Factors Associated With Gestational Diabetes Mellitus in Rural Areas of Limpopo Province: A Descriptive Analysis

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Abstract

Background: Sustainable Developmental Goal (SDG) no 3 of the United Nations Organisation places emphasise on ensuring healthy lives and promoting the well-being of all people of all age groups. Yet the prevalence of Gestational Diabetes Mellitus (GDM) is increasing and this can have an adverse impact on maternal and infant health and well-being. Currently, more studies have been conducted in International countries on prevalence and risk factors of GDM and few in South African Context. The current study sought to investigate the prevalence, risk factors, maternal and infant outcomes of women with gestational diabetes mellitus in Mopani District.

Methods: A cross-sectional descriptive study was conducted amongst pregnant women during Antenatal Care Clinic Visits at Nkhensani Hospital, Nkhensani Gateway clinic and Giyani Healthcare Centre. Information from participants was collected using adapted questionnaire from Michigan Diabetes Research and Training Centre DCP 2.0 and data entry form, captured on Microsoft excel spread sheet and analysed using Statistical Package for Social Sciences (SPSS) and p-value of <0.05 was considered statistically significant.

Results: One hundred and one (101) pregnant women (74%) who were attending antenatal care clinic visits at Nkhensani Hospital, Nkhensani Gateway Clinic and Giyani Healthcare Centre completed the questionnaire. Prevalence of Gestational Diabetes Mellitus (GDM) in Mopani District was 1.9% (2 women). Pregnant women above 30 years with secondary education, employed, obese and at gestational age of 31-35 weeks were more likely to present with GDM. A family history of diabetes was significantly associated with development of GDM.

Conclusions: The use of various GDM screening strategies across population and countries resulted in discrepancies in the prevalence rate. Universal GDM screening strategy which will benefit our socioeconomic and clinical context to ensure that the true burden of GDM is determined needs to be adopted.

Background

A greater proportion of women of reproductive age are now overweight or obese. Gestational diabetes mellitus (GDM) pose as a global health concern because of its health devastating health outcomes on both the mother and child which can subsequently affect their health and well-being. GDM and maternal obesity are associated with long-term adverse consequences in the offspring and subsequent generations and are important drivers of increased global burden of diabetes and cardiovascular disease. A systematic review conducted in 47 countries situated in sub-Saharan Africa found that the prevalence of GDM across countries depend on population, screening criteria and diagnostic criteria used [1, 2]. GDM is a glucose tolerance disorder diagnosed for the first time in pregnancy [3]. During second and third trimester, women are susceptible to insulin resistant. However, this condition does resolve after pregnancy.

The aim of the study was to investigate the prevalence, risk factors, maternal and infant outcomes of women with gestational diabetes mellitus in the Greater Giyani Area, Mopani District, Limpopo Province. The objectives of the study were to determine the socio-demographic characteristics of pregnant women with GDM; determine the prevalence and risk factors of GDM; describe the maternal and infant outcomes associated with GDM and determine the association of socio-demographics, risk factors with maternal and infant outcomes.

The global prevalence of GDM was reported to be increasing and it ranged from 1.4%-14% [4] and this varied due to ethnic group, racial group and screening criteria used. In Africa, the prevalence was found to be ranging from 0%-9% with exception being in Tanzania with prevalence being at 13.9% in high-risk women, 609 pregnant women from urban area and 301 pregnant women from rural area participated in this study [1]. This shows that the role of urbanisation has an influential role as often people who resides in urban areas are in close proximity with fast-food shops, physical inactivity due to increase in modern technologies which can lead to weight-gain or obesity. In Limpopo rural community situated in Limpopo province, a prevalence of 8.8% was found [5].

