Diabetes & Metabolic Syndrome: Clinical Research & Reviews 13 (2019) 2533–2539

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

Original Article

Barriers in determining prevalence of type 2 diabetes mellitus among postpartum GDM: The research and retraining needs of healthcare professionals

E.U. Nwose [a, b, *], M. Mogbusiaghan [b], P.T. Bwititi [c], G. Adoh [b], O. Agofure [b], E.O. Igumbor [b]

[a] School of Community Health, Charles Sturt University, Orange, Australia
[b] Department of Public & Community Health, Novena University, Ogume, Nigeria
[c] School of Biomedical Sciences, Charles Sturt University, Orange, Australia

ARTICLE INFO

Article history:
Received 3 June 2019
Accepted 8 July 2019

Keywords:
Antenatal service
GDM screening register
Healthcare system
Postpartum follow-up
Staff re-training

ABSTRACT

Aim: A large percentage of gestational diabetes (GDM) are undiagnosed, and prevalence of postpartum type 2 diabetes (T2DM) is unknown, especially in developing countries. This study assessed barriers to GDM diagnosis and postpartum follow-up; to determine educational needs.

Materials and methods: This was a clinical observational study of records and procedures of antenatal services at two hospitals. Laboratory and medical records were reviewed for availability of data on anthropometrics, blood glucose, gestational age, urinalysis, and lipid profile for GDM register. Antenatal clinic protocol was observed for GDM diagnosis. BMI was derived and data were analyzed using SPSS version 20.

Results: Critical barriers attributable to health systems included lack of screening for blood sugar as part of routine antenatal protocol, and lack of GDM registers at both facilities. There was 6.5% registration of pregnancies in first trimester, 22% pre-pregnancy obesity, and 2.6% high blood pressure. Positive glucosuria cases were not followed-up for GDM diagnosis.

Conclusions: There is neither concerted effort to diagnose GDM, nor systematic records of screening and postpartum follow-up. The gap in diabetology knowledge and practice calls for re-training of antenatal healthcare professionals. GDM screening checklist needs to be established and positive results entered into GDM registers for proper management during and after delivery.

1. Introduction

Global prevalence of type 2 diabetes mellitus (T2DM) in women of reproductive age is increasing. Similarly, the incidence of hyperglycemia diagnosed for the first time during pregnancy has increased to 16.2% worldwide [1]. However, it is estimated that >90% of the cases of hyperglycaemia during pregnancy are in low-mid income countries (LMIC), which includes Nigeria [2].

Gestational diabetes mellitus (GDM), defined as glucose intolerance with onset or first recognition during pregnancy that is not clearly overt diabetes, is a precursor for T2DM for mother and unborn child [3], hence the need for diagnosis and management [4–6]. The risk factors for GDM include history or family history and obesity. Consequences include adverse pregnancy outcomes such as macrosomia baby, induction of labor, and caesarean section as well as transgenerational cycle of T2DM [4,7,8]. Although, approximately 95% of GDM cases revert to normal after pregnancy [9], reports indicate that about 50% who presented with GDM progress to T2DM and associated metabolic syndrome indices [10,11].

In the face of growing tide of T2DM coming from GDM, a gap in healthcare is surfacing. For instance, low rate of postpartum screening of T2DM in women previously managed for GDM has come to the fore [12]. Women who had GDM need postpartum follow-up to prevent diabetes [6,13,14]. However, a postpartum follow-up is possible if records of GDM are available i.e. GDM register.

In Nigeria, the prevalence of T2DM in patients previously managed for GDM is unknown. For instance, in Delta State of Nigeria [15,16], there is no valid data on occurrence of T2DM in

* Corresponding author. School of Community Health, Charles Sturt University, Orange, NSW, 2800, Australia.
E-mail address: enwose@csu.edu.au (E.U. Nwose).

https://doi.org/10.1016/j.dsx.2019.07.002
1871-4021/

women previously screened for GDM. A review of antenatal data from Warri Central Hospital indicated up to 9% positive for hyperglycaemia [16]. This data may offer a glimpse of women who may progress to T2DM if not properly managed, but there is no clear program for management in antenatal service.

Statement of the Problem: GDM has increasingly become an issue of global concern [10,17,18]. Yet, there is lack of sufficient epidemiological data regarding incidence of T2DM in previously managed GDM patients in Delta State, Nigeria. This estimate was based on one study from Nigeria for the entire Africa [2]. Previous report from study area identified difficulties in GDM data access as well as inconsistency in attendance and method of screening [16]. Therefore, there is need to determine the barriers of the antenatal service with a view to develop GDM register in the health facilities as well as re-training of healthcare professionals (HCP).

The broad objective was to establish a program for GDM patients to be followed up to allow prevention of T2DM. Specific objectives included to assess:

i. Availability of GDM register at antenatal clinic (ANC), or start one.
ii. Perception of antenatal HCP regarding GDM register.
iii. Barriers to ascertain incidence of GDM and consequently postpartum T2DM.
iv. ANC clients at risk of GDM who needed preventive management and follow-up.
v. Identify cardiovascular risk factors in GDM.

