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Research Article

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Prevalence and Associated Factors of Gestational Diabetes Mellitus Among Pregnant Women Receiving Antenatal Care in Public Health Facilities in Bule Hora, Southern Ethiopia: A Cross-Sectional Study

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Abstract

Objectives: *Gestational diabetes mellitus (GDM) is a public health challenge that severely endangers the lives of mothers and children. In Ethiopia, its prevalence and predictors have scarcely been studied and have not been studied in the context of the present study. This study aimed to assess the prevalence and associated factors of GDM among pregnant women in Bule Hora, southern Ethiopia.*

Results: *A total of 190 pregnant women were interviewed and studied. The mean age of the pregnant women was 30.06 (SD ± 5.53) years. Approximately three-quarters (74.2%) of pregnant mothers were in their second trimester (24-28 weeks) of pregnancy. Approximately one-third (31.6%) of the participants were overweight/obese, with a mid-upper arm circumference (MUAC) greater than or equal to 28 cm. The mean fasting blood sugar level was 83.46 (SD ± 8.84) mg/dL. The prevalence of GDM in this study was 7.4%. A family history of diabetes (AOR = 5.7; 95% CI: 1.28-25.27), elevated triglyceride concentration (AOR = 5.6; 95% CI: 1.258-25.46), history of having a macrosomic baby (AOR = 6.8; 95% CI: 1.56-29.59), and history of abortion (AOR = 4.4; 95% CI: 1.09-18.39) were factors associated with GDM.*

Keywords: Gestational Diabetes, Pregnancy, Prenatal Care, Maternal Health, Reproductive Health, Child Health

1. Introduction

The World Health Organization (WHO) defined gestational diabetes mellitus (GDM) as carbohydrate intolerance that results in variable-severity hyperglycemia at first recognition during pregnancy [1]. GDM causes a wide range of adverse maternal and neonatal outcomes and is a concern for maternal and child health [2,3].

GDM often occurs during the 2nd/3rd trimester of pregnancy because placental hormones play an important role in adverse effects on maternal glucose metabolism [4]. As pregnancy progresses, hormones such as estrogen, progesterone, leptin, cortisol, placental lactogen and growth hormone increase the state of insulin resistance [5]. The main reason is that the human placental lactogen generated by the placenta increases maternal blood glucose levels and causes the body of the mother to be less sensitive to insulin, leading to elevated blood glucose levels and resulting in GDM [6].

Globally, GDM affects ~15% of pregnant mothers, 87.6% of whom are pregnant in low- and middle-income countries [7]. A review revealed that the incidence of GDM in sub-Saharan Africa

was 14% and that in the Middle East and North Africa ranged from 8.4 to 24.5%, respectively [8,9]. The study also showed that the prevalence of GDM varied to some extent between regions of Africa, as reported to be 6% and 14% in East and West Africa, respectively [10,11]. Differences in the magnitude of GDM were also observed within subregions, such as Rwanda and Tanzania, where the prevalence rates were 8.3% and 19.5%, respectively [12,13]. Two decades ago, the incidence of GDM in the rural area of northern Ethiopia was reported to be 3.7% [14].

GDM leads to long-term public health problems, as it is associated with the increasing epidemic of type 2 diabetes among women. It is a short-lived phenomenon for pregnant women; however, more than 50% of women develop type 2 diabetes later in life [15].

Identifying the magnitude of GDM and common risk factors is important for minimizing the risk of an adverse outcome and establishing appropriate strategies and health policies. Studies on this topic are limited to Ethiopia. To our knowledge, no previous studies on GDM and its determinants have been conducted in the present study setting. Therefore, we sought to assess the prevalence and associated factors of GDM among pregnant women in public health facilities in Bule Hora, southern Ethiopia.

2. Main Text

2.1 Methods

2.1.1 Study Design, Setting, and Period

A cross-sectional study was conducted in public health facilities to determine the prevalence of GDM and associated factors among women receiving antenatal care (ANC) in Bule Hora, southern Ethiopia. The study was carried out for 3 months from March 1 to May 30, 2021. The health facilities were Bule Hora General Hospital and Bule Hora Town Health Center. The facilities provide prenatal care to more than 11,000 pregnant women per year.

2.1.2 Participant Eligibility Criteria

Pregnant women (24-32 weeks of gestational age) with ANC data from March 1 to May 30, 2021, were enrolled in the study, while pregnant women with overt diabetes, on medications such as steroids, β-adrenergic agonists, and antipsychotic drugs, or with mental illness or thyroid- or adrenal-related diseases were excluded.

2.1.3 Sample Size Determination and Sampling Method

A total of 190 study participants were recruited using a convenient sampling technique. The sample size was calculated based on a single population proportion formula using a previous study conducted in Gonder, Ethiopia [16].

