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Original Research Article

Evaluation of Obesity Indices for Hyperglycemia Prediction in the Adult Population of Gaya, Bihar

Anisha[1], Dipti Panwar[2]

[1]Tutor, Department of Physiology, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India

[2]Tutor, Department of Pathology, Nalanda Medical College and Hospital, Patna, Bihar, India

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Corresponding author: Dipti Panwar
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Abstract:

Background: Diabetes mellitus is recognized to have an association with obesity. Body Mass Index (BMI), Waist Circumference (WC), and Waist-Height Ratio are a few of the obesity markers that can be used to evaluate and categorize obesity status (WHtR). The goal of the current study was to evaluate the predictive value of these obesity markers for hyperglycemia.

Methods: We assessed the levels of BMI, WC, WHtR, and Random Capillary Blood Glucose (RCBG) in 180 adult volunteers from Gaya, Bihar, India. To evaluate associations and differences of measured parameters among various categories, Chi-square, unpaired Student's t-test, and Pearson correlation were used. The best obesity indices to predict hyperglycemia (RCBG 130 mg/dl) and cut-off values for prediction were found using receiver operating curve analysis.

Results: It was discovered that RCBG levels were substantially linked with age of individuals, WC, and WHtR (but not BMI). Compared to BMI and WC, the largest proportion of patients were classed as obese by WHtR. The best obesity indicator for predicting hyperglycemia in both male and female patients was likewise discovered to be WHtR.

Conclusion: In adults who appear to be in good health, WHtR can be utilized as a convenient, non-invasive, and cost-effective obesity index for screening and hyperglycemia prediction. Consequently, it is possible to further urge selected people to have blood glucose tests done in order to detect diabetes and prediabetes early.

Keywords: Type 2 Diabetes, Obesity, Waist Measurement, Ratio Of Waist To Height Arbitrary Capillary Blood Sugar.

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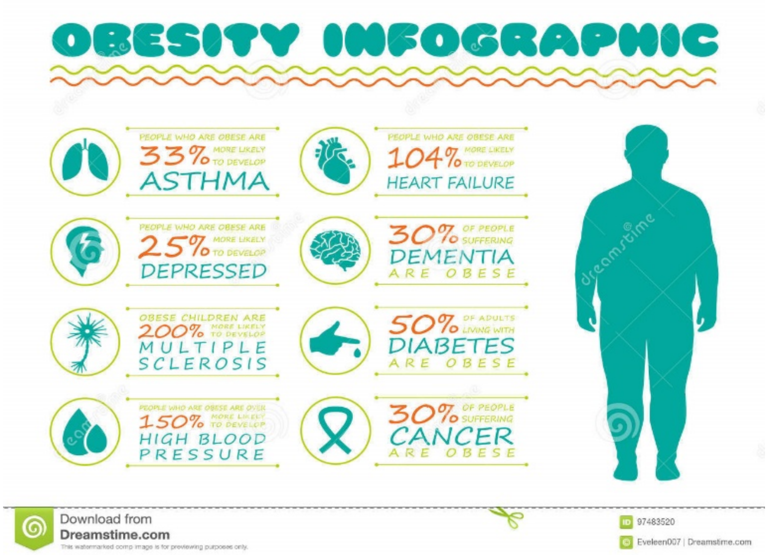
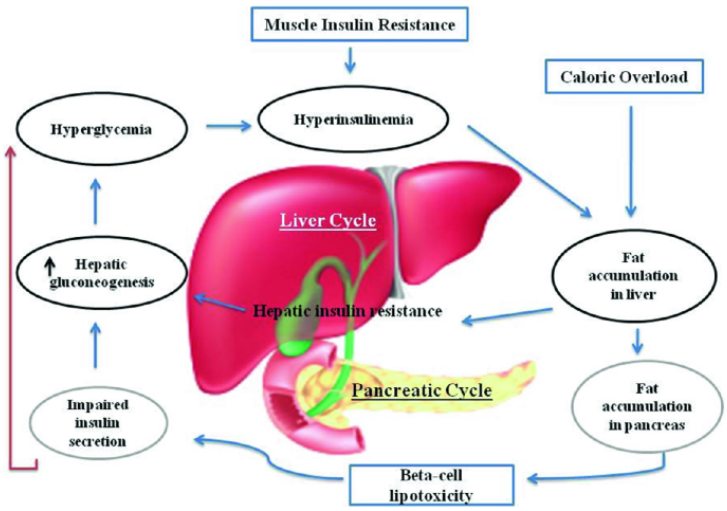
Introduction

