DIABETES MELLITUS AMONG PREGNANT MOTHERS AND ITS EFFECT ON MATERNAL AND BIRTH OUTCOMES IN WOLAITA ZONE, SOUTHERN ETHIOPIA

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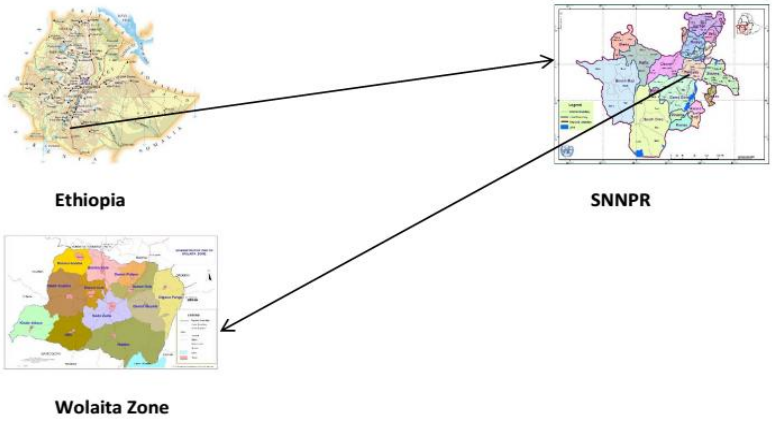

DISSERTATION FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (PHD) IN PUBLIC HEALTH, ADDIS ABABA UNIVERSITY, ETHIOPIA

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DIABETES MELLITUS AMONG PREGNANT MOTHERS AND ITS EFFECT ON MATERNAL AND BIRTH OUTCOMES IN WOLAITA ZONE, SOUTHERN ETHIOPIA

A PHD DISSERTATION SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF THE ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (PHD) IN PUBLIC HEALTH

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By: Eskinder Wolka Woticha

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APPROVED BY THE EXAMINING BOARD

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Original Papers

This thesis is based on the following original research papers:

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Paper IV: Eskinder Wolka Woticha, Wakgari Deressa, Ahmed Reja. Barriers for detection and management of gestational diabetes mellitus in Southern Ethiopia: A qualitative study. Diabetes and Metabolic Syndrome: Clinical Research and Reviews, 2019; 13(3): 1827-1831. DOI: 10.1016/j.dsx.2019.04.005

List of Acronyms

AAU: Addis Ababa University

ACOG: American College of Obstetricians and Gynecologists

ADA: The American Diabetes Association

ADIPSI: The Australasian Diabetes In Pregnancy Society

ANC: Antenatal Care

AOR: Adjusted Odds ratio

APH: Antepartum Hemorrhage

BMI: Body Mass Index

CI: Confidence Interval

COR: Crude Odds Ratio

CS: Caesarean Section

DIPSI: Diabetes in Pregnancy Study Group India

DM: Diabetes Mellitus

FBS: Fasting Blood Sugar

FMOH: Federal Ministry of Health

GDM: Gestational Diabetes Mellitus

IADPSG: International Association of Diabetes and Pregnancy Study Group

IUFD: Intra Uterine Fetal Death

LBW: Low Birth Weight

LMCs: Low- and Middle-income Countries

MUAC: Mid Upper Arm Circumference

NDDG: National Diabetes Data Group

OR: Odds Ratio

OGTT: Oral Glucose Tolerance Test

PPH: Postpartum Hemorrhage

RBS: Random Blood Sugar

RR: Risk Ratio

SD: Standard deviation

SNNPR: Southern Nation's Nationalities and People Region

UK NICE: United Kingdom National Institute for Health and Care Excellence

VIF: Variance Inflation Factor

WDF: World Diabetes Federation

WHO: World Health Organization

WSU: Wolaita Sodo University

ZHD: Zonal Health Department

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Abstract

Background: Currently, diabetes mellitus (DM) is considered as one of the top health problems of the World. The World Health Organization (WHO) estimated that, globally, hyperglycemia is the third highest risk factor for premature mortality, next to high blood pressure and tobacco use. World estimate of 8.8% (415 million) adults aged 20-79 affected by DM in 2015 with little gender difference and in the same year the estimate of hyperglycemia in pregnancy in Africa was 10.5% affecting 3.3 million live births. Its burden is increasing and the largest increase will take place in low and middle-income countries. The magnitude of diabetes is nearly equal among both sexes but it uniquely affects women through its impact during pregnancy. Today as many as 60 million women of reproductive age have type 2 diabetes and gestational diabetes mellitus (GDM), affects up to 15% of pregnant women worldwide. Poorly controlled diabetes is important cause of maternal and fetal complications among pregnant mothers. Early identification, close monitoring and management of diabetes mellitus among pregnant women can meaningfully improve pregnancy and birth outcome. In Ethiopia, although diabetes mellitus is recognized as one of the major non-communicable diseases, the burden among pregnant women and its effect on pregnancy and birth outcomes are not well researched.

Objective: To assess the magnitude of DM and its effect on maternal and birth outcomes among pregnant mothers in Wolaita Zone, Southern Ethiopia

Methods: This study has been undertaken in Wolaita Zone, Southern Ethiopia. Institution-based retrospective document review with a cross-sectional design, cross-sectional study and retrospective cohort study designs were employed respectively to determine magnitude of pre-existing diabetes, prevalence of GDM and effect of diabetes on pregnancy and birth outcome among mothers receiving maternity services in selected health facilities in Wolaita Zone. Qualitative study was done to explore detection and management modalities of GDM. The study took place from August 2017 to June 2018. The study populations were pregnant mothers and health care providers. Data were collected by document review or data extraction, interviewing of pregnant women by structured questionnaire, and in-depth interview of health professionals engaged in maternity care. Oral glucose tolerance test was performed and GDM was diagnosed based on WHO criteria.

Data were entered in to Epi Info version 7 and analysis was done by STATA version 14. Descriptive statistics was computed and data were presented using figures and tables. Chi-square and corresponding p-value were determined to assess the association between dependent and independent variables for the first objective. Binary logistic regression was applied to show the association of independent variables with dependent variables. Thematic analysis approach was used to analyze qualitative data using NVIVO version 12. The study was approved by Institutional Review Board of College of Health Sciences, Addis Ababa University.

Results: Magnitude of pre-existing DM among mothers receiving maternity care within one year period was 2.8% 95% CI (1.5, 4.2). The magnitudes among urban and rural residents were 3.3% and 1.4% respectively. Pre-existing diabetes mellitus was significantly associated with family history of diabetes (Chi square 24.8, P-value, 0.001). Previous history of spontaneous abortion (aOR: 5.3; 95%CI: 1.6-17.4) and fetal macrosomia (aOR: 3.9; 95%CI: 1.2-13.1), were identified to be significantly associated with pre-existing diabetes.

Prevalence of GDM was 4.2% (95% CI, 2.5, 6.2) with mean post glucose load level of 160.1 mg/dl (6.3) and 15(4%) among urban residents and 7(4.9%) among rural residents. The proportion of GDM increases with increase in number of pregnancies. Previous history of spontaneous abortion (aOR: 3.5; 95%CI: 1.7-14.6) and family history of type II diabetes (aOR: 4.3; 95%CI: 1.3-8.7) were significantly associated with GDM.

Mothers with DM were 2.9 times more likely to be delivered by caesarean section than non-diabetic mothers (aRR: 2.9, 95%CI: 1.3-6.2) and the risk of pre-term delivery is 2.5 times higher among mothers with DM, (aRR: 2.5, 95% CI: 1.1-6.2).

Screening of women for GDM was done by selective screening within 24-28 weeks of gestational age. The participants also mentioned that they made diagnosis of GDM based on WHO criteria. Health care providers use dietary modification, exercise and drug treatment to treat GDM. Participants confirmed that lack of standard guidelines and protocols, lack of attention of mid-level workers to screen GDM, inadequate trained health care providers, shortage of supplies and equipment and late antenatal care visits were barriers to detection and management of GDM.

Conclusions and Recommendations: The magnitude of pre-existing DM is almost the same as that of International Diabetes Federation estimate to Ethiopia. Family history of diabetes is found to be associated with pre-existing DM. Pre-existing diabetes is associated with increased risk of abortion and fetal macrosomia. The prevalence of GDM is higher compared to other studies conducted in the country. Diabetes mellitus among pregnant mothers is associated with increased risk of pre-term birth and caesarean section delivery. Commonly reported challenges to detect GDM among mothers were lack of standard guidelines and protocols, lack of trained health care providers, shortage of supplies and equipment and late antenatal care visits.

Strengthening screening, care and prevention strategies for gestational diabetes mellitus are important to improve maternal and child health. Early detection and management of diabetes mellitus should be one of the key activities to improve maternal and child mortality and morbidity. Policy makers and health care leadership need to address challenges for detection and management of GDM, by strengthening the health care system by availing standard guidelines and protocols, providing on job training for mid-level health care providers, fulfilling supplies and consumables and working on early antenatal visits of pregnant mothers. National large scale study is important to estimate the burden of DM among pregnant mothers and its effect on maternal and birth outcomes at national level.

Key words: Gestational diabetes mellitus, pre-existing diabetes, pregnant mothers, Southern Ethiopia

1. Introduction

1.1 Background

Diabetes mellitus (DM) is a metabolic disorder resulting from a defect in insulin production, impaired insulin action or both. The function of insulin to control glucose can be affected in two ways. A problem with insulin secretion can occur in pancreatic cells, such as in type I diabetes mellitus. The other is, insulin may not act effectively in promoting glucose uptake. This is known as insulin resistance, and is seen in type II diabetes mellitus and gestational diabetes mellitus [1].

Diabetes mellitus is classified according to its etiology and clinical presentation of the disorder into four types: Namely, type 1 diabetes, type 2 diabetes, gestational diabetes mellitus (GDM), and other specific types. Type 1 diabetes is sometimes called insulin dependent, immune-mediated or juvenile-onset diabetes. It is caused by destruction of the insulin-producing cells of the pancreas, typically due to an auto-immune reaction, where they are attacked by the body's defense system. The beta cells of the pancreas therefore produce little or no insulin, the hormone that allows glucose to enter body cells. The reason why this occurs is not fully understood. The disease can affect people of any age, but usually occurs in children or young adults. Type 2 diabetes is characterized by insulin resistance and relative insulin deficiency, either of which may be present at the time that diabetes becomes clinically manifest. Gestational diabetes mellitus (GDM) is a glucose intolerance of varying degrees of severity which starts or is first recognized during pregnancy, regardless of whether insulin is used for treatment or if the condition persists after pregnancy [1].

Diabetes mellitus is one of the major non-communicable diseases on the rise worldwide, causing 4.8 million deaths and morbidity in 371 million people every year[2]. It is the fourth or fifth leading cause of death in most high-income countries and there is substantial evidence that increase in epidemic in many economically developing and newly industrialized nations. The number of studies describing the epidemiology of diabetes over the last 20 years has been extraordinary. It is now recognized that it is the low- and middle-income countries that face the greatest burden of diabetes[2].

It is estimated that approximately 285 million people worldwide, or 6.6% in the age group 20-79, had diabetes in 2010, some 70% of whom live in low- and middle-income countries [3]. This

number is expected to increase by more than 50% in the next 20 years if preventive programs are not put in place. By 2030, some 438 million people, or 7.8% of the adult population, are projected to have diabetes. The largest increases will take place in the regions dominated by developing economies[3].

Globally, the magnitude of DM is roughly equal in both sexes but the adverse effect of diabetes is more serious among women because of its impact during pregnancy. Based on evidences, the spread of diabetes is higher in countries with developing economies. As a result, more women of reproductive age have diabetes and more pregnancies are complicated by diabetes. At present as many as 60 million women of reproductive age have type 2 diabetes and gestational diabetes mellitus, affects up to 15% of pregnant women worldwide[3].

According to the International Diabetes Federation, the global prevalence of hyperglycemia in pregnancy in women 20–49 years was estimated to be 16.2% and affecting 20.9 million live births, in 2015, and about 75% of cases were expected to occur in low- and middle-income countries. In 2015, the estimate of hyperglycemia in pregnancy in Africa was 10.5% affecting 3.3 million live births [4].

Diabtes mellitus that occurs during pregnancy can be either pre-existing diabetes or gestational diabetes. Pre-existing diabetes is also known as pre-gestational diabetes and refers to diabetes detected before pregnancy and diagnosed as type I DM, type II DM, or other rare types of DM. The World Health Organization(WHO) defines GDM as ‘any degree of glucose intolerance with onset or first recognition during pregnancy [5, 6].

The physiological changes of pregnancy put the human body in a state of carbohydrate intolerance. Pregnancy- specific hormones, such as human placental lactogen and the increased levels of cortisol and prolactin, increase the resistance to insulin and the demand for hormone increases to maintain homeostasis of blood glucose[7].

Common feature of all types of DM is hyperglycemia and poorly controlled hyperglycemia is important cause of maternal and fetal complications among pregnant mothers[8]. Regardless of the cause, hyperglycemia in pregnancy can result in adverse obstetric and neonatal outcomes[8].

1.2 Statement of the Problem

Currently, diabetes is considered as one of the top health problems of the globe, the World Health Organization (WHO) estimated that, globally, hyperglycemia is the third highest risk factor for premature mortality, next to high blood pressure and tobacco use[9].

The prevalence of diabetes in Africa was estimated to be 3.2% (14.2 million) in 2015 and nearly half of these cases live in four populous countries of Africa; namely, Nigeria, Ethiopia, Democratic Republic of Congo and South Africa [4]. International Diabetes Federation estimate of adult prevalence of diabetes in Ethiopia in 2015 was 2.9%[4].

Presence of maternal diabetes mellitus during pregnancy has important consequences for both mother and child. It can result in a significantly higher risk of maternal and child mortality and morbidity. In regions such as Africa, where as much as 80% of diabetes is undiagnosed, unrecognized diabetes aggravates the situation [10]. Infants born to mothers with pre-existing type I or type II diabetes mellitus are at greater risk of congenital anomalies, perinatal mortality and significant morbidity in the short and long term. Pregnant women with pre-existing diabetes are at greater risk of perinatal morbidity and diabetic complications. The chances of an early miscarriage or having a baby with malformations are enhanced for women with type 1 diabetes, and the incidence of maternal mortality among pregnant women with type 1 diabetes in some countries is 5–20 times higher than that of women without diabetes[10].

Diabetes mellitus complicates 3–5% of all pregnancies and is a major cause of maternal and perinatal morbidity and mortality. A diabetic pregnant woman and her fetus are at increased risk of pregnancy complications such as pre-eclampsia, infections, obstructed labour, postpartum hemorrhage, preterm births, stillbirths, macrosomia, miscarriage, intrauterine growth retardation, congenital anomalies, birth injuries and death in worst case scenarios[11, 12]. Elevated insulin level in the fetus that occurs in both pre-existing diabetes and GDM is associated with perinatal problems [13]. These include; having big baby which can make difficulty of spontaneous vaginal delivery, neonatal hypoglycemia, preterm birth, hyper-bilirubinaemia and hypocalcaemia[13].

Gestational diabetes mellitus contributes to the rising type 2 diabetes epidemic both in mothers and children [14]. It is a momentary phenomenon for the pregnant mother, but more than 50% of

the women develop type 2 diabetes in future life and the tendency of their children to develop obesity as young children and type 2 diabetes later on is found to be higher [14].

Appropriate diagnosis, care and management of diabetes mellitus in the pre-pregnancy, pregnancy and post-pregnancy periods are important to minimize the risk of complications, long-term effects or mortality of the mother and/or baby[15].

1.3 Rationale of the Study

Despite the high burden of DM in low- and middle-income countries, little is known about its contribution in pregnancy in these countries. Currently, availability of factors like changes in life style, dietary habits, urbanization, physical inactivity, the tendency towards delayed marriage and older maternal age in different parts of the globe are making favorable ground and the prevalence of diabetes may very well be on the rise and it will have serious health consequences for mothers and children in low resource settings with poor obstetric care[16]

From the cost perspective, many African countries employ a selective screening approach for GDM and the estimated percentage of pregnant women screened is unclear [17]. In order to suggest policy changes regarding screening and management of GDM, which will ultimately prevent the effects of GDM on the mother and her offspring and in turn reduce the financial and health burden to a country, it is essential that the extent of the condition is well understood.

In Ethiopia, although diabetes mellitus is recognized as one of the major non-communicable diseases, the burden among pregnant women and its effect on pregnancy and birth outcome are not well researched.

Determining the magnitude of the problem and identification of common risk factors and adverse outcomes for mothers and the newborns as well as understanding the current situation of detection and management of DM with possible gaps would be important to mitigate the problem on timely bases.

This study aimed to investigate the magnitude of pre-existing diabetes and GDM among pregnant mothers in study site. It also aimed at investigation of the effect of DM among mothers and their newborns. The study also explored detection and management of GDM with potential barriers to mitigate the problem.

The study will enable evidence based policy making and health care practice by informing the extent of the problem and it is also important for identifying areas of future studies.

2. Literature Review

2.1 Magnitude of gestational diabetes mellitus

The magnitude of GDM varies from country to country based on some ethnic groups, life style, educational status, history of diabetes among family members and many other factors [18] . Gestational diabetes mellitus is the common cause of hyperglycemia in pregnancy, accounting for about 90% of all diabetes during pregnancy [19]. It has been reported that GDM affects 1%–14% of all pregnancies, and that its incidence has been gradually increasing[20]. It is estimated that among some high risk groups the prevalence rate may be as high as 30% and the differences in magnitude may be due to the use of different diagnostic criteria, time when studies were done, maternal age and residence [21].

Studies in various countries report that the prevalence of GDM and its magnitude is different based on some factors. Studies conducted in India, Sri Lanka, Nigeria, China and Argentina revealed that the prevalence of GDM were 6.94%, 5.5%, 6.45%, 4.90% and 5.8% respectively [22-26]. A study conducted in Qatar revealed shows that, the prevalence of GDM among pregnant women attending antenatal clinic was 16.3% [27]. Another Cross sectional study conducted at the department of Gynecology at Khyber Teaching Hospital in Pakistan showed the prevalence of gestational diabetes among pregnant women attending antenatal clinic was 26.3% [28]. Furthermore another study conducted in Gaza showed relatively low prevalence of GDM which was 1.8%[29].

