National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Correlation of body mass index with flow rates and maximum voluntary ventilation: A comparative study

Khaleel Ahmed Manik[1], Leena S Hiremath[2], Imran Jagadal[3]

[1]Department of Physiology, MES Medical College, Kolathur, Kerala, India, [2]Department of Physiology, K. S. Hegde Medical Academy, Mangalore, Karnataka, India, [3]Department of Physiology, Jawaharlal Nehru Medical College, Belgaum, Karnataka, India

Correspondence to: Khaleel Ahmed Manik, E-mail: khals2000@yahoo.co.in

Received: May 07, 2017; **Accepted:** May 26, 2017

ABSTRACT

Background: In an obese individual, weighing 140 kg more than 50% of body weight is represented by adipose tissue. **Aims and Objective:** The aim is to study correlation of body mass index (BMI) and flow rates (forced expiratory flow 25-75% [FEF 25-75%], FEF 75%, peek expiratory flow [PEF], and maximum voluntary ventilation [MVV]) of pulmonary function test in controls and patients. **Materials and Methods:** The study was conducted in the Department of Physiology, SDM College of Medical Sciences and Hospital, Dharwad. A total of 150 male students in the age group of 15-24 years of the college formed the individuals of the study. **Results:** FEF 25-75%: The mean (±SD) FEF 25-75% at rest in overweight group was 3.76 ± 0.88 L/s, in obese group was 3.75 ± 1.08 L/s, and in controls was 1.66 ± 0.85 L/s ($P > 0.05$). FEF 75%: The mean (±SD) FEF 75% at rest in overweight group was 1.70 ± 0.58 L/s, in obese group was 1.79 ± 0.74 L/s, and in controls was 2.11 ± 0.94 L/s. It is significantly less in overweight group compared to control group. PEF: The mean (±SD) PEF at rest in overweight group was 8.48 ± 0.89 L/s, in obese group was 8.04 ± 1.72 L/s, and in controls was 8.60 ± 1.18 L/s ($P > 0.05$). MVV: The mean (±SD) MVV at rest in overweight group was 145.62 ± 12.65 L/min, in obese group was 137.06 ± 33.96 L/min, and in controls was 151.41 ± 26.07 L/min. It is significantly less in obese group compared to control group. **Conclusion:** Correlation of BMI with PFT shows a significant negative correlation of BMI with flow rates (FEF 25-75%, FEF 75%, PEF, and MVV) of the pulmonary function test.

KEY WORDS: Forced Expiratory Flow at 25-75%, Forced Expiratory Flow at 75% of FVC, Peak Expiratory Flow, Maximal Voluntary Ventilation

INTRODUCTION

Physiologic system, orchestrated through endocrine and neural pathways, permits humans to survive starvation for as long as several months.[1] However, in the presence of nutritional abundance and a sedentary lifestyle and influenced importantly by genetic endowment, this system increases adipose energy stores resulting in obesity that produces adverse health consequences.[2] Adipose tissue accounts for about 20% of the total body weight of a normal young adult, about 15 kg in the average person.

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2017.7.0517928052017	

The WHO consultation on obesity, Geneva interim report on “obesity-preventing and -managing the global epidemic 1997”: Has recognized that overweight and obesity represent a rapidly growing threat to the health of population worldwide. It recognized obesity as a disease, which is prevalent in both developing and developed countries and affects children and adults alike. Indeed obesity and overweight are so common that they are replacing the more traditional public health concern such as undernutrition and infectious diseases as some of most significant contribute to ill health.

There are different measures to assess obesity. One of the most commonly used is body mass index (BMI) which is a measure of general obesity.[3] Indices used to measure regional and central obesity are subscapular skinfold thickness, waist circumference and abdominal sagittal diameter and ratios such as Waist-Hip ratio. These have been considered as better and more sensitive than BMI.[4]

On the other end of the spectrum, purely mechanical consequences of obesity including various forms of hypoventilation syndrome and dramatic reduction in various lung volumes have also been established.[5] Hence, the present study is taken up to study correlation of BMI and flow rates (forced expiratory flow 25-75% [FEF 25-75%], FEF 75%, peak expiratory flow [PEF], and maximal voluntary ventilation [MVV]) of pulmonary function test in controls and patients.

