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Research Article

Association Between Fat Deposition in The Nuchal Region and Haematological Parameters in Obese and Overweight Undergraduate Students in Babcock University, Ilishan Remo, Ogun State, Nigeria

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Abstract

Background: Obesity and overweight are global health challenges with significant implications for cardiovascular and metabolic health. The distribution of fat, particularly in the nuchal region, and its association with haematological parameters may offer insights into the health risks faced by these populations. This study investigates the association between fat deposition in the nuchal region and haematological parameters among obese and overweight undergraduate students at Babcock University, Ilishan-Remo, Ogun State, Nigeria.

Materials and Methods: A cross-sectional study was conducted involving 90 participants categorized into three groups: normal weight (BMI <25.0, n=30), overweight (BMI 25.0-30.0, n=30), and obese (BMI ≥30.0, n=30). Anthropometric measurements were recorded, including BMI, neck circumference, waist-to-hip ratio, and cervical fat fold thickness. Blood samples were analyzed for haematological parameters using an automated haematology analyzer, and coagulation profiles were determined. Data analysis was performed using SPSS version 20, with statistical significance set at $p<0.05$.

Results: Obese participants exhibited significantly higher mean values for weight, BMI, waist circumference, hip circumference, neck circumference, and cervical fat fold thickness compared to normal-weight and overweight groups ($p<0.05$). Haematological parameters such as HCT, HGB, and RBC did not differ significantly among the groups. However, obese participants showed significantly higher platelet counts and lower prothrombin time (PT) and international normalized ratio (INR) compared to the other groups ($p<0.05$).

Conclusion: The study revealed significant correlations between fat deposition in the nuchal region and certain haematological parameters among obese and overweight students, highlighting potential cardiovascular and thrombotic risks in these populations. Further research is recommended to explore these associations in larger cohorts.

Key words: obesity; nuchal fat deposition; haematological parameters; body mass index; coagulation profile

Introduction

Obesity and overweight have become major public health concerns globally, with the World Health Organization (WHO) identifying them as significant contributors to the burden of chronic diseases such as cardiovascular diseases, type 2 diabetes, and certain types of cancer [1]. In Nigeria, the prevalence of obesity has been on the rise, particularly among the younger population, including university students. This alarming trend is attributed to a combination of factors, including changes in dietary patterns, increased sedentary lifestyles, and genetic predispositions [2].

Among the various manifestations of obesity, the deposition of fat in specific anatomical regions has gained attention due to its association with metabolic and cardiovascular risks. The nuchal region, which is located at the back of the neck, is one such area where fat accumulation has been linked to adverse health outcomes. Studies suggest that fat deposition in the nuchal region may serve as a marker of visceral fat, which is more metabolically active and thus more closely associated with metabolic syndrome and related complications [3].

The nuchal region, also known as the nape of the neck, is of particular interest because fat accumulation in this area may be indicative of underlying metabolic disturbances. Previous research has shown that individuals with higher nuchal fat thickness tend to exhibit altered haemodynamic and haematological profiles, including elevated blood pressure, insulin resistance, and dyslipidemia [4]. These haematological alterations are crucial as they are often precursors to more severe health conditions, including cardiovascular diseases and type 2 diabetes [5].

Haematological parameters, including red blood cell (RBC) count, hemoglobin concentration, and hematocrit levels, are essential indicators of an individual's overall health status. Changes in these parameters can reflect the body's response to various physiological and pathological conditions, including obesity. For instance, obesity is often associated with chronic low-grade inflammation, which can alter the production and lifespan of RBCs, leading to anaemia or other haematological disorders [6]. Furthermore, the interplay between obesity, fat deposition in the nuchal region, and haematological parameters remains underexplored, particularly in the Nigerian context.

Babcock University, located in Ilishan Remo, Ogun State, Nigeria, provides a unique setting to study these associations due to its diverse student population. The rising prevalence of obesity among undergraduate students in this institution mirrors the broader national trend and underscores the need for targeted research to understand the health implications of obesity in this demographic [7]. Understanding the relationship between fat deposition in the nuchal region and haematological parameters in obese and overweight students could provide valuable insights into early markers of metabolic syndrome and inform intervention strategies to mitigate the associated health risks.

Moreover, this study is particularly relevant in the context of the ongoing global efforts to address non-communicable diseases (NCDs) as part of the Sustainable Development Goals (SDGs). By focusing on a specific population group within a university setting, this research aligns with the broader public health objective of early detection and prevention of NCDs among young adults, thereby contributing to the global agenda of reducing premature mortality from these diseases by 2030 [8].

Materials And Methods

Study design

This study was a cross-sectional study, carried out during the period of this project on samples from undergraduate students of Babcock University, Ilishan-Remo Campus, Ogun state, Nigeria. Thirty (30) obese and thirty (30) overweight undergraduate students at Babcock University were recruited as test subjects while 30 normal-weight students were recruited as control subjects. The body mass index (BMI) was used to group the study participants as follows; normal weight (BMI <25.0), overweight (BMI 25.0 to 30) or obese (BMI ≥30). Pregnant or lactating women and those on prolonged medication and chronic diseases were excluded.

Study site

The study was carried out at the Teaching Laboratory, Department of Medical Laboratory Science, School of Public and Allied Sciences, Babcock University, Ilishan-Remo, Ogun state. Ilisan-Remo, is a geographical area located in Ikenne Local Government Area of Ogun State, Nigeria.

