ORIGINAL ARTICLE

Central Obesity and Screen-Detected Hyperglycaemia in Urban India: A Primary Care Perspective from a Low- and Middle-Income Country

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Abstract

Background: Central obesity is an important risk factor for impaired glucose metabolism and type 2 diabetes mellitus, particularly among urban populations in low- and middle-income countries. Early identification of individuals at risk of hyperglycaemia using simple anthropometric measures may strengthen opportunistic screening at the primary healthcare level. The study aimedto assess the association between central obesity and screen-detected hyperglycaemia among adults attending an urban primary health care facility in northern India. **Material & Methods:** An analytical cross-sectional study was conducted among 150 adults attending an urban primary health care facility in Ghaziabad, Uttar Pradesh, using consecutive sampling. Data regarding socio-demographic characteristics, anthropometric measurements, blood pressure, and random blood sugar levels were collected using a predesigned semi-structured questionnaire. Waist circumference and body mass index were assessed using standard procedures. Correlation analysis and multivariable logistic regression, adjusted for age, sex, BMI, family history of diabetes, systolic blood pressure, and central obesity, were performed to identify predictors of hyperglycaemia. **Result:** The mean waist circumference and body mass index were 91.53 ± 14.26 cm and 27.02 ± 6.27 kg/m^2 respectively. Random blood sugar showed significant positive correlation with waist circumference (r=0.200, p=0.014), body mass index (r=0.181, p=0.027), and systolic blood pressure (r=0.199, p=0.015). Multivariable logistic regression identified body mass index and systolic blood pressure as factors independently associated with screen-detected hyperglycaemia. **Conclusion:** Central obesity demonstrated significant association with screen-detected hyperglycaemia and other cardiometabolic risk factors. Waist circumference demonstrated a modest positive correlation with random blood sugar but was not independently associated with hyperglycaemia after adjustment.

Keywords: Central Obesity, Hyperglycemia, Waist Circumference, Body Mass Index, Primary Health Care, Noncommunicable Diseases.

Introduction

India is experiencing a rapid epidemiological transition, with non-communicable diseases (NCDs) emerging as a major public health challenge. Diabetes mellitus is among the leading contributors to morbidity and mortality, with the International Diabetes Federation estimating that over 77 million adults in India are living with diabetes, a substantial proportion of whom remain undiagnosed.[1] Rapid urbanisation, nutritional transition, and increasingly sedentary lifestyles have accelerated the burden of obesity and glucose dysregulation, particularly in urban populations.[2] Early identification of individuals at risk is therefore essential to facilitate timely interventions and reduce diabetes-related complications.

Central obesity, commonly assessed using waist circumference, reflects visceral fat accumulation and is a well-established determinant of insulin resistance and impaired glucose metabolism.[3] Unlike body mass index (BMI), which measures overall adiposity, waist circumference better reflects abdominal fat distribution and has been shown to correlate more closely with metabolic abnormalities.[4,5] Visceral adipose tissue is metabolically active and releases free fatty acids and pro-inflammatory cytokines that impair insulin signalling and glucose uptake, thereby increasing the risk of hyperglycaemia.[6] Since these metabolic alterations often remain clinically silent, many individuals with dysglycaemia remain undiagnosed until complications develop.[7]

Primary healthcare facilities provide an ideal platform for opportunistic screening of individuals at risk of diabetes. In resource-constrained settings, simple anthropometric measures such as waist circumference are inexpensive, non-invasive, and easy to incorporate into routine clinical practice.[8,9] Their use may facilitate early identification of high-

risk individuals and strengthen preventive strategies within primary healthcare services.

Evidence from both international and Indian studies consistently demonstrates a positive association between central obesity and impaired glucose metabolism. A comprehensive systematic review and dose-response meta-analysis involving more than 216 cohort studies reported that anthropometric indicators of abdominal adiposity, including waist circumference, were strongly associated with the risk of type 2 diabetes mellitus across diverse populations.[10] Similarly, a study among Chinese adults with normal BMI demonstrated that increasing waist circumference was independently associated with impaired glucose metabolism, prediabetes, and undiagnosed diabetes even after adjustment for BMI.[11] In India, studies have shown that central obesity is associated with glucose intolerance, hypertension, dyslipidaemia, and other components of metabolic syndrome.[12,13] Evidence from urban populations further supports the utility of waist circumference as a simple marker for identifying individuals at increased metabolic risk.[14] International studies from Latin America and the United States have likewise demonstrated that abdominal obesity independently predicts diabetes across different populations.[15,16] These findings are particularly relevant to South Asians, who tend to develop visceral adiposity and metabolic abnormalities at lower BMI thresholds than Western populations.[17,18]