2. Materials and methods

2.1. Ethical consideration

Approvals were obtained from Ndokwa-West local government and EBGH for the ongoing work at the facilities. Ethical clearance from Novena University, and a letter of introduction from the department of Public and Community Health, were obtained and forwarded to various healthcare facilities.

2.2. Research design

This was a descriptive observational study, carried out as described [19], and in WHO research methods [20], Data collection followed an initial phase of individual and focus group discussions with healthcare professionals, after which there was an audit of ANC protocol. Records of antenatal patients from two hospitals in Delta State were accessed.

1. September 2018–October 2018 at Eku Baptist Government Hospital and
2. October 2013–September 2016 at Central Hospital, Warri.

Data collected included age and other demographic information of de-identified patients, height, weight measurements, gestational age at the time of registration, urinalysis results, blood sugar (fasting or random) results and dates of tests. A total of 123 sample records were analyzed.

2.3. Population/sampling

2.3.1. Central Hospital Warri

Medical records of women who attended the antenatal clinic (October 2013 to September 2016) were re-visited as follow up of previous report [16]. Individual and focus group discussions involved interviews with ANC service staff. Questions for discussion revolved around suspected and/or confirmed cases of GDM at the facility and perception regarding GDM register. The study also obtained records of registered antenatal patients. A total of 164 files were audited and only four was selected for further review.

2.3.2. Eku General Hospital

Patients registered and attended antenatal clinic were followed-up in terms of protocol from arrival to discharge. They comprised first time registrants visiting on Mondays and/or Wednesday and re-visiting patients who came on Fridays; from September 2018–October 2018. Urinalysis results was used to identify glucosuria in screening for GDM at registration and antenatal care. The purposive sampling was adopted in selection, based on characteristics of respondents, and 119 antenatal patients were reviewed.

2.4. Data collection

This was in three steps. First, enquiries were made about GDM register and screening. Second, perceptions of the HCPs regarding GDM register were determined. Third, personal participation in scheduled ANC to observe/review antenatal procedures and determine barriers to evaluation and registration of GDM.

2.5. Data analysis

Data were variously sorted to perform 4 different statistical analysis.

1. On the basis of maternal age, participants were categorized into two dichotomous groups of $\leq$34 and $\geq$ 35 years [21], to compare risk of GDM [22].
2. On the basis of gestational age at registration, three groups of (1–12 weeks), (13–26 weeks) and (27–37 weeks) were compared for prevalence of cardiovascular risk factors using gestational weight gain recommendations and considering weight gain of '1.35 ± 0.45 Kg' in first trimester and 1.0 lb (0.45 Kg) a week during the rest of the pregnancy [23,24]. Systolic and diastolic blood pressures were also compared.
3. Data were re-sorted on the basis of blood glucose check and reviewed for percentage of positive results identified and followed-up.
4. Data were further reviewed to determine glucosuria and/or ketonuria followed-up for diagnosis of GDM.

3. Results

On first objective, observation from individual and focus group discussions was that there were no GDM registers at antenatal clinics at both medical facilities. Further, blood sugar test was not routinely done on pregnant women and this was confirmed at the laboratory. At EBGH, glucosuria and/or ketonuria and patients' complaints could lead to further blood glucose screening. (Fig. 1). Cases of GDM were not often observed at the facility, therefore the protocol of GDM screening of glucosuria was not followed. Central Hospital Warri on the other hand does blood glucose check on selection basis, but not on registration. Patients were asked to come later (about 2–3 months from the day of registration). The results were not differentiated into a separate GDM register but recorded into general hospital laboratory register. Thus, the enquiry on *suspected and/or confirmed cases of GDM at the facility* yielded lack of GDM diagnosis at both hospitals.

On second objective, which was assessment of perception of antenatal healthcare providers regarding GDM register; there was unanimous agreement that GDM register was welcome. The discussion around HCP's perception regarding GDM register indicated

