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Health Status Assessment of Young Adults Using Body Mass Index, Blood Pressure Indices and Peak Expiratory Flow Rate: A Case Study in Iwo, Osun State, Nigeria

O.I. OLURANTI[++], F.O. AWOBAJO*, D.S. AROKOYO, T.O. EMMANUEL, E.O. AYANGOKE, O.S. MICHAEL, L.D. ADEDAYO, O.O. ONASESO, J.O. YESUFU**, A.O. OJO, O. BAMIDELE

Department of Physiology, Bowen University, Iwo, Osun State, Nigeria

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Abstract: Introduction: Health issues involving the cardiovascular system and metabolism are among the cause of adverse medical conditions. Therefore, identifying the links among the risk factors can help reduce morbidity related to the associated diseases. **Methods:** A cross-sectional study involving hundred and fifty-one young adults in Iwo, Osun state, Nigeria. Blood pressure, pulse rate, rate pressure product, body mass index and peak expiratory flow rate were assessed according to standard procedures. **Results:** Overweight male are 2.65% while 3.65% of female are overweight. Grade I and II obesity of 8.61%, 19.21% and 11.92%, 11.26% was recorded in male and female participants respectively. Grade III obesity of 19.86% and 21.85% was recorded in male and female participants respectively. Blood pressure report showed that while 15.23% of male and 23.81% of the female participants had normal blood pressure values, 30.46% of male and 21.19% of female fell under pre-hypertension stage. 3.97% of male and 4.64% of female participants were at stage 1 hypertension. The females had lesser PEFR compared with the males. Body mass index was positively correlated with systolic and diastolic blood pressure. The correlation between PEFR and blood pressure was statistically significant. **Conclusion:** Early clinical detection of cardio-metabolic disease tendencies in young adults with prompt medical intervention will prevent the occurrence of the disease in adulthood.

Keywords: Body Mass Index, Pre-Hypertension, Young Adult

1. INTRODUCTION

Obesity presents an increasing threat to the health of the populations in a number of countries with its attendant cardiovascular diseases (CVDs) responsible for over 31% of all death annually and worldwide (Dua *et al.*, 2014). In 2016, over 1.9 billion adults aged 18 and up were overweight, with over 650 million of those being obese (WHO, 2020). Obesity and overweight are becoming more common in developing countries due to change in lifestyle (Barbosa *et al.*, 2012; Ani and Uvere, 2014). The use of BMI has been used to monitor the obesity epidemic that started in the 1980s and continued until the end of the century. High body mass index (BMI) may be linked to hypertension-related morbidity and mortality, as well as other chronic diseases (Mungreiphy *et al.*, 2011).

High blood pressure (HBP) is a non-communicable disease, and a cause of cardiovascular dysfunction, which is linked with high mortality and morbidity. The disease is a hidden danger to people's health around the world, affecting up to one-third of the global population (Alwan, 2011). Many uncontrollable risk factors play a role in the recorded increase in high BP among the populace. While there are uncontrollable factors such as heredity, race, salt sensitivity, age, and gender; diet, weight gain and obesity, stress levels, sodium consumption, physical inactivity, and the use of some medications are all factors that can be regulated (Clark *et al.*, 2012). The 7th Joint National Committee on Prevention, Detection, Evaluation, and Treatment of Hypertension coined the word pre-hypertension to describe a new type of blood pressure. A systolic blood pressure of 120 to 139 mmHg and/or a diastolic blood pressure of 80 to 89 mmHg, according to the commission, is indicative of a pre-hypertensive condition (Chobanian *et al.*, 2003). Patients who are pre-hypertensive have a greater risk of developing hypertension later in life, as well as an elevated risk of cardiovascular complications, regardless of other risk factors (Gyamfi *et al.*, 2018). The rate pressure product is an easily observable index that defines the response of coronary circulation to myocardial metabolic demands and correlates well with myocardial oxygen demand (Cockcroft *et al.*, 2005). The Rate Pressure Product is used to calculate the amount of energy required and the amount of stress placed on the heart during exercise. It is a measurement of myocardial oxygen consumption (MVO2) (Rishu *et al.*, 2013; Sembulingam *et al.*, 2015) that represents the internal

