body position is an important technique that effectively restores and increases lung functions. We aimed to address the possible changes in spirometric parameters in asymptomatic overweight individuals with central obesity with a change in posture from sitting to supine in comparison to normal weight non-obese ones.

Methods: Enrolled subjects were healthy Egyptian males, aged between 20–45 years old, asymptomatic and non-smokers. They underwent spirometry. The following parameters were measured; forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), FEV₁/FVC ratio, and forced expiratory flow (FEF)_{25-75%}. They were classified into overweight with central obesity (n=40) and healthy control (n=40) groups based on their body mass index (BMI), weight-hip ratio (WHR), and waist circumference (WC). Spirometric parameters were compared between the 2 groups and in both setting and supine positions.

Results: The central obesity group showed significantly lower all spirometric parameters in comparison to the control one. All measured spirometric parameters had a significant reduction with supine position. There were negative correlations between both the WC and WHR and spirometric parameters.

Conclusion: In this study of young Egyptian males, individuals with central obesity had reduced spirometric parameters in comparison to healthy ones. Change in position from sitting to supine has significant effects on spirometric parameters in both healthy middle age males with normal weight and those with overweight and central obesity. These results could have important clinical implications.

Key words: Obesity; position; males; central; spirometry; healthy; asymptomatic; changes.

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Introduction

The World Health Organization (WHO) defines adult obesity by a body mass index (BMI) greater than or equal to 30 kg/m² and overweight as a BMI over 25 kg/m² [1]. Obesity has become a global health issue [2,3]. Obesity, especially abdominal obesity, is related to cardiovascular disease, metabolic syndrome, and risk factors of all-cause mortality [4-6]. Central (also called abdominal or android) obesity is defined as increased fat deposition in the thorax, abdomen, and visceral organs, with apple-like body shape in males [7]. The waist circumference (WC) and the waist-to-hip ratio (WHR) had become the easiest accepted measurements for abdominal obesity [3,8,9]. The mechanical properties of the lungs and chest wall are much affected in obesity. Excessive fat accumulation in the thoracic-abdominal region restricts the chest wall expansion and diaphragmatic muscle contraction, lengthens abdominal muscles, reduces the upper airway calibre, modifies airway configuration, and increases in intra-abdominal pressure [10-14]. It is well-known that the lung function can be affected by several factors such as age, sex, physical activity, and body positions [10-14]. Among these factors, body position changes can be used as an intervention to improve lung function [15-17], given the direct effect of body position on chest wall motion, respiratory muscles performance, and breathing patterns [15-18], particularly in individuals with obesity [15-17]. Several body positions (such as sitting, Fowler's, side lying, supine, and prone positions) have been shown to affect lung function and help in preserving lung performance and reducing the risk of complications [18-20].

Several studies have focused on the cardiovascular effects of obesity, yet few ones addressed changes in spirometric parameters due to obesity [15,17,21]. Furthermore, studying the effects of both abdominal obesity as a specific type of obesity and multiple body positions on lung function in the same group of individuals is not well understood yet.

Therefore, the current study aimed to address the possible changes in spirometric parameters in asymptomatic overweight individuals with central obesity with a change in posture from sitting to supine in comparison to normal weight non-obese ones.

Materials and Methods

Study population

The subjects were recruited from the general population. The inclusion criteria included male, aged between 20-45 years old, asymptomatic and free from any underlying health conditions particularly cardiovascular or respiratory disease and willing to undergo the study. All smokers were excluded. The participant had no contraindication to spirometry. All subjects were informed about the research objectives and methods and written consent was obtained prior to data collection. Ethical approval was obtained from the Ethical Committee of the Faculty of Medicine, Assiut University, Egypt (Approval number 5882).

The subjects were classified into overweight with central obesity (n=40) and healthy control (n=40) groups based on their body mass index (BMI), weight-hip ratio (WHR), and waist circumference (WC). The healthy control group had BMI: 18.5-<25 kg/m² while the overweight one had BMI 25-<30 kg/m² [22]. Pre-specified cut-off points for defining central obesity in men is WHR >0.9 [23,24] and WC >94 cm [25,26].

