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Gestational diabetes and changes in dietary quality and food group consumption before and during pregnancy: a pilot cross-sectional study in Malawian women attending antenatal clinics

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Abstract

This pilot cross-sectional study, conducted in two public hospitals in Malawi, assessed gestational diabetes mellitus (GDM) in pregnant women attending antenatal clinics and compared their dietary quality and food group consumption before and during pregnancy. The study targeted women aged 18 to 49 years within 24 to 28 weeks of gestation. GDM was diagnosed according to the International Association of Diabetes and Pregnancy Study Group criteria and assessed dietary quality before and during pregnancy using a 30-day qualitative food frequency questionnaire. We compared changes in dietary quality and specific food group mean scores using paired *t*-tests at $p < 0.05$. Of the 508 women enrolled, 22.7% were diagnosed with GDM. The overall diet quality significantly decreased during pregnancy compared to before; a similar trend was observed in women diagnosed with GDM compared to those without GDM ($p < 0.0001$). Among women with GDM, the mean score of the following food groups significantly ($p < 0.05$) decreased during pregnancy: cruciferous vegetables, deep orange vegetables and tubers, citrus fruits, deep orange fruits, other fruits, nuts and seeds, poultry, fish, low fat dairy, whole grains, and liquid oils and significantly ($p < 0.05$) increased in the following food groups; red meat, processed meat, sugar-sweetened beverages, sweets, sugary snacks and ice cream. In conclusion, GDM is prevalent in Malawian women enrolled in this study and is coupled with inadequate dietary quality, especially during pregnancy. Since dietary quality is pivotal to GDM management, more in-depth longitudinal dietary studies are needed to inform nutritional interventions to prevent and better manage GDM.

Introduction

Gestational diabetes mellitus (GDM), typically diagnosed between the 24th and 28th week of gestation in women without pre-existing diabetes, is characterised by hyperglycaemia in pregnancy (HIP).(1–4) In 2024, the International Diabetes Federation (IDF) estimated the global prevalence of HIP to be 19.7% in women aged 20 to 49 years, affecting 23 million live births.(3) Approximately 89.5% of HIP cases occur in low-resource settings with limited access to antenatal care services,(3) such as Malawi. In 2024, the IDF estimated the prevalence of HIP in Africa to be 13.9%, affecting 4.7 million live births.(3) GDM, if not identified or adequately managed, poses serious health risks to the mother, including preeclampsia and the development of type 2 diabetes mellitus (T2DM), and to the child, such as macrosomia and childhood obesity.(1,3,4) Although GDM is a public health problem and screening (fasting blood glucose) is recommended, it is unfortunately not routinely done during antenatal care services in Malawi due to limited resources, including human capacity at potentially large clinics. In addition, dietary intervention, which is integral to management, is minimal to non-existent, especially if the disease is not recognised or diagnosed. This gap in routine care highlights the need for enhanced focus on antenatal services, especially regarding critical conditions like GDM, which is a significant concern.(5,6)

Limited national data exists on GDM prevalence in Malawi. A study conducted in urban hospitals in Blantyre (the second largest city) showed rates of 24% using International Association of Diabetes and Pregnancy Study Group (IADPSG) criteria versus 1.6% with World

Health Organization criteria, a disparity linked to differences in blood glucose thresholds.[7] This disparity is associated with cut-points for blood glucose that are significantly different between the two,[8,9] but the IADPSG criteria have been touted to be better able to predict adverse pregnancy outcomes.[10,11] Therefore, the 24% is concerning if left untreated or poorly managed.

Diet, in conjunction with medical nutrition therapy, is one of the cornerstones in preventing and managing diabetes and indeed GDM as well. Diet quality is critical for foetal growth, pregnancy weight gain, and maintaining euglycemia in the management of GDM.[12] However, dietary intervention is inadequately addressed in Malawi and rarely done for GDM due to the limited availability of registered dietitians to provide dietary assessment and advice regarding GDM, and other healthcare professionals have limited time and expertise. A high-quality and diversified diet before and during pregnancy and adhering to dietary patterns rich in whole grains, fruits, vegetables, and legumes and low in refined grains and sweetened beverages have been associated with a reduced risk of GDM.[13,14] Furthermore, modified dietary interventions such as low-glycemic-index foods, the Dietary Approaches to Stop Hypertension, low-carbohydrate diets, soy protein-enriched diets, fat modification diets, and usual GDM dietary advice improved maternal glycemic status and birth outcomes in 18 randomised controlled trials reported in 10 countries in a systematic review in 2018.[15]

The comparison of dietary quality of Malawian women with or without GDM has not been elucidated, but adults with T2DM in Malawi consume diets that are disproportionately high in carbohydrates and limited in fruits and vegetables.[16] Therefore, it is important to assess the changes in dietary quality and food group consumption before and during pregnancy to identify challenges and guide nutrition education and counselling strategies when GDM occurs. The objective of the current study was to compare dietary quality and food group consumption before and during pregnancy of women screened for GDM in Malawi.

