Full Length Research Paper

Correlation of body mass index (BMI) with hematological indices and procoagulants among people with obesity in Sapele, Southern Nigeria

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Obesity occurs when Body Mass Index (BMI) of an individual is above 30.0 with several effects on hematological indices and procoagulants hence, this study aims to evaluate correlation of BMI with hematological indices and procoagulants among people with obesity. This was a cross sectional and descriptive study carried out at Central Hospital, Sapele, General Hospital, Oghara and Biomed Diagnostic Centre, Sapele in Southern Nigeria. 415 subjects with age between 18 and 65years were enrolled for this study including 312 obese experimental subjects (comprising of 111males and 201females) and 103 non-obese normal control subjects (comprising 40males and 63females). 5.0mls of venous blood was collected from all subjects into EDTA container for Full Blood Count determination using Sysmex XN330 automated hematology analyzer and plasma procoagulant level was determined using ELISA method. Data analysis was done using Microsoft Excel 2010 and Statistical Package for Social Sciences (IBM SPSS) version 21.0 software. The collated results were expressed as mean and standard deviation. BMI had a significant correlation with NLR at P<0.05 while PLR, MPV, PDW and Platocrit had no significant correlation with BMI. Correlation matrix of the relationship between BMI and procoagulant parameters reveals that, BMI had significant correlation with TF, sVCAM, and vWFAg at P<0.05. While, FG, tPA and PAI had no significant correlation with BMI at P<0.05. BMI had significant correlation with NLR, TF, sVCAM, and vWFAg while PLR, MPV, PDW, Platocrit, FG, tPA and PAI had no significant correlation with BMI among people with obesity.

Key words: Body mass index (BMI), hematology indices, procoagulants, Sapele, Nigeria.

INTRODUCTION

Body mass index (BMI) is a simple and widely acceptable method for estimation of body fat accumulation (Mei et al., 2002). BMI was formulated in the 19th century by Adolphe Quetelet in 1871. BMI has become an accurate

reflection of body fat percentage in majority of adult population. However, it is less accurate in body builders and pregnant women (NHLBI, 2013). BMI is calculated by dividing body weight (kg) by square of height (kg/m^2) of an individual. Classification of BMI is such that, a person with BMI of < 18.5 kg/m^2 is considered to be underweight while BMI of 18.5 to 24.9 kg/m^2 is termed normal weight and BMI > 25.0 kg/m^2 is overweight in adult. Obesity is said to set in when the BMI of an individual is 30.0 kg/m^2 (Sturm, 2007).

Obesity is a complex medical problem with multifaceted and interrelated causes. It is also a medical condition in which excess body fat has accumulated to the level that it has an adverse effect on health (Friedman, 2019). Uncontrolled body weight gain is associated with many chronic diseases such as: cardiovascular diseases, type 2 diabetes mellitus, asthma and others. Obesity results in low life expectancy and low economic productivity globally (Haslam and James, 2005). A combination of too much calories intake and sedentary life style are the major causes of obesity, which ultimately results in the formation of excess adipose tissue either in the visceral or in the subcutaneous cavity (Lau et al., 2007). However, few cases are due principally to hereditary (Bleich et al., 2008).

In obesity, damaged to the endothelial barrier and vessel injury as a result of chronic inflammation leads to exposure of extravascular tissue factor to its ligand factors and results in rapid activation of clotting cascade that contributes to thrombosis and alteration of procoagulant such as: TF, soluble Vascular Cell Adhesion Molecules (sVCAM), and von willebrand factor Antigen (vWFAg), Fibrinogen (FG), tissue Plasminogen Activator (tPA) and Plasminogen Activator Inhibitor (PAI) (Hoffman et al., 2007).

Furthermore, obesity is an increasing trend in a developing country like Nigeria and it has remained a strong risk factor for build-up of chronic diseases with several impacts on hematological indices including neutrophil-lymphocyte ratio (NLR), platelet-lymphocyte ratio (PLR), platelet distribution width (PDW), and mean platelet volume (MPV) (Hoffman et al., 2007). In Nigeria, studies reviewed showed that the prevalence rate of overweight individuals is between 20.3 and 35.1%, while obesity is between the range from 6.0 to 22.2% (Kadiri and Salako, 2007; Innocent et al., 2013) giving a ratio of 1:2 between male to female, respectively. Adienbo et al. (2012) reported a general prevalence rate of 47.26% in the Niger Delta while Siminialayi et al. (2008) reported a prevalence rate of 16.3% in Okirika and 14% in Port Harcourt, River State, Nigeria and the prevalence of obesity in Sapele is not well documented.

