

Original Article

A cross-sectional anthropometric analysis of diabetic patients in a tertiary care facility: Implications for risk assessment and targeted interventions

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Abstract

Understanding how body measurements such as Body Mass Index (BMI), waist circumference, and waist-to-hip ratio correlate with diabetes can provide valuable insights for its management and prevention. This study evaluates the anthropometric parameters of patients with diabetes mellitus attending Irrua Specialist Teaching Hospital (ISTH) and assesses their association with diabetes type and risk. This cross-sectional study involved 200 adult patients with diabetes mellitus. Measurements included height, weight, BMI, waist and hip circumferences, and waist-to-hip ratio. Descriptive statistics, gender comparisons, Pearson correlation, and logistic regression analyses, using IBM SPSS version 26.0, evaluated the associations between these measurements and diabetes. The mean age of participants was 50.41 years, with a mean BMI of 27.92 and a waist circumference of 94.20 cm. Significant gender differences were observed in age, height, weight, waist and hip measurements, and waist-to-hip ratio ($p < 0.001$). Patients with Type 2 diabetes showed higher anthropometric values than those with Type 1. BMI and waist circumference correlated with diabetes risk ($p = 0.004$), with logistic regression identifying BMI as a significant predictor ($p = 0.015$). Anthropometric factors, particularly BMI and waist circumference, are associated with diabetes risk and can be useful for screening purposes.

Keywords: diabetes mellitus, anthropometric, BMI, waist circumference, risk factors, diabetes type 2

Introduction

Diabetes mellitus is a chronic, progressive condition characterized by elevated blood glucose levels due to defects in insulin secretion, insulin action, or both. It is one of the most significant public health challenges in the 21st century, affecting millions globally. The World Health Organization (WHO) projects that the prevalence of diabetes will nearly double by 2030, from 177 million in the year 2000 to 370 million [1]. This upward trajectory is alarming and highlights the need for comprehensive management and preventive strategies to curb the diabetes pandemic.

The global burden of diabetes is particularly pronounced in developing countries, where healthcare

systems are often under-resourced and ill-equipped to manage the complexities of chronic diseases like diabetes. In 2010, the prevalence of diabetes among adults worldwide was estimated at 285 million, or 6.4% of the global adult population [2]. This figure is expected to rise to 439 million, representing a 7.7% increase, by 2030 [1]. Such projections underscore the urgent need for innovative approaches to prevention and management, especially in low- and middle-income countries like Nigeria, where the healthcare system faces numerous challenges, including a growing population of individuals at risk for metabolic disorders.

A significant contributor to the increasing prevalence of diabetes is the rising rate of obesity, a well-established risk factor for numerous metabolic disorders,



including type 2 diabetes mellitus (T2DM) [3]. Obesity not only intensifies insulin resistance but also heightens the risk of cardiovascular diseases, ischemic heart disease, and other components of metabolic syndrome [4]. As obesity becomes more widespread across developed and developing nations, so does the incidence of diabetes, perpetuating a cycle of chronic disease burden.

Anthropometric measurements are crucial for predicting type 2 diabetes risk, with studies suggesting that central adiposity indicators, such as the waist-to-hip ratio (WHR), may outperform general obesity measures, like body mass index (BMI), in predicting diabetes risk [5, 6]. Central fat distribution, reflected by a higher WHR, is considered a better marker of visceral fat accumulation, which is closely linked to insulin resistance and the onset of T2DM [7]. Research has shown that higher WHR is independently associated with an increased risk of diabetes, regardless of BMI [8]. However, some studies argue that BMI remains a valuable predictor of diabetes risk, particularly in specific populations [9].

The debate over the most predictive anthropometric measure for diabetes underscores the need for further research across diverse populations. In Nigeria, where obesity and diabetes rates are rising rapidly, limited data exist on the relationship between anthropometric indices and diabetes risk. This gap is especially pronounced in rural areas like Irrua, where access to healthcare and diagnostic services is restricted, leading to underreporting and underestimation of diabetes prevalence [9].

