Original Article

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Effect of Body Mass Index (BMI) on Concentrations of Serum Lipid Profile and Electrolytes in Students of Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria

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Abstract

Introduction: Body Mass Index (BMI) is a nutritional index used to measure the level of obesity in individuals and other weight associated abnormalities. This study was intended to investigate the effect of the various BMI classifications on total cholesterol (TCHOL), triglyceride (TG), high density lipoprotein (HDL), low density lipoprotein (LDL), potassium, sodium and chloride.

Material and Methods: A total of 100 samples were collected, 25 from each BMI classification of normal, underweight, overweight and obese individuals. Five millimetres of whole blood samples were collected into plain and EDTA anticoagulant bottles respectively after an overnight fast by venepuncture. The studied biochemical parameters were determined using WHO-approved methods and data obtained were analysed using the student t-test obtained from SPSS version 23.

Result: The result showed that BMI normal TCHOL(1.67±0.22) significantly decreased (P<0.05) when compared with the BMI obese (2.33±0.52). In a similar vein, plasma TG of the normal BMI (0.54±0.32) significantly decreased (P<0.05) when compared with the BMI obese TG (1.10±0.38). Other statistical comparisons revealed a non-significant difference.

Conclusion: In conclusion, this study has shown that an increasing BMI is associated with higher cholesterol and triglyceride concentrations.

Keywords: *BMI, Lipids, Electrolytes, Metabolism*

Introduction

Non-communicable diseases (NCD) have surpassed communicable diseases as the leading causes of morbidity and mortality in Nigeria[1]. This paradigm shift is largely due to recent advances in medicine that have engendered the development of improved varieties of drugs and vaccines to effectively combat communicable diseases as well as the non-communicable ones. Other factors spurring this transition include changes in dietary patterns and their consequences, cigarette smoking, alcohol consumption and inadequate exercise. “Unhealthy diets and a lack of physical activity may manifest in people as raised blood pressure, increased blood glucose, elevated blood lipids and obesity. These metabolic risk factors can lead to cardiovascular disease, the leading NCD in terms of premature deaths” [2]. The major cause of obesity and overweight is an energy imbalance between calories consumed (Unhealthy diets) and calories expended (by way of physical activity) which is directly linked to heart-related diseases [3-4].

Body mass index or BMI is a statistical index using a person's weight and height to provide an estimate of body fat in males and females of any age[5]. It is used to screen for weight categories that may lead to health problems. There are several classifications and definitions of underweight, normal weight, overweight and obesity. However, the one that is commonly adopted is the definition by the World Health Organization (WHO). According to WHO an individual would be considered to be underweight if his/her BMI was in the range of 15 to 19.9 kg/m2, normal weight if the BMI was 20 to 24.9 kg/m2, overweight if the BMI was 25 to 29.9 kg/m2, and obese if it was 30 to 35 kg/m2 or greater[6].

WHO reported "that in 2016, more than 1.9 billion adults (18 years and above) were overweight, and of these over 650 million were obese. The worldwide prevalence of obesity nearly tripled between 1975 and 2016" [7].

BMI is used to evaluate weight-related complications and, to some extent, physiological processes. An important benefit of BMI is the evaluation of obesity and overweight. Being overweight and obese could be a sign of disease conditions and ageing pathways. The rise in overweight and obesity rates has prompted a parallel upswing in the prevalence of several diseases associated with them. These include type II diabetes, cardiovascular disease, hypertension, osteoarthritis, several types of cancer, gallbladder disease, and sleep apnea [8-9].

Lipid profile and electrolytes are established routine biochemical parameters employed in assessing the physiological and pathophysiological state of an individual. Several pathological conditions are diagnosed with these parameters. These parameters are important risk biomarkers in evaluating the cardiovascular system because they indicate the presence of some sort of evolving or established disease[10-11]. Lipid profile parameters such as total cholesterol, triacylglycerol, high density lipoprotein (HDL) and low density lipoproteins (LDL) correlate with BMI abnormalities[12-13]. Similarly, electrolytes such as sodium, potassium, chloride and bicarbonate play a crucial role in physiological processes and homeostasis.

A lot of BMI linked disease conditions are associated with a distorted plasma lipid profile and/or plasma electrolytes. Most published articles focused on the effect of abnormal BMI on either serum lipid profile or electrolytes without critically looking at the synergistic and antagonistic roles of these parameters. The interplay of lipid profile and electrolytes in normal and abnormal BMI conditions is the quest of this study. In a similar vein, there is a dearth of literature on this topic; hence an inroad study could benefit the health system of Bayelsa State and Nigeria at large.

