International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Relationship between Body Mass Index, Blood Pressure and Respiratory Indices among Male Students of University of Calabar, Cross River State, Nigeria

E. J. Ani[1], C. O. Nku[2], V. U. Nna[3], J. N. Nwangwa[4]

[1,2,3,4]Department of Physiology, Faculty of Basic Medical Sciences, College of Medical Sciences, University of Calabar, P.M.B. 1115, Calabar, Nigeria.

Abstract: ***The prevalence of obesity, cardiovascular diseases and pulmonary dysfunction is increasing the world over. Some reports have demonstrated the interplay between these three factors. This study therefore assessed the relationship between body mass index (BMI), blood pressure (BP) and some respiratory indices among the younger population of a Nigerian University community. A total of 382 male students of the University of Calabar, Cross River State, Nigeria were assessed in this study. Body weight, height, BMI, peak expiratory flow rate (PEFR), rate of respiration (RR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP) were assessed using standard methods. Three hundred and fifty students met the inclusion criteria. Individuals aged 26 – 30 years had significantly higher (p<0.05) BMI, compared with the group aged 18 – 21 years. Respiratory rate was significantly lower (p<0.01) in the group aged 22 – 25 years, compared with the group aged 18 – 21 years. Diastolic pressure was significantly higher (p<0.05) in the group aged 26 – 30 years, compared with those aged 18 – 21 years. Body mass index had a significant positive correlation with PEFR (p<0.001), SBP (p<0.001), MAP (p<0.001) and age (p<0.01), but correlated negatively with respiratory rate (p<0.05). There was no incident of obesity within the population studied, while MAP increased with increasing age; a physiological variation. The results obtained from our study have also demonstrated the fact that there exists a relationship between BMI, cardiovascular and respiratory indices.***

Keywords: Blood pressure, body mass index, body weight, obesity, respiratory rate

1. Introduction

Body mass index (BMI) is one of the most accurate anthropometric measurements used to determine when extra kilograms in body weight as related to the height of that individual translates into health risks. It is defined as weight (kg) divided by the square of height (m^2) of an individual [1]. Body mass index therefore correlates positively with body weight. With increase in body weight, the risk of developing obesity is higher. Obesity in turn facilitates the occurrence of several ill conditions like; type 2 diabetes mellitus [2,3], cardiovascular disease [4] and respiratory disorders [5,6].

Pulmonary function is a complex combination of several processes. Peak expiratory flow rate is one of the important parameters in pulmonary function testing that has evolved as a clinical tool for diagnosis, management and follow up of respiratory diseases [7-9]. For the assessment of ventilatory capacity, PEFR (defined as the largest expiratory flow rate achieved with a maximally forced effort from a position of maximal expiration expressed in litres/min) is considered to be the simplest among the pulmonary function indices. It was first introduced by Adorn in 1942 as a measurement of ventilatory function and was accepted in 1949 as an index of spirometry [10, 11]. Measurement of PEFR has been reported to be useful in managing respiratory diseases, especially to differentiate between obstructive and restrictive respiratory diseases.

Blood pressure has been shown to vary in several health conditions. In adult life, weight gain seems to be an important risk factor for the development of hypertension [12-14]. Several studies have linked an increase in body weight with increased tendency to develop cardiovascular disease [15-17]. The relationship between measures of body mass and blood pressure has been extensively documented, usually with body mass index as the measure of relative weight [18]. Since BMI is the simplest, affordable and non-invasive method of measuring obesity prevalence in a large population, this was adopted to ascertain how it correlates with blood pressure and respiratory indices.

2. Materials and Methods

2.1 Subject Selection

This research was carried out using 382 male subjects randomly selected from various faculties in the University of Calabar. Subjects with cardiovascular and respiratory disorders were excluded from the study. After applying the exclusion criteria, 350 subjects were qualified and were aged 18 – 30 years. The equipment employed for this study included a bathroom scale, peak expiratory flow meter, a height scale (metre rule), sphygmomanometer and stop watch.

2.2 Measurement of Body Weight and Height

Body weight was measured using a bathroom scale (Hanson, CHINA). The subjects were made to stand upright on the scale wearing only shorts after taking off their shoes, clothes and socks. The body weights of all the subjects were recorded. Standing height of each subject was taken with the

Licensed Under Creative Commons Attribution CC BY

subject standing erect against a height measurement metre rule placed against the wall. The subject's occiput, shoulders, buttocks and back of the heel were made to touch the wall with the subject looking forward.

