Original Research Article

Evaluating The Role Of Anthropometric Indicators In Predicting Gestational Diabetes Mellitus: A Hospital Based Study

Dr. Soumya Khanna[1], Dr. Shikha Sachan[2], Prof. C. Mohanty[3]

[1]Associate Professor, Department of Anatomy, Institute of Medical Sciences, Varanasi, Uttar Pradesh, India.
[2]Associate Professor, Department of Obstetrics and Gynecology, Institute of Medical Sciences, Varanasi, Uttar Pradesh, India.
[3]Professor, Department of Anatomy, United Institute of Medical Sciences, Praygraj, Uttar Pradesh, India.

Corresponding Author
Prof. C. Mohanty, Professor, Department of Anatomy, United Institute of Medical Sciences, Praygraj, Uttar Pradesh, India.

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ABSTRACT

Background
Gestational diabetes mellitus (GDM) is a prevalent endocrine disorder identified by glucose intolerance during pregnancy, associated with numerous complications for both the mother and the child.
Methods
This study investigates the correlation between anthropometric parameters, specifically mid-arm circumference (MAC), bicipital skinfold thickness (BSFT), and tricipital skinfold thickness (TSFT), and the development of GDM. Conducted at the Sir Sunderlal Hospital, Banaras Hindu University, the study involved 250 pregnant women between 24-28 weeks of gestation, screened using a 75 g Oral Glucose Tolerance Test (OGTT). Anthropometric measurements were analyzed using Pearson's correlation coefficient and multivariate logistic regression.
Results
The findings reveal that while weight and height did not significantly predict GDM, both tricipital skin fold thickness and Bicipital skin fold thickness exhibited a significant positive correlation with Gestational diabetes mellitus incidence (Odds ratio for TSFT = 1.35, BSFT = 1.29). This suggests that TSFT and BSFT are reliable indicators for early GDM prediction.

Conclusion
The study concludes that incorporating regional anthropometric measurements, particularly TSFT and BSFT, into prenatal care protocols could enhance early GDM detection and intervention, potentially improving maternal and fetal outcomes. Future research should focus on refining these predictive models and integrating them into broader maternal health strategies to mitigate GDM-related risks.
Key words: Pregnancy, Oral Glucose tolerance test, skin fold thickness, Body mass index

INTRODUCTION

Gestational diabetes mellitus (GDM) is a frequent endocrine disorder that arises during pregnancy, usually detected in the latter stages.[1,2] Defined by the onset of glucose intolerance during pregnancy, GDM is linked to several complications for both the mother and the baby, including miscarriage, pre-eclampsia, and diabetic-related issues such as nephropathy, neuropathy, and infections. Moreover, conditions like diabetic retinopathy and nephropathy can worsen during pregnancy.[3,4]

The disorder results from hormonal changes during pregnancy, with major contributing factors being a family history of diabetes and a high Body Mass Index (BMI). Women who previously delivered babies weighing over 4.5 kg are at an elevated risk. Ethnic groups, particularly in South Asia, have higher rates of GDM.[4,5,6]

Preventive measures and effective management within prenatal care can help mitigate the incidence of GDM. Recommendations from the World Health Organization and the International Association of Diabetes and Pregnancy Study Groups (IADPSG) suggest screening with a 75 g Oral Glucose Tolerance Test (OGTT) between 24 and 28 weeks of gestation, diagnosing GDM when specific glucose levels are exceeded.[7]

GDM prevalence varies worldwide: 14% in the USA[8], 7.3% in China [9], 14.5% in India[6], and 5.7% in Sri Lanka[10]. There is a notable correlation between high body fat and GDM, implying that measurements such as weight, height, and skinfold thickness might be effective in predicting GDM, especially in countries with limited resources like India.

The study aims to investigate the link between body mass dimensions and GDM and to determine if anthropometric measurements can predict GDM early in pregnancy.