Material and methods

Location of Study

This study was carried out in Amassoma, Bayelsa state Nigeria. Bayelsa state is located within latitude 4° 15' North and Latitude 5° and 23' South. It is also within longitude 5° 22' west and 6° 45' East. It is bounded by Delta state on the North, Rivers state on the East and the Atlantic Ocean on the western and southern part. According to projections from the 2006 Census figures (which was 1,704,515), Bayelsa State as of 2021 has a projected population of about 2,277,961 people [14]. Amassoma is the second largest cosmopolitan city in Bayelsa State.

Ethical Consideration

Informed consent was obtained from the subjects before the sampling was done. The ethical clearance and approval of the study were obtained from the ethics committee of the Niger Delta University, Wilberforce Island, Bayelsa State.

Study Population

The population used in this study comprises normal BMI, underweight, overweight and obese individuals. A total of one hundred subjects constituted the sample size as indicated by the method of Araoye[15]. The sample size spread equally across the various BMI categorizations.

Sampling Technique

Systematic random sampling was used to select subjects. After obtaining consent from suitable subjects, their physical data (weight and height) was obtained using a stadiometer. Thereafter, after an overnight fast, blood was collected with a 5ml syringe via venipuncture method and dispensed into plain and EDTA tubes. The samples were then spun and separated using a bucket centrifuge. The serum derived was forwarded to the laboratory for biochemical analysis.

Selection Criteria

Healthy individuals were recruited for the study as confirmed by the university clinician. Pregnant women and subjects with a history of chronic diseases were excluded.

Anthropometric Measurements

Height and body weight were measured according to the protocol by Norton and Eston [16]. Height was measured for each participant standing erect without footwear, against a mounted stadiometer. Weight was measured to the nearest 0.1 kg with the participants lightly dressed using a portable manual weighing scale (Seca 874 Flat scale, Creative Products, MI, USA). The weighing scale has a maximum recordable weight of 110 kg. At the commencement measurement daily, the functionality and accuracy of the weighing scale were checked by using a known standardized weight placed on the scale. Before each measurement, the scale was usually balanced to zero. Body mass index (BMI) was determined using weight (in kilogramme, Kg) divided by height (metres, m) squared. i.e., Kg/m2.

Laboratory Methods

Serum total cholesterol, triacylglycerol, high density lipoprotein (HDL) concentrations were estimated quantitatively using Agappe kit as specified by Agappe Diagnostics (Switzerland) (Agappe Kit Leaflet). Serum LDL concentration was derived mathematically as specified by Carl & Edward[17]. However, serum chloride, sodium, potassium and bicarbonate concentrations were measured using ion-selective electrode (ISE) machine manufactured by IFRI IONIX brand.

Statistical Analysis

The statistical package for social sciences (SPSS), version 23 (SPSS Inc., Chicago, IL, USA) and Microsoft Excel version 2010 was used for all analyses. Results were expressed as mean ± standard deviation while comparisons were made between different body mass indexes using the student's t-test The level of statistical difference was set at $p<0.05$ at 95% confidence interval.

Result

Below is a presentation of the results of this study;

Table 1 shows mean presentations of the studied biochemical parameters with respect to the BMI classifications. Table 2 shows that BMI normal total CHOL (1.67±0.22) decreased significantly ($P<0.05$) when compared with the obese (2.33±0.52). Furthermore, BMI normal TG (0.54±0.32) decreased significantly ($P<0.05$) when compared with the obese (1.10±0.38). Other biochemical comparisons were normal.

Discussion

The BMI is a convenient tool used to broadly categorize a person as underweight, normal weight, overweight, or obese based on tissue mass (muscle, fat and bone) and height. There is a strong association between BMI and body fat [18-19]. One of the significances of this categorization is that individuals with obesity have a significantly higher risk of eventually becoming diabetic, developing cancer, cardiovascular diseases, osteoarthritis, sleep apnoea, liver and gallbladder diseases. Having obesity

Table 1: The mean measured serum lipid profile and electrolyte concentration in BMI categorizations