2.3 Measurement of Blood Pressure

Blood pressure was measured using an Omron MX3 plus digital blood pressure monitor (Model HFM 742F, Omron Health Care UK Ltd, United Kingdom). The reading was obtained thrice, and the average of the 3 measurements was used as the subject's blood pressure. Readings were taken after the subjects had sat down and rested for 30 minutes. This ensured that a resting blood pressure was obtained [18].

2.4 Body Mass Index (BMI)

The BMI of each subject was obtained mathematically using the formula:

$$BMI = \frac{\text{Body Weight (Kg)}}{\text{Height}^2\ (m^2)}$$

2.5 Measurement of Respiratory Rate and Peak Expiratory Flow Rate

The subjects were asked to remove their shirts and lie supine on the couch. The respiratory movement of the chest wall was observed for a few minutes as the chest increased and decreased its circumference. After noting a steady inspiratory and expiratory movement, the normal resting RR was counted (without the knowledge of the subject) for 1 minute, using a stop watch. The value was recorded as RR in cycles/minute. Peak expiratory flow rate was measured using the mini-Wright peak flow metre (Clement Clark International Ltd. Edinburgh way Harlow, Essex, CM20 2TT, England). The reading was taken thrice, and the highest of the three readings was recorded as the PEFR.

2.6 Statistical Analysis

Results are presented as mean ± SEM. Data analysis was done using SPSS version 17.0 and Microsoft Excel analyser (version 2010). One way analysis of variance (ANOVA) was employed in this study. Statistical significance was set at $p<0.05$.

3. Results and Discussion

Over the years, various researchers have worked on the relationship between body adiposity and pulmonary function. Obesity in particular was reported to inversely correlate with PEFR consequent upon the accumulation of adipose tissue in and around the respiratory structures [19]. Results of body weight showed that subjects aged 18 – 21, 22 – 25 and 26 - 30 years weighed 63.9 ± 0.9, 65.3 ± 0.05 and 67.1 ± 1.1 kg. Although body weight was higher in subjects aged 26 – 30 years compared with the other 2 age groups, this was not significant (Table 1). Also, there was no significant difference in the height of the subjects across the 3 age groups. Consequently, the calculated BMI was 21.95 ± 2.07, 22.33 ± 1.81 and 22.9 ± 2.20 kg/m^2, for subjects aged 18 – 21, 22 – 25 and 26 – 30 years respectively. Body mass index was significantly ($p<0.01$) higher in the group aged 26 – 30 years, compared with the group aged 18 – 21 years (Table 1). However, the observed BMI in all 3 age groups in this study were within normal range consequent upon the CDC 2006 BMI classification. Based on the CDC 2006, weight status in adults are classified as follows: adults with BMI below 18.5 were classified as underweight, those who had BMI between 18.5 – 24.9 were classed as having normal weight while those with BMI between 25.0 – 29.9 and greater than 30 were termed overweight and obese, respectively [20-22]. Respiratory rate for subjects aged 18 – 21, 22 – 25, and 26 – 30 years was 20.2 ± 0.4, 19.3 ± 0.2 and 19.7 ± 0.4 c/min, respectively. Respiratory rate was significantly ($p<0.05$) lower in the group aged 22 – 25 years, compared with the group aged 18 – 21 years. Peak expiratory flow rate was not significantly different across the different age groups studied (Table 1).

A high blood pressure (BP), also called hypertension, is categorized as such when repeated measurements of BP gives a value equal to or above 140/90 mmHg, while prehypertension, the precursor to high blood pressure, is considered to be repeated readings of over 120/80 mmHg. Table 2 showed that systolic blood pressure (SBP) for subjects aged 18 – 21, 22 – 25 and 26 – 30 years was 124.9 ± 1.29, 125.6 ± 0.81 and 125.8 ± 1.51 mmHg respectively. SBP was not significantly altered across the different age groups in this study. Diastolic blood pressure (DBP) for subjects aged 18 – 21, 22 – 25 and 26 – 30 years was 72.2 ± 0.92, 73.6 ± 0.58 and 74.9 ± 1.00 mmHg respectively. DBP was significantly ($p<0.05$) higher in subjects aged 26 – 30 years, compared with subjects aged 18 – 21 years. There was no significant difference in the mean arterial pressure (MAP) of the subjects in the different age groups (Table 2).

