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Rural Living Residence is Associated with Risk Factors of Gestational Diabetes: A Retrospective Comparative Cross-sectional Study in Central Uganda

William Lumu

dhabaguma@gmail.com

Mengo hospital

Susan Nakireka

Mengo hospital

Ronald Kasoma Mutebi

Mengo Hospital

Richard Billy Ndiwalana

Mengo Hospital

David Muyanja

Mengo Hospital

Geraldine Nassejje

Mengo hospital

Harriet Nabukalu

Mengo hospital

Rebecca Mayega

Mengo hospital

David Munvaneza

Mengo hospital

Sylivia Nakacwa

Mengo hospital

Ezra Nunda

Mengo hospital

Christine Ssevume

Mengo hospital

Robinson SSebuufu

Mengo Hospital

Annet Kugonza

Mengo Hospital

Simon Peter Nsingo
Mengo Hospital

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Abstract

Background

Gestational diabetes (GDM) is a major public health problem. The risk factors of GDM are not the same in gravida residing in different geographical areas due to rural-urban differences in maternal metabolic health and risk factors of diabetes. The study aimed to assess the association between rural living residence and GDM risk factors in Central Uganda.

Methods

This is a retrospective comparative cross-sectional study in which data from 600 women with GDM from 2016–2018 was extracted, with 300 from Luwero district(rural) and 300 from Mengo hospital(urban). Data on socio-demographics, clinical characteristics and risk factors was collected. Diagnosis of GDM was based on the IADSPG/ADA one step approach using a 75g OGTT (Oral Glucose Tolerance Test). The risk factors for GDM were defined using standard methods. The socio-demographic and clinical characteristics were described appropriately depending on their distribution. The Modified Poisson regression analysis model was used to explore the association between rural living residence and GDM risk factors expressed as adjusted prevalence ratios with their 95% confidence intervals and p-values. Statistical significance was set at < 0.05.

Results

Overall,600 women with GDM were included (n = 300 urban, n = 300 rural). The median age was 27years (IQR 21–32), with rural women younger than urban ones(P < 0.001). Rural women were shorter (≤ 150cm) P < 0.001, had family history of diabetes (P < 0.001), and parity (≥ 5) P < 0.001 compared to their urban counterparts. Rural living residence was positively and significantly associated with history of hypertension(APR = 1.343,95% CI 1.164–1.55,P < 0.001),history of GDM (APR = 1.391,95% C.I 1.208-1.60,P < 0.001),family history of diabetes(APR = 1.343,95% C.I 1.158–1.557,P < 0.001).Women with parity ≥ 5 were 31.6% more likely to be rural (APR = 1.316,95% CI 1.261–1.584,P < 0.001). The likelihood of having a height < 150cm was more than 38% with rural women than urban ones (APR = 1.381,95% C.I 1.228–1.612, P < 0.001). Women in rural areas were 31% less likely to be older than 35years APR = 0.687 (0.558– 0.847, P < 0.001).

Conclusion

We found that rural living residence is associated with risk factors of gestational diabetes. With increasing burden of diabetes in rural areas, universal screening for GDM may provide a window of

opportunity to detect and manage glucose abnormalities including intermediate hyperglycemia and type 2 diabetes in rural clinical settings.

Background

Gestational diabetes (GDM) is described as elevated blood glucose levels initially identified during pregnancy at concentrations lower than those of evident diabetes(1).It affects approximately 9–14% of pregnancies worldwide; the variation in its prevalence is due to differences in risk factors and screening and diagnosis methods. It is rising alongside type 2 diabetes(T2D) and obesity(2).

Gestational diabetes continues to be a neglected maternal health problem despite its linkage with several pregnancy complications and its associated risk of T2D and cardiovascular disease (CVD) for both the mother and the unborn child later in life. Indeed, many middle-and low-income countries including Uganda have suboptimal screening rates for GDM, and routine prenatal care rarely includes GDM screening. This lack of political priority for GDM on the international scene is a missed opportunity to improve maternal health and accelerate progress towards the most off-track Millenium Development Goal number 5(3) (4)

Pregnant women who have a number of predetermined or chosen risk factors should be evaluated for GDM according to Uganda Clinical Guidelines (5). However, this is not routinely done in public health facilities. In some cases, screening is carried out on an individual basis using the clinician's discretion and a random blood glucose is used in place of the Oral Glucose Tolerance test(5). Moreover, selective screening fails to identify more than 50% of women with GDM, according to a study conducted in rural West Nile(4).Therefore, the management and follow up of women with GDM in this part of the country is limited as a result of selective and inconsistent testing.