Materials and methods

Study design and settings

A pilot cross-sectional study was conducted between February and May 2023 at Bwaila District Hospital and the Kamuzu Central Hospital (KCH) Ethel Mutharika maternity unit in Lilongwe, Malawi, targeting pregnant women aged 18 to 49 years who attended the antenatal clinic. The Bwaila district hospital offers free antenatal care. On average, 150 pregnant women receive antenatal care services daily. In contrast, the KCH-Ethel Mutharika maternity unit offers paying antenatal care services for those not referred from other health facilities. On average, 30 pregnant women receive antenatal care daily.

Ethics approval and consent to participate

Ethical approval was obtained from the National Health Sciences Research Committee (NHSRC) in the Ministry of Health in Malawi, approval number 22/10/3069. Permission to conduct the study was obtained from Kamuzu Central and Bwaila District Hospitals. Participants were asked to provide written informed consent or thumbprints for study participants who could not write. In this study, the researchers adhered to the procedures in accordance with the ethical standards of the NHSRC.

Inclusion and exclusion criteria

The study included pregnant women between the 24th and 28th week of gestation, singleton, and with no prior diagnosis of diabetes. The clinicians determined the gestational age using the bi-parietal diameter, head circumference, femur length, and abdominal circumference through the MINDRAY ultrasound scanner. Exclusion criteria included pregnant women <18 years or ≥50 years, gestational age <24 weeks or above 28 weeks, and those with pre-existing diagnosed diabetes.

Sample size

Based on the prior study in Blantyre, Malawi, we assumed a GDM prevalence of 24±5% diagnosed using the IADPSG.[7] We calculated a sample size of 517 pregnant women to achieve 80% power, at α=0.05. Using probability proportional to size, 471 pregnant women were sampled from Bwaila district hospital, and 46 from Ethel Mutharika maternity unit at KCH.

Sampling and recruitment process

Recruitment and data collection were conducted over two days. On the first day, nurse-midwife technicians enrolled eligible participants consecutively during the antenatal clinic days. Participants who met the inclusion criteria and consented were asked to come for an oral glucose tolerance test (OGTT) and face-to-face interviews the following day. The nurse-midwife technicians approached 724 women; 176 had a gestational age of <24 weeks or >28 weeks; 15 declined to participate, and 15 did not show up for a OGTT (Figure 1). Of the 517 remaining pregnant women between 24 and 28 weeks of gestational age who participated in the study, nine had incomplete dietary information. The final sample, therefore, included 508 participants, achieving a response rate of 98.3%. This resulted in slightly reduced statistical power compared to what we had expected with 517 participants.

Gestational diabetes diagnosis

After an overnight fast of 8–14 hours, fasting blood glucose and an oral glucose tolerance test (OGTT) were performed. During OGTT, participants ingested 75 g of anhydrous glucose in 250–300 ml of water.[17] Nurse-midwives and clinical laboratory technicians performed the fasting blood glucose test and OGTT. Using a glucometer (*model: SD Check Blood Glucose Monitoring System*), a finger-prick blood sample was taken for fasting and a one- and two-hour postprandial capillary blood glucose readings. GDM diagnosis was based on the IADPSG criteria. The IADPSG stipulates that a pregnant woman is diagnosed with GDM if one or more of the following parameters are met: 1) fasting plasma glucose ≥ 92 mg/dl; 2) one-hour postprandial plasma glucose of ≥ 180 mg/dl; and 3) postprandial 2-hour plasma glucose of ≥153 mg/dl following a 75 g oral glucose load.[2,8] Those diagnosed with GDM were referred for clinician review and management, as this study was conducted outside of routine antenatal activities.

Other parameters collected

Four trained clinical dietitians and a nutritionist collected the following data using face-to-face interviews: ***Socio-demographic and economic characteristics***, including age, marital status, education level, and principal occupation of the participants.