MATERIALS AND METHODS

The study was conducted under the auspices of the laboratory setup of the Department of Physiology, SDM College of Medical Sciences and Hospital, Dharwad. A total of 150 male students in the age group 15-24 years of the college formed the individuals of the study with applying exclusion criteria, i.e., those with history of smoking or atopy, asthma, BMI <18.5 or >29.9, history or family history of asthma, congenital cardiopulmonary disease, and age <15 or >25 years

These individuals were divided into three groups based on BMI as follows:

- Group-I (controls): 50 controls BMI 18.5-22.9 (age and sex matched)
- Group-II (overweight): 50 students with BMI 23-24.9
- Group-III (obese): 50 students with BMI 25-29.9.

Method of Data Collection

Identification data name, age, sex, and address were recorded. Age was calculated in years to the nearest birthday. Height and weight of each individual were recorded. BMI was calculated using the formula: BMI = Weight in Kg/[Height in m]^2

- A detailed clinical examination of respiratory, cardiovascular, and central nervous systems was done.
- Lung function tests were recorded using Spirovit SP-1.

Spirovit SP-1

The instrument used in this study was Spirovit SP-1 manufactured by Schiller. It's a type of flow sensing Spirometer. This is a low-cost high-performance instrument capable of giving highly accurate and repeatable test results and represents the major advancement in computerized pulmonary function testing. It is the best instrument for routine screening of large number of the patient. The following Lung Function parameters are provided by the Spirovit SP1: FEF 25-75%, FEF at 75% of FVC, peak expiratory flow (PEF) and maximal voluntary ventilation (MVV).

Procedure

All maneuvers were performed in sitting position and at rest with the nose clip in place. The individual was asked to loosen tight clothing, if any. Each student was taught about the various maneuvers to be performed for about 5 min. Demonstration was also given. Every individual was given ample time to understand carefully and then was allowed to do some practice blows. Sufficient rest was provided between the procedures.

Statistical Analysis

Compares mean values of more than two groups and correlation analysis were employed in the present study using SPSS version 20 ANOVA.

RESULTS

The mean (±SD) height in overweight group was 170 ± 6.1 cm, in obese group was 168 ± 6.1 cm, and in controls was 170 ± 7.2 cm. There was no statistically significant difference between any of the groups. The mean (±SD) weight in overweight group was 69.44 ± 4.35 kg, in obese group was 75.72 ± 8.11 kg, and in controls was 60.80 ± 4.84 kg. As BMI is the basis of division in all three groups, they have significantly increasing weight with increasing BMI (Table 1).

BMI

The mean (±SD) BMI in overweight group was 23.94 ± 0.55 kg/m^2, in obese group was 26.81 ± 1.45 kg/m^2 and in controls was 21.04 ± 1.26 kg/m^2. As BMI is the basis of division, hence all three groups have significantly different BMI.

Flow Rates

Flow rates of controls, overweight, and obese groups are shown in Table 2.

FEF 25-75%: The mean (±SD) FEF 25-75% at rest in overweight group was 3.76 ± 0.88 L/s, in obese group was 3.75 ± 1.08 L/s, and in controls was 1.66 ± 0.85 L/s. There was no statistically significant difference between any of the three groups.

FEF 75%

The mean (±SD) FEF 75% at rest in overweight group was 1.70 ± 0.58 L/s, in obese group was 1.79 ± 0.74 L/s, and

Table 1: Height, weight and BMI controls, overweight, and obese groups

Parameter	Mean±SD			*P* value	Significance
	Control (*n*=50)	Overweight (*n*=50)	Obese (*n*=50)		
Height (cm)	170±7.2	170±6.1	168±6.1	0.121	NS
Weight (kg)	60.80±4.84	69.44±4.35■	75.72±8.11▲☻	0.000	S
BMI (kg/m^2)	21.04±1.26	23.94±0.55■	26.81±1.45▲☻	0.000	S

■: Significantly different between control and overweight groups. ▲: Significantly different between control and obese groups. ☻: Significantly different between overweight and obese groups. SD: Standard deviation, BMI: Body mass index, FEF: Forced expiratory flow, PEF: Peek expiratory flow, MVV: Maximum voluntary ventilation

Table 2: Flow rates of controls, overweight, and obese groups

Parameters	Mean±SD			*P* value	Significance
	Control (*n*=50)	Overweight (*n*=50)	Obese (*n*=50)		
FEF 25-75% (L/s)	4.16±0.99	3.76±0.88	3.75±1.08	0.067	NS
FEF 75% (L/s)	2.11±0.94	1.70±0.58■	1.79±0.74	0.020	S
PEF (L/s)	8.60±1.18	8.48±0.89	8.04±1.72	0.088	NS
MVV (L/min)	151.41±26.07	145.62±12.65	137.06±33.96▲	0.022	S