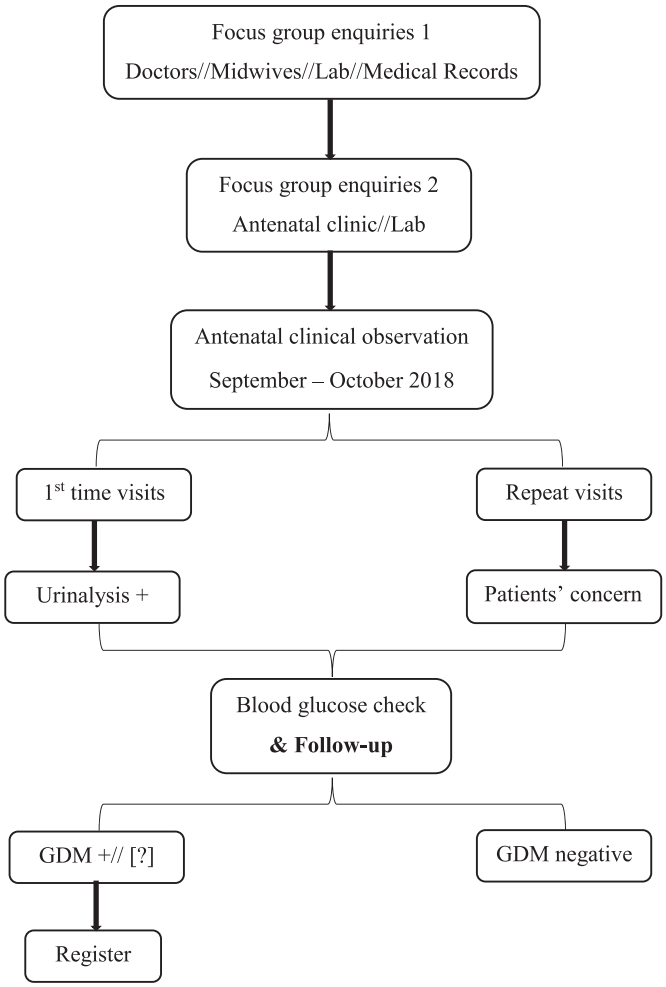

Fig. 1. Graphical summary of observational approach.

100% were aware of the increasing prevalence of diabetes in pregnancy and outcomes to mother and child. They agreed that timely detection enables monitoring thereby reducing complications. The staff cited cases of macrosomia leading to increased caesarian sections and understood that these could have been due to undetected GDM.

On the third study objective concerning assessment of barriers to evaluation of GDM and prevalence of postpartum T2DM, eight reasons were noted including four common in both hospitals. All barriers had factors of health system but some were attributable to patients (Table 1).

In the fourth assessment, data to determine the percentage of women registering at specific trimester of pregnancy was analyzed. The women were stratified based on gestational age of pregnancy at registration into 3 groups (G1, G2 and G3). A last group (G4) were those whose gestational age could not be determined on registration. The result indicates that more women registered in 2nd and 3rd trimesters of pregnancy and many did not know their gestational age (Table 2).

Based on evaluation of advanced maternal age as risk factor for GDM in stratified age groups in both facilities, data was sorted into 2 categories: ≤ 34 and ≥ 35 years. Results show that 108/123 of the population were $\leq$34 years, translating to 12.2% being $\geq$35 years. Comparison of BMI and blood pressure between gestational age groups shows differences in dichotomized, but not in trimester groups; though, results of group averages indicate neither hypertension, nor obesity (Fig. 2).

In assessment for fifth objective in Central Hospital Warri, attempt was made to select all results from the 3 years' data from the antenatal records register. However, the register only included dates of registration, name, age, address of patients and blood sugar results. There were no records of weights, heights and blood pressures, which made determining cardiovascular risk, difficult.

Eku General Hospital, patients' record files were assessed and on analysis of BMI as a cardiovascular risk factor that complicates GDM, it was found that among the 'N = 119' participants evaluated at the facility:

1. 91 had gestational age recorded
2. 64 patients had heights and weights taken for BMI Kg/m^2 estimations.

Based on the 2009 recommendations for gestational weight gain [24]. and considering weight gain of '1.35 ± 0.45 Kg' in first three months of pregnancy and 0.45 Kg (i.e. 1 lb) a week during the rest of pregnancy [23]; participants were distributed into pre-pregnancy BMI categories. The results shows that the majority in

Table 2
Sample size of patients according to gestational age.

Group	Trimester (GA) of Registration	N	% Population
G1	1st trimester (1–12 weeks)	8	6.50%
G2	2nd trimester (13–26 weeks)	51	41.50%
G3	3rd trimester (27 weeks–37)	32	26.00%
G4	GA Undefined	32	26.00%
	Total	**123**	**100%**

Table 1
Distribution of barriers into health systems and patients' factors.

Features	Health system	Patients' factor
GDM Screening	Neither routinely done, nor on day of registration. Patients selected are given an appointment	Some patients do not come for appointments
Gestational age	Inability to determine some cases	Some patients' inability to affirm last menstrual date and/or afford ultrasound scans.
KAP		Some patients do not register on time for their antenatal and may register late into their second and even third trimester
Waiting times during clinic	Limited resources and crowds coming for clinic translates to slow process	Some patients leave clinic without having assigned tests done, because of long travel distances/transport constraints
BMI assessment	Height and weight measurements are often left unchecked or unrecorded	Not applicable
Laboratory records	Not separate for antenatal clinic to allow for easy access and evaluation of records	
Laboratory results	Positive glucosuria and ketonuria often not promptly followed-up	

KAP: knowledge, attitude and practice.