According to findings from some African countries, the magnitude of GDM is increasing. A cross-sectional study conducted in selected urban and rural communities in Tanzania revealed that the overall prevalence of GDM averaged 5.9%, with 8.4% in urban and 1.0% in rural areas[30]. A study conducted in Abakaliki metropolis, Ebonyi State Nigeria among pregnant women showed the prevalence rate of GDM was 4.8%[31]. Another study conducted on prevalence of gestational diabetes among antenatal attendees in a tertiary hospital in south Nigeria also showed, a prevalence of 3.3%[32].

In Ethiopia, there is no a recent study that assessed the prevalence of GDM, but some years back, a community based survey of gestational diabetes in 18 rural villages of the eastern zone of

Tigray Administrative Region, Northern Ethiopia reported that the prevalence of GDM was found to be 3.7% (95% CI 2.5–4.9) [33].

2.2 Risk Factors of Gestational Diabetes Mellitus

The susceptibility of women belonging to races or ethnic groups, such as Hispanic-America, Native-America, South-East Asia, Africa and Australia to GDM is higher than others and there is increase in prevalence of GDM among these races [34-36].

A study conducted in South Eastern Nigeria suggested that there is a significant relationship ($p<0.05$) between previous macrosomic baby, parity, previous history of caesarean section, family history of diabetes and occurrence of GDM [37]. In that study family history of diabetes was independently and significantly associated with the development of GDM [37]. From other evidence previous delivery of a baby with a weight of 4.0kg or more increases the risk of gestational diabetes[38].

A study conducted in Tanzania showed that Prevalence of GDM was higher for women who had a previous stillbirth (OR 2.8, 95% CI 1.55.4), family history of type 2 diabetes (OR 2.1, 95% CI 1.14.2), and Mid Upper Arm Circumference (MUAC) above 28 cm (OR 1.9, 95% CI 1.13.3), and lower for women with normal hemoglobin compared with anemia (OR 0.45, 95% CI 0.220.93)[20, 30].

According to the study conducted on risk factors of GDM in Karnataka, India, previous history of GDM, family history of DM, and caesarean delivery were found to be significantly associated factors [39]. Another study from the same country found that increasing age, body mass index, weight, and positive family history for DM were highly prone to GDM and those women were considered as high risk group[40].

A study conducted in Qatar reported that, the risk of GDM increases with women's age and number of pregnancy [41]. The prevalence of GDM is increasing with the number of pregnancies; the prevalence was highest among women gravida 4 or more (11.2%) and lowest among primigravida (2.7%) [41]. Pregnant women having a positive paternal history of diabetes type 2 had a significantly higher prevalence than those who did not have such a history[41].

Study conducted in Iran noted that, Women with GDM were more likely to be over the age of 30, have a positive family history of diabetes, a history of macrosomia, glycosuria in pregnancy and obesity[42].

A study from China indicated that maternal age was strongly and positively associated with the risk of GDM [43]. Compared to women younger than 30 years, the risk of GDM for women older than 30 years was more than doubled. Obese women (BMI>28 kg⁄m2), had an approximately 3-fold increased risk for GDM as compared with women who were not obese or overweight. In addition, a previous history of spontaneous abortion was associated with a significantly increased risk for GDM [43].

2.3 Screening and Diagnosis of Gestational Diabetes Mellitus

Despite the recognition of maternal and fetal adverse effects of GDM in different parts of the world, agreement on screening and diagnosis still remain controversial. Concerning screening practice some organizations like the UK National Institute for Health and Care Excellence (NICE) and the American College of Obstetricians and Gynecologists (ACOG) recommend selective screening based on risk factors[44, 45]. Others like the International Association of Diabetes and Pregnancy Study Group (IADPSG), the Australasian Diabetes In Pregnancy Society (ADIPSI), the American Diabetes Association (ADA), and the Diabetes in Pregnancy Study Group India (DIPSI) recommend universal screening of all women[46-48].

According to the finding from surveys, countries use a variety of screening approaches, including universal, routine screening of all pregnant women, selective screening based on risk factors or a mixed approach of both. For example in India, some states use universal screening while others use selective screening, almost all parts of Finland use universal screening, Cuba uses universal screening where resource allows, in Brazil and Slovenia national guidelines recommend universal screening, and in Belgium and Ireland, national guidelines recommend selective screening [49]. Most countries use criteria such as history or family history of GDM, family history of DM, previous poor obstetric history, and body mass index for selective screening of mothers [49].

The other controversy in diagnosis and screening process of GDM is whether screening should consist of only fasting glucose, random glucose, or glucose challenge test [50]. Diagnostic

criteria also vary, from using 100 g glucose or 75g glucose load, to whether to consider one reading or two readings[50].

For example, in 2013, the WHO reviewed their 1999 recommendation, and the new guideline is important to differentiate GDM and other existing DM by setting cut-off for blood glucose level. [51]. Different diagnostic criteria are presented briefly in Table 1 below.

Table 1: Different diagnostic criteria used to diagnose gestational diabetes mellitus.

No.	Organization	Screening test	Blood Glucose threshold	Diagnostic criteria
1	WHO 1985[52]	2 hr 75g OGTT	Fasting ≥7.8 mmol/L 2 hr ≥11.1 mmol/L	At least one
2	WHO 1999[53]	2 hr 75g OGTT	Fasting ≥7.0 mmol/L 2 hr ≥7.8 mmol/L	At least one
3	WHO 2013[51]	2 hr 75g OGTT	Fasting: 5.1-6.9 mmol/L 1 hr ≥10 mmol/L 2 hrs ≥8.5-11.0 mmol/L	At least one
4	International Association of Diabetes and Pregnancy Study Group (IADPSG)[47]	75g OGTT	Fasting 5.1-6.9 mmol/L 1 hr ≥ 10 mmol/L 2 hr ≥ 8.5-11.0 mmol/L	At least one
5	American Diabetes Association (ADA)[54] **Two steps** Step 1	50 g (1 hr ≥ 7.8 mmol/L)	Fasting 5.3 mmol/L 1 hr ≥ 10.0 mmol/L 2 hrs ≥ 8.6 mmol/L 3 hr ≥ 7.8 mmol/L	Two or more
	Step 2	100g OGTT	Fasting ≥5.8 mmol/L 1 hr ≥ 10.6 mmol/L 2 hr ≥ 9.2 mmol/L 3 hr ≥ 8.0 mmol/L	
		One step: 75g OGTT	Fasting ≥5.3 mmol/L 1 hr ≥ 10 mmol/L 2 hrs ≥8.6 mmol/L	At least one
6	Australian Diabetes Association In Pregnancy Society (ADIPSI)[55]	75g OGTT	Fasting ≥5.1 mmol/L 1 hr ≥ 10 mmol/L 2 hr ≥ 8.5-11.0 mmol/L	At least one
7	Diabetes In Pregnancy Study Group India (DIPSI)[56]	75g OGTT	2 hr ≥7.8 mmol/L	Only one
8	Diabetes Pregnancy Study Group (DPSG)[57]	75g OGTT	Fasting >5.2 mmol/L 2 hr ≥ 9.0 mmol/L	At least one
9	National Diabetes Data Group (NDDG)[58]	3 hr 100g OGTT	Fasting ≥5.8 mmol/L 1 hr ≥10.6 mmol/L 2 hrs ≥9.2 mmol/L 3 hrs ≥ 8.0 mmol/L	At least two

2.4 Management of Gestational Diabetes

The strategies and techniques for the management of GDM during pregnancy have greatly improved through the past two decades. It has been established that good metabolic control maintained throughout pregnancy can decrease maternal and fetal complications in diabetes. Among management approaches diet is the mainstay of treatment in GDM, in addition, physical activity is helpful when it is not possible to maintain normal glucose level by diet alone. So, patients diagnosed with GDM should monitor their blood glucose levels, exercise, and undergo nutrition counseling for the purpose of maintaining normal blood sugar level. Treatment starts with medical nutrition therapy, exercise, and glucose monitoring aiming to achieve normal glucose level [59].

Diet

Calorie requirement for GDM women is 30-35 kcal/kg for normal weight, 25-30 kcal/kg for overweight and 35-40 kcal/kg for underweight subjects. Severe calorie restriction to < 1500 cal/d is not advisable. For patients with a body mass index greater than 30 kg per m^2, the American Diabetes Association suggests lowering daily caloric intake by 30 to 33 percent (to approximately 25 kcal per kg of actual weight per day), which avoids ketonemia. Regular exercise has been shown to improve glycemic control in women with GDM, but it has not been shown to affect perinatal outcomes[60]. Diets composed of 50%-60% carbohydrates will often result in hyperglycemia and excessive weight gain. So, calorie intake from carbohydrate has to be limited to 33%-40%, with the remaining calories divided between protein (20%) and fat (40%)[61].

Insulin

When glycemic targets are not achieved with in two weeks of the diet, pharmacological treatment is recommended. Insulin therapy generally has been started when capillary blood glucose levels go beyond 105 mg per dL (5.8 mmol per L) in the fasting state and 120 mg per dL (6.7 mmol per L) two hours after meals [62].

2.5 Pre-existing Diabetes and its adverse outcomes

Pre-gestational diabetes is already established DM diagnosed before pregnancy and continued through pregnancy or pre-existing DM refers to pregnant women who have previously been diagnosed with type I or type II diabetes mellitus, or other rare types of diabetes mellitus[12].

Fetal effect

Evidences reported that, pre-existing diabetes is associated with increased risk of stillbirth, neonatal mortality and congenital anomalies[63]. It was reported that, the risk of developing major congenital anomalies like neural tube defects, caudal regression syndrome, ventricular septal defects, and transposition of great vessels is higher than minor congenital anomalies. Skeletal, cardiac, central nervous, gastrointestinal and genitourinary systems of the fetus can be affected by pre-existing DM[64].

Although there is strong link between hyperglycemia and malformations, the mechanism by which it occurs is not clearly defined [65]. It is supposed that hyperglycemia could cause damage to the developing yolk sac, an elevated production of free oxygen radicals, deficiency of myoinositol and arachidonic acid and a disturbance in signal transduction; increasing evidences suggest that embriopathies might be connected to a disruption in intracellular signaling by inositol-derived effectors and prostaglandin precursors such as arachidonic acid [65]. Also, a as a result of the presence of these fuels, some type of genotoxic effect might occur which could cause morphologic harms in the fetus[65].

High insulin level in the fetus during pre-existing DM can result in neonatal adverse effects in similar fashion with the phenomena that occurs during GDM. As well as increased risk of perinatal mortality, pre-existing diabetes has been linked to macrosomia, large-for-gestational age, shoulder dystocia, neonatal hypoglycemia, preterm birth, hyper-bilirubinaemia and hypocalcaemia [13].

Elevated insulin level in the fetal circulation can also delay pulmonary maturation which is linked with the low production of surfactant leading to the respiratory distress syndrome

secondary to hyaline membrane disease [66]. This condition is about six-fold more frequently found in newborns of women with diabetes than in non-diabetic women[66].

Hypoglycemia is a common neonatal complication that occurs in diabetic pregnancies [67]. Right after the section of the umbilical cord, the deprivation of maternal glucose supply, can lead to this condition that generally happens in the first hours of life. If this disorder is not prevented and managed early, it will have short term and long term health effects on the newborn [67].

Infants of mothers with pre-existing DM are at high risk of developing type II diabetes and obesity in the long term and this effect is attributed to the intrauterine environment and genetic predisposition[68].

Diabetes in pregnancy may also be associated with adverse neuro-developmental outcome, particularly attention span and motor functions with the outcome aggravated with poorer glycemic control[69].

A study conducted in Saudi Arabia on pre-existing DM and adverse pregnancy outcomes revealed that pre-existing DM is associated with increased risk for macrosomia, stillbirth, preterm delivery and low APGAR scores at 5 minutes[70].

A population-based cohort study conducted in the UK has shown that women with type 1 diabetes have a higher risk of late fetal loss, four- to five-fold increase in perinatal death, and a four- to six-fold in stillbirth compared to the general population[71]. Neonatal mortality is also higher among infants of diabetic mothers in approximately 15-fold compared to the general population[72].

Maternal Effect

Pre-existing DM has been associated with caesarean section, hypertension in pregnancy and preterm birth[13]. Study from Saudi Arabia showed that 50% of women with pre-existing diabetes had caesarean section delivery; while the corresponding figure for non-diabetic women was less than 20%[73]

Pre-existing DM among pregnant mothers is associated with increased risk of diabetic nephropathy, diabetic retinopathy [74]. For example, it is reported that, the magnitude of diabetic progression during pregnancy ranged between 16% and 84% , additionally, the risk of myocardial infarction significantly increased in women with type I diabetes [74].

Diabetic retinopathy, a very prevalent micro vascular complication of diabetes, remains the leading cause of acquired blindness in young and middle - aged adults in the world [75]. Hormonal, hemodynamic, metabolic and immunologic changes during pregnancy aggravate the progression of diabetic retinopathy among mothers with DM. The exact reason for etiology of retinopathy acceleration during pregnancy is still not clear; proposed mechanisms involve rapid improvement in glycemic control, altered hemodynamic properties, with the reduction of blood flow in the retina and immune-inflammatory processes[75].

Changes in glucose disposal and insulin kinetics seen in pregnancy have special importance for women with pre-gestational diabetes because hypoglycemia, many times of severe intensity, can occur generally in early pregnancy, a period when insulin requirements may decrease, possibly because of nausea and vomiting, compared to pre-pregnancy and to the second half of pregnancy; it is a dangerous condition that can leave important sequellae to the mother and the fetus[76]. A study conducted in the Netherlands revealed that despite a high frequency of planned pregnancies, maternal and perinatal complications were still increased in women with type 1 diabetes[77].

The conceptual framework in figure 1 below shows risk factors for preexisting diabetes mellitus, gestational diabetes mellitus and their consequences on maternal and birth outcomes. It also indicates details of maternal and fetal complications that can be potentially occurred among mothers with diabetes mellitus.

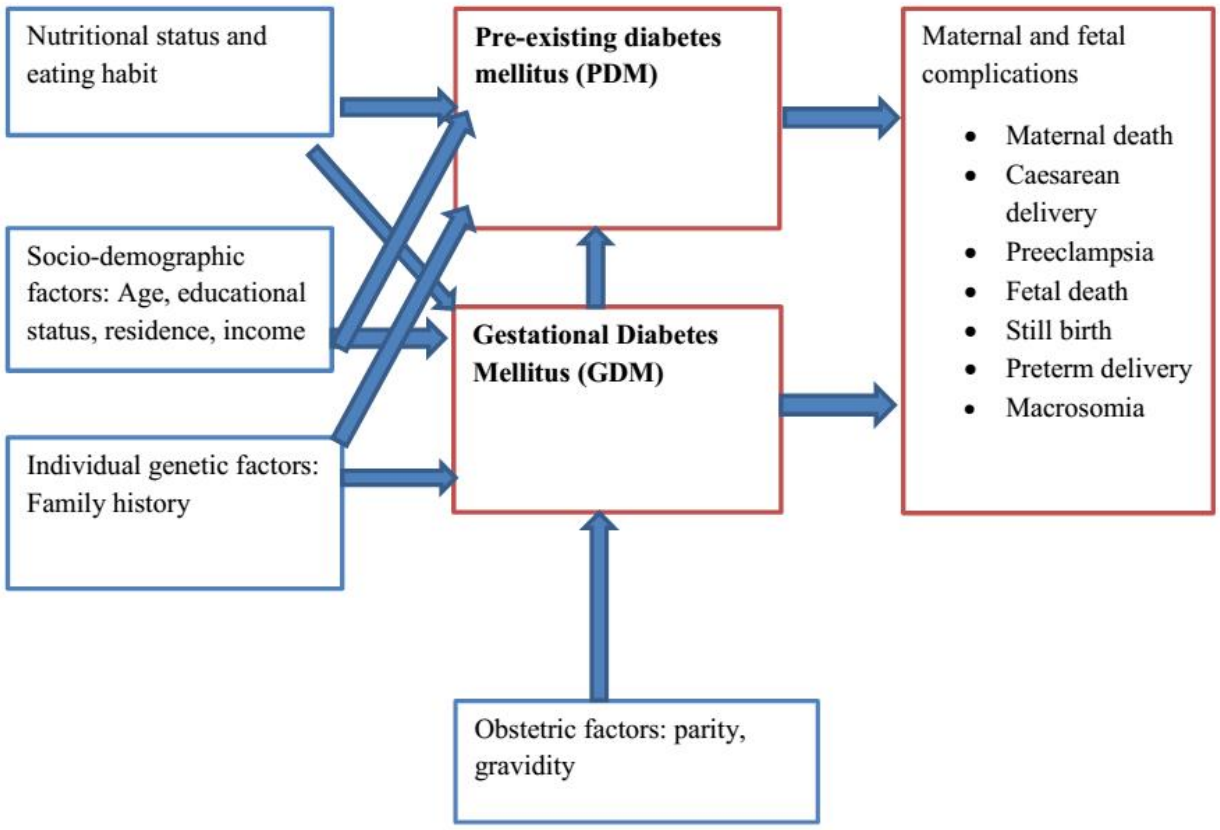

Figure 1: Conceptual frame work of Risk factors for Diabetes Mellitus and its effect on maternal and birth outcomes, 2018

3. Objectives

3.1 General Objective

To assess the magnitude of diabetes mellitus and its effect on maternal and birth outcome among pregnant mothers in Wolaita Zone, Southern Ethiopia

3.2 Specific Objectives

1. To assess the magnitude of pre-existing diabetes mellitus among pregnant women and identify associated risk factors
2. To determine the prevalence of gestational diabetes and identify associated risk factors among pregnant women
3. To identify the effect of diabetes mellitus on pregnancy and birth outcome
4. To explore the detection and management modalities of gestational diabetes mellitus

Research questions

1. What is the magnitude of pre-existing diabetes mellitus and what are the associated factor among pregnant women in Wolaita Zone, Southern Ethiopia?

2. What is the prevalence of gestational diabetes mellitus and what are the associated risk factor among pregnant women in Wolaita Zone?

