Correlation between Anthropometric Indices and Fasting Blood Glucose Levels among Adults in Aboh Mbaise Local Government Area, Imo State Nigeria

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Abstract

To establish effective diabetes and obesity preventive and management methods in Nigeria, it is imperative to comprehend the link between anthropometric indices and fasting blood glucose level. The relationship may be influenced by Nigerians' distinct genetic composition and environmental factors, such as diet and lifestyle, indicating the need for research to offer more thorough insights into the precise factors that lead to the development of diabetes especially in the local context. This correlational study examined the correlation between the anthropometric indices (Body Mass Index [BMI], waist-to-hip ratio [WHR]) and blood glucose levels among adults in Aboh Mbaise Local Government Area (LGA), Imo State, Nigeria, and also explored the socio-demographic factors associated with elevated blood sugar. The population of the study was 194,779. A multiple-stage sampling procedure was used to draw 420 respondents that filled out the survey questionnaire (containing individual anthropometric and clinical measurements). Data were analyzed using frequency and percentage, Spearman's correlation coefficient (ρ), and other non-parametric tests (Chi-square, Mann-Whitney, and Kruskal-Wallis tests). Findings revealed significant moderate positive correlations between anthropometric indices and blood glucose levels, with BMI (ρ=0.310, p=0.001) showing a slightly stronger relationship than WHR (ρ =0.245, p=0.002). A significant association was found between BMI categories and WHR risk levels (p=0.005). Gender differences in blood glucose levels were significant (p=0.035), with females showing higher levels. Family history of diabetes was significantly associated with elevated blood glucose (p=0.011). These findings demonstrate the significance of anthropometric measurements in diabetes risk assessment. The results obtained from this study could greatly enhance Nigeria's public health initiatives. By clearly defining the correlation between blood glucose and anthropometric indices in Aboh Mbaise LGA, the study would help design focused screening initiatives to identify individuals who are at risk of acquiring diabetes or are obese.

Keywords: Diabetes, Obesity, Anthropometric indices, BMI, WHR, Lifestyle factors

Introduction

The rising prevalence of Diabetes *mellitus* is a major public health concern globally, in Nigeria, Imo State and down to Aboh Mbaise. According to estimates by the International Diabetes Federation (IDF), diabetes currently affects an estimated 537 million adults worldwide between the ages of 20-79 (10.5% of all adults in this age range) and is projected to increase to 783 million by 2045 (Khalil et al., 2024: Kumar et al:, 2024: Odukoya et al., 2024). In Africa alone, DM is and predicted to increase by 129% (55 million) by 2045 (Lule et al., 2024: Odukoya et al., 2024), relative to other regions, the African continent has the largest proportion of people with undiagnosed diabetes, with 54% (13 million) of adults living with diabetes but unaware of it (Lule et al., 2024) and Sub-saharan Africa (SSA) accounting for 60% of undiagnosed population (Matsinkou, et al., 2024). Nigeria stands out as one of the countries with the highest burden of diabetes (Matsinkou et al. 2024), with a prevalence rate of 5.8% and 46.4% of the population, undiagnosed (Odukoya et al., 2024) reflecting significant gaps in disease detection and management. Acccording to Chidozie et al. (2021), Imo State accrues a prevalence rate of 11.0%, were Aboh Mbaise LGA emerged the 3rd highest with a 16% prevalence rate after Ngor Okpala and Ikeduru out of 27 Local Government Areas (LGAs) that were studied necessitating concerted efforts, geared towards nipping it in the bud (Chidozie et al., 2021).

Diabetes is a metabolic disease marked by elevated blood sugar levels (Uloko et al., 2018). According to Al-Ishaq et al. (2019), blood sugar level is an essential component of metabolic health which is mostly controlled by insulin. Diabetes mellitus is consistently high blood glucose levels brought on either insulin resistance or decreased insulin production (Al-Ishaq et al., 2019). Uloko et al. (2018) opines that factors such as urbanization and modifications to lifestyles (such as rapid growth in unhealthy consumption of food, and a rise in sedentary behaviours have resulted in an overall decrease in physical activity and are responsible for this upward trend in diabetes (Uloko et al., 2018). This disease can result in a number of detrimental health consequences, including retinopathy, nephropathy, neuropathy, and cardiovascular disease. Furthermore, the pathophysiology of type 2 diabetes is linked to a number of metabolic risk factors, such as insulin resistance, poor glucose tolerance, and dyslipidemia, all of which have been demonstrated to correlate with measurements of body compositions referred to as anthropometric indices (Yakubu et al., 2020).