It is imperative to understand the prevalence and burden of risk factors in the Ugandan context in order to conduct focused screening based on predetermined or selected risk factors. There is research evidence that the risk factors and pregnancy related outcomes of GDM differ among gravida living in different geographic locations. This is because maternal metabolic health and diabetes risk factors differ between rural and urban areas(6).Additionally, pregnant women in rural areas have been shown to have higher body mass index(BMI) and more chronic comorbid conditions, such as hypertension, than those in urban areas (6).The disparity in risk factors in the rural areas is further exacerbated by lower educational attainment, insufficient insurance coverage (6, 7) ,and a dearth of subspeciality diabetes-focused care(8). Moreover, rural hospitals have more resources and doctors for specialized obstetric care than rural medical centers (6–8).

According to the most recent 2023 National Non-Communicable Disease (NCD) steps survey, the prevalence of diabetes in Uganda has more than doubled over the past 10 years (9).Although, the prevalence of diabetes in rural and urban areas of the country does not differ significantly, there was a notable increase in prevalence in rural areas between 2014 and 2023. This is as a result of the rise in risk factors including overweight and sedentariness in rural areas(9). This may or may not be congruent with

GDM. Usually, the prevalence of GDM reflects that of T2D in the general population (10). Furthermore, whether GDM risk factors change between urban and rural areas in our context is unknown. The disparity between the burden of risk factors in Uganda's rural and urban areas has not been thoroughly investigated. The association between the risk factors and living in a rural area is also unclear. Understanding the association could help with the development of context-specific GDM screening and management procedures in a nation with low screening rates.

Thus, the current study set out to determine the association between risk factors for gestational diabetes and rural living residence.

Methods

Study design

This was a retrospective comparative cross-sectional study.

Setting

The study involved women diagnosed and managed for GDM grouped in terms of living residence i.e. rural and urban which was also the area of location of the health facilities. We extracted data from the files of women who were screened for GDM in Mengo hospital and 23 health facilities in Luwero district in the Gestational Diabetes in Central Uganda (GICU) program from 2016 to 2018. The program was implemented by Uganda Diabetes Association (UDA) and Reproductive Health Uganda (RHU). The total number of 10,000 women attending routine antenatal care clinics in 23 health facilities in Luwero and Mengo Hospital were enrolled into the program. Five thousand (5,000) women were enrolled in 23 health units in Luwero while 5,000 were enrolled in Mengo hospital (Fig. 1). In Luwero District, screening for GDM was provided at the 23 public and private health clinics providing antenatal services from Health Centre II to Health Centre IV and at one RHU clinic, which is a private provider/Non-Governmental Organization.

Within the facilities, the protocol for performing the OGTT included instructing women to fast for 8 hours and then come to the facilities. After a 15-minute rest, their fasting blood glucose was measured using a calibrated ACCUCHECK active glucometer. After measurement of their fasting blood glucose, they were then given 75grams of glucose dissolved in 300mls of clean drinking water and asked to drink the solution for three minutes. One and two hours later, their blood glucose levels were once more assessed.

The diagnosis of GDM was based on the current IADSPG/ADA screening guidelines that use a one-step approach of a 75g OGTT (Oral Glucose Tolerance Test) when one of the following values were met or surpassed:

0-hr (fasting) ≥ 92mg/dl

1-hr≥180mg/dl

2-hr≥153mg/dl (2).

All women diagnosed with GDM were advised to deliver from a health facility. Women with GDM in Luwero were linked to the hospitals which had medical officers, operating theatres and a nursery for premature births. The community women's groups followed these women after delivery for support after pregnancy in terms of nutrition and adherence to life style modification advice and following the recommendations on follow up screening to prevent subsequent T2D.

Furthermore, those who delivered at a health facility had their baby monitored and managed for adverse neonatal outcomes such as hypoglycaemia, respiratory distress etc before discharge while the mother was given post-natal follow up and re-testing for diabetes 6–12 weeks after delivery. All mothers underwent a non-pregnant OGTT. Those diagnosed with impaired fasting glucose, impaired glucose tolerance and T2D were referred for further medical treatment of their conditions. All women irrespective of their results on OGTT were encouraged to continue with lifestyle modifications. All mothers diagnosed with GDM were screened for diabetes with a non-pregnant OGTT. Those diagnosed with impaired glucose tolerance and T2D were referred for further medical treatment of their conditions.

Sample size

The formula for comparative cross-sectional studies, which compare two groups, was utilized to get the sample size(11).