2.1.4 Data Collection Tools and Procedures

Information such as age, marital status, residence, level of education, last normal menstrual period (LNMP), family history of DM, birth weight of the previous child (if any), and behavioral and lifestyle characteristics was collected through face-to-face interviews. Blood pressure and mid-upper arm circumference (MUAC) were also measured. The estimation of gestational age was based on a reliable LNMP combined with a first-trimester ultrasound. Furthermore, the obstetric and medical histories of the participants were extracted from prenatal care cards.

A nonstretchable measuring tape was used to measure the MUAC of the left arm. Since most pregnant mothers cannot remember their weight before conception, it was difficult to determine their body mass index (BMI). The MUAC was used as a reliable measure because it is quite stable during conception and highly correlated with BMI before conception [17,18]. Pregnant mothers with a MUAC ≥28 cm were considered overweight and/or obese [19].

The physical activities that pregnant women perform as part of their daily lives were evaluated using the International Physical Activity Questionnaire (IPAQ). Study participants were asked to recall their physical activity during the last seven days before the interview. Data were reported as metabolic equivalents (MET minutes per week) using the IPAQ scoring protocol to assess women with high, moderate, or low levels of physical activity [20].

Dietary diversity was evaluated according to a 24-hour food recall method using the 2016 version of the Women's Minimum Dietary Diversity Measurement Technique of the Food and Nutrition Technical Assistance (FANTA). The minimum dietary diversity score (MDDS) was divided into two groups depending on whether the pregnant woman had eaten the list of specified food groups in the previous 24 hours. Five or more MDDSs were classified as having adequate dietary diversity [21].

Additionally, pregnant mothers were asked 'How often have they consumed coffee since their pregnancy?' If 'daily' or 'sometimes a week', they were labeled as being exposed to caffeine. They were also asked 'How often have they consumed alcohol since their pregnancy?' If 'daily' or 'sometimes a week', they were labeled as exposed to alcohol.

2.1.4 Blood Specimen Collection and Laboratory Analysis

Venous blood samples were obtained from each participant in serum separation tubes (SSTs) to measure fasting blood sugar levels, lipid profiles and liver function. The samples were analyzed using a Mindray BS-200E analyzer. The diagnosis of GDM was made according to the 2013 WHO criteria [22]. Consequently, the diagnosis of GDM was made if the FBS level was ≥ 92 mg/dL.

2.1.5 Data Quality Assurance

The quality of the data was ensured by properly designing the tool, and the questionnaire was pretested in 5% of randomly selected pregnant women at Kercha Primary Hospital. The proper functioning of the instruments and laboratory reagents was verified daily by quality control tests.

2.1.6 Data Analysis and Interpretation

Data entry and analysis were performed using SPSS v25. Descriptive statistics, such as frequency, percentage, mean and standard deviation, were used to present the variables. Logistic regression analysis was used to identify factors associated with GDM. Variables with a P value ≤ 0.25 in the bivariate analysis were exported to the multivariate analysis to assess the possible effect of confounders. A P value of < 0.05 was considered to indicate statistical significance.

3. Results

3.1 Sociodemographic Characteristics of the Participants

A total of 190 pregnant women were enrolled in this study. Among them, 165 (86.6%) were urban residents. The mean age of the pregnant women was 30.06 (SD ± 5.53) years. Most of the respondents (59.5%) belonged to the Oromo ethnic group. Sixty-four (37.7%) of the expectant mothers had completed their postsecondary education. (Table 1).

Variables	Category	Frequency (%)
Age, mean 30.06 (SD ± 5.53) years		
Age group (yrs.)	< 25	34 (17.9)
	25–29	43 (22.6)
	30–34	48 (25.3)
	> 34	65 (34.2)
Marital status	Single	4 (2.1)
	Married	170 (89.5)
	Divorced/Separated	14 (7)
	Widow	2 (1)
Educational level	No formal education	18 (9.5)
	Primary ed. (grade 1–8)	59 (31.1)
	Secondary ed. (grade 9–12)	49 (25.7)
	Post-secondary education	64 (33.7)
Religion	Protestant	103 (54.2)
	Orthodox	26 (13.7)
	Muslim	40 (21.1)
	Others*	21 (11)
Ethnicity	Oromo	113 (59.5)
	Amhara	15 (7.9)
	Gurage	19 (10)
	Others**	43 (22.6)
Residence	Urban	165 (86.8)
	Rural	25 (13.2)
Occupational status	Employed	47 (23.6)
	Non-employed	152 (76.3)

Table 1: Sociodemographic Characteristics of Study Participants in Public Health Centers in Bule Hora, Southern Ethiopia, 2021

Others* - Catholic & Jehovah's Witnesses; Others** - Tigre & Somali
SD, standard deviation

3.2 Clinical and Behavioral Characteristics of The Study Participants

Among the study participants, approximately one-third (31.6%) were overweight or obese. More than 90% of pregnant mothers had desirable blood pressure readings. The mean FBS level was 83.46 (SD ± 8.84) mg/dL. Approximately 70% of the respondents had a total cholesterol value less than 200 mg/dL.