Various health institutions across countries are using different GDM diagnostic and screening criteria and this has a major influential impact on the prevalence. The Oral Glucose Tolerance Test (OGTT) was commonly used in Ethiopia and South Africa whilst in Morocco and Nigeria, Carpenter and Coustan's criteria are used to diagnose GDM and an increased in prevalence was observed when using Carpenter and Coustan's criteria as compared to OGTT [6]. Risk factor-based selective screening is the prime method which is used to diagnose GDM and this method is associated with poor sensitivity and specificity [7]. That is, this method might not be able to correctly identify those with GDM and those without GDM. Moreover, selective screening involves a health practitioner identifying pregnant women at risk of GDM by considering factors such as family history of diabetes, maternal age, past obstetric history and then screens them for the condition.

Screening for GDM across South Africa varied due to discrepancies in protocols. A study reported that in Pretoria, the International Association of Diabetes in Pregnancy Study Groups (IADPSG) criteria is used; in Johannesburg, National Institute for Health and Care Excellence (NICE) is used; and Western Cape use IADPSG, NICE as well as a criterion which was developed provincially [7]. The study further highlighted that the use of Universal screening (wherein all pregnant women are screened for GDM) in conjunction with NICE criteria yielded a high GDM prevalence of 17% while prevalence of 25.8% was found when using Universal screening together with IADPSG criteria [7]. This illustrates that IADPSG criteria has high sensitivity and specificity.

Risk factors known to predispose pregnant women to GDM include advanced maternal age, race, family history of diabetes, gestational weight gain (GWG), physical inactivity, psychological stress, hormonal contraceptive [4, 8, 9, 10, 11]. The relative risk of Indian women to develop GDM is 11.3 times compared to white women counterpart [8]. Various studies conducted highlighted that advanced maternal age was mostly associated with an increased likelihood of developing GDM. Women above age of 30 years are at

increased risk of GDM [12, 13]. Although GDM can be asymptomatic, it is associated with increased risk of complications associated with pregnancy and childbirth. Women with GDM are at great risk of developing pre-eclampsia, antepartum haemorrhage, pregnancy-induced hypertension and premature rupture of membranes which can result in preterm-labor [3]. Infants born from mothers with GDM have been found to be at risk of developing Type 2 diabetes, macrosomia, birth trauma, intrauterine foetal death [4, 14, 15].

Studies on prevalence of GDM and risk factors have been conducted previously across countries and in South Africa. In South Africa, a study on prevalence and risk factors of GDM in Mopani District, Limpopo province has not been done to determine the extent of this disease burden. This study will allow for the burden of GDM to be determined as well as risk factors which make pregnant women in Mopani District to be susceptible to developing GDM. Furthermore, this will allow for relevant and appropriate interventions to be designed and implemented.

Methods

The aim of the study was to investigate the prevalence, risk factors, maternal and infant outcomes of women with gestational diabetes mellitus in the Greater Giyani Area, Mopani District, Limpopo Province. A cross-sectional descriptive design was adopted as this design allowed GDM and associated risk factors to be examined as they exist in defined population at a particular point in time (ANC visits) [16]. The study was conducted at Nkhensani hospital, Nkhensani Gateway clinic and Giyani Healthcare centre which are all suited in Greater Giyani Area, Mopani District.

Recruitment of participants was done in three health facilities i.e. Nkhensani Hospital, Nkhensani Gateway clinic and Giyani Healthcare Centre from where we drew a random sample of 136 pregnant women attending ANC visits at the three study sites. The sample size at Nkhensani Hospital was estimated to be 72 pregnant women; Nkhensani Gateway was estimated at 18 pregnant women; and Giyani Healthcare centre was estimated at 46 pregnant women. Research purpose and rationale were explained to the women as they wait to consult during their ANC visit. Only 101 pregnant women participated in the study and others refused with no reasons being cited. For those who agreed to participate, an informed consent was given to them to ensure that they consent to participate in the study. There was no monetary reimbursement. Criteria for enrolment were that the women had to be pregnant and attending ANC visits at the selected three study sites and there were no exclusion criteria.