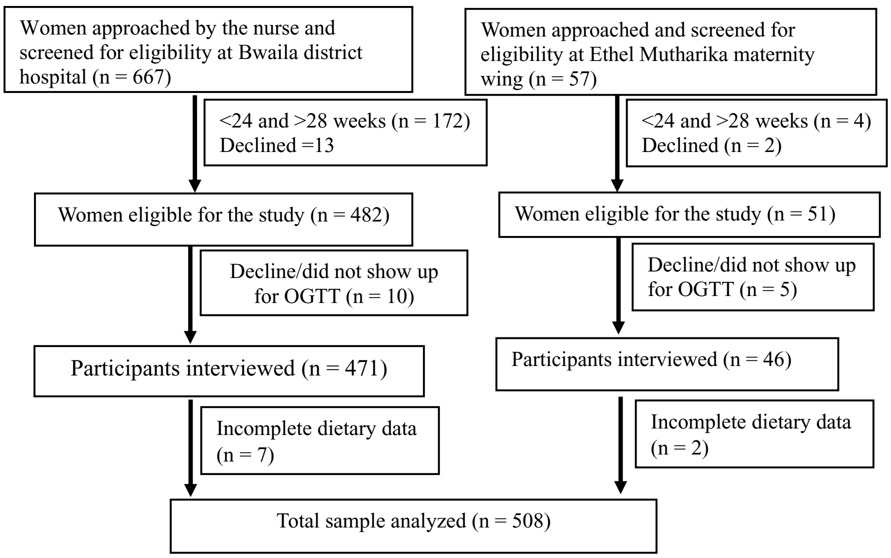

Figure 1. Participants' recruitment flowchart.
Note: OGTT, Oral Glucose Tolerance Test.

Maternal health information

The maternal health information collected included family history of diabetes, number of previous pregnancies, and Mid-upper Arm Circumference (MUAC). MUAC is a surrogate indicator of nutritional status during pregnancy and correlates with pre-pregnancy weight and body mass index.[18–21] The pregnant woman's MUAC was measured by clinical dietitians or a nutritionist using a non-elastic measuring tape at the marked mid-point of the left arm/non-dominant hand to the nearest 0.1 cm.[22] Duplicate MUAC measurements were taken from each pregnant woman, and the average value was recorded. Studies have collectively reported that the MUAC of >28 cm indicates overweight in late pregnancy (>19 weeks).[20,21,23] As such, prior gestational diabetes studies in Tanzania have used the MUAC cut-off of >28 cm for overweight and <28 cm for normal nutritional status.[24–26] In this study, MUAC of < 23 cm was used for underweight, ≥23 cm to <28 cm for normal nutritional status, and ≥28 cm for overweight/obesity.[21,27,28] HIV status was also noted for descriptive purposes, given the metabolic implications,[29] and potential for impact on blood glucose levels.[29–31]

Dietary quality assessment

Maternal dietary quality before and during pregnancy was assessed using a 30-day qualitative food frequency questionnaire (FFQ) to calculate the prime diet quality score (PDQS).[32] In this study, the 30-day FFQ recall during pregnancy referred to the period immediately preceding the interviews, and for the period before pregnancy, the target was 30 days before confirmation/knowledge of pregnancy. The PDQS is one of the global metrics for diet quality.[32,33] The PDQS has been adapted for use in different rural and urban African settings, such as Tanzania, among women of reproductive age[34–36] and among healthcare workers, adults (both men and women), and adolescents in Burkina Faso, Ethiopia, Ghana, Nigeria, and Tanzania.[37,38] In this study, for each food grouping in the FFQ, we adapted it to include examples of locally available and commonly consumed foods to guide the participants. The PDQS measures overall diet quality rather than specific nutrients[32] and has been found to predict chronic conditions such as coronary heart disease[33], gestational diabetes, and hypertension during pregnancy.[39] Participants were asked to recall the frequency of food consumption of the 22 food groups before and during pregnancy. These food groups were divided into two components: (1) the unhealthy food groups, such as fried foods, white roots and tubers, red meat, processed meats, refined grains and baked goods, sweets, sugary snacks, and ice cream, and sugar-sweetened beverages, (2) healthy food groups such as dark green leafy vegetables, cruciferous vegetables, deep orange vegetables, other vegetables, citrus fruits, deep orange fruits, other fruits, beans, peas and soya products, eggs, nuts and seeds, poultry, fish, low-fat dairy, whole grains, and liquid oils.[32] The frequency of food consumption included daily, 5–6 times per week, 3–4 times per week, 1–2 times per week, 2–3 times per month, and one time per month or less.[32] Using a trichotomous scoring approach, where the consumption frequency was grouped into three; zero for one time/month or less and 2–3 times/month, one for 1–2 times/week and 3–4 times/week, and two for 5-6 times/week and daily.[32] The healthy food groups were coded positively, while unhealthy food groups were reverse-coded, with eggs as a neutral category,[32] for coding purposes only. The PDQS has a score of 0–42; the higher the PDQS score, the better the diet quality.[32] We also calculated the score for healthy and unhealthy specific food groups.

