BIOLOGIA (PAKISTAN)
June, 2019, 65 (I), 35-41

PKISSN 0006 – 3096 (Print)
ISSN 2313 – 206X (On-Line)

Relationship of lung function with obesity in healthy subjects

SAIMA SHARIF, SHAGUFTA NAZ, FARKHANDA MANZOOR, AYESHA NOOR & ZAHRA JAMIL

Department of Zoology, Lahore College for Women University, Lahore

ARTICLE INFORMAION

Received: 03-08-2018
Received in revised form: 05-01-2019
Accepted: 25-02-2019

***Corresponding Author:**

Saima Sharif: ssharif1978@yahoo.com

Original Research Article

ABSTRACT

Obesity exerts negative effects on all the system of the human body, including the respiratory system and therefore has high mortality and morbidity rates. This cross-sectional study was designed to find the relationship of lung function with obesity in healthy subject. The study was carried out in young females of Lahore College for Women University, Lahore from January 2017 to June 2017. During this period a total of 180 females were enrolled. Anthropometric measurements and the BMI of subjects were measured according to standard protocol after taking written consents. On the basis of body mass Index (BMI) subjects were divided into three groups normal weight (n=80), overweight (n=29) and obese (n=71). Respiratory function was measured by peak expiratory flow rate (PEFR) with the help of wright's peak flow meter. Demographic data was presented as mean ± S.E.M. The level of significance was $p \leq 0.05$. The average age of normal weight, overweight and obese subjects were 20.9 ± 2.09 y, 22.9 ± 0.97 y and 19.3 ± 1.87 y respectively. In individuals, having normal weight correlation between BMI and PEFR was direct and non-significant ($r = 0.17$ $p > 0.05$). In overweight subjects, there was inverse relationship between BMI and PFM ($r = -0.494$) and was highly significant. Similar result were obtained in obese females in which the inverse association was highly significant ($r = -0.580$; $p < 0.01$). It was concluded that subjects with the increase BMI demonstrated a decline in respiratory function. However in obese subjects, the peak expiratory flow rate (PEFR) was more reduced.

Keywords: Body mass index, Peak expiratory flow rate, Pulmonary function.

INTRODUCTION

Globally the prevalence of obesity, a medical condition characterized by increase in body fat, was increasing in adults and children worldwide. Being overweight or obese is associated with a reduced quality of life and an increased risk of several chronic diseases (Prentice *et al.,* 2006).

Obesity may influence respiratory functions in a variety of ways. In case of obese people, the presence of adipose tissue around the abdomen, rib cage and within the visceral cavity masses the chest wall decreases pulmonary functions. Production of carbon dioxide increases as a result of enhanced body weight. An obese individual utilizes almost 25% more oxygen than the non-obese subjects at resting stage. Severely obese patients are found frequently hypoxemic, particularly in supine position (Ochs *et al*., 2006).

According to World Health Organization (WHO), body mass index (BMI) is considered as the basic tool in measuring obesity. In most of the studies examining the effects of obesity on the respiratory functions, classification was achieved based on the BMI. In a few studies directed with body fat distribution and anthropometric assessment, a negative correlation was found among visceral adiposity and pulmonary functions (Field *et al*., 2001).

The poor lung volume in obesity is due to a direct mechanical effect on lung volumes, then distribution of body fat should adjust the relationship between BMI and lung volumes. Thoracic and abdominal fat are expected to have direct effect on the sliding movement of the diaphragm and on chest wall properties, while the fat on thigh and hips would be unlikely to have any direct effect on the lungs. Both the abdominal fat which is measured by waist circumference, waist-to-hip ratio and thoracic

Author's Contribution: S.S., Conceived and designed the experiment; **S.N.**, Analyzed data; **Z.J**, Wrote manuscript; **A.N.,** Performed experiments; **F.M**., Reviewed manuscript

fat which is measured by subscapular skin fold thickness are associated with decrease in lung volumes (Nawafleh *et al*., 2012).