AIM OF THE STUDY

To find the correlation between various anthropometric parameters namely mid arm circumference, bicipital skin fold thickness and tricipital skin fold thickness in development of GDM

MATERIALS AND METHODS

The study, which was correlational in nature, took place in the outpatient department of obstetrics and gynecology at Sir Sunderlal Hospital, Banaras Hindu University. The participants were pregnant mothers with amenorrhea lasting 24-28 weeks who had undergone an oral glucose tolerance test between the 26th and 28th weeks of pregnancy.

The sample size was calculated using the Lwanga and Lemeshow equation.

$n=Z^2 pq/d^2$

It was 191 considering the prevalence of GDM in India being 14.5% . Considering 20% will be missing data then sample size will be 229.
The present study have taken 250 sample size.

Criteria for Inclusion
Pregnant women ranging from 24 weeks to 28 weeks of gestation.
Pregnancies involving a single fetus.

Criteria for Exclusion
Mothers diagnosed with pre-existing diabetes, whether previously identified or indicated by an HbA1C value over 5.5% at the initial visit.
Mothers with medical disorders.

The 75 g oral glucose tolerance test (OGTT) is was conducted between the 24th and 28th weeks of pregnancy to screen for gestational diabetes mellitus (GDM). Following the World Health Organization (WHO) guidelines, GDM is diagnosed if the plasma glucose level reaches or exceeds 140 mg/dl (7.8 mmol/l) two hours after ingesting a 75 g glucose solution. This criterion helped in identifying pregnant women with impaired glucose tolerance.

Those diagnosed with gestational diabetes mellitus (21 cases) were admitted for further evaluation and treatment and were monitored regularly until they gave birth and were discharged from the hospital. Initially, diet therapy was implemented, and the need for insulin therapy was assessed based on each individual's blood glucose levels and overall glycemic control.

The mid-upper arm circumference was measured following the protocol outlined in the National Health and Nutrition Examination Survey anthropometry manual, using a non-stretchable tape. The subject stood upright with weight evenly distributed, the right arm bent at a 90˚ angle, and the palm facing upward. Proper positioning involved marking the lateral end of the right scapula and drawing a horizontal line from the acromion process. Measurements were taken from this mark to the tip of the olecranon process along the arm's posterior surface, with the tape centered. The midpoint was marked, and the circumference was measured perpendicularly. Tricipital and bicipital skinfold thicknesses were also measured using calipers at the same level on the arm's posterior and anterior surfaces. The anthropometric data were analyzed using the Statistical Package for the Social Sciences (SPSS version 25.0). Ethical approval for the study was obtained from the Ethics Review Committee of the Institute of Medical Sciences, Banaras Hindu University.

RESULTS

In this study, 250 participants were analyzed initially through descriptive analysis of all study variables. Pearson's correlation coefficient was employed to assess associations among selected main continuous variables. Anthropometric measurements between cases and controls were compared using multivariate logistic regression.

Table1 shows the height of the study population ranged from 145 cm to 170 cm (with a mean of 157.56 cm and standard deviation of 4.63). The majority fell within the 156 cm to 164 cm height range, constituting 68.8% of the participants (N = 172).

Height (in cm)	Frequency	Distribution (%)
145-150	20	8.0
151-155	56	22.4
156-160	92	29.6
161-164	80	31.6
165-170	2	0.8

Table 1: Distribution of height in the study population

In terms of weight (Table 2), it ranged from 48 kg to 98 kg (with a mean of 66.44 kg and standard deviation of 8.68 kg). The majority of participants were in the 58 kg to 72 kg weight range.

Weight Range (kg)	Frequency	Distribution (%)
48 – 52	10	4.0%
53 – 57	25	10.0%
58 – 62	50	20.0%
63 – 67	60	24.0%
68 – 72	50	20.0%
73 – 77	30	12.0%
78 – 82	15	6.0%
83 – 87	5	2.0%
88 – 92	3	1.2%
93 – 98	2	0.8%

Table 2: Distribution of weight in the study population

Majority of the sample had Body mass index (BMI) ranging between 18.5 – 24.9. (Table 3)
Table 3 indicates 15 out of 56 women (26.8%) having BMI between 18.5-24.9 were diagnosed with GDM. 50% of pregnant women with BMI in range of 30-34.9 were diagnosed with GDM. 100% of pregnant women having BMI above 35 were diagnosed with GDM.