Despite the established relationship between central obesity and diabetes, limited evidence is available regarding the association between waist circumference and screen-detected hyperglycaemia among adults attending urban primary healthcare facilities in India, where opportunistic screening forms an important component of non-communicable disease prevention. Understanding this relationship could help strengthen risk stratification and support simple, low-cost screening strategies in primary care. Therefore, the present study was undertaken to assess the association between waist circumference and screen-detected hyperglycaemia among adults attending an urban primary healthcare facility in Ghaziabad, Uttar Pradesh.

Primary Objective

To assess the association between waist circumference and screen-detected hyperglycaemia among adults attending an urban primary health care facility.

Secondary Objectives

To determine the association of waist circumference with other metabolic risk factors such as BMI, blood pressure, and family history of diabetes.

Material & Methods :

Study Design: Analytical cross-sectional study.

Study Setting: Urban primary health care facility attached to the Department of Community Medicine, Santosh Deemed to be University, Ghaziabad

Study Period: The study was done over a period of 4 months.

Study Population: Adults aged ≥30 years attending the urban primary health care facility over the study period.

Inclusion Criteria

- Aged ≥30 years.
- Not previously diagnosed with diabetes mellitus.
- Willing to provide informed consent.

Exclusion Criteria

- Known diabetes mellitus.
- Pregnant women.
- Severe illness precluding participation.

Sample Size and Sampling Technique: As this was a facility-based analytical cross-sectional study, all eligible adults attending the Urban Primary Health Care Centre during the study period who fulfilled the inclusion criteria were recruited using consecutive sampling until a sample size of 150 participants was achieved.

Data Collection Procedure: Eligible participants attending the urban health centre were recruited after obtaining informed consent. Waist circumference and other anthropometric measurements were recorded using standardised techniques. Capillary blood samples were collected for random blood glucose estimation. Participants with elevated blood glucose values were counselled and referred for confirmatory testing and further management.

Data Collection tools and techniques:

1. **Socio-demographic and health history:** Information on socio-demographic characteristics, family history of diabetes, anthropometric measurements, blood pressure, and capillary random blood glucose was collected using a pretested semi-structured questionnaire and standard measurement procedures.
2. **Anthropometry:**
   - **Waist circumference:** Measured at the midpoint between the lower rib and iliac crest using a non-stretchable tape.
   - Height and weight: Measured using standard protocols to calculate BMI.
3. **Blood Pressure:** Measured with a validated automatic sphygmomanometer.
4. **Glycaemia Measurement:**
   - Capillary random blood glucose measured using a calibrated glucometer following aseptic procedures.
   - Participants with elevated glucose values were counselled and appropriately referred.

Operational Definitions

- **Central obesity:** Waist circumference ≥90 cm (men), ≥80 cm (women).
- **Screen-detected hyperglycaemia:** Random capillary

glucose ≥140 mg/dL.

Quality Control

- Training of research staff on standardised measurement techniques.
- Calibration of instruments (glucometer, weighing scale, tape).
- Daily review of data for completeness and accuracy.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26. Continuous variables were tested for normality using the Shapiro-Wilk test and were expressed as mean ± standard deviation (SD), while categorical variables were summarized as frequency and percentage.

The independent samples t-test was used to compare continuous variables between males and females. Pearson's correlation coefficient was used to assess the correlation between random blood glucose, waist circumference, body mass index (BMI), and blood pressure. Multivariable logistic regression analysis was performed to identify independent predictors of screen-detected hyperglycaemia. Age, gender, central obesity, BMI, systolic blood pressure, and family history of diabetes were included in the regression model based on clinical relevance and evidence from the literature.The goodness-of-fit of the logistic regression model was assessed using the Hosmer-Lemeshow goodness-of-fit test. Multicollinearity among the independent variables was assessed using the Variance Inflation Factor (VIF).Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. A two-sided p-value <0.05 was considered statistically significant.

Ethical Considerations: The study was reviewed and approved by the Institutional Ethics Committee, Santosh Deemed to be University, Ghaziabad, Uttar Pradesh (SU/2026/CRF/462). Written informed consent was obtained from all participants prior to enrolment. Confidentiality and anonymity of the participants were strictly maintained throughout the study. Participants detected with elevated blood glucose levels were counselled and referred appropriately.