[++]Corresponding author: Email: olufemi.oluranti@bowen.edu.ng Tel. No: 08053416937
*Department of Physiology, University of Lagos, Nigeria
**Department of Physiology, University of Ibadan, Nigeria

myocardial workload when the heart beats, while the external myocardial function reflects different stages of exercise (Fornitano and Godoy, 2006). One of the most relevant parameters of pulmonary function research is peak expiratory flow rate, which is used as a clinical instrument for the diagnosis, treatment, and follow-up of respiratory diseases (Ani *et al.,* 2014). The highest expiratory flow rate achieved with a maximally forced effort from a position of maximum inspiration, expressed in liters/min, is known as the peak expiratory flow rate (PEFR) (Dharamshi *et al.,* 2015). PEFR means that the bronchi and larger bronchioles are constricted reflexively. Height, weight, BMI, gender, chest circumference, and malnutrition are all factors that affect PEFR values (Gulla and Kabra, 2017).

Most of the cardiovascular dysfunctions are preventable through healthy lifestyle interventions (Chiuve *et al.,* 2006). Therefore the identification of these risk factors (heart rate, body mass index, blood pressure and peak expiratory flow rate) in younger generation is crucial to prevent the development of non communicable diseases. However, these risk factors which are non-invasive and practicable for community health assessment were assessed among young adults in Iwo, Osun state, Nigeria.

2. MATERIALS AND METHODS

2.1. Participant

This was a cross sectional study that involved 151 young adults (76 males and 75 females) in Iwo, Osun State, Nigeria. The participants were between 17-25 years who consented and participated in this study. The result collation and analysis were done at the department of Physiology, Bowen University, Iwo. Approval of the study was obtained from the College of Health Sciences, Bowen University ethical committee.

2.2. Inclusion and Exclusion criteria

Smoker, alcoholics and those on drugs (either prescribed or not) were excluded

2.3. Data collection

Anthropometric parameters, Height (m) and Weight (Kg) were measured. BMI was calculated by dividing body mass (kg) by body height squared (m^2) and was categorized into different grades of normal, overweight and grade I, II, III obesity using the criteria given by World Health Organization. Pulse rate and Blood pressure were measured by palpitation and a sphygmomanometer respectively. A peak flow meter was used to calculate the peak expiratory flow rate. Rate pressure product was calculated by multiplying heart rate and systolic pressure.

After the subject sat for 5 minutes with his or her back supported, feet on the floor, and right arm supported, blood pressure was taken. The sphygmomanometer used was an Accoson sphygmomanometer with a cuff that fit the size of the adolescent's upper arm. The stethoscope was mounted over the brachial artery pulse, proximal and medial to the cubital fossa, and about 2 cm above the cubital fossa, below the bottom edge of the cuff. The systolic and diastolic pressures heard by the stethoscope were recorded. Sample collection was carried out in the morning.

2.4. Statistical analysis

Data were analyzed by two way ANOVA using SPSS version 12 and presented as mean ± SEM. P values were considered significant at the level of $\alpha = 0.05$. Pearson Chi-square was used for correlation analysis.

3. RESULTS

Table 1: Participants BMI compared with the distribution according to WHO classification

Participants parameters	Male participant	Female participant	**WHO designation** (WHO, 1997)	**BMI (kg/m^2)**
Body weight (kg)	69.41 ± 13.38	64.41 ± 14.74	Underweight	< 18.5
Height (m^2)	1.73 ± 0.07	1.63 ± 0.08	Normal range	18.5 – 24.9
BMI (kg/m^2)	39.99 ± 7.08	39.51 ± 8.38	Overweight (Pre-obese)	25.0 – 29.9
			Grade I obesity	30.0 – 34.9
			Grade II obesity	35.0 – 39.9
				≥ 40.0

BMI classification (kg/m^2) By WHO	Male (n = 76)	Female (n = 75)	% Distribution	
			Male	Female
Underweight (< 18.5)	-	-	0.00	0.00
Normal range (18.5 – 24.9)	-	1.00	0.00	0.66
Overweight / Pre-obese (25.0 – 29.9)	4.00	6.00	2.65	3.97
Grade I obesity (30.0 – 34.9)	13.00	18.00	8.61	11.92
Grade II obesity (35.0 – 39.9)	29.00	17.00	19.21	11.26
Grade III obesity (≥ 40.0)	30.00	33.00	19.86	21.85

SBP = systolic blood pressure; DBP = diastolic blood pressure (Bethesda, 2004)
From table 2, 2.65% of male were overweight while 3.65% of female were overweight. Grade I obesity of 8.61% and 11.92% for male and female respectively. Grade II obesity of 19.21% and 11.26% for male and female participants respectively. Grade III obesity of 19.86% for male and 21.85%.