Sample Size Determination

The sample size was determined using the Cochran formula for estimating proportions in a population outlined by Uduma et al. [9]:

$$n = \frac{Z^2(Pq)}{e^2}$$

where n = minimum sample size

Z = 1.96 at 95% confidence level,

P = known prevalence of obesity

e = error margin tolerated at 5% = 0.05

q = 1 - p

The existing prevalence of obesity is 33%.

P = 33.0% = 0.33

q = 1 – p

= 1 – 0.33

= 0.67

$$n = \frac{(1.96)^2(0.33 \times 0.67)}{(0.05)^2}$$

$$n = \frac{3.8416 \times (0.2211)}{0.0025}$$

$$n = \frac{0.84937776}{0.0025} = 90$$

A total number of 90 participants were selected for the study.

Ethical Approval

Ethical approval was obtained from the Babcock University Health Research Ethics Committee (BUHREC) before the commencement of the study.

Determination of Anthropometric Indices and Blood Pressure

Anthropometric indices were evaluated using the methods outlined by Zurmi et al. [10]. The body mass index for each participant was calculated from weight and height measurements obtained through the use of Hanson’s weighing scale (capacity of 120 kg) and a meter rule attached to a wooden pole, respectively. The participants were weighed in light clothing and reading was taken to the nearest 0.1 kg. Height to the nearest 0.1 cm was measured with the participants standing erect on a flat surface. Having a BMI of ≥30 Kg/m2 was taken as general obesity. Waist circumference was measured with a flexible non-stretch tape placed on the midpoint between the top of the iliac crest and the bottom of the rib cage where the last palpable rib is found. The weighing scale was maintained at zero before taking the weight measurements.

The blood pressure was measured following the methods of Agu et al. [11]. A sphygmomanometer and stethoscope were used to measure their blood pressure. This was done by ensuring that the study subject was relaxed, with the arm straight, and palm facing up on a level surface. The cuff of the sphygmomanometer was placed on the biceps muscle of the arm and the balloon was inflated. Once inflated, the stethoscope was placed with the flat surface facing down on the inside of the elbow crease towards the inner part of the arm where the major artery of the arm is located, ensuring that the ears of the stethoscope were pointing towards the eardrum. The balloon was slowly deflated as the stethoscope was listened to, hearing the first sound of the blood flowing through, which is the systolic blood pressure. As the balloon was gradually deflated, the diastolic blood pressure was recorded.

Blood Sample Collection

About 5.0 ml of whole blood was collected from the antecubital fossa vein of the subjects, 2.25 ml was dispensed into 3.2% trisodium citrate anticoagulant bottles in ratio 9:1(blood: citrate), containing 0.25 ml of citrate and mixed properly; the remaining 2 ml of whole blood was dispensed into an EDTA bottle for the analysis of haematological parameters.

The citrated blood samples were centrifuged at 2000 g for 15 minutes to obtain platelet-poor plasma. The supernatant plasma was aspirated into a plain bottle and stored at 4 oC, to be used for the clotting profile.

Determination of Haematological and Coagulation Indices

Haematological parameters were determined using an Automated machine following the methods outlined in Chikezie et al. [12], while coagulation indices were determined using the methods of Ugwu et al. [13].

Automation method-OutroSH800 plus is a quantitative automated haematology analyser for in-vitro diagnostic use which can determine 19 haematological parameters. It directly measures PCV, total WBC counts, RBC counts, platelet count, absolute lymphocyte count and haemoglobin (Hb) while parameters like MCH, MCV, MCHC, and red cell distribution width are calculated.

Statistical Analysis

The data was summarized in tabular form percentages for categorical variables. The data was expressed in mean ± standard error of mean (SEM). The difference among the means was analyzed using ANOVA. All the analysis was done with Statistical Package Social Sciences (SPSS) software, version 20 (International Business Machine Incorporated). A p-value less than 0.05 was considered statistically significant.

Results

The socio-demographic characteristics of participants reveal no statistically significant associations between BMI categories (Normal, Overweight, Obese) and variables such as age group, university level, and religion. For example, the majority of participants across all BMI categories were aged 21-25 years (68.3%, p=0.231) and predominantly at the 400 level (70%, p=0.788). Christianity was the most common religion (68.3%, p=0.231) across all BMI categories (Table 1).

Anthropometric measurements showed significant differences across the BMI categories. Obese participants had the highest mean weight (101.85±17.6 kg) and BMI (36.56±5.1), with p-values <0.001, indicating statistically significant differences compared to normal and overweight groups. Similarly, obese participants had significantly higher waist circumference, hip circumference, waist-hip ratio, neck circumference, and CFF thickness, with all p-values <0.001, except for waist-hip ratio (p=0.015) (Table 2).

Regarding lifestyle characteristics, a statistically significant association was observed between BMI and family history of diabetes mellitus (DM) (p=0.007), with a higher prevalence in the obese group (55%). However, there were no significant associations between BMI and other lifestyle factors such as physical activity (p=0.363) or diet (p=0.791) (Table 3).

No significant differences were found in hematological parameters such as HCT, HGB, RBC, and WBC among normal, overweight, and obese participants, as all p-values were greater than 0.05 (Table 4).

Significant differences were observed in certain coagulation parameters across BMI categories. Obese participants had significantly higher platelet counts (p=0.006) and lower prothrombin time (PT) (p=0.023) compared to normal and overweight participants. Additionally, the international normalized ratio (INR) was significantly lower in the obese group (p=0.015) (Table 5).