The complex relationship between adult blood sugar levels and anthropometric indices has drawn more attention, especially in light of the rising prevalence of type 2 diabetes and obesity worldwide (Yakubu et al., 2020). Moreover, indicators of body composition and fat distribution that are easily available and non-invasive consists of anthropometric indices, which include measurements such as body weight, height, waist circumference, and body mass index (BMI) (Ejike & Ukegbu, 2017). It is commonly acknowledged that anthropometric indices, including BMI, waist circumference (WC), and waist-to-hip ratio (WHR), are significant indicators for determining the risk of diabetes and its co-morbidity such as obesity (Crimarco et al., 2020). In alignment with this, Biadgo et al. (2016) reported that anthropometric measures are important for recognizing the risk of vascular complications in diseases such as type 2 diabetes. However, Callahan (2023) noted that BMI does not distinguish between muscle and fat; it may not be as accurate in some populations. Nevertheless, BMI is a commonly used metric that computes body weight in relation to height and provides a general indication to determine if an individual is underweight, normal weight, overweight, or obese (Zierle-Ghosh & Jan, 2023). As an alternative, the Waist-to-Hip Ratio sheds light on the distribution of fat, particularly between abdominal and gluteal fat; larger ratios suggest that visceral fat accumulation has more health hazards (Arif et al., 2023).

Studies (Biadgo et al., 2016; Kuriyan, 2018) have shown a substantial correlation between blood sugar levels and various bio-markers. Anthropometric measurements have been strongly correlated with blood glucose levels in a number of investigations. For instance, Biadgo et al. (2016) discovered that among patients with type 2 diabetes in Northwest Ethiopia, haematological indices, which comprise a variety of anthropometric measurements, had a significant correlation with fasting blood glucose levels. Furthermore, Kuriyan (2018) research highlights the significance of precise body composition methods in determining the connection between metabolic diseases and obesity. According to the study, specific anthropometric measurements can reveal information about the likelihood of insulin resistance and high blood sugar (Kuriyan, 2018). Clearly, these findings suggest that body measurements can be used as predictors for blood glucose management.

In order to establish effective diabetes and obesity preventive and management methods in Nigeria, it is imperative to comprehend the link between these anthropometric indices and blood sugar level (Sirisena & Okeahialam, 2022). Moreover, available studies on the relationship between anthropometric indices and blood sugar levels in the Nigerian population, where the prevalence of diabetes is rising at a fast pace, is noticeably lacking, despite the fact that there is a growing investigation on this scope in other countries (Uloko et al., 2018). Furthermore, the relationship between anthropometric indices and blood sugar levels may be influenced by Nigerians' distinct genetic composition and environmental factors, such as diet and lifestyle (Olamoyegun et al., 2024), indicating the need for research to offer more thorough insights into the precise factors that lead to the development of diabetes. There is therefore the need for research in this local context.

Investigating the correlation between anthropometric indices and blood glucose levels is crucial in the particular context of South-East Nigeria, an area going through fast socio-economic and lifestyle changes. In alignment with this, a study by Cookey et al. (2022) revealed that casual blood sugar checks might detect undiagnosed diabetes individuals in Nigeria. In South-East Nigeria, particularly Aboh Mbaise of Imo State, obesity rates are rising and the correlation between several obesity metrics and diabetes incidence is especially noticeable. According to Jung et al. (2016), visceral fat mass is a strong predictor of diabetes and pre-diabetes, which emphasizes the significance of assessing various anthropometric measures in relation to blood sugar levels. Furthermore, research in Nigeria showed that co-morbidity such as diabetes has been linked to obesity (Ononamadu et al., 2017). Further diabetes results in South East Nigeria can be greatly enhanced by placing a strong emphasis on including anthropometric measurements into standard clinical evaluations. The development and application of focused strategies to address this expanding health issue are hampered by the absence of precise data. Due to dearth of localized data, the current study aims to investigate the correlation of obesity and diabetes in Aboh Mbaise Local Government Area in Imo State Nigerian.