Table 2: Blood pressure parameters in participants and their distribution according to JNC VII

Parameters	**Male**	**Female**	**Blood pressure distribution according to JNC VII**			
			Normal	**Pre-hypertension**	**Stage 1 hypertension**	**Stage 2 hypertension**
PR (bpm)	71.18 ± 0.95	78.26 ± 1.47				
SBP (mmHg)	123.40 ± 1.51	116.30 ± 1.34	< 120	120 - 139	140 - 159	≥ 160
DBP (mmHg)	76.63 ± 1.24	72.84 ± 1.12	and < 80	or 80 - 89	or 90 - 99	or ≥ 100
RPP (mmHg*bpm)	8805 ± 184.80	9133 ± 223.70				

Blood pressure classification (mmHg)	**Male (n = 76)**	**Female (n = 75)**	**Total mean (N = 151)**	**% Distribution**	
				Male	**Female**
Normal	23.00	36.00	29.50 ± 9.19	15.23	23.81
Pre-hypertension	46.00	32.00	39.00 ± 9.90	30.46	21.19
Stage 1 hypertension	6.00	7.00	6.50 ± 0.71	3.97	4.64
Stage 2 hypertension	1.00	0.00	0.50 ± 0.71	0.66	0.00

SBP = systolic blood pressure; DBP = diastolic blood pressure (Bethesda, 2004)
PR = pulse rate; SBP = systolic blood pressure; DBP = diastolic blood pressure; RPP = rate pressure product.
The values of SBP and DBP were higher in male than female while PR and RPP were lower in male than female.
15.23% (23) of male and 23.81% (36) of female had normal blood pressure values. However, 30.46% of male and 21.19% of female fell under pre-hypertension while 3.97% of male and 4.64% of female are at stage 1 hypertension. The distribution showed only 0.66% of male have stage 2 hypertension

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Table 3: Relationship between the BMI and blood pressure distribution / percentage distribution of the participants

BMI classification (kg/m^2)	Normal		Pre-hypertension		Stage 1 Hypertension		Stage 2 Hypertension	
	Male	Female	Male	Female	Male	Female	Male	Female
Underweight	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
Normal	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	1.00 (0.66%)	0.00 (0%)	0.00 (0%)
Overweight / Pre-obese	2.00 (1.33%)	1.00 (0.66%)	1.00 (0.66%)	2.00 (1.33%)	1.00 (0.66%)	3.00 (1.99%)	0.00 (0%)	0.00 (0%)
Grade I obesity	7.00 (4.64%)	9.00 (5.96%)	5.00 (3.31%)	7.00 (4.46%)	1.00 (0.66%)	2.00 (1.33%)	0.00 (0%)	0.00 (0%)
Grade II obesity	9.00 (5.96%)	11.00 (7.29%)	20.00 (13.25%)	6.00 (3.97%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
Grade III obesity	6.00 (3.97%)	15.00 (9.93%)	21.00 (13.91%)	17.00 (9.27%)	2.00 (1.33%)	1.00 (0.66%)	1.00 (0%)	0.00 (0%)