The following formula was used to obtain the number of the participants in each group i.e. urban and rural.

$$n = \frac{r+1}{r} * \left(Z\alpha\ /2 + Z\beta\ \right)^2 * P * \frac{(1-P)}{P1-P2}$$

Where:

n=Sample size needed per group

r=ratio of participants in urban to rural facilities (r = 1, study had equal participants in each group)

Zα/2: Z score of the desired confidence level (1.96 for 95% Confidence Interval)

Zβ: Z-score of desired power of 80% power. (i.e.0.84 for a power of 80%

P1: Expected proportion(prevalence) in rural health facilities.

P2: Expected proportion(prevalence) in urban health facilities.

P: Average proportions(prevalence) (P1 + P2)/2

The data from a Tanzanian study (12) where the prevalence (P1) of GDM was 20.5% in rural areas while the prevalence (P2) of GDM was 31.6% in urban areas was used to calculate the sample size.

$$n = \frac{1+1}{1} * \ (1.96 + 0.84)^2 * 0.205 + 0.316/2 * \frac{(1 - 0.2605)}{0.205 - 0.316}$$

The calculated sample size was 245 per group. The sample size was increased by 20% to cater for the dropping of files with more than 75% of missing data resulting into 49 women added to each group (i.e. 294) which was rounded to 300. Therefore, the total sample was 600 for both rural and urban health facilities.

Sampling

All the files of the parturient women were eligible as long as they contained data on OGTT and risk factor profile. The files of women who transferred out of these facilities during the two-year program were excluded.

The files were sorted consecutively before data was extracted. From Luwero district, there were three Health Centre IVs, seventeen Health Centre IIIs and three Health Center IIs. Women were enrolled into the program in a ratio of 14:1.5:1 respectively. The same ratio was used to select the number of charts from the different levels of health facilities. Therefore, 14/16.5x300 = 255 files were selected from Health Center IVs i.e.85 from each facility. For Health Centre IIIs,1.5/16.5X300 = 27 files were selected i.e. 9 charts from each facility. Regarding Health Centre IIs, 1/16.5x300 = 18 files were selected i.e. 6 files from each facility. To obtain the desired sample size of 300, we selected files in Mengo Hospital consecutively.

Data collection

Research assistants were trained by the Principal Investigator to extract data from mothers' files who were screened and managed for GDM in 23 health facilities in Luwero and Mengo hospital from 2016 to 2018 and record it in the data extraction form **(Supplementary file 1: Data Extraction Form).** The training was held in Mengo Hospital for 2 days. It was based on the research protocol. The trained Research assistants collected data. The data was checked daily by the Principal Investigator for completeness prior to entry into the computer. Data extracted from patient files was coded and entered into epi data manager and exported into STATA version 16 (Statacorp LLC, College Station, Texas, United States of America) for analysis. Extracted data was stored in a computer that was locked by a password known only to the Principal Investigator. Using the 3-2-1 backup technique, we maintained three copies of our data: two backups and the original. These copies were kept on two distinct media types: cloud storage devices, external storage, and internal hard drives.

Variables

The study evaluated the association between rural living residence and risk factors of GDM. The following data was collected.

Independent (Predictor) Variable

This was comprised of the living residence of the pregnant woman.

Living residence was either urban or rural as indicated on the woman's file. There were 23 health facilities in Luwero district, which is 70 kilometers from Kampala. The women from these health facilities were thought to reside in the country's rural areas. These areas lack metropolitan hubs, developed roads, schools, and are less populated than the main city. Women who attended Mengo Hospital and lived in Kampala and its surrounding areas made up the urban.

Dependent (Outcome) Variables

Dependent (Outcome) Variables
The dependent variables included information on socio-demographics (age,occupation,marital status and education attainment), medical history (family history of diabetes and hypertension), past obstetric history of GDM, parity, history of twin pregnancy, history of macrosomia ≥ 4 kg, baseline fasting blood glucose, blood pressure, weight, height, and body mass index.

Fasting blood glucose

Following an 8-hour fast and a 15-minute rest period, the women's fasting blood glucose levels were assessed using a calibrated ACCUCHECK active glucometer.

Anthropometric measurements

Midwives in these facilities followed standard procedures to measure blood pressure(13)weight and height(14). Briefly, OMRON digital blood pressure machine was used to take three measurements an average of which was recorded in the mother's file. Regarding weight, mothers were instructed to take off any jewelry, heavy clothing, and shoes or slippers before taking their weights. Height was measured with a handheld stadiometer. Both the weight and height were recorded to the nearest 0.1measurements.

