Awareness and Screening Practices for Gestational Diabetes Mellitus among Pregnant Women in Arusha Urban, Tanzania

***Msollo, S.S.[2], H.D. Martin[1], A.W. Mwanri[2] and P. Petrucka[3]**

[1]School of Life Sciences, Nelson Mandela African Institution of Science and Technology, Arusha-Tanzania.
[2]Depertment of Food Technology, Nutrition and Consumer Sciences, Sokoine University of Agriculture, P.O. Box 3006, Morogoro-Tanzania.
[3]College of Nursing, University of Saskatchewan, Saskatoon, Canada.

*Correspondence: msollosafiness@yahoo.co.uk; Phone: +255 782 057968/755 332207

Abstract

Awareness is an important aspect for seeking self-prevention, diagnosis, and management of gestational diabetes mellitus. This study aimed to assess awareness and history of screening practices for gestational diabetes mellitus among pregnant women in Arusha Urban District of Arusha City Council, Tanzania. A cross-sectional study was conducted in 2018, among 468 randomly selected pregnant women attending antenatal clinics at Ngarenaro and Kaloleni Health Centers in urban areas of Arusha District. Data collection was done through face-to-face interviews using a structured questionnaire and analyzed using SPSS™ version 20. Almost 60% of the participants completed primary school and were self-employed (55.8%) basically in small business. Few women were aware of the existence of gestational diabetes mellitus (10.7%). Among the aware women, 36, 23, 26 and 30% knew the meaning, effects, symptoms and risk factors for gestational diabetes mellitus respectively. Twelve (24%) of these women, obtained this information from the antenatal clinic while 38(76%) from different media. Awareness was positively associated with post-secondary (AOR 13.7, 95% CI: 4.07-46.15) and secondary education levels (AOR 5.5, 95% CI: 1.78-16.76). About 8.2% of the women were screened for gestational diabetes mellitus in their previous pregnancy in urine whereby 13.2% reported to have high urine glucose and provided with nutrition counselling without further follow up from the antenatal care. Therefore, awareness and screening practices for gestational diabetes mellitus are insufficient in the study area which may be attributed to low prioritization and limited resources.

Keywords: Gestational diabetes mellitus, awareness, Screening, pregnant women, Tanzania

Introduction

Gestational diabetes mellitus (GDM) is a form of hyperglycemia in pregnancy (HIP) which occurs due to pregnancy-induced changes in maternal glucose metabolism and insulin sensitivity. This increases the demand for insulin production on the mother's pancreas as pregnancy grows (World Health Organization [WHO], 2013; Palani *et al.,* 2014). In most cases, these women meet the increased insulin demand, but failure to accommodate results into poor glycemic control (Palani *et al.,* 2014). Although GDM disappears after delivery, misdiagnosis and/or mismanagement may lead to short and long-term health risks to the mother and her new born within five to ten years postpartum (International Diabetes Federation [IDF], 2017).

Globally, the prevalence of GDM ranges from 1 to 28%, depending on influencing factors, such as maternal age, socioeconomic status, ethnicity, body composition, screening methods, and used diagnostic criteria (Jiwani *et al.,* 2012). It also ranges from 0.6 to 27.5% in the high-income countries and 0.4 to 24.3% in the low- and middle-income countries (Chiefari *et al.,* 2017; Kanguru *et al.,* 2014). In Tanzania, GDM varies from 1.0% in rural to 27.9% in urban areas (Mwanri *et al.,* 2014; Msollo *et al.,* 2019; Njete *et al.,* 2018). The reported high prevalence

needs great attention because undiagnosed and unmanaged GDM may subject women to a risk of developing Type 2 diabetes mellitus (T2DM) later in life as well as obesity and diabetes to the newborn (IDF, 2015; Lehnen *et al.,* 2013). Thus, GDM awareness and screening can provide opportunity for immediate actions to prevent its negative effects however, there is no enough data on the level of awareness among pregnant women in Tanzania.

Despite the increasing rate of GDM in urban areas of Tanzania from 18% in 2014 to 27.9% in 2020 (Mwanri *et al.,* 2014; Mukuve *et al.,* 2020), majority of pregnant women and other population groups may be unaware of its existence which can delay its diagnosis, prevention and management (Mukuve *et al.,* 2020). Hence, there is a need for training to the physicians, paramedical people and the public including women of reproductive age regarding GDM (Lakshmi *et al.,* 2018). Adequate knowledge about GDM will potentiate opportunities to adopt healthier lifestyles and better healthcare-seeking patterns, which may contribute to designing of appropriate intervention for early diagnosis and management (Elamurugan and Arounassalame, 2016).