The tendency for body weight to increase with increasing age is high. The pattern of increase in body weight is similar with BMI since height is relatively constant when one grows above 20 years of age. Body mass index therefore correlates positively with age. Results from our study showed a significant ($p<0.01$) weak positive correlation between BMI and age (Table 3). Table 3 also shows a significant ($p<0.001$) weak positive correlation between BMI with PEFR, and a significant ($p<0.05$) weak negative correlation between BMI and RR. Previous reports had indicated a rather strong positive correlation between BMI and PEFR. Ulger *et al* [23] and Hakala *et al* [24] had previously reported a significant positive correlation between BMI and PEFR in obese children and in obese patients with asthma respectively. The variation with our report may be as a result of the normal BMI recorded, compared to that reported by those researchers mentioned.

Observations made in this study show a weak positive correlation between BMI and MAP (Table 3). SBP and DBP also correlated positively with BMI, and were both significant ($p<0.001$). Other reports have shown varying differences. Earlier studies [25,26] reported a positive correlation between BMI, SBP and DBP, contrary to some reports [27,28] which showed no correlation between BMI and BP. The weak positive correlation between BMI and

Licensed Under Creative Commons Attribution CC BY

MAP observed in this study may be due to the fact that the BMI of the study population (students) is largely accounted for by body fat rather than muscle mass, since the population was drawn from non – athletes or non – exercising subjects. This is in contrast to athletes whose BMI is accounted for by muscle mass [29].

4. Conclusion

There was no incident of obesity within the population studied, while MAP increased with increasing age; a physiological variation. The results obtained from our study have also demonstrated the fact that there exists a relationship between BMI, cardiovascular and respiratory indices.

able 1: Anthropometric and respiratory parameters of the study population

Age (years)	*Height (m)*	*Weight (kg)*	*BMI (kg/m^2)*	*RR (c/min)*	*PEFR (L/min)*
18 – 21	1.7 ± 0.01	63.9 ± 0.9	21.95 ± 2.07	20.2 ± 0.4	559.4 ± 7.1
22 – 25	1.7 ± 0.00	65.3 ± 0.5	22.33 ± 1.81	19.3 ± 0.2*****	563.5 ± 4.5
26 – 30	1.7 ± 0.01	67.1 ± 1.1	22.9 ± 2.20[a]	19.7 ± 0.4	567.9 ± 7.9

*p = 0.05 vs 18 – 21years; a = p<0.01 vs 18 – 21years

Table 2: Blood pressure of the study population

Parameter	*Age (years)*		
	18 – 21 (n = 85)	*22 – 25 (n = 200)*	*26 – 30 (n = 65)*
SBP (mmHg)	124.9 ± 1.29	125.6 ± 0.81	125.8 ± 1.51
DBP (mmHg)	72.2 ± 0.92	73.6 ± 0.58	74.9 ± 1.00*****
MAP (mmHg)	89.7 ± 0.92	90.9 ± 0.59	91.9 ± 1.03

*p<0.05 vs 18 – 21years; N = 350

Table 3: Correlation of the different variables measured

Parameter	**Correlation (r)**	**P - value**
BMI vs Age	+ 0.164	*P<0.01*
BMI vs RR	– 0.034	*P>0.05*
BMI vs PEFR	+ 0.211	*P<0.001*
BMI vs SBP	+ 0.288	*P<0.001*
BMI vs DBP	+ 0.124	*P>0.05*
BMI vs Pulse rate	+ 0.049	*P>0.05*
BMI vs MAP	+0.216	*P<0.001*
Age vs MAP	+ 0.083	*P>0.05*

5. Acknowledgement

Authors hereby acknowledge the male students of University of Calabar who willingly participated in this study.

6. Competing Interest

Authors hereby declare that no competing interest(s) exist.