Objectives of the Study

1. To determine the relationship between anthropometric indices (WHR and BMI) and blood glucose levels among adults in Aboh Mbaise LGA in Imo State Nigeria;
2. To examine the association between anthropometric indices (WHR and BMI) and obesity among adults in Aboh Mbaise LGA in Imo State Nigeria;and
3. To investigate the relationship between socio-demographic factors (age, gender, marital status, educational level, ethnicity, occupation, income) and blood glucose levels among adults in Aboh Mbaise LGA in Imo State Nigeria.

Research Questions

1. What is the relationship between anthropometric indices (BMI and WHR) and blood glucose levels among adults in Aboh Mbaise LGA, Imo State, Nigeria?
2. What is the association between anthropometric indices (BMI and WHR) and obesity among adults in Aboh Mbaise LGA, Imo State, Nigeria?
3. What is the relationship betweenocio-demographic factors (age, gender, marital status, educational level, ethnicity, occupation, income) and blood glucose levels among adults in Aboh Mbaise LGA, Imo State, Nigeria?

Hypotheses

$H0_1$: Anthropometric indices (BMI and WHR) are not significantly associated with blood glucose levels among adults in Aboh Mbaise LGA in Imo State, Nigeria ($p \leq .05$).
$H0_2$: Anthropometric indices (BMI and WHR) are not significantly associated with obesity among adults in Aboh Mbaise LGA in Imo State, Nigeria ($p \leq .05$).
$H0_3$: Socio-demographic factors do not have a significant influence on blood sugar levels among adults in Aboh Mbaise LGA in Imo State, Nigeria ($p \leq .05$).

Methods

The correlational survey design was adopted for the study. This design was specifically chosen because it allows for the simultaneous measurement of anthropometric indices (body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR)) and blood glucose levels at a single point in time. This approach is appropriate for investigating relationships between anthropometric measurements and glycemic status in a defined population (Wang & Cheng, 2020). The population of the study comprised of adults in Aboh Mbaise Local Government Area (LGA), Imo State, Nigeria. The population of adults there was projected to 194,779. Using the National Population Commission (2006) figure. A sample size of 420 adults was drawn for the study. The multi-stage sampling procedure was used to draw the sample size. Stage one involved the drawing of adults in the 12 administrative wards of Aboh Mbaise LGA in Imo State. Stage two involved a random selection of equal amount of households based on the required sample size. Stage three involved the inclusion of eligible adult participants (18years and above who have been there for at least six months and are therefore conversant with the local way of life and food customs); and using simple random sampling of balloting without replacement to draw 35 adults from each of the 12 wards selected. This gave a total of 420 adults.

The tools for anthropometric measurements were used in accordance with established procedures; a calibrated digital scale with a 0.01 kg precision was used to measure the weight of participants, portable stadiometer for height measurement (in meters). The waist circumference (WC) was measured using a non-stretchable tape parallel to the floor, halfway between the top of the iliac crest and the bottom edge of the last perceptible rib, while the hip circumference (HC) was measured at the widest portion of the buttocks, with the tape parallel to the floor. Both measurements were recorded in centimeter (cm). The Body Mass Index (BMI) was calculated using the formula: weight (kg) divided by height squared (m^2). while BMI values were classified according to WHO classification into underweight (<18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥30 kg/m^2). The waist circumference was divided by the hip circumference to determine the Waist-to-Hip Ratio (WHR). The WHO definition of metabolic syndrome states that WHRs of ≥ 0.85 for women and ≥0.90 for men are markers of central obesity (Sruthi et al., 2023). The clinical measurement for the fasting blood glucose (FBG) was done with the glucometer (in mg/dl). The WHO classification of blood glucose level:

Categories	Values (mg/dl)
Normal	70 – 100
Hyperglycemia	100 – 125
Diabetes	≥ 125
Hypoglycemia	< 70

The questionnaire consisted of 15 items and has two sections, A and B. Section A dealt with 10 items on personal variables of the respondents, while Section B consisted of five items which contained information on clinical and anthropometric measurements. The data collected were first inputted into a Microsoft Excel spreadsheet for the purposes of cleaning and structuring. The cleaned data were then imported into Statistical Package for Social Sciences (SPSS) software version 25.0 for extensive analysis. Descriptive statistics which consist of frequency and percentage were used to summarize categorical variables such as gender, education level, and BMI categories. Inferential statistics were also performed to assess correlations and associations between variables.

Table showing the different inferential statistics performed in the study.

S/n	Objective	Tests
1.	Relationship between anthropometric indices and blood glucose	Spearman's Rank Correlation
2.	Anthropometric indices(WHR and BMI) associated with obesity	Kruskal-Wallis test Chi-square test
3.	Relationship between socio-demographic factors and blood glucose levels	Mann-Whitney Kruskal-Wallis Test

Spearman's correlation coefficient was calculated to assess the strength and direction of rel ationships between (BMI, WC, WHR, and blood glucose). Kruskal-Wallis test and Chi-square test were conducted to examine the association between anthropometric indices (WHR) and BMI. Mann-Whitney and Kruskal-Wallis tests assessed the relationship between socio-demographic and socio-economic factors and blood glucose. Statistical significance was set at $p \leq 0.05$ for all analyses. Results were presented as frequencies, percentages, means ± standard deviations and correlation coefficients. Visual representations of data, including tables and bar charts, were created to enhance the interpretation and communication of findings.

Results

Out of the 420 adults drawn for the study, only 400 duly filled out the survey questionnaire (containing individual anthropometric and clinical measurements) and were used for analyses Hence, the final sample was 400.

Anthropometric Indices (WHR and BMI) Associated with Fasting Blood Glucose levels

Table 1a**. Spearman's Correlation between Fasting Blood glucose Level and Waist-Hip Ratio (N=400)**

Variable	Blood Sugar Level (mg/dL)	Waist-Hip Ratio
Blood Sugar Level (mg/dL)	1	0.245
Waist-Hip Ratio	0.245	1
p-value (2-tailed)	–	0.002

Table 1a, shows the Spearman's correlation between blood sugar level and waist-hip ratio (WHR) among the participants (n = 400). The correlation coefficient of 0.245 indicates a significant positive but moderate relationship between blood sugar level and waist-hip ratio (p = 0.002). This suggests that higher waist-hip ratios are significantly associated with higher blood sugar levels**,** which align with known research, that central obesity (higher WHR) is a risk factor for elevated blood sugar and diabetes.

Table 1b**: Spearman's Correlation between Fasting Blood glucose Level and BMI (n=400)**

Variable	**Blood glucose Level (mg/dL)**	**BMI**
Blood Sugar Level (mg/dL)	1	0.310
BMI	0.310	1
p-value (2-tailed)	–	0.001

Table 1b, shows the Spearman's correlation between blood glucose levels and BMI among the study participants (n = 400**).** The correlation coefficient of 0.310 suggests a significant moderate positive relationship between blood sugar level and BMI (p = 0.001). This implies that higher BMI is significantly associated with increased blood glucose levels.

Anthropometric Indices (WHR and BMI) Associated with Obesity

Table 2**: BMI Categories by Waist-to-Hip Ratio Risk Levels (n=400)**

BMI Category	**Low Risk**	**Moderate Risk**	**High Risk**	**Total**	**Chi-Square**	**Df**	**p-value**
Underweight	27 (18.0%)	7 (17.1%)	29 (13.9%)	63 (15.8%)			
Normal weight	29 (19.3%)	6 (14.6%)	40 (19.1%)	75 (18.8%)			
Pre-obesity	22 (14.7%)	6 (14.6%)	33 (15.8%)	61 (15.3%)	24.875	10	0.005
Obesity class I	23 (15.3%)	7 (17.1%)	34 (16.3%)	64 (16.0%)			
Obesity class II	26 (17.3%)	7 (17.1%)	43 (20.6%)	76 (19.0%)			
Obesity class III	23 (15.3%)	8 (19.5%)	30 (14.4%)	61 (15.3%)			

Table 2, shows the distribution of BMI categories across waist-to-hip ratio (WHR) risk levels among the study participants (n = 400). The chi-square test result (χ^2 = 24.875, df = 10, p = 0.005) indicates a significant association between BMI categories and WHR risk levels.