Awareness can also enable women with a history of GDM to understand their conditions and the recommended follow-up glucose testing, to take responsibility of visiting their health practitioners on their own initiative, and for changing their lifestyles (Koning *et al.,* 2016). As knowledge is an important component of health literacy, insufficient knowledge about the disease leads to poor understanding of medical information, limiting adherence to management strategies and, for the case of GDM, it contributes to adverse pregnancy outcomes (Baker, 2006; Ostlund *et al.,* 2003). Furthermore, since GDM may accelerate the development of T2DM among pregnant women and affect the future health of their newborns, then creating awareness may serve as an opportunity for prevention of T2DM and other complications a great deal. Unfortunately, there is limited information on the level of awareness on GDM among pregnant women and public at large, suggesting for a study to establish the missing information. This study was therefore conducted to assess awareness and screening practices for GDM among pregnant women in urban areas in Arusha city for appropriate measures to be taken to enhance self-care through early diagnosis, prevention, and management. The results from this study may serve as a basis for designing GDM educational interventions for pregnant women in Tanzania and similar resource challenged contexts.

Materials and methods

Study area

This study was conducted from March to December 2018 involving pregnant women attending antenatal clinic (ANC) at Ngarenaro and Kaloleni Health Centers in urban areas of Arusha District in Arusha city. These centers were selected among 24 health facilities with both, ANC and delivery services. The two centers had a total of 10 422 out of 26 167 pregnant women which is about 40% of all women who started first ANC visit in urban areas in Arusha City (DHIS, 2018). These centers were purposive selected due to their central location in the urban area of the City and accommodating a large number of pregnant women.

Study approach and design

This study was part of a large cross-sectional study which was conducted in urban areas of Arusha City to establish the prevalence of hyperglycemia in pregnancy, risk factors and developing a simple method for identification of women with or at risk of GDM in Tanzania.

Sample size determination and sampling technique

Eligible women were randomly selected using a table of random numbers to obtain the required sample size of 468 participants. This was done after each woman has understood the aim of the study, agreeing to participate, and signing an informed consent. This sample size of 468 women was obtained using the sample size calculation formula for prevalence studies (Daniel, 1999). Due to limited large-scale data, in Tanzania, the prevalence of 50% was used in the formula for maximum reality (Macfarlane, 1997) with assumed attrition rate of 20%.

Purposive sampling was employed to obtain one district located in urban areas out of the seven districts of Arusha Region. Two ANC centers (Ngarenaro and Kaloleni) were purposively selected from the 24 facilities with both ANC and delivery services as nearly 40% of pregnant women were accessing ANC services from across the City in 2018. Proportionate sampling was used to select pregnant women from the two ANCs to ensure a total of 468 respondents where by 31% of the pregnant women were selected from Kaloleni and 69% from Ngarenaro.

Inclusion and exclusion criteria

The study included pregnant women residing in urban areas of Arusha District in Arusha City with a gestational age of ≥24 weeks. It excluded pregnant women who were unable to give responses, such as critically ill, unable to communicate, mentally disturbed as well as those who were unwilling to provide consent.

Data collection (Tool, pretesting and procedure)

The questionnaires were prepared in both English and Kiswahili languages. These were then pre-tested with 20 pregnant women who were not part of the study subjects. This tool was administered through face to face interviews to collect information on background characteristics of the pregnant women, such as maternal and gestational age, education levels, occupation, income, and parity. This was followed by questions on awareness about GDM which involved the existence, meaning, symptoms, consequences, and risk factors as well as sources of the information and practices in screening GDM in their previous pregnancies. The questionnaire included both closed (yes/no) and open ended (short answer) questions. The researchers recorded verbal responses and ticked responses if matched with provided alternatives. Responses were coded and awareness was determined by the percentages of women who answered the questions correctly. The grading was adapted from Dhyani *et al.* (2018) with excellent knowledge regarded as ≥75% correct, good knowledge between 51% and 74% correct; average knowledge between 26% and 50% and poor knowledge ≤25%.

Ethical clearance

The study was approved by the Tanzanian National Institute of Medical Research (NIMR) with a reference number NIMR/HQ/R.8a/Vol. IX/2694 and the permission for conducting the interviews was provided by the Arusha City Director.