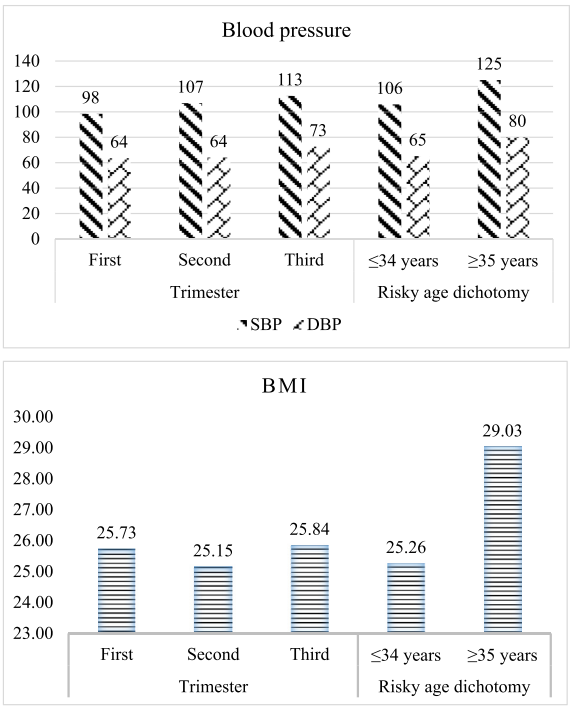

Fig. 2. Comparison of BMI & BP between gestational age groups.

pre-pregnancy had normal weight, but up to 22% were obese (Fig. 3A).

Critical evaluations of blood pressures were considered for analyzing GDM cardiovascular risks. Based on this, 114 women with recorded systolic and diastolic blood pressures were categorized according to BP level recommended by American Heart Association (AHA): <90/60 mm Hg (low), ≤130/80 mm Hg (normal) and ≥140/90 mm Hg (high or hypertension in pregnancy). The results show that 2.6% had SBP <90 mm Hg, and 94.8% were normal. The diastolic data was analyzed for percentage distribution and results indicate that considering blood pressure as a parameter, 2.6% of the population with recorded blood pressure had high blood pressure (Fig. 3B).

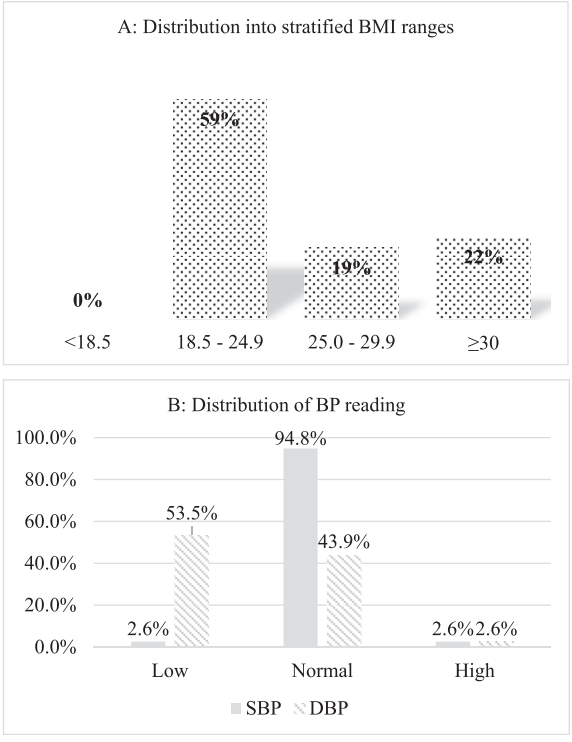

Fig. 3. Distribution of BP & BMI into diagnostic categories.

FBS/RBS data was re-sorted to determine frequency of either tests carried out and data were analyzed for positives by either test. It was observed that a larger percentage were not checked for blood glucose levels on registration and these represented the pool from Eku Government Hospital and specifically:

- 1-patient had RBS check done and result was normal
- 4-patients had FBS checks done and 3 (75%) were hyperglycaemia
- 118 (95.9%) were not checked for blood glucose

Lastly, glucosuria and/or ketonuria data were analyzed to determine percentage positives followed up as per GDM diagnosis protocol and it was found that:

- 6.8% had positive results that could be followed up and this comprised 3.4% positive for glucosuria and another 3.4% with ketonuria
- 93.2% were negative for both urine glucose and ketones

4. Discussion

This study assessed barriers in determining prevalence of T2DM in women previously managed for GDM in Delta State. The first observation was absence of diabetes register in antenatal sections of medical facilities under study. This is in contrast with expected standard practices of diabetes registers for management and follow up of diabetes patients [25], including those with GDM postpartum [26,27]. The absence of diabetes register is a challenge in determining prevalence of GDM; and progression to T2DM. It had been suggested from a Nigerian teaching hospital that a checklist of GDM risk factors is necessary to improve identification of susceptible antenatal patients [28]. The report highlighted significance of checklist and what this report adds is an articulation that GDM register is yet to be adopted in Nigeria and perhaps sub-Saharan Africa at large. To support this articulation, it is pertinent to note that none of the studies included in the systematic review report on prevalence of GDM was based on GDM register [29]. One of the studies was a 'retrospective review of delivery registry'; and enquiry at the teaching hospital affirms that GDM register is not available (Personal communication: Prof Ulasi, University of Nigeria Teaching hospital).