BMI	No of cases	No of GDM cases	Distribution (%)
< 18.5	2	0	0
18.5-24.9	184	0	0
25-29.9	56	15	26.8
30-34.9	4	2	50
35-39.9	3	3	100
≥40	1	1	100
	250	21	8.4

Table 3: prevalence of GDM cases according to BMI distribution of pregnant women

The anthropometric measurements such as height and weight tend to have a significant positive correlation. BMI also exhibits a significant positive correlation with weight, indicating that as weight increases, BMI tends to increase as well. Furthermore, the BMI values of study participants are positively associated with their weight. However, there is a negative correlation between the height of the study participants and their BMI. (Table 5)

Variables	Pearson's	P value
Weight and height	0.416	0.008
Height and BMI	-0.011	0.876
Weight and BMI	0.769	<0.001

Table 5 : degree of association between following variables; Weight , height and BMI

The mid-arm circumference of the participants varied from 21 cm to 39 cm, with a mean of 27.24 cm and a standard deviation of 3.87 cm. Most participants fell within the 25 cm to 29 cm range. (Table 6)

The biceps skinfold thickness ranged from 6 mm to 35 mm, with a mean of 11.76 mm and a standard deviation of 5.45 mm. The majority were in the 9 mm to 18 mm range. (Table 6)
For triceps skinfold thickness, the values ranged from 9 mm to 42 mm, with a mean of 22.38 mm and a standard deviation of 8.33 mm. Most participants, specifically 145 individuals (58%), were in the 19 mm to 28 mm group. (Table 6)

Variable	values (in cm)	Frequency	Percentage (%)
Mid Arm circumference	21-25	43	17.2
	26-30	113	45.2
	31-35	82	32.8
	35-39	12	4.8
Biceps skin fold thickness	6-12	156	62.4
	13-18	72	28.8
	19-24	10	4.0

	25-30	8	3.2
	31-35	4	1.6
Triceps skin fold thickness			
	9-18	45	18
	19-28	145	58
	29-38	32	12.8
	38-42	28	11.2

Table 6: Distribution of Anthropometric Measurements (Mid-Arm Circumference, Biceps Skinfold Thickness, and Triceps Skinfold Thickness) in the study population

The thickness of skin folds at the triceps and biceps shows a significant and positive correlation with the mid-upper arm circumference. Additionally, when examined independently, the skin fold thicknesses at the triceps and biceps also exhibit a significant positive correlation with each other. (Table 7)

Variables	Pearson's	P value
MAC and BSFT	0.518	<0.001
MAC and TSFT	0.702	<0.001
MAC and BSFT	0.312	<0.001

Table 7: Distribution of the Degree of Correlation for Regional Anthropometric Measurements

A multivariate logistic regression analysis revealed that weight (Odds ratio = 0.97, 95% CI = 0.90 - 1.14), height (Odds ratio = 0.96, 95% CI = 0.81 - 1.15), and mid-upper arm circumference (MAC) (Odds ratio = 0.74, 95% CI = 0.55 - 1.32) did not show significant differences. However, tricipital skinfold thickness (TSFT) (Odds ratio = 1.35, 95% CI = 1.08 - 1.48) and bicipital skinfold thickness (BSFT) (Odds ratio = 1.29, 95% CI = 1.09 - 1.61) were significantly different between participants with and without GDM. Therefore, TSFT and BSFT are independently associated with gestational diabetes mellitus in this population.

DISCUSSION

A study from 2010 found that skinfolds at the biceps, subscapular area, triceps, ribs, supra-iliac region, and knee were linked to the occurrence of gestational diabetes mellitus (GDM).[11] The subscapular skinfold, in particular, was highlighted as a significant and independent marker for identifying pregnant women at risk, aiding in preventive strategies. However, measuring the subscapular skinfold in routine clinical practice is difficult and often inaccurate. The current study focuses solely on the thickness of bicipital and tricipital skinfolds, as well as mid-upper arm circumference. The reliability of the findings could be enhanced by including additional parameters and employing combined diagnostic accuracy methods, such as parallel or series interpretations.