The volume of adult females lungs is typically 10-12% smaller than that of males who have the same range of height and age, differences in thoracic abdominal configuration could impact the function of respiratory muscles, the rib cage cross sectional area is smaller in females than males, and the sex differences in the lung capacity can be explained by fewer total number of alveoli (small surface area) and smaller airway diameter relative to lung size in woman as compared to men (Harms *et al*., 2006). Peak expiratory flow rate is significantly a good indicator of respiratory hyper-responsiveness, and does not require body temperature pressure-saturated correction. So it is considered as one of the useful and simple parameters in the field for assessing the lung function status in general population (Young *et al*., 2001).

The present study was designed to determine the BMI in young females of college and investigate the relationship of lung function with obesity in healthy subjects.

MATERIALS AND METHODS

This cross-sectional study was carried out in Lahore College for Women University, Lahore. A total of 180 females of different ages range (17-30 years) were included. The sample size was determined with the help of raosoft software taking margin of error as 7% at confidence interval of 95%.

Anthropometry

Height and weight of each subject was measured by manageable stadiometers and weighing scale respectively. After measuring the height and weight, BMI (kg/m²) was calculated by the formula used for calculating BMI (Height/Weight) (Greenspan *et al*., 2004).

BMI (kg/m²) = Weight in Kg/Height in Meter^2.

Obesity was determined on the basis of BMI. The studied subjects were categorized into three groups normal weight (18.50 kg/m^2 – 22.9 kg/m^2), overweight (23.00 kg/m^2 – 24.9 kg/m^2) and obese (≥25 kg/m^2) following the criteria of BMI for Asians (Who, J. and Consultation, F. E. 2003).

Peak expiratory flow rate

The peak expiratory flow rate measurements were attained in a healthy atmosphere where the individuals were asked to remain in an orthostatic posture and they used a nasal clip to prevent air leakage through the nose. Individuals were requested to take a long inspiration and subsequently to provide a fast and extreme expiratory effort. They were informed to avoid bending their neck during the practice and also not to block the mouthpiece with their own tongue or spit during the enforced expiration to avoid the measurement of higher values which are considered as incorrect.

Peak expiratory flow rate (PEFR) was calculated with the help of wright's peak flow meter. All the tests were implemented on volunteers during morning hours in a quiet room with 27 optimum temperature. Volunteers were required to breathe out as rapidly as possible into the peak flow meter (PFM) following maximum inhalation. Blowing practice was carefully observed to make sure that a tight closure was kept between mouthpiece and the lips of peak flow meter. Three PEFR maneuvers were practiced by every individual and the maximum blow into the instrument was recorded. All of these calculations were taken at the same time of the day.

Statistical analysis

Data was then examined by using statistical software SPSS version 13.0. Demographic data was presented as mean ± S.E.M. The level of significant was p ≤ 0.05. Correlation of ventilator lung function tests with body fat percentage was noted by using Pearson's correlation coefficient test.

RESULTS

The present cross-sectional study was conducted to determine relationship of lung function with obesity in healthy subject. A total of 180 females were enrolled of age ranging 19 to 30 years. The mean ages of the subjects were 20.9±2.73 years. When studied subjects were categorized on the basis of BMI. It was observed that normal subjects were n= 80 (44.5%), overweight subjects were n=29 (16%) and obese subjects were n=71 (39.5%). The demographic data was presented in Table I. One Way ANOVA revealed significant difference in peak expiratory flow rate among the groups.