Assessing anthropometric measures could provide crucial insights into the risk of obesity and diabetes in this population, enabling the development of tailored interventions. For instance, determining whether WHR is a superior predictor of diabetes risk compared to BMI among Nigerian patients could guide the creation of culturally relevant diabetes prevention and screening guidelines. Exploring other anthropometric indices, such as waist circumference and skinfold thickness, may offer a broader perspective on the relationship between body fat distribution and metabolic health [9].

Anthropometric data can also shed light on the impact of body structure on the types and complications of diabetes. Certain skeletal dimensions might correlate with metabolic risks, influencing insulin sensitivity and glucose metabolism. Measures such as BMI, waist circumference (WC), and WHR offer valuable insights into body composition and fat distribution, which are critical in understanding diabetes risk [9].

Diabetes mellitus is a growing health concern in Nigeria, particularly in rural areas like Irrua, where healthcare resources are limited. Despite the increasing prevalence of obesity and diabetes, there is a lack of data on the most effective anthropometric measurements for predicting diabetes risk in this population. Current evidence suggests that central fat distribution, as indicated by the waist-to-hip ratio (WHR), may be a better predictor of type 2 diabetes than general adiposity, as measured by body mass index (BMI) [5–7]. However, this relationship has not been adequately studied in Nigerian populations, particularly in the rural context. This study aims to address this gap by evaluating the predictive value of BMI and WHR for diabetes risk among patients at the Irrua Specialist Teaching Hospital. By doing so, it seeks to inform future screening and prevention strategies tailored to the Nigerian population.

This study was conducted to investigate the anthropometric predictors of diabetes among patients attending the Tertiary Specialist Teaching Hospital in Irrua, Edo State, Nigeria, with the objectives to: assess the prevalence of diabetes and its types among patients attending the Specialist Teaching Hospital, evaluate the relationship between body mass index (BMI) and the risk of type 2 diabetes mellitus (T2DM) in the study population, determine the correlation between waist-to-hip ratio (WHR) and the risk of type 2 diabetes mellitus (T2DM) in the study population, compare the predictive value of BMI and WHR in assessing the risk of type 2 diabetes among the patients, evaluate the relationship between body mass index (BMI), waist-to-hip ratio (WHR) and any other type of diabetes in the assessment in the study population.

The findings of this study would provide evidence-based insights into the most effective anthropometric measures for predicting diabetes risk in a Nigerian population. Understanding the relationship between BMI, WHR, and diabetes risk can lead to improved screening protocols, enabling earlier detection and intervention, particularly in resource-limited settings such as rural areas.

Moreover, the findings of this study could contribute to the global body of research on diabetes risk factors, with a particular focus on African populations, which are often underrepresented in diabetes studies. The results will also help healthcare providers develop culturally and contextually appropriate guidelines for managing and preventing diabetes, thereby improving patient outcomes and reducing the burden on the healthcare system.

Material and methods

This cross-sectional study was conducted to evaluate anthropometric parameters associated with diabetes among patients attending a tertiary health facility located in Edo State, Nigeria. The hospital serves a diverse population and provides a range of healthcare services, including outpatient and inpatient care for patients with diabetes and other chronic conditions. The sample size was calculated using the random sampling formula for this cross-sectional study.

Participants included adult patients aged 18 years and older who were diagnosed with diabetes mellitus. A total of 200 patients were recruited from the hospital's outpatient department.

Inclusion criteria include adults aged 18 to 88 years, diagnosed with diabetes mellitus (type 1 and type 2) and willingness to participate and provide informed consent. In contrast, exclusion Criteria include Patients with acute infections or chronic conditions that may affect anthropometric measurements (*e.g.*, recent surgeries, malignancies), Pregnant women or those who have given birth within the last six months, and Patients with any cognitive impairment that would hinder informed consent or understanding of the study.

The following anthropometric measurements were taken:

- Height: Measured to the nearest 0.1 cm using a stadiometer;
- Weight: Recorded to the nearest 0.1 kg using a digital weighing scale;
- Body Mass Index (BMI): Calculated using the formula: $BMI = \text{Weight (kg)} / \text{Height (m)}^2$;
- Waist Circumference (WC): Measured at the midpoint between the lower rib and the iliac crest using a flexible tape measure;

- Hip Circumference (HC): Measured at the widest part of the hips;
- Waist-to-hip Ratio (WHR): Calculated using the formula: $WHR = \text{Waist Circumference (cm)} / \text{Hip Circumference (cm)}$.