Study methods

Spirometry

Standard spirometry was performed in all individuals by mean of a fully equipped computerized system (Quark PFTs ergo, P/N Co9035-12-99; Cosmed Srl, Albano Laziale, RM, Italy). All pulmonary function tests were carried out at a fixed time of the day in the morning (9.00-12.00 hours) to minimize diurnal variation. Each subject was informed about the whole maneuver and was encouraged to practice it before testing. The apparatus was calibrated daily and operated within the ambient temperature range of 20-25°C. The tests were repeated three times after adequate rest. The best result of three reproducible tests was taken. The subjects were asked to perform the forced expiration maneuver in the sitting position first. The same procedure was repeated after 15 min interval in supine position. Three trials with FVC within 5% of each other were selected for analysis in both positions. Three minutes intervals were given before each trial. Acceptability and reproducibility of the graphs were evaluated well before accepting the result. The data collected included forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), FEV₁/FVC ratio and forced expiratory flow (FEF) 25% -75 % according to the guidelines of the American Thoracic Society and European Respiratory Society [27].

Anthropometric measurements

Weight and height were measured with subjects wearing lightweight clothing and barefoot by using a stadiometer and then calculating BMI (it is the ratio of weight in kilograms to the square of height in meters, expressed in units of kg/m²). By tape, we measured waist circumference (WC): the distance at midway level between the lower margin of the last rib and the iliac crest, just above belly button. Then we measured hip circumference (HC): the distance around the largest part of hips at the widest part of buttocks without compressing the soft tissues. Finally, we calculated waist-to-hip ratio (WHR) by dividing waist circumference by hip circumference.

Body positions

Participants performed two body positions including sitting with back support, and supine positions. Vital signs (heart rate, blood pressure, respiratory rate, and oxygen saturation) were recorded during each position to ensure that they remained stable. Sitting position was to sit upright with neck and chest aligned and straight. A rest period was 15 min before each position change. Supine position was to lie flat on the bed, head and neck in neutral position and supported by a pillow. Figure 1 shows flow chart of the study.

Statistical analysis

Parameters were expressed as mean ±SD. An independent samples *t*-test used to assess the difference between the means of the two groups. Paired *t*-test was used to compare the changes in the same group but different positions. Correlation between anthropometric data spirometric parameters was carried out using Spearman's correlation test. A p<0.05 was considered statistically significant. The SPSS (Statistical Package for Social Science) software version 25 was used for statistical analysis.

Results

Demographic characteristics

The baseline characteristics are shown in Table 1. There were statistically significant differences in weight, height BMI, WC, WHR, systolic blood pressure, and respiratory rate between the control and central obesity groups.

Differences in spirometric parameters between groups in 2 positions

The differences between control and central obesity groups in spirometric parameters in 2 positions are shown in Table 2. Characteristically, the central obesity group showed significantly lower all spirometric parameters (FEV₁, FVC, FEV₁/FVC, and FEF_{25-75%}).

Effects of change in position

The effects of changing position from sitting to supine in the control and central obesity groups are shown in Tables 3 and 4, respectively. All measured spirometric parameters had a statistically significant reduction with supine position.

Correlations between the anthropometric and supine spirometric parameters

Table 5 shows significantly negative correlations between WC and spirometric parameters as well as between WHR and spirometric parameters.

Discussion

Although obesity is common in the community, still it is a modifiable risk factor for a large number of disorders that increase morbidity and mortality in obese subjects. The tested hypothesis of this study was the impact of central obesity in different body positions on spirometric parameters among young males.