3. What are effects of diabetes mellitus on pregnancy and birth outcome in Wolaita Zone, Southern Ethiopia?

4. How do health professionals detect and manage GDM in Wolaita Zone, Southern Ethiopia?

4. Methods and Materials

4.1 Study area and Period

The study was conducted in Wolaita Zone, Southern Nations, Nationalities and People Region. The Southern Nations, Nationalities, Peoples Region (SNNPR) is one of the nine regions in Ethiopia and it consists of different languages and ethnic groups with diverse cultures. The area of the Region covers 10% of the national landmass and its boundaries include Kenya in the south, South Sudan to the southwest, Gambela Regional state to the west and Oromia Regional State to the North and North-East. The Region is composed of 13 Zones and 104 Woredas, of which Wolaita Zone is situated in the South central part of the Region 330 km from Addis Ababa and 165 km south west of the Regional Capital, Hawassa. The Zone has a total population of about 2 million in 2017, based on the projection from the 2007 National Census. Wolaita Zone is one of the most densely populated areas in the country, with an average of 640 people living per square kilometer. Expected number of pregnant women in the Zone in 2016 was estimated to be is 66,646[78].

The study area in general had 12 administrative districts and three town administrations. Likewise this area had 3 Hospitals, 70 Health Centers and 380 health posts. Among those, 12 Health Centers and all three hospitals provided diagnostic and management care for pregnant women with diabetes mellitus[78]. The study took place from August 2017 to June 2018 at different phases.

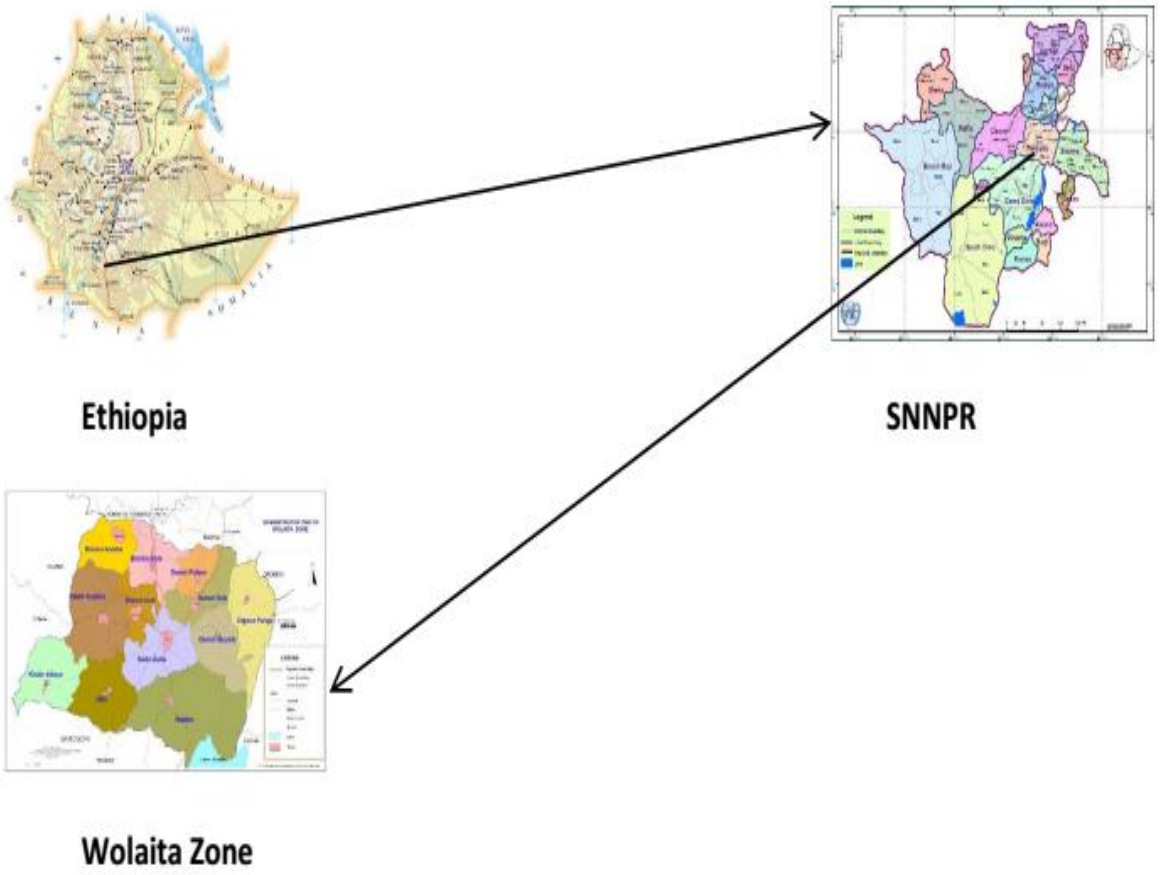

Figure 2: Map of Study area, Wolaita Administrative Zone (Source: Wolaita Zone Finance and Economic Development Department, 2014)

4.2 Study design

Mix of methods were used to address each specific objective. Cross sectional design with retrospective document review was done to determine the magnitude of preexisting diabetes mellitus among pregnant women and the study was done from the period of January to March 2018. For second objective, to determine the prevalence of gestational diabetes mellitus, cross sectional study design was employed from August 2017 to October 2017. The third objective was addressed by retrospective cohort study to compare maternal and birth outcomes of mothers with diabetes mellitus and non-diabetic women. A qualitative descriptive study approach was used to explore detection and management of gestational diabetes mellitus.

4.3 Source and study population

All pregnant mothers who attended antenatal care/ delivery service at the hospitals and health centers in Wolaita Zone during study period were source population. The study population to determine the magnitude of pre-existing diabetes was medical records of pregnant mothers who attended maternity services at the study hospitals and health centers in one year period from January 1, to December 31, 2017. The study population for second objective included pregnant mothers with gestational age of 24-28 weeks who were attending antenatal care service from August to October 2017 in selected study health facilities. Mothers who received maternity service and gave birth within 18 months period (from January 1, 2017 to June 30, 2018) in selected health facilities were study population for third objective. Health professionals working in antenatal clinic, delivery, and other maternal health services were included as study population for fourth objective.

Inclusion criteria

Complete document for the intended study was included for data extraction. For the second objective, pregnant mothers of gestational age of 24-28 weeks, previously non-diabetic and willing for GDM screening were included.

4.4 Sample size determination

For the first objective, sample size was calculated using single proportion formula by considering the following assumptions; confidence level of 95%, expected proportion 50% to get maximum sample size, margin of error 4%, Z - $\alpha/2$, Z value corresponding to a 95% level of significance = 1.96.

. $$n = \frac{(Z_{\alpha/2})^2 p(1-p)}{(e^2)}$$

The total sample sizes used for the study were 600.

The total sample was assigned to study facilities proportionally based on case load and systematic sampling method was used to identify the assigned number from maternal medical records.

Sample size for the second objective was calculated as follows;

The sample size was calculated using a single population proportion formula with the following assumptions: 3.7% of the magnitude of gestational diabetes (P) from study conducted in Northern Ethiopia[33], 2% marginal error, 95%CI, 1.5 design effect and 10% for non-response.

$$n = \frac{(Z_{\alpha/2})^2 p(1-p)}{(e^2)}$$

Where, n= sample size, P=3.7% and, d (e) = 0.02% (2% margin of error), Z - α/2= Z value corresponding to a 95% level of significance = 1.96.

The total sample size was 564.

For the third objective, number of exposed and unexposed mothers has been calculated using Epi Info version 7 software. Two sided confidence level of 95%, power 80%, exposed to unexposed ration of 1:2, expected proportion of outcome in unexposed group was 31.8% and in exposed group found to be 46.6%. This was calculated according to the study conducted in Saudi Arabia by estimating the proportion of miscarriage among exposed and unexposed women[79, 80]. The final sample sizes used for the study were 136 exposed and 272 unexposed mothers and it is shown in the table 2 below.

Table 2: Variables used for sample size determination for effect of diabetes mellitus on pregnancy and birth outcome, Wolaita Zone, Southern Ethiopia, 2017.

Variable	Proportion Among Exposed (p1)	Proportion among unexposed(p2)	Ratio of exposed to unexposed(r)	Total sample size(n1+n2)
Macrosomia	11.2	3.1	1:2	381(127:254)
Caesarean section	31.9	15.4	1:2	251(84:176)
Abortion complication	46.6	31.8	1:2	**408(136:272)**

For fourth objective, health care leadership, physicians, nurses, health officers and midwives engaged in providing maternity services in the study facilities were purposively selected. Total of 18 health care providers were included in qualitative component of the study.

4.5 Sampling technique

For the first objective, total sample was assigned to study facilities proportionally based on case load and systematic sampling method with sampling interval of (K=6) was used to identify the assigned number from maternal medical records from three hospitals and four health centers (details of sample size with respective sampling frame and sampling interval across selected health facilities is indicated in annex III). All three hospitals providing diagnostic and management care for mothers with diabetes mellitus and four randomly selected health centers were included in this component of the study. For the second objective, the screening was done for antenatal attendants in four health centers and two hospitals during the study period. For the third objective, all potential documents were collected and reviewed based on the checklist from selected health facilities within the study period. Data were extracted for all exposed groups identified during the study period. For each identified exposed group, the medical records of corresponding and immediate next two unexposed groups were reviewed with in the same period to address third objective. Eighteen study participants providing maternity service for more than six months in the studied health facilities were selected purposively for the fourth objective.

4.6 Data collection procedure and instruments

, Data were extracted using a checklist prepared in English to determine the magnitude of pre-existing diabetes. Antenatal care registry, labour ward registry, and other missing data were obtained from the maternal medical records. Data were collected by nurses and midwives who have ample experience on clinical practice and data collection. Intensive training was given to data collectors and supervisors on how to extract data from medical records. Constant supervision was done during data collection time. The Supervisors ensured data completeness and consistency daily.

A structured questionnaire was used to identify the prevalence of gestational diabetes mellitus, and details about socio-demography, family history, medical and obstetric history were collected. Blood pressure was measured; 75gm oral glucose was administered, capillary glucose level was measured at 0hr and 2hrs using HemoCue Glucose, and GDM was diagnosed based on the 2013 WHO criteria [51]. A blood sample was taken using finger prick. On the first visit, mothers were asked to fast overnight and return to the center for fasting blood glucose measurement. Mid-upper arm circumference (MUAC) was measured using a non-stretchable tape. Gestational age was calculated from the last menstrual period.

For the third objective, data abstraction was done from maternal registry and medical records of mothers who gave birth within 18 months period (January 1, 2017 to June 30, 2018) by using structured checklist. Data were extracted for exposed group and the medical records of corresponding two consecutive unexposed groups were reviewed with in the same period. Experienced and trained data collectors were involved in the data collection process.

For the qualitative study, in-depth interview was chosen as the data collection method to capture experiences related to detection and management of gestational diabetes. Semi structured interview guide was used to collect data. Data collectors with past experience were trained in (on study overview, objectives, participant selection, detailed tool review, interview approach, and role play of interview skills). The interview was audio-recorded using digital recorder.

Conducting in-depth interview was chosen as the data collection method to capture practices and experiences related to detection and management of gestational diabetes. This method elicits

candid responses in a private setting regarding professional topics of discussion. It is useful to have each participant has more time and opportunity to share feelings, perspectives, and experiences concerning the problem. The interviewer had plenty of time to probe and obtain in-depth responses since respondents tend to express themselves more freely.

Again this method is appropriate for this research since we were interviewing someone with specific knowledge and experience concerning the issue and it is better suited to sitting down one-on-one. It also allows considerable opportunity to probe answers and for intensive investigation of individual experiences and thoughts.

4.7 Variables of the study

Dependent variable for the first objective was pre-existing DM (Type I and Type II) and independent variables included; Socio-demographic characteristics, obstetric variables, medical history and family history.

For the second objective, gestational diabetes mellitus was dependent variable and socio-demographic characteristics, maternal medical and obstetric variables; past history of neonatal outcome and family history were included as independent variables.

For the third objective, the study measured maternal and birth outcomes among diabetic and non-diabetic mothers. Maternal outcome was measured by obstetric complications, including pre-eclampsia, caesarean delivery, obstructed labour, postpartum hemorrhage, antepartum hemorrhage, maternal sepsis and maternal death. Birth outcome measures, included in this study were abortion, still birth, preterm delivery, macrosomia (birth weight≥4 kg), and early neonatal death. Exposed groups were women diagnosed with GDM during index pregnancy or who had pre-existing diabetes and unexposed groups were women with neither GDM nor pre-existing DM.

4.8 Data management and analysis

For the first objective, data were entered and cleaned by Epi Info version 7 and analysis was done using STATA version 14 software programs. Tables and figures were used to present descriptive data. Chi-square and logistic regression analysis model were used to check the

relationship between preexisting diabetes and some variables. Model fitness was evaluated by Hosmer-Lemeshow goodness-of-fit tests.

For the second objective, Epi Info 7 and STATA 14 programs were used for data entry and analysis respectively. Descriptive figures, frequency and percentages were calculated. Tables and figures were used to show descriptive findings. Multivariable logistic regression model was used to compute adjusted odds ratio and to evaluate the relationship between variables. *P*-values less than .05 were considered for statistical significance.

For the third objective, data entry and cleaning were done by Epi Info version 7 and data were analyzed using STATA version 14. Descriptive statistics was computed and presented. Means were compared for continuous variables. The number and percentage of outcome variables were calculated based on the exposure status. The demographic characteristics and the pregnancy outcomes of the women with DM were compared to the outcomes of all non-diabetic women who gave birth during the same period. Logistic regression analysis model was used to check the effect of diabetes mellitus on pregnancy and birth outcome. Risk Ratio was calculated and P-value of less than 0.05 was considered for statistical significance. Variance inflation factor (VIF) was used to check multicollinearity among variables and no multicollinearity was identified. Model fitness was evaluated by Hosmer-Lemeshow goodness-of-fit tests.

For the qualitative study, prior to analyzing data, in-depth interviews were transcribed and translated into English. A qualitative thematic analysis approach was used to analyze the data. The transcripts were transferred into NVIVO version 12 software packages. Data coding was done in each category using the software. Once coding was complete, code reports were produced for each code, cleaned and prepared for synthesis. During synthesis and write up meaning units were identified in relation to the aim of the study. Emerging meaning units that were extracted from each topic of the analysis coded and then combined together to form categories depending on their differences and similarities.

4.9 Data Quality Assurance

Data collectors with previous experience on data collection were recruited for all data collection components. Training was given to data collectors and supervisors on study overview and details about tools and measurements. Tool of second objective was pre-tested in 5% of calculated sample size in institutions not selected for actual study before data collection. Supervisors checked data for completeness and guided data collectors in case of difficulties. Finally the principal investigator monitored overall quality of data. For the data extraction component, data were collected by nurses and midwives who have ample experience on clinical practice and data collection. Intensive training was given to data collectors and supervisors on how to extract data from medical records. Continuous supervision was done during data collection time. The Supervisors ensured data completeness and consistency on daily basis.

4.10 Ethical considerations

Ethical Approval: Ethical clearance was obtained from research ethics committee of the School of Public Health, and Institutional Review Board of the College of Health Sciences, Addis Ababa University (Protocol number: 037/17/SPH, Data: June 2017). Letter was sent to all concerned bodies and permission was obtained from the Wolaita Zone Health Department and respective health facilities.

Informed consent: All mothers and health care providers were informed about the purpose, benefits, and risks of the study, being the anonymity and the right to refuse at any stage of the interview and procedure. During their normal ANC visit, the procedure and the possible effects of oral glucose tolerance test (OGTT) was explained to the women, emphasizing that participation is voluntary. We got written consent from all mothers before starting any component of data collection. Confidentiality was clarified and guaranteed. Women diagnosed with GDM and other medical problems were referred for appropriate care and management.

Benefits: There may be no direct benefit to the facility or participants in participating in this study. However, the information we gained is expected to help service providers and policy makers working in maternal and newborn health to have information for service and program improvement which in turn is important to ensure better health of mothers and newborns. In

addition, women diagnosed with GDM were referred to the physician for treatment and counseling.

Possible Risks: There was no risk related to involvement in this study except for a few minutes devoted to respond the questions and minor pain during finger prick to collect blood sample.

Confidentiality: During data extraction, the names of mothers were not included so that information obtained was kept confidential. The information was used only for the study purpose. Confidentiality of the responses was assured.

Privacy: All possible measures were taken to assure the privacy of mothers and health care providers during data collection and blood sample collection.

4.11 Summary Table of study objectives and methods

S. No	Objectives	Study design	Study population	Sample size	Data collection tools	Data analysis
1	To assess the magnitude of pre-existing diabetes mellitus among pregnant women and associated risk factors	Institution based cross sectional	Medical records of pregnant mothers who attended antenatal or delivery services in one year period from January 1, to December 31, 2017	600	Data extraction check list	Descriptive analysis and bivariate analysis for some variables
2	To determine the prevalence of gestational diabetes and associated risk factors among pregnant women	Institution based cross sectional	Pregnant mothers with gestational age of 24-28 weeks who were attending antenatal care service from August to October 2017	564	Structured questionnaire	Descriptive analysis and binary logistic regression
3	To identify the effect of diabetes mellitus on pregnancy and birth outcome	Retrospective cohort	Medical records of mothers who received maternity service and gave birth within 18 months period (from January 1, 2017 to June 30, 2018)	136 mothers with DM, and 272 without DM	Data extraction check list	Descriptive analysis and logistic regression analysis
4	To explore the detection and management modalities of gestational diabetes	Qualitative study	Health professionals working in antenatal clinic, delivery, and other maternal health services	18 in-depth interviews	Semi-structured interview guide	Thematic analysis

5. Results

5.1 Magnitude of pre-existing diabetes mellitus

5.1.1 Socio-demographic and obstetric characteristics

Of the total 600 mothers included in the analysis, more than two-third (68.8%) were in the age range of 21-30 years with mean age of 26.8 and SD 5.1. Nearly all, 98.9% were married and most of the women (75.7%) were urban residents. One, two and three pregnancies were documented for 36.8%, 33.0% and 15.5% of the mothers respectively. More than half, (55.8%) of the mothers had at least one live birth before index pregnancy. The distribution of women in relation to age, residence, marital status, gravidity and parity is presented in Table 3.