Statistical data analysis

Data were analyzed using SPSS™ Version 20 for descriptive statistics such as means, frequencies, and percentages as well as inferential statistics. Chi-square test was computed to determine relationship between social demographic characteristics and awareness on existence of GDM (the women who were aware and unaware) and finding factors related to awareness for inclusion in the logistic regression model. The logistic regression analysis was done to provide the crude and adjusted odd ratios for factors associated with GDM awareness using backwards elimination method. The dependent variable was awareness on the existence of GDM with Yes and/or No responses. Statistical inference was based on 95% confidence intervals (CIs) and significance at $p<0.05$ whereby age and parity of the women were used to control for confounders during data analysis.

Results and Discussion

Demographic characteristics of women

The women's mean maternal age was 28 (SD 5.84) years, of which 65% had the age ≥ 25 years. Nearly 60% of women completed primary school education whereby 55.8% were self-employed basically in small business and 54.4% earning an average income of <250,000 Tanzanian Shillings per month (<110 American dollars). Moreover, 50.4% reported as second or third gravidity (Table 1).

Awareness on gestational diabetes mellitus among pregnant women

Among the 468 interviewed pregnant women, 10.7% were aware of an existence of GDM before the introduction of the study and 34% correctly defined it as diabetes with first recognition during pregnancy. Among the

Table 1: Demographic characteristics of participants involved in GDM study

Variables	Frequency	Percent
Age of the respondents		
<25years	164	35.0
≥25 years	304	65.0
Education levels		
Never went to school	8	1.7
Primary level	275	58.8
Secondary level	164	35.0
College/University	21	4.5
Occupation status		
Formally employed	46	9.8
Self employed	261	55.8
Unemployed	161	34.4
Income per month		
<250,000	255	54.5
250,000-450,000	33	7.1
≥450,000	13	2.8
Don't know	167	35.7
Gravidity		
Prime	142	30.3
Second and third	236	50.4
Fourth and above	90	19.2

participants who were aware on the existence of GDM, few (23%) were aware of its effects mentioning prenatal and perinatal death, delivery of a microsomal infant, and development of diabetes later in life for the mother and the newborn (Table 2).

Moreover, few women (26%) were aware of symptoms of GDM, such as extreme tiredness, diaphoresis (excessive sweating), and polydipsia (excessive thirst). In addition, 30% of the women were aware of the risk factors for GDM such as history of delivery ≥ 4kg babies and family history of T2DM (Table 2).

The observed lack of awareness about GDM may be attributed to capacities within the health system which has not well prioritized GDM as one among the risk factors for poor pregnancy outcomes. This limits the health care providers in promoting and attending this pregnancy challenge in the ANC programs. This finding is consistent with a similar study in North Karnataka where most of the women had poor knowledge about GDM (Dhyani *et al.,* 2018). However, a study conducted in Samoa reported that more than half of the women (58%) were aware that GDM can occur initially during pregnancy and 23% indicated uncertainty while 19% were unaware of the disease at all (Price *et al.,* 2017).

Furthermore, lack of awareness on the effects of GDM to the mother or the newborn, could be due to the fact that very few women understood that GDM can cause prenatal death, diabetes later in life to the mother and the newborn, as well as childhood and adult obesity. This may complicate the implementation of diagnosis, prevention, and management interventions as women may not see the importance of regular screening, prevention and management. These findings are supported by Bhavadharini *et al.* (2017) that, most of the participants were unaware of the possible effects of GDM on

Table 2: Participant's awareness about GDM

Variables tested	Frequency	Percent
Awareness on existence of GDM		
Yes	50	10.7
No	418	89.3
Awareness on the meaning of GDM		
Yes	18	36.0
No	32	64.0
If yes what is GDM		
Diabetes first occurring in pregnancy	18	34.0
Do not know the meaning	32	64.0
Awareness on the symptoms of GDM		
Yes	13	26.0
No	37	74.0
If yes what are the symptoms of GDM		
Frequent urination	6	46.0
Tiredness	3	23.0
Frequent thirst	4	31.0
Awareness on the effects of GDM		
Yes	14	23.0
No	36	77.0
If yes what are the effects of GDM		
Overweight baby	2	14.2
Diabetes later in life to mother and child	6	42.9
Prenatal death	6	42.9
Awareness on the causes of GDM		
Yes	15	30.0
No	35	70.0
If yes what are the causes of GDM		
Family history of type 2 diabetes	12	80.0
Previous delivery to >4kg babies	3	20.0

the mother or the baby. Similarly, awareness on the effects of GDM was poor as most of women did not know its consequences after pregnancy and the increased risk for T2DM in future (Elamurugan and Arounassalame, 2016; Shriraam *et al.,* 2013).