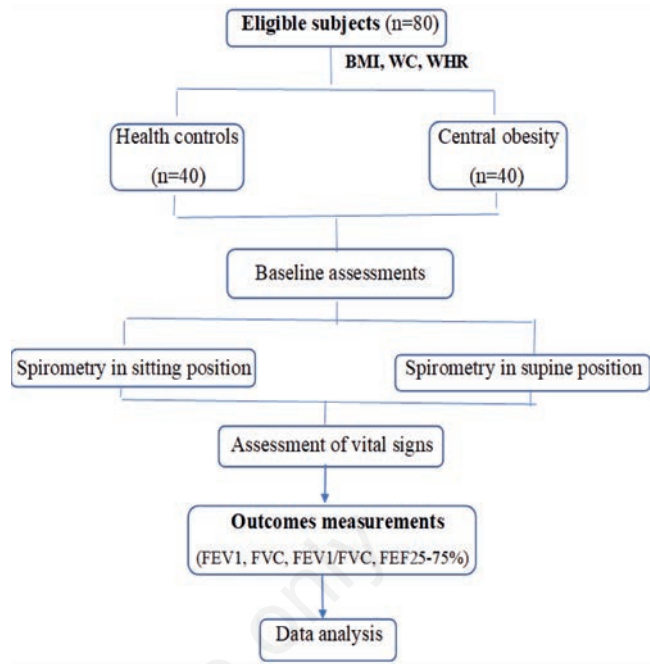


Figure 1. Flow chart of the study. BMI, body mass index; WC, waist circumference; WHR, waist-hip ratio; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEF forced expiratory flow.

Table 1. Demographic characteristics of the study subjects.

	Control group (n=40)	Central obesity group (n=40)	p
Age (years)	32.37±5.61	32.73±5.99	0.808
Weight (kg)	68.4±3.74	78.2±4.35	0.000
Height (cm)	170.47±3.46	170.8±3.03	0.693
BMI (kg/m ²)	23.53±0.88	26.79±0.91	0.000
Waist circumference (WC), cm	81.3±3.87	96.8±3.01	0.000
Waist/hip ratio (WHR)	0.85±0.03	0.95±0.04	0.000
Systolic blood pressure (mmHg)	111.67±3.02	116.20±4.09	0.000
Heart rate	81.30±4.89	84.87±7.57	0.034
Respiratory rate	14.03±1.09	15.63±1.13	0.000
SpO ₂	97.63±0.76	97.5±0.86	0.529

Data are expressed as mean ± SD; SpO₂, oxygen saturation.

Table 2. Differences in spirometric parameters between control and central obesity groups in 2 positions.

	Control group (n=40)	Central obesity group (n=40)	p
FEV ₁ sitting position	3.47±0.19	2.90±0.28	0.000
FEV ₁ supine position	3.20±0.16	2.58±0.32	0.000
FVC sitting position	4.20±0.21	3.64±0.29	0.000
FVC supine position	3.98±0.18	3.35±0.42	0.000
FEV ₁ /FVC sitting position	82.91±3.24	79.81±5.12	0.007
FEV ₁ /FVC supine position	80.44±3.29	76.86±3.81	0.002
FEF 25-75% sitting position	3.83±0.07	3.74±0.05	0.000
FEF 25-75% supine position	2.91±0.14	2.68±0.05	0.000

FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, FEV₁/FVC ratio; FEF, forced expiratory flow.

Characteristically, in comparison to the control group, the central obesity one showed significantly lower all spirometric parameters. Furthermore, all measured spirometric parameters had a significant reduction with supine position.

The significantly lower values of spirometric parameters in central obesity group could be explained by lower respiratory muscle strength in those subjects [15]. Moreover, it was reported that increased BMI leads to narrower airways which explain functional airway changes [28]. Furthermore, prior studies had shown that obese subjects tend to have a small airway collapse in comparable to normal weight subjects [13,14].

On the other hand, our results are not in agreement with those obtained by Al Lawati and Al Atbi [17]. The authors enrolled young Omani males in their study for the effects of obesity on the airflow parameters while changing the posture from sitting to supine position in non-obese, overweight, and obese individuals. However, they found that the difference in airflow parameters with the change in posture from sitting to supine position was not significantly different in obese subjects as compared with non-obese and overweight subjects. They explained the obtained results by small sample size or because of the fixed age group (19-25 years old). Differences between results of the current study and that of Al

Lawati and Al Atbi [17] could be attributable to different population phenotypic characteristics and/or methodological analysis.

In a recent study, Peralta and co-workers [21] estimated the lung function trajectories during adulthood from 20-year weight change profiles using data from the population-based European Community Respiratory Health Survey (ECRHS). The 3,673 participants were recruited at age 20-44 years with repeated measurements of weight and lung function (FVC, FEV₁) in 3 study waves (1991-93, 1999-2003, 2010-14) until they were 39-67 years of age. The authors concluded that moderate and high weight gain over 20 years was associated with accelerated lung function decline, while weight loss was related to its attenuation. Thus, control of weight gain is important for maintaining good lung function in adult life [21].