■: Significantly different between control and overweight groups. ▲: Significantly different between control and obese groups. SD: Standard deviation, FEF: Forced expiratory flow, PEF: Peek expiratory flow, MVV: Maximum voluntary ventilation

Table 3: Correlation of BMI and flow rates [FEF 25-75%, FEF 75%, PEF, MVV]

Parameters	*r* value	*P* value
FEF 25-75% (L/s)	−0.111	0.177
FEF 75% (L/s)	−0.143	0.080
PEF (L/s)	−0.139	0.089
MVV (L/min)	−0.196	0.016*

SD: Standard deviation, FEF: Forced expiratory flow, PEF: Peek expiratory flow, MVV: Maximum voluntary ventilation. *$P<0.05$

in controls was 2.11 ± 0.94 L/s. It is significantly less in overweight group compared to control group.

PEF

The mean (±SD) PEF at rest in overweight group was 8.48 ± 0.89 L/s, in obese group was 8.04 ± 1.72 L/s, and in controls was 8.60 ± 1.18 L/s. There was no statistically significant difference between any of the three groups.

MVV

The mean (±SD) MVV at rest in overweight group was 145.62 ± 12.65 L/min, in obese group was 137.06 ± 33.96 L/min, and in controls was 151.41 ± 26.07 L/min. It is significantly less in obese group compared to control group.

Correlation of BMI with PFT

There is a significant negative correlation of BMI with FEF 25-75% (r = −0.111), FEF 75% (r = −0.143), PEF (r = −0.139), and MVV(r = −0.196) (Table 3).

DISCUSSION

There are very less data on correlation of BMI with PFT, using the new WHO classification of BMI proposed in 2000, specific for Asians.[6] We have tried to look for this relation according to this new BMI classification for Asians. Our results confirm the findings of many others who have shown that lung volumes decrease as body weight increases.

FEF 75%

The mean (±SD) FEF 75% at rest in overweight group was 1.70 ± 0.58 L/s, in obese group was 1.79 ± 0.74 L/s, and in controls was 2.11 ± 0.94 L/s. It is significantly less in overweight group compared to control group. Martinez et al.[7] showed similar decrease in FEF 75-85% in obese people in their study. Jackson et al.[8] and Sahebjami and Gartside[9] showed decrease in FEF 75% in obese people in their study. Low PEF and FEF 75% and FEF 75-85% values which are flow rates at high lung volumes indicate that probably the smaller airways are also affected in the pathology caused by excess fat deposition in the abdomen and in the chest cavities, the exact mechanism may be related to small airway collapse due to decreased lung volumes with increasing obesity or it may be independent. This is the reason why obese people are at increased risk of respiratory symptoms, such as breathlessness, particularly during exercise, even if they have no obvious respiratory illness.[10,11]

MVV

The mean (±SD) MVV at rest in overweight group was 145.62±12.65 L/min, in obese group was 137.06±33.96 L/min, and in controls was 151.41 ± 26.07 L/min. It is significantly less in obese group compared to control group. The MVV test evaluates the respiratory endurance and is influenced by the respiratory muscle strength, the lung and chest compliance, and the control of breathing and airway resistance.[12,13] In the case of obese individuals, this variable is reduced mainly by mechanical injury to the respiratory muscles, caused in particular by the excessive weight on the thorax.[14]

Studies done by De Lorenzo[15] and Sahebjami[9] have also shown similar results. Due to an obese individual's respiratory muscles should work constantly against a less compliant chest wall and higher airway resistance, it would be expected that they could generate increased pressures. Kelly et al.[16] examined the maximum inspiratory and expiratory pressures at different lung volumes in 45 morbidly obese patients, who on an average weighed 183% of their predicted weights. These were compared with the pressures of 25 nonobese age-matched individuals. At all lung volumes, the pressures generated by the obese patients were lower than those of the nonobese patients, despite heightened demands for diaphragmatic work. It is estimated that the MVV, a measurement of respiratory muscle endurance, is reduced by 20% in healthy obese individuals.[17,18] This may result from diaphragm dysfunction due to increased abdominal and visceral adipose tissue deposition. It has been suggested that the additional load causes a length-tension disadvantage for the diaphragm due to fiber overstretching, which is particularly worse while the individual is supine.[11] There is a significant negative correlation of BMI with FEF 75-85% (−0.173) and MVV(−0.196).