The data were analyzed using IBM SPSS version 26.0. Descriptive statistics, including means, standard deviations (SD), minimum, and maximum values, were calculated for all anthropometric and demographic parameters. To compare gender-based differences in these parameters, independent samples t-tests were conducted. Pearson correlation analysis was used to assess the relationships between BMI, waist-to-hip ratio, and diabetes type. Logistic regression analysis was performed to evaluate the predictive power of anthropometric measurements (weight, BMI, waist circumference, hip circumference, and waist-to-hip ratio) on diabetes risk and type, with a significance level set at $p < 0.05$.

Results

Descriptive statistics for anthropometric and demographic parameters of participants

Table 1 presents the descriptive statistics for the anthropometric and demographic parameters of the study participants. The mean age of the participants was 50.41 years, with a range of 22 to 88 years. The mean height was 162.69 cm, with a minimum value of 15.94 cm and a maximum of 221.03 cm. The average weight was 75.11 kg, with a range from 50.30 kg to 110.20 kg. The mean Body Mass Index (BMI) was 27.92, with a standard deviation of 3.53. Waist circumference had a mean of 94.20 cm, ranging from 70.00 cm to 128.27 cm, while the mean hip circumference was

Table 1: Descriptive statistics for anthropometric and demographic parameters of participants.

Parameters	N	Minimum	Maximum	Mean	SD
Age	200	22	88	50.41	12.57
Height (cm)	200	15.94	221.03	162.69	13.37
Weight (kg)	200	50.30	110.20	75.11	10.29
BMI	200	16.00	42.2	27.92	3.53
Waist circumference (cm)	200	70.00	128.27	94.20	9.99
Hip circumference (cm)	200	78.74	123.19	102.85	7.72
Waist-to-hip ratio	200	0.76	1.26	0.92	0.06

102.85 cm. The waist-to-hip ratio averaged 0.92, with a standard deviation of 0.06.

Gender-based comparison of anthropometric parameters

Table 2 compares the anthropometric parameters between male and female participants. Age differences were statistically significant, with males having a higher mean age (52.65 years) compared to females (48.03 years) ($p=0.009$). Males were also significantly taller (169.10 cm) and heavier (80.48 kg) than females, whose average height and weight were 155.88 cm and 69.40 kg, respectively ($p<0.001$ for both). No significant difference was found in BMI ($p=0.645$), indicating similar average BMI values between males (27.81) and females (28.04). Waist circumference (99.09 cm for males vs. 89.01 cm for females), hip circumference (105.49 cm for males vs. 100.04 cm for females), and waist-to-hip ratio (0.94 for males vs. 0.89 for females) all showed significant differences, with males exhibiting higher values in all measures ($p<0.001$).

Comparison of anthropometric parameters between Diabetes Type 1 and Type 2 Diabetes

Table 3 compares anthropometric parameters between patients with Type 1 Diabetes and Type 2

Diabetes. There were no significant differences in age ($p=0.544$), height ($p=0.945$), or waist-to-hip ratio ($p=0.118$). However, significant differences were found in weight ($p=0.021$), BMI ($p=0.004$), waist circumference ($p=0.018$), and hip circumference ($p<0.001$). Participants with Type 1 diabetes had lower weights (65.55 kg), BMIs (23.87), waist circumferences (84.73 cm), and hip circumferences (89.77 cm) compared to those with Type 2 diabetes (75.40 kg, 28.04, 94.49 cm, 103.25 cm, respectively).

Pearson correlation matrix of BMI, waist-to-hip ratio, and diabetes type

Table 4 presents the Pearson correlation matrix for BMI, waist-to-hip ratio, and diabetes type. BMI was positively correlated with diabetes type ($r=0.202$, $p=0.004$), indicating that higher BMI was associated with an increased likelihood of having diabetes. The waist-to-hip ratio showed a significant positive correlation with BMI ($r=0.181$, $p=0.010$), but was not significantly correlated with diabetes type ($r=-0.111$, $p=0.118$).