Obesity and high BMI are considered as indicators of our health status in Nigeria and since hematological indices and procoagulant evaluation are key indicators of status (Haslam, 2007), therefore it is imperative to analyze the correlation of BMI with hematological indices and procoagulant in order to elucidate the pathophysiological effect of overweight among people with obesity in Sapele, Sourthern Nigeria. Nevertheless, whether or not environmental factor do contribute to obesity in Sapele remain unclear.

MATERIALS AND METHODS

This was a cross sectional and descriptive study carried out at Central Hospital, Sapele, General Hospital, Oghara and Biomed Diagnostic Centre, Sapele. A total of four hundred and fifteen (415) subjects were enrolled for the study. These include three hundred and twelve (312) obese subjects (comprising 111 males and 201 females), 103 non-obese subjects (comprising 40 males and 63 females) used as control.

Study area

Sapele is a city located in central part of Delta State, Nigeria. It is positioned at a height of 9 m above sea level at latitude 5.89° and longitude 5.68°. Sapele was established as a trading village in the mid-19th century, occasionally visited by the Europeans. The city had one of Nigeria major ports, though not working at the moment. Its industries' capacities include timber processing, rubber processing, palm oil factories, furniture, tamarind, balm and footwear manufacturing. The study work was carried out in Central Hospital, Sapele, General Hospital, Oghara and Biomed Diagnostic Centre, Sapele; these three facilities are all located within Sapele City and its environs.

Study population

Sapele has a population of about 174,273 (Population Census, 2006). Presently, the estimated population of Sapele is put at about 270,360 with different tribes consisting of Okpe, Urhobo, Itsekiri, Ibo, Ijaw, Isoko, Hausa, Edo, Yoruba, Ibibio, Nupe, Tiv, Fulani, etc. The main occupations are farming, factory and industrial worker, artisan, trading and civil service. The common diets are starch, yam, garri, rice, beans, plantain, palm oil, fish, meat, and periwinkle.

Sample size determination

Sample size estimation was determined using the formula as proposed by Araoye (2004).

$$N = Z^2 pq/d^2$$

where N = Minimum sample size, Z = Standard normal deviation set at 1.96 which corresponds to 95% confidence interval, and P = Proportion of the population estimated to have a particular characteristic d = degree of accuracy put as 0.05.

Calculation of sample size

The proportion of population estimate of obesity in studies done in Port Harcourt, River State is 14%, respectively (Siminialayi et al., 2008).

$$N = Z^2 pq/d^2$$

Z = 1.96, P = 14% (0.14), d = degree of accuracy set at 0.05, q = 1 − P = 1 - 0.14 = 0.86.
N = $[(1.96)^2 \times 0.14 \times 0.86] / (0.05)^2$

N = [3.84 × 0.14 × 0.86] / 0.0025
N = 0.462/0.0025
N = 185

To improve precision of the study, the estimated sample size (Ns)

Ns = 185/0.9
Ns = 205

The estimated minimum sample size is 205.
The sample size for the study was 312 obese individuals and 103 normal weight individuals as control.

Inclusion criteria

Obese adults within the age ranges of 18 and 65 years who reside in Sapele and its environ were recruited in the study.

Exclusion criteria

People that were critically ill and/or on any form of medication, pregnant women, hypertensive patients, patients with communicable and non-communicable diseases and those who refused consent where excluded from this study.

Height measurement

Height of a subject was measured by asking subject to wear light clothes and put off their shoes, hats or head gear and to stand with back to the tape measure then hold their head in a position where he or she can look straight at a spot, head high, on the opposite wall. A flat rule was placed on the subject's head, so that the hair, if present was pressed flat. Height was measured to the nearest meter (m) at the level where the flat rule touched the rigid tape.

Weight measurement

Weight was determined using a standiometer. Weight of a subject was measured by asking him or her to take off heavy outer garments, empty their pockets and step on the weighing scale and reading obtained from the scale reader.

Body mass index (BMI)

Body mass index was calculated at a ratio of an individual's weight (kg) to height (m^2). BMI categories were defined using the WHO (2005), which, cut points in units of kg/m^2, normal weight = 18.5 to < 25, overweight = 25 to < 30 and Obese ≥30.