With the Body Mass Index (BMI) computation, the midwives divided the square of the height in meters by the weight in kilograms. The mothers were categorized using standard BMI cut-offs as underweight (BMI < 18.5 Kg/m2), normal (BMI ≥ 18.5 < 25 Kg/m2), overweight (BMI > 25 to < 30 Kg/m2), and obese (BMI > 30 Kg/m2)(13).

Definition of variables

The rural living residence was defined as living in Luwero, a rural part of the country located 70Km from Kampala and outside municipalities characterized by a low population, large amounts of undeveloped land and a livelihood heavily dependent on peasant farming(15).All women attending health facilities in Luwero were considered to be rural living. The urban residence was comprised of women who attended Mengo hospital residing in Kampala city and its suburbs.

The GDM risk factors were defined as follows: Age≥35years, parity ≥ 5, body mass index ≥ 30Kg/m^2, height<150cm, history of hypertension, history of poor pregnancy outcomes (abortion, fetal loss), history of delivering a baby≥4Kg, history of previous GDM, history of pregnancy induced hypertension, history of delivering twins(16) and history of smoking(17).

Data analysis

Data extracted from patient charts/files was coded and entered into epi data manager and exported into STATA version 16 (Statacorp LLC, College Station, Texas, United States of America) for analysis. The socio-demographic and clinical characteristics were described in terms of proportions, percentages, median and interquartile ranges. The Mann-Whitney test was used to compare continuous variables while the Chi-square test was used to compare categorical ones between urban and rural living residences. We employed a Modified Poisson regression analysis model to investigate the relationship between GDM risk factors and rural living residence since the prevalence of the risk factors was not uncommon (i.e., > 20%). Bi-variable analysis was used to determine the unadjusted prevalence ratios. The multi-variable model was used to include the variables with p ≤ 0.20. Adjusted prevalence ratios were calculated along with their p-values and 95% CIs. At the two-tailed level, the results were considered statistically significant when the p-value was less than 0.05

Results

Socio-demographic and clinical characteristics of the women with GDM in urban and rural health facilities in Central Uganda

A total of 600 women with GDM were included in this study and their median age was 27(IQR 21-32). Urban women were older than their rural counterparts(p<0.001). Women in rural areas were less educated than urban ones(p<0.001). Regarding occupation, rural women were mainly peasant farmers, house wives or not employed at all compared to those in urban areas(p<0.001) (**Table 1**).

Table 1: Social-demographic & clinical characteristics of women with GDM in urban and rural health facilities in Central Uganda

Variable	Urban(n=300)	Rural(n=300)	All(N=600)	P-value
Median Age in years (IQR)	29(25-33)	22(19-30)	27(21-32)	<0.001
Education level				
No formal education	6(10.7%)	50(89.3%)	56(9.3%)	
Primary	28(13.7%)	177(86.3%)	205(34.2%)	
O-level	83(58.9%)	58(41.4%)	141(23.5%)	
A-level	39(81.2%)	9(18.8%)	48(8.0%)	
Tertiary	144(96.0%)	6(4.0%)	150(25.0%)	<0.001
Occupation				
Farmer	16(12.9%)	108(87.1%)	124(20.7%)	
Business	113(84.3%)	21(15.7%)	134(22.35)	
Teacher	37(82.2%)	8(17.8%)	45(7.5%)	
House wife	70(45.8%)	83(54.2%)	153(25.5%)	
None	8(9.1%)	80(90.9%)	88(14.7%)	
Other	46(82.14%)	10(17.86%)	56(9.3%)	<0.001
Marital status				
Single	25(20.0%)	100(80.0%)	125(20.8%)	
Married	270(57.7%)	198(42.3%)	468(78.0%)	
Separated	5(71.4%)	2(28.6%)	7(1.2%)	<0.001
Baseline blood glucose				
<5.5mmol/l	204(41.8%)	284(58.2%)	488(81.3%)	
5.5-6.99mmol/l	87(85.3%)	15(14.7%)	102(17.0%)	
≥7mmol/l	9(90.0%)	1(10.0%)	10(1.7%)	<0.001

IQR Interquartile range, n frequency

Rural women were less heavy and shorter than their urban counter parts (p<0.001). Correspondingly, rural women tended to be more overweight than urban ones. The median fasting blood glucose, 1-hour blood glucose and 2-hour blood glucose values were 5.8mmol/l (IQR5.5-6.3),10.6mmol/l (IQR 9.4-10.5) and 8.7mmol/l (IQR 8-9.1) respectively (**Table 2).**