Parameters	Normal n = 25	Under n = 25	Over n = 25	Obese n = 25
CHOL (mmol/L)	1.67 ±0.22	2.16 ± 0.25	1.95 ±0.61	2.33±0.52
TG (mmol/L)	0.54 ±0.32	0.75 ±0.31	1.32 ±0.88	1.10 ±0.38
LDL (mmol/L)	0.64 ±0.43	0.42 ±0.26	0.53± 0.36	0.33 ±0.18
HDL (mmol/L)	1.69 ±0.68	1.46 ±0.18	1.12 ±0.12	1.17 ±0.46
K+ (nmol/ml)	3.44 ±0.53	3.40 ±0.61	3.98 ±0.62	3.36 ±0.55
CL- (mEq/l)	105.88±12.83	101.91±16.67	103.41±9.56	109.23±16.11
Na (mmol/L)	19.04 ±3.65	22.87±10.39	20.38 ±7.35	18.78 ±6.66

KEY: CHOL: cholesterol, TG: Triglyceride, HDL: High density lipoprotein, CL-: Chloride, Potassium, NA: Sodium, NORMAL: normal weight, UNDER: underweight, OVER: overweight, OBESE: obese weight. n: indicates the number of samples collected for the study from individuals.

Table 2: Comparison of the mean concentration and standard deviation of the biochemical parameters measured for the various BMI classifications

Parameter	Body Mass Index	T-Value	P-Value	Comment
Cholesterol (mmol/L)	Normal weight vs Underweight.	0.50	0.64	NS
	Normal weight vs Overweight.	0.79	0.46	NS
	Normal weight vs Obese.	3.45	0.01	S
Triglyceride (mmol/L)	Normal weight vs Underweight.	-1.99	0.10	NS
	Normal weight vs Overweight	-2.29	0.06	NS
	Normal weight vs Obese	-2.99	0.02	S
High density lipoprotein (mmol/L)	Normal weight vs Underweight	1.16	0.51	NS
	Normal weight vs Overweight	1.32	0.06	NS
	Normal weight vs Obese	1.25	0.07	NS
Low density lipoprotein (mmol/L)	Normal weight vs Underweight	1.86	0.11	NS
	Normal weight vs Overweight	0.44	0.67	NS
	Normal weight vs Obese	1.84	0.12	NS
Potassium (mmol/l)	Normal weight vs Underweight	-0.46	0.66	NS
	Normal weight vs Overweight	-2.41	0.06	NS
	Normal weight vs Obese	-0.06	0.95	NS
Chloride (mEq/ll)	Normal weight vs Underweight	0.36	0.73	NS
	Normal weight vs Overweight	0.49	0.63	NS
	Normal weight vs Obese	0.33	0.75	NS
Sodium (mmol/l)	Normal weight vs Underweight	-0.62	0.56	NS
	Normal weight vs Overweight	-0.89	0.42	NS
	Normal weight vs Obese	-0.16	0.88	NS
KEY: BMI: Body Mass Index S: significant, NS: non-significant				

heightens the risk of premature death [20-21]. The results revealed an increase in both cholesterol (hypercholesterolaemia) and triglyceride (hypertriglyceridemia) in subjects from the underweight to obese category (Table 1 &2). A comparison of these parameters between normal and obese participants was statistically significant. This finding denotes a significant association between the development of hypercholesterolaemia and hypertriglyceridemia with obesity. Similar findings were reported by other authors[22-25].

A strong association between body mass index and serum electrolyte has been reported as an independent factor for electrolyte disruption [26-28]. BMI has also been reported to have a strong correlation with serum lipid profile[22,29-30]. The results for LDL and HDL show a decrease in serum concentration in underweight to obese participants. This finding in combination with elevated concentrations of triglyceride and cholesterol are consistent with the diagnosis of dyslipidaemia, especially in the obese participant as revealed by this study. A similar finding was reported by other researchers [31-33]. However, even if two people have exact BMI, their level of body fatness may differ and this may not be absolute[34-35]. This underscores the need to ensure the weight is kept within the normal limit.

The electrolyte concentrations exhibited no significant defined change in sodium, potassium and chloride concentration across the different BMI classifications. A similar finding was reported by Baumgart et al [36]. On the other hand, no significant correlation between lipid profile and electrolytes concerning the BMI classification was established. This finding affirms the non-existent interplay between serum lipid profile and electrolytes in normal and abnormal weight conditions as reported by other authors [36-37].

The data presented in the study revealed that lipid profile and electrolytes do not have a synergistic or antagonistic effect on BMI normality or abnormality. However, the study further sustained an already established association between increased BMI and plasma cholesterol and triglycerides.

Conclusion

In conclusion, the study established an association between increased BMI and cholesterol and triglyceride. Furthermore, the study did not establish an interplay plasma lipid profile and electrolytes, in the various BMI classifications.

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