A translated questionnaire with open and closed-ended questions was used (see Annexure A). This questionnaire was adapted from Michigan Diabetes Research and Training Centre DCP 2.0 [17] and it captured socio-demographic information such as age, educational level, occupation, employment status, weight, height; number of pregnancy, gestational weeks of 1st antenatal care clinic visit (ANC). A data entry form was used to capture obstetric history from participant maternal record book.

Data Collection

The quantitative data was collected using questionnaire with open and closed-ended questions and data entry form. The design of the data collection tools was coordinated by the researcher and the research supervisors with expertise in conducting research. In addition, the questionnaire was piloted to ensure that the questions are clear, relevant, and appropriate. As the participants were completing the questionnaire, the researcher would request participant's maternity casebook to capture information required from the data entry form.

Statistical analysis

Descriptive statistics consisting of summary of statistics (i.e. mean and range) for numerical data and frequencies for categorical data were used. Two-sample t-test for proportions was used to compare the two groups (i.e. GDM cases and non-GDM cases). Data collected was captured on Microsoft word excel spread sheet and transferred to Statistical Package for Social Sciences (SPSS) programme for analysis. A p-value of < 0.05 was considered statistically significant.

Results

Demographics

A total of hundred and one (101) pregnant women participated in this study after 136 pregnant women were recruited to participate. Considering the antenatal care attendance, 71.4% of the women attended their 1st ANC visit after 8 weeks of gestation. Majority (61.4%) of women were aged <30 years and their mean age was 27 ± 6.9 years, ranging from 14 to 43 years. The proportion of women with secondary educational level was 68% followed by tertiary and primary educational level at 19% and 10% respectively. Only 3% of the women did not attend school at and 52.5% of the pregnant women were unmarried. The overall prevalence of very high levels of body-mass index (BMI) in the current study were reported as overweight was at 44% and obesity was at 31%. A family history of diabetes was reported also reported at 14% as illustrated in Table 1.

Association of age of pregnant women with socio-demographic variables

Women who were 35 years and older were more likely to be married, employed, and attend their 1st Antenatal care Clinic Visit (ANC) after 8 weeks of gestation. However, employment status was not Employment status, ANC visit were not statistically significant ($P > 0.05$). Women in the age group 25-29 years and ≥ 35 years were more likely to have a family history of diabetes when compared to other groups ($p > 0.05$) as demonstrated in Table 2.

The mother's gravida decreased with increase in age ($P < 0.001$). In women who had had 2 or more pregnancies, mother's gravida increased with increasing age ($p < 0.001$). The percentage of mothers who

had pregnancies which reached a viable gestational age (including live births and stillbirths) decreased with increasing age for mothers with parity zero, from 94% (16 pregnant women) in age group <20 years, to 2% (8 pregnant women) in age group 30 – 34 years. Those who had had one or more parity, the proportion of mothers who had pregnancies which reached a viable gestational age increased with increasing age ($p<0.001$). Family history of diabetes mellitus was not associated with the age of the pregnant woman ($p=0.161$) as shown in Table 2.

Prevalence and risk factors of gestational diabetes mellitus

A prevalence of gestational diabetes was 1.9% (95% CI: 0.24-6.97). No significant association was found between GDM and these independent variables: maternal age, level of education, marital status, employment status, BMI, and gestational age ($P=1.000$). Women who were above 30 years with secondary education; employed; obese; and with gestational age of the foetus between 31-35 weeks were more likely to present with GDM. Most women with family history of diabetes were more likely to present with GDM than women with no family history as publicized in table 3.

Discussion

The current research employed a cross-sectional descriptive design to capture a 'snapshot' of gestational diabetes in Mopani district. Questionnaire adapted from Michigan Diabetes Research and Training Centre DCP 2.0 which has been piloted signifies reliability of the present study findings.

