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Prevalence of Hyperglycemia among Pregnant Mothers in Isingiro District Uganda: A Call to Enhance Antenatal Care Services

Nuwahereza, Innocent[1, 3]*, Tumuhimbise, Manasseh[1, 2], Lynda, Sagrestano[1, 5], Mbatide, Joan [1,3], Kato, Dennis[3], Nyanzi, Sadrach[3] , Katushabe, Jane[3] , Baluku, G. Kisunzu[3] , Berinde, Anthony[1], and Aturinda, Susan[1]

[1]Ishaka Health Plan, P. O Box 111 Bushenyi; Uganda.
[2]Maternal Newborn and Child Health Institute, Mbarara University of Science and Technology, Uganda; P. O Box 1410 Mbarara; Uganda.
[3]MINC Medical Center-Isingiro District Uganda.
[4]MINC Public Health Consultants Uganda.
[5]Institute for Sociology, Lüdwig-Maximillians-Universität München.
*Corresponding author E-mail: nuwahereza.innocent@yahoo.com

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ABSTRACT: Globally, gestational diabetes mellitus (GDM) is a public health concern affecting 14% of all pregnancies and continues to increase worldwide. The case of developing countries display a dark situation with over 16% of pregnant mothers being at risk due to related factors like increasing urbanization, decreasing levels of physical activity, changes in dietary patterns and increasing prevalence of obesity. The findings contribute towards enhancing antenatal care (ANC) services as a complete package of maternal health care in Isingiro district and other similar resource constrained settings in Uganda. To achieve the study purpose, the study determined the prevalence, maternal characteristics and the association thereof among pregnant mothers at MINC Medical Center in Isingiro District Western Uganda.

Methods: A descriptive cross sectional study design was adopted. Maternal characteristics were collected using an interview method. A questionnaire was used to collect data about the participants' maternal characteristics including age, sex, parity, level of education and lifestyle related information. The questionnaire was filled by a trained research assistant on behalf of the participant. The characteristics were grouped into two categories: bio-data and maternal history.

Results: Majority of the respondents (235, 76.6%) were in the age bracket 19-30 years, with the mean age 26.4 years, this is the most reproductive age of most mothers. The majority of the respondents were primary school leavers (193, 63.4%). Most women attending ANC are either housewives or shop attendants (169, 55.2%).

Conclusion: The results of the present study highlight the importance of introducing random blood sugar (RBS) as a point of care test in the ANC for early screening of GDM. Incorporating of age related advantages while sensitizing mothers during the ANC visit in relation to GDM. Additionally, integrating lifestyle modification topics for mothers so as to delay lifestyle related diseases including diabetes mellitus.

Keywords: Hyperglycemia, pregnancy, gestational diabetes mellitus

INTRODUCTION

Gestational diabetes mellitus (GDM) is a global public health concern affecting approximately 6-34% of pregnancies, with rates continuing to rise, in part due to increasing rates of hyperglycemia (high blood sugar) and pre-existing type 2 diabetes mellitus T2DM (Larrabure-Torrealva *et al*., 2018; Zhu and Zhang, 2016). Although data from low and middle income countries (LMICs) are sporadic, available studies show that Africa is on the high end of the spectrum, with as many as 14% of pregnant mothers identified as having GDM (Macaulay *et al*., 2014; Nakabuye *et al*.,2017). Women in LMICs experience high risk of hyperglycemia or GDM as the result of many

contributing factors, such as increasing urbanization, decreasing levels of physical activity, changes in dietary patterns, and increasing prevalence of obesity (Larrabure-Torrealva *et al*., 2018; Macaulay *et al*., 2014; Zhu and Zhang, 2016). The urbanization of Africa, for example, has resulted in a large increase in diabetes and affiliated chronic diseases (Macaulay *et al*., 2014), and research in Uganda suggests that 5% of the population is diabetic, with a trend towards increasing prevalence (Nyanzi *et al*., 2014).

GDM has direct effects on the health of the mother and fetus, including complications such as fetal hypoglycemia at birth, fetal macrosomia, pre-eclampsia/hypertensive disorders in pregnancy, shoulder dystocia, and increased risk of puerperal sepsis, emergency caesarian section, and persistent Type 2 diabetes mellitus (Gilmartin *et al*., 2008; WHO, 2018). In addition, children born of a mother suffering from GDM are more susceptible to impaired glucose tolerance and obesity (Kim *et al*., 2011).