Relationship between Socio-Demographic Factors and Blood Sugar Level:

Table 3a**: Mann-Whitney Test for Socio-Demographic Variables and Blood glucose Level (n=400)**

Variable	n(%)	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	p-value
Gender						
Female	217 (54.3)	212.87	46296.5	17583.5	-2.103	0.035
Male	183 (45.8)	184.50	33796.5			
Family History of Diabetes						
No	235 (58.8)	187.24	43902.5	16729.5	-2.555	0.011
Yes	165 (41.3)	226.83	37420.5			

Table 3a, shows the Mann-Whitney test results for the relationship between socio-demographic variables and blood glucose levels. Gender showed a significant difference (p = 0.035), with females having a higher mean rank (212.87) than males (184.50), indicating a significant gender effect on blood glucose levels.

Family history of diabetes was also significant (p = 0.011), showing that individuals with a family history of diabetes had higher blood glucose levels compared to those without.

Table 3b**: Kruskal-Wallis Tests for Socio-Demographic Variables and Blood glucose Level (n=400)**

Variables	n(%)	Mean Rank	Kruskal-Wallis H	Df	p-value
Age					
Young Adults	93(23.3)	213.11			
Early Middle-Aged	66(16.5)	204.66			
Late Middle-Aged	73(18.3)	197.67	7.057	4	0.133
Early Elderly	68(17.0)	217.63			
Late Elderly	100(25.0)	176.45			
Marital Status					
Divorce	9(2.3)	227.89			
Married	243(60.8)	196.85	6.561	4	0.161
Single	133(33.3)	211.31			
Widow	11(2.8)	169.41			
Widower	4(1.0)	87			
Highest Educational Level					
No formal education	7(1.8)	257.21			
Primary School	118(29.5)	192.31	2.427	3	0.489
Secondary School	194(48.5)	203.69			
Tertiary Education	81(20.3)	199.9			

Ethnicity					
Efik/Ibibio	30(7.5)	171.53			
Hausa	15(3.8)	214.7	3.871	3	0.276
Igbo	350(87.5)	201.4			
Yoruba	5(1.3)	268.7			
Present Occupation					
Apprentice	2(0.5)	152			
Businessman/Business woman	56(14.0)	197.15			
Civil /Public Servant	47(11.8)	200.7	9.28	7	0.233
Employed	13(3.3)	194.88			
Retired	48(12.0)	189.31			
Self-Employed	111(27.8)	209.61			
Student	90(22.5)	216.99			
Unemployed	33(8.3)	151.7			
Average monthly income					
Above 200,000	60(15.0)	204.53			
101,000-200,000	136(34.0)	194.79			
50,000-100,000	196(49.0)	202.79	0.917	4	0.922
Below 50,000	8(2.0)	198.46			

Table 3b, shows the results of the Kruskal-Wallis tests assessing the relationship between socio-demographic variables and blood glucose levels among the study participants (n= 400). Age was not significantly associated with blood glucose level (H = 7.057, df = 4, *p* = .133), though early elderly participants had the highest mean rank (217.63), while late elderly participants had the lowest (176.45).