Table 3: Selected Socio-demographic characteristics of respondents, Wolaita Zone, Southern Ethiopia, 2017

Characteristics (n=600)		Number	Percent
Age	16-20	72	12
	21-25	205	34.2
	26-30	208	34.7
	31-35	75	12.5
	>35	40	6.7
Residence	Urban	454	75.7
	Rural	146	24.3
Marital status	Married	593	98.9
	Single /Divorced /Widowed	7	1.2
Gravidity	One	221	36.8
	Two	198	33.0
	Three	93	15.5
	Four	48	8.0
	Five or more	40	6.7
Parity	Nullipara	265	44.2
	Para I	161	26.8
	Multipara (2-4)	145	24.2
	Grand multipara (5 or more)	29	4.8

5.1.2 Maternal and fetal complications

Basic maternal and fetal complications were assessed in this study (Table 4). The magnitude of preeclampsia among mothers was 5.7%. According to medical records, 2.7% and 5% of mothers had still birth and preterm delivery respectively. Macrosomia was documented in 7.2% of mothers and caesarean section rate was 10.5%. Abortion complication was recorded in 10% of mothers and 3 cases of early neonatal death was occurred (Table 4).

Table 4: Selected Obstetric characteristics of respondents, Wolaita Zone, Southern Ethiopia, 2017

Characteristics (n=600)		Number	Percent
Preeclampsia	Yes	34	5.7
	No	566	94.3
Still birth	Yes	16	2.7
	No	584	98.3
Macrosomia	Yes	43	7.2
	No	557	92.8
Preterm delivery	Yes	30	5
	No	570	95
Antepartum hemorrhage	Yes	8	1.3
	No	592	98.7
Postpartum hemorrhage	Yes	10	1.7
	No	590	98.3
History of Abortion	Yes	60	10
	No	540	90
Caesarean delivery	Yes	63	10.5
	No	537	89.5
Early neonatal death	Yes	3	0.5
	No	597	99.5
Family history of diabetes	Yes	63	10.5
	No	537	89.5

5.1.3 Magnitude of preexisting diabetes mellitus

Magnitude of preexisting diabetes among mothers who received maternity care within one year period from January 1, 2017 to December 31, 2017 in study area was 2.8% 95% CI (1.5, 4.2). The magnitudes among urban and rural residents were 3.3% and 1.4% respectively.

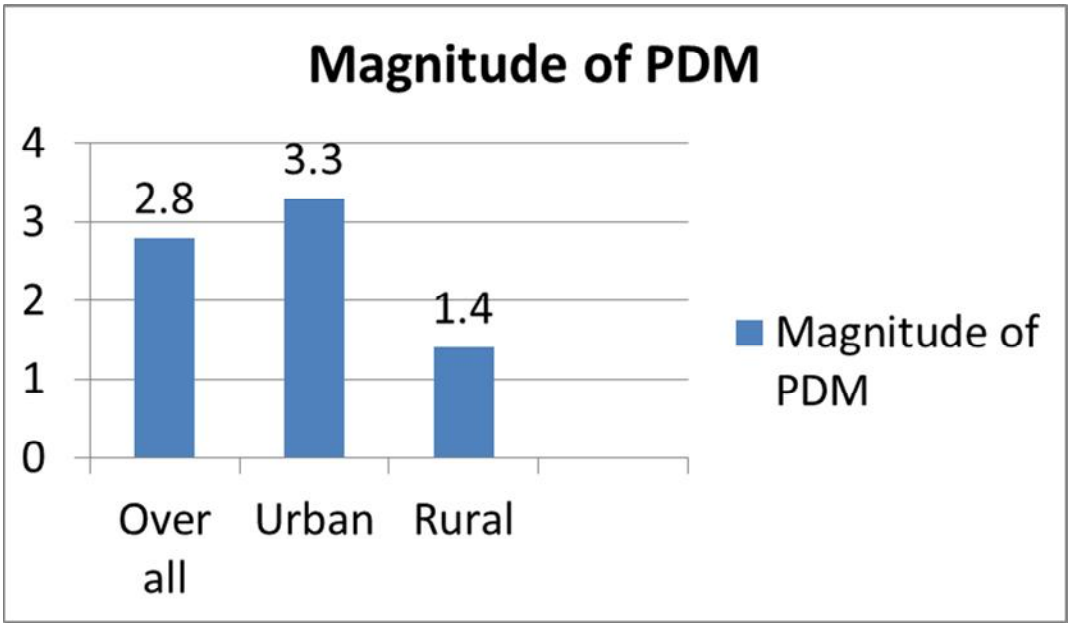

Figure 3 : Magnitude of preexisting diabetes mellitus in Wolaita Zone, Southern Ethiopia, 2017

Of 17 cases of preexisting diabetes, 12 cases were type II diabetes mellitus and the rest 5 cased were type I diabetes mellitus. No case of preexisting diabetes mellitus was documented for mothers less than 20 years of age and highest proportion (8%) was identified for mothers aged more than 35 years. Highest proportion of preexisting diabetes was documented for mothers with four pregnancies and none for women with first pregnancy (Table 5).

Table 5: Magnitude of preexisting diabetes mellitus versus selected socio-demographic and obstetric variables, Wolaita Zone, Southern Ethiopia, 2017.

Variable	Category	Pre-existing DM		Total N(%)
		Yes N (%)	No N(%)	
Age	16-20	0(0.0)	72(100.0)	72(100.0)
	21-25	4(2.0)	201(98.0)	205(100.0)
	26-30	8(3.8)	200(96.2)	208(100.0)
	31-35	2(2.7)	73(97.3)	75(100.0)
	More than 35	3(7.5)	37(92.5)	40(100.0)
Residence	Urban	15(3.3)	439(96.7)	454(100.0)
	Rural	2(1.4)	144(98.6)	146(100.0)
Marital status	Married	16(2.7)	577(97.3)	593(100.0)
	single/divorced/widowed	1(14.3)	6(85.7)	7(100.0)
Gravidity	One	0(0.0)	221(100.0)	221(100.0)
	Two	3(1.5)	195(98.5)	198(100.0)
	Three	7(7.5)	86(92.7)	93(100.0)
	Four	5(10.4)	43(89.6)	48(100.0)
	Five or more	2(5.0)	38(95.0)	40(100.0)
Parity	Nullipara	4(1.5)	261(98.5)	265(100.0)
	Para one	3(1.9)	158(98.1)	161(100.0)
	Multi para (2-4)	9(6.2)	136(93.8)	145(100.0)
	Grand multipara (5 or more)	1(3.4)	28(96.6)	29(100.0)

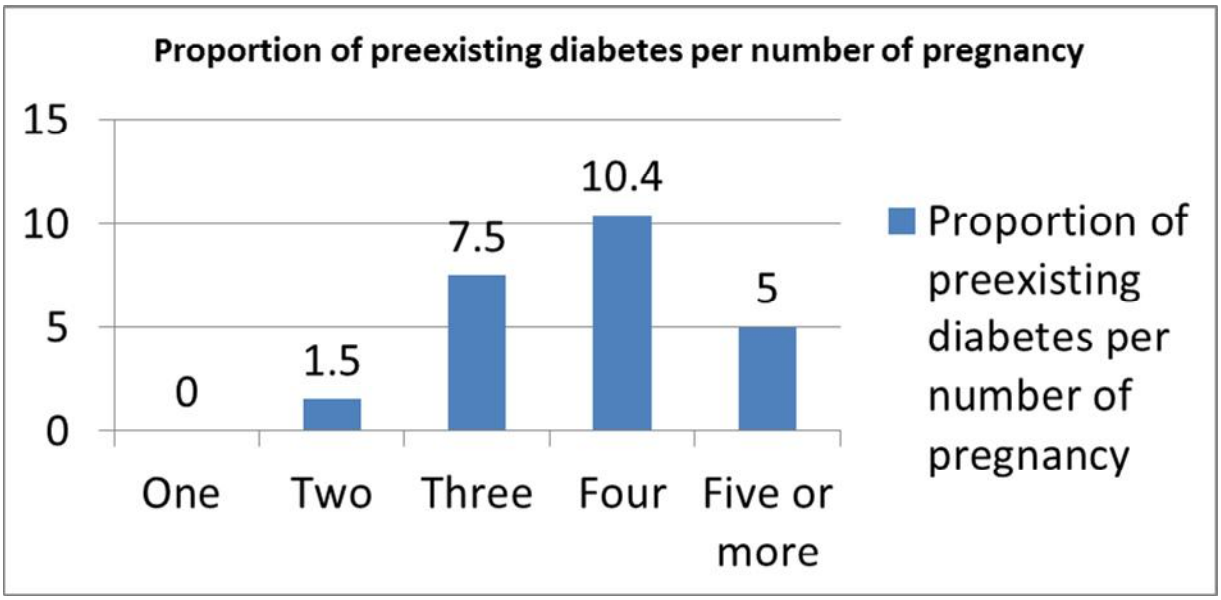

Figure 4: Number of preexisting diabetes mellitus according to number of pregnancies, Wolaita Zone, Southern Ethiopia, 2017.

The mean age (standard deviation) of mothers with preexisting diabetes mellitus and was 31.8(±5.1) and for those without diabetes was 26.7(±5.0). Diabetic mothers were significantly older (P- value, 0.001) than non-diabetic mothers.

The result showed that higher proportion of mothers with diabetes mellitus had preeclampsia than non-diabetic mothers (23.5% versus 4.8%). Based on the study, 29.4% of mothers with diabetes had caesarean section delivery and the corresponding figure for non-diabetic mothers was 9.9%.

5.1.4 Factors associated with preexisting diabetes mellitus

Preexisting diabetes mellitus is significantly associated with family history of diabetes (chi square 24.8, P-value, 0.001).

Binary logistic regression model was used to assess the relationship between some variables and preexisting diabetes mellitus. In multivariate logistic regression model, previous history of spontaneous abortion (AOR: 5.3; 95%CI: 1.6-17.4) and fetal macrosomia (AOR: 3.9; 95%CI: 1.2-13.1), were identified to be significantly associated with preexisting diabetes.

5.2 Prevalence of gestational diabetes mellitus

5.2.1 Socio demographic Characteristics

Total sample size required for the study was 564, among those 518 pregnant women participated in the study and making the response rate of 91.8%. Of 518 women included in the study, 376(72.6%) were urban residents. Majority, 388(74.9%), were 21-30 years old. The mean age was 25.7 (4.4), nearly all, 506(97.7) were married. Most of the mothers, 422(81.5%), were from Wolaita ethnic group and 89(17.2%) had not attended any formal education. Nearly half, 242 (46.7%) were housewives and working as government employee is the leading occupation of their partners, 205(40.5%) (Table 6).

Table 6: Selected Socio-demographic characteristics of respondents, Wolaita Zone, Southern Ethiopia, 2017

Characteristics		**Number**	**Percent**
Age(n=518)	16-20	77	14.9
	21-25	206	39.8
	26-30	182	35.1
	31-35	41	7.9
	>35	12	2.3
Residence (n=518)	Urban	376	72.6
	Rural	142	27.4
Marital status(n=518)	Married	506	97.7
	Single /Divorced /Widowed	12	2.3
Religion (n=518)	Protestant	342	66
	Orthodox	137	26.4
	Muslim	17	3.3
	Catholic	11	2.1
	Others+	11	2.1
Ethnicity (n=518)	Wolaita	422	81.5
	Amhara	47	9.1
	Gamo	27	5.2
	Guraghe	12	2.3
	Others ++	10	1.9
Education of mother (n=518)	No formal education	89	17.2
	Primary	124	23.9
	Secondary	150	29.0
	Post- secondary	155	29.9

Occupation of mother (n=518)	House wife	242	46.7
	Government Employee	174	33.6
	Petty Trade	60	11.6
	NGO Employee	26	5.0
	Daily laborer	16	3.1
Spouse's Education (n=506)	No formal education	70	13.8
	Primary	101	20.0
	Secondary	127	25.1
	Post -secondary	208	41.4
Spouse's Occupation (n=506)	Government Employee	205	40.5
	Petty Trade	137	27.1
	NGO Employee	55	10.9
	Daily laborer	82	16.2
	Others+++	27	5.3

+ Apostolic, Traditional ++ Oromo, Tigrie, Silte +++ Farmer, Broker

5.2.2 Obstetric Characteristic of respondents

Basic obstetric characteristics were assessed in this study. Screening of GDM was carried out at 24 to 28 gestational weeks. Of the 518 study participants, majority, 372(71.8%) had two or more pregnancies at the time of data collection, with mean gestational age of 26 weeks. More than one third of the respondents, 187(36.1%), were multi-para. Out of 372 mothers who had two or more pregnancies, 45(12.1%) had previous history of still birth, 67(18%) had previous history of abortion, and caesarean section rate was 16.1% (Table 7).

Table 7: Selected obstetric and medical history of respondents, Wolaita Zone, Southern Ethiopia, 2017

Characteristics		Number	Percent
Gravidity	One	146	28.2
	Two	164	31.7
	Three	107	20.7
	Four	57	11.0
	Five or more	44	8.5
Parity	Nullipara	154	29.7
	Para one	177	34.2
	Multipara (2-4)	154	29.7
	Grandmultipara (≥5)	33	6.4
Gestational Age in weeks	24	124	23.9
	25	86	16.6
	26	88	17.0
	27	93	18.0
	28	127	24.5
Birth Weight of previous child (n=308)	Less than 2.5kg	12	3.8
	2.5-3.9kg	236	76.6
	4kg or more	60	19.5
Previous still birth (n=372)	Yes	45	12.1
	No	327	87.9
Previous abortion (n=372)	Yes	67	18.0
	No	305	82.0
Previous caesarean section (n=372)	Yes	60	16.1
	No	312	83.9
Previous history of GDM (n=372)	Yes	19	5.1
	No	353	94.9
Family history of type II DM (n=416)	Yes	57	13.7
	No	359	86.3

5.2.3 Prevalence of GDM

Overall prevalence of gestational diabetes mellitus was 4.2%, 95% CI (2.5, 6.2) with mean post glucose load level of 160.1 mg/dl (6.3) and 15(4%) among urban residents and 7(4.9%) among rural residents. The proportion of gestational diabetes mellitus increases with increase in number of pregnancies (Figure 5).

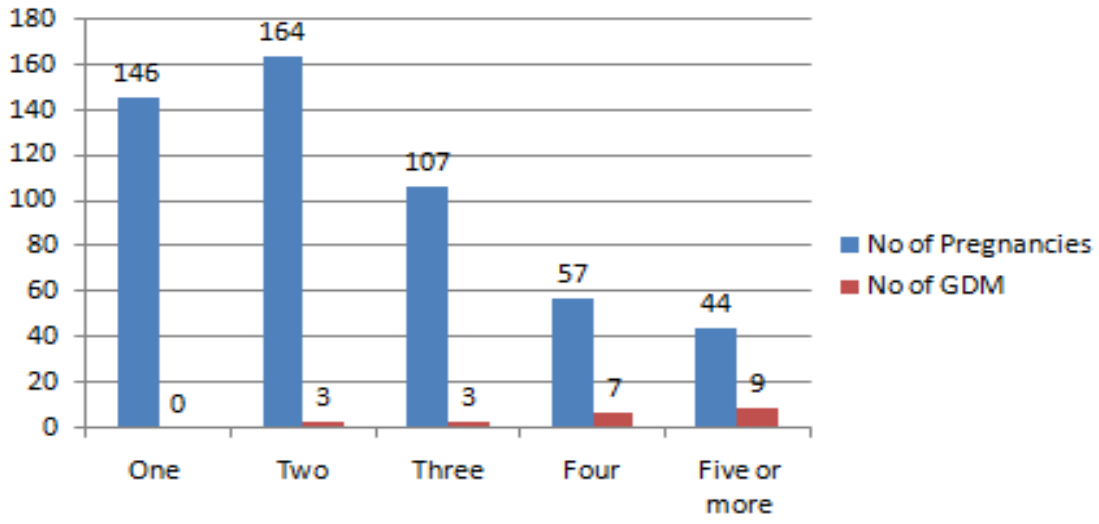

Figure 5: Number of Pregnancies and corresponding number of gestational diabetes mellitus of respondents in Wolaita Zone, Southern Ethiopia, 2017.

Gestational diabetes mellitus was more common in multiparaous pregnant women, GDM was diagnosed in 4(2.3%) of primiparaous, 7(4.5%) of multiparaous and 11(33.3%) of grand multiparaous mothers and in other words 18%, 32% and 50% of total diagnosed cases were primiparaous, multiparaous and grand multiparaous mothers respectively.

5.2.4 Risk factors associated with gestational diabetes mellitus

Factors associated with GDM were identified by using binary logistic regression model. In bivariate logistic regression model, previous history of still birth (COR: 4.8; 95%CI: 1.9-12.3), previous history of spontaneous abortion (COR: 4.2; 95%CI: 1.8-10.4), family history of type II diabetes (AOR: 6.2; 95%CI: 1.4-9.8) and previous caesarean section (COR: 7.5; 95%CI: 3.1-18.4) were identified to be statistically significant.

Multivariable analysis was used to control potential confounders. Accordingly, previous history of spontaneous abortion (AOR: 3.5; 95%CI: 1.7-14.6), family history of type II diabetes (AOR: 4.3; 95%CI: 1.3-8.7) and previous caesarean section (AOR: 7.5; 95%CI: 1.3-14.4) were found to be independently associated (Table 8).

Table 8: Bivariate and Multivariate logistic analysis of factors associated with gestational diabetes mellitus among participants, Wolaita zone, Southern Ethiopia, 2017

Variable	Category	Gestational Diabetes Mellitus		COR(95%CI)	AOR(95%CI)
		Yes N (%)	No N(%)		
Residence	Urban	15(4)	361(96)	0.8(0.3, 2.0)	3.6(0.4, 13.6)
	Rural	7(4.9)	135(95.1)	1	1
Previous still birth	Yes	8(17.8)	37(82.2)	4.8(1.9, 12.3)	2.8(0.2, 3.5)
	No	14(4.3)	313(95.7)	1	1
Previous spontaneous abortion	Yes	10(14.9)	57(85.1)	**4.2(1.8, 10.4)***	**3.5(1.7, 14.6)***
	No	12(3.9)	293(95.1)	1	1
Birth weight of previous child	Less than 3999	14(5.8)	228(94.2)	1	1
	4000gm or more	8(13.3)	52(86.7)	0.4(0.2, 1.2)	0.7(0.5, 1.8)
Previous caesarean section	Yes	12(20.0)	48(80.0)	**7.5(3.1, 18.4)***	**7.5(1.3, 14.4)***
	No	10(3.2)	302(96.8)	1	1
Family history of type II DM	Yes	11(16.2)	57(83.8)	**6.2 (1.4, 9.8)***	**4.3(1.3, 8.7)***
	No	11(3.0)	359(97.0)	1	1
MUAC	Less than 28cm	13(3.6)	346(96.4)	1	1
	More than 28cm	9(5.7)	150(94.3)	0.6(0.3, 1.5)	0.9(0.1, 1.8)

5.3 Effect of diabetes mellitus on pregnancy and birth outcome

5.3.1 Socio-demographic and Obstetric characteristics

The study included total of 408 mothers delivered in the study facilities from January 1, 2017 to June 30, 2018. Of these, 136 mothers had diabetes mellitus and 272 were non-diabetic women.