Table 2: Medians for clinical characteristics of women with GDM in urban and rural health facilities in Central Uganda

Variable (Units)	Urban(n=300)	Rural(n=300)	All(N=600)	P-value
	Median (IQR)	Median (IQR)	Median (IQR)	
Parity	2(1-3)	3(3-6)	2(1-4)	<0.001
Weight (Kg)	69(60-74)	59(54-65)	62(56-71)	<0.001
Height(cm)	167(162-170)	153(147.75-159.9)	160(152-168)	<0.001
BMI(Kg/m^2)	24(20.73-27.8)	25.15(23-27.25)	24.66(22-27.36)	0.003
SBP (mmHg)	113(103.5-121)	110(100-120)	110(101-120)	0.008
DBP (mmHg)	69.5(63-76)	67(60-72.5)	69(61-75)	<0.001
Baseline FBG (mmol/l)	5.1(4.5-5.8)	4.4(3.9-4.9)	4.7(4.2-5.3)	<0.001
FBG at OGTT (24-28 WOA) mmo/l	5.9(5.5-6.5)	5.8(5.4-6.1)	5.8(5.5-6.3)	0.002
1-hr BG at OGTT (24-28 WOA) mmol/l	10.8(9.8-10.9)	10.3(9.4-10.8)	10.6(9.4-10.9)	<0.001
2-hr BG at OGTT (24-28 WOA) mmo/l	8.9(8.1-9.4)	8.3(7.8-8.9)	8.7(8-9.1)	0.001

IQR Interquartile range, n frequency, Kg Kilogram, BMI Body Mass Index, SBP Systolic Blood Pressure, DBP Diastolic Blood Pressure Fasting Blood Glucose, BG Blood Glucose, OGTT Oral Glucose Tolerance Test, WOA Weeks of Amenorrhea

Differences in proportions of risk factors of GDM among women with GDM in urban and rural health facilities in Central Uganda

In this study, urban women tended to be 35years and older 53(61.6%) compared to their rural counterparts 33(38.4%), p=0.02. Regarding parity, rural women 96(67.6%) delivered 5 children and more compared to urban women 46(32.4%), p<0. 001.However, obesity was higher among urban women than among rural women 46(64.8%) vs 25(35.2%) respectively. A short stature of less than 150cm was more prevalent among rural women than among urban ones (125(93.3%) vs 9 (6.7%) respectively, p<0.001. Family history of diabetes was reported more among rural women 222(55.5%) than urban ones 178(44.5%), p<0. 001.Regarding other risk factors, history of diabetes in the mother(p<0.001), previous GDM history(p=0.001) were more among urban women than rural ones **(Table 3).**

Table 3: Proportions of risk factors for GDM among women in urban & rural health facilities in Central Uganda

Variable (Units)	Urban	Rural	All	P-value
	n=300	n=300	N=600	
Age≥35years	53(61.6%)	33(38.4%)	86(14.3%)	0.02
Parity≥5	46(32.4%)	96(67.6%)	142(23.7%)	<0.001
BMI(≥30Kg/m2)	46(64.8%)	25(35.2%)	71(11.8%)	0.008
Height <150cm	9(6.7%)	125(93.3%)	134(22.3%)	<0.001
History of hypertension	171(61.5%)	107(38.5%)	278(46.3%)	<0.001
History of poor pregnancy outcomes	161(48.2%)	173(51.8%)	334(55.7%)	0.324
History of delivery of a baby ≥ 4Kg	121(49.8%)	122(50.2%)	243(40.5%)	0.934
Previous GDM	114(60.0%)	76(40.0%)	190(31.7%)	0.001
History of pre-eclampsia	68(56.2%)	53(43.8%)	121(20.2%)	0.127
History of twin pregnancy	135(54.4%)	113(45.6%)	248(41.3%)	0.068
Family history of DM	178(44.5%)	222(55.5%)	400(66.7%)	<0.001
Smoking	31(57.4%)	23(42.6%)	54(9.0%)	0.254

n frequency, Kg Kilogram, BMI Body Mass Index, GDM Gestational Diabetes, DM Diabetes Mellitus

There were no urban-rural disparities regarding the following risk factors; history of poor pregnancy outcomes(p=0.324), history of delivering a baby ≥ 4Kg(p=0.934), history of pre-eclampsia(p=0.127), history of twin pregnancy(p=0.068) and smoking(p=0.254).