Waist circumference

Waist circumference was obtained using flexible non stretching tape (Iloh et al., 2012). The subjects were asked to stand straight with arms at the side and feet together. The iliac crest and lower rib cage was first identified by palpation. The waist circumference was taken as the midpoint between the lower border of the lower rib cage and iliac crest in a horizontal plane parallel to the floor as proposed by Iloh et al. (2012).

Waist hip ratio (WHR)

Hip circumference was obtained by the use of a measuring tape to the nearest centimeter. The waist to hip ratio was obtained by dividing waist circumference by hip circumference.

Waist-Hip Ratio = Waist Circumference/Hip circumference

Waist height ratio (WHtR)

Waist height ratio was computed by the formula waist circumference divided by height.

Waist Height Ratio = Waist Circumference/Height

Sample collection

Venous blood (4.5 ml) was collected from all participants into EDTA container. The blood sample was analyzed within 1 h of collection using Sysmex XN330 automated hematology analyzer.

Ethical approval

Ethical clearance for this study was obtained from the ethics committee of Central Hospital, Sapele Medical Zone, Sapele on the 8th of December, 2016 with reference number SNZ/A.31VOL.3/54. Informed consent was also obtained from individuals as well as completed structured questionnaire.

Sample analysis

Full blood count (FBC) test

The EDTA sample was placed in a position where the aperture is immersed in the blood and the aspirator button was pressed. A suspension of blood cell passes through a small orifice simultaneously with an electric current. After measurement, the reading of the full blood count result containing hematological indices was displayed on the screen and result recorded.

Procoagulant test

Venous blood (4.5 ml) was collected and dispensed into EDTA container. Samples were further allowed to stand and centrifuge at 3000 rpm for 5 min to obtain plasma, which was kept at -20°F until time for analysis. The blood sample was later analyzed for various procoagulant using ELISA method.

Elisa method's principle

Standard solutions and samples were added to antibody specific pre coated micro-elisa stripplate wells, when combined with the specific antibody, then reacted with biotinylated detection antibody specific for correspondent human proagulant and Avidin-Horseradish Peroxidase (HRP) conjugate after incubation to produce specific colored solution with substrate solution, which changes color with the addition of stop solution. The Optical Density (OD) was measured spectrophotemetrically at wavelength of 450 nm. The OD value was proportional to the concentration of a given procoagulant in the plasma.

Data analysis

Data analysis was done using Microsoft Excel 2010 and Statistical

Table 1. Comparison of Mean ±SEM of procoagulant parameters between obese and control within the age 50-65 year group.

Variable	Obese (n=48) Mean ±SEM	Normal (n=20) Mean ±SEM	t-test	p-value
FG(ng/ml)	41.83±15.63	30.75±0.87	1.396	0.174
vWFAg(µ/l)	84.88±58.96	40.50±0.58	1.482	0.150
sVCAM(µ/l)	4.42±1.17	3.25±0.29	1.956	0.061
tPA(pg/ml)	229.83±82.54	192.50±20.21	0.887	0.383
PAI(pg/ml)	265.92±64.30	295.00±5.77	-0.890	0.382
TF(pg/ml)	74.54±20.05	62.50±14.43	1.144	0.263

**Significant ($p<0.01$), *Significant ($p<0.05$), †Not Significant.

Package for Social Sciences (IBM SPSS) version 21.0 software. The collated results were expressed as mean and standard deviation. Inferential analysis adopted includes: student t-test, correlation and two-way analysis of variance (ANOVA) followed by least significant different (LSD) post-hoc test for the obese. Statistical significance was set at $P>0.01$.

RESULTS

BMI had a significant correlation with Neutrophil-Lymphocyte Ratio (NLR) at $P<0.05$ while Platelet-lymphocyte Ratio (PLR), Mean Platelet Volume (MPV), Platelet Distribution Width (PDW) and Platocrit (Pcrit) had no significant correlation with BMI shown in Table 2. On the other hand, using the 2-tail ANOVA, the correlation matrix of the relationship between BMI and procoagulant parameters in the study group reveals that, BMI had a significant correlation with Tissue Factor (TF), soluble Vascular Cell Adhesion Molecules (sVCAM), and von willebrand factor Antigen (vWFAg) at $P<0.05$. While, Fibrinogen (FG), tissue Plasminogen Activator (tPA) and Plasminogen Activator Inhibitor (PAI) had no significant correlation with BMI at $P<0.05$ shown in Table 3. Nevertheless, Table 1 shows comparison of procaogulant between obese people and non-obese subjects.

