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ORIGINAL ARTICLE

FREQUENCY OF BRONCHIAL OBSTRUCTION IN OBESE NON-ASTHMATIC CHILDREN: A PILOT SURVEY

Terez Boshra Kamel
Department of Pediatrics, Faculty of Medicine, Ain Shams University, Egypt

Email: terez2003@hotmail.com

Background: ***Prevalence and severity of obesity in children is dramatically increasing worldwide. Epidemiological evidence demonstrates that obesity results in an increased risk of developing incident asthma. Obese children demonstrate increased asthma severity, as indicated by increased exacerbations and decreased asthma control; however, they do not appear to have increased airway cellular inflammation.***

Aim: ***Study aimed to explore frequency of bronchial obstruction in obese non-asthmatic children.***

Methods: ***In a case control observational study, 30 obese non-asthmatic children (male/female: 11/19) were studied and compared to a control group of 30 normal weight children. The mean age ± SD of patients was 9.00 ± 2.21 years. Forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_1) were used as measures of ventilatory function.***

Results: ***There were no significant differences in FEV_1%, FVC% and FEV_1% / FVC% by study group ($P > 0.05$). Only three patients had obstructive abnormalities (3.33%) documented on pulmonary function tests. No correlation was observed between pulmonary function parameters and anthropometric measurements.***

Conclusion: ***Despite pulmonary function test parameters of the obese children were similar to those of the normal weight children, baseline pulmonary function tests and their regular assessment are recommended for early discovery of bronchial obstruction.***

Keywords: Bronchial obstruction, obese, children.

INTRODUCTION

Childhood obesity is associated with a range of adverse respiratory consequences.[1] It is associated with numerous co-morbidities that affect the health of cardiovascular, pulmonary, metabolic, endocrine, psychosocial and neuro-cognitive systems.[2] The association between obesity and asthma has also raised new concerns about whether the mechanical effects of obesity on the respiratory system contribute to airway dysfunction that could induce or worsen asthma.[3] Spirometric variables, such as forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC), tend to decrease with increasing BMI.[3-5] Several mechanisms have been proposed on the possible effects of obesity on pulmonary function. The most common abnormalities reported are reduced expiratory reserve volume and functional residual capacity due to reduced chest wall and lung compliance and increased respiratory resistance.[6,7] It is also believed that increased pulmonary blood volume leads to congestion resulting in thickening of the airway wall; thus reducing airway size.[8]

Aim of the work: This study aimed at surveying the frequency of bronchial hyper-reactivity in non-asthmatic children with simple obesity.

PATIENTS AND METHOD

This cross-sectional case-control study was conducted over the period from December 2009 till June 2010 at the Pediatric Pulmonary Functions Unit; Children's hospital; Ain Shams University.

Current work included thirty obese children whose body mass indices (BMI) were above the 95th percentile according to sex- and age-specific BMI reference range using the new charts provided by the Centers for Disease Control and Prevention (1, 9). They were recruited randomly from the Outpatient's clinic, Children's Hospital, Ain Shams University. They were evaluated for the complaint of excess body weight, with no history of asthma or other atopic diseases. The obese group was 11 males and 19 females, their ages ranged from 6 to 12.5 years with a mean age 9.00 ± 2.21 years and their body mass index (BMI) mean ±SD was 27.32 ± 3.21.

Thirty healthy non-obese non-asthmatic children who have normal physical examination composed the control group, their mean age 9.2±2.08 years, they were 13 males and 17 females.

Exclusion criteria: Those with obesity secondary to an organic condition; having a chronic cardio-respiratory or neuromuscular problem or history of asthma and other atopic diseases were excluded from the study.

An informed consent was obtained from the subjects and their parents. The Pediatric Department Board ethically approved the study.

A questionnaire was administered by the investigators to determine risk factors including daily TV viewing time, eating habits, daily physical activities, and family history of obesity. Parents were asked about the child's snoring, difficulty breathing, observed apnea, cyanosis, struggling to breathe, shaking the child to "make him or her breathe," watching the child sleep, afraid of apnea, the frequency and loudness of snoring, and daytime symptoms such as excessive daytime sleepiness to determine obstructive sleep apnea (OSA) symptoms. Anthropometric measurements and spirometry were performed in all subjects.