Among mothers with diabetes mellitus, 23 (16.9%) had Type I DM, 36 (26.5%) had Type II DM, 72(52.9%) had GDM, and 5(3.8%) had been diagnosed with other rare type of diabetes.

Mean age (standard deviation) of mothers with DM was 28.9 (±5.0), and mean age (standard deviation) of mothers without DM was 26.1 (±4.8). Average number of pregnancies for mothers with DM was 2.6 (±1.2) whereas for mothers without DM was 1.9(±1.1). The diabetic mothers were significantly older (p value=0.001); and they had significantly more pregnancies (p value=0.004) compared to the non-diabetic women. Almost all of mothers with DM and without DM (97.1% with DM and 99.3% without DM) were married and majority, were urban residents (Table 9).

Table 9: Comparison of maternal demographic characteristics between non-diabetic women, and women with diabetes mellitus from January 1, 2017 to June 30, 2018 in Wolaita Zone, Southern Ethiopia

Characteristics		Mothers with DM (n=136) N (%)	Non-diabetic mothers (n=272) N(%)
Age	16-20	7(5.1)	40(14.7)
	21-25	29(21.3)	103(37.9)
	26-30	58(42.6)	87(32.0)
	31-35	27(19.9)	29(10.7)
	>35	15(11.0)	13(4.8)
Marital status	Married	132(97.1)	270(99.3)
	Single	4(2.9)	2(0.7)
Address	Urban	112(82.4)	201(73.9)
	Rural	24(17.6)	71(26.1)
Gravidity	One	28(20.6)	115(42.3)
	Two	39(28.7)	93(34.2)
	Three	39(28.7)	35(12.9)
	Four	15(11.0)	16(5.9)
	Five or more	15(11.0)	13(4.5)
Parity	Nullipara	35(25.7)	135(49.6)
	Para one	37(27.2)	73(26.8)
	Multipara (2-4)	55(40.4)	53(19.5)
	Grand multipara (≥5)	9(6.6)	11((4.0)

5.3.2 Maternal and Fetal complications

One case of maternal sepsis occurred in mother with diabetes mellitus and one maternal death happened in both exposed and unexposed group which resulted in total pregnancy related maternal loss of two. Total of three early neonatal deaths reported for mothers with diabetes mellitus.

The proportion of pre-eclampsia and antepartum hemorrhage were higher among mothers with diabetes mellitus than non-diabetic mothers (9.6% versus 3.3%) and (4.4% versus 0.7%) respectively.

The study also documented that, higher proportion of women with diabetes mellitus had obstructed labor (5.9% versus 3.3%). Still birth rate for diabetic mother was higher, 4.4% than non-diabetic mothers, 1.8%. Table 9 below shows the proportion of maternal and birth complications among exposed and unexposed group.

Table 10: Maternal and birth complications of women with diabetes mellitus and non-diabetic women from January 1, 2017 to June 30, 2018 in Wolaita Zone, Southern Ethiopia

Characteristics		Mothers with DM (n=136) N (%)	Non-diabetic mothers (n=272) N(%)
Pre-eclampsia	Yes	13(9.6)	9(3.3)
	No	123(90.4)	263(96.7)
Still birth	Yes	6(4.4)	5(1.8)
	No	130(95.6)	267(98.2)
Macrosomia	Yes	16(11.8)	11(4.0)
	No	120(88.2)	261(96.0)
Pre-term delivery	Yes	15(11.0)	10(3.7)
	No	121(89.0)	262(96.3)
Abortion	Yes	1(0.8)	0(0)
	No	135(99.2)	272(100)
Antepartum Hemorrhage	Yes	6(4.4)	2(0.7)
	No	130(95.6)	270(99.3)
Post-partum hemorrhage	Yes	1(0.7)	1(0.4)
	No	135(99.3)	271(99.6)
Obstructed labour	Yes	8(5.9)	9(3.3)
	No	128(94.1)	263(96.7)
Caesarean delivery	Yes	28(20.6)	19(7.0)
	No	108(79.4)	253(93.0)
Early neonatal death	Yes	3(2.2)	0(0.0)
	No	133(97.8)	272(100.0)

5.3.3 Effect of diabetes mellitus on maternal and birth outcome

Pregnancy of diabetic mothers was significantly complicated by pre-eclampsia when compared with non-diabetic mothers, (RR= 2.8: 95% CI; 1.2-7.4). The neonates of diabetic mothers were significantly macrosomic, the risk is almost three fold, (RR= 2.9: 95%CI; 1.4-7.1). Although there was increased risk of having still birth and obstructed labour for exposed group of mothers, the differences were not statistically significant (Table 11). Multivariate model indicated that the risk of pre-term delivery is 2.5 times higher among mothers with diabetes mellitus when compared to non-diabetic mothers, (aRR= 2.5: 95% CI; 1.1-6.2) (Table 12). Mothers with diabetes mellitus were 2.9 times more likely to be delivered by caesarean section than non-diabetic mothers (aRR= 2.9: 95%CI; 1.3-6.2) (Table 13).

Table 11: Bivariate logistic regression analysis showing risk ration of maternal and birth outcome of mothers with diabetes mellitus and non-diabetic mother from January 1, 2017 to June 30, 2018, Wolaita Zone, Southern Ethiopia

Characteristics		Exposed (n=136) N (%)	Unexposed (n=272) N(%)	RR, 95% CI	p-value
Pre-eclampsia	Yes	13(9.6)	9(3.3)	**2.8(1.2, 7.4)***	0.0084
	No	123(90.4)	263(96.7)	1	
Still birth	Yes	6(4.4)	5(1.8)	1.7 (0.9, 2.9)	0.1303
	No	130(95.6)	267(98.2)	1	
Macrosomia	Yes	16(11.8)	11(4.0)	**2.9(1.4, 7.1)***	0.0031
	No	120(88.2)	261(96.0)	1	
Pre-term delivery	Yes	15(11.0)	10(3.7)	**3.1(1.3, 7.4)***	0.0035
	No	121(89.0)	262(96.3)	1	
Obstructed labour	Yes	8(5.9)	9(3.3)	1.4(0.8, 2.4)	0.2201
	No	128(94.1)	263(96.7)	1	
Caesarean delivery	Yes	28(20.6)	19(7.0)	**2.9 (1.5, 6.4)***	0.0001
	No	108(79.4)	253(93.0)	1	

Table 12: Multivariate logistic regression analysis showing risk ratio of pre-term delivery among mothers with diabetes mellitus and non-diabetic mother from January 1, 2017 to June 30, 2018, Wolaita Zone, Southern Ethiopia

Characteristics		Preterm delivery		ARR, 95% CI	p-value
		Yes	No		
Diabetes mellitus	Yes	15(11.0)	121(89.0)	**2.5 (1.1, 6.2)***	0.03
	No	10(3.8)	262(96.2)	1	
Pre-eclampsia	Yes	5(22.7)	17(77.3)	**4.2 (1.4, 12.9)***	0.01
	No	20(5.2)	366(94.8)	1	
Age category	<35	18(5.5)	306(94.5)	0.9(0.6, 1.5)	0.8
	≥35	7(8.3)	77(91.7)	1	
Parity	Nullipara	9(5.3)	161(94.3)	1.4(0.6, 3.3)	0.5
	Para one	6(5.5)	104(94.5)	1.7(0.3, 3.7)	
	Multipara	10(7.8)	118(92.2)	1	
Gravidity	Primigravida	7(5.0)	136(95.0)	0.7(0.4, 1.4)	0.4
	Multigravida	18(4.9)	347(95.1)	1	
Previous abortion	Yes	7(15.2)	39(84.8)	3.1 (0.8, 10.8)	0.1
	No	11(5.0)	208(95.0)		

Table 13: Multivariate logistic regression analysis showing risk ratio of caesarean delivery among mothers with diabetes mellitus and non-diabetic mother from January 1, 2017 to June 30, 2018, Wolaita Zone, Southern Ethiopia

Characteristics		Caesarean Delivery		ARR, 95% CI	p-value
		Yes	No		
Diabetes mellitus	Yes	28(20.6)	108(79.4)	**2.9(1.3, 6.2)***	0.006
	No	19(7.0)	253(93.0)	1	
Pre-eclampsia	Yes	5(22.7)	17(77.3)	1.3 (0.3, 5.1)	0.7
	No	42(10.9)	344(89.1)	1	
Age category	<35	36(11.1)	288(88.9)	0.8(0.6, 1.3)	0.4
	≥35	11(13.1)	73(86.9)	1	
Parity	Nullipara	12(7.1)	158(92.9)	0.6(0.3, 1.4)	0.2
	Para one	14(12.7)	96(87.3)	1.7(0.3, 3.7)	
	Multipara	21(16.4)	107(86.3)	1	
Gravidity	Primigravida	10(7.0)	133(93.0)	1.7(0.8, 3.2)	0.1
	Multigravida	37(14.0)	228(86.0)	1	
Previous abortion	Yes	8(17.4)	38(82.6)	1.8 (0.7, 5.3)	0.2
	No	29(13.2)	190(86.8)	1	
Macrosomia	yes	5(18.5)	22(81.5)	1.5(0.5, 4.5)	0.4
	No	42(11.0)	339(89.0)	1	

5.4 Detection and management of gestational diabetes mellitus

5.4.1 Background of participants

This qualitative analysis was done using the transcripts of 18 in-depth interview participants. The participants were physicians, nurses and midwives who were involved in providing maternal and child health services in Wolaita Zone, Southern Ethiopia. Six of the participants were females and the rest were males with in age range of 26-48 years. Regarding their profession, six were obstetricians, four were general practitioners, three were midwives, three were clinical nurses and two of them were health officers by profession and their experience ranged from 4years to 16 years.

5.4.2 Detection of GDM

Participants were asked about detection method of GDM in their respective health facilities. All participants mentioned that screening of women for GDM was based on the risk factor assessment known as selective screening. According to participants, health care providers screen pregnant mothers with one or more risk factors within 24-28 weeks of gestational age. The participants also mentioned that they diagnosis GDM based on the WHO criteria. The participant from Wolaita Sodo University teaching referral hospital indicated detection method of GDM as follows;

"Here in our hospital, we use selective screening method to detect GDM. We understand that GDM has negative consequences both for mother and fetus if not detected early. We screen selectively by asking past history of having big baby, family history of diabetes and obesity. We will focus our screening from 24-28 weeks of gestational age. Physicians working in antenatal care screen mothers by testing blood sugar level" (Male physician, aged 36)

The reason for selecting selective screening was explored in the interviews. The main reason given by the respondents as to why selective screening was preferred and used was the issue of cost-effectiveness, but some participants strongly suggest universal screening of all pregnant mothers during antenatal care by considering the seriousness of the problem.

The participant from the Sodo Christian Hospital noted that;

"We do screening selectively, by considering history of still birth, having big baby, age greater than 35 and family history of type II diabetes. In general we follow selective screening technique because of cost but it is better to do universal screening for all pregnant mothers during antenatal care for better detection" (Female midwife, aged 28).

Another participant also reported that the problem is becoming common and including GDM screening as baseline investigation for all pregnant mothers is important. According to the participant, mothers are not screened consistently in the facility like other investigations and he said;

"This case is very common in our health facility; we commonly detect GDM during ANC care. But screening is not routine and consistent, not assessed as base line. We screen mothers when there is complication and high level of suspicion, otherwise we do not consider it as baseline assessment during ANC. It is better if we include it as baseline assessment for all antenatal attendants" (Male Obstetrician, aged 40).

Respondents were nearly unanimous that they screen the women at 24 to 28 weeks of gestation and they also emphasised that it is not always possible to screen the women in this period of pregnancy because of late antenatal visit.

" According to the guideline, we try to do screening at 24-28 weeks of gestational age but the problem is that most mothers are not visiting ANC clinic at early time, some may visit health facilities during late third trimester, this is also one challenge" (Male midwife, aged 32)

5.4.3 Management of GDM

Health care providers noted the importance of three different modalities of treatment options for GDM; these three methods include diet, exercise and treatment by insulin. Health care providers use dietary modification and exercise as first stage of treatment and they use insulin if it is not possible to control blood glucose level by diet and exercise. Lack of awareness on treatment options of GDM among mid-level workers was reported.

"*After detection of GDM, we start our management by dietary modification, exercise and counselling the mother to come back for follow up visits. If it is not possible to control blood*

glucose level with initial management, we start pharmacological management specifically, we give insulin for the mother and follow accordingly" (Male general practitioner, aged 28).

5.4.4 Barriers and challenges to early detection and management of GDM

Participants pointed out some barriers and challenges for detection and management of GDM. These include; lack of standard guidelines and protocols, lack of trained health care providers, shortage of supplies and equipment and late antenatal care visits.

Participants were asked a series of questions about guidelines and clinical standards relevant to detection and management of GDM. Many of the respondents noted that lack of standard protocols and guidelines for detection and management of GDM is one barrier. They explained that in the absence of standards, screening of women will take place based on subjective judgement of providers. One of the participants explained the issue as follows;

"*In our hospital, we don't have guideline specific for GDM screening and management unlike other obstetric complications. No standard available regarding GDM, I hope the government will provide these things in future*" (Female Midwife, aged 32)

Another participant from health canter echoed that lack of standard protocol is a challenge for detection and management of GDM, and he said;

"*There is no standard or guideline for screening of GDM in our health centre. Providers give little attention for this case and it is not considered as a serious problem; I think this is the reason why for lack of awareness creation activities, lack of guidelines and standards and so on*" (Male Nurse, aged 27)

Lack of trained health care providers was mentioned as one problem for detection and management of GDM, according to the participants. They mentioned that there is lack of awareness among health care providers particularly mid-level providers in facility and the major reason for this is lack of on job training on detection and management of GDM. Training, seen as a critical component of strengthening detection and management of GDM and respondents called for training at all levels.

"*Firstly, on job training is important on screening and management of GDM. There is different training in other area but training on GDM doesn't exist. Specially, training is necessary for mid- level workers since they encounter mothers during antenatal care, there should be awareness on GDM detection*" (Male obstetrician, aged 34)

Another participant said staff training as mandatory for service provision and specifically specialized training in detection and management of GDM including refresher training that did not currently exist; he said,

"*There is shortage of trained providers here. The reason is, there is no special on job training concerning GDM detection and management, so it is better to provide on job training for health care workers, we are providing care from our knowledge of academic training; as to me refreshment training is necessary to all providers,* we don't have training on GDM, *for example there is continuous training on issues like PICT, HBV, VDRL but no training provided on detection and management of GDM"* (Male general practitioner, aged 32)

Lack of supplies and equipment were also reported as challenges for screening and management of GDM. Shortage of supplies and infrastructures including space, laboratory reagents and glucose solutions were found to be challenges for detection and management of GDM.

"*There is also shortage of supplies like oral glucose preparation. We prepare oral glucose solution, but it is better to access glucose solution for screening of GDM. Lack of space/room is another challenge to follow high risk mothers in separate room. So it is better to fulfil supplies and equipment for better care and management*" (Female general practitioner, aged 29).

Health care providers explained that most pregnant women do not attend antenatal care in the recommended gestational period for GDM screening; late antennal visit is common and this is another challenge for early detection of GDM. They also noted that larger proportions of women attend antenatal visits at health posts and health centers and providers in those facilities have relatively lower experience of detection and management of GDM. One of the participants noted the issue as follows;

"*Another big challenge is late antenatal visit; mothers attend antenatal care during late pregnancy and this is not ideal time of recommendation for screening. Some mothers visit health facilities during the time of delivery. Most ANC visit takes place at health centre and health centre is staffed with mid-level health care providers who have lower awareness of GDM screening*" (Male Obstetrician, aged 38)

Another participant also noted that late antenatal visit is challenge to screen mothers for GDM and he said;

"*For me detection rate of GDM is very low, but the problem is common here. The other problem is that there is no appropriate ANC follow up, our report might seem good concerning ANC follow up, but in reality what I observe is there is huge gap and awareness problem among mothers on ANC. It is better to do awareness creation on community about the problem since the magnitude of the problem is increasing from time to time'* (Male Obstetrician, aged 42).

5.5 Summary of findings by specific objectives

S.No.	Objectives	Summary of main findings
1	To assess the magnitude of pre-existing diabetes mellitus among pregnant women and associated risk factors	Magnitudes of preexisting diabetes among mothers receiving maternity care within one year period was 2.8% and among urban and rural residents, 3.3% and 1.4% respectively. Preexisting diabetes mellitus is significantly associated with family history of diabetes (chi square 24.8, P-value, 0.001). Previous history of spontaneous abortion (AOR: 5.3; 95%CI: 1.6-17.4) and fetal macrosomia (AOR: 3.9; 95%CI: 1.2-13.1), were identified to be significantly associated with preexisting diabetes.
2	To determine the prevalence of gestational diabetes and associated risk factors among pregnant women	Prevalence of gestational diabetes mellitus was 4.2% (95% CI, 2.5, and 6.2) with mean post glucose load level of 160.1 mg/dl (SD: 6.3). The prevalence of gestational diabetes mellitus increases with increase in number of pregnancies. Previous history of spontaneous abortion (AOR: 3.5; 95%CI: 1.7-14.6), family history of type II diabetes (AOR: 4.3; 95%CI: 1.3-8.7) and previous caesarean section (AOR: 7.5; 95%CI: 1.3-14.4) were found to be significantly associated with gestational diabetes mellitus.
3	To identify the effect of diabetes mellitus on pregnancy and birth outcome	Pregnancy of diabetic mothers was significantly complicated by pre-eclampsia when compared with non-diabetic mothers, (RR: 2 .8, 95% CI: 1.2-7.4). The risk of macrosomia is higher for neonates of diabetic mothers than non-diabetic, (RR: 2.9, 95%CI: 1.4-7.1). Mothers with diabetes mellitus were 2.9 times more

		likely to be delivered by caesarean section than non-diabetic mothers (RR: 2.9, 95%CI: 1.3-6.2) and the risk of pre-term delivery is 2.5 times higher among mothers with diabetes mellitus, (RR: 2.5, 95% CI: 1.1-6.2).
4	To explore the detection and management modalities of gestational diabetes	Screening of women for GDM was done based on the risk factor assessment known as selective screening within 24-28 weeks of gestational age. Health care providers use dietary modification, exercise and drug treatment to treat GDM. Participants confirmed that lack of standard guidelines and protocols, lack of awareness on GDM, inadequate trained health care providers, shortage of supplies and equipment and late antenatal care visits were barriers to detection and management of GDM.