Gestational diabetes mellitus is any degree of glucose intolerance which is first diagnosed during pregnancy (WHO, 2018). Although there is no consensus concerning screening and classification of GDM (Macaulay *et al*., 2014), the World Health Organization (WHO, 2018) has developed guidance for early diagnosis of hyperglycemia and GDM based on blood glucose levels. Hyperglycemiais diagnosed when one or more of the following criteria are met:

(i) Fasting plasma glucose 5.1-6.9 mmol/L (92-125mg/dL).
(ii) 2-hour plasma glucose 11.1 mmol/L (200 mg/dL) following a 75 g oral glucose load.
(iii) Random plasma glucose 11.1 mmol/L (200 mg/dL) with or without symptoms of diabetes" (WHO, 2018).

Although these diagnostic guidelines are intended for all primary health care providers, routine use of these guidelines in antenatal centers of resource constrained countries, such as Uganda, remains limited (Hod *et al*., 2015; Nielsen *et al*., 2012; WHO 2018). In Uganda, where there are no well-established national guidelines for GDM screening, most clinicians at antenatal centers focus on history taking, clinical exams, and urine examination. This approach leaves many pregnant women with hyperglycemia unnoticed until they develop overt symptoms of diabetes and its complications (Nakabuye *et al*., 2017).Yet, screening and identifying GDM offers an opportunity to improve antenatal services and contain adverse maternal and fetal outcomes related to GDM. Because GDM is understudied in Uganda, the current study was designed to determine the prevalence of hyperglycemia using random (e.g., non-fasting) blood glucose testing, as well as associated maternal characteristics of women attending the antenatal clinic at MINC Medical Center in Isingiro District Western Uganda, in Isingiro District in south western Uganda.

To achieve the study purpose, a descriptive cross-sectional design was adopted.

METHODOLOGY

Measures

Maternal characteristics, including maternal history and biological data, were collected using a combination of structured interviews and a review of the patient's antenatal card (i.e., medical chart). A series of questions was developed to assess characteristics such as age, level of education, occupation, gravidity, number of live births, and history of abortion/miscarriage. Blood pressure was captured from the participant's antenatal card. To assess blood glucose levels, participants were referred to the point of care (POC) screening testing room for random blood glucose testing. A One touch glucometer calibrated in ml mol by the manufacturer and supplied by future medicals Uganda limited, Kampala for the study purposes was used to test the participants' random (non-fasting) blood glucose. The supplies used in blood testing, including savlon soap, cotton, swabs, and pickers, were provided in kind by MINC Medical Center.

Participant sampling and procedures

Participants in the study were drawn from the pool of pregnant women attending the antenatal clinic at MINC Medical Center in Isingiro District Western Uganda for 20 working days during August and September of 2020. Isingiro district has one government health center IV (Rwenkobwa HCIV), one health center three (Kabingo HCIII) and one private not for profit health center III (Kyabirikwa HCIII).

At the time of the study MINC Medical Center was the largest private health center chosen purposively because the facility clients were able to meet the basic costs for a random blood glucose and further still, the facility had homogeneous coverage for mothers attending ANC at the facility including referrals from the two community health facilities and a one private not for profit facility. The sample size was determined using the Kish and leislie (1965) formula:

$n = (Z^2PQ)/D^2$

Where;

n is the sample size,
Z is the score for a given confidence interval,
P is a known estimated prevalence,
Q = (1-P) i.e. the population not at risk
D is the permissible error of estimation.

The closest indicator shows that 22% of the African population is pregnant at any point in time (WHO, 2020. Using this ratio, it was estimated that the population of pregnant women in Isingiro at any given time is approximately 521 (UBOS, 2014). Based on this calculation, 322 participants were recruited into the study; however, after removing those with incomplete data at the time of analysis, the final sample consisted of 306 participants with complete data. Prior to data collection, the research team, which included a nurse counselor, a registered midwife, a laboratory technician, and a data clerk, underwent a two-day training conducted by the lead researcher. The training included information on the purpose, methods, and tools to be used in the study. Team members were thoroughly trained in the informed consent procedures, as well as best practices for data collection techniques and protecting patient confidentiality. The trainees then collected pilot data from 10 participants attending the antenatal clinic at Ishaka Adventist hospital allow for practice as well as an assessment of the understandability of the study tools, which were adjusted based on feedback from the pilot study. Once finalized, the study protocol and materials were reviewed and approved by the research ethics committee of MINC Public Health Consultants Uganda.