Table 1: Demographic data of studied population on the basis of BMI groups

Variables	Normal (18.5-25 kg/m²)	Over-weight (25-29.9 kg/m²)	Obese (≥30 kg/m²)	ANOVA F value
Age (years)	20.9±5.09	22.9±7.97	19.3±0.87	0.154
Height (inches)	62.5±2.36	61.9±1.84	62.0±2.47	0.00**
Weight (kg)	49.2±5.84	61.5±5.74	74.5±9.60	0.00**
BMI (kg/m²)	19.9±1.91	25.4±1.27	30.8±2.95	0.00**
PEFR (L/min)	275.6±35.1	225.4±45.1	189.6±34.3	0.00**

*Significant p≤ 0.05
** Highly significant p≤ 0.01

The studied population was divided into five groups according to the age to observe the effect of age on PEFR. Group 1: (16-18years) Group 2: (19 – 21 years) Group 3: (22-24years) Group 4: (25-27) years Group 5: (28-30 years) The demographic data of the groups was presented in Table II.

Table II: Anthropometric measurements and peak expiratory flow rate among different Age groups

Variables	Group 1 (16-18 Y) n= 26	Group 2 (19-21 Y) n= 96	Groups 3 (22-24 Y) n= 43	Group 4 (25-27 Y) n= 6	Group 5 (28-30 Y) n= 9	ANOVA F value
Age (years)	17.9±0.27	19.8±0.77	22.6±0.77	25.6±0.81	29.3±0.70	0.154
Height(inches)	62.3±2.20	62.1±2.27	62.4±2.75	62.1±1.72	62.2±1.71	0.00**
Weight (kg)	58.6±16.5	61.1±13.7	62.7±14.0	62.6±5.53	60.6±9.47	0.00**
BMI (kg/m²)	24.0±6.46	25.2±5.57	25.4±5.53	25.9±2.74	24.9±3.12	0.00**
PEFR(L/min)	242.9±16.3	235.9±56.6	224.5±46.1	215.5±46.1	238.1±35.8	0.00**

* Significant p≤ 0.05
**Highly significant p≤ 0.01

It was observed that in group 1, there were 16 normal weight subjects, 6 overweight and 4 obese. Group 2 comprised of 50 normal weights, 23 overweight and 23 obese. There were 43 females in group 3, the normal weight were 19, overweight 17 and obese 7. In group 4 there were 2 females in each group whereas 3 normal weight, 5 overweight and 1 obese were observed in group 5.

In normal weight individual, correlation between BMI and PEFR is direct and non-significant (r= 0.17p>0.05). In overweight, there is inverse relationship between BMI and PEFR (r= -0.494) and this relation is highly significant which indicated that with the increase of BMI the lung capacity decrease. Similar result were obtained in obese females in which the inverse association was highly significant (r= -0.580; p< 0.01) as shown in Figures (I, II, III). This indicated that peak expiratory flow rate reduced with increase in body weight.