6. Discussion

6.1 Magnitude of pre-existing diabetes mellitus

The study assessed magnitude of pre-existing DM among mothers received maternity care in three hospitals and four health centers from January 1 to December 31, 2017 in Wolaita Zone, Southern Ethiopia. A total of 600 mothers were included in the analysis, nearly all, (98.9%), were married and three fourth of the women, (75.7%), were urban residents. From the finding the dominant numbers of maternity service users in study facilities were urban dwellers. More than half, (55.8%) of the mothers included in our study had at least one live birth before index pregnancy and number of multigravida women included in the study was higher than primigravida women.

Magnitude of pre-existing DM among mothers received maternity care within one year period in study area was 2.8% (95%CI; 1.5-4.2). The magnitudes among urban and rural residents were 3.4% and 1.4% respectively. Majority, 70.5% of pre-existing DM were type II DM and the rest 5 cased were type I DM. This figure is comparable with adult diabetes prevalence estimate of world diabetes federation for Ethiopia [4]. The magnitude is lower than the finding of facility based retrospective cohort study conducted in Saudi Arabia[79].

In this study, some demographic characteristics of women with pre-existing DM were compared with non-diabetic mothers. The finding suggested that diabetic mothers were significantly older than non-diabetic women and this was documented by evidence from other study [81].

The result showed that higher proportion of mothers with DM had pre-eclampsia than non-diabetic mothers. It was reported that pregnancy associated with diabetes is commonly complicated with pregnancy induced hypertension and preeclampsia [11, 82].

Caesarean section delivery increased three fold among mothers with DM. The reason behind the tendency towards delivery by caesarean section can be linked with higher rate of macrosomia occurs among diabetic mothers. This finding is supported by other studies that reported women with pre-existing diabetes mellitus are more likely to be delivered by caesarean section [83].

Our study revealed that there is association between family history of diabetes and pre-existing DM among pregnant mothers. International Diabetes Federation report indicated that some of factors which play a significant role in pre-existing diabetes generally include obesity, unhealthy diets, physical inactivity, family histories of DM and maternal age [1]

Persistent high blood sugar level in mothers can have influence on fetal growth and weight and having big baby is related to maternal diabetes [84]. In our study, fetal macrosomia occurs 3.9 times more likely among diabetic mothers. Macrosomia can result in obstetric complications like caesarean delivery, birth asphyxia or perinatal mortality [85].

Based on the result, abortion is more common among mother with DM when compared with non-diabetic mothers. It is supposed that hyperglycemia could cause damage to the developing yolk sac, an increased production and liberation of free oxygen radicals and genotoxic effect might occur and this can result in damages in the fetus and miscarriages [65].

6.2 Prevalence of gestational diabetes mellitus

The core purpose of this section of study was to measure the prevalence of GDM and to identify factors associated with it in Wolaita Zone, Southern Ethiopia. Total of 518 pregnant women with duration of 24-28 weeks of pregnancy were examined for gestational diabetes mellitus by using WHO 2013 recommendation. The overall prevalence of gestational diabetes mellitus was 4.2% , 15(4%) among urban residents and 7(4.9%) among rural residents which is relatively higher than previous point estimate of study conducted in Northern Ethiopia[33]. It is also reported that GDM is increasing in most parts of the world during the past 20 years among several groups of population[16]. This finding is almost comparable with findings of studies in Sri Lanka and Nigeria but lower than some other countries' studies like India , Qatar, Argentina, Pakistan and Tanzania[22, 26-28, 30]. Differences in prevalence of gestational diabetes mellitus among different countries can be related to differences in socio-economic status, life style and variations in screening and diagnostic methods. Differences in screening technique and use of various diagnostic criteria have enacted difficulty in comparing the situation of GDM across countries; despite this fact, our finding indicates that the magnitude of the problem is increasing in the area.

In our study, the proportion of gestational diabetes mellitus increases with increase in number of pregnancies and was more common in multiparaous pregnant women; similar finding was

reported by the study done in Qatar and it was indicated that the risk of GDM increases with number of pregnancy[41].

In this study, GDM was associated with previous history of abortion; the odds of developing GDM was 3.5 times higher among women with previous history of abortion when compared with those who had no history of spontaneous abortion. This result is consistent with other study conducted in China and the study mentioned that previous history of spontaneous abortion was linked with elevated possibility of acquiring GDM [43].

Family history of type II diabetes mellitus was linked with the occurrence of GDM. From other evidence, those mother with positive family history of type II diabetes mellitus have higher risk of developing GDM[38].

Previous history of caesarean section was independently predictor of gestational diabetes mellitus. This result is consistent with studies conducted in different countries. A study conducted in South Eastern Nigeria suggested that there is a significant relationship between previous history of caesarean delivery and occurrence of gestational diabetes[37]. Similar findings have been stated in studies conducted in Tanzania and India , GDM was significantly associated with previous history of caesarean sections[28, 39]. There was no statistically significant association between mid-upper arm circumference and high blood pressure with occurrence of GDM.

6.3 Effect of diabetes mellitus on pregnancy and birth outcome

The study revealed maternal and birth outcome of diabetic and non-diabetic mothers received maternity service in three hospitals and four health centers from January 1, 2017 to June 30, 2018 in Wolaita Zone, Southern Ethiopia. Total of 136 diabetic mothers and 272 non-diabetic mothers were included in the study. The finding indicated that women with diabetes mellitus were older and had higher number of pregnancies when compared to non-diabetic pregnant women.

In this study, one case of maternal sepsis occurred in mother with diabetes mellitus and one case of maternal death occurred in each of exposed and unexposed group which resulted in total maternal mortality of 2 cases out 408. Total of three early neonatal deaths reported for mothers with diabetes mellitus. Although it is not possible to do statistical analysis, all of early neonatal deaths occurred in mothers with diabetes mellitus. Higher risk of fetal loss, perinatal death, and still birth for women with DM were documented in a conducted in the United Kingdom [71]. It was reported that neonatal mortality was found to be higher among infants of diabetic mothers than non-diabetic women [72]. Another evidence also indicated that DM is linked with increased risk of stillbirth and neonatal mortality [63].

The study indicated that the proportion of pre-eclampsia and antepartum hemorrhage were higher among mothers with diabetes mellitus than non-diabetic mothers. Based on our study, the pregnancy of diabetic mothers was 2.8 times more likely complicated by pre-eclampsia than non-diabetic mothers. Another study also reported that, pre-eclampsia and postpartum hemorrhages are more likely to be found in pregnancies complicated by diabetes [77].

Compared to non-diabetic group, the likely hood of women with DM to be delivered by caesarean section was three times higher. Study from Saudi Arabia showed 50% of women with diabetes had caesarean section delivery; while the analogous figure for non-diabetic women was less than 20%[79]. This may be associated with high blood sugar of diabetic mothers can be moved to the fetus by crossing placenta and this can elicit increased insulin level in the fetus and this in turn can result in increased fetal growth. Evidences reported that, having big baby and caesarean delivery were linked with increased maternal blood sugar level [86]. The finding of this study showed that, newborns of diabetic mothers had considerably higher birth weight

compared to those of non-diabetic mothers; this indicated that the neonates of mothers with diabetes mellitus were significantly macrosomic; the risk is almost three fold.

The risk of pre-term delivery is 2.5 times higher among mothers with diabetes mellitus when compared to non-diabetic mothers. Although there was increased risk of having still birth for exposed group of mothers, the differences were not statistically significant. Hyperinsulinemia in the fetus can affect lung maturation by hampering surfactant production from alveolar cells and can result in respiratory problems. Respiratory distress among newborns of mothers with DM can occur six times more likely compared with their counterparts [66]. A study conducted in Saudi Arabia revealed that pre-existing diabetes mellitus is associated with increased risk for macrosomia, stillbirth and preterm delivery [87].

6.4 Detection and management of gestational diabetes mellitus

This study aimed to explore barriers for detection and management of GDM in health facilities of Wolaita Zone, Southern Ethiopia. The participants were physicians, nurses and midwives who were involved in providing maternal and child health services in the study area. The findings revealed that screening of women for GDM was done by based on the risk factor assessment or selective screening. Health care providers screen pregnant mothers with one or more risk factors within 24-28 weeks of gestational age. The participants also mentioned that they made diagnosis of GDM based on WHO criteria. The WHO diagnostic criteria are generally accepted in many countries in the world including many African countries [88, 89]. In most developing nations where funds are limited, it is common to screen pregnant women for GDM based on availability of risk factors in selective manner during antenatal care [90, 91].

Findings from this study showed that health care providers use dietary modification and exercise as first stage of treatment and they use insulin if is not possible to control blood glucose level by diet and exercise. Blood glucose level monitoring, life style modifications like exercise and nutritional advice are important part of recommended management protocols for mothers with GDM. Treatment starts with medical nutrition therapy, exercise, and glucose monitoring and insulin can be used if these methods fail to maintain normal glucose level [92].

Our study reveals that providers in health facilities face many challenges related to screening and management of GDM. Lack of standards and guidelines and inadequate on job training on GDM

are among repeatedly mentioned obstacles. According to our participants, health facilities that provide maternity care should have standard protocol for detection and management of GDM. However, all the participants noted that there is no standard protocol to screen and manage pregnant mothers with GDM. According to the participants, it is possible to find undiagnosed and untreated mothers or late diagnosis with possible complications. Guidelines are important for effective screening and management of GDM during pregnancy and this is helpful to ensure good pregnancy outcome. In addition, it is important to prevent long term complications of GDM like preventing future progression to type II diabetes [93].

In countries like Ethiopia, a lot should be done to reduce maternal and neonatal mortality to acceptable level; there should be continuous improvement to avail better access of obstetric care. However, the situation is challenged by additional burden of non-communicable diseases worsening the health of mothers and newborns in low and middle income countries [94]. To increase awareness and improve detection of GDM in pregnancy, providing training for mid-level health care providers could be helpful and this has already been practiced in countries like India and screening is done by mid-level at first level care[95].

In addition, findings from this study also illustrate that health facilities have shortage of supplies, consumables and properly equipped laboratories and considered as barriers for early detection and management of GDM. So, health system planners and leadership should consider fulfilling essential supplies for screening of GDM.

The issue of pregnant women not attending antenatal care in the recommended gestational period for GDM screening was another challenge for early detection of GDM. According to participants the pregnant women do not always attend the antenatal care clinic in the optimal time for the GDM screening. World Health Organization (WHO) focused antenatal guideline recommends screening of mothers for GDM as baseline investigation for all mothers during antenatal visit [96].

7. Internal validity and generalizability of the results

Quantitative epidemiological study designs included in this study were observational cross sectional and retrospective cohort study designs. Any observational study design is prone to chance, bias and confounder and generate weaker evidence compared to randomized controlled trials. Internal validity refers to the ability of the study to measure what it claims to measure or the ability to measure correctly what is supposed to measure.

In this study, the role of chance was minimized by considering adequate sample size which was calculated using appropriate statistical assumptions. In some of the categories of independent variables, small sample sizes were observed during analysis and in such situations, re-categorizing by merging or excluding very small categories were done. The effect of chance was assessed and estimated using significance tests and confidence intervals. In all studies of this thesis, the role of chance was quantified and reported using appropriate statistical methods, including logistic regression, P-value less than 0.05 was used for statistical significance.

Different methods were used to minimize the effect of bias. Careful design of questionnaire and checklists, random selection of study subjects and training of data collectors were among the major methods used to minimize the role of bias in this study.

The other sources of error in epidemiologic studies are confounding variables. To control the effect of confounding variable in quantitative study, binary logistic regression model was used.

Regarding representativeness and generalization of the findings, since the study participants were represented from both urban and rural residents and probability sampling technique was employed, it is appropriate to represent the Zone. The study area is similar with other parts of Southern region of Ethiopia in terms of demographics, economic structure and health service utilization. This may allow the findings of this study to be generalized to other areas of the country, especially to communities with similar socio-economic backgrounds. However, the external generalizability to other parts of the country may depend on the similarities of the existing socio- cultural, socio-economic and maternal and child health care related factors.

To ensure credibility of the qualitative findings in this study, data collectors who were well familiar with the study area were selected. Dependability refers whether the findings of this study may be repeated in other places by other researcher and the study tools are annexed for

others to do consistently. Transferability is the term used to refer to the external validity in qualitative studies, which will depend on the similarities of the cultural context of the study area and population.

8. Strengths and limitations of the study

Strengths of the study includes, inclusion of adequate sample size especially for screening of gestational diabetes mellitus by using oral glucose tolerance test and to determine pre-existing diabetes and the effect of diabetes mellitus on pregnancy and birth outcome, all medical records of patients who had been treated over the study years which gave us the true picture of the target population and can avoid selection bias. No study assessed the burden of diabetes mellitus among pregnant mothers in the study region so far and this study generated important evidence for the area.

There were also limitations during the process of conducting this study. The issue of data incompleteness was one of the limitation s of the medical record review , but the potential limitation was minimized by careful abstraction of data from all potential medical records. Incomplete documents were excluded during data collection. It was not possible to include variables like obesity and nutritional status in analysis because these variables were not captured appropriately by medical records.

Our study to determine the prevalence of gestational diabetes mellitus was cross-sectional and screening was done during the time of ante natal care visits. Pregnant mothers were not followed until delivery, and women who might have un-diagnosed type 2 diabetes were classified as having gestational diabetes mellitus, but the definition of gestational diabetes mellitus considers such cases. The current study is health facility based and mothers who did not have antenatal follow up were not included in the study. Medical records of mothers who received maternity care in health facilities were included and assessed for the presence of pre-existing diabetes and its effect, so those did not receive care at health facilities were not included in our study

9. Conclusions

In conclusion, 2.8% of women receiving maternity services in the studied facilities had preexisting diabetes mellitus. Family history of diabetes was found to be associated with preexisting diabetes.

The finding of this study pointed out that, the prevalence of GDM was 4.2% which was higher compared to other studies conducted in the country. Gestational diabetes mellitus increased with increase in number of pregnancies and was more common in multiparaous pregnant women. Previous histories of spontaneous abortion, family history of type II diabetes mellitus and previous caesarean delivery were found to be risk factors for gestational diabetes.

Diabetes mellitus among pregnant mothers was associated with increased risk of pre-term delivery, macrosomia and maternal complications of pre-eclampsia and caesarian delivery. So, diabetic mothers and their offspring were at increased risk of adverse pregnancy outcomes compared with non-diabetic mothers.

Lack of awareness on treatment options of GDM among mid-level workers was reported. Providers faced various challenges related to the detection and management of GDM. Commonly reported challenged were lack of standard guidelines and protocols, lack of trained health care providers, shortage of supplies and equipment and late antenatal care visits.

10. Recommendations

Based on the findings, the following recommendations are forwarded to concerned bodies.

Federal Ministry of Health, Regional Health Bureau and Zonal Health Department:

- Strengthening follow up of pregnant mothers with preexisting diabetes at high risk clinic during antenatal care to control and manage hyperglycemia effectively
- Screening of mothers for gestational diabetes mellitus as base line test during antenatal care is essential
- Health care leadership need to address the challenges to diagnose and manage diabetes mellitus during pregnancy by strengthening the health care system by availing standard guidelines and protocols for detection and management of GDM.
- Providing on job training for health care providers at primary care level for early detection and management of diabetes mellitus during pregnancy
- Fulfilling supplies and consumables used for detection and management of diabetes mellitus among pregnant mothers
- Working on early antenatal visits of pregnant mothers and strengthening screening of mothers for diabetes mellitus at baseline investigation during antenatal care

Health care providers

- Should provide education on prevention and control strategies of diabetes mellitus during pregnancy
- Should design appropriate method to educate mothers on early antenatal visit and screen mothers during antenatal care

Researchers:

- National large scale study is important to estimate the burden of gestational diabetes mellitus and preexisting diabetes among pregnant mothers at national level and its effect on maternal and birth outcome.

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13. Appendices

Annex I: Published original papers and or manuscripts

Original paper –One

Magnitude of pre-existing diabetes mellitus among pregnant women in Wolaita Zone, Southern Ethiopia: Health facility based cross sectional study

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Abstract

Background: The presence of maternal diabetes mellitus during pregnancy has complications for both mother and child. Preexisting diabetes can result in higher risk of maternal and child mortality and morbidity. In Ethiopia, the magnitude of preexisting diabetes among pregnant women is not well studied.

Objective: The aim of this study was to assess the magnitude of preexisting diabetes mellitus among pregnant women in Wolaita Zone, Southern Ethiopia.

Methods: Retrospective document review was done to determine the magnitude of preexisting diabetes mellitus in three hospitals and four health centers. A total of 600 pregnant mothers who attended maternity services at the study health facilities in one year period from January 1, to December 31, 2017 were included in the study. Data were collected from medical records of mothers. Chi-square and logistic regression analysis model were used to check the relationship between preexisting diabetes mellitus and independent variables.

Results: Of the total of 600 mothers included in analysis, magnitude of preexisting diabetes among mothers received maternity care within one year period was 2.8%. The magnitudes among urban and rural residents were 3.4% and 1.4% respectively. Preexisting diabetes mellitus is significantly associated with family history of diabetes (Chi square 24.8, P-value, 0.001). Previous history of spontaneous abortion (aOR: 5.3; 95%CI: 1.6-17.4) and fetal macrosomia (aOR: 3.9; 95%CI: 1.2-13.1), were identified to be significantly associated with preexisting diabetes.