DISCUSSION

Neutrophils lymphocytes ratio (NLR) had positive significant correlation with BMI, this implies that excessive weight gains increase NLR. Remember NLR is an index to evaluate inflammatory status of an individual and according to a report by Kim and Park (2008), obese subjects had an elevated circulating neutrophil levels and increased number of blood cytokines such as TNF-α, IL-1β, IL-8 and IL-6 in circulation due to persistent inflammation and tissue injury through antigenic presentation and secretion of chemokines, prostaglandins as well as leucotrienes (Ramos et al., 2003). In addition, excessive weight gain leads to altered changes in adipose tissue activity that induces increase production of inflammatory marker which in turn plays great responsibilities in the pathogenesis of metabolic syndrome in obesity. The correlation of BMI with NLR is in accordance with the reports of Yilmaz et al. (2015). On the other hand, Platelet-lymphocyte Ratio (PLR), Mean Platelet Volume (MPV), Platelet Distribution Width (PDW) and Platocrit (Pcrit) had no significant correlation with BMI in this study and the reason for this result is unclear.

However, vWFAg had positive correlation with BMI. This implies that weight gain increases plasma level of vWFAg. Studies carried out in mice by researchers found out that increased inflammatory cytokines induce depletion of anti-oxidant stores, up-regulation of adhesion molecules on lung endothelium and enhanced susceptibility of endothelium to injury, resulting in elevated vWFAg levels (Klein et al., 2008). The result in this study is in line with the result obtained by Guo et al. (2016).

Furthermore, soluble Vascular Cell Adhesion Molecules (sVCAM) also had a positive correlation with BMI. This implies that excessive weight gains increase plasma sVCAM level, which is consistent with report of previous study by Porreca et al. (2004) who observed that, obesity is involved in increased levels of sVCAM, which is an atherosclerostic marker, that represent essential markers for inflammatory processes involving activation of endothelial tissues (Porreca et al., 2004).

TF also had positive correlation with BMI. This implies that excessive weight gain leads to elevated plasma tissue factor levels in obese subject. This is in line with the findings of previous study by Wolfram and Fahumiya (2005), whose results showed that, coagulation activation following tissue factor upregulation in fatty body is common in obese people. The report further stated that inflammation and metabolic alteration increases TF expression in adipocytes and macrophages in people with obesity (Woznaik et al., 2009).

Conclusion

BMI had a significant correlation with NLR, TF, sVCAM,

Table 2. Correlation of BMI with some hematological indices.

Parameter	Correlation (r)	P value
BMI vs. NLR	0.024	0.024*
BMI vs. PLR	0.041	0.681[†]
BMI vs. MPV	0.O26	0.796[†]
BMI vs. PDW	0.037	0.710[†]
BMI vs. Pcrit	0.059	O.559[†]

**Correlation Significant (0.01), *Correlation Significant (0.05), [†]Correlation not significant.

Table 3. The correlation matrix of the relationship between BMI and procoagulant parameters in the study group.

Group			BMI (kg/m^2)	FIB (ng/ml)	vWFAg (u/l)	sVCAM (ng/ml)	tPA (pg/ml)	PAI (pg/ml)	TF III (pg/ml)
	BMI (kg/m^2)	r	1	0.102	0.163*	0.141*	0.123	0.124	0.162*
		p		0.151	0.021	0.047	0.082	0.081	0.022
	FIB (ng/ml)	r		1	0.435**	0.888**	0.899**	0.341**	0.474**
		p			0.000	0.000	0.000	0.000	0.000
	vWFAg (U/L)	r			1	0.663**	0.603**	0.698**	0.817**
		p				0.000	0.000	0.000	0.000
Test	sVCAM (ng/ml)	r				1	0.950**	0.529**	0.730**
		p					0.000	0.000	0.000
	tPA (pg/ml)	r					1	0.431**	0.671**
		p						0.000	0.000
	PAI (pg/ml)	r						1	0.736**
		p							0.000
	TF (pg/ml)	r							1
		p							

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). r = Pearson correlation, and p = significant/p-value.

and vWFAg, while PLR, MPV, PDW, Platocrit, FG, tPA and PAI had no significant correlation with BMI among people with obesity in Sapele, Southern Nigeria.

Recommendation

More research on the effect of increase BMI on procoagulant and hematological parameters is recommended so as to elucidate the pathophysiologic effect of weight gain in people of Southern Nigeria.

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