Most of the respondents (78%) participated in moderate physical exercise. One hundred and seventy-three (91.1%) pregnant mothers had no history of alcohol consumption, while the majority had a history of coffee consumption (135, 71.1%). Three-quarters (75.3%) of the study participants were classified as having inadequate dietary diversity.

Among the participants, 26.3% had a family history of DM. Approximately 60% had at least one prior live birth (multipara). One hundred and sixty-five (86.8%) had previously had healthy pregnancies and healthy babies. One hundred forty-one (74.2%) pregnant mothers were in their 2nd trimester (24-28 weeks) of pregnancy (Table 2).

Parameters	Category	NO
MUAC, mean 25.23 (SD ± 3.34) cm		
MUAC	< 28 cm	130 (68.4)
	≥ 28 cm	60 (31.6)
Blood pressure (mmHg)	≤ 120/80	172 (90.5)
	> 120/80	18 (9.5)
FBS (mg/dL)	< 92	176 (92.6)
	92–125	14 (7.4)
Total cholesterol (mg/dL)	< 200	132 (69.5)
	≥ 200	58(30.5)
Triglyceride (mg/dL)	≤ 150	137 (72.1)
	> 150	53 (27.9)
HDL-C (mg/dL)	≤ 50	16 (8.4
	> 50	174 (91.6)
LDL-C (mg/dL)	< 130	168 (84.4)
	≥ 130	31 (15.6)
AST (U/L)	10–42	132 (69.5)
	> 42	58 (30.5)
ALT (U/L)	10–40	108 (56.8)
	> 40	82 (43.2)
Level of physical activity	High	12 (6.3)
	Moderate	149 (78)
	Low	29 (15.3)
Dietary diversity status	≥ 5 (Adequate)	47(24.7)
	< 5 (Inadequate)	143(75.3)
Alcohol consumption	Yes	17(8.9)
	No	173 (91.1)
Coffee consumption	Yes	135(71.1)
	No	55(28.9)
Family history of diabetes	Yes	50 (26.3)
	No	140 (73.7)
Parity	Nullipara	43 (22.6)
	Primipara	37 (19.5)
	Multipara	110 (57.9)
History of having a macrosomic baby	Yes	25 (13.2)
	No	165 (86.8)
History of cesarean section delivery	Yes	20 (10.5)
	No	170 (89.5)
History of abortion	Yes	47 (24.7)
	No	143 (75.3)
History of stillbirth	Yes	14 (7.4)
	No	176 (92.6)
History of GDM	Yes	16 (8.4)
	No	174 (91.6)
Gestational age in weeks	Second trimester (24–28 weeks)	141 (74.2)
	Third trimester (29–32 weeks)	49 (25.8)

Table 2: Clinical and Behavioral Characteristics of the Study Participants in Public Health Centers in Bule Hora, Southern Ethiopia, 2021

MUAC, mid-upper arm circumference; FBS, fasting blood sugar; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; AST, aspartate aminotransferase; ALT, alanine aminotransferase; GDM, gestational diabetes mellitus

3.3 Factors Associated With Gestational Diabetes Mellitus

According to the binary logistic regression, overweight and/or obesity, inadequate diet diversity, late gestational age of the mother (29 to 32 weeks), total cholesterol level (> 200 mg/dl), triglyceride level (> 150 mg/dl), history of abortion, history of having a macrosomic baby, family history of DM, and history of CS delivery were associated with GDM.

Multivariate analysis indicated that a family history of diabetes (AOR = 5.7; 95% CI: 1.28-25.27), elevated triglyceride levels (AOR = 5.6; 95% CI: 1.258-25.46), a history of having a macrosomic baby (AOR = 6.8; 95% CI: 1.56-29.59) and a history of abortion (AOR = 4.4; 95% CI: 1.09-18.39) were associated with GDM (Table 3).