Conclusions: The magnitude of pre-existing diabetes is high in the study area. Family history of diabetes is found to be associated with preexisting diabetes. Preexisting diabetes is associated with increased risk of abortion and fetal macrosomia. National large scale study is important to estimate the burden of preexisting diabetes among pregnant mothers at national level and its effect on maternal and birth outcome.

Key words: Pre-existing diabetes, Pre-gestational diabetes, Southern Ethiopia

Introduction

In pregnancy, diabetes mellitus (DM) can either be pre-existing or gestational diabetes mellitus (GDM). Pre-existing diabetes refers to pregnant women who have previously been diagnosed with type I or type II diabetes mellitus, or other rare types of diabetes mellitus [1,2]. Preexisting DM can be also described as pre-gestational diabetes and it is already identified diabetes and continued through pregnancy [3].

Currently, diabetes is considered as one of the top health problems of the world, the World Health Organization (WHO) estimated that, globally, hyperglycemia is the third highest risk factor for premature mortality, next to high blood pressure and tobacco use [4]. The World estimate of 8.8% (415 million) adults aged 20-79 affected by DM in 2015 with little gender difference. The prevalence in Africa was estimated to be 3.2% (14.2 million) in 2015 and nearly half of these cases live in four populous countries of Africa; namely, Nigeria, Ethiopia, Democratic Republic of Congo and South Africa. International Diabetes Federation estimate of adult prevalence of diabetes in Ethiopia in 2015 was 2.9% [5].

Pregnant mothers affected by preexisting diabetes can develop different complications including higher risk of maternal and child mortality and morbidity [6]. Infants born to mothers with pre-existing diabetes are at greater risk of short term and long term complications. Acute pregnancy complications such as pre-eclampsia, infections obstructed labour, postpartum hemorrhage, preterm births, stillbirths, birth injuries and death in worst case scenarios were documented in mothers with diabetes mellitus [7, 8]. In addition, the chance of an early miscarriage is higher for women with diabetes mellitus and maternal mortality ratio among diabetic mothers in some countries increases up to twenty fold when compared with non-diabetic mothers [9].

Chronic complications like congenital malformation, neural tube defect and congenital heart diseases can occur among infants of mothers with pre-existing diabetes. It can also affect multiple systems, including skeletal, cardiac, central nervous, gastrointestinal and genitourinary systems [10]. The infants of mothers with pre-existing diabetes are at high risk of developing type II diabetes and obesity in the long term and this effect is attributed to the intrauterine environment and genetic predisposition [11].

Complications of kidney, eye complications, and the risk of myocardial infarction is significantly increased in women with type I diabetes as long term effect [12].

Appropriate diagnosis, care and management of DM before and during pregnancy are important to minimize the risk of long term and short term complications. Controlling blood sugar through a healthy diet, gentle exercise and blood glucose monitoring, and in some cases insulin or oral medication can prevent the harm [13].

In Ethiopia, although DM is recognized as one of the major non-communicable diseases, the magnitude of preexisting diabetes among pregnant women is not well studied. Documenting the burden of preexisting on pregnancy is very important to inform health policy and program in the country.

The aim of this study was to assess the magnitude of preexisting DM among pregnant women in Wolaita Zone, Southern Ethiopia.

Methods

Study area and period

The study was conducted in three hospitals and four health centers in Wolaita Zone, Southern Ethiopia. The Zone is located in the South Central part of the country, 385 km distance from the capital, Addis Ababa. The Zone has total population of about 2 million in 2017 as projected from 2007 national census. The study area in general has 12 administrative Woreda and three town administrations. Likewise this area share 3 Hospitals, 70 health centers and 380 health posts, among these 12 Health Centers and all three hospitals provide diagnostic and management care for pregnant women with diabetes mellitus. Expected number of pregnant women in the zone in 2016 is estimated to be is 66,646 [14]. Data were collected in three months period from January to March, 2018.

Study design and Population

Retrospective document review was done to determine the magnitude of preexisting diabetes mellitus among pregnant women. All pregnant mothers who attended maternity services at the study hospitals and health centers in one year period from January 1, to December 31, 2017 were included in the study.

Sampling size and sampling procedure

Sample size was calculated by using single proportion formula by considering the following assumptions; confidence level of 95%, expected proportion 50% to get maximum sample size, margin of error 4%, Z - $\alpha/2$, Z value corresponding to a 95% level of significance = 1.96.

The total sample sizes used for the study were 600.

The total sample was assigned to study facilities proportionally based on case load and systematic sampling method was used to identify the assigned number from maternal medical records.

Data Collection

Data collection was done from the period of January to March 2018 from maternal medical records by using structured checklist. Data extraction was performed from selected documents in study facilities. Data were collected by nurses and midwives who have ample experience on clinical practice and data collection. Intensive training was given to data collectors and supervisors on how to extract data from medical records. Continuous supervision was done during data collection time. The Supervisors ensured data completeness and consistency on daily basis.

Data analysis

Data were entered and cleaned by Epi Info version 7 and analysis was done by using STATA version 14 software. Tables and figures were used to present descriptive data. Chi-square and logistic regression analysis model were used to check the relationship between preexisting diabetes and some variables. Model fitness was evaluated by Hosmer-Lemeshow goodness-of-fit tests.

Ethical considerations

Ethical approval was obtained from the Institutional Review Board of College of Health Sciences, Addis Ababa University. Letter of permission was written by Wolaita Zone health department to all study facilities. Facility administrators confirmed their willingness to provide all necessary documents and information for the study. Confidentiality of all the information obtained from medical records and registers was maintained.

Results

Socio-demographic and obstetric characteristics

Of the total of 600 mothers included in analysis, more than two-third (68.8%) were in the age range 21-30 years. Nearly all, 98.9% were married and most of the women (75.7%) were urban residents. One, two and three pregnancies were documents for 36.8%, 33.0% and 15.5% of mothers respectively. More than (55.8%) of the mothers had at least one live birth before index pregnancy. The distribution of women in relation to age, residence, marital status, gravidity and parity is presented in Table 1.

Table 1. Selected Socio-demographic characteristics of respondents, Wolaita Zone, Southern Ethiopia, 2017

Characteristics (n=600)		Number	Percent
Age	16-20	72	12
	21-25	205	34.2
	26-30	208	34.7
	31-35	75	12.5
	>35	40	6.7
Residence	Urban	454	75.7
	Rural	146	24.3
Marital status	Married	593	98.9
	Single /Divorced /Widowed	7	1.2
Gravidity	One	221	36.8
	Two	198	33.0
	Three	93	15.5
	Four	48	8.0
	Five or more	40	6.7
Parity	Nullipara	265	44.2
	Para I	161	26.8
	Multipara (2-4)	145	24.2
	Grand multipara (5 or more)	29	4.8

Maternal and fetal complications

Basic maternal and fetal complications were assessed in this study. The magnitude of preeclampsia among mothers was 5.7%. According to medical records, 2.7% and 5% of mothers had still birth and preterm delivery respectively. Macrosomia was documented in 7.2% of mothers and caesarean section rate was 10.5%. Abortion complication was recorded in 10% of mothers and 3 cases of early neonatal death was occurred (Table 2).

Table 2: Selected Obstetric characteristics of respondents, Wolaita Zone, Southern Ethiopia, 2017

Characteristics (n=600)		Number	Percent
Preeclampsia	Yes	34	5.7
	No	566	94.3
Still birth	Yes	16	2.7
	No	584	98.3
Macrosomia	Yes	43	7.2
	No	557	92.8
Preterm delivery	Yes	30	5
	No	570	95
Antepartum hemorrhage	Yes	8	1.3
	No	592	98.7
Postpartum hemorrhage	Yes	10	1.7
	No	590	98.3
History of Abortion	Yes	60	10
	No	540	90
Caesarean delivery	Yes	63	10.5
	No	537	89.5
Early neonatal death	Yes	3	0.5
	No	597	99.5
Family history of diabetes	Yes	63	10.5
	No	537	89.5

Magnitude of preexisting diabetes mellitus

Magnitude of preexisting diabetes among mothers received maternity care within one year period from January 1, 2017 to December 31, 2017 in study area was 2.8%. The magnitudes among urban and rural residents were 3.4% and 1.4% respectively. Of 17 cases of preexisting diabetes, 12 cases were type II diabetes mellitus and the rest 5 cased were type I diabetes mellitus. No case of preexisting diabetes mellitus was documented for mothers less than 20 years of age and highest proportion (8%) was identified for mothers aged more than 35 years (Figure 1).

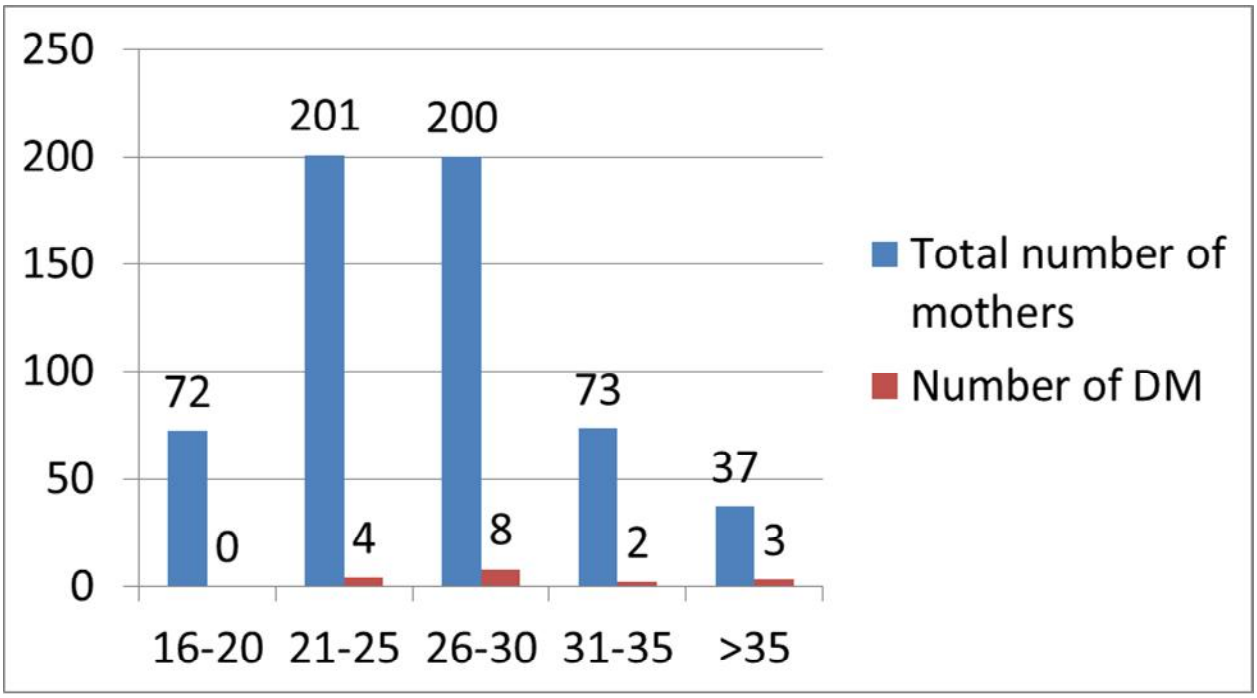

Figure 1: Number of preexisting diabetes mellitus according to age category, Wolaita Zone, Southern Ethiopia, 2017.

Highest proportion of preexisting diabetes was documented for mothers with three or more pregnancies and none for women with first pregnancy (Figure 2).

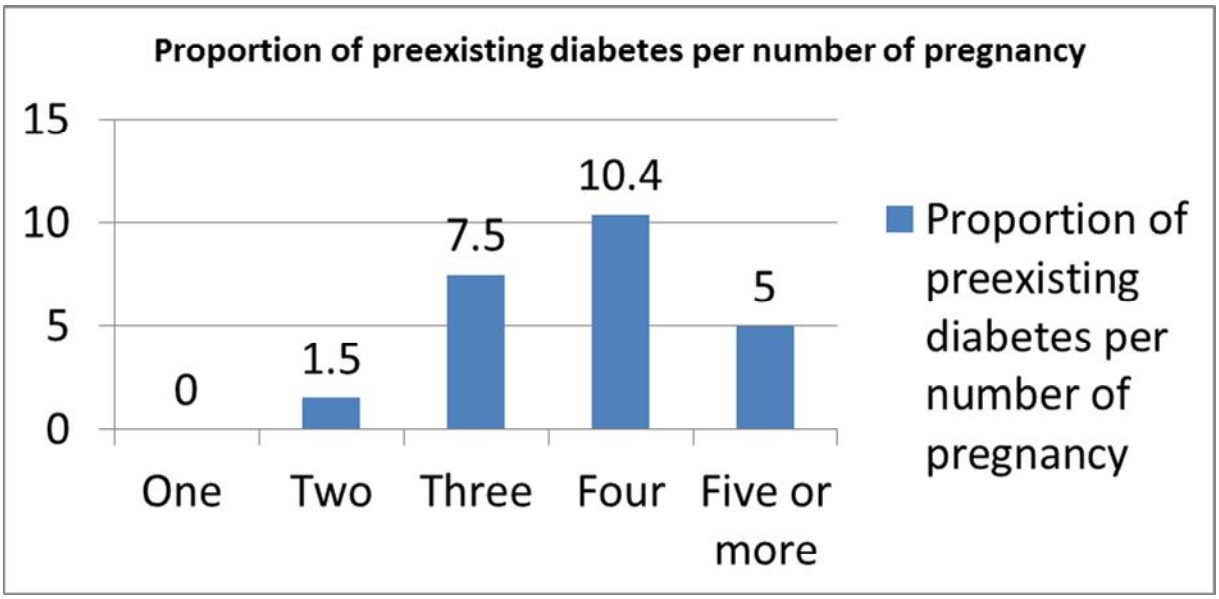

Figure 2: Proportion of preexisting diabetes mellitus according to number of pregnancies, Wolaita Zone, Southern Ethiopia, 2017.

The mean age (standard deviation) of mothers with preexisting diabetes mellitus and was 31.8(±5.1) and for those without diabetes was 26.7(±5.0). Diabetic mothers were significantly older (P- value, 0.001) than non-diabetic mothers.

The result showed that higher proportion of mothers with diabetes mellitus had preeclampsia than non-diabetic mothers (23.5% versus 4.8%). Based on the study, 29.4% of mothers with diabetes had caesarean section delivery and the corresponding figure for non-diabetic mothers was 9.9%.

Factors associated with preexisting diabetes mellitus

Preexisting diabetes mellitus is significantly associated with family history of diabetes (chi square 24.8, P-value, 0.001). Binary logistic regression model was used to assess the relationship between some variables and preexisting diabetes mellitus. In multivariate logistic regression model, previous history of spontaneous abortion (aOR: 5.3; 95%CI: 1.6-17.4) and fetal macrosomia (aOR: 3.9; 95%CI: 1.2-13.1), were identified to be significantly associated with preexisting diabetes.

Discussion

The study assessed magnitude of preexisting diabetes mellitus among mothers received maternity care in three hospitals and four health centers from January 1 to December 31, 2017 in Wolaita Zone, Southern Ethiopia. Total of 600 mothers included in the analysis, nearly all, 98.9% were married and most of the women (75.7%) were urban residents. From the finding the dominant number of maternity service users in study facilities was urban dwellers. More than half (55.8%) of the mothers included in our study had at least one live birth before index pregnancy and this indicated number of multigravida women included in the study was higher than primigravida women.

Magnitude of preexisting diabetes among mothers received maternity care within one year period in study area was 2.8%(95%CI; 1.5-4.2). The magnitudes among urban and rural residents were 3.4% and 1.4% respectively. This figure is comparable with adult diabetes prevalence estimate of world diabetes federation for Ethiopia [5]. The magnitude is lower than the finding of facility based retrospective cohort study conducted in Saudi Arabia [15]. Majority, 70.5% of preexisting diabetes were type II diabetes mellitus and the rest 5 cased were type I diabetes mellitus.

In this study, some demographic characteristics of women with preexisting diabetes mellitus were compared with non-diabetic mothers. The finding suggested that diabetic mothers were significantly older than non-diabetic women and this was documented by evidence from other study [16].

The result showed that higher proportion of mothers with diabetes mellitus had preeclampsia than non-diabetic mothers. It was reported that pregnancy associated with diabetes is commonly complicated with pregnancy induced hypertension and preeclampsia [17, 7].

Caesarean section delivery increased three fold among mothers with diabetes mellitus. This finding is supported by other studies that report women with preexisting diabetes mellitus are more likely to be delivered by caesarean section [16, 18]. The reason behind the tendency towards delivery by C/S can be linked with higher rate of macrosomia occurs among diabetic mothers.

Our study revealed that there is association between family history of diabetes and preexisting diabetes mellitus among pregnant mothers. International diabetes federation report indicated that some of factors which play a significant role in preexisting diabetes generally include obesity, unhealthy diets, physical inactivity, family histories of DM and maternal age [19].

Persistent high blood sugar level in mothers can have influence on fetal growth and weight and having big baby is related to maternal diabetes [20]. In our study, fetal macrosomia occurs 4.9 times more likely among diabetic mothers. Macrosomia can result in obstetric complications like caesarean delivery, birth asphyxia or perinatal mortality [21]. Based on the result, abortion is more common among mother with diabetes mellitus when compared with non-diabetic mothers. It is supposed that hyperglycemia could cause damage to the developing yolk sac, an increased production and liberation of free oxygen radicals and genotoxic effect might occur and this can result in damages in the fetus and miscarriages [22].

This study was limited to assess the magnitude of preexisting diabetes among mothers who received care in health facilities and it did not address those mothers who had not visited studied health facilities during study period.

Conclusion and recommendations

The results of this study showed that, 2.8% of women giving birth in study area have preexisting diabetes mellitus which shows increasing rate and diabetic women were significantly older. Family history of diabetes is found to be associated with preexisting diabetes. Preexisting diabetes is associated with increased risk of abortion and fetal macrosomia. Higher proportion of mothers with diabetes mellitus had preeclampsia and caesarean delivery. Special attention should be given for pregnant mothers with preexisting diabetes during antenatal care to control and manage hyperglycemia effectively. National large scale study is important to estimate the burden of preexisting diabetes among pregnant mothers at national level and its effect on maternal and birth outcome.

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Original paper-Two

ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Prevalence of gestational diabetes mellitus and associated factors in Southern Ethiopia

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ABSTRACT

Background: Presence of gestational diabetes mellitus during pregnancy has serious complications for both mother and child. Its burden is increasing in low and middle-income countries but, little is known about its contribution in Ethiopia.