A systematic review conducted in sub-Saharan Africa reported the prevalence of GDM ranging between 0 and 9% [5]. Almost 6% of pregnancies in the United States (US) are affected by GDM with prevalence ranging from 1–25% depending on the population and diagnostic criteria used [18]. In Nigeria, one study found the prevalence of GDM to be 3.8%, 8.1%, 7.5%, and 8.6% in accordance with 1999 WHO, new 2013 WHO modified IADPSG and IADPSG criteria [19]. A recent prospective cohort study conducted at a level 1 clinic in Gauteng province of South Africa reported the prevalence of GDM to be 7%, 17% and 26% in accordance with 1999 WHO, National Institute for health and Care Excellence (NICE) and IADPSG [7]. In this study, the prevalence of GDM was 1.9%.

Moreover, the reason for low prevalence of GDM in this study is not documented; however, small sample size might have contributed. Another contributing reason could be that studies used different diagnostic criteria in determining the prevalence of GDM. International uniformity for ascertainment and diagnosis of GDM has not been reached and has remained an argumentative issue [20]. WHO has recognized and adopted the IADPSG diagnostic criteria, however the implementation of this new criterion in screening for GDM remains debatable due to lack of evidence from prospective randomised studies to show improved maternal and foetal outcome with this adoption [20].

There are three screening approaches of GDM and these are one-step approach, two-step approach and clinical risk factors approach. With one-step approach, 75 g two-hour fasting oral glucose test is done;

this approach is commonly [18]. Regarding the two-step approach, it involves firstly administering a 50 g non-fasting Oral Glucose Challenge Test at 24 to 28 weeks of gestation followed by a 100 g fasting test for women who had a positive screening test from first administration of glucose [18]. Furthermore, this approach has been found to be easy to perform and generally well tolerated in comparison with one-step approach [18].

This abovementioned finding resonates with a study conducted which demonstrated that a modified two-step screening strategy with a Glucose Challenge Test (GCT) and clinical risk factors might be a practical and alternative to the universal one-step approach with a 75 g OGTT to reduce the workload and the need for a fasting test in about 50% of women [21].

Several studies have reported various risk factors associated with GDM. In contrast, in the present study, maternal age and BMI were not statistically associated with GDM. This can be attributed to a small sample size and less cases of GDM identified in this study (2 cases from $n = 101$). In this study, women with GDM were not significantly more obese or overweight than those without gestational diabetes ($P = 1.000$). Moreover, this is not in line with other studies which showed that diabetes is highly correlated with obesity [22]. The reason for high BMI being as risk factor for GMD is because of weight gain in pregnancy which is more likely to promote hyperglycaemia.

In agreement with previous studies conducted, family history of diabetes mellitus was significantly associated with GDM. Family history of diabetes in first degree relatives have been found to be the most significant risk factors for gestational diabetes which further emphasizes the role of genetics in susceptibility toward this condition [1, 6, 24, 25]. In addition, a study proposed that screening and early identification of this possible risk factor in pregnant women would be helpful and cost-effective in planning maternal health services and providing high quality prenatal care to women who may develop gestational diabetes mellitus [26].

A prospective study conducted in China among Chinese women found that higher educational level was related to reduce risk of gestational diabetes after adjustment for potential confounders [27]. A cross-sectional study conducted amongst pregnant women attending their first prenatal clinic at Korle-Bu Teaching hospital in Accra, found higher level of education positively associated with the development of GDM [28]. A study conducted in Italy found that high levels of maternal education were associated with reduced risks of gestational diabetes compared to less educated women. The reason for this might be that higher educational level provides pregnant women with more knowledge for understanding the risk factors associated with GDM [27].

Similarly, a matched pair case-control study conducted with 276 GDM women and 276 non-GDM women in two hospitals in Beijing China was done and it was found that the number of women who developed GDM was significantly higher in those who received more than 12 years of education when compared to those who received less than 9 years of education with p-value of 0.001 [29]. The reason for this might be lifestyle change and diet i.e. consumption of fast food. Education, income and place of residence showed no correlation with GDM diagnosis [30]. Similar to this, the finding of the present study, showed no

significant association between level of education and GDM, however, pregnant women with secondary education were more likely to have shown signs of GDM. In Netherlands, one study found that low maternal education level was associated with GDM [31]. This might be because lower education status is related to a traditional diet which is inexpensive but has high concentration of fat and carbohydrate contents.