Most of the participants in this study were not aware of the risk factors for GDM, while this is a very important aspect of self-care as it can help in earlier self-identification for immediate action to prevent adverse pregnancy outcomes and long-life health effects. A similar study in India reported that, although a greater proportion of the women were aware of the conditions of diabetes mellitus (DM) and GDM, the knowledge about the risk factors, causes of GDM, and future risk for T2DM was low (Shriraam *et al.,* 2013). The same study stressed that proper precautions and self-care can be taken if women have good knowledge about the risk factors and the consequences of untreated GDM (Shriraam *et al.,* 2013).

Factors influencing awareness on gestational diabetes mellitus

Awareness on GDM was significantly associated with the education level. This is due to fact that the odd of been aware on GDM was almost 14 times for women with college/ university levels of education and 6 times for those with secondary levels of education as compared to those with primary levels of education or never attended formal education. After adjusting for income, occupation, age and gravidity, awareness still remained significantly associated with College and secondary education levels (Table 3).

The significant association between awareness about GDM with both level of education in this study could probably be explained by the fact that educated women can easily search for information from different sources and may have obtained GDM knowledge at school either through training or sharing of experiences. A similar study from Ghana reported that pregnant women with higher levels of education were more aware of the risk factors associated with GDM and, possibly, its management and outcomes (Azu and Essel, 2017). On the other hand, this finding mirrors a study from the urban areas of Chidambaram in India where no significant association between occupation and GDM knowledge was indicated (Lakshmi *et al.,* 2018).

History of GDM screening in previous pregnancies

About 8.2% of the women reported to have been screened for GDM in their previous pregnancy using urine samples with five (15.2%) reporting positive results. These diagnosed women reported to have been provided with counselling and referred to the doctor/regional hospital for further actions but none were followed up after diagnosis (Table 4).

The majority of the women in the current study reported to be rarely screened for GDM

Table 3: Participants' attributes associated with awareness of GDM

Risk factors	GDM awareness			
	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Education levels				
Primary/Non-formal education	1		1	
Secondary	12.6(5.2-30.6)	<0.001	5.5(1.78-16.76)	0.003
College/University	25.5(10.4-62.5)	<0.001	13.7(4.07-46.15)	<0.001
Gravidity				
Prime	1			
Second and third	1.46(0.67-3.205)	0.341	1.2(0.23-2.54)	0.567
Fourth and above	2.37(0.92-6.16)	0.050	2.11(0.53-4.57)	0.076
Occupation				
Unemployed	1		1	
Non-formal employed	0.11(0.05-0.26)	0.824	0.14(0.05-0.4)	0.638
Formally employed	1.1(0.51-2.33)	<0.001	1.0 (0.33-2.5)	0.631
Income level (Tshs)				
<250,000	1		1	
250,00-450,00	7.05(1.57-31.7)	0.011*	2.1(0.95-47.0)	0.638
>450,000	4.7(1.04-21.3)	0.045*	0.59(0.02-12.0)	0.680

Note: Large number of Confidence Intervals (CI) may be due to a small number of women falling in the category as very few women were aware of the existence of GDM. Abbreviation: OR–Odd ratio. Significant at P<0.05

Table 4: History of GDM screening and management in previous pregnancies

Variables Tested	Frequency	Percent
Tested glucose in previous pregnancies		
Yes	38	8.2
Do not know	430	91.8
Which testing method was used		
Urine	38	100.0
Blood	0	0.0
If tested what was the status		
Normal	33	84.8
High/detected	5	15.2
If high were you treated		
Yes	3	60.0
No	2	40.0
If yes, how were you treated		
Education and refereed to hospital	3	100.0
Medication	0	0.0
Were you followed up after diagnosed		
Yes	0	0.0
No	5	100.0

in their previous pregnancies and, for those who were screened, the common test used was glucose in urine. A large proportion of pregnant women reported never being tested for GDM in their previous pregnancies, may be attributed to lack of awareness on what is exactly tested as it is a common practice that all pregnant women are screened for GDM and proteinuria using urine samples. The observed screening practice may be attributed to the guidelines used by the health systems where Tanzanian guidelines as well as the ANC cards are still recommending urine testing.