Result

A total of 150 adults attending the urban primary health care facility were included in the study. The mean age of participants was 34.04 ± 13.71 years, and females constituted the majority of the study population. The mean waist circumference, body mass index (BMI), and random blood sugar (RBS) levels were 91.53 ± 14.26 cm, 27.02 ± 6.27 kg/m^2, and 128.46 ± 31.64 mg/dL respectively. A substantial proportion of participants had central obesity according to Asian Indian waist circumference criteria. Among the 150 study participants, 29 (19.3%) had screen-detected hyperglycaemia (capillary random blood glucose -140 mg/dL), while 121 (80.7%) had normal blood glucose levels. Detailed socio-demographic and anthropometric characteristics are presented in Table 1.

Table 1: Baseline socio-demographic, anthropometric and clinical characteristics of study participants (N=150)

Variable	Mean ± SD / n (%)
Age (years)	34.04 ± 13.71
Female	100 (66.7)
Male	50 (33.3)
Waist circumference (cm)	91.53 ± 14.26
Body mass index (kg/m^2)	27.02 ± 6.27
Random blood sugar (mg/dL)	128.46 ± 31.64
Systolic blood pressure (mmHg)	115.41 ± 10.80
Diastolic blood pressure (mmHg)	75.72 ± 12.27
Family history of diabetes present	54 (36.0)

Random blood sugar demonstrated significant positive correlation with waist circumference (r=0.200, p=0.014), body mass index (r=0.181, p=0.027), and systolic blood pressure (r=0.199, p=0.015). Waist circumference also showed significant positive correlation with BMI and systolic blood pressure, indicating clustering of cardiometabolic risk factors. Correlation coefficients are summarized in Table 2.

Table 2. Pearson correlation between random blood glucose and selected anthropometric and clinical variables among study participants

Variables	Pearson correlation coefficient (r)	p-value
Random blood sugar vs Waist circumference	0.200	**0.014**
Random blood sugar vs BMI	0.181	**0.027**
Random blood sugar vs Systolic BP	0.199	**0.015**
Waist circumference vs BMI	0.573	**<0.001**
Waist circumference vs Systolic BP	0.306	**<0.001**
BMI vs Systolic BP	0.263	**0.001**
Systolic BP vs Diastolic BP	0.463	**<0.001**

Participants with central obesity demonstrated higher mean random blood sugar and blood pressure levels compared to those without central obesity. However, no statistically significant gender differences were observed with respect to waist circumference, blood pressure, BMI, or random blood sugar levels. The association between central obesity and selected metabolic parameters is shown in Table 3.

Table 3. Gender-wise comparison of anthropometric and clinical parameters among study participants

Variables	Female Mean ± SD	Male Mean ± SD	p-value
Waist circumference (cm)	90.74 ± 14.60	93.10 ± 13.57	0.866
Random blood sugar (mg/dL)	125.96 ± 35.50	120.26 ± 21.82	0.491
Systolic BP (mmHg)	114.67 ± 10.75	116.88 ± 10.93	0.992
Diastolic BP (mmHg)	75.28 ± 13.82	76.60 ± 8.62	0.707
BMI (kg/m^2)	27.09 ± 6.09	26.87 ± 6.67	0.219

Multivariable logistic regression analysis was performed among all 150 participants to identify factors independently associated with screen-detected hyperglycaemia. The analysis showed that body mass index (AOR = 1.09, 95% CI: 1.01-1.19; p = 0.031) and systolic blood pressure (AOR = 1.05, 95% CI: 1.01-1.10; p = 0.025) were independently associated with screen-detected hyperglycaemia, whereas central obesity, age, gender, and family history of diabetes were not statistically significant after adjustment. The multivariable logistic regression model demonstrated an adequate fit to the data (Hosmer-Lemeshow x^2 = 13.65, df = 8, p = 0.091). The model was statistically significant overall (Omnibus likelihood ratio x^2 = 19.10, df = 6, p = 0.004). The model explained 14.6% of the variance according to the Cox & Snell R^2 and 24.7% according to the Nagelkerke R^2. No evidence of multicollinearity was observed among the independent variables (all VIF values ranged from 1.11 to 1.52). The model correctly classified 86.8% of participants (Table 4).