Logistic regression analysis of anthropometric measurements in predicting diabetes risk

Table 5 shows the results of a logistic regression analysis to predict diabetes risk based on anthropometric

Table 2: Gender-based comparison of anthropometric parameters.

Parameters	Gender	N	Mean	SD	T-test	P-value
Age	Male	103	52.65	11.87	2.636	0.009*
	Female	97	48.03	12.91		
Height (cm)	Male	103	169.10	7.19	8.029	0.000*
	Female	97	155.88	14.98		
Weight (kg)	Male	103	80.48	9.06	9.009	0.000*
	Female	97	69.40	8.27		
BMI	Male	103	27.81	3.73	-0.462	0.645
	Female	97	28.04	3.33		
Waist circumference (cm)	Male	103	99.09	9.38	8.256	0.000*
	Female	97	89.01	7.78		
Hip circumference (cm)	Male	103	105.49	7.85	5.333	0.000*
	Female	97	100.04	6.53		
Waist-to-hip ratio	Male	103	0.94	0.051	5.659	0.000*
	Female	97	0.89	0.07		

Note: * – Correlation is significant at the 0.05 level (2-tailed).

Table 3: Comparison of anthropometric parameters between Diabetes Type 1 and Type 2 Diabetes.

Parameters	Diabetes Type	N	Mean	SD	T-test	P-value
Age	DM Type 1	6	47.33	20.64	-0.608	0.544
	DM Type 2	194	50.51	12.31		
Height (cm)	DM Type 1	6	163.06	9.01	0.069	0.945
	DM Type 2	194	162.68	13.49		
Weight (kg)	DM Type 1	6	65.55	8.24	-2.335	0.021*
	DM Type 2	194	75.40	10.22		
BMI	DM Type 1	6	23.87	2.68	-2.906	0.004*
	DM Type 2	194	28.04	3.49		
Waist circumference (cm)	DM Type 1	6	84.73	9.46	-2.385	0.018*
	DM Type 2	194	94.49	9.89		
Hip circumference (cm)	DM Type 1	6	89.77	9.01	-4.403	0.000*
	DM Type 2	194	103.25	7.34		
Waist-to-hip ratio	DM Type 1	6	0.96	0.14	1.571	0.118
	DM Type 2	194	0.92	0.06		

Note: * – Correlation is significant at the 0.05 level (2-tailed).

Table 4: Pearson correlation matrix of BMI, waist-to-hip ratio, and diabetes type.

Parameters	Correlation	BMI	Waist-to-hip ratio	Diabetes Type
BMI	Pearson correlation	1		
	Sig. (2-tailed)			
	N	200		
Waist-to-hip Ratio	Pearson correlation	.181*	1	
	Sig. (2-tailed)	.010		
	N	200	200	
Diabetes Type	Pearson correlation	.202**	-.111	1
	Sig. (2-tailed)	.004	.118	
	N	200	200	200

Note: * – Correlation is significant at the 0.05 level (2-tailed); ** – Correlation is significant at the 0.01 level (2-tailed).

Table 5: Logistic regression analysis of anthropometric measurements in predicting diabetes risk.

	Parameters	B	S.E.	Wald	df	Sig.	Exp(B)/OR
Step 1 ^a	Weight (kg)	-.142	.103	1.903	1	.168	.868
	BMI	.216	.089	5.879	1	.015	1.241
	Waist circumference (cm)	.713	.396	3.249	1	.071	2.041
	Hip circumference (cm)	-.366	.331	1.224	1	.269	.693
	Waist-to-hip ratio	-56.257	31.804	3.129	1	.077	.000
	Constant	31.876	28.074	1.289	1	.256	6.973E+13

Note: ^a – Variable(s) entered on step 1: Weight (kg), BMI, Waist circumference (cm), Hip circumference (cm), Waist-to-hip ratio.

Table 6: Logistic regression parameter estimates for predicting Diabetes Type 1.