The study utilized a systematic random sampling technique whereby at the start of the study the first pregnant woman in the antenatal clinic attendance register was enrolled in the study, followed by every second pregnant woman. If the sampled mother did not meet the inclusion criteria or declined to participate, the subsequent one was then selected. To be included in the study, participants had to attend the antenatal care services clinic at MINC Medical Center-Isingiro, have no known history of diabetes mellitus, and voluntarily consent to take part in the study. Sampled participants were individually invited into a secure clinical room provided by the MINC Medical Center-Isingiro administration. A trained member of the research team reviewed and obtained informed consent, ensuring each participant that she could withdraw from the study at any time. Following consent, the researcher conducted the structured interview portion of the study, and recorded responses in writing on data collection forms. Participants were then directed to the laboratory for random blood glucose testing. The consent and interview process lasted approximately 30 minutes per participant, and the glucose testing lasted approximately 3-5 minutes. Collected data was cross-checked at the end of each day for completeness and then securely stored in a locked cabinet in the office of Ishaka Health Plan.To ensure anonymity, no personally identifying information was collected, and numerical codes were used to link the questionnaire data to the laboratory data. Upon completion of data collection, the raw data was securely stored in the office of the Head of the Maternal and Child Health department.

Data analyses

Data analyses were conducted using Stata (version 16). Descriptive statistics were used to examine maternal characteristics and hyperglycemia prevalence. Odds ratios were used to assess associations between maternal characteristics and hyperglycemia prevalence. An odds ratio of greater than one implies that there is a higher likelihood of hyperglycemia in the sample with the characteristic versus the comparison without the characteristic. The odds ratio and p-values were used to establish the association and level of significance between maternal characteristics and hyperglycemia prevalence. Only odds ratios with $p< 0.05$ were considered statistically significant.

RESULTS

A study conducted at St. Francis Hospital, Nsambya, in Kampala in central Uganda found a GDM prevalence rate of 31.9% (Nakabuye *et al*., 2017). Similarly, 32.1% of pregnant women were found to have GDM in a study in Cameroon in central Africa (Munang *et al*., 2017). Therefore 30% was adopted as the benchmark prevalence rate of GDM to determine the sample size for this study. The desired confidence interval was 95% (1.96) with the permissible error of an estimation of 5% (Nakabuye *et al*., 2017). Thus: $n = (1.96^2 \text{ X } 0.30 \text{ X } 0.699)/ (0.05)^2 = 322$. Therefore, data were collected from a sample of 322 pregnant women who completed the structured interview of maternal characteristics and the test of random (e.g., non-fasting) blood glucose levels. Of those, complete data were available for 306 women, who were included in the final analyses. Table 1 presents descriptive data on the study variables, as well as results of the odds ratio analyses.

Maternal characteristics and pregnancy history

The women included in the sample ranged in age from 15 to 42 years of age, with a mean age of 26.4 years. More than half of the sample (63.7%) reported only a primary school education. Most of the women worked in either agriculture (55.6%) or business (36.2%). Several characteristics related to pregnancy history were assessed in the sample. More than a third of the women were pregnant for the first time (38.5%), and another 23.0% were pregnant for the second time. Thirteen percent reported this to be their 5th pregnancy, and 62.5% reported having at least one child at home. Most of the respondents (93.5%) reported no history of miscarriage or abortion. With respect to the current pregnancy, most of the women (72.2%) were in the third trimester. The blood pressure of the majority of participants was within the normal range of 120/60 to 139/79mmHg (85.9%).

Table 1: Risk factors associated with Hyperglycemia.