BMI: The mean (±SD) BMI in overweight group was 23.94 ± 0.55 kg/m^2, in obese group was 26.81 ± 1.45 kg/m^2, and in controls was 21.04 ± 1.26 kg/m^2. As BMI is the basis of division of all three groups, they have significantly different BMI.

FEF 25-75%: The mean (±SD) FEF 25-75% at rest in overweight group was 3.76 ± 0.88 L/s, in obese group was 3.75 ± 1.08 L/s, and in controls was 1.66 ± 0.85 L/s. There was no statistically significant difference between any of the three groups.

CONCLUSION

Correlation of BMI with PFT shows a significant negative correlation of BMI with flow rates [FEF 25-75%, FEF 75%, PEF, and MVV] of the pulmonary function test.

REFERENCES

1. Flier JS, Flier EM. Biology of obesity. Harrisons's Principles of Internal Medicine. 17th ed. New York: McGraw Hill Publishers; 2005. p. 622-37.
2. Farooqi IS. Obesity. In: Warrel DA, editor. Oxford Text Book of Medicine. 5th ed. Oxford: Oxford University Press; 2010. p. 1525-35.
3. West JB. Best & Taylor's Physiological Basis of Medical Practice. 12th ed. Baltimore: Williams & Wilkins; 1990. p. 741.
4. Davson H, Eggleton MG, Starling EH, Evans CL. Principles of Human Physiology. 13th ed. London: J. & A. Churchill Ltd; 1962. p. 615.
5. Zargar AH, Masoodi SR, Laway BA, Khan AK, Wani AI, Bashir MI, et al. Prevalence of obesity in adults - An epidemiological study from Kashmir Valley of Indian Subcontinent. J Assoc Physicians India. 2000;48(12):1170-4.
6. James P. Oxford Text Book of Public Health. 5th ed. Oxford: Oxford University Press; 2009. p. 1046-58.
7. Martinez FJ, Foster G, Curtis JL, Criner G, Weinmann G, Fishman A, DeCamp MM, et al. Predictors of mortality in patients with emphysema and severe airflow obstruction. Am J Respir Crit Care Med. 2006;173(12):1326-34.
8. Jackson H, Hubbard R. Detecting chronic obstructive pulmonary disease using peak flow rate: Cross sectional survey. BMJ. 2003;327(7416):653-4.
9. Sahebjami H, Gartside PS. Pulmonary function in obese subjects with a normal FEV1/FVC ratio. Chest. 1996;110(6):1425-9.
10. Feldstein CA, Akopian M, Olivieri AO, Kramer AP, Nasi M, Garrido D. A comparison of body mass index and waist-to-hip ratio as indicators of hypertension risk in an urban Argentine population: A hospital-based study. Nutr Metab Cardiovasc Dis. 2005;15(4):310-5.
11. Sharp JT, Druz WS, Kondragunta VR. Diaphragmatic responses to body position changes in obese patients with obstructive sleep apnea. Am Rev Respir Dis. 1986;133(1):32-7.
12. Sparer J, Stowe MH, Bello D, Liu Y, Gore RJ, Youngs F, et al. Isocyanate exposures in autobody shop work: The SPRAY study. J Occup Environ Hyg. 2004;1(9):570-81.
13. Balabinis CP, Psarakis CH, Moukas M, Vassiliou MP, Behrakis PK. Early phase changes by concurrent endurance and strength training. J Strength Cond Res. 2003;17(2):393-401.
14. Olabinri BM, Olaleye MT, Akinola FF, Omotoso EO. Age-specific association between percent body fat and pulmonary function in apparently normal children in Ogbomoso, Oyo state, Nigeria. Afr J Biomed Res. 2006;9:83-7.
15. Manson JE, Stampfer MJ, Hennekens CH, Willett WC. Body weight and longevity. A reassessment. JAMA. 1987;257(3):353-8.
16. Kelly TM, Jensen RL, Elliott CG, Crapo RO. Maximum respiratory pressures in morbidly obese subjects. Respiration. 1988;54(2):73-7.
17. Ray CS, Sue DY, Bray G, Hansen JE, Wasserman K. Effects of obesity on respiratory function. Am Rev Respir Dis. 1983;128(3):5016.
18. Koenig SM. Pulmonary complications of obesity. Am J Med Sci. 2001;321(4):249-79.

How to cite this article: Manik KA, Hiremath LS, Jagadal I. Correlation of body mass index with flow rates and maximum voluntary ventilation: A comparative study. Natl J Physiol Pharm Pharmacol 2017;7(9):995-998.

Source of Support: Nil, **Conflict of Interest:** None declared.