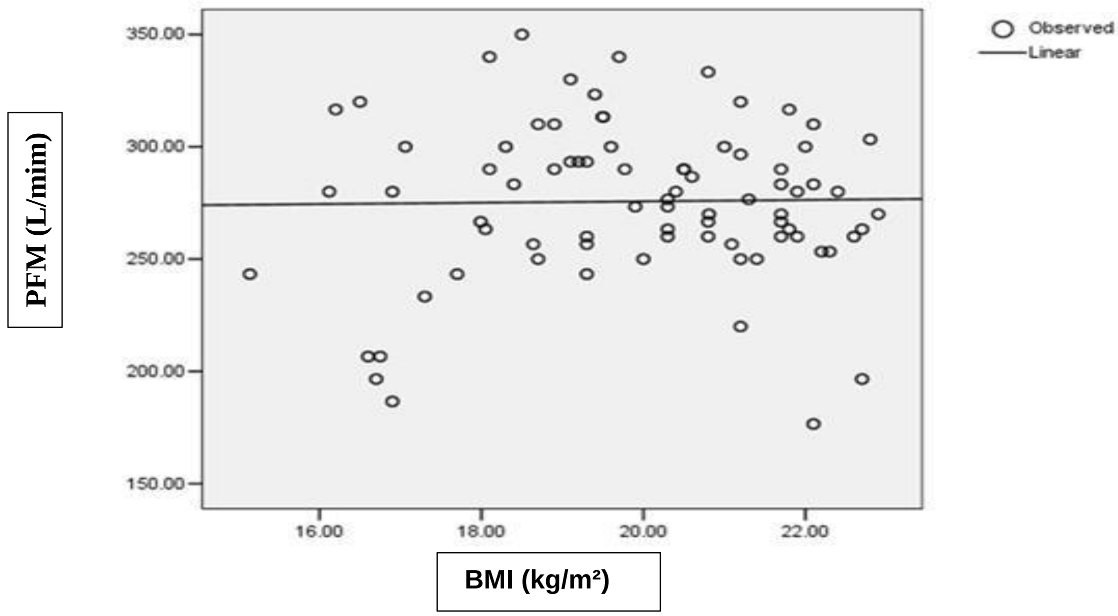

Fig. I: Relationship between PFM (L/min) and BMI (kg/m²) in Normal Weight subject (r= 0.17p>0.05).

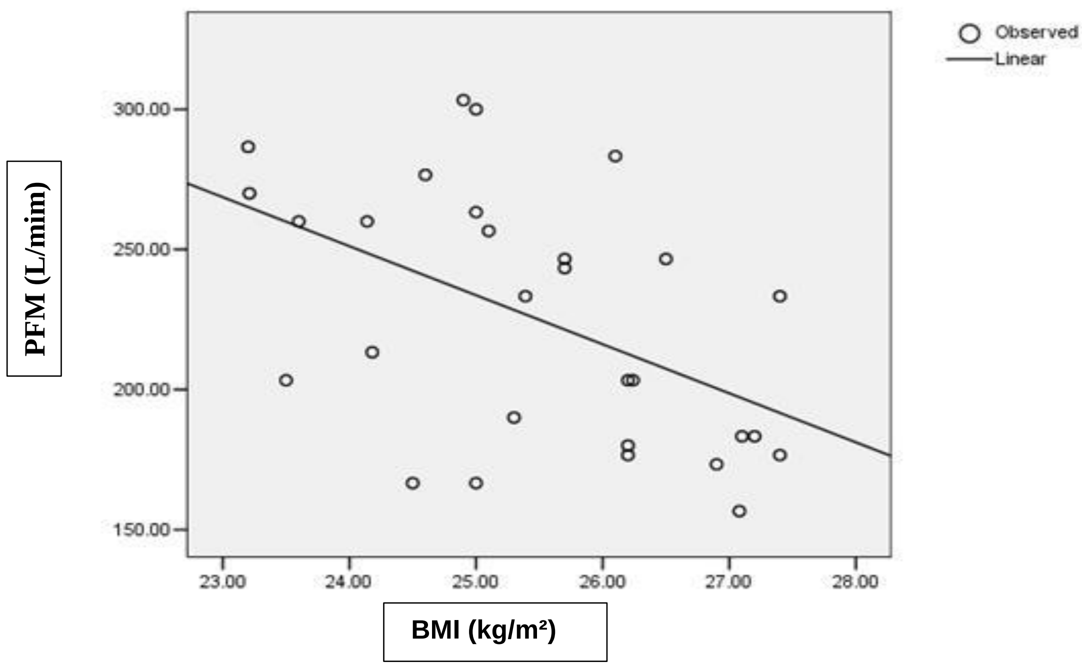

Fig. II: Relationship between PFM (L/min) and BMI (kg/m²) in Overweight Subjects (r= -0.494).