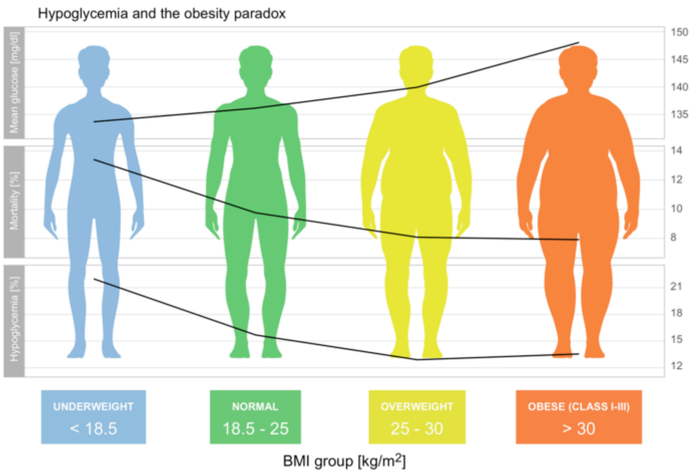
Diabetes mellitus (DM) is a well-known non-communicable illness associated with obesity. [1] Cases of DM and obesity are both on the rise right now, particularly in India. [2,3] Even among young people, prediabetes and diabetes are becoming more common worldwide and in India, having a negative impact on both health and the economy. [4-6] Many prediabetic and diabetic patients in India go undiagnosed, [5-7] necessitating the need for an appropriate screening approach for the early detection of these cases.

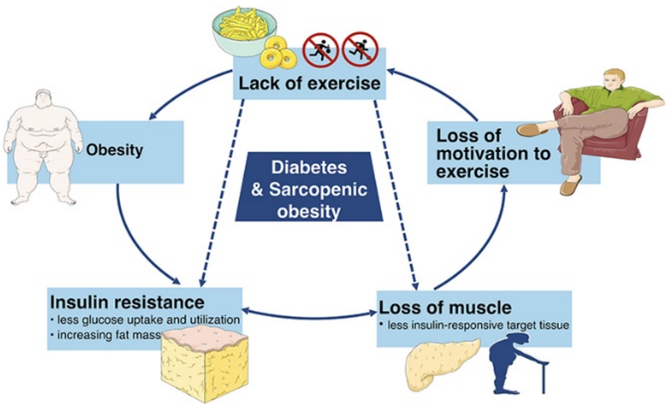
Measurement of blood glucose levels, an invasive test, is essentially the foundation for diagnosing hyperglycemia (prediabetic and diabetic). The word "diabesity" was invented to describe diabetes occurring in obese people and the direct association between high blood sugar levels (hyperglycemia) and obesity indices like Body Mass Index (BMI), Waist-Hip Ratio (WHR), and Waist Circumference (WC) has already been well established [1,8]. An inexpensive, rapid, and non-invasive way to test for hyperglycemia and diabetes risk at an early stage is provided by the previously noted high correlation between obesity indices and DM.





There are numerous ways to measure obesity, including BMI, waist-to-height ratios (WHtR), waist circumference ratios (WC), and waist-to-hip ratios (WHR). [8,9] While WC, WHR, and WHtR are less complex ways of assessing the fat distribution and central obesity, BMI is utilised as criteria for recognition and classification of widespread obesity [10-12]. It has been claimed that measuring central or abdominal obesity is a more accurate way to predict the likelihood of developing diseases associated to obesity [11-13].