Data analysis

IBM SPSS version 25 was used for all statistical analyses at a 0.05 significance level (two-sided). Categorical variables were summarised as proportions, and continuous variables were summarised using means and corresponding standard deviations (SD). Chi-square tests for categorical variables and independent student's *t*-tests for continuous variables were used to determine if there were significant associations between participants' characteristics and gestational diabetes status. The mean difference in the PDQS and food group scores during and before pregnancy were summarised using mean ±SD, 95% confidence interval, lower and upper limit, and compared using a paired *t*-test.

Table 1. Characteristics of the participants by gestational diabetes mellitus status

Variables	Overall (n = 508)		Women without GDM (n = 394)		Women diagnosed with GDM (n = 114)		*p*-value
	n	%	n	%	n	%	
Mean (SD) age in years*	27.34†	5.91‡	27.26†	5.83‡	27.61†	6.17‡	0.818
Age category							0.422
18–30 years	359	70.7	275	76.6	84	23.4	
31–43 years	149	29.3	119	79.9	30	20.1	
Marital status							0.849
Married	470	92.5	365	77.7	105	22.3	
Divorced/never married	38	7.5	29	71.9	9	20.9	
Educational level							0.263
≤Primary	213	41.9	160	75.1	53	24.9	
≥Secondary	295	58.1	234	79.3	61	20.7	
Primary occupation							0.29
Employed (full/part-time)	102	20.1	82	80.4	20	19.6	
Small-scale business	174	34.3	128	73.6	46	26.4	
None	232	45.7	184	79.3	48	20.7	
Study site							0.962
Ethel Mutharika maternity unit	44	8.7	34	77.3	10	22.7	
Bwaila District Hospital	464	91.3	360	77.6	104	22.4	
Gestation age (in weeks) at OGTT*	25.90†	1.51‡	25.89†	1.49‡	25.96†	1.54‡	0.529
Maternal gravida							0.459
Primigravida	134	26.4	107	79.9	27	20.1	
Multigravidas (≥2 times)	374	73.6	287	76.7	87	23.3	
HIV status							0.37
Women living with HIV	222	43.7	168	75.7	54	24.3	
Women without HIV	286	56.3	226	79.0	60	21	
Family history of diabetes							<0.0001
Yes	86	16.9	47	54.7	39	45.3	
No	422	83.1	347	82.2	75	17.8	
Mean (SD) MUAC in cm*	26.62†	3.29‡	26.37†	3.07‡	27.44†	3.88‡	0.001
MUAC category							<0.000
MUAC <23 cm (underweight)	43	8.5	30	69.8	13	30.2	
MUAC ≥23 to < 28 cm (Normal)	315	62.0	266	84.4	49	15.6	
MUAC≥ 28 cm (overweight/obese)	150	29.5	98	67.3	52	34.7	

Notes: *Student *t*-test; †mean; ‡SD; GDM, Gestational Diabetes Mellitus; HIV, Human Immunodeficiency Virus; MUAC, Mid-Upper Arm Circumference; OGTT, Oral Glucose Tolerance Test; SD, Standard Deviation.

Results

Characteristics of the participants

The characteristics of the participants by gestational diabetes status are depicted in Table 1. Most participants (70.7%) were between 18 and 30 years old. About 22.7% ($n = 114$) were diagnosed with gestational diabetes mellitus (GDM). Among those women living with HIV, 24.3% were diagnosed with GDM compared to 21.0% among women without HIV. No significant difference was observed in the proportion of women diagnosed with GDM by study site (Bwaila District Hospital = 22.4%; and KCH-Ethel Mutharika maternity unit = 22.7%). Among those with a family history of diabetes, 45.3% were diagnosed with GDM compared to 17.8% among those without a family history of diabetes ($p < 0.0001$). Similarly, of the women with an indication of overweight/obesity (MUAC of ≥28 cm) 34.7% had GDM,

Table 2. Comparison of mean prime diet quality score during and before pregnancy

Dietary Quality	During pregnancy		Before pregnancy		Mean difference		95% Confidence interval	
	Mean	SD	Mean	SD	Mean	SD	Lower-upper limit	*p*-value
Overall PDQS	18.34	3.36	21.63	3.62	−3.28	4.73	(−3.70; −2.87)	<0.0001
Women without GDM	18.39	3.55	22.23	3.56	−3.84	4.80	(−4.73; −2.92)	<0.0001
Women diagnosed with GDM	18.32	3.37	21.45	3.61	−3.12	4.73	(−3.59; −2.66)	<0.0001
Overall, the unhealthy food group score	6.99	2.08	5.61	2.12	1.38	2.65	(1.15; 1.61)	<0.0001
Women without GDM	7.04	2.10	5.61	2.16	1.44	2.75	(1.17; 1.71)	<0.0001
Women diagnosed with GDM	6.80	1.99	5.61	1.98	1.18	2.39	(0.74; 1.63)	<0.0001
Overall, the healthy food group score	11.35	3.32	16.02	3.58	−4.67	3.73	(−4.99; −4.34)	<0.0001
Women without GDM	11.28	3.31	15.82	3.66	−4.57	3.71	(−4.93; −4.20)	<0.0001
Women diagnosed with GDM	11.60	3.40	16.62	3.28	−5.02	3.78	(−5.73; −4.32)	<0.0001