In this study, marital status was not significantly associated with the development of gestational diabetes. A study conducted in Beijing, China showed that more pregnant women in control group were married compared to those with GDM and that was no statistically significant association between marital status and GDM with p-value of 0.069 [29]. The present study did though highlight that married pregnant women were more likely to be above 35 years of age ($P = 0.052$). A population-based prospective study conducted in Netherlands showed that maternal lower income was associated with increased the risk of GDM [31]. In contrast to this study, there was no significant association between employment status and GDM ($P = 0.535$). This finding is in line with previous studies which found no significant relationship between household income and GDM [27, 32].

Regarding the limitations of this study, the sample size in this study was small which in turn affected the generalizability of this research study findings to the overall population of pregnant women. One of this study objective was to describe the maternal and infant outcomes associated with gestational diabetes mellitus. As a result of poor documentation on participant's antenatal medical records (maternity casebook and hospital), there was no information about infant and maternal adverse health outcomes specifically those on those who were diagnosed with gestational diabetes. This information was important because it could have demonstrated the association between the infant and maternal health outcomes with GDM. Furthermore, information on the participants' medical records was insufficient to be captured on data entry form which resulted in missing data.

Conclusions

This study supports SDG goal no 3 which focuses on promoting good health and well-being. Non-communicable diseases (NCDs) pose as a global burden of disease, leading causes of death and the rate of deaths are expected to increase to 60% and 70% in the year 2020 [33]. GDM is one of the NCDs. The current study determined the prevalence of GDM in Mopani district to be 1.9% and the risk factors were identified to be maternal age, BMI and family history of diabetes.

The findings of this study suggest that there is a need for uniform screening and diagnostic criteria of GDM which has both high specificity and sensitivity. This will ensure that the condition is identified early and intervention is initiated sooner. The current study is significant to inform health governing bodies from global, international, national and local as well as university institutions to look closely at the best screening and diagnostic approach for GDM which is cost-effective, time efficient and relevant to wide variety of populations and ethnic groups. Thus, international and local collaborations need to be

strengthened to ensure that life expectancy is increased; infant and maternal mortality and morbidity reduces and mostly important, good health for all is build.

It is recommended that best strategy for diagnosing GDM to improve pregnancy outcomes need to be established. This will need research academics focusing on child and maternal health to collaborate and perform a randomised-control trials (RCTs) on a large scale comparing screening and diagnostic criteria. Health facilities i.e. hospitals and clinics must conduct awareness campaigns to educate women about risk factors of GDM and its adversative outcomes so that they are able to know measures to take on GDM risk factors which are modifiable. More studies of this nature need to be conducted on a large scale.

List Of Abbreviations

ANC Antenatal clinic

GCT Glucose challenge test

GDM Gestational diabetes mellitus

GWG Gestational weight gain

IADPSG International association of diabetes in pregnancy study groups

NCDs Non-communicable diseases

NICE National institute for health and care excellence

OGTT Oral glucose tolerance test

RCTs Randomised-control trials

SDG Sustainable developmental goals

SPSS Statistical package for social sciences

Declarations

Ethics approval and consent to participate

The current study was conducted following the ethical guidelines set by the South African Department of Health where in it was conducted after getting the ethical approval from the Turfloop Research Ethics Committee (TREC) with ethics reference number TREC/19/2019:PG from the University of Limpopo in South Africa. The Department of Health in Limpopo Province and Mopani District Health Office also gave consent for the research to be conducted at the hospital (Nkhensani) and two clinics (Nkhensani Gateway and Giyani Health Centre). Therefore, the current study was conducted in a manner that minimised

possible harm to the participants and it was conducted by researchers who had the appropriate ethics and scientific educational training and qualifications to conduct research. A public health care professional who was the main investigator provided supervision to participants together with assistance from an epidemiologist. Lastly, the participants signed informed consent form before participating in the study and they were not paid for their participation.