Nevertheless, perception of antenatal healthcare providers regarding GDM register was positive and unanimous. In regards to knowledge, attitude and practice (KAP) that translates into capacity, motivation and opportunity (CMO) components of behavioural change wheel (BCW); it seems there is motivation/attitude and opportunity in healthcare professionals to practice. Therefore, to complete the BCW – i.e. implement the structured checklist of GDM risk factors necessary to improve identification of antenatal patients who are susceptible [28], capacity/knowledge is needed, hence, development of GDM register, which includes assessable risk factors, is recommended. Lack of knowledge in healthcare practitioners is a barrier to GDM screening and management [30]; and this report suggests that empowering antenatal service facilities with GDM register and associated re-training is necessary.

On assessing barriers to determination of prevalence of GDM

and T2DM postpartum, many factors were observed, which included time of registration for antenatal services, method and period of data collection, and record of data collected. There was also issue of KAP of women and the health system towards antenatal procedures (Table 1). This agrees with Nielsen et al. (2012) who reported barriers to GDM diagnosis and intervention to include absence of clinical practice protocols and systems for patients' follow up, plus patients-related factors such as distance to antenatal clinic, amongst others [30]. In terms of patient follow up, the top-most barrier was the record of data collected – i.e. absence of register to enable follow up. It has been suggested that factors inside and outside healthcare such as characteristics of tests "are important for further improving and expanding GDM screening and related services" [31]. This report contributes evidence-based emphasis that development of GDM register, which is currently non-existent, can motivate improvement in GDM care.

Although, GDM screening appears to be carried out as recommended in this facility (Fig. 1), positive results are not systematically recorded in a diabetes register for easy follow-up. Orru et al. (2018) in the same facility identified 9% with positive FBS in antenatal population in 2013–2016. According to IDF (2017), 50% of this population may be at risk of developing T2DM and should have been followed-up. However, this could not be determined from our study due to lack of documentation. On the other hand, in the second facility (EBGH), some barriers cited in the first facility were also observed but the major barrier was of GDM tests not routinely done on registration for antenatal services, regardless of trimester of registration. The practice of not screening for GDM observed in this facility is in disagreement with recommendations from IADPSG that pregnant wom3n with risk factors be tested and assessed for GDM on 1st prenatal visit and a universal screening be done at 24–28 weeks' gestation [3].

From the assessment of 4th study objective, distribution of ANC patients according to gestational age at time of ANC registration show that approximately 42% report in 2nd trimester and about a quarter report in 3rd trimester (Table 2). What is concerning is the associated barrier around HCP' knowledge and practice that there is lack of clarity on how to handle late ANC registration. In the context of early detection and intervention of GDM, the concern is buoyed by lack of screening whereby registered clients with GDM go undetected throughout pregnancies. This constitutes a challenge in determining prevalence of GDM progression postpartum to T2DM. Indeed, patients previously managed for GDM could not be determined due to absence of data; hence the need of a register.

Some women in the sample population showed cardiovascular risk factors for GDM. Considering advanced maternal age ($\geq$35 years) as a risk factor [32], approximately 12% were at risk for GDM. This is in agreement with prevalence rates of about 13% [9,33], which may be less in some communities [34]. For instance, a report of Korean women indicated up to 9.5%, in 2011 and this was higher in the 40–44 years group. Studies show prevalence of GDM to increase with age [35]; thus the patients in this study needed to have been screened for GDM.

Again, using the estimated pre-pregnancy BMI to identify cardiovascular risks, the study found that 17.2% and 21.9% with recorded BMI were overweight and obese, respectively and therefore showed a cardiovascular risk for GDM and ultimately postpartum T2DM. More women may also be at risk of obesity before the end of pregnancy considering a weekly addition of 0.45 Kg after week 14 of pregnancy (Fig. 3). It is pertinent that patients with this risk factor be screened for GDM [3]; and this report highlights that these women are not screened despite presence of this risk i.e. high BMI.

Results from blood pressure evaluation showed that 2.6% had high blood pressures and therefore cardiovascular risk associated with GDM. Other studies showed that high blood pressure before and during pregnancy is associated with increased risk of GDM [34,36]. Additionally, GDM and high blood pressure in the same pregnancy increases risk of developing T2DM, hypertension and cardiovascular disease postpartum [37]. Therefore, there is an unmet need of proper screening for GDM, especially as high blood pressures constitutes further risk of adverse maternal and neonatal outcomes during and after pregnancy.

In this study, where screening for blood glucose was conducted, FBS test was commonly employed, which reaffirms report by Orru et al. (2018). It was found that 2.4% showed a positive for FBS and these were registered for follow up especially given that high FBS level during pregnancy is a risk factor for T2DM" [38]. However, this may be a poor representation of the number in this population since about 96% were not tested for blood glucose, thus constituting barrier to ascertain the prevalence of GDM and consequently postpartum T2DM.