A 2015 Australian study discovered that BMI and waist-to-hip ratio are strong predictors of gestational diabetes in native Aboriginal mothers.[12] However, since this study was limited to a specific ethnic group, its findings may not be universally applicable. The current study also took place in a single setting but did not focus on a specific ethnic or sociodemographic group. Despite this, the sample size was relatively small, and the waist-to-hip ratio was not included among the study parameters.

The present study's results indicate a significant positive correlation between regional anthropometric measurements and the incidence of GDM. This finding underscores the potential utility of these measurements in predicting GDM. However, it is important to note that the combined effect of these parameters on GDM predictability was not evaluated. Future research should focus on utilizing these anthropometric parameters with well-chosen study samples to predict GDM more accurately, as they show high feasibility as a predictive screening method.
Moreover, the ability of anthropometric parameters to predict GDM should be examined across mothers of varying categories. Future studies should investigate the applicability of this method in groups differing by parity, maternal age, pre-pregnancy Body Mass Index, and family history of diabetes mellitus or GDM. Additionally, determining the optimal gestational age for obtaining anthropometric measurements to ensure accurate predictions is essential. The present study faced financial and time constraints, which limited the exploration of these aspects. While these limitations did not affect the reliability of the measurements concerning the study parameters, they significantly impacted the study's internal and external validity. These challenges can be addressed in future research.

In comparison to other predictive methods, such as biochemical markers and genetic testing, anthropometric measurements offer a non-invasive, cost-effective, and easily implementable option. Biochemical markers, while highly accurate, require sophisticated laboratory setups and trained personnel, which may not be feasible in resource-limited settings. Genetic testing, on the other hand, provides insights into the hereditary risk of GDM but is often expensive and not routinely available.

Anthropometric measurements, by contrast, can be easily integrated into routine prenatal care without the need for specialized equipment or training. This makes them particularly valuable in low- and middle-income countries where healthcare resources are limited. By providing an early indication of GDM risk, these measurements enable timely interventions that can significantly reduce the incidence of adverse maternal and fetal outcomes associated with GDM.

With advancements in technology, the use of digital tools and mobile health applications to measure and monitor anthropometric parameters could revolutionize prenatal care. Such tools can ensure consistent and accurate measurements, facilitate real-time data sharing with healthcare providers, and enable personalized care plans for pregnant women at risk of GDM. Mobile health applications, for example, could allow pregnant women to track their own measurements and receive automated alerts if their readings indicate an increased risk of GDM.

Future research should also explore the integration of multiple anthropometric parameters to develop a composite risk score for GDM. This approach could potentially increase predictive accuracy and allow for more nuanced risk stratification. Additionally, investigating the interplay between anthropometric indicators and other biomarkers, such as insulin resistance markers and inflammatory cytokines, could offer a more comprehensive understanding of GDM pathophysiology.

From a public health perspective, implementing anthropometric screening in prenatal care can have significant implications for managing GDM at the population level. Early identification and management of GDM can reduce healthcare costs associated with pregnancy complications and improve long-term health outcomes for both mothers and their offspring. Public health campaigns aimed at educating pregnant women about the importance of maintaining a healthy body weight and regular monitoring can also contribute to reducing the incidence of GDM.

CONCLUSION

Regional anthropometric measurements are positively correlated with each other. Both tricipital skinfold thickness (TSFT) and bicipital skinfold thickness (BSFT) are significantly associated with GDM. The likelihood of predicting GDM is notably higher using these measurements. Therefore, incorporating regional anthropometric measurements into antenatal care practices is recommended. A comprehensive study should be conducted to evaluate the effectiveness of early GDM predictions by combining various anthropometric measurements. Based on the results, strategies should be integrated into maternal care guidelines. Targeted prevention of GDM in mothers identified through these anthropometric predictions can lead to successful obstetric outcomes.

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