Consent for publication

Prior to participants participating in the study, they signed an informed consent and were informed that their personal information will not be revealed in the event of research publication.

Availability of data and materials

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The principal investigator with co-investigators did not have any actual or potential competing interests in taking part in the current research.

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Authors' contributions

The design of the study including the data management and writing of the article was done as a collaborative effort from all authors involved in the study. ME contributed to the conception, design including analysis and interpretation of data while NE made substantial contribution in the acquisition of data and manuscript writing. ME and NT collaborated on analysis, interpretation of data, writing and revising of the final manuscript.

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Tables

Table 1: Demographics information of pregnant women

	No	(%)
Age (years)		
<20	16	15.8
20-24	24	23.7
25-29	22	21.8
30-34	25	24.8
35+	14	13.8
Level of Education		
None	3	3
Primary	10	10
Secondary	69	68
Tertiary	19	19
Marital status		
Married	48	47
Unmarried	53	53
Body Mass Index (BMI)		
Underweight:($<18.5 \text{ kg/m}^2$)	-	-
Normal weight ($18.5 - 25 \text{ kg/m}^2$)	26	26
Overweight ($25 - 30 \text{ kg/m}^2$)	44	44
Obese (30 kg/m^2)	31	31
Employment		
Employed	32	32
Unemployed	69	64
Family history of diabetes		
No history of diabetes	87	86
History of diabetes	14	14

Table 2: Association of age of pregnant women by selected demographics

	Age (years)					p-value
	<20	20-24	25-29	30-34	≥35	
Marital status						
Single	12(71)	17(68)	10(50)	10(40)	4(29)	0.052
Married	5(29)	8(32)	10(50)	15(60)	10(71)	
Employment status						
Employed	1(6)	3(12)	8(40)	10(40)	10(72)	<0.001
Unemployed	16(94)	22(88)	12(60)	15(60)	4(28)	
1st ANC visit (weeks)						0.055
≤4	1(6)	5(20)	-	3(12)	-	
5 – 8	6(35)	3(12)	3(15)	4(17)	-	
>8	10(59)	17(68)	17(85)	17(71)	14(100)	
Mother's gravida						
1	15(88)	11(44)	3(15)	1(4)	-	<0.001
2	2(12)	14(56)	10(50)	8(32)	1(7)	
≥3			7(35)	16(64)	13(93)	
Mother's parity						
0	16(94)	14(56)	4(20)	2(8)		<0.001
1	1(6)	11(44)	10(50)	8(32)	1(7)	
≥2			6(30)	15(60)	13(93)	
Family history of DM						
Yes	3(18)	2(8)	4(20)	1(4)	4(29)	0.161
No	14(82)	23(92)	16(80)	24(96)	10(71)	

Table 3: Selected demographics associated with GA

	n	Gestational Diabetes		p-value
		Yes	No	
Maternal Age (years)				1.000
<30	62	1(2)	61(98)	
≥30	39	1(3)	38(97)	
Education				1.000
None	3	-	3(100)	
Primary	10	-	10(100)	
Secondary	69	2(3)	67(98)	
Tertiary	19	-	19(100)	
Marital status				1.000
Married	48	1(2)	47(98)	
Unmarried	53	1(2)	52(98)	
Employment status				0.535
Employed	32	1(3)	31(97)	
Unemployed	69	1(1)	68(99)	
BMI				1.000
Normal weight (18.5 – 25 kg/m ²)	26	-	26(100)	
Overweight (25 - 30 kg/m ²)	44	1(2)	43(98)	
Obese (30 kg/m ²)	31	1(3)	30(97)	
Gestation Age (weeks)				0.530
≤25	22	-	22(100)	
26-30	16	-	16(100)	
31-35	33	2(6)	31(94)	
36 - 40	30		30(100)	
Family history diabetes				0.018
Yes	14	2(14)	12(86)	
No	87	-	87(100)	

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [DataColletionTool.docx](#)
- [DataColletionTool.docx](#)