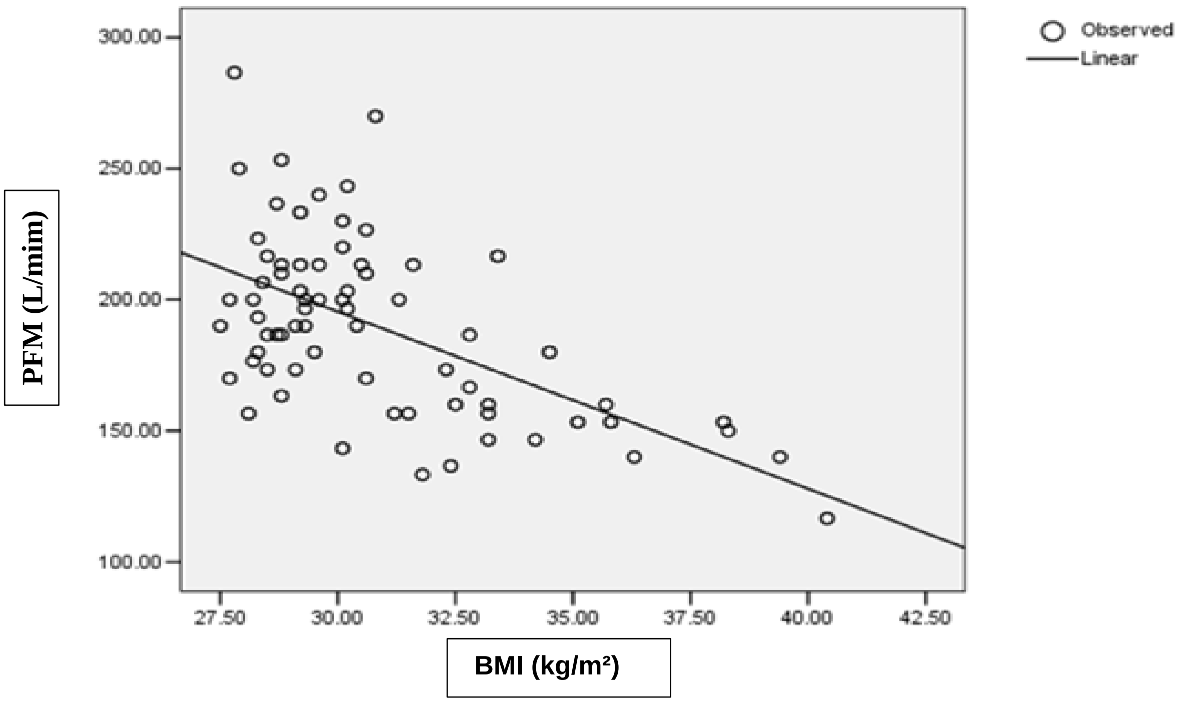

Fig. III: Relationship between PFM (L/min) and BMI (kg/m²) in Obese Subjects (r= -0.580; p< 0.01).

DISCUSSION

Peak Flow Meter (PFM) and BMI are the common and simple methods to assess lung function and obesity. Peak Flow Rate (PFR) is a valuable tool in diagnosis of lung functions. PEFR depends on various factors which includes airway resistance, maximal voluntary muscular effort and BMI. Body Mass Index calculation is a powerful tool for the categorization of adiposity and body composition among the adults and children. It is also known as Quetelet's index and is normally used to assess body fatness. PEFR depends upon individual respiratory muscle power. Voluntary effort and force of contraction tends to decrease in obesity (Canoy *et al*., 2004).

In this present study subjects were categorized into three groups on the basis of BMI. PEFR and BMI values were measured. In our study, individuals with normal BMI had high values of PEFR and obese subjects have low PEFR ($p<0.001$). This is in accordance with the study that has shown a direct positive association between PEFR and BMI (Lewis *et al*., 2003; Koenig *et al*., (2001).

Body Mass Index (BMI) is one of the simple methods to assess oneself about their fat distribution. Apart from pollution and hereditary, obesity has become one of the major factor which affects the lung function. Many studies had been carried out on several types of obesity-induced functional impairment, disorders and diseases. Gibson *et al.,* 2000) and Rubinstein *et al*., 1990) identified that, obesity impairs the pulmonary functions by inducing airway hyper responsiveness in adults. Many studies had been conducted in obesity and pulmonary function in the teenagers with the age range of 17 to 25 years or in the adult people with age above 28 years. Age group of 19-25 years was found to be the essential adolescent age which was extremely susceptible for obesity. Furthermore, pattern of distribution of fat in males was different from that of the females, which showed variation in lung functions (Muxworthy *et al*., 1951).