Anthropometric measurements

Height was measured to the nearest 1 cm against a wall chart, and weight was measured to the nearest 0.1 kg using an electronic digital scale. BMI was calculated as weight (kg) divided by the square of height in meters (kg/m^2). Waist circumference was measured as the minimum abdominal circumference between the xiphoid process and the umbilicus. Hip circumference was measured as the maximum circumference over the buttocks. The waist-to-hip ratio (WHR) was calculated as the ratio between these two circumferences. The height and weight of patients' parents were also measured by the same physician and BMI was calculated.

Spirometry

Dynamic spirometry (Jaeger, Germany) was performed in all subjects. The best of at least three technically acceptable values for forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC) were selected. Forced vital capacity and FEV_1 were used as measures of ventilatory function. The spirometric pulmonary function test results were expressed as percentages of predicted normal values. For the purpose of this study, the threshold of abnormality was identified as less than 80% of the predicted value.[10]

Obstructive airway disease was identified as a decrease in the FEV_1/FVC ratio to less than 80%. The various pulmonary deficits were classified as "mild" (> 70%), "moderate" (< 70% and > 60%), "moderately severe" (< 60% and > 50%), and "severe" (< 50%). The reversibility test was applied to subjects whose FEV_1/FVC ratio decreased to less than 80%. Salbutamol sulfate was inhaled twice and FEV1 was measured 15 minutes later. If the difference in FEV1 before and after bronchodilator inhalation was greater than or equal to 15%, the test was accepted as positive.[10]

Statistical analysis

Data were analyzed using SPSS (Statistical Program for Social Science) version 15 as follows: quantitative variables as mean, SD and range, qualitative variables as number and percentage. Chi-Square test X^2 and Fisher exact test were performed. Paired t test was performed in comparison between parameters of the two groups. P< 0.05 was considered a significant.

RESULTS

Thirty children with exogenous obesity aged between 6 to 12.5 years with a mean age 9.00 ± 2.21 years and their body mass index (BMI) mean ±SD was 27.32 ± 3.21 were enrolled and compared to 30 healthy normal weight children (mean age 9.2 ± 2.08 years). The male/ female ratio of the obese and normal weight children were 11/19 and 13/17, respectively. Demographic characteristics and obesity-associated risk factors are given in Table 1. The children in the two groups were comparable for a number of baseline characteristics, including age, sex, and child feeding practices, parental obesity, passive cigarette smoking, Obstructive sleep apnea symptoms (Fig. 1) and performance of physical activity, except for television viewing. Significantly more obese subjects are reported to watch television more than one hour a day ($p < 0.05$).

Anthropometric measurements of the obese and control groups are given in Table 2. The mean values of weight, relative weight, and BMI were significantly higher in the obese group, as expected ($p < 0.01$). Obese subjects compared to non-obese subjects did not differ in any of the lung function measurements Table 3. Three patients in the obese group (3.33%) had obstructive abnormalities documented on their pulmonary function tests (two had moderately severe and one had mild obstructive abnormality). The reversibility test was positive in these three patients. These three patients had no asthma symptoms such as dyspnea, wheezing, chronic cough or previous history of atopy.

Table 1. Demographic Characteristics and Obesity-Associated Risk Factors.

Characteristics	Obese (n=30)	Non-obese (n=30)
Age (years)	9.00 ± 2.21	9.2 ± 2.08
Sex (male / female)	11 / 19	13 / 17
Passive cigarette smoking	18 / 30 (60%)	14 / 30 (46.66%)
Physical activity < 1 hour / day	17 / 30 (56.66%)	10 / 30 (33.33%)
Fast food eating	22 / 30 (73.33%)	18 / 30 (60%)
TV watching >1 hour / day	27 / 30 (90%)	10 / 30 (33.33%)
Exclusive breast feeding > 6 months	12 / 30 (40%)	15 / 30 (50%)
Obstructive sleep apnea symptoms	10 / 30 (33.33%)	2 / 30 (6.66%)

Table 2. Anthropometric Measures of Obese and Non-Obese Children.