In comparison to the western population, the Indian population has a higher risk of diabetes and other non-communicable diseases associated with obesity, even at lower obesity indices levels. [2,3] Research showing the relationship between obesity and diabetes and the corresponding cutoff points for the Indian population are few[3] and contentious because some have found a substantial relationship [14–16] while others have not [9,17] in different regions of India. This study examined the relationship between RCBG levels and obesity indices (BMI, WC, and WHtR) and their cutoff values for predicting hyperglycemia as a practical, affordable, and non-invasive technique.

Methods

In Gaya (Bihar), India, this study was carried out in the department of physiology, Anugrah Narayan Magadh Medical College, Gaya. RCBG level estimation and obesity indices assessments were provided free of charge to apparently healthy Varanasi locals who attended the institute (including patients' attendants, students, and staff) during the course of the study. Consecutive site visitors who gave permission and agreed to take part in the study were enrolled and put to the test. Volunteer individuals who were over 17 and did not have DM diagnoses met the inclusion criteria. To prevent medication-related confounding with blood glucose levels and other indicators, subjects younger than 17 years of age with self-reported diagnosed DM and who were taking antidiabetic drug treatment were excluded.

All tests and measurements were done between the hours of 11 am and 5 pm. The Glucometer was used to test RCBG levels in order to maximize subject compliance and convenience while adhering to all aseptic precautions and the instrument's approved operating procedures. [8,18,19] To categories subjects, RCBG levels between 140 and 130 mg/dl were used as the standard for normalcy and hyperglycemia, respectively. [19]

The department's resident doctors measured each patient's height (Ht) and weight (Wt). The subjects were told to take off their heavy clothing, jeweler, and shoes. To measure weight to the closest 0.5 kg, a calibrated weighing balance was employed. Subjects' heights were measured to the closest 0.5 cm using a wall-mounted stature meter [19]. The level between the iliac crest and the lower border of the costal margin was measured using a rigid measuring tape. The following criteria were used to determine a person's BMI (Kg/m2): 18.5 - underweight; 18.5-22.9 - normal; 23-24.9 - overweight; and 25 - obese [2]. For all participants, the WHtR cutoff was determined to be 0.5 [9,11]. The WC limit was set at 90 cm for men and 80 cm for women. [2,9]

180 participants in all were enrolled in this study during the study period after meeting the inclusion criteria. These 1880 seemingly healthy people' data (130 men and 50 women) were examined. Data were tallied, and participants were given RCBG, BMI, WC, and WHtR statuses based on the predetermined parameters mentioned above. The Statistical Package for the Social Sciences (SPSS) software, version 20, was used to conduct the statistical analysis. Unpaired Student's t-test was used to compare the data mean between male and female participants. To examine the correlation between numerical data, Pearson correlation was used. The difference in RCBG status distribution across categories of age and obesity indices was examined using the Pearson Chi-square test. To determine Area Under Curve (AUC), cutoffs, and sensitivity and specificity, Receiver Operating Characteristic (ROC) curve analysis was done (based on highest Youden index) [12]. It was deemed statistically significant at P < 0.04.

Results

Table 1 includes a comparison of male and female subjects, descriptive statistics for measured variables, and a correlation with RCBG levels. For male and female subjects, we discovered no discernible difference in age, RCBG levels, BMI, or WC. As would be predicted, males had higher mean Wt and Ht than females. Female individuals had considerably higher WHtR than male subjects while having lower WC and Ht. Age of subjects in males and WC in females are positively connected with RCBG levels, according to a correlation study [Table 1]. When WHtR was determined for the entire population, RCBG and WHtR exhibited a positive connection [Table 1].