Gestational Diabetes risk factors significantly associated with rural living residence

From the Modified Poisson regression model for multi-variable analysis**(Table 4)**,rural living residence was positively and significantly associated with history of hypertension(APR=1.343,95% CI 1.164-1.55,P<0.001),history of previous gestational diabetes(APR=1.391,95%C.I 1.208-1.60,P<0.001),family history of diabetes(APR=1.343,95% C.I 1.158- 1.557,P<0.001).Furthermore, women with parity ≥5 were 31.6% more likely to be rural (APR=1.316,95% CI 1.261-1.584,P<0.001) while the likelihood of having a height <150cm was more than 38% with rural women than urban ones (APR=1.381,95% C.I 1.228-1.612,P<0.001). Women in the rural areas were 31% less likely to be 35years and older (APR=0.687 (0.558– 0.847, P<0.001). There was no association between rural living residence and BMI, history of delivering a big baby, history of poor pregnancy outcomes, twin pregnancy and pre-eclampsia.

Table 4: Gestational Diabetes risk factors associated with rural living residence among women with GDM on Modified Poisson Regression Analysis.

Variable	CPR (95% CI)	P-value	APR (95% CI)	P-value
Maternal age (years)				
<35	1	–	1	–
≥35	0.584 (0.454 – 0.751)	<0.001	0.687 (0.558– 0.847)	<0.001
Parity				
<5	1	–	1	–
≥5	1.481(1.301 – 1.624)	<0.001	1.316 (1.261 – 1.584)	<0.001
Maternal height (cm)				
≥150	1		1	–
<150	1.349 (1.201- 1.512)	<0.001	1.381 (1.228 – 1.612)	<0.001
Hypertension				
No	1	–	1	–
Yes	1.535 (1.305 – 1.807)	<0.001	1.343 (1.164 – 1.550)	<0.001
Previous GDM				
No	1	–	1	–
Yes	1.323 (1.130 – 1.548)	0.001	1.391 (1.208 – 1.600)	<0.001
Family history of diabetes				
No	1	–	1	–
Yes	1.371 (1.173 – 1.602)	<0.001	1.343 (1.158 – 1.557)	<0.001
Body Mass Index (Kg/m^2)				
<30	1	–	–	–
≥30	1.349 (1.112 – 1.637)	0.002	–	–
History of big baby≥4Kg				
No	1	–	–	–
Yes	0.993 (0.843 –	0.934	–	–

	1.169)			
History of preeclampsia				
No	1	–	–	–
Yes	1.160 (0.967 – 1.393)	0.11	–	–
Twin pregnancy				
No	1	–	–	–
Yes	1.000 (0.788 – 1.269)	1	–	–
History of maternal poor outcome				
Yes	1	–	–	–
No	1.084 (0.924 – 1.272)	0.323	–	–

CPR Crude Prevalence Ratio, APR Adjusted Prevalence Ratio, CI Confidence Interval, GDM Gestational Diabetes

Discussion

The current study was aimed at establishing the association between rural living residence and risk factors of GDM. History of hypertension, previous gestational diabetes, family history of diabetes, parity ≥ 5, and height<150cm were positively and significantly associated with rural living residence. We also showed that age ≥ 35years was less likely associated with rurality.

Our study was conducted in Luwero district, a rural area that was formerly ravaged by the Bush war from 1981–1986 (18).Some of the problems of civil conflicts are severe malnutrition and famine exposure(19).Participants in our study are grand offsprings of women who were exposed to inutero and childhood malnutrition during the civil conflict. We found that our participants from the rural area were smaller and shorter with higher BMIs than their urban counterparts. This finding could be explained by the Developmental Origins of Heath and Disease (DoHad) hypothesis which links prenatal malnutrition with Non-Communicable Disease risk (20).Similarly, a community based Ethiopian survey in rural Ethiopia mooted that chronic malnutrition as a result of prolonged famine in that area led to a relatively high prevalence of GDM (21).

Furthermore, rural women were less educated and were involved in less professional jobs (i.e. peasant farming, house wifehood). It has been shown that a low education level, non-professional occupation and early age at first birth are associated with a high fertility rate (high parity) (22, 23)

Lei Y et al 2025 showed that educational level, employment status, career advancement aspirations, and age-related anxiety were significantly associated with delayed childbearing (24). This could explain why our rural study participants had a higher parity and were less likely to be older than 35 years of age.