The assessment of urine glucose and ketones as indications for GDM showed 3.4% with glucosuria and 3.4% with ketonuria. Besides glucosuria, pregnancy complicated by gestational diabetes is associated with significant ketonaemia and ketonuria [39], yet, this study observed that despite the presence of these, further screening was not conducted. Therefore, there is an issue of KAP of antennal service providers regarding GDM screening for a timely diagnosis, which calls for re-training of healthcare professional.

4.1. Implications for research and clinical practice

4.1.1. Research

There are controversies regarding GDM screening strategy to adopt and this is related in part to healthcare resources and the patients' perspectives [8,40]. Indeed, one of the identified areas needing further research is level of uptake of different screening strategies [40]. We report a situation where the uptake is only in principle, but not in practice or concertedly followed-up to GDM diagnosis. Therefore, determination of cost-effectiveness, benefits of screening at <24 weeks gestation, and predictiveness of BMI not truly realistic. This calls for investigation of KAP of healthcare providers. Also important is the epidemiological status, ethnic differences affect prevalence [29,36]. For instance, report on Nigeria indicates <3% prevalence of GDM [41], and another shows 13% [9]. It must be pointed out that the differences could be due to different methodologies as highlighted by Fawole et al. (2014) [28]. Thus, prevalence of GDM is currently unknown and T2DM postpartum still a subject of epidemiological investigation.

4.1.2. Practice

Boyle et al. (2018) highlighted that GDM registration rates were related to reminding diabetes educators about register and to carry out registration [27]; thus GDM register is a practice' oversight that is not limited to Nigeria or sub-Saharan Africa. The emphasis of this report has been on barriers due to deficiencies of the HCPs, therefore the clinical practice implication extends beyond reminding diabetes educators about GDM register. For instance, laboratory and medical record departments can benefit from resource empowerment and re-training on ANC registers. To train/re-train ANC staff on GDM register include raising their consciousness to complete screening and diagnosis of GDM, which involves a combination of, at least, repeated glucosuria and FBS checks and evaluation of family history [41]. Given the overwhelming need to improve identification of undiagnosed diabetes [6,14,42], and the risk of 50% GDM progressing to T2DM [10]; our observation highlights clinical practice omission that requires correction.

5. Conclusion

This study distinguished a problem, requiring diabetes education, in the health system that there are no systematic records of GDM patients or means of postpartum follow-up to monitor or prevent progression to T2DM. Several barriers to diagnosis of GDM were identified, which constitute re-training need of HCP. Furthermore, despite the presence of risk factors for GDM and its associated cardiovascular risks in some pregnancies, routine GDM screening was not prioritized and this poses a challenge in its detection before end of pregnancy. The relevance of this report lies in the re-training need for HCP on diagnosis and management of GDM, especially as about 50% progress to T2DM.

Authors' contributions

EUN with PTB conceptualized the work as part of prediabetes and cardiovascular complications study. MM and GA with support from OA and EOI. EUN and MM did the statistics as well as drafted the initial manuscript. GA, OA and EOI reviewed the first draft. MM revised the draft. PTB critically reviewed the revision for intellectual content. EUN and PTB wrote the final manuscript.

Conflicts of interest

The authors have no competing interests to declare.

Acknowledgement

The delegated antenatal clinic, laboratory and medical records staff at Eku Baptist-Government and Warri Central hospitals have participated enthusiastically in this work. The management and staff of the hospitals are appreciated for their support. In particular, the outstanding collaborations of Mr. Emmanuel Oluero and Ms. Mary Orru are acknowledged.