Diabetes Type ^a	B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower bound	Upper bound
DM Type 1	Intercept	-31.876	28.074	1.289	1	.256		
	Weight (kg)	.142	.103	1.903	1	.168	1.152	.942 1.409
	BMI	-.216	.089	5.879	1	.015	.806	.676 .959
	Waist circumference (cm)	-.713	.396	3.249	1	.071	.490	.226 1.064
	Hip circumference (cm)	.366	.331	1.224	1	.269	1.442	.754 2.758
	Waist-to-hip ratio	56.257	31.804	3.129	1	.077	2.705E+24	.002 3.187E+51

Note: ^a – The reference category is: DM Type 2.

measurements. BMI emerged as a significant predictor (Exp(B)=1.241, $p=0.015$), suggesting that higher BMI increases the risk of diabetes. Waist circumference was also marginally significant (Exp(B)=2.041, $p=0.071$), indicating that a larger waist circumference may elevate the risk. Other variables such as weight, hip circumference, and waist-to-hip ratio were not significant predictors of diabetes risk ($p>0.05$).

Logistic regression parameter estimates for predicting Diabetes Type 1 and Type 2

Tables 6 and 7 present the logistic regression estimates for predicting Diabetes Type 1 and Type 2. For Type 1 diabetes, the waist-to-hip ratio was highly significant (Exp(B)=2.705E+24, $p=0.077$), although the confidence intervals were extremely wide, suggesting an implausible estimate. BMI, waist circumference, and weight showed no significant predictive value

for the development of Type 1 diabetes. Conversely, for Type 2 diabetes, BMI (Exp(B)=1.241, $p=0.015$) and waist circumference (Exp(B)=2.041, $p=0.071$) were significant, with higher values indicating increased risk for Type 2 diabetes. The waist-to-hip ratio for Type 2 diabetes was similarly non-significant with extremely large confidence intervals.

Discussion

The anthropometric evaluation of diabetes among patients at Irrua Specialist Teaching Hospital (ISTH) provides valuable insights into how body composition and demographic parameters relate to diabetes risk and the differentiation between different types of diabetes. In this study, the mean age of 50.41 years highlights that the majority of participants fall within the middle-aged and older adult categories, a population

Table 7: Logistic regression parameter estimates for predicting Diabetes Type 2.

Diabetes Type ^a	B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower bound	Upper bound
DM Type 2	Intercept	31.876	28.074	1.289	1	.256		
	Weight (kg)	-.142	.103	1.903	1	.168	.868	.709 1.061
	BMI	.216	.089	5.879	1	.015	1.241	1.042 1.478
	Waist circumference (cm)	.713	.396	3.249	1	.071	2.041	.940 4.433
	Hip circumference (cm)	-.366	.331	1.224	1	.269	.693	.363 1.326
	Waist-to-hip ratio	-56.257	31.804	3.129	1	.077	3.697E-25	3.137E-52 435.658

Note: ^a – The reference category is: DM Type 1.

more predisposed to diabetes. The BMI mean of 27.92, indicative of an overweight population, further reveals the connection between obesity and diabetes prevalence. Waist circumference (mean, 94.20 cm) and waist-to-hip ratio (mean, 0.92) indicate central obesity, a well-established risk factor for diabetes. These findings correlate with studies by Bai *et al.* [10], which documented similar anthropometric profiles among diabetic populations in Nigeria. Such data underline the importance of addressing obesity and its associated metabolic risks in diabetes prevention strategies.

Gender differences in anthropometric parameters, as presented in Table 2, showed significant disparities in height, weight, waist circumference, hip circumference, and waist-to-hip ratio, with males consistently showing higher values. However, BMI showed no significant difference between genders, suggesting comparable levels of obesity. Males had significantly higher waist-to-hip ratios and waist circumferences, pointing to more pronounced abdominal obesity. This aligns with findings by Ashtary-Larky *et al.* [11], who attributed these differences to gender-specific patterns of fat distribution. The higher waist-to-hip ratio in males suggests a greater risk of metabolic syndrome, a precursor to Type 2 diabetes, as supported by Yousif *et al.* [12].