Table 4. Multivariable logistic regression analysis showing predictors of screen-detected hyperglycaemia

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Central obesity	1.24	0.34–4.55	0.742
Age	0.99	0.99–1.00	0.649
Age	0.99	0.99–1.00	0.649
Male gender	0.95	0.36–2.52	0.919
Body mass index (BMI)	1.09	1.01–1.19	**0.031***
Family history of diabetes	0.41	0.15–1.14	0.088
Systolic blood pressure	1.05	1.01–1.10	**0.025***

*Adjusted for age, gender, BMI, systolic blood pressure, family history of diabetes and central obesity.

Discussion

The present analytical cross-sectional study assessed the association between central obesity and screen-detected hyperglycaemia among adults attending an urban primary health care facility in Ghaziabad, Uttar Pradesh. The findings demonstrated a significant positive correlation between waist circumference and random blood sugar levels. However, waist circumference did not remain independently associated with screen-detected hyperglycaemia after adjustment for age, sex, body mass index, systolic blood pressure, and family history of diabetes, indicating that its association may be influenced by other metabolic factors.

The mean age of the participants in the present study was 34.04 ± 13.71 years, with a predominance of younger adults and females. Urbanisation and lifestyle transitions in Indian cities have increasingly shifted the burden of metabolic disorders toward younger age groups. Similar findings have been documented by Misra et al., who observed rising prevalence of obesity and glucose intolerance among relatively younger urban Indian populations owing to sedentary lifestyle patterns and nutritional transition.[11]The predominance of females in the current study may reflect better utilisation of urban health services by women or greater health-seeking behaviour among female participants attending the primary healthcare facility.

An important observation of the present study was the high mean waist circumference (91.53 ± 14.26 cm) and mean BMI (27.02 ± 6.27 kg/m^2), indicating a substantial burden of central obesity and overweight among the study participants. These findings are consistent with evidence from South Asian populations demonstrating a higher tendency for visceral adiposity even at comparatively lower BMI levels.[18] South Asians characteristically exhibit the "thin-fat phenotype," wherein increased abdominal fat accumulation predisposes individuals to insulin resistance and metabolic abnormalities despite lower generalized obesity.[7] This phenotype contributes significantly to the rising burden of type 2 diabetes mellitus in India and other low- and middle-income countries.

The present study demonstrated a statistically significant positive correlation between waist circumference and random blood sugar levels (r=0.200, p=0.014). This finding supports a positive correlation between central obesity and dysglycaemia. However, because waist circumference was not independently associated with screen-detected hyperglycaemia after multivariable adjustment, it should be considered a complementary anthropometric measure rather than an independent predictor. Similar observations were reported by Misra et al., who found that central obesity was more strongly associated with hyperglycaemia and insulin resistance than generalized obesity among Asian Indians.[11] Likewise, Xi et al. reported that increasing waist circumference was independently associated with impaired glucose

metabolism and undiagnosed diabetes even among individuals with normal BMI.[13] These findings collectively reinforce the concept that waist circumference is a better reflection of metabolically active visceral fat, which contributes directly to insulin resistance through release of inflammatory cytokines and free fatty acids.

The significant correlation observed between BMI and random blood sugar further emphasises the contribution of excess adiposity to impaired glucose metabolism. In the multivariable logistic regression model, BMI remained independently associated with screen-detected hyperglycaemia, whereas waist circumference did not retain statistical significance after adjustment. This may reflect shared variance between BMI and waist circumference, as both are measures of adiposity, together with the relatively small sample size and potential residual confounding.[12]

Another notable finding of the present study was the significant positive correlation of waist circumference with systolic blood pressure and BMI. These findings indicate clustering of metabolic syndrome components among centrally obese individuals. Central obesity has been widely recognized as a key driver of metabolic syndrome, contributing to hypertension, dyslipidaemia and glucose intolerance through multiple pathophysiological mechanisms including endothelial dysfunction, chronic low-grade inflammation and insulin resistance.[20] Similar observations were reported by Goel et al. in an urban Indian population, where elevated waist circumference was strongly associated with hypertension and other components of metabolic syndrome.[15] The coexistence of obesity, elevated blood pressure and hyperglycaemia in the present study highlights the need for integrated non-communicable disease screening strategies at the primary healthcare level.

The absence of statistically significant gender differences in waist circumference, blood sugar and BMI in the current study suggests that metabolic risk factors are increasingly prevalent among both males and females in urban settings. This finding is particularly important from a public health perspective, as urban lifestyle modifications, reduced physical activity and unhealthy dietary practices are now affecting both genders almost equally. Similar findings have been observed in other urban Indian studies where obesity and dysglycaemia were found to be prevalent across both sexes.[2]

Interestingly, the present study did not find a statistically significant association between family history of diabetes and waist circumference. Although family history is a well-established non-modifiable risk factor for diabetes mellitus, its lack of significant association in the current study could be due to the relatively small sample size or possible recall bias among participants regarding family history status. Additionally, environmental and behavioural factors such as sedentary lifestyle, unhealthy dietary habits and physical inactivity may exert a stronger influence on central obesity in urban populations compared to genetic predisposition alone.