References

[1] International Diabetes Federation IDF. Diabetes atlas. eighth ed. Brussels, Belgium: International Diabetes Federation; 2017. http://www.diabetesatlas.org/resources/2017-atlas.html. [Accessed 23 August 2018].
[2] Guariguata L, Linnenkamp U, Beagley J, Whiting DR, Cho NH. Global estimates of the prevalence of hyperglycaemia in pregnancy. Diabetes Res Clin Pract 2014;103:176–85. https://doi.org/10.1016/j.diabres.2013.11.003.
[3] International Association of Diabetes and Pregnancy Study Groups Consensus Panel, Metzger BE, Gabbe SG, Persson B, Buchanan TA, Catalano PA, et al. International association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. Diabetes Care 2010;33:676–82. https://doi.org/10.2337/dc09-1848.
[4] Garrison A. Screening, diagnosis, and management of gestational diabetes mellitus. Am Fam Physician 2015;91:460–7.
[5] O'Dea A, Tierney M, McGuire BE, Newell J, Glynn LG, Gibson I, et al. Can the onset of type 2 diabetes be delayed by a group-based lifestyle intervention in women with prediabetes following gestational diabetes mellitus (GDM)? Findings from a randomized control mixed methods trial. Int J Diabetes Res 2015;2015:798460. https://doi.org/10.1155/2015/798460.
[6] Keely E. An opportunity not to be missed–how do we improve postpartum screening rates for women with gestational diabetes? Diabetes Metab Res Rev 2012;28:312–6. https://doi.org/10.1002/dmrr.2274.
[7] Shokry E, Marchioro L, Uhl O, Bermudez MG, Garcia-Santos JA, Segura MT, et al. Impact of maternal BMI and gestational diabetes mellitus on maternal and cord blood metabolome: results from the PREOBE cohort study. Acta Diabetol 2019;56:421–30. https://doi.org/10.1007/s00592-019-01291-z.
[8] Hartling L, Dryden DM, Guthrie A, Muise M, Vandermeer B, Aktary WM, et al. Screening and diagnosing gestational diabetes mellitus. Evidence report/technology assessment, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4781607/; 2012. 1-327.
[9] Macaulay S, Dunger DB, Norris SA. Gestational diabetes mellitus in Africa: a systematic review. PLoS One 2014;9:e97871. https://doi.org/10.1371/journal.pone.0097871.
[10] International Diabetes Federation. World diabetes day 2017: women and diabetes. 2017.
[11] Kapur A, Seshiah V. Women & diabetes: our right to a healthy future. Indian J Med Res 2017;146:553–6. https://www.worlddiabetesday.org/about-wdd/wdd-2017.html. [Accessed 2 November 2017].
[12] Chamberlain C, Fredericks B, McLean A, Oldenburg B, Mein J, Wolfe R. Associations with low rates of postpartum glucose screening after gestational diabetes among Indigenous and non-Indigenous Australian women. Aust N Z J Public Health 2015;39:69–76. https://doi.org/10.1111/1753-6405.12285.
[13] Gabbe SG, Landon MB, Warren-Boulton E, Fradkin J. Promoting health after gestational diabetes: a National Diabetes Education Program call to action. Obstet Gynecol 2012;119:171–6. https://doi.org/10.1097/AOG.0b013e3182393208.
[14] Hamel MS, Werner EF. Interventions to improve rate of diabetes testing postpartum in women with gestational diabetes mellitus. Curr Diabetes Rep 2017;17:7. https://doi.org/10.1007/s11892-017-0835-x.
[15] Orru MI, Nwose EU, Bwititi PT, Igumbor EO. World diabetes day 2017 focus: antepartum hyperglycaemia (or gestational prediabetes) is more in women below 40 years. Int J Reprod Contracept Obstet Gynecol 2018;7:355–6. https://doi.org/10.18203/2320-1770.ijrcog20175491.
[16] Orru MI, Nwose EU, Bwititi PT, Igumbor EO. Screening for gestational diabetes: evaluation of prevalence in age-stratified subgroups at Central hospital Warri Nigeria. Int J Reprod Contracept Obstet Gynecol 2018;7:63–8. https://doi.org/10.18203/2320-1770.ijrcog20175487.
[17] Committee on Practice Bulletins-Obstetrics. ACOG Practice bulletin No. 190: gestational diabetes mellitus. Obstet Gynecol 2018;131:e49–64. https://doi.org/10.1097/AOG.0000000000002501.
[18] Chiefari E, Arcidiacono B, Foti D, Brunetti A. Gestational diabetes mellitus: an updated overview. J Endocrinol Investig 2017;40:899–909. https://doi.org/10.1007/s40618-016-0607-5.
[19] Vince K, Poljičanin T, Brkić M, Rodin U, Matijević R. Prevalence of diabetes five years after having gestational diabetes during pregnancy — Croatian national study. Prim Care Diabetes 2018;12:325–30. https://doi.org/10.1016/j.pcd.2018.02.003.
[20] World Health Organization Health Research Methodology. A guide for training in research methods. second ed. Manila: World Health Organization Regional Office for the Western Pacific; 2001. p. 11–42. www.wpro.who.int/publications/docs/Health_research_edited.pdf. [Accessed 5 August 2016].
[21] Diabetes Research, Wellness Foundation. Increased risk of gestational diabetes for mothers aged over 35. 2015. https://www.drwf.org.uk/news-and-events/news/increased-risk-gestational-diabetes-mothers-aged-over-35. [Accessed 16 March 2019].
[22] Ewenighi CO, Nwanjo HU, Dimkpa U, Onyeanusi JC, Nnatuanya IN, Onoh LUM, et al. Prevalence of gestational diabetes mellitus; Risk factors among pregnant women (In Abakaliki Metropolis, Ebonyi State Nigeria.). Natl J Integrated Res Med 2013;4:56–61.
[23] Johnson TC. Gain weight safely during your pregnancy. WebMD; 2018. https://www.webmd.com/baby/guide/healthy-weight-gain#1. [Accessed 15 October 2018].
[24] Moore Simas TA, Waring ME, Sullivan GM, Liao X, Rosal MC, Hardy JR, et al. Institute of medicine 2009 gestational weight gain guideline knowledge: survey of obstetrics/gynecology and family medicine residents of the United States. Birth (Berkeley, Calif) 2013;40:237–46. https://doi.org/10.1111/birt.12061.
[25] Carstensen B, Jorgensen ME, Friis S. The epidemiology of diabetes and cancer. Curr Diabetes Rep 2014;14:535. https://doi.org/10.1007/s11892-014-0535-8.
[26] Laine MK, Kautiainen H, Gissler M, Raina M, Aahos I, Jarvinen K, et al. Gestational diabetes in primiparous women-impact of age and adiposity: a register-based cohort study. Acta Obstet Gynecol Scand 2018;97:187–94. https://doi.org/10.1111/aogs.13271.
[27] Boyle DIR, Versace VL, Dunbar JA, Scheil W, Janus E, Oats JJN, et al. Results of the first recorded evaluation of a national gestational diabetes mellitus register: challenges in screening, registration, and follow-up for diabetes risk. PLoS One 2018;13. e0200832-e, https://doi.org/10.1371/journal.pone.0200832.
[28] Fawole A, Ezeasor C, Bello F, Roberts A, Awoyinka B, Tongo O, et al. Effectiveness of a structured checklist of risk factors in identifying pregnant women at risk of gestational diabetes mellitus: a cross-sectional study. Niger J Clin Pract 2014;17:495–501. https://doi.org/10.4103/1119-3077.134051.
[29] Mwanri AW, Kinabo J, Ramaiya K, Feskens EJ. Gestational diabetes mellitus in sub-Saharan Africa: systematic review and metaregression on prevalence and risk factors. Trop Med Int Health 2015;20:983–1002. https://doi.org/10.1111/tmi.12521.
[30] Nielsen KK, de Courten M, Kapur A. Health system and societal barriers for gestational diabetes mellitus (GDM) services - lessons from World Diabetes Foundation supported GDM projects. BMC Int Health Hum Right 2012;12:33. https://dx.doi.org/10.1186/1472-698X-12-33.
[31] Nielsen KK, Rheinlander T, Kapur A, Damm P, Seshiah V, Bygbjerg IC. Factors influencing timely initiation and completion of gestational diabetes mellitus screening and diagnosis - a qualitative study from Tamil Nadu, India. BMC Pregnancy Childbirth 2017;17:255. https://doi.org/10.1186/s12884-017-1429-y.
[32] Jolly M, Sebire N, Harris J, Robinson S, Regan L. The risks associated with pregnancy in women aged 35 years or older. Hum Reprod (Oxf) 2000;15:2433–7. https://doi.org/10.1093/humrep/15.11.2433.
[33] Melchior H, Kurch-Bek D, Mund M. The Prevalence of gestational diabetes. Dtsch Arztebl Int 2017;114:412–8. https://doi.org/10.3238/arztebl.2017.0412.
[34] Tamayo T, Tamayo M, Rathmann W, Potthoff P. Prevalence of gestational