It was also reported in this study that women who were detected with positive glucose in the urine were referred to the doctor or hospitals for further diagnosis and management. However, there was limited follow-up after diagnosis from the service providers in ANC, making it difficult to tell whether the referred women went for further diagnosis, how they were managed, and whether the problem ended or persisted even after delivery. In this case, health care providers need to monitor and follow-up of these women to ensure that management is done appropriately. The current finding is supported by a similar study done in 30 health facilities in Tanzania where urine tests for protein and glucose were commonly performed, but blood glucose testing was rarely done unless in the case of positive urine tests, suspect symptoms, or known diabetes diagnosis (Ramaiya *et al.,* 2018). Therefore, it was reported that some health facilities have never found any woman with glycosuria, which is likely due to low sensitivity of urine test strips in detecting GDM cases (Ramaiya *et al.*, 2018).

Also, in some facilities, the prevalence was reported to be small likely due to missed opportunities caused by limited screening for diabetes, lack of guidelines, and poor documentation. Another study conducted in rural India was inconsistent to these findings as pregnant women are screened for GDM using blood samples and monitored at least once weekly (Appajigol and Bellary, 2015). Similar to the current findings, Utz *et al.* (2017) found that the majority of the pregnant women are referred to either a general practitioner or a specialist (i.e., endocrinologist/gynecologist)

after diagnosis of GDM. Although referrals are common due to lack of enough specialists for diabetes care in many developing settings, the additional costs may increase the rate of lost to follow-up as well as drop out (Beran and Yudkin, 2006; Nielsen *et al.,* 2012). Pregnant women can adhere to early diagnosis, follow up, and general self-care interventions if they are aware of the costs associated with unmanaged GDM. Furthermore, updating knowledge and skills of healthcare providers need to be supported by uniform national standards enabling the front line healthcare workers to manage women with GDM to increase access and consistency in providing care (Utz *et al.,* 2017).

Main source of information about GDM

The main sources of information about GDM were reported to be different social media such as newspapers, radios, internet, and television (76%) while those reported ANC were 24% among the aware women (Table 5).

Nevertheless, most of the women declared that it was their first time to hear about GDM from our study when it was introduced to understand the aim. Lack of awareness may be attributed by the currently used Focused Antenatal Care (FANC) model and policies in place. This model integrates ANC with care and counselling related to several other conditions and women are immunized against tetanus, tested and treated for anaemia, vitamin A, or iodine deficiencies. They also receive testing and, if necessary, treatment for Human Immunodeficiency Virus or acquired immunodeficiency syndrome (HIV/AIDS), sexually transmitted infections (STIs), malaria and tuberculosis (Kearns *et al.,* 2014) however, GDM screening and management has not been prioritized among services offered. The Tanzania National Health Policy on the other hand, has put more efforts in family planning, pregnancy, sexually transmitted diseases, gender based violence, violence against children, female genital mutilation, harmful traditional practices, breast and cervical cancer screening, prevention and treatment of infertility (MoHCDGEC, 2017). Nevertheless, GDM is not mentioned as a priority health condition in the health policy while this policy is the source of many health related guidelines. The low emphasis on the ANC guidelines may have contributed to low consideration of GDM in the regular ANC programs offered, leading into lack of awareness among pregnant women. This finding affirms that most women do not have accessible information to very important issues regarding their health. The appropriate source of information was expected to be the ANC but, it was the least used source, which is likely attributable to the lack of GDM information within the ANC programs. This creates a need to incorporate GDM in ANC guidelines to enable healthcare providers include it in their day-to-day education programs for easier access by pregnant women. This is supported by a study done in Tanzania which revealed that facility staffs were less trained or received fewer refresher courses in diabetes (0–5%), hypertension (4-6%), and other NCDs (0–16%) compared to training in PMCTC (39%), management of postpartum bleeding (31%) and HIV/AIDs (31%) (Ramaiya *et al.,* 2018).

Similar studies in India and Samoa reported that, although it is encouraging to see the role played by mass media in creating awareness about GDM, the healthcare providers were mentioned as a source of information by very few women (Price *et al.,* 2017; Shriraam *et al.,* 2013). Health care providers have to be reliable source of information to create awareness among antenatal women by including GDM in their routine health care education programs (Shriraam *et al.,* 2013).