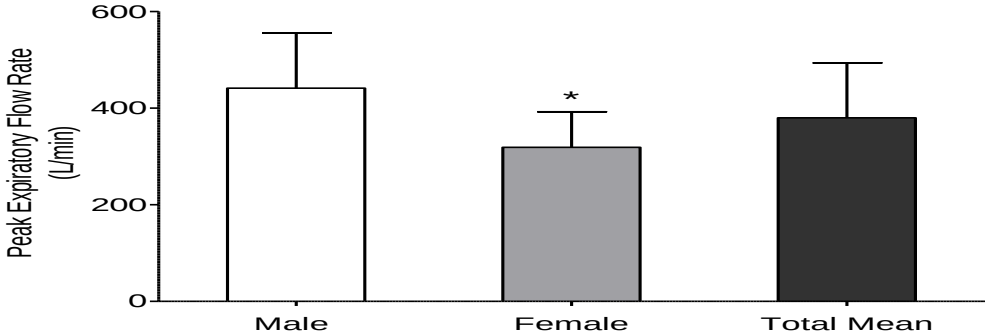

Fig. 1: Peak expiratory flow rate (PEFR) of the participants

Each bar represents mean ± Standard Deviation.

* = significant difference when compared with the male participants at $p < 0.05$.

Note: PEFR (L/min) for the male and female participants were 441.10 ± 13.11 and 318.80 ± 8.43 respectively ($p < 0.0001$; $t = 7.851$; $F = 2.417$). The value for the total mean of PEFR = 379.90 ± 113.70. The females had lesser PEFR compared with the males

Table 4: Correlation between BMI and Blood pressure indices; PEFR and Blood pressure indices of the participants

Variables	r	P	Variables	r	p
BMIvs RPP	0.08	0.3153	PEFRvs RPP	0.00	0.9972
BMI vs SBP	0.33	<0.0001*	PEFR vs SBP	0.18	0.0280*
BMI vs DBP	0.28	0.0005*	PEFR vs DBP	0.18	0.0280*
BMI vs PR	-0.14	0.0950	PEFR vs PR	-0.13	0.1037
BMI vs PEFR	0.13	0.1142			

Pearson correlation (2 tailed). * = correlation is significant at the 0.05 level.

The body mass index (BMI), pulse rate (PR) and peak expiratory flow rate (PEFR) showed no correlation.

The systolic and diastolic blood pressures were positively associated with BMI. Peak expiratory flow rate (PEFR), rate pressure product (RPP) and pulse rate (PR) and were not correlated.

The correlation between PEFR and blood pressure (SBP and DBP) is statistically significant, even though the r value showed no correlation.

4. DISCUSSION

Male participants had greater height and weight on average than their female counterparts. This was also observed by Aliyu *et al.* (2014) This may be due to a variation in bone density between males and females, with males' bones being denser. In both clinical and epidemiological research, the body mass index (BMI) is the most basic and suitable tool for measuring relative body fatness, and it was recommended as a common criterion of overweight and obesity (World Health Organization, 2014). Out of the 151 participants, 2.65%

of male were overweight while 3.65% of female were overweight; male and female grade I obesity rates were 8.61 % and 11.92 %, respectively.; male and female grade II obesity rates were 19.21% and 11.26% respectively and grade III obesity of 19.86% for male and 21.85% **(Table 2).** The prevalence of overweight/obese in this study was similar to that of undergraduate medical students from a medical college in Tamilnadu, Indian where 24% of overweight and 9.3% obese were reported (Mani, 2014). However, this prevalence varies with some other findings among undergraduate and adolescents both in Nigeria and abroad (Ansa *et al.,* 2010; Kumar *et al.,* 2014; Manchukonda and Srivastava, 2015; Solomon *et al.,* 2017). Females were found to be more overweight and obese than males in this study, which is consistent with previous findings and has been attributed to hormonal changes as a result of puberty, which are normally more rapid and pronounced in females (Yadav *et al.,* 2016). High prevalence of obesity among students and young adult could be due to adopting unhealthy life styles and indulging in fast food and fried items (Manojan *et al.,* 2014) as positive association between junk food and BMI have been reported (Shah *et al.,* 2014). Furthermore, relative to men, females who were malnourished as children are more likely to be obese (Schneider *et al.,* 2010). Obesity in childhood is a risk factor for adulthood obesity, and children who are overweight or obese as children are more likely to be obese as adults (Strong *et al.,* 2008).