diabetes and risk of complications before and after initiation of a general systematic two-step screening strategy in Germany (2012-2014). Diabetes Res Clin Pract 2016;115:1–8. https://doi.org/10.1016/j.diabres.2016.03.001.
[35] Koo BK, Lee JH, Kim J, Jang EJ, Lee CH. Prevalence of gestational diabetes mellitus in Korea: a national health insurance database study. PLoS One 2016;11:e0153107. https://doi.org/10.1371/journal.pone.0153107.
[36] Hedderson M, Ehrlich S, Sridhar S, Darbinian J, Moore S, Ferrara A. Racial/ethnic disparities in the prevalence of gestational diabetes mellitus by BMI. Diabetes Care 2012;35:1492–8. https://doi.org/10.2337/dc11-2267.
[37] Li LJ, Aris IM, Su LL, Chong YS, Wong TY, Tan KH, et al. Effect of gestational diabetes and hypertensive disorders of pregnancy on postpartum cardiometabolic risk. Endocrine connections 2018;7:433–42. https://doi.org/10.1530/EC-17-0359.
[38] Kim C, Newton KM, Knopp RH. Gestational diabetes and the incidence of type 2 diabetes: a systematic review. Diabetes Care 2002;25:1862–8. https://doi.org/10.2337/diacare.25.10.1862.
[39] Bronisz A, Ozorowski M, Hagner-Derengowska M. Pregnancy ketonemia and development of the fetal central nervous system. Internet J Endocrinol 2018;2018:1242901. https://doi.org/10.1155/2018/1242901.
[40] Benhalima K, Damm P, Van Assche A, Mathieu C, Devlieger R, Mahmood T, et al. Screening for gestational diabetes in Europe: where do we stand and how to move forward?: a scientific paper commissioned by the European Board & College of Obstetrics and Gynaecology (EBCOG). Eur J Obstet Gynecol Reprod Biol 2016;201:192–6. https://doi.org/10.1016/j.ejogrb.2016.04.002.
[41] Wokoma FS, John CT, Enyindah CE. Gestational diabetes mellitus in a Nigerian antenatal population. Trop J Obstet Gynaecol 2001;18:56–60. https://doi.org/10.4314/tjog.v18i2.14430.
[42] Mbanya JCN, Motala AA, Sobngwi E, Assah FK, Enoru ST. Diabetes in sub-Saharan Africa. Lancet 2010;375:2254–66. https://doi.org/10.1016/S0140-6736(10)60550-8.