Similarly, marital status did not show a significant relationship with blood glucose level (H = 6.561, df = 4, *p* = .161). Among the categories, divorced participants had the highest mean rank (227.89), while widowers had the lowest (87.00). Also, Highest education level was not significantly associated with blood glucose level *(H = 2.427, df* = 3, *p* = .489). Participants with no formal education had the highest mean rank (257.21), while those with primary school education had the lowest (192.31). Ethnicity did not show a significant association with blood glucose level (H = 3.871, df = 3, *p* = .276). Yoruba participants had the highest mean rank (268.70), while Efik/Ibibio participants had the lowest (171.53). Present occupation was not significantly associated to blood glucose level (H = 9.28, df = 7, *p* = .233). Students had the highest mean rank (216.99), while unemployed individuals had the lowest (151.70). Finally, average monthly income was not significantly associated with blood glucose level (H = 0.917, df = 4, *p* = .922). Participants earning above ₦200,000 had a mean rank of 204.53, those earning between ₦101,000-₦200,000 had the lowest mean rank (194.79), while those earning ₦50,000-₦100,000 had a slightly higher mean rank of 202.79. Participants earning below ₦50,000 had a mean rank of 198.46.

Discussion

The findings in table 1 highlight a significant positive correlation between anthropometric indices (BMI and WHR) and blood glucose levels. This suggests that individuals with higher BMI and WHR are more likely to have elevated blood glucose levels. However, the correlation with BMI appears slightly stronger than that with WHR, indicating that BMI may be a more robust predictor of blood glucose in this sample. The results align with findings from Odili and Abatta (2015) in South East Nigeria, which also identified BMI as a predictor of blood glucose levels. Their study quantified this relationship, showing that a 2 kg/m² increase in BMI raised blood glucose by 0.18 mmol. This supports the idea that excess body weight, as measured by BMI, contributes to higher blood glucose levels. However, the study from Indonesia (Yuliawuri et al., 2024) reported a weak, non-significant correlation between BMI and blood glucose levels ($r = 0.82$, $p = 0.411$). Yuliawuri et al. (2024) suggested using body fat percentages instead of BMI as a more precise measure of adiposity. This highlights a limitation of BMI as it does not differentiate between fat and muscle mass, which could affect its reliability as a predictor of blood glucose. Regarding WHR, this study's findings are in line with a study by Gwarzo et al. (2020) which reported that WHR correlated positively with FBG but only among female participants. This indicates that abdominal fat distribution (WHR) may have stronger metabolic consequences in women, possibly due to differences in hormonal regulation, insulin sensitivity, and fat metabolism. Similarly, Yadav (2023) reported significantly higher random blood sugar levels in individuals with elevated WHR among a healthy young adult Indian population. However, conflicting evidence comes from Ojeka et al. (2021), who found a significant negative correlation between fasting blood sugar and WHR This inconsistency suggests that the relationship between WHR and blood sugar might depend on other factors, such as the type of blood sugar measurement (fasting vs. random), population characteristics, or differences in fat distribution patterns. Clearly, while both BMI and WHR correlate with blood glucose, BMI appears to be a stronger related factor in this study. Also, WHR's correlation with blood sugar might be more variable across populations and measurement methods. Furthermore, the variations in findings across different studies (e.g., Nigeria, Indonesia, India) indicate that regional, genetic, or lifestyle factors may influence the relationship between anthropometric indices and blood glucose levels.

Finding in table 2, revealed a significant association between BMI categories and WHR risk levels, suggesting that individuals with higher BMI are more likely to fall into higher WHR risk categories. This aligns with existing evidence that central adiposity (WHR) is often elevated among individuals with higher BMI, reinforcing the relationship between general obesity (BMI) and abdominal obesity (WHR). The findings align with Aydin et al. (2024), who found significant associations between BMI and WHR, noting gender-based differences in body composition. This suggests that while both men and women experience an association between BMI and WHR, fat distribution patterns may vary between the sexes. One of the most striking findings of this study is the simultaneous presence of under-nutrition and obesity: A smaller number of the participants were underweight and more than half fell into one of the obesity classes. This pattern exemplifies the "double burden" of malnutrition, where under-nutrition and over-nutrition co-exist within the same population. This is a growing concern in many low- and middle-income countries (LMICs), including Nigeria, driven by: socio-economic disparities, where some individuals struggle with food insecurity while others have excessive caloric intake; Nutritional transition, with a shift from traditional diets to processed, calorie-dense foods that promote obesity; Urbanization and sedentary lifestyles, contributing to rising obesity rates (Kiosia et al., 2024).