Owing to the link between obesity and other cardiovascular risk factors, especially hypertension, the rising prevalence of obesity in childhood and adolescence is a major cause for concern (Oluremi *et al.,* 2017). The body mass index (BMI) and blood pressure (SBP and DBP) of male participants were found to be significantly associated in this research. This research confirms what several other studies have found: being overweight in adolescence is closely linked to elevated systolic and diastolic blood pressure. (Ogboye, 2012; Ujunwa *et al.,* 2013). Epidemiological investigators also reported significant positive correlation of BMI with SBP and DBP (Ferguson *et al.,* 2008; Wang *et al.,* 2010). This may be due to a rise in overall blood volume and cardiac production caused in part by increased caloric demand induced by excess body weight and obesity, which could also increase peripheral vascular resistance and sympathetic nervous function (Poirier *et al.,* 2005). Increases in body weight (BMI) have an effect on adipocyte function and adipokine secretion (Leptin and adiponectin). Hypertension and other cardiovascular diseases are influenced by these adipokines (Selthofer-Relatić *et al.,* 2012). Male participants had higher mean systolic and diastolic blood pressure than female participants, which is consistent with Mungreiphy *et al.* (2011) and Aliyu *et al.* (2014). Several studies have shown that males have a higher proportion of hypertension than females (Al-Majed and Sadek, 2012; Aounallah-Skhiri *et al.,* 2012).

In this study, the height and peak expiratory flow rate (PEFR) values were higher in males than in females. These findings corroborate earlier reports (Mishra *et al.,* 2013; Jangam *et al.,* 2014). PEFR has previously been significantly linked to height and weight (Dharamshi *et al.,* 2015). However, no correlation between PEFR, blood pressure indices and body mass index in this study. Safer rate pressure product (RPP) values should be between 7.00 and 9.00 at rest. Any RPP total value greater than 10,000 (10.00) indicates a higher risk of heart disease (Fletcher *et al.,* 1979). RPP is thought to be cardio-protective because it indicates more parasympathetic nerve activity and increased parasympathetic tone (Figuero *et al.,* 2012). As a result, males seem to be safer than females, with more parasympathetically mediated cardio-protection. In this study, males had a lesser RPP than females. Males have lower RPP with lower BMI and HR, which protects them from stress-induced cardiovascular problems, according to a previous study (Sembulingam *et al.,* 2013).

As a result, hypertension, overweight, and obesity tendencies in young adults may be a subject public health concerns. In this area, intensive medical education and knowledge of risk factors through campaigns aimed at alleviating or preventing hypertension and obesity are therefore critical. Also the quality of service provided in hospitals should increase to boost better understanding and management of these ailments.

REFERENCES:

Aliyu S. U, J. T. Ahmad, A.Y. Oyeyemi (2014) Relationship Between Body Mass Index And Blood Pressure Among University Students In Maiduguri, Nigeria International Journal of Recent Advances in Multidisciplinary Research: 01(11); 091-096

Al-Majed H T. and AA. Sadek (2012) Pre-hypertension and hypertension in college students in Kuwait: a neglected issue. J Family Commun Med.; 19:105Pp

Alwan A., D. R. MacLean and L.M. Riley, (2010) Monitoring and surveillance of chronic non-communicable diseases: progress and capacity in high-burden countries. The Lancet; 376: 1861-1868

Ani E. J., C. O. Nku V.U. Nna and J. N. Nwangwa (2014) Relationship between Body Mass Index, Blood

Pressure and Respiratory Indices among Male Students of University of Calabar, Cross River State, Nigeria International Journal of Science and Research (IJSR); 3(12): 2028-2031

Ani P. N, and P.O. Uvere (2014) Prevalence of overweight, obesity and thinness among adolescents in rural and urban areas of Enugu State , Nigeria. Int J Basic Appl Sci; 3(1): 1–7.

Ansa V.O., M. U. Anah F.A. Odey P.N. Mbu E.I. Agbor (2010) Relationship between Parental Socio-economic Status and Casual Blood Pressure in Coastal Nigerian Adolescents. West Afr J Med; 22; 29(3).

Aounallah-Skhiri H., J. El Ati and P. Traissac (2012) Blood pressure and associated factors in a North African adolescent population. A national cross-sectional study in Tunisia. BMC Public Health. 2012; 12:98.