In the current study, we showed that history of hypertension, previous GDM and family history of diabetes were associated with rural living. Our findings collate the recently conducted WHO NCD STEPS survey of 2023 which showed that there were more significant increases in the prevalence of some risk factors in rural areas than urban ones in the last decade namely sedentariness $p < 0.001$, high blood glucose $p < 0.001$ and overweight/obesity $p < 0.001$(9).The same survey showed that the prevalence of hypertension in rural and urban areas is still high and has not changed in the last 10 years. The highly prevalent NCD risk factors in the rural areas are potentially explained by the increasing urbanization and westernization of rural communities in middle and low-income countries including Uganda (25). Urbanization is associated with consumption of unhealthy diets, excessive alcohol and sedentary life style that predispose to central obesity leading to insulin resistance (26–28). Insulin resistance underpins the development of hypertension, type 2 diabetes(27) and gestational diabetes (29).Conversely, overweight,(BMI ≥ 25Kg/M^2,family history of diabetes, non-white ethnicity, multiparity and older maternal age are significant risk factors for progression to diabetes after GDM(30).All these determinants are prevalent among our rural participants, this could partly explain why diabetes has increased in the rural areas in Uganda as depicted by the 2023 WHO NCD STEPS survey (9).It is known that intrauterine exposure to the metabolic environment of maternal diabetes, or GDM, is linked with increased risk of altered glucose homeostasis(impaired fasting glucose, impaired glucose tolerance, and T2D) in the offspring, starting in childhood leading to a higher prevalence of diabetes in the next generation(10).With erratic selective GDM screening in the country, there is a missed opportunity to diagnose and treat T2D among post GDM women.

Similar to our findings, several studies have shown that women living in rural areas give birth at a young age and have lower education status (31–34)and higher BMIs(6). Additionally, a study done by Graham et al 2007 showed a higher proportion of rural women with pre-existing and or hypertension and or diabetes compared to urban ones ($p < 0.001$). Whereas some studies have investigated the prevalence of GDM and its determinants in rural areas (4, 35–38), they have not shown whether these are associated with rural living residence as is the case for our study.

The current study highlights GDM risk factors that are associated with rural living residence. They resonate with the NCD risk factors that have increased in rural Uganda in the last 10 years. Typically, the incidence of GDM mirrors the incidence of T2D in the background population (10).Therefore, universal screening of all expectant women for GDM provides a window of opportunity to screen, diagnose and manage non-communicable diseases including T2D and other cardiovascular disease conditions early. Our findings may potentially underpin change in policy, i.e. from selective to universal GDM screening.

The strengths of our study are worth mentioning, to our knowledge this is the first study in Uganda to evaluate the association between GDM risk factors and rural living residence. Secondly, we had robust

data on risk factors of GDM to delineate their association with rurality. However, being a retrospective study, not all relevant information and data could be collected for all participants. Nevertheless, our study yielded pertinent data on the GDM risk factors and their association with rural living residence.

Conclusion

The current study has shown that rural living residence is associated with GDM risk factors i.e. history of hypertension, previous gestational diabetes, family history of diabetes, parity ≥ 5, and height<150cm. It has also shown that age ≥ 35years is less likely associated with rurality. Our study has provided data that may be potentially useful in designing context specific screening and management protocols for GDM in the country already faced with low screening rates. Furthermore, these factors being determinants of progression to T2D post GDM, our study findings highlight the opportunity to screen and manage T2D and other non-communicable diseases in our rural settings where diabetes has increased significantly in the last 10 years.

Abbreviations

ADA: American Diabetes Association

APR: Adjusted Prevalence Ratio

BG: Blood Glucose

BMI: Body Mass Index

CPR: Crude Prevalence Ratio

DBP: Diastolic Blood Pressure

DM: Diabetes Mellitus

DOHad: Developmental Origins of Heath and Disease

FBG: Fasting Blood Glucose

GICU: Gestational Diabetes in Central Uganda

IADSPG: International Association of Diabetes and Pregnancy Study Groups

IQR: Interquartile Range

NCD: Non-Communicable Diseases

OGTT: Oral Glucose Tolerance Test

RHU: Reproductive Health Uganda

SBP: Systolic Blood Pressure

UDA: Uganda Diabetes Association

WHO: World Health Organization

WOA: Weeks of Amenorrhea

Declarations

Ethics approval and consent of participants

In this retrospective comparative cross-sectional study, we obtained a waiver of informed consent and approval from Mengo Hospital Research EthicsCommittee (approvalnumber MH 136/07-2025). We de-identified selected files and used codes to ensure participants' confidentiality. The study was conducted in observance of the Declaration of Helsinki.