References

[1] Stamler J. Epidemiologic findings on body mass and blood pressure in adults. .*Annual Epidemiology*. 1991;(1): 347–362.
[2] Chan JM, Rimm EB, Colditz GA, Stampfer MJ, Willett WC. Obesity, fat distribution, and weight gain as risk factors for clinical diabetes in men. *Diabetes Care*. 1994;17(9):961-9.
[3] Colditz GA, Willett WC, Stampfer MJ, Manson JE, Hennekens CH, Arky RA, Speizer FE. Weight as a risk factor for clinical diabetes in women. *Am J Epidemiol*. 1990;132(3):501-513.
[4] Lowder SC, Brown RD. Essential cardiovascular regulation. *Amercan Journal of Medical Sciences*. 1975;58: 272-275.
[5] Strolls PJ and Rogers RM. Obstructive sleep apnea. *New England Journal of Medicine*. 1996;334: 99-104.
[6] Zerah F, Harf A, Perlememuter L, Larino H, Lorino A and Atlan G. Effects of obesity on respiratory resistance. *Chest*, 1993;103: 1470-1476.
[7] Bandyopadhyay A, Tripathy S, Kamal RB, Basak AK. Peak expiratory flow rate in college students of Uttar Pradesh, India. *Indian Biologist*. 2007;39(1): 71-75.
[8] Bandyopadhyay A, Bhattacharjee I, Dalui R, Pal S. Pulmonary function studies of healthy Non-smoking male University students of Kolkata, India- Revisited. *Malaysian Journal of Medical Sciences*, 2013;20(2): 17-24.
[9] Bandyopadhyay A. Pulmonary function studies in young healthy Malayasians of Kelantan, Malayasia. *Indian Journal of Medical Research*, 2011;134: 653-657.
[10] American Thoracic Society: Standardization of Spirometry; 1994 Update. *American Journal of Respiratory Critical Care Medicine*, 1995;152: 1107-1136.
[11] Jain SK, Kumar R, Sharma DA. Peak Expiratory flow rates (PEFR) in healthy Indian adults: A statistical evaluation-I. *Lung India*, 1983;1(3): 88-91.
[12] Goldstein DJ. Beneficial health effects of modest weight loss. *International Journal of Obesity* 1992;16: 397–415.
[13] Pi-Sunyer FX. Short-term medical benefits and adverse effects of weight loss. *Ann International Medicine* 1993;119: 722–726.
[14] Bosello O, Armellini F, Zamboni M and Fitchet M. The benefits of modest weight loss in type II diabetes. *International Journal of Obesity*, 1997;**21** (Suppl 1): S10–SS3.
[15] Friedman GD, Selby JV, Quesenberry CP, Armstrong MA, Klatsky AL. Precursors of essential hypertension: body weight, alcohol and salt use, and parental history of hypertension. *Prev Med* 1988;17: 387–402.
[16] Yong LC, Kuller LH, Rutan G, Bunker C. Longitudinal study of blood pressure: changes and determinants from adolescence to middle age. The Dormont High School follow-up study 1957–1963 to 1989–1990. *American Journal of Epidemiology*, 1993;138: 973–983.
[17] Huang Z, Willett WC, Manson JE. Body weight, weight change, and risk for hypertension in women. *Ann International Medicine*, 1998;128: 81–88.
[18] Ibu JO, Ani EJ, Ofem OE, Enwerem CU, Okiyi N. Assessment of body mass index (BMI) in teenagers in Calabar, Nigeria. *Global Journal of Medical Sciences*. 2006; 5(2): 73–77.
[19] Naimark and Chemaick. Compliance of the respiratory system and the components in health and obesity. *Journal of Applied Physiology*, 1998; 15:377-382.
[20] Centers for Disease Control and Prevention (2009). Adult BMI Retrieved August 10 2009, from

Licensed Under Creative Commons Attribution CC BY

http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html

[21] Barlow S & Expert Committee (2007). Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: Summary report. *Pediatrics*, 120, S164-S192.

[22] Barlow SE, Dietz WH. Obesity evaluation and treatment: expert committee recommendations. *J Pediatr*. 1998; 102(3): e29.

[23] Ulger Z, Demir E, Tanac R, Gokpen D, Gulen F. the effects of childhood obesity on respiratory function tests and airway hyper-responsiveness. *The Turkish Journal of Pediatrics.* 2006; 48(1): 43-50.

[24] Hakala K, Stenius-Aarniala B, Sovijarvi A. Effects of weight loss on peak flow variability, airways obstruction, and lung volumes in obese patients with asthma. Chest 118,1315-21.

[25] Kadiri S, Walker O, Salako BL, Akinkugbe O. Blood pressure, hypertension and correlates in urbanized workers in Ibadan, Nigeria: a revisit. *J Hum Hypertens* 1999; 13: 23-27.

[26] Njelekela M, Negishi H, Nara Y, Tomohiro M, Kuga S, Noguchi T et al. Cardiovascular risk factors in Tanzania: a revisit. *Acta Trop* 2001; 79: 231-239.

[27] Alexander JK, Dennis EW, Smith WC. Blood volume, cardiac output and distribution of systemic blood flow in extreme obesity. *Cardiovascular Research Centre Bulletin.* 1962;1: 33.

[28] Taylor CK. Blood pressure study (Letter). *Pediatrics*, 1995; 66(6): 1083-1084.

[29] Jeukendrop A, Gleeson M. Sports nutrition. *Human Kinetics.* 2005; 894: 134-136.

Licensed Under Creative Commons Attribution CC BY