Anthropometric Parameter Mean ± SD	Obese (n=30)	Non –obese (n=30)
Weight (kg)	52.7±15.42	28.9±9.87
Height (cm)	138.05±14.52	134.01±10.8
BMI (kg / m2)	27.32±3.21	17.88±0.9
Triceps skin fold thickness (mm)	24.30±5.77	14.21±4.01
Neck circumference (cm)	33.35±2.83	26.42±1.73
Waist circumference (cm)	91.30±17.80	79.11±10.2
Hip circumference (cm)	151.50±18.35	131.52±15.64

Table 3. Ventilatory Functions in Obese and Non-Obese.

Ventilatory Function	Obese (n=30)		Non-obese (n=30)		P
	Mean	±SD	Mean	±SD	
FVC (L) (%predicted)	94	18.49	96	8.38	0.43
FEV1 (L) (%predicted)	92.3	14.60	96.60	11.63	0.61
FEV1 / FVC % (% predicted)	107	10.2	103	5.08	0.18

FVC: Forced vital capacity.
FEV_1: Forced expiratory volume in 1 second.

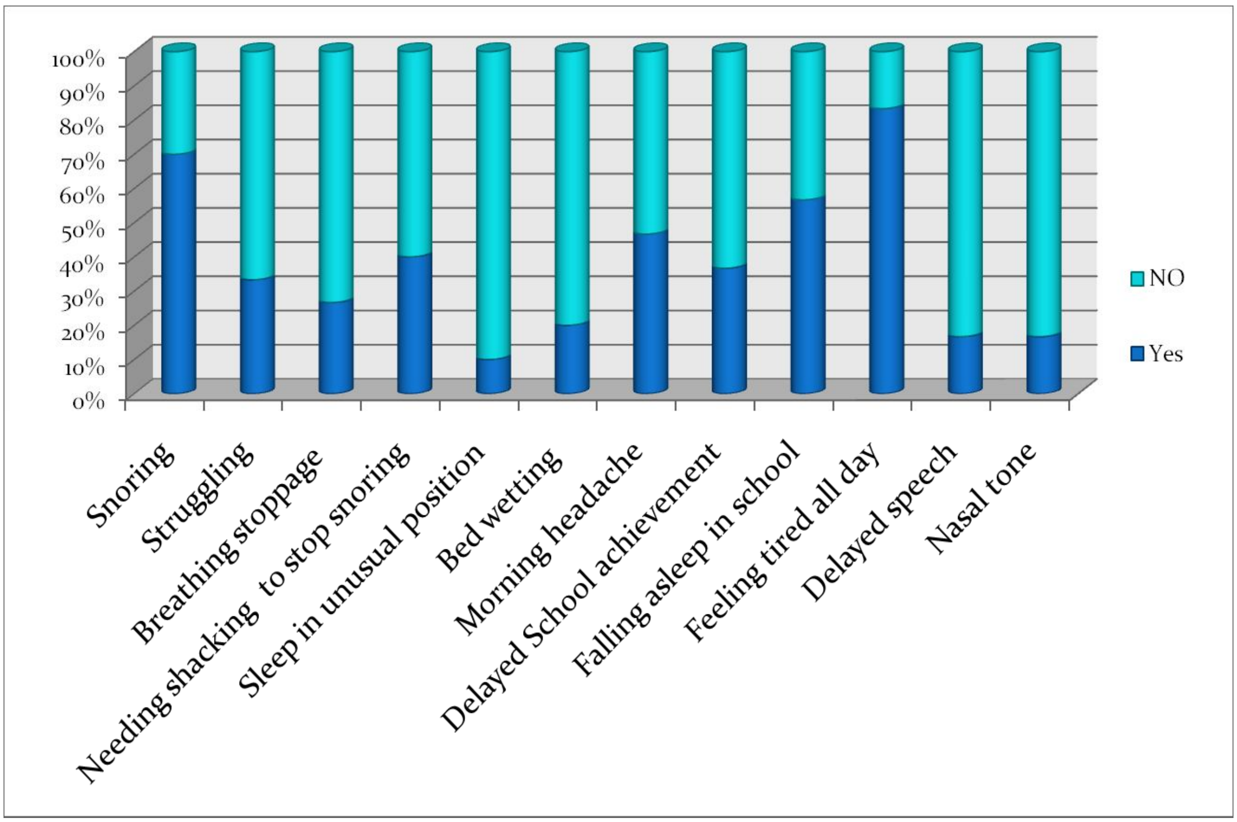

Fig 1. Frequency Of Each Obstructive Sleep Apnea Symptom In Obese Children.

DISCUSSION

Many studies have demonstrated an association between obesity and ventilatory abnormalities in adults.[11-13] However, investigations into this issue in childhood are limited[14-16] and studies conducted to date have yielded conflicting results.

Consistent with both Chaussain et al[14] and Bosisio et al,[5] present results revealed that FEV_1 %, FVC% and FEV_1%/FVC% were near to those of the control group. Similar studies in children confirm reduced functional residual capacity and static lung volumes. Moreover, current data showed three out of thirty with obstructive airway disease (3.33%), in agreement with Mallory et al.[4] who reported eight out of 34 (2.94%) had obstructive changes in pulmonary function.

Although abnormalities of the respiratory function are a common finding in adult obesity,[17] conclusions from adult studies cannot be granted since physiological function and body fat deposition are different from those of children and also there are so many confounding factors such as smoking status, and an abnormal pulmonary function test value can be considered to be caused by intrinsic lung disease or factors other than obesity.

Moreover, Ray et al.[17] emphasized that total lung capacity and vital capacity may be reduced only in extreme obesity. Previous studies suggested that patterns of fat deposition are important in determining the consequences of obesity and that high waist hip ratio (WHR) is inversely related to spirometry and static lung volume.[18]