Barbosa Filho V.C., W. de Campos R. Bozza and S. Lopes (2012) The prevalence and correlates of behavioral risk factors for cardiovascular health among Southern Brazil adolescents: a cross-sectional study. BMC Pediatr.; 12, 130. https://doi.org/10.1186/1471-2431-12-130

Bethesda, A. (2004). The seventh report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC VII). https://www.ncbi.nlm.nih.gov/books/NBK9633/ (Accessed 27 March 2019).

Chiuve S.E., M.L. McCullough and F. M. Sacks (2006) Healthy Lifestyle Factors in the Primary Prevention of Coronary Heart Disease Among Men. Circulation; 114(2):160–7.

Clark C.E., R.S. Taylor A. C. Shore, and J.L. Campbell (2012) The difference in blood pressure readings between arms and survival: primary care cohort study. Br Med J; 344:1-13.

Cockcroft J.R., I.B. Wilkinson M. Evans P. McEwan J.R. Peters S. Davies, M.F. Scanlon and C.J. Currie (2005) Pulse pressure predicts cardiovascular risk in patients with type 2 diabetes mellitus. Am J Hypertens; 18(11):1463-1467.

Dharamshi H.A., A. Faraz E. Ashraf S.S. Alam A. Ali Q. Shakeel M.A. Abidi, S.S. Rizvi Z. Fatima H.A. Wasy F. Fatima M. Mahar and T Naqvi (2015). Variation of PEFR with Height, Weight and Waist-Hip Ratio in Medical Students. International achieves Of medicine; 8 (2015). http://dx.doi.org/10.3823/1683

Dua S, B., M. P. Sharma M. Dhall and S. Kapoor (2014) Body mass index relates to blood pressure among adults. North Am J Med Sci;6:89-95.

Ferguson T. S., N. O. Younger M.K. Tulloch-Reid M.B. Wright E.M. Ward and D.E..Ashley (2008) Prevalence of pre-hypertension and its relationship to risk factors for cardiovascular disease in Jamaica: Analysis from a cross- sectional survey. BMC Cardiovasc Disord; 8:20. https://doi.org/10.1186/1471-2261-8-20

Figuero M. A., R. E. Demeersman and J. Manning (2012) The autonomic and rate pressure product responses of tai chi practitioners. N Am J Med Sci 4: 270-275.

Fletcher G. F., J. D. Cantwell and W. Watt (1979) Oxygen consumption and hemodynamic response of exercises used in training of patients with recent myocardial infarction. Circulation; 60: 140-144).

Fornitano L.D., and M. F. Godoy (2006) Increased rate-pressure product as predictor for the absence of significant obstructive coronary artery disease in patients with positive exercise test. Arquivos brasileiros de cardiologia 86:138-44.

Gulla K.. S.K. Kabra (2017) Peak Expiratory Flow Rate as a Monitoring Tool in Ashma Indian J Pediatr DOI 10.1007/s12098-017-2398-x

Gyamfi D., C. Obirikorang E. Achaempong K. O. Danquah E.A. Asamoah and F. Z. Liman (2018). Prevalence of pre-hypertension and hypertension and its related risk factors among undergraduate students in a tertiary institution, Ghana. Alexandria Journal of Medicine; 54 (2018): 475-480

Jangam S., D. Sangeeta and R.H Taklikar (2014) A comparative study of peak expiratory flow rate and anthropometry in college students of same age group Int. J. Bioassays; 3 (3): 1881-1883

Kumar C. A., N. Revannasiddaiah A. Gopi, and V.H. Nanjundappa (2014) A cross-sectional study on the dietary factors and their association with body mass index among undergraduate medical students in a medical college. Int J Res Health Sci; 2(2):591-8.

Manchukonda R. and A. Srivastava (2015) Estimation of body mass index and risk evaluation of diabetes and cardiovascular diseases in undergraduate students. Int J Res Med Sci ;3(9):2410-8.

Mani G. (2014) Assessment of body mass index and its associated nutritional factors among undergraduate medical students in Tamil Nadu, India: A cross sectional study. J Pioneer Med Sci.; 4(3):137-42.

Manojan K. K., P. V. Benny and A. Bindu (2014) Prevalence of obesity and overweight among medical students based on new Asia pacific BMI guidelines. Int J Prevent Therap Med.; 2(1):15-7.