Factor	Sample Size (N=306) n (%)	Random Blood Glucose Levels		Odds ratio	95% CI	p-value
		***Normal* (< 11. 0 mmol/L) n (%)**	***Abnormal* (> 11.0 mmol/L) n (%)**			
Age Range						
15to18	16 (5.2)	10(62.5)	6(37.5)	1		
19to24	125 (40.8)	116(92.8)	9(7.2)	7.73	2.29-26.15	0.001*
25to30	110 (35.9)	95(86.4)	15(13.6)	3.8	1.20-11.99	0.023*
31to36	28 (9.2)	22(78.6)	6(21.4)	2.2	0.57-8.53	0.255
37to42	27 (8.8)	15(55.6)	12(44.4)	0.75	0.21-2.66	0.656
	306	258 (84.3)	48 (15.7%)			
Education						
None	2 (.65)	2(100.0)	0(0.0)	1		
Primary	193 (63.1)	158(81.9)	35(18.3)	0.62	0.21-1.88	0.402
Secondary	78 (25.5)	69(88.5)	9(11.5)	1.057	0.30-3.71	0.930
Tertiary	33 (10.8)	29(87.9)	4(12.1)	1		
	306					
Occupation						
Agriculture/Peasant	169 (55.6)	129(76.3)	40(23.7)	0.121	0.042-0.35	0.000*
Business	110 (36.2)	106(96.4)	4(3.6)	1		
Civil servants (teachers, nurses, midwives)	16 (5.3)	14(87.5)	2(12.5)	0.264	0.044-1.576	0.144
None	9 (3.0)	9(100.0)	0(0.0)	1		
Student	2 (.66)	0(0.0)	2(100.0)	1		
	304					
Gravidity						
Prime	117 (38.5)	111(94.9)	6(5.1)	5.37	1.78-16.25	0.003*
Second	70 (23.0)	56(80.0)	14(20.0)	1.16	0.45-3.00	0.757
Third	46 (15.1)	35(76.1)	11(23.9)	0.923	0.34-2.52	0.877
Fourth	31 (10.2)	25(80.7)	6(19.4)	1.201	0.38-3.87	0.748
Fifth	40 (13.2)	31(77.5)	9(22.5)	1		
	304					
History of Abortion/Miscarriage						
No	286 (93.5)	247(86.4)	39(13.6)	1		
Yes	20 (6.5)	11(55.0)	9(45.0)	0.192	0.075-0.496	0.001*
	306					
Trimester						
1st	34 (11.1)	34(100.0)	0(0.0)	1		
2nd	51 (16.7)	36(70.6)	15(29.4)	0.42	0.21-0.85	0.017*
3rd	221 (72.2)	188(85.1)	33(12.9)	1		
	306					
Hyperglycemia						
No	271 (88.6)	231(85.2)	40(14.8)	1		
Yes	35 (11.4)	27(77.1)	8(22.9)	0.58	0.25-1.38	0.219
	306					
Blood pressure -Diastolic bp						
40to59	126 (41.2)	108(85.7)	18(14.3)	1		
60to79	38 (12.4)	32(84.2)	6(15.8)	0.889	0.33-2.43	0.818
80to99	142 (46.4)	118(83.1)	24(16.9)	0.819	0.42-1.59	0.557
	306					
Blood pressure - Systolic bp						
120to139	47 (15.4)	38(80.9)	9(19.2)	1		
70to89	19 (6.2)	17(89.5)	2(10.5)	2.01	0.39-10.33	0.402
90to119	240 (78.4)	203(84.6)	37(15.4)	1.299	0.58-2.91	0.524
	306					

Prevalence of hyperglycemia in pregnancy

Hyperglycemia was diagnosed using random (e.g., non-fasting) blood glucose testing at point of care, as it generates instantaneous results for medical intervention and the technique is recommended by WHO (2018) for use in resource limited settings. A random blood glucose level of >11.1mmol/L was set as the cutoff for diagnosis, in accordance with WHO (2018) recommendations. Based on this cutoff, 16.4% of the pregnant women in this sample can be diagnosed as being hyperglycemic, which is higher than the sub Saharan average of 12.6% (Munang *et al*., 2017). This suggests that 16.4% the expectant mothers in the sample are at a comparatively increased risk of maternal and fetal complications related to GDM.

Examinations of associations between hyperglycemia and other maternal characteristics indicate that hyperglycemia occurred more frequently among women aged 19-24 years (OR = 7.73, 95%, CI1.20-26.16, p<0.01), followed by those aged 25-30 (OR = 3.80, 95%, CI1.20-11.99, p<0.05). However, the high odds ratio in the age bracket 19-30 can be explained in part by the majority of participants falling into this age range, and thus younger and older ages should also be screened for hyperglycemia.

Educational level was not associated with increased odds of developing hyperglycemia, however, those who worked in agriculture had significantly greater odds of developing hyperglycemia than those in other occupations (OR = 0.121, 95%,CI0.042-0.35, p<0.01).

Primigravid mothers were more likely to have hyperglycemia than their multigravid counterparts (OR = 5.37, 95%CI1.78-16.25, p<0.01). Having one or more children was associated with higher odds of developing GDM (OR = 0.02, 95%CI 0.004-0.138, p<0.01), as was having a history of miscarriage or abortion (OR = 0.192,95%CI 0.75-0.496, p<0.01).However, blood pressure was not statistically significantly associated with increased odds of developing hyperglycemia. Overall, the study reveals that age and parity are the leading maternal risk factors associated with hyperglycemia in the study context.