The findings of the present study carry important implications for public health practice, especially within resource-constrained urban primary healthcare settings in low- and middle-income countries. Opportunistic screening using simple anthropometric measurements such as waist circumference may facilitate early identification of individuals at risk of hyperglycaemia and other metabolic disorders. Waist circumference measurement is inexpensive, non-invasive, rapid and feasible even in low-resource primary care facilities. The World Health Organization and several diabetes associations have emphasized the utility of waist circumference in cardiometabolic risk stratification.[9] Given the growing burden of undiagnosed diabetes in India, routine waist circumference assessment may complement opportunistic screening for metabolic risk in primary healthcare settings; however, larger prospective studies are needed before establishing its independent predictive value.

The National Programme for Prevention and Control of Non-Communicable Diseases (NP-NCD)advocates opportunistic screening for non-communicable diseases at the primary healthcare level.[19] The present findings support strengthening such screening initiatives by integrating central obesity assessment as a practical risk stratification tool. Early identification of high-risk individuals may facilitate lifestyle modification interventions, counselling and referral services before progression to overt diabetes and cardiovascular complications.

Conclusion

The present study demonstrated a significant association between central obesity and screen-detected hyperglycaemia among adults attending an urban primary health care facility in Ghaziabad. Waist circumference showed a statistically significant positive correlation with random blood sugar levels, body mass index, and systolic blood pressure, indicating that central obesity is an important marker of underlying metabolic risk. The findings highlight the growing burden of obesity-related non-communicable diseases among urban adults, including younger age groups.

Waist circumference demonstrated a modest positive correlation with random blood glucose and may complement opportunistic screening for hyperglycaemia in primary healthcare settings. However, it did not remain independently associated with screen-detected hyperglycaemia after adjustment for age, sex, body mass index, systolic blood pressure, and family history of diabetes. Therefore, waist circumference should be considered a complementary anthropometric measure rather than a standalone predictor. Larger prospective studies with representative populations are warranted to establish its independent predictive value.

Strengthening community-based screening and awareness activities focusing on obesity reduction, healthy lifestyle promotion, and early metabolic risk detection is essential for addressing the rising burden of non-communicable diseases in urban populations of low- and middle-income countries.

Limitations Of The Study

The present study has certain limitations. Being a cross-sectional study, causal relationships between central obesity and hyperglycaemia cannot be established. Random blood sugar (RBS) was used as the primary outcome measure for screening hyperglycaemia rather than confirmatory diagnostic tests such as fasting plasma glucose, HbA1c, or oral glucose tolerance testing. Consequently, some participants may have been misclassified because RBS is primarily a screening tool and is influenced by the timing and composition of recent meals. The study was conducted in a single urban health facility with a relatively small sample size, which may limit generalizability of findings. The use of consecutive sampling may have introduced selection bias, and residual confounding due to unmeasured behavioural and lifestyle factors cannot be excluded.Although the logistic regression model demonstrated good overall classification accuracy, its sensitivity for detecting screen-detected hyperglycaemia was low, indicating that some individuals with hyperglycaemia may not have been correctly identified by the model.

Despite these limitations, the study provides valuable evidence regarding the association between central obesity and screen-detected hyperglycaemia in an urban primary care setting. The findings reinforce the importance of waist circumference as a simple and effective screening tool for identifying individuals at increased metabolic risk in low-resource healthcare environments.

Recommendations

Routine measurement of waist circumference may be considered as part of opportunistic screening activities at primary healthcare facilitiesas a simple, low-cost, and feasible approach for early identification of individuals at risk of hyperglycaemia and other non-communicable diseases. Strengthening community-based screening programmes focusing on central obesity may improve early detection and timely intervention for metabolic disorders, particularly in low- and middle-income settings.

Health education interventions promoting healthy dietary habits, regular physical activity, and weight management should be integrated into primary healthcare services. Further multicentric longitudinal studies with larger sample sizes and confirmatory biochemical investigations are recommended to better understand the causal relationship between central obesity and hyperglycaemia. Future research should also explore the influence of behavioural, socioeconomic, and lifestyle determinants on metabolic risk among urban populations.

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