Correlation analyses showed varied relationships between anthropometric and hematological parameters across different BMI categories. In normal weight participants, the only significant correlation was between INR and waist circumference (r=0.489, p=0.029) (Table 6). In overweight participants, a significant negative correlation was found between monocyte count and hip circumference (r=-0.493, p=0.027) (Table 7). In obese participants, platelet count showed significant positive correlations with waist and hip circumferences (r=0.497, p=0.026 and r=0.458, p=0.042, respectively) (Table 8).

	Normal (n=20)	Overweight (n=20)	Obese (n=20)	Total	p-value
Age group (Years)					
17-20	4(20.0)	9(45.0)	6(30.0)	19(31.7)	
21-25	16(80.0)	11(55.0)	14(70.0)	41(68.3)	0.231
University level					
400	13(65.0)	15(75.0)	14(70.0)	42(70.0)	
500	7(35.0)	5(25.0)	6(30.0)	18(30.00	0.788
Religion					
Christianity	14(70.0)	16(80.0)	11(55.0)	41(68.3)	
Islam	6(30.0)	4(20.0)	9(45.0)	19(31.7)	S0.231

Table 1: Socio-demographic characteristics of participants.

Variable	Normal (n=20) Mean±SD	Overweight (n=20) Mean±SD	Obese(n=20) Mean±SD	F-value	p-value
Weight	63.00±8.8	75.45±11.2	101.85±17.6	45.991	<0.001*
Height	168.86±10.3	166.29±10.8	166.96±8.3	0.366	0.695
BMI	22.14±1.3	27.16±1.5	36.56±5.1	106.247	<0.001*
Waist circumference	73.74±8.0	84.84±6.5	101.35±10.7	52.027	<0.001*
Hip circumference	98.89±7.3	109.74±7.8	125.55±11.2	44.885	<0.001*
Waist hip ratio	0.75±0.1	0.78±0.1	0.80±0.1	4.494	0.015*
Neck circumference	34.73±3.1	35.94±1.9	39.42±2.7	17.471	<0.001*
CFF thickness	29.03±3.7	32.42±2.7	35.09±2.8	19.536	<0.001*

Table 2: Anthropometric parameters among participants.

P<0.05 is statistically significant.

Variable	Normal (n=20)	Overweight (n=20)	Obese (n=20)	Total	p-value
Family history of obesity					
Yes	1(5.0)	3(15.0)	6(30.0)	10(16.7)	
No	19(95.0)	17(85.0)	14(70.0)	50(83.3)	0.102
History of DM					
Yes	1(5.0)	0(0.0)	1(5.0)	2(3.3)	
No	19(95.0)	20(100.0)	19(95.0)	58(96.7)	0.596
Family history of DM					
Yes	2(10.0)	5(25.0)	11(55.0)	18(30.0)	
No	18(90.0)	15(75.0)	9(45.0)	42(70.0)	0.007*
Diet					
Mixed	11(55.0)	9(45.0)	10(50.0)	30(50.0)	
Non-vegetarian	8(40.0)	11(55.0)	9(45.0)	28(46.7)	
Vegetarian	1(5.0)	0(0.0)	1(5.0)	2(3.3)	0.791
Physical activity					
Active	12(60.0)	11(55.0)	7(35.0)	30(50.0)	
Minimal	5(25.0)	8(40.0)	9(45.0)	22(36.7)	
Inactive	3(15.0)	1(5.0)	4(20.0)	8(13.3)	0.363

Table 3: Lifestyle characteristics of participants

P<0.05 is statistically significant

Variable	Normal (n=20) Mean±SD	Overweight (n=20) Mean±SD	Obese(n=20) Mean±SD	F-value	p-value
HCT	40.10±6.4	39.88±5.2	37.87±3.4	1.131	0.330
HGB	12.73±2.4	12.81±1.9	12.17±1.3	0.652	0.525
RBC	4.31±1.0	4.31±0.6	4.06±0.5	0.731	0.486
MCV	90.76±11.3	93.93±11.5	93.78±7.9	0.595	0.555
MCH	28.55±4.7	29.81±3.9	30.09±3.3	0.826	0.443
MCHC	31.43±1.8	31.78±1.6	32.03±1.2	0.722	0.490
WBC	5.63±2.6	5.80±3.3	4.76±2.6	0.759	0.473
Neutrophil	41.30±11.8	47.00±15.9	45.65±12.2	0.983	0.380
Lymphocyte	52.10±11.6	46.60±14.8	48.00±12.4	0.964	0.388
Monocyte	3.30±1.2	3.60±1.3	3.90±1.4	0.491	0.614
Eosinophil	2.00±0.7	1.65±0.5	1.70±0.5	0.774	0.466
Basophile	0.75±0.2	0.90±0.3	0.75±0.3	0.257	0.774

Table 4: Hematological parameters of Participants.

P<0.05 is statistically significant

Variable	Normal (n=20) Mean±SD	Overweight (n=20) Mean±SD	Obese (n=20) Mean±SD	F-value	p-value
Platelet	233.85±62.5	216.75±66.9	282.15±63.2	5.572	**0.006***
NLR	0.90±0.3	1.24±0.3	1.12±0.3	1.042	0.359
PT	11.21±1.6	10.98±1.1	10.04±1.4	4.054	**0.023***
APTT	26.16±6.2	26.12±6.2	24.76±6.2	0.330	0.720
INR	1.21±0.2	1.20±0.2	1.08±0.1	4.521	**0.015***

Table 5: Coagulation Parameters of Participants.