Consent for publication

Not applicable

Availability of data and materials

The data sets used and or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare no competing interests.

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Authors contributions

WL, SN, RKM, RBN, SPN conceptualized the study and designed the methodology. RS, RBN, and WL developed the statistical plan for the study. RKM, with the help of RS and WL, analyzed the data. WL, SN, RKM, RBN, DM, GN, HN, RM, SN, EN, RS, AK and SPN designed the manuscript and revised and approved its final version.

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Figures

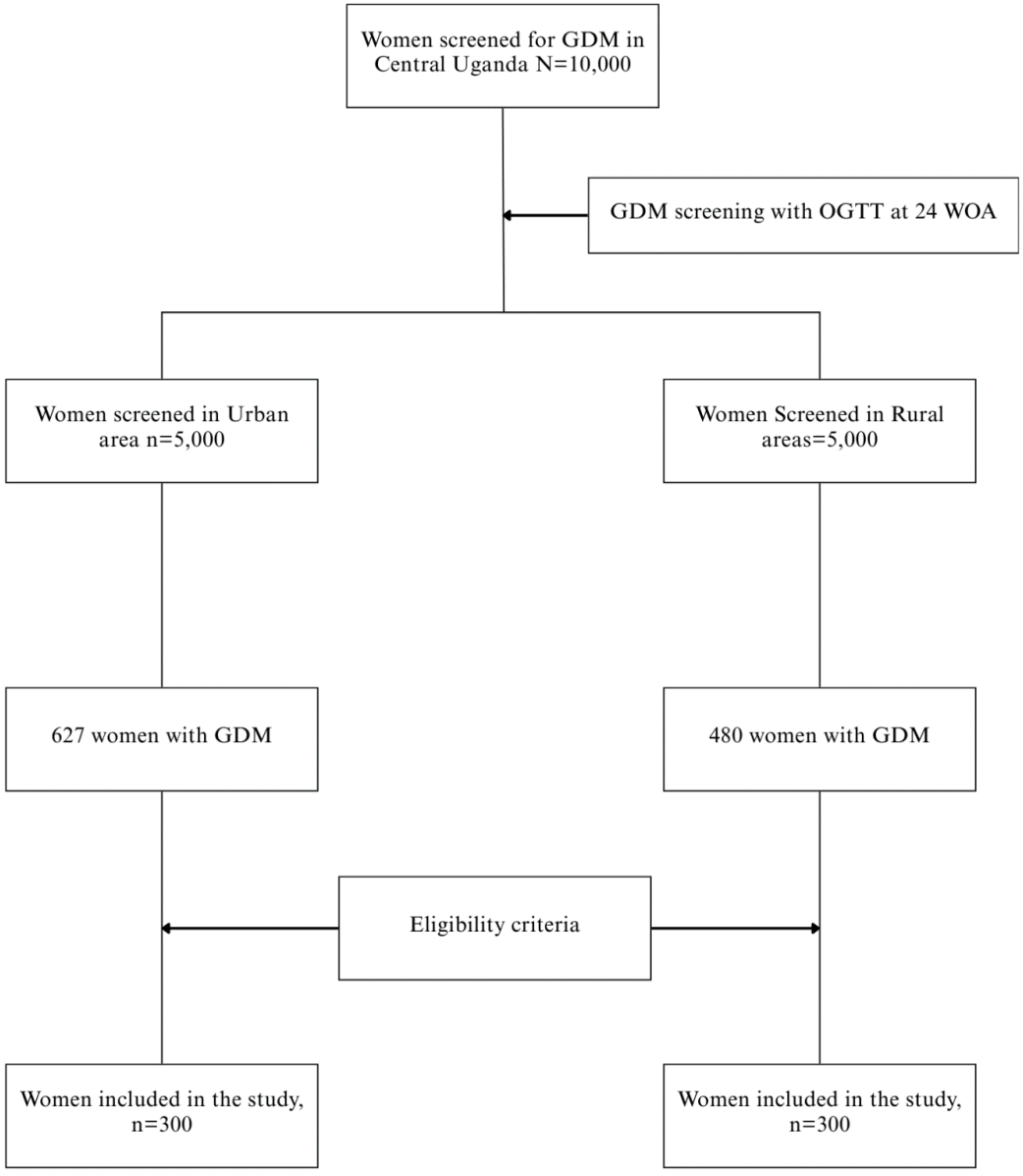


Figure 1

Flow chart showing enrollment of study participants.

Supplementary Files

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- DataExtractionForm.docx