Table 1: Correlations and descriptive statistics with random capillary blood glucose (RCBG) levels

Parameter	Mean (SD) N=180	Male (n-130) Mean (SD)	Female (n-50)	Male vs Female (unpaired student t-Test; P-value)	Pearson correlation with RCBG levels (r, P value)		
					Male	Females	Total
Age (years)	38.18 (14.98)	39.06 (15.33)	35.93 (13.91)	0.201	0.232, 0.005	0.252, 0.067	0.232, 0.002
Random capillary blood glucose (mg/dl)	1 11.98	112.36	111.01 (24.98)	0.833	-	-	-

Weight (Kg)	66.67(13.36)	69.73(12.53)	58.90(12.31)	0.001	-0.033, 0.692	0.134, 0.336	0.001, 0.982
Height (cm)	165.23 (8.81)	168.94 (6.60)	155.76 (6.30)	0.001	-0.126, 0.141	0.090, 0.518	-0.053-0.664
Body mass index (Kg/m^2)	24.41 (4.51)	24.41 (4.13)	24.36 (5.40)	0.960	0.017, 0.0833	0.300, 0.027	0.155, 0.32
Waist Circumference (cm)	90.70 (11.66)	90.90 (11.83)	90.20 (11.38)	0.714	-	-	-
Waist-height ratio	0.54 (0.06)	0.52 (0.06)	0.57 (0.06)	0.002	0.153, 0.073	0.258, 0.060	0.161, 0.027

The number of subjects with normal and high RCBG levels in the various categories of measured variables was then examined by cross-tabulation. Overall, 88.2% of participants had normal RCBG levels, whereas 11.6% had high levels. According to BMI, 64.89% of patients were considered obese by WC, while 78.1% of subjects were considered obese by WHtR. Male and female respondents did not differ in terms of age group distribution or RCBG status.

But female individuals had higher rates of both generalized and central obesity than male subjects did. Table 2 shows the examination of ROC curves for AUC and the upper and lower bounds of the measured obesity indices for hyperglycemia (RCBG values ≥130 mg/dl)

Table 2: Analysis of the receiver operating curve.

Test parameters	**Area under curve**	**Standard error**	**P value**	**95% Confidence interval**		**Cutoff**	**Sensitivity, specificity**
				Lower bound	**Upper bound**		
Males (RCBG ≥130 mg/dl)							
BMI (kg/m^2)	0.586	0.060	0.261	0.466	0.706	22.62	0.937, 0.344
WC (cm)	0.638	0.061	0.070	0.522	0.755	83.4	2, 0.293
WHtR	0.693	0.048	0.011	0.596	0.790	0.535	2, 0.495
Females (RCBG ≥130 mg/dl)							
BMI (kg/m^2)	0.701	0.080	0.080	0.112	0.857	24.33	0.832, 0.616
WC (cm)	0.754	0.123	0.042	0.512	0.997	93.51	0.832, 0.661
WHtR	0.754	0.111	0.042	0.536	0.973	0.595	0.832, 0.661

Discussion

The prevention of diabetes as well as the reduction of undiagnosed cases depend on the early detection of hyperglycemia. Even when blood sugar levels are still prediabetic, diabetes can be postponed or prevented by changing one's lifestyle.

In India, the financial burden on patients and the lack of knowledge of the existence of risk factors for diabetes limit the early detection of hyperglycemia (like obesity). The purpose of the current study was to evaluate the efficacy of easily measurable obesity indicators as a noninvasive, affordable, user-friendly, and early screening technique for the prediction of hyperglycemia.

In the current investigation, 180 apparently healthy persons were evaluated (130 men and 50 women), and their BMI was calculated for generalized obesity and their WC and WHtR for central obesity. The percentage of obese participants in this study was higher than in prior studies in the

Indian population, demonstrating that obesity is significantly more common in , India. [9] The majority of patients were classified as obese using the WHtR criteria, which was followed by the WC and BMI criteria. This pattern has also been noted in the Indian population in the past [9].