Mishra J., S. Mishra, and S. Satpathy (2013) Variations in PEFR among Males and Females With Respect To Anthropometric Parameters (IOSR-JDMS. e-ISSN: 2279-0853, p-ISSN: 2279-0861; 5(1): 47-50

Mungreiphy, N., K.. Satwanti, and S. Rashmi (2011). Association between BMI, Blood Pressure, and Age: Study among Tangkhul Naga Tribal Males of Northeast India. Journal of Anthropology; 748147: 1-6.

Ogboye OA. (2012) Blood Pressure and its Correlates in Children and Adolescents in Urban Nigeria. http://go.warwick.ac.uk/wrap (Accessed 27 March 2019)

Oluremi O. S., E.E. Eyitayo A.S, Olusoji O.A, Eyitope and A. Olukemi (2017) Association between High Body Mass Index and High Blood Pressure among Adolescents in Ado-Ekiti, Ekiti State, Nigeria Public Health Research; 7(4): 85-90

Poirier P., I. Lemieux P. Mauriege E, Dewailly C, Blanchet J. Bergeron and J.P. Despres (2005) Impact of waist circumference on the relationship between blood pressure and insulin: the Quebec Health Survey. Hypertension; 45:363-367.

Rishu S, V. Gupta L, Walia and N, Mittal (2013) Rate pressure product predicts cardiovascular risk in type 2 diabetics with cardiac autonomic neuropathy. Nat J Physiol, Pharma and Pharmacology; 3: 43–47

Schneider H. J., N. Friedrich J. Klotsche L. Pieper M. Nauck U. John M. Dörr . S. Felix, H. Lehnert and D Pittrow (2010) The predictive value of different measures of obesity for incident cardiovascular events and mortality. J Clin Endocrinol Metab.; 95: 1777-1785.

SelthoferRelatić K., D. Divković, R. Radić V. Vizjak R. Selthofer and R Steiner (2012) Overweight – early stage of "adipokines related cardiovascular disease s": leptin and adiponectin relation to anthropometric parameters. Med GlasLjekkomore Zenicko-dobojk antona; 9:198-203.

Sembulingam P., K. Sembulingam, and G. Mohesh. (2013) Gender differences in body mass index and blood pressure among normal healthy undergraduate students. Int J Med Res Health Sci.; 2(3):527-532.

Sembulingam P., K, Sembulingam S, Ilango and G. Sridevi (2015) Rate pressure product as a determinant of physical fitness in normal young adults. IOSR-JDMS 1: 8-12.

Shah T., G. Purohit S.P. Nair B. Patel Y. Rawal and R.M. Shah (2014) Assessment of obesity, overweight and its association with the fast food consumption in medical students. J Clin Diagno Res.:8(5): 5-7.

Solomon O. O., E. E. Emmanuel, O. Abidemi Solomon, Eyitope and O. Amu, Amodu (2017) Association between High Body Mass Index and High Blood Pressure among Adolescents in Ado-Ekiti, Ekiti State, Nigeria Public Health Research 2017, 7(4): 85-90

Strong K. A., S.L. Parks E. Anderson R. Winett and B.M. Davy (2008) Weight gain prevention: Identifying theory-based tar-gets for health behavior change in young adults. Journal of the American Dietetic Association; 108:170815.

Ujunwa F.A., A.N. Ikefuna ARC. Nwokocha and J.M. Chinawa (2013) Hypertension and prehypertension among adolescents in secondary schools in Enugu, South East Nigeria. Ital J Pediatr; 39(1):70.

Wang H., J. Cao J. Li J, Chen X, Wu and X, Duan (2010) Blood pressure, body mass index and risk of cardiovascular disease in Chinese men and women. BMC Public Health; 10:189.

World Health Organization, (2014). Obesity and overweight. Fact sheet. No 311.Geneva

World Health Organization (1997). Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation on Obesity. Geneva: World Health Organization. 1997.

World Health Organization.World health Report (2020): Overweight and Obesisty. Geneva, Switzerland: World Health Organization; 2020

Yadav S. S., P. Saini, Z. A. Khan, T. Bachloo, R. Kumar and J. Singh (2016) Assessment of Body Mass Index among undergraduate medical students-a cross sectional study from the medical college of Haryana. Int J Med Sci Public Health; 5(4):705-8.