Table 5: Main sources of information on GDM among pregnant women (n=50)

Variables tested	Frequency	Percent
The reported sources of information on GDM		
During ANC	12	24
Social media (internet, radio, television etc.)	38	76

Limitations of the study

This study acts as a basis for understanding the level of GDM knowledge among pregnant women. However, health care providers were not included to provide information on the practices related to GDM diagnosis and management as it was assumed that they already know the condition.

Conclusions and Recommendations

Awareness about GDM was very low among pregnant however, it was significantly associated with education. The main source of the information about GDM was reported to be the social media, while healthcare workers were expected to be a reliable source of information related to health. Furthermore, the women diagnosed with GDM are not followed up from the ANC creating a need to establish monitoring and follow up mechanisms to prevent short and long-term effects to the mother and the newborn. Awareness creation by different health stakeholders, using both social media, and regular ANC education programs may reach more people to encourage self-care that can facilitate early diagnosis and proper management to avoid GDM associated complications.

Acknowledgements

The author acknowledge The World Bank through CREATES project in Nelson Mandela African Institution of Science and Technology in Arusha-Tanzania for their funds which made the entire study to be done successful. Authors also convey thanks to the nurses-in-charge Martha Sima from Ngarenaro ANC and Winfrida Masawe from Kaloleni ANC for their assistance on data collection arrangements. Participants are acknowledged for their positive participation in the study and our research assistants Rafiki Julius and Janeth Ringo for assisting in data collection.

Competing Interests

The Authors declare that there is no conflict of interest.

References

Appajigol, J.S. and Bellary, S. (2015). Knowledge and practices of rural family physicians and obstetricians towards gestational diabetes mellitus. *International Journal of Community Medicine and Public Health,* 2(2):153-155.

Azu, T.D. and Essel, J. (2017). Awareness and knowledge of gestational diabetes mellitus among pregnant women at the Tema General Hospital, Ghana. *An International Journal of Nursing and Midwifery,* 1(2)33-40.

Baker, D.W. (2006). The meaning and the measure of health literacy. *Journal of General Internal Medicine,* 21(1): 878–883

Beran, D, Yudkin, J.S. (2006). Diabetes care in sub-Saharan Africa. Lancet 2006: (368) 1689–1695.

Bhavadharini, B., Deepa, M., Nallaperumal, S., Anjana, R.M. and Mohan, V. (2017). Knowledge about gestational diabetes mellitus amongst pregnant women in South Tamil Nadu. *Journal of Diabetology,* 8:22-6.

Chiefari, E., Arcidiacono, B., Foti, D. and Brunetti, A. (2017). Gestational diabetes mellitus: An updated overview. *Journal of Endocrinological Investigation,* 40(9): 899–909

Daniel W.W. Biostatistics: A Foundation for analysis in the health sciences, 7th ed. R. Wiley. New York. 1999. xiv +755. ISBN 0-471-16386-4.

District Health Information System (DHIS) Two. (2018). The District report of 2018 in Arusha District. Arusha,Tanzania: Unpublished report.

Dhyani, V., Mahantashetti, N.S., Ganachari, M.S., Kambar, S. and Ghatnatti, V. (2018). Awareness of gestational diabetes mellitus among pregnant women attending a tertiary health center. *Indian Journal of Health Science and Biomedical Research,* 11:51–55.

Elamurugan, S. and Arounassalame, B. (2016). What do mothers know about gestational diabetes: Knowledge and awareness. Indian *Journal of Obstetrics and Gynecology Research,* 3(4): 393–396.

International Diabetes Federation (2017). International Diabetes Federation Atlas (8th

ed). Brussels, Belgium: Author

International Diabetes Federation. IDF Diabetes Atlas. 7th ed. Brussels, Belgium: International Diabetes Federation; 2015.

Jiwani, A., Marseille, E., Lohse, N., Damm, P., Hod, M. and Kahn, J.G. (2012). Gestational diabetes mellitus: Results from a survey of country prevalence and practices. *The Journal of Maternal-Fetal and Neonatal Medicine,* 25(6): 600–610.

Kanguru, L., Bezawada, N., Hussein, J. and Bell, J. (2014). The burden of diabetes mellitus during pregnancy in low- and middle-income countries: A systematic review. Global Health Action. 7(1): 23987, doi: 10.3402/gha.v7.23987.