Note: GDM, Gestational diabetes mellitus; PDQS, Prime Diet Quality Score.

compared to 30.2% and 15.6% among those underweight (MUAC of <23 cm) and with normal weight status (MUAC of ≥ 23 to <28 cm), respectively ($p < 0.0001$) (Table 1).

Changes in dietary quality

The mean PDQS before and during pregnancy were far below the maximum PDQS of 42, indicating inadequate dietary quality. The comparison of dietary quality changes before and during pregnancy is presented in Table 2. There was a significant decrease in the overall mean PDQS (before: 21.63 ± 3.62 vs. during: 18.34 ± 3.36); women without GDM (before: 22.23 ± 3.56 vs. during: 18.39 ± 3.55) and for those diagnosed with GDM (before: 21.45 ± 3.61 vs. during 18.32 ± 3.37), $p < 0.001$. The mean healthy food group score significantly decreased during pregnancy compared to before pregnancy ($p < 0.0001$). In contrast, the mean unhealthy food group score significantly increased during pregnancy compared to before pregnancy ($p < 0.0001$) (Table 2).

Changes in food group consumption

Table 3 shows mean changes in the food group score before and during pregnancy. Overall, there were changes in 16 of the 22 food groups. For the healthy food groups, a significant decrease in the food group score was observed in the following food groups during pregnancy ($p < 0.05$): cruciferous vegetables, deep orange vegetables and tubers, other vegetables, citrus fruits, deep orange fruits, other fruits, nuts and seeds, poultry, fish, low-fat-dairy, whole grains, and liquid oils. There was also a significant increase in the unhealthy food groups score ($p < 0.05$), including red meat, processed meat, sugar-sweetened beverages, sweets, sugary foods, and ice cream (Table 3). Similar significant changes were observed in women without GDM (Table 5). The only difference is that for those diagnosed with GDM (Table 4), there were changes in other vegetable food group scores, but the changes were not statistically different when compared before and during pregnancy.

Discussion

This study assessed GDM among pregnant Malawian women accessing antenatal care services at public hospitals and compared their dietary quality and food group consumption before and during pregnancy. Although not prioritised, GDM was prevalent in Malawian women enrolled in this study. Additionally, we observed a decline in overall dietary quality and a decrease in the consumption of healthy foods, concurrent with an increase in the consumption of unhealthy foods. A similar trend was observed among women without GDM and those diagnosed with GDM.

Prior studies within Sub-Saharan African countries reported a wide GDM prevalence depending on the criteria used; GDM prevalence ranged from 12 to 39%: 12.0% in Ethiopia,[40] 19.5%–39% in Tanzania,[41–43] Cameroon (20.9%),[44] and Malawi (1.6% to 24%).[7] In the current study, 22.7% were diagnosed with GDM based on IADPSG criteria, within the previously reported ranges. MUAC is used as a surrogate to assess body mass index during pregnancy, especially in resource-limited settings.[18,19] MUAC has been previously reported to be associated with GDM risk in urban and rural areas of Tanzania.[24–26] Similarly, we also observed that a significant proportion of women diagnosed with GDM had a MUAC of ≥28 cm or <23 cm. In addition, almost a third of the women with HIV were diagnosed with GDM, which warrants the need to explore GDM risk among women HIV and for further studies to provide more focused information on HIV and risk for GDM in pregnant women.

Achieving better PDQS as an indicator of high dietary quality has been previously reported to lower the risk of GDM and hypertension in pregnancy[39] and ischaemic heart disease,[33] mainly in high-income countries. In the present study, the overall PDQS regrettably declined during pregnancy compared to before, especially since the scores overall were lower than what would be regarded as adequate. Equally, among women without GDM and those diagnosed with GDM, the dietary quality also declined during pregnancy. The overall healthy food group scores also decreased, while the unhealthy food group scores increased during pregnancy. A recent systematic review and meta-analysis of 19 studies and 108,084 participants showed that adhering to high dietary quality, such as the Mediterranean diet, dietary approaches to stop hypertension, dietary recommendations, alternate healthy eating index, and overall plant-based diet index, before and during pregnancy, reduces the GDM risk.[13] In addition, a systematic review of observational studies reported that a diet rich in fruits,