In this study, anthropometric measurements of the obese children group were not correlated with their spirometric measurements. Although the waist-to-hip ratio was significantly higher in the obese group, it may not be sufficiently high to exert any effect on pulmonary function. It is also possible that anthropometric measurements have failed to determine fat distribution accurately. Conventional anthropometric measurements have been criticized as being unreliable and insufficiently sensitive to assess intra-abdominal fat.[19] A more valid and precise measure of body fat distribution, such as measurements obtained with modern investigation methods such as CT, MRI or DEXA (dual energy X ray absorptiometry) would be preferred, but they carry the hazards of radiation.

Furthermore, the deposition of visceral fat is very age-dependent; in one study, visceral fat was shown to increase in men from 12.4% of body surface at age younger than 40 years to 18% after age 65.[20] This increase was independent of obesity. By contrast, the figure was 5.4% for adolescents and adiposity for male and female children is predominantly subcutaneous which may not constitute a great health risk.[18]

There have been reports in the literature suggesting an association between asthma and obesity.[21,22] Although only three patients had reversible obstructive abnormality documented on their pulmonary function tests, they had no respiratory or atopic symptoms previously and since any of the provocation tests was not performed, further studies are needed to determine whether obesity causes or enhances bronchial hyper-reactivity.

Current study has certain limitations. First, it was a cross-sectional study and, since measurements of the obese subjects were taken at a single point in time, they may not have accurately reflected the clinical status. Second, radiological assessment would have been helpful in this study, since it is capable of determining fat distribution more accurately than anthropometric indices. Lastly, provocation tests would be beneficial in detecting subtle cases of bronchial hyper-reactivity in obese children.

CONCLUSION

Baseline pulmonary function test parameters were not different between obese and normal weight children. Anthropometric parameters had no significant effect on pulmonary function. Longitudinal studies including provocation tests are needed to explore the effects of different levels of obesity on pulmonary function in children.

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