Another important finding in this study was that all measured spirometric parameters had a statistically significant reduction with supine position. Even in the control group, all measured spirometric parameters had a statistically significant reduction with supine position. This is in accordance with the results obtained by Patel *et al.* [29] and Vilke *et al.* [30], who observed significant reduction in supine position values. These findings could be explained by the effect of abdominal content and intra-abdominal pressure on ventilation process with position changes. Moreover, extra fat deposition in the ribcage and abdominal area elongates the diaphragmatic and abdominal muscles and consequently affects the respiratory muscle function and contraction [15,31]. Low gravity compression in sitting position played a role in increasing chest wall compliance and decreasing resistance to the diaphragmatic contraction due to the weight of the abdominal content [32,33].

We had observed significantly negative correlations between the anthropometric measurements on one hand and all the evaluated spirometric parameters on the other hand. These results are in accordance with those of Feng *et al.* [34], who reported a correlation between lung function parameter and WHR, but this study was carried out in Chinese children and adolescents in the sitting position only. To the best of our knowledge, there were no comparable studies regarding the correlation between anthropometric and spirometric parameters in supine position in adult subjects.

The results of the current study have important implications. We have observed that even in the control group, all measured spirometric parameters had a statistically significant reduction with supine position. This should alarm us for the bad sequelae of overweight, even before reaching the stage of obesity. These findings support those of Peralta *et al.* [21] that moderate and high weight gains are associated with accelerated lung function decline, while weight loss is related to its attenuation. Our results could have significant implications in the management of critically ill patients, particularly those who are mechanically ventilated, and those who had impaired lung functions due to respiratory disorders [4,35].

Finally, our findings could have implications in the era of the recent epidemic of COVID-19. Recently, the CDC announced that adults of any age with certain underlying medical conditions are at increased risk for severe illness from the virus that causes COVID-19 (defined as hospitalization, admission to the ICU, intubation or mechanical ventilation, or death). One of these underlying conditions is obesity [36].

Despite that the current study is a prospective one with non-invasive simple procedures, it is not without limitations. These limitations include small sample size, females were not included, and a complete panel of pulmonary function tests (*e.g.*, lung volumes, respiratory muscle strength) was not carried out. Further studies including larger sample size and female subjects with the implementation of comprehensive pulmonary function testing are warranted.

Table 3. Effects of change in position in the control group.

	Sitting position	Supine position	p
FEV ₁	3.48±0.19	3.21±0.16	0.000
FVC	4.20±0.21	3.99±0.18	0.000
FEV ₁ /FVC	82.92±3.24	80.44±3.29	0.000
FEF 25-75%	2.94±0.14	3.83±0.07	0.000

FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, FEV₁/FVC ratio; FEF, forced expiratory flow.

Table 4. Effects of change in position in the central obesity group.

	Sitting position	Supine position	p
FEV ₁	2.90±0.28	2.58±0.32	0.000
FVC	3.60±0.25	3.45±0.43	0.017
FEV ₁ /FVC	81.81±4.09	76.86±3.82	0.009
FEF 25-75%	2.68±0.05	3.73±0.05	0.000

FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, FEV₁/FVC ratio; FEF, forced expiratory flow.

Table 5. Correlations between the anthropometric and supine spirometric parameters.

	r	p
WHR - FEV ₁	-0.611	0.000
WHR - FVC	-0.611	0.000
WHR - FEV ₁ /FVC	-0.361	0.015
WHR - FEF25-75%	-0.528	0.000
WC - FEV ₁	-0.691	0.000
WC - FVC	-0.606	0.000
WC - FEV ₁ /FVC	-0.463	0.001
WC - FEF25-75%	-0.505	0.001

WC, waist circumference; WHR, waist/hip ratio; FEV₁, forced expiratory volume in one second; FVC, forced vital capacity; FEV₁/FVC, FEV₁/FVC ratio; FEF, forced expiratory flow.

Conclusions

Our study showed a strong relationship between central obesity and spirometric parameters among young Egyptian males. Individuals with central obesity had reduced spirometric parameters in comparison to healthy ones. Change in position from sitting to supine has significant effects on spirometric parameters in both healthy middle age males with normal weight and those with overweight and central obesity. These results could have important clinical implications. Further studies are warranted.

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