Variables	Category	GDM Status		COR (95% CI)	AOR (95% CI)	PValue
		Non- GDM n (%)	GDM n (%)			
Family history of diabetes	No	137 (97.9)	3 (2.1)	1	1	-
	Yes	39 (78)	11 (22)	12.8 (3.42,48.47)	5.7 (1.28, 25.27)	0.02*
Triglycerides (mg/dL)	< 150	134 (97.8)	3 (2.2)	1	1	-
	≥ 150	42 (79.2)	11(20.8)	11.6 (3.12, 43.91)	5.6 (1.258, 25.46)	0.024*
History of having a macrosomic baby	No	159 (96.4)	6 (3.6)	1	1	-
	Yes	17 (68.0)	8 (32.0)	12.4 (3.86, 40.2)	6.8 (1.56, 29.59)	0.01*
History of abortion	No	138 (96.5)	5 (3.5)	1	1	-
	Yes	38 (80.9)	9 (19.1)	6.5 (2.06, 20.6)	4.4 (1.09, 18.39	0.038*

Table 3: Multivariate Logistic Regression Analysis of Factors Associated with GDM Among Pregnant Women in Public Health Centers in Bule Hora, Southern Ethiopia, 2021

*Statistically significant ($p < 0.05$)
GDM, gestational diabetes mellitus; COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval

4. Discussion

The overall prevalence of GDM among pregnant women was 7.4%. This finding was consistent with studies conducted in Egypt (8%), Tanzania (5.9%), Bangladesh (5%), and Iran (6.8%) [10,23-25].

The prevalence of GDM in the present study was found to be almost twice that of the study conducted in Wolaita, Ethiopia, which was 4.2% [26]. The reason for the high prevalence of GDM in the present study compared to the former could be differences in screening techniques and sociodemographic characteristics of the study participants. However, the results of this study were less than those of studies conducted on urban women in Tigray, Ethiopia (13%), Gondar, Ethiopia (12.8%), Tanzania (19.5%), and Cameroon (20.5%) [13,14,16,27]. Variations in the incidence of GDM among the studies mentioned above could also be explained by differences in diagnostic criteria, sample size used, and population characteristics [28].

A family history of DM, a history of abortion, a history of having a macrosomic baby, and elevated serum triglyceride concentrations were significantly associated with GDM. The study showed that pregnant women with a family history of DM were approximately six times more likely to develop GDM during pregnancy than were those without any occurrence of DM in their families. This finding is consistent with the results of previous studies conducted in the US and Iran [25,29]. This could be because hyperglycemia is associated with genetically nonfunctional beta cells and a familial predisposition to insulin secretory defects [30]. Furthermore, lifestyles and living standards between families are more likely to be similar, resulting in the sharing of related risk factors [31].

Pregnant mothers with a history of abortion were found to be 4.4 times more likely to develop GDM than their counterparts who had not undergone an abortion. This finding is consistent with studies conducted in Wolaita, Ethiopia and China, and the study also revealed that a history of spontaneous abortion was associated with a greater probability of developing GDM [27,32]. The risk of abortion during the index pregnancy could be indicative of poor blood glucose control and various endocrine system problems that affect normal insulin metabolism, which could then predispose women to a recurrent risk of GDM.

In line with a previous study, the probability of having GDM among pregnant women who had a macrosomic baby (>4 kg) in their previous pregnancy was almost seven times greater than that among pregnant women with an average baby weight [33]. This could be because the large weight of the infant during the index pregnancy can be indicative of poor control and/or poor maternal diet or may reflect the severity of GDM, which could predispose women to recurrent GDM.

Pregnant women with a higher level of triglycerides in their blood were 5.6 times more likely to develop GDM than those with a normal concentration of triglycerides. This result is supported by studies conducted in China by Jin et al [34]. This could be because insulin resistance increases the serum triglyceride concentration.

5. Limitations

The study adopted a cross-sectional study design and consisted of a relatively smaller number of participants. The diagnosis of GDM was made solely by FBS due to the limited available resources.

6. Conclusion

A family history of DM, a history of having a macrosomic baby, a history of abortion, and elevated triglyceride concentrations were factors significantly associated with GDM. Greater efforts must be made to address the factors associated with GDM and optimize quality of life. Special attention should be given to those with the conditions mentioned above by increasing the frequency of hospital follow-up visits to evaluate and closely monitor their health status.

Declarations

Ethics approval and consent to participate

This study was carried out according to the principles of the Declaration of Helsinki. Ethical approval was obtained from the Research and Ethics Review Committee of the Department of Medical Laboratory Science of the Faculty of Health Sciences of Addis Ababa University (DRERC/592/21/MLS). The purpose of the study was clearly explained to each study participant and written consent was obtained. The confidentiality of the participants was strictly handled during the interview process, data processing, and writing of the report.

Availability of data and materials

All relevant data are in the manuscript file.

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The study was sponsored by Addis Ababa University. The sponsor had no role in the design of the study; the collection, analysis, or interpretation of the data; or the preparation of the manuscript.

Authors' contributions

WDB prepared the proposal, analyzed and interpreted the findings, and prepared the manuscript. RGA exhaustively reviewed, edited and drafted the final manuscript. MW & TG advised and oversaw general research work and assisted in the identification and interpretation process. ESD played an advisory role. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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