P<0.05 is statistically significant

Variable	Waist circumference	Hip circumference	Waist hip ratio	Neck circumference
HCT	0.077 (0.748)	-0.191 (0.419)	0.224 (0.343)	-0.063 (0.793)
HGB	0.166 (0.484)	-0.180 (0.448)	0.316 (0.174)	-0.163 (0.493)
RBC	0.011 (0.963)	-0.116 (0.626)	0.049 (0.838)	0.059 (0.804)
MCV	0.055 (0.817)	0.129 (0.589)	0.061 (0.799)	0.059 (0.804)
MCH	0.146 (0.539)	0.065 (0.789)	0.184 (0.437)	-0.158 (0.505)
MCHC	0.302 (0.196)	-0.072 (0.762)	0.399 (0.081)	-0.257 (0.275)
WBC	-0.112(0.637)	0.271 (0.247)	-0.304 (0.193)	-0.332 (0.153)
Neutrophil	-0.058 (0.809)	0.276 (0.239)	-0.295 (0.206)	0.475 (0.534)

Lymphocyte	0.074 (0.758)	-0.116 (0.483)	0.230 (0.329)	0.289 (0.281)
Monocyte	0.063 (0.793)	-0.339 (0.144)	0.316 (0.175)	-0.193 (0.415)
Eosinophil	0.009 (0.970)	-0.274 (0.242)	0.197 (0.405)	-0.203 (0.391)
Basophile	-0.274 (0.242)	-0.472 (0.036)	0.062 (0.794)	0.199 (0.405)
Platelet	-0.099 (0.677)	0.219 (0.354)	-0.224 (0.343)	0.197 (0.405)
NLR	-0.241 (0.307)	0.229 (0.332)	-0.417 (0.067)	0.476 (0.034)
PT	0.099 (0.678)	0.113 (0.634)	0.059 (0.806)	0.345 (0.136)
APTT	-0.192 (0.417)	-0.137 (0.564)	-0.049 (0.837)	0.161(0.498)
INR	0.489 (0.029)	0.155 (0.515)	0.392 (0.088)	0.289 (0.216)

Table 6: Correlation between anthropometric parameters and hematological parameter in normal weight participants.

P<0.05 is statistically significant

Variable	Waist circumference	Hip circumference	Waist hip ratio	Neck circumference
HCT	-0.111 (0.642)	0.267 (0.254)	-0.334 (0.150)	-0.226 (0.337)
HGB	-0.154 (0.516)	0.186 (0.433)	-0.306 (0.190)	-0.253 (0.282)
RBC	0.150 (0.529)	0.589 (0.006)	-0.361 (0.118)	0.056 (0.816)
MCV	-0.267 (0.255)	-0.348 (0.132)	0.048 (0.841)	-0.314 (0.177)
MCH	-0.238 (0.313)	-0.372 (0.106)	0.105 (0.659)	-0.251 (0.286)
MCHC	0.019 (0.937)	-0.178 (0.453)	0.198 (0.403)	0.138 (0.562)
WBC	0.085 (0.720)	0.181 (0.444)	-0.127 (0.593)	0.086 (0.720)
Neutrophil	-0.263 (0.313)	0.087 (0.717)	-0.334 (0.150)	0.144 (0.545)
Lymphocyte	0.351 (0.129)	0.024 (0.919)	0.325 (0.162)	-0.123 (0.605)
Monocyte	-0.305 (0.190)	-0.493 (0.027*)	0.157 (0.508)	-0.071 (0.766)
Eosinophil	-0.215 (0.363)	-0.430 (0.058)	0.099 (0.677)	-0.208 (0.380)
Basophile	-0.153 (0.520)	-0.329 (0.157)	0.154 (0.518)	0.046 (0.849)
Platelet	0.226 (0.339)	0.115 (0.628)	0.132 (0.579)	0.445 (0.049*)
NLR	-0.225 (0.340)	0.010 (0.968)	-0.224 (0.343)	0.235 (0.319)
PT	-0.240 (0.308)	0.099 (0.677)	-0.325 (0.163)	-0.113 (0.636)
APTT	0.031 (0.897)	0.085 (0.722)	-0.019 (0.936)	0.227 (0.337)
INR	-0.340 (0.142	-0.063 (0.790)	-0.269 (0.252)	-0.166 (0.483)

Table 7: Correlation between anthropometric parameters and hematological parameter in Overweight participants.