Table 3. Comparison of mean food group scores during and before pregnancy of the overall sample

Overall sample (n=508)	During pregnancy		Before pregnancy		Mean difference		95% Confidence interval	
Food groups	Mean	SD	Mean	SD	Mean	SD	Lower-upper limits	*p*-value
Dark green leafy vegetables	1.16	0.78	1.24	0.73	−0.08	1.03	(−0.17; 0.01)	0.086
Cruciferous vegetables	0.82	0.71	1.16	0.73	−0.30	1.00	(−0.40; −0.20)	<0.0001
Deep orange vegetables	0.56	0.62	1.13	0.72	−0.58	0.94	(−0.66; −0.49)	<0.0001
Other vegetables	1.40	0.65	1.19	0.76	0.21	1.00	(0.13; 0.30)	<0.0001
Citrus fruits	0.80	0.72	1.13	0.72	−0.34	1.01	(−0.42; −0.25)	<0.0001
Deep orange fruits	0.42	0.60	1.08	0.72	−0.67	0.90	(−0.74; −0.59)	<0.0001
Other fruits	0.85	0.71	1.13	0.72	−0.28	0.98	(−0.37; −0.20)	<0.0001
Beans, peas, and soya products	1.08	0.76	1.13	0.73	−0.43	1.03	(−0.13; 0.05)	0.346
Nuts and seeds	0.77	0.71	1.18	0.72	−0.41	0.98	(−0.50; −0.32)	<0.0001
Poultry	0.72	0.75	1.09	0.77	−0.38	1.08	(−0.47; −0.28)	<0.0001
Fish	0.84	0.70	1.13	0.73	−0.30	0.96	(−0.38; −0.21)	<0.0001
Low-fat dairy	0.23	0.59	1.14	0.75	−0.91	0.93	(−1.00; −0.83)	<0.0001
Whole grains	0.84	0.70	1.13	0.73	−0.29	0.97	(−0.38; −0.21)	<0.0001
Liquid oils	0.88	0.70	1.16	0.70	−0.29	1.00	(−0.37; −0.20)	<0.0001
Eggs	1.18	0.71	1.14	0.76	−0.03	1.09	(−0.07; 0.12)	0.570
White roots and tubers	0.86	0.76	0.84	0.75	0.02	1.03	(−0.07; 0.11)	0.698
Red meat	1.12	0.70	0.84	0.72	0.28	0.97	(0.19; 0.36)	<0.0001
Processed meat	1.49	0.66	0.92	0.71	0.56	0.96	(0.48; 0.65)	<0.0001
Refined grains and baked products	0.47	0.64	0.44	0.60	0.03	0.40	(−0.04; 0.11)	0.399
Sugar-sweetened beverages	1.10	0.71	0.90	0.74	0.20	0.97	(0.12; 0.29)	<0.0001
Sweets, sugary snacks, ice cream	1.15	0.72	0.81	0.73	0.34	1.03	(0.25; 0.42)	<0.0001
Fried foods	0.79	0.74	0.85	0.76	−0.06	1.02	(−0.14; 0.03)	0.225

Note: SD, Standard Deviation.

Table 4. Comparison of mean food group consumption score before and during pregnancy of women diagnosed with gestational diabetes mellitus

Women diagnosed with GDM (n = 114)	During pregnancy		Before pregnancy		Mean difference		95% confidence interval	
Food groups	Mean	SD	Mean	SD	Mean	SD	lower-upper limit	*p*-value
Dark green leafy vegetables	1.20	0.77	1.26	0.78	−0.06	1.09	(−0.26; 0.14)	0.549
Cruciferous vegetables	0.78	0.73	1.25	0.74	−0.47	1.01	(−0.66; −0.27)	<0.0001
Deep orange vegetables	0.62	0.69	1.13	0.72	−0.51	1.01	(−0.70; −0.32)	<0.0001
Other vegetables	1.31	0.69	1.27	0.78	0.06	1.02	(−0.15; 0.22)	0.714
Citrus fruits	0.85	0.74	1.22	0.73	−0.37	0.98	(−0.55; −0.19)	<0.0001
Deep orange fruits	0.43	0.59	1.13	0.72	−0.70	0.91	(−0.85; −0.53)	<0.0001
Other fruits	0.87	0.71	1.18	0.67	−0.31	0.92	(−0.48; −0.14)	0.001
Beans, peas, and soya products	1.16	0.79	1.25	0.71	−0.08	1.00	(−0.27; 0.10)	0.351
Nuts and seeds	0.83	0.76	1.18	0.74	−0.34	1.00	(−0.53; −0.16)	<0.0001
Poultry	0.80	0.80	1.17	0.74	−0.37	1.07	(−0.57; −0.17)	<0.0001
Fish	0.85	0.69	1.11	0.76	−0.25	1.05	(−0.45; −0.06)	0.011