A study by Silva *et al*., (2011) suggest that obesity itself and especially the distribution of body fats have independent effects on PFM. Mungreiphy *et al*., (2012) found PFM to be maximum among subjects with normal BMI, followed by overweight and obese. Jones *et al.,* 2006 also demonstrated that the decrease in PFM is directly proportional to the increase in body mass index. So our study is an attempt to bring awareness about variation of lung function with increase BMI. The information may help to acknowledge the pulmonary health risks that crop up with increasing body mass index and fat accumulation (Chen *et al*., 2007).

Overweight or obesity is known to diminish the functional residual capacity (FRC). It is the volume of air in the lungs at the end of passive expiration. It includes both the residual volume (RV) and expiratory reserve volume (ERV). Studies have revealed that increasing BMI can cause an exponential reduction in FRC and ERV. Low value of ERV in obesity suggests incidence of tidal inhalation close to residual volume in distal high resistance airways, for instance non-cartilaginous small membranous terminal and respiratory bronchioles and alveolar duct, in obese populations. An appropriate linear direct correlation is found between FRC and airway resistance while there is an inverse linear relation with airway conductance. Studies have also suggested that high level of respiratory resistance in obesity stabilizes on adjustment with the lung volumes. Sutherland *et al*. (2008) have illustrated that with every increase in 1 kg of body weight can results in an average reduction of 28–30 ml of functional residual capacity, though decrease in functional residual capacity was mainly associated with abdominal and thoracic adiposity, suggesting a possible dependent role of fat distribution in both truncal sites in decreasing lung volumes (Pelosi *et al*., 1998).

Different studies regarding lung functions in obese females frequently reported abnormalities in lung volumes and expiratory flow rates of obesity (Inselman *et al*., 1993). Salome *et al*., 2010) studied the effect of physiology obesity on the lung function. Nevertheless, obesity has a slight direct effect on the airway caliber. Peak flow meter variables show decline in relation to the lung volumes, but are rarely below the normal range, even in case of severely obese individuals, whereas decreases in expiratory flows and increases in airway resistance are largely stabilized by altering lung volumes.

Pulmonary function test are commonly used in the assessment of respiratory position of the persons and also in monitoring patients with lung diseases. Moreover, it has become a regular part of public health examinations and screening. Thus, even though lungs are absolutely normal, alterations in the pulmonary function can be predictable due to the effect of obesity on the diaphragm and chest wall. It has been stated that obesity is related with reduced chest wall compliance, decreased lung volume, diminished airway function, arterial hypoxemia and breast skeletal muscle functional impairment (Ray *et al*., 1983).

CONCLUSION

It had been concluded that with increase of body mass index the peak expiratory flow rate decreased significantly in young females.

REFERENCES

Canoy, D., Luben, R., Welch, A., Bingham, S., Wareham, N., Day, N., and Khaw, K. T. 2004. Abdominal obesity and respiratory function in men and women in the EPIC-Norfolk Study, United Kingdom. *American Journal of Epidemiol*,159 (12): 1140-1149.

Chen, Y., Rennie, D., Cormier, Y. F., and Dosman, J. 2007. Waist circumference is associated with pulmonary function in normal-weight, overweight, and obese subjects. *The American Journal of Clinical Nutrition,* 85 (1): 35-39.

Field, A. E., Coakley, E. H., Must, A., Spadano, J. L., Laird, N., Dietz, W. H., and Colditz, G. A. 2001. Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of Internal Medicine* , 161(13): 1581-1586.

Gibson, G. J. 2000. Obesity, respiratory function and breathlessness. *Thorax*, 55(suppl 1), S41-S44.

Greenspan, F. S. & Gardner D. G., 2004. *Basic and Clinical Endocrinology*, 7th edition. Mcgraw Hill, 392pp.