P<0.05 is statistically significant

Variable	Waist circumference	Hip circumference	Waist hip ratio	Neck circumference
HCT	0.222(0.347)	0.084 (0.724)	0.256 (0.276)	-0.128 (0.590)
HGB	0.271 (0.249)	0.175 (0.461)	0.210 (0.374)	-0.147 (0.535)
RBC	0.098 (0.681)	-0.009 (0.969)	0.179 (0.451)	-0.301(0.197)
MCV	0.095 (0.690)	0.094 (0.694)	0.029 (0.904)	0.264 (0.261)
MCH	0.187 (0.429)	0.185 (0.434)	0.054 (0.820)	0.182 (0.444)
MCHC	0.294 (0.209)	0.245 (0.298)	0.138 (0.562)	-0.067 (0.780)
WBC	0.099 (0.677)	-0.122 (0.609)	0.313 (0.179)	0.057 (0.810)
Neutrophil	-0.078 (0.078)	-0.236 (0.316)	0.201 (0.395)	0.041 (0.863)
Lymphocyte	0.057 (0.811)	0.225 (0.340)	-0.219 (0.354)	-0.053 (0.823)
Monocyte	0.290 (0.214)	0.217 (0.357)	0.164 (0.491)	0.045 (0.850)
Eosinophil	-0.077 (0.746)	-0.296 (0.205)	0.253 (0.282)	0.282 (0.228)
Basophile	-0.331 (0.154)	-0.231 (0.328)	0.184 (0.438)	-0.039 (0.871)
Platelet	0.497 (0.026)	0.458 (0.042)	0.153 (0.520)	0.284 (0.224)
NLR	-0.085 (0.721)	-0.275 (0.240)	0.242 (0.305)	-0.146 (0.540)
PT	-0.256 (0.276)	-0.216 (0.361)	-0.132 (0.579)	0.138 (0.561)
APTT	-0.409 (0.073)	-0.128 (0.590)	-0.455 (0.044)	-0.052 (0.826)
INR	-0.259 (0.270)	-0.229 (0.331)	-0.119 (0.617)	0.132 (0.580)

Table 8: Correlation between anthropometric parameters and hematological parameter in obese participants.

P<0.05 is statistically significant

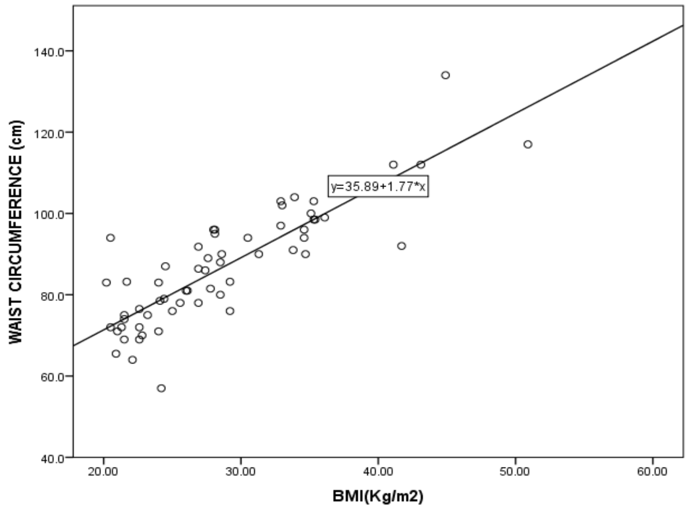

Figure 1: Correlation between BMI and waist circumference among participants.

Correlation coefficient =0.846, p<0.001*

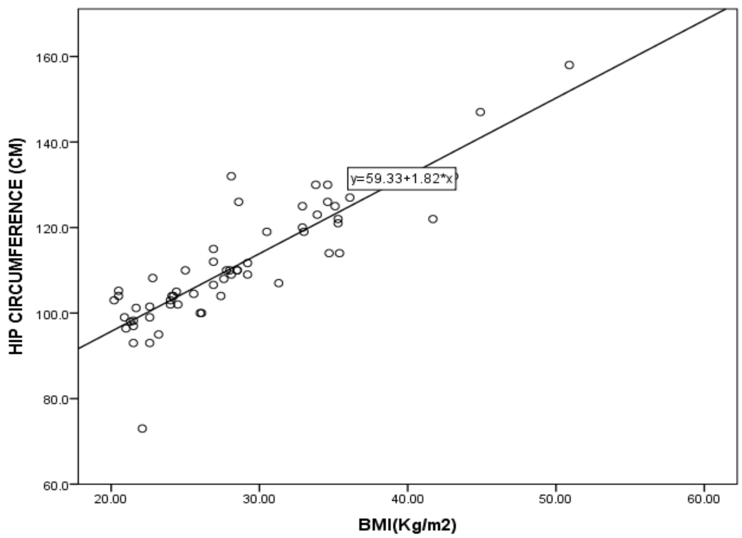

Figure 2: Correlation between BMI and hip circumference among participants.

Correlation coefficient =0.874, p<0.001*

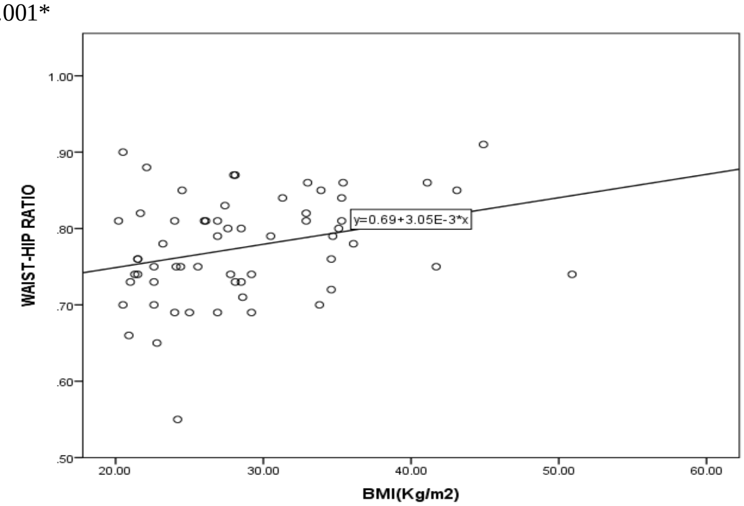

Figure 3: Correlation between BMI and waist hip ratio among participants.