(*Continued*)

Table 4. (*Continued*)

Women diagnosed with GDM (n = 114)	During pregnancy		Before pregnancy		Mean difference		95% confidence interval	
Food groups	Mean	SD	Mean	SD	Mean	SD	lower-upper limit	*p*-value
low-fat dairy	0.21	0.59	1.17	0.74	−0.95	0.96	(−1.13; −0.77)	<0.0001
Whole grains	0.75	0.74	1.11	0.75	−0.36	0.99	(−0.54; −0.17)	<0.0001
Liquid oils	0.94	0.67	1.12	0.71	−0.19	0.92	(−0.36; −0.02)	0.027
Eggs	1.22	0.68	1.08	0.78	0.14	1.05	(−0.05; 0.33)	0.155
White roots and tubers	0.81	0.81	0.87	0.72	−0.06	1.01	(−0.25; 0.13)	0.520
Red meat	1.12	0.68	0.83	0.70	0.29	0.98	(0.11; 0.47)	0.002
Processed meat	1.41	0.81	0.92	0.68	0.49	1.00	(0.31; 0.68)	<0.0001
Refined grains and baked products	0.49	0.72	0.46	0.57	0.04	0.91	(−0.13; 0.20)	0.682
Sugar-sweetened beverages	1.08	0.71	0.88	0.78	0.20	0.92	(0.03; 0.37)	0.021
Sweets, sugary snacks, ice cream	1.06	0.73	0.74	0.74	0.32	1.02	(0.13; 0.51)	0.001
Fried foods	0.82	0.72	0.92	0.78	−0.10	1.04	(−0.29; 0.10)	0.323

Note: GDM, Gestational Diabetes Mellitus; SD, Standard Deviation.

Table 5. Comparison of mean food group scores during and before pregnancy among women without gestational diabetes mellitus

Women without GDM (n = 394)	During pregnancy		Before pregnancy		Mean difference		95% Confidence interval	
Food groups	Mean	SD	Mean	SD	Mean	SD	Lower-upper limit	*p*-value
Dark green leafy vegetables	1.14	0.77	1.23	0.71	−0.08	1.01	(−0.18; 0.02)	0.102
Cruciferous vegetables	0.83	0.70	1.13	0.72	−0.30	1.00	(−0.40; −0.20)	<0.0001
Deep orange vegetables	0.54	0.59	1.11	0.71	−0.57	0.91	(−0.66; −0.48)	<0.0001
Other vegetables	1.43	0.64	1.16	0.71	0.27	0.98	(0.17; 0.37)	<0.0001
Citrus fruits	0.78	0.71	1.11	0.71	−0.33	1.71	(−0.43; −0.23)	<0.0001
Deep orange fruits	0.41	0.59	1.06	0.72	−0.65	0.05	(−0.74; −0.56)	<0.0001
Other fruits	0.85	0.12	1.12	0.74	−0.27	1.00	(−0.37; −0.17)	<0.0001
Beans, peas, and soya products	1.06	0.75	1.09	0.72	−0.03	1.04	(−0.13; 0.07)	0.563
Nuts and seeds	0.75	0.69	1.18	0.72	−0.43	0.98	(−0.53; −0.33)	<0.0001
Poultry	0.69	0.73	1.07	0.78	−0.38	1.09	(−0.49; −0.27)	<0.0001
Fish	0.83	0.70	1.14	0.72	−0.31	0.94	(−0.40; −0.22)	<0.0001
low-fat dairy	0.23	0.59	1.18	0.70	−0.94	0.87	(−1.03; −0.86)	<0.0001
Whole grains	0.87	0.69	1.14	0.73	−0.27	0.96	(−0.37; −0.17)	<0.0001
Liquid oils	0.86	0.70	1.18	0.70	−0.31	0.98	(−0.41; −0.22)	<0.0001
Eggs	1.16	0.71	1.17	0.75	−0.01	1.11	(−0.11; 0.10)	0.927
White roots and tubers	0.88	0.74	0.84	0.76	−0.41	1.03	(−0.06; 0.14)	0.436
Red meat	1.12	0.70	0.85	0.73	0.28	0.97	(0.18; 0.37)	<0.0001
Processed meat	1.51	0.65	0.92	0.72	0.59	0.94	(0.49; 0.68)	<0.0001
Refined grains and baked products	0.46	0.63	0.43	0.62	0.03	0.88	(−0.06; 0.12)	0.462
Sugar-sweetened beverages	1.11	0.71	0.91	0.73	0.20	0.10	(0.11; 0.30)	<0.0001
Sweets, sugary snacks, ice cream	1.17	0.72	0.83	0.73	0.34	1.04	(0.24; 0.44)	<0.0001
Fried foods	0.79	0.74	0.83	0.75	−0.04	1.02	(−0.14; 0.05)	0.401

Note: GDM, Gestational Diabetes Mellitus; SD, Standard Deviation.