The analysis of anthropometric differences between patients with Type 1 and Type 2 diabetes in Table 3 further illustrates the distinct etiologies of these conditions. Patients with Type 2 diabetes exhibited significantly higher values for weight, BMI, waist circumference, and hip circumference compared to those with Type 1 diabetes. These results are consistent with those of Aghaei *et al.* [13], who emphasized the role of obesity in Type 2 diabetes but found it less relevant for Type 1 diabetes, which is primarily autoimmune. These findings highlight the importance of weight management in Type 2 diabetes prevention and management, particularly in populations where obesity prevalence is high. On the other hand, the absence of significant anthropometric differences in Type 1 diabetes shows the need for a different set of risk assessment tools for this group.

The Pearson correlation analysis in Table 4 reveals a positive relationship between BMI and diabetes type, suggesting that a higher BMI is more closely associated with Type 2 diabetes. This aligns with global research, such as that by Gray *et al.* [14], which has demonstrated that increased BMI is a critical predictor of Type 2 diabetes. While the waist-to-hip ratio did not show a significant correlation with diabetes type, it was significantly correlated with BMI, reflecting the intertwined nature of general and central obesity. This suggests that

while the waist-to-hip ratio is an important indicator of fat distribution, its predictive value for Type 2 Diabetes may vary depending on population characteristics.

Logistic regression analysis in Table 5 further confirms the role of BMI as a significant predictor of diabetes risk, with an odds ratio suggesting that higher BMI increases the likelihood of diabetes. Waist circumference emerged as a marginally significant predictor, reinforcing the role of central obesity in the pathogenesis of diabetes. These findings are consistent with those of He *et al.* [15], who emphasized BMI and waist circumference as critical metrics for identifying individuals at risk for diabetes. The non-significance of other variables, such as weight and hip circumference, suggests that specific indices of obesity, rather than general body size, are more relevant for assessing diabetes risk.

Tables 6 and 7 show the predictive values of anthropometric measurements for Type 1 and Type 2 diabetes. BMI and waist circumference were significant predictors for Type 2 diabetes, emphasizing the role of obesity and central fat accumulation in its development. These results agree with the findings of Ruze *et al.* [16], who identified abdominal obesity as a cornerstone of Type 2 diabetes pathophysiology. Conversely, no anthropometric variables significantly predicted Type 1 diabetes, consistent with its autoimmune etiology. The extreme confidence intervals for waist-to-hip ratio in predicting diabetes types highlight potential limitations in sample size or methodological approaches, necessitating caution in interpreting the results.

The findings of this study hold significant implications for public health and clinical practice. The high prevalence of obesity among participants, as reflected in BMI and waist circumference measures, reveals the urgent need for targeted interventions to address obesity in diabetes prevention programs. For instance, integrating anthropometric assessments into routine diabetes screening can facilitate the early identification of individuals at risk. Additionally, gender-specific differences in anthropometric parameters suggest that tailored strategies may be more effective in mitigating the risk of diabetes. For males, addressing abdominal obesity could be a priority, while for females, comprehensive weight management programs may yield better outcomes.

In the Nigerian context, where diabetes prevalence is rising alongside urbanization and lifestyle changes, these findings provide critical evidence for the development of localized intervention strategies. Previous studies, such as Uloko *et al.* [17] and Chukwuonye *et al.* [18], have highlighted the increasing burden of diabetes in Nigeria and the pivotal role of obesity in this trend.

The results from ISTH reinforce these observations, offering specific anthropometric parameters as actionable metrics for diabetes risk stratification. For healthcare facilities in resource-limited settings, adopting these measurements can enhance early detection and preventive care, particularly among high-risk populations.

Conclusion

This study highlights the crucial role of anthropometric indices, specifically BMI and waist circumference, in predicting diabetes risk and distinguishing between different types of diabetes. These findings align with global research while offering valuable localized insights for the Nigerian population. The gender-specific differences in anthropometric parameters further underscore the need for targeted interventions to address the distinct risk profiles of males and females. Integrating these findings into public health initiatives and clinical practice would enhance diabetes prevention and management strategies, thereby reducing the burden of this growing epidemic.

Conflict of interest

The authors declare no conflict of interest.

Ethics approval

The approval for this study was obtained from the Ethics Committee of the Health Research Ethics Unit of the University (approval ID: 025/25).

Consent to participate

Written informed consent was obtained from all the participants.

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