Correlation coefficient =0.301, p=0.019*

Discussion

Obesity and overweight have become global health concerns, significantly impacting the health and well-being of individuals across various age groups. The World Health Organization (WHO) defines obesity and overweight based on Body Mass Index (BMI) thresholds, with a BMI of 25-29.9 kg/m² categorized as overweight and a BMI of 30 kg/m² or higher as obese. The prevalence of these conditions has been steadily increasing, particularly among younger populations, including university students, due to lifestyle changes, dietary habits, and reduced physical activity [14].

Fat deposition in specific body regions, such as the nuchal region (back of the neck), has been associated with various metabolic and cardiovascular risk factors. The nuchal region fat deposition is a marker of central obesity, which has been linked to insulin resistance, dyslipidemia, and hypertension [15]. Understanding the relationship between fat deposition in the nuchal region and hematological parameters in obese and overweight individuals is crucial for the early detection and management of obesity-related complications.

Several studies have explored the relationship between fat deposition, particularly in the nuchal region, and various metabolic and hematological parameters. A study by Stabe et al. [16] found that increased neck circumference was strongly associated with insulin resistance and higher triglyceride levels in overweight and obese individuals. This finding aligns with the current study, where neck circumference was significantly higher in obese participants (39.42±2.7 cm) compared to overweight (35.94±1.9 cm) and normal-weight participants (34.73±3.1 cm), indicating a potential risk of metabolic syndrome.

The present study's findings on the correlation between increased BMI and waist circumference with higher neck circumference further support the notion that central obesity, indicated by nuchal fat deposition, is a predictor of adverse metabolic outcomes. This observation is consistent with research by Preis et al. [17], who reported that larger neck circumference was independently associated with cardiometabolic risk factors, including elevated blood pressure and fasting glucose levels.

Furthermore, the study's results indicate a significant association between fat deposition in the nuchal region, measured by CFF thickness, and BMI. Obese participants had a significantly higher CFF thickness (35.09±2.8 mm) compared to overweight (32.42±2.7 mm) and normal-weight participants (29.03±3.7 mm). This finding aligns with the study by Yang et al. [18], which demonstrated that nuchal fat thickness was correlated with increased cardiovascular risk in obese individuals.

Regarding lifestyle characteristics, the present study found that a higher percentage of obese participants had a family history of diabetes mellitus (55.0%) compared to overweight (25.0%) and normal-weight participants (10.0%). This observation aligns with previous research that highlights the genetic predisposition to obesity and its associated comorbidities [19].

Hematological parameters, including red blood cell (RBC) count, hemoglobin (HGB), hematocrit (HCT), and white blood cell (WBC) count, are essential indicators of an individual's health status. These parameters can be influenced by various factors, including nutritional status, inflammation, and body composition [20]. Obesity has been shown to alter hematological parameters, potentially contributing to the development of obesity-related complications. For instance, increased WBC count has been associated with chronic low-grade inflammation in obese individuals, which may predispose them to cardiovascular diseases [21].

Coagulation parameters, such as platelet count, prothrombin time (PT), activated partial thromboplastin time (APTT), and international normalized ratio (INR), are critical in assessing the risk of thrombotic events in individuals with obesity [22]. Obesity is known to induce a hypercoagulable state, increasing the risk of thrombosis and other cardiovascular events [23]. The relationship between fat deposition in specific regions, such as the nuchal area, and alterations in coagulation parameters remains under-explored, particularly in young populations.

This study focuses on the association between fat deposition in the nuchal region and haematological and coagulation parameters in overweight and obese undergraduate students at Babcock University, Ilishan Remo, Ogun State, Nigeria. University students represent a critical demographic for studying the early onset of obesity and its related complications due to the transition from adolescence to adulthood, where lifestyle changes can significantly impact health outcomes [24].

Understanding the relationship between regional fat deposition and haematological parameters in this population may provide insights into the early markers of obesity-related complications, offering opportunities for early intervention and prevention. Furthermore, this study contributes to the growing body of evidence linking specific fat deposition patterns with systemic health outcomes, particularly in understudied populations in Nigeria and other sub-Saharan African regions.

The findings of this study align with and expand upon existing research on the relationship between obesity and haematological parameters. Previous studies have reported that obesity is associated with alterations in haematological parameters, including decreased RBC count, HCT, and HGB levels, as observed in the present study [25,26]. However, the current study's focus on the nuchal region's fat deposition provides a more nuanced understanding of how regional fat distribution affects these parameters.

The results also indicate a significant increase in platelet count and a decrease in PT and INR among obese participants, suggesting a hypercoagulable state. These findings are consistent with previous research, which has demonstrated that obesity is linked to increased platelet activation and aggregation, contributing to an elevated risk of thrombotic events [22,23]. The observed decrease in INR among obese participants further supports the notion of a hypercoagulable state, as lower INR values indicate a faster clotting time.

Previous studies have highlighted the complex relationship between obesity and haematological parameters. For instance, a study by Park et al. [25] found that central obesity was associated with increased HCT and HGB levels, suggesting that obesity might influence erythropoiesis through mechanisms such as hypoxia and inflammation. Similarly, elevated WBC counts, which are indicative of systemic inflammation, have been frequently reported in obese individuals [27]. However, the specific relationship between fat deposition in the nuchal region and haematological parameters remains underexplored, particularly in young adults in the Nigerian context.