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vegetables, legumes, eggs, and food rich in antioxidants may also reduce the risk of developing GDM.[14]

Among women diagnosed with GDM and those without GDM, we observed that the food group scores of four of the seven unhealthy food groups, such as red meat, processed meat, sugar-sweetened beverages, sweets, sugary snacks, and ice cream, increased significantly during pregnancy. The interpretation of the increase in consumption of unhealthy foods, such as red meat, should be done with caution, considering the elevated micronutrient needs, especially iron, during pregnancy, and that the increase may reflect an indication to meet these demands. Furthermore, since we used the qualitative FFQ, we were unable to derive the total calories, macronutrient, and micronutrient intakes; however, the data helped provide information about food choices and in determining items that require further investigation in future studies. Similar to our findings, a cohort study in urban Tanzania also showed a high intake of sugar-sweetened beverages, refined grains, and baked products during pregnancy.[36] In contrast, the scores of the eleven healthy food groups decreased, especially those for cruciferous vegetables, deep orange vegetables and tubers, citrus fruits, deep orange fruits, other fruits, nuts and seeds, poultry, fish, low-fat dairy, whole grains, and liquid oils. Systematic reviews and a case-control study suggest that adequate intake of fruits, vegetables, nuts, legumes, fish, eggs, and whole grains before and during pregnancy is associated with a reduced risk of GDM and hypertensive disorders.[14,45,46] The decrease in healthy food group consumption and increase in unhealthy food group consumption, as found in this study, is worrisome, considering the importance of an adequate, quality diet in pregnancy to meet the nutrient demands for optimal birth outcomes. Therefore, providing medical nutrition therapy to those at risk for or diagnosed with GDM, developing contextual nutrition guidelines for GDM management, and providing nutrition education focusing on diet quality (healthy and unhealthy food groupings) during antenatal visits should be advocated for and recommended in Malawi.

Based on Malawian diets, it is not surprising that the food group score did not change for the following food groups: dark green leafy vegetables, other vegetables, beans, peas, soya products, eggs, white roots, tubers, and refined grains. Generally, the diet in Malawi primarily consists of staple foods, including maize, roots, tubers, vegetables, and beans. The diet changes might be attributed to household income and pregnancy cravings. Furthermore, agricultural seasonality may affect the availability of certain foods, especially for plant foods such as vegetables, hence it might have influenced the dietary quality, since we collected data between February and May, which coincided with part of the rainy season (December to April) and the start of the harvest season (April to May). Therefore, food choices during the non-rainy season inevitably change. Therefore, seasonality is likely a factor in determining dietary quality, given the timing of the study. However, further longitudinal research is needed to better understand the factors contributing to changes in dietary quality before and during pregnancy, as well as the relationship between pregnancy outcomes, GDM, and birth outcomes in both urban and rural settings.

Strengths and limitations

The study's strength is that few studies in resource-limited settings, particularly in Malawi, have assessed the dietary quality before and during pregnancy regarding GDM; these findings provide preliminary results that can be used for larger studies. The study has limitations. First, most participants could not recall their exact pre-pregnancy weight, which made it difficult to calculate the pre-pregnancy body mass index and assess the adequacy of weight gain during pregnancy. Secondly, there might be recall biases regarding food consumption, mainly before pregnancy. Lastly, the study was a pilot cross-sectional study; therefore, the data and analyses are limited to associations, but not causality.

Conclusions

In Malawian women, gestational diabetes (GDM) is an under-recognised and under-explored issue. Changes in dietary quality and food group consumption before and during pregnancy are concerning, given the increased nutritional needs required during this period. Therefore, there is a need for localised longitudinal dietary assessment studies, particularly among those at risk for or diagnosed with gestational diabetes, to guide the development of nutrition/dietary recommendations to help prevent and manage GDM in Malawi.

Availability of data and materials. The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

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Competing interests. The authors declare that they have no competing interests.

Ethical statement. Ethical approval was obtained from the National Health Sciences Research Committee (NHSRC) in the Ministry of Health in Malawi, approval number 22/10/3069. Permission to conduct the study was obtained from Kamuzu Central and Bwaila District Hospitals. Participants were asked to provide written informed consent or thumbprints for study participants who could not write. In this study, the researchers adhered to the procedures in accordance with the ethical standards of the NHSRC.

Consent for publication. Not applicable.

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