DISCUSSION

Globally hyperglycemia and GDM affect as many as 1 in 7 live births (Zhu and Zhang, 2016) and have severe consequences for pre- and post-natal fetal-maternal morbidity and mortality(Gilmartin *et al*., 2008; WHO, 2018). Studies of Africa report as many as 14% of pregnant mothers with GDM (e.g., Macaulay *et al*., 2014; Nakabuye *et al*., 2017). However, the prevalence rate of hyperglycemia at the IAH antenatal center (ANC) in Bushenyi District, Uganda was found to be higher, at 16.4%. Results indicate that most mothers attending the ANC live in a semi-urban setting, are in the most active reproductive age bracket (19-30), have low levels of education and live a sedentary lifestyle. These findings suggest that screening for hyperglycemia in antenatal settings is critical for promoting the health and well-being of women and children in Uganda and other LMIC, and has the potential of positively impacting the UN (2017) Sustainable Development Goals (e.g. SDG3; Ensure healthy lives and promote wellbeing for all at all ages). Without specific emphasis on screening for hyperglycemia during pregnancy, the efforts to fight neonatal and maternal mortality and morbidity will fall short.

Pregnant women in low income countries are not consistently screened for hyperglycemia and GDM even though these regions account for 85% of global deliveries and 88% of GDM cases (WHO, 2015). In the absence of national guidelines on screening for hyperglycemia and GDM, most antenatal centers focus on history taking, clinical exams and sometimes urine analysis to assess the GDM risk. This approach lacks consistency in results, leaving many cases undetected until the patients develop overt symptoms of diabetes (Nakabuye *et al*., 2017). In the current study random blood glucose testing was preferred because it generates consistent, instantaneous, reliable, and low-cost results. Replicating random blood glucose testing during point of care testing in the ANC centers holds potential to increase access to testing and will accelerate early treatment of women before diabetes develops or progresses.

The association of hyperglycemia with maternal age in the current sample was high for women in the age bracket of 19-24years (OR: 7.73, 95%CI1.20-26.16, P=0.001). At the same time, this age bracket had the highest number of participants (76.6%), which suggests that the high odds ratio is a result of the higher frequency of participants between 19 and 30 years in the study. The current study findings suggest higher risk for hyperglycemia and GDM with advanced maternal age, consistent with previous research (Erem *et al*., 2015). This suggests that to reduce the chance of developing hyperglycemia and GDM, mothers should be encouraged to plan pregnancies and deliveries at or before 30 years.

Gravidity/parity is another factor highly associated with hyperglycemia and GDM (e.g., Jang *et al*, 2011, and in the current sample primigravid women were less likely to have hyperglycemia than multigravidwomen (OR: 5.37, 95%CI1.76-16.25, P=0.003). However, there are few population-based studies showing gravidity or parity as risk factors, either independently or in combination with other associated factors. The current study has several strengths including utilization of trained interviewers and a standardized random blood glucose test. Random blood glucose testing is affordable, convenient, reliable, and appropriate for rural settings, providing immediate results for prompt diagnosis of hyperglycemia at each maternal contact during antenatal visits. Additionally, the

sample is relatively large and data collection stretched over a period of 40 clinic days, thus yielding sufficient statistical power to assess associations between hyperglycemia and relevant maternal characteristics. As there is very limited research of this nature in Uganda, the results provide a basis for further research in Uganda. However, the current study also has some limitations. First, hyperglycemia was assessed with non-fasting women, whereas fasting participants would yield more fine-tuned results. Most of the maternal characteristics were assessed using self-reports, and thus social bias cannot be completely ruled out. Whereas previous studies have assessed hyperglycemia and pregnancy outcomes, this study included maternal characteristics and pregnancy history, but not pregnancy outcomes, and the data allowed only for univariate analyses. Participants were mothers from within the hospital catchment area of south western Uganda and the results may not be generalizable to the whole population of Uganda. Thus, further research is needed to address these issues to better understand the prevalence and course of hyperglycemia and GDM throughout Uganda.

Conclusion

The results of the present study highlight the importance of introducing random blood glucose testing as a point of care test in the antenatal clinic for early screening of hyperglycemia and GDM, and provide preliminary evidence that this type of test is an effective screening tool in LMIC such as Uganda. Routine screening during antenatal visits, coupled with educational interventions that sensitize women about the risks and prevention of hyperglycemia and integrate lifestyle modification topics, have the potential to impact the health and wellbeing of women and their children by delaying or preventing lifestyle related diseases such as diabetes mellitus.

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