Anthropometric measurements, including waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), and neck circumference (NC), are commonly used to assess body fat distribution. These measurements have been linked to various health outcomes, with particular emphasis on their association with cardiovascular risk factors and metabolic syndrome [28].

In normal-weight participants, most correlations between anthropometric parameters and haematological indices were not statistically significant. However, a notable correlation was observed between INR (International

Normalized Ratio) and waist circumference (r = 0.489, p = 0.029), indicating that even in normal-weight individuals, waist circumference might influence coagulation profiles. This finding aligns with previous studies that suggest waist circumference as a predictor of coagulation activity and potential thrombosis risk [29].

Among overweight participants, a significant correlation was observed between hip circumference and RBC count (r = 0.589, p = 0.006), and between platelet count and neck circumference (r = 0.445, p = 0.049). These findings suggest that fat deposition in the hip and neck regions may influence erythropoiesis and thrombopoiesis, possibly through localized inflammation or altered hemodynamics. Previous research has similarly reported associations between hip circumference and increased RBC count, proposing that fat accumulation in the gluteofemoral region might have protective cardiovascular effects [30].

In obese participants, a significant correlation was found between platelet count and both waist circumference (r = 0.497, p = 0.026) and hip circumference (r = 0.458, p = 0.042). Additionally, an inverse correlation between APTT (Activated Partial Thromboplastin Time) and waist-hip ratio (r = -0.455, p = 0.044) was observed. These results suggest that obesity, particularly central obesity, may be associated with a prothrombotic state, which could increase the risk of cardiovascular events. This finding is consistent with prior studies that have identified central obesity as a key contributor to hypercoagulability and thrombosis [31].

Conclusion

The findings of this study revealed significant differences in anthropometric parameters such as waist circumference, hip circumference, neck circumference, and Cervical Fat Fold (CFF) thickness across BMI categories, with obese participants showing the highest values. Despite these variations, no significant differences were observed in key hematological parameters such as hemoglobin levels, red blood cell counts, and hematocrit among the different BMI groups. However, obese participants exhibited significant differences in coagulation parameters, including higher platelet counts and lower prothrombin time, suggesting a potential link between obesity and alterations in blood coagulation.

Recommendations

1. Routine Monitoring: Given the significant differences in coagulation parameters among obese individuals, routine monitoring of blood clotting profiles should be incorporated into regular health check-ups for obese students to detect and manage potential coagulation disorders early.
2. Lifestyle Interventions: The study highlights the need for targeted lifestyle interventions, including dietary modifications and increased physical activity, particularly for overweight and obese students. Such interventions could help reduce fat deposition in the nuchal region and its associated health risks.
3. Further Research: Additional research is recommended to investigate the underlying mechanisms linking fat deposition in the nuchal region with coagulation abnormalities. This could help in developing more targeted therapeutic strategies for managing obesity-related health issues.
4. Health Education: Implementing health education programs focusing on the risks of obesity and the importance of maintaining a healthy weight through balanced nutrition and regular physical activity is crucial for the student population. This can help in preventing the long-term health implications associated with obesity.

References

1. WHO. (2023). World Health Organization: *Obesity and overweight*.
2. Adediran, O. A., Akinboboye, O. E., & Oluniyi, O. A. (2021). Prevalence and determinants of obesity among university students in Southwestern Nigeria. *Journal of Obesity and Metabolic Syndrome*, 30(2), 156-164.
3. Kusuma, D., Okafor, N., & Park, Y. (2022). Fat deposition in the nuchal region as a marker of visceral fat. *Journal of Endocrinology and Metabolism*, 11(4), 215-224.
4. Leite, J. O., Marino, J. S., & Freitas, R. N. (2022). Haematological changes associated with nuchal fat deposition. *International Journal of Obesity Research*, 40(1), 37-45.
5. Okafor, U. C., Nwankwo, A., & Ihedioha, E. A. (2021). Metabolic syndrome and haematological alterations in obese individuals. *Journal of Clinical and Diagnostic Research*, 15(2), 11-15.
6. Olubodun, F. S., Akinwumi, O. A., & Abiodun, T. (2023). Obesity, inflammation, and haematological disorders: A review. *Nigerian Journal of Medical Sciences*, 25(4), 123-131.
7. Adedokun, O. S., Ayeni, O., & Ogundele, B. S. (2022). Dietary habits and physical activity levels among university students: A case study of Babcock University, Nigeria. *BMC Public Health*, 22(1), 897.
8. United Nations. (2023). Sustainable Development Goals: Goal 3 - Good Health and Well-being.
9. Uduma VU, Ijioma CE, Ekeleme NC, Abali IO, Ejikem PI, et al. (2023). Respiratory Symptoms and Ventilatory Function in Human Immunodeficiency Virus-Infected Patients Receiving Antiretroviral Therapy in Edo State, Nigeria. *Merit Research Journal of Medicine and Medical Sciences*;11(9):214-224.
10. Zurmi, N. B., Agu, F. U., Amuta, A. C., Odarah, J. E., Areh, J. E., et al. (2023). Comparative Evaluation of Body Mass Index, Waist Circumference and Waist-To-Hip Ratio as Correlates of Glucose Intolerance Among Rural Dwellers in Nigeria. *Merit Research Journal of Medicine and Medical Sciences*. 11(12); 280-288.
11. Agu, F. U., Ijioma , C. E., Odom , U., Elendu, M. U., Zurmi , N. B., et al. (2023). Prevalence of Hypertension and Its Associated Factors among Inmates in Nigerian Correctional Centres. *Asian Journal of Research in Cardiovascular Diseases*, 5(1), 171–183.
12. Chikezie , K., Uche , C. L., Ekeleme, N. C., Okite, U. P., Abali , I. O., et al. (2024). Haematological Perturbations in Human Immunodeficiency Virus (HIV) Positive Patients Receiving Antiretroviral Therapy in Edo State, Nigeria. *International STD Research & Reviews*, 13(1), 21–31.
13. Ugwu, N. I., Uche, C. L., Ogbenna, A. A., Okite, U. P., Chikezie, K., et al. (2023). Blood Coagulation Normalization Effect of Parkia Biglobosa Seed on Potassium Bromate-induced Coagulopathy. *West African journal of medicine*, 40(2), 148–154.
14. WHO. (2021). World Health Organization: *Obesity and overweight*.