Kearns, A., Hurst, T., Caglia, J., Langer, A. (2014). Focused Antenatal Care in Tanzania. Delivering individualized, targeted, high-quality care. Country-Level programs. Pp.11.

Koning, S.H., Lutgers, H.L., Hoogenberg, K., Trompert, C.A., van den Berg, P.P. and Wolffenbuttel, B.H.R. (2016). Postpartum glucose follow-up and lifestyle management after gestational diabetes mellitus: General practitioner and patient perspectives. *Journal of Diabetes and Metabolic Disorders* 15: 56.

Lakshmi, D., Felix, A.J. W., Devi, R., Manobharathi, M. and Felix, A.J.W. (2018). Study on knowledge about gestational diabetes mellitus and its risk factors among antenatal mothers attending care, urban Chidambaram. *International Journal of Community Medicine and Public Health,* 5 (10): 4388-4392.

Lehnen, H., Zechner, U. and Haaf, T. (2013). Epigenetics of gestational diabetes mellitus and offspring health: The time for action is in early stages of life. Molecular Human Reproduction 19(7): 415–422.

Macfarlane, S.B. (1997). Conducting a descriptive survey: Choosing a sampling strategy. Tropical Doctor 27(1):14-21.

Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC), (2017). The National Health Policy, 2017 (6 th ed). For External Consultations with Ministries, Departments and Agencies. Tanzania.

Msollo, S.S., Martin, H.D, Mwanri, A.W. and Petrucka, P. (2019). Prevalence of hyperglycemia in pregnancy and influence of body fat on development of hyperglycemia in pregnancy among pregnant women in urban areas of Arusha Region, Tanzania. BMC Pregnancy and Childbirth 19(1) 315.

Mukuve, A., Noorani, M., Ibrahim Sendagire, I. and Mgonja, M. (2020). Magnitude of screening for gestational diabetes mellitus in an urban setting in Tanzania; a cross-sectional analytic study. BMC Pregnancy and Childbirth (2020) 20:418. https://doi.org/10.1186/s12884-020-03115-3.

Mwanri, A.W., Kinabo, J., Ramaiya, K. and Feskens, E.J.M. (2014). Prevalence of gestational diabetes mellitus in urban and rural Tanzania. Diabetes Research and Clinical Practice 103(1):71–78.

Nielsen, K.K., de Courten, M. and Kapur, A. (2012). Health system and societal barriers for gestational diabetes mellitus (GDM) services-lessons from World Diabetes Foundation supported GDM projects. BMC International Health and Human Rights 12(1): 33.

Njete, H.I., John, B., Mlay, P., Mahande, M.J. and Msuya, S.E. (2018). Prevalence, predictors and challenges of gestational diabetes mellitus screening among pregnant women in northern Tanzania. Tropical Medicine and International Health 23(2):236–242.

Ostlund, I., Hanson, U., Björklund, A., Hjertberg, R., Eva, N., Nordlander, E. *et al.* (2003). Maternal and fetal outcomes if gestational impaired glucose tolerance is not treated. Diabetes Care 26:2107-11.

Price, L.E., Lock, L.J.P, Archer, L.E. and Ahmed, Z. (2017). Awareness of gestational diabetes and its risk factors among pregnant women in Samoa. Hawaii Journal of Medical and Public Health 76(2): 48–54.

Ramaiya, K. L., Swai, A.M., Mutabingwa, T.K., Mwanri, A.W. and Kagaruki, G.B. (2018). Capacity and capability of Tanzania health facilities to diagnose and manage diabetes mellitus in pregnancy. Diabetes Research and Clinical Practice 145: 119-129.

Shriraam, V., Rani, M.A., Sathiyasekaran, B.W. C. and Mahadevan, S. (2013). Awareness of gestational diabetes mellitus among antenatal women in a primary health center in South India. *Indian Journal of Endocrinology and Metabolism,* 17(1):146

Staynova, R., Gueorguiev, S., Petkova-gueorguieva, E., Ivanova, S. and Ivanov, K. (2017). Importance of self-Monitoring of blood glucose in gestational diabetes : Pharmacists role in improving patient's compliance-Pilot study abstract. *OSR Journal of Pharmacy* 7(10), 78–82.

Utz, B., Assarag, B., Essolbi, A., Barkat, A., Delamou, A. and De Brouwere, V. (2017). Knowledge and practice related to gestational diabetes among primary health care providers in Morocco: Potential for a defragmentation of care. Primary Care Diabetes 11(4): 389–396.