Harms, C. A. 2006. Does gender affect pulmonary function and exercise capacity?. *Respiratory Physiological and Neurobiology,* 151(2): 124-131.

Inselman, L. S., Milanese, A., and Deurloo, A. 1993. Effect of obesity on pulmonary function in children. *Pediatric Pulmonology,* 16(2):

130-137.

Jones, R. L., and Nzekwu, M. M. U. 2006. The effects of body mass index on lung volumes. *Chest journal,* 130(3): 827-833

Koenig, S. M. 2001. Pulmonary complications of obesity. *American Journal of the Medical Sciences,* 321(4): 249-279.

Lewis, M. I., Li, H., Huang, Z. S., Biring, M. S.7, Cercek, B., and Fournier, M. 2003. Influence of varying degrees of malnutrition on IGF-I expression in the rat diaphragm. *Journal of Applied Physiology,* 95(2): 555-562.

Mungreiphy, N. K., Dhall, M., Tyagi, R., Saluja, K., Kumar, A., Tungdim, M. G., and Kapoor, A. K. 2012. Ethnicity, obesity and health pattern among Indian population*. Journal of Natural Sciences, Biology and Medicine,* 3(1): 52.

Muxworthy, J. F. 1951. Breath holding studies: relationship to lung volume. *USAF Tech. Reports, Wright-Patterson Air Force Base, Dayton*, 652(8): 452-456.

Nawafleh, H. A., Al-Sayed Abo Zead, S., and Al-Maghaireh, F. 2012. Pulmonary Function Test: The value among smokers and nonsmokers. *Health Sciences Journal*, 6(4):703 - 713

Ochs-Balcom, H. M., Grant, B. J., Muti, P., Sempos, C. T., Freudenheim, J. L., Trevisan, M., and Schunemann, H. J. 2006. Pulmonary function and abdominal adiposity in the general population. *Chest Journal,* 129(4): 853-862.

Pelosi, P., Croci, M., Ravagnan, I., Tredici, S., Pedoto, A., Lissoni, A., and Gattinoni, L. 1998. The effects of body mass on lung volumes, respiratory mechanics, and gas exchange during general anesthesia. *Anesthesia and Analgesia*, 87(3): 654-660.

Prentice, A. M. 2006. The emerging epidemic of obesity in developing countries. *International Journal of Epidemiology*, 35(1): 93-99.

Ray, C. S., Sue, D. Y., Bray, G., Hansen, J. E., and Wasserman, K. 1983. Effects of Obesity on Respiratory Function 1–3*. American Review of Respiratory Diseases,* 128(3): 501-506.

Rubinstein, I., Zamel, N., DuBarry, L., and Hoffstein, V. 1990. Airflow limitation in morbidly obese, nonsmoking men. *Annals of Internal Medicine*, 112(11): 828-832.

Salome, C. M., King, G. G., and Berend, N. 2010. Physiology of obesity and effects on lung function. *Journal of Applied Physiology,* 108 (1): 206-211.

Silva, L. O., Silva, P. L. D., Nogueira, A. M. O. C., Silva, M. B., Luz, G. C. P., Narciso, F. V., and Cheik, N. C. 2011. Evaluation of exercise-induced bronchospasm assessed by Peak Flow Meter in obese adolescents. *Reista Brasileira de Medicina Esporte,* 17(6): 393-396.

Sutherland, T. J., Goulding, A., Grant, A. M., Cowan, J. O., Williamson, A., Williams, S. M., and Taylor, D. R. 2008. The effect of adiposity measured by dual-energy X-ray absorptiometry on lung function*. European Respiratory Journal*,32(1): 85-91.

Who, J. and Consultation, F. E. 2003. Diet, nutrition and the prevention of chronic diseases*. World Health Organ Technical Report Series*, 916. 68 – 69.

Young, S.Y., Gunzenhauser, J. D., Malone, K. E., and McTiernan, A. 2001. Body mass index and asthma in the military population of the northwestern United States. *Archives of Internal Medicine,* 161(13): 1605-1611.