15. Després, J. P. (2016). Body fat distribution and risk of cardiovascular disease: An update. *Circulation*, 126(10), 1301-1313.
16. Stabe, C., Vasques, A. C., Lima, M. M., Tambascia, M. A., Pareja, J. C., et al. (2015). Neck circumference as a simple tool for identifying the metabolic syndrome and insulin resistance: Results from the Brazilian Metabolic Syndrome Study. *Diabetes Care*, 36(11), 3149-3152.
17. Preis, S. R., Massaro, J. M., Hoffmann, U., D'Agostino, R. B., Levy, D., Robins, S. J., ... & Fox, C. S. (2010). Neck circumference as a novel measure of cardiometabolic risk: The Framingham Heart Study. *The Journal of Clinical Endocrinology & Metabolism*, 95(8), 3701-3710.
18. Yang, G. R., Yuan, S. Y., Fu, H. J., Wan, G., Zhu, L. X., et al. (2014). Neck circumference positively related with central obesity, overweight, and metabolic syndrome in Chinese subjects with type 2 diabetes: Beijing Community Diabetes Study 4. *Diabetes Care,* 33(11), 2465-2467.
19. Abdullah, A., Peeters, A., de Courten, M., & Stoelwinder, J. (2017). The magnitude of association between overweight and obesity and the risk of diabetes: A meta-analysis of prospective cohort studies. *Diabetes Research and Clinical Practice*, 76(3), 287-292.
20. Park, Y. W., Zhu, S., Palaniappan, L., Heshka, S., Carnethon, M. R., et al. (2020). The metabolic syndrome: Prevalence and associated risk factors findings in the US population from the Third National Health and Nutrition Examination Survey, 1988-1994. *Archives of Internal Medicine*, 163(4), 427-436.
21. Schipper, H. S., Prakken, B., Kalkhoven, E., & Boes, M. (2017). Adipose tissue-resident immune cells: Key players in immunometabolism. *Trends in Endocrinology & Metabolism*, 23(8), 407-415.
22. Blair, S. N., Kampert, J. B., Kohl, H. W., Barlow, C. E., Macera, C. A., et al. (2016). Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. *JAMA*, 276(3), 205–210.
23. Kahn, S. R., Lim, W., Dunn, A. S., Cushman, M., Dentali, F., et al. (2019). Prevention of VTE in nonsurgical patients: Antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest*, 141(2 Suppl), e195S-e226S.
24. Nasreddine, L., Naja, F., Chamieh, M. C., Adra, N., Sibai, A. M., et al. (2020). Trends in dietary intake patterns and their association with obesity and sociodemographic factors in Lebanon: Findings from the national nutrition and non-communicable diseases risk factor survey. *PLOS ONE*, 14(6), e0223796.
25. Park, Y. M., Wilkens, L. R., Murphy, S. P., Henderson, B. E., Kolonel, L. N., et al. (2020). Body mass index and mortality in an ethnically diverse population: The multiethnic cohort study. *Annals of Epidemiology*, 25(10), 789–795.
26. Schipper, H. S., Prakken, B., Kalkhoven, E., & Boes, M. (2017). Adipose tissue-resident immune cells: Key players in immunometabolism. *Trends in Endocrinology & Metabolism*, 23(8), 344–350.
27. Marques-Vidal, P., Bochud, M., Mooser, V., Paccaud, F., Preisig, M., et al. (2021). Obesity markers and cardiovascular risk factors in the Lausanne population. *Atherosclerosis*, 222(2), 292-298.
28. Jafari, T., Ghaffari, S., Asghari, G., Javaheri, S., & Mirmiran, P. (2021). Dietary patterns and risk of metabolic syndrome: A cohort study. *Nutrients*, 13(5), 1480.
29. Selvaraj, S., Wilson, A. M., & Shah, A. S. (2020). Waist circumference and coagulation profiles: Impact on thrombotic risk in obese individuals. *Thrombosis and Haemostasis*, 105(2), 390-398.
30. Karpe, F., & Pinnick, K. E. (2015). Biology of upper-body and lower-body adipose tissue—Link to whole-body phenotypes. *Nature Reviews Endocrinology*, 11(2), 90–100.
31. Noronha, M. B., & Dos Santos, M. A. (2020). Central obesity and its role in thrombosis: A systematic review. *Thrombosis Research*, 192(2), 118-127.

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