The amount of RCBG was shown to be substantially linked with females' WC and all participants' WHtR, but not with BMI [Table 1]. Previous research on the Indian population has produced mixed findings. Some studies [9,17] showed no association between blood glucose levels and obesity indices, while others identified sizable positive relationships [14,20].

Abdominal adiposity is measured by WC [10,12]. It has previously been discovered to be the best predictor for Type II diabetes [12,21], considerably greater in Type II diabetic males, and strongly linked with that condition. When seen in females and all individuals combined, WC is revealed to be significantly and positively linked with RCBG in the current study [Table 1]. In various prior research in the population of Pune city, India, it was found that there was a significant positive correlation between fasting blood sugar and WC and that diabetes was associated with high WC [14,20].

WC is a significant predictor of hyperglycemia in females, according to the study of the ROC curve [Table 2], with a cutoff level of 93.5 cm at 83.31% and 65% sensitivity and specificity, respectively. Although the cutoff reported in one prior study on Indian diabetic guys was 102.75 cm (at 65% and 75% sensitivity and specificity, respectively), the WC cutoff in males for high RCBG was 83.51 cm (at sensitivity 100% and specificity 29.3%). [12] The considerably higher WC threshold for females may suggest that males are more likely to experience hyperglycemia even at lower WC values, presumably as a result of physiological differences between the genders.

Those with WHtR 0.5 have been shown to have a substantial association with cardiovascular disease since WHtR is also a measure of visceral fat. [10,11] With a maximum AUC value (0.98) for the Homeostatic Model Assessment of Insulin Resistance, WHtR is considered to be a helpful screening tool for individuals with high risk of diabetes[11,22] and insulin resistance. [23] In our investigation, RCBG levels in the entire population had a positive correlation with WHtR, which was considerably greater in females. WHtR was discovered to be a significant predictor for hyperglycemia in both males and females after further ROC curve study. Males' WHtR cutoffs for elevated RCBG were determined to be 0.535 (with a sensitivity of 100% and a specificity of 49.6%), while females' cutoffs were 0.596 (with a sensitivity of 83.2% and a specificity of 66.1%)

The strongest predictor of hyperglycemia in both males and females, according to a comparison of the three assessed obesity indices, was found to be the WHtR, followed by WC and BMI. Even for the prediction of DM-related problems and early health hazards related to central obesity, WHtR had been reported to be better metrics than BMI alone [10,11,24]. Cutoffs of BMI indicating hyperglycemia in study participants were discovered to be below values currently regarded as normal according to existing criteria of BMI-wise obesity classification for the Indian population, indicating that even having normal range BMI, adult participants can have hyperglycemia.

The WC threshold for the risk of hyperglycemia in males (83.4 cm) likewise met the standards for normal, but was extremely high (93.4 cm) for females. The WHtR cutoffs for both males and females were found to be higher than the previously established cutoff (0.4) for high WHtR, indicating that WHtR levels above these cutoffs should be viewed as an alarming sign for the risk of hyperglycemia in both genders.

Hence, more than generalized obesity, the current data lend support to the idea that central or abdominal obesity is linked to a higher risk of hyperglycemia [25]. While measures of central obesity (WC and WHtR) showed significant connection with RCBG and were better at predicting high RCBG status in the study individuals, measures of general adiposity (BMI) [11,12] showed no significant correlation with RCBG and was not the best classifier for hyperglycemia. As previously reported [13], WHtR demonstrated to be the most accurate index for identifying obesity and screening for and predicting high blood sugar levels. [26]

Conclusion

The best obesity index for predicting hyperglycemia was discovered to be WHtR. A straightforward, non-invasive, low-cost approach for detecting and predicting hyperglycemia is WHtR measurement. For the purpose of confirming hyperglycemia, subjects with WHtR levels over the stated threshold values may be advised to undergo blood glucose tests.

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