Finding in table 3 showed two significant socio-demographic factors influencing blood sugar levels: gender differences and family history of diabetes. However, it did not find significant associations between blood sugar levels and other socio-demographic variables, such as age, marital status, education level, ethnicity, occupation, or income. These findings contributed to the growing discourse on how socio-demographic characteristics shape metabolic health outcomes, particularly in a community-specific context (Aboh Mbaise, Nigeria). The study found a statistically significant gender difference in blood glucose levels, with females having higher levels than males. Oestrogen and progesterone fluctuations can affect insulin sensitivity, particularly in postmenopausal women, leading to higher fasting glucose levels. Also, women typically have higher body fat percentage than men, particularly subcutaneous and visceral fat, which has been linked to insulin resistance (Borah & Goswami, 2016). This finding contrasts with a prior study by Borah and Goswami (2016), who reported elevated fasting blood glucose in both sexes, with males having slightly higher levels, though not statistically significant. In contrast, Uloko et al. (2018), in a Nigerian study, did not find significant gender-based differences but observed a general increase in diabetes prevalence with age. However, Islam (2017) found gender differences in diabetes prevalence in Bangladesh, but male participants had a higher risk. Thus, while the current study suggests a higher risk for females, this relationship may vary depending on regional, genetic, and lifestyle factors. The significant association between family history of diabetes and blood sugar levels from this study aligns with established research. Alrashed et al. (2023) reported a higher percentage risk of diabetes among individuals with a family history. Furthermore, their study reported nearly half diabetes risk if the father had diabetes and 39.3% diabetes risk if the mother had diabetes. This supports the idea that having a diabetic parent substantially increases the likelihood of developing high blood sugar levels or diabetes. Individuals with a family history of diabetes may inherit genetic mutations affecting insulin production, insulin resistance, or glucose metabolism (Alrashed et al., 2023). Ismail et al. (2021) emphasized that family history is not purely genetic but also reflects lifestyle patterns, including dietary habits, physical activity levels, and obesity rates, which can influence diabetes risk. Individuals with a family history tend to develop diabetes earlier in life, requiring preventive interventions such as early screening and lifestyle modifications. Interestingly, the study did not find significant associations between blood glucose levels and age, marital status, education, ethnicity, occupation, or income. This contradicts Uloko et al. (2018), who found increasing diabetes prevalence with age in Nigeria. Similarly, Islam (2017) in Bangladesh identified age as a significant predictor of diabetes ($p < 0.05$). Studies in LMICs have found an inverse relationship between income/education and diabetes risk, where lower socio-economic status is linked to higher diabetes prevalence due to poor access to healthcare, unhealthy diets, and limited physical activity. However, the lack of association in this study suggests that Aboh Mbaise may have unique socio-economic dynamics that differ from urban or national trends.

Conclusion

This research has identified several essential connections that deepen the current comprehension of diabetes risk factors in Nigeria. The positive correlation between higher BMI/WHR and increased blood glucose levels reaffirms the well-established association between obesity, central adiposity, and glucose dysregulation. This relationship remains strong across different socio-demographic variables, such as age, marital status, educational level, ethnicity, occupation, or income. As diabetes and obesity remain pressing public health issues around the globe, research that uncovers population-specific risk factors and potential intervention strategies becomes increasingly important. Also, this study contributes valuable insights to that critical body of knowledge.

Recommendations

Based on the findings and conclusions, the researchers hereby recommend the following:

1. The study indicated that the correlation between WHR and blood sugar could vary across different populations and measurement techniques. Future investigations could integrate body fat percentage or visceral fat assessments to enhance precision in predicting blood glucose levels.

2. Healthcare professionals should encourage individuals to adopt healthier lifestyles for effective behaviour changes.
3. Regular blood glucose monitoring should be recommended, particularly for high-risk groups.
4. Future research should explore regional variations, cultural influences, and lifestyle factors affecting blood glucose levels.
5. Governments and Non-governmental organizations (NGOs) ought to invest in education focusing on diabetes risk factors and healthy living.

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