Aims and Objective: The aim of this study was to determine the prevalence of gestational diabetes mellitus and to identify associated factors in Wolaita Zone, Southern Ethiopia.

Materials and Methods: Institution based cross sectional study was carried out from August to October 2017 in Wolaita Zone, southern Ethiopia. A total of 518 pregnant women were participated from 2 hospitals and 4 health centers. Capillary blood samples were collected at fasting and 2 hours after 75gm glucose load to measure blood sugar and diagnosis of gestational diabetes mellitus was made by using 2013 World Health Organization (WHO) criteria. Binary logistic regression model was applied to assess risk factors of gestational diabetes mellitus.

Results: Prevalence of gestational diabetes mellitus was 4.2% (95% CI, 2.5, 6.2) with mean post glucose load level of 160.1 mg/dl (6.3) and 15(4%) among urban residents and 7(4.9%) among rural residents. The proportion of gestational diabetes mellitus increases with increase in number of pregnancies.Previous history of spontaneous abortion (AOR: 3.5; 95%CI: 1.7-14.6), family history of type II diabetes (AOR: 4.3; 95%CI: 1.3-8.7) and previous caesarean section (AOR: 7.5; 95%CI: 1.3-14.4)were found to be significantly associated with gestational diabetes mellitus.

Conclusions: The prevalence of gestational diabetes mellitus is higher as compared to other studies conducted in the country. Strengthening screening, care and prevention strategies for gestational diabetes mellitus are important to improve maternal and child health.

Key words: Gestational diabetes mellitus; Southern Ethiopia; Diabetes in pregnancy; Wolaita Zone

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INTRODUCTION

Gestational diabetes mellitus (GDM) is a glucose intolerance of altering degrees of seriousness which starts or identified for first time during pregnancy. [1]Globally, prevalence of hyper-glycaemia in pregnancy among women of reproductive age group was approximated to be 16.9% and, about 90% of cases were estimated to happen in developing countries.[1]

The health situation of pregnant mother with diabetes and her unborn child can be endangered with different levels of complications. These complications can lead to death in worst situations.[2]

Gestational diabetes mellitus has also long-term public health importance. It contributes to the rising type 2 diabetes epidemic. It is a momentary phenomenon for the pregnant mother, but more than 50% of the women develop type 2 diabetes in future life and the tendency of their children to develop obesity as young children and type 2 diabetes later on is found to be higher.[3]

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The magnitude of GDM differs across countries based on some reasons like ethnic groups, life style, level of educational, family history of diabetes and many other factors.[4]

The most common cause of hyperglycaemia occurring during pregnancy is GDM, and its contribution is about 90% of all diabetes during pregnancy. [5] It has been reported that GDM affects up to about 1 in 10pregnancies, and its prevalence has been progressively increasing.[6]

Currently, availability of factors like changes in life style, dietary habits, urbanization, physical inactivity, the tendency towards delayed marriage and older maternal age in different parts of the globe are making favourable ground and the prevalence of GDM may very well be on the rise.[7]

Because of cost, numerous countries in Africa detect blood glucose level of pregnant women to diagnose GDM based on identified risk factors selectively and the proportion of women suffering from the caseand the magnitude of the problem are unclear.[8]

In Ethiopia, although diabetes mellitus is recognized as one of the major non-communicable diseases, the magnitude of GDM among pregnant mothers and factors associated with it were not well researched.

Identifying the prevalence of the problem and common risk factors would be important to mitigate the problem on timely bases and helpful to health policy and program improvement.

Therefore, the study aimed to identify the prevalence of gestational diabetes mellitus among pregnant mothers and associated factors in Southern region of Ethiopia.

MATERIALS AND METHODS

The study was conducted in Southern part of Ethiopia from August 2017 to October 2017. The study site is one of the nine regions in Ethiopia and it consists of many different languages and ethnic groups within own diverse culture. The area of the region covers 10% of the national landmass and its boundary shows; there is Kenya to the south, Sudan to the southwest, Gambela regional state of Ethiopia to the west and Oromia regional state of Ethiopia to the Northand North-East. The region is composed of 13 zones and of which Wolaita Zone is the one and situated in the south central part of the region, 330 km distance from Addis Ababa. The Zone has total population of about 2 million in 2017 as projected from 2007 national census. Wolaita zone is one of the most densely populated areas in the country with an average of 640 people living per square kilometre. There are 3 Hospitals, 70 health centers and 380 health posts in the study area and among these 12 Health Centers and all three hospitals provide diagnostic and management service for pregnant women with diabetes mellitus.[9]

Cross sectional study design was employed. Mothers with gestational age of 24-28 weeks who were attending antenatal care service in selected 2 hospitals and 4 health centers during the survey period were included. The health facilities were selected randomly from total facilities providing treatment and care for pregnant women with gestational diabetes. The proportion from study conducted in Northern Ethiopia was used to calculate sample size.[10] Our assessment involved 518 eligible mothers and all of them were willing for blood glucose level test. Women with previously diagnosed diabetes were excluded from the study. All mothers attending antenatal care service in the selected health facilities within study period were screened for GDM.

Structured questionnaire was used, and details pertaining to socio-demography, family history, medical and obstetric history were collected. Blood pressure was measured, 75 gm oral glucose administered, capillary glucose level was measured at 0hr and 2hr using HemoCue Glucose and GDM was diagnosed based on 2013 WHO criteria.[11]

We used Epi Info 7 and STATA 14 (StataCorp, College Station, TX, USA) programs for data entry and analysis. Descriptive figures, frequency and percentages were calculated. Tables and figures were used to show descriptive findings. Multivariable logistic regression model was used to compute adjusted odds ratio and to evaluate the relationship between variables. *P*-values less than. 05 were considered for statistical significance.

The study was approved by Institutional Review Board of Addis Ababa University. Wolaita Zone health department wrote letter of support and confirmed their willingness to conduct the research prior to the study. We got written consent from all participants before starting any component of data collection. Confidentiality was clarified and guaranteed. Women diagnosed with GDM and other medical problems were referred to appropriate care and management.

RESULTS

Socio demographic Characteristics

Total sample size required for the study was 564, among these 518 pregnant women participated in the study and making the response rate of 91.8%. Of 518 women

included in the study, 376(72.6%) were urban residents. Majority, 388(74.9%), were 21-30 years old. The mean age was 25.7 (4.4), nearly all, 506(97.7) were married. Most of the mothers, 422(81.5%), were from Wolaita ethnic group and 89 (17.2%) had not attended any formal education. Nearly half, 242 (46.7%) were housewives and working as government employee is the leading occupation of their partners, 205(40.5%) (Table 1).

Obstetric characteristic of respondents

Basic obstetric characteristics were assessed in this study. Screening of GDM was carried out at 24 to 28 gestational weeks. Of the 518 study participants, majority, 372(71.8%) had two or more pregnancies, with mean gestational age of 26 weeks. More than one third of the respondents, 187(36.1%), were multi-para. Out of 372 mothers who had two or more pregnancies, 45(12.1%) had previous history of still birth, 67(18%) had previous history of abortion, and caesarean section rate was 16.1% (Table 2).

Prevalence of GDM

Overall prevalence of gestational diabetes mellitus was 4.2% with mean post glucose load level of 160.1 mg/dl (6.3) and 15(4%) among urban residents and 7(4.9%) among rural residents. The proportion of gestational diabetes mellitus increases with increase in number of pregnancies (Figure 1).

Gestational diabetes mellitus was more common in multiparaous pregnant women, GDM was diagnosed in 4(2.3%) of primiparaous, 7(4.5%) of multiparaous and 11(33.3%) of grand multiparaous mothers and in other words 18%, 32% and 50% of total diagnosed cases were primiparaous, multiparaous and grand multiparaous mothers respectively.

Risk factors associated with gestational diabetes mellitus

Factors associated with GDM were identified by using binary logistic regression model. In bivariate logistic regression model, previous history of still birth (COR:4.8; 95%CI:1.9-12.3), previous history of spontaneous abortion (COR: 4.2; 95%CI: 1.8-10.4), family history of type II diabetes (AOR:6.2; 95%CI: 1.4-9.8) andprevious caesarean section (COR: 7.5; 95%CI: 3.1-18.4) were identified to be statistically significant.

Multivariable analysis was used to control potential confounders. Accordingly, previous history of spontaneous abortion (AOR: 3.5; 95%CI: 1.7-14.6), family history of type II diabetes (AOR: 4.3; 95%CI: 1.3-8.7) andprevious caesarean section (AOR: 7.5; 95%CI: 1.3-14.4) were found to be independently associated (Table 3).

Table 1: Selected Socio-demographic characteristics of respondents, Wolaita Zone, Southern Ethiopia, 2017

Characteristics	Number	Percent
Age (n=518)		
16-20	77	14.9
21-25	206	39.8
26-30	182	35.1
31-35	41	7.9
>35	12	2.3
Residence (n=518)		
Urban	376	72.6
Rural	142	27.4
Marital status (n=518)		
Married	506	97.7
Single/divorced/widowed	12	2.3
Religion (n=518)		
Protestant	342	66
Orthodox	137	26.4
Muslim	17	3.3
Catholic	11	2.1
Others+	11	2.1
Ethnicity (n=518)		
Wolaita	422	81.5
Amhara	47	9.1
Gamo	27	5.2
Guraghe	12	2.3
Others ++	10	1.9
Education of mother (n=518)		
No formal education	89	17.2
Primary	124	23.9
Secondary	150	29.0
Post- secondary	155	29.9
Occupation of mother (n=518)		
House wife	242	46.7
Government employee	174	33.6
Petty trade	60	11.6
NGO employee	26	5.0
Daily laborer	16	3.1
Spouse's education (n=506)		
No formal education	70	13.8
Primary	101	20.0
Secondary	127	25.1
Post -secondary	208	41.4
Spouse's occupation (n=506)		
Government employee	205	40.5
Petty trade	137	27.1
NGO employee	55	10.9
Daily laborer	82	16.2
Others+++	27	5.3

+ Apostolic, Traditional++Oromo, Tigrie, Silte +++ Farmer, Broker

DISCUSSION

The core purpose of this study was to measure the prevalence of GDM and to identify factors associated with it in Wolaita Zone, Southern Ethiopia. Total of 518 pregnant women with duration of 24-28 weeks of pregnancy were examined for gestational diabetes mellitus by using WHO 2013 recommendation. The overall prevalence of gestational diabetes mellitus was 4.2%, 15 (4%) among urban residents and 7(4.9%) among rural

Table 2: Selected obstetric and medical history of respondents, Wolaita Zone, Southern Ethiopia, 2017

Characteristics	Number	Percent
Gravidity		
One	146	28.2
Two	164	31.7
Three	107	20.7
Four	57	11.0
Five or more	44	8.5
Parity		
Nullipara	154	29.7
Para one	177	34.2
Multipara (2-4)	154	29.7
Grandmultipara (>5)	33	6.4
Gestational age in weeks		
24	124	23.9
25	86	16.6
26	88	17.0
27	93	18.0
28	127	24.5
Birth weight of previous child (n=308)		
Less than 2.5 kg	12	3.8
2.5-3.9 kg	236	76.6
4 kg or more	60	19.5
Previous still birth (n=372)		
Yes	45	12.1
No	327	87.9
Previous abortion (n=372)		
Yes	67	18.0
No	305	82.0
Previous caesarean section (n=372)		
Yes	60	16.1
No	312	83.9
Previous history of GDM (n=372)		
Yes	19	5.1
No	353	94.9
Family history of type II DM (n=416)		
Yes	57	13.7
No	359	86.3

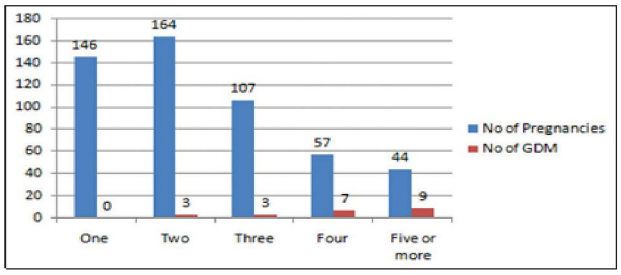

Figure 1: Number of Pregnancies and corresponding number of gestational diabetes mellitus of respondents in Wolaita Zone, Southern Ethiopia, 2017

residents which is relatively higher than previous point estimate of study conducted in Northern Ethiopia.[10] It is also reported that GDM is increasing in most parts of the world during the past 20 years among several groups of population.[7] This finding is almost comparable with findings of studies in Sri Lanka and Nigeria[12,13] but lower than some other countries' studies like India[14], Qatar[15], Argentina[16], Pakistan[17] and Tanzania.[18]Differences in prevalence of gestational diabetes mellitus among different countries can be related to differences in socio-economic status, life style and variations in screening and diagnostic methods. Differences in screening technique and use of various diagnostic criteria have enacted difficulty in comparing the situation of GDM across countries; despite this fact, ourfinding indicates that the magnitudeof the problem is increasing in the area.

In our study, the proportion of gestational diabetes mellitus increases with increase in number of pregnancies and was more common in multiparaous pregnant women; similar finding was reported by the study done in Qatar and it was indicated that the risk of GDM increases with number of pregnancy.[19]

In this study, GDM was associated with previous history of abortion; the odds of developing GDM was 3.5 times higher among women with previous history of abortion when compared with those who had no history of spontaneous abortion. This result is consistent with other study conducted in China and the study mentioned that previous history of spontaneous abortion was linked with elevatedpossibility of acquiring GDM.[20]

Family history of type II diabetes mellitus was linked with the occurrence of GDM. From other evidence,those mother with positive family history of type II diabetes mellitus have higher risk of developing GDM.[21]

Previous history of caesarean section wasindependently predictor of gestational diabetes mellitus. This result is consistent with studies conducted in different countries. A study conducted in South Eastern Nigeria suggested that there is a significant relationship between previous history of caesarean delivery and occurrence of gestational diabetes.[22] Similar findings have been stated in studies conducted in Tanzania[17] and India[23], GDM was significantly associated with previous history of caesarean sections. There was no statistically significant association between mid-upper arm circumference and high blood pressure with occurrence of GDM.

CONCLUSION

The finding of this study point out that, the prevalence of GDM is higher as compared to other studies conducted in the country. The proportion of gestational diabetes mellitus increases with increase in number of pregnancies and was more common in multiparaous pregnant women. Previous histories of spontaneous abortion, family history of type II

Table 3: Bivariate and multivariate logistic analysis of factors associated with gestational diabetes mellitus among participants, Wolaita zone, Southern Ethiopia, 2017

Variable	Category	Gestational diabetes mellitus		COR (95%CI)	AOR (95%CI)
		Yes N (%)	No N(%)		
Residence	Urban	15 (4)	361 (96)	0.8 (0.3, 2.0)	3.6 (0.4, 13.6)
	Rural	7 (4.9)	135 (98.1)	1	1
Previous still birth	Yes	8 (36.4)	37 (10.6)	4.8 (1.9, 12.3)	2.8 (0.2, 3.5)
	No	14 (63.6)	313 (89.4)	1	1
Previous spontaneous abortion	Yes	10 (45.5)	57 (16.3)	4.2 (1.8, 10.4)*	3.5 (1.7,14.6)*
	No	12 (54.5)	293 (83.7)	1	1
Birth weight of previous child	Less than 3999	14 (63.6)	228 (81.4)	1	1
	4000 gm or more	8 (36.4)	52 (18.6)	0.4 (0.2, 1.2)	0.7 (0.5, 1.8)
Previous caesarean section	Yes	12 (54.5)	48 (13.7)	7.5 (3.1, 18.4)*	7.5 (1.3,14.4)*
	No	10 (45.5)	302 (86.3)	1	1
Family history of type II DM	Yes	11 (50)	57 (13.7)	6.2 (1.4, 9.8)*	4.3 (1.3, 8.7)*
	No	11 (50)	359 (86.3)	1	1
MUAC	Less than 28 cm	13 (59.1)	346 (69.8)	1	1
	More than 28 cm	9 (40.9)	150 (30.2)	0.6 (0.3, 1.5)	0.9 (0.1, 1.8)

diabetes mellitus and previous caesarean delivery were found to be risk factors of gestational diabetes. Health care providers should promote blood glucose level testing and strengthen gestational diabetes mellitus screening based on risk factors and putting preventive measures in place is helpful to prevent long term effects of GDM on the mother and newborn.

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Authors Contribution:
EW- Conceived and designed the study, reviewed the literature, performed analysis and interpretation of data, prepared the manuscript and critical revision of the manuscript; **WD-** Assisted with the study design, analysis and interpretation and critical revision of the manuscript; **AR-** Assisted interpretation and critical revision of the manuscript.

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Original paper- Three

Effect of diabetes mellitus on pregnancy and birth outcome in Wolaita Zone, Southern Ethiopia: Retrospective cohort study

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Abstract

Background: Presence of diabetes mellitus (DM) during pregnancy is important cause of maternal and fetal complications. Studies that address the effect of DM on pregnancy and birth outcome are scarce in Ethiopia. The aim of this study was to determine the effect of DM on maternal and birth outcome in Wolaita Zone, Southern Ethiopia.

Methods: A retrospective cohort study was done to compare maternal and birth outcome of mothers with DM and non-DM who received maternity service in three hospitals and four health centers in Southern Ethiopia. A total of 136 exposed (with DM) and 272 unexposed (non-DM) mothers were included in the study. Data were extracted from medical records of mothers by experienced and trained data collectors. Means were compared for continuous variables. Logistic regression analysis model was used to check the effect of DM on pregnancy and birth outcome. Risk Ratio was calculated and P-value less than 0.05 was considered statistically significant.

Results: Pregnancy of diabetic mothers was significantly complicated by pre-eclampsia when compared with non-diabetic mothers, (RR= 2.8: 95% CI; 1.2-7.4). The risk of macrosomia was higher for neonates of diabetic mothers than non-diabetic mothers, (RR= 2.9: 95% CI; 1.4-7.1). From multivariate analysis, mothers with DM were 2.9 times more likely to be delivered by caesarean section than non-diabetic mothers (RR= 2.9: 95%CI; 1.3-6.2) and the risk of pre-term delivery was 2.5 times higher among mothers with DM, (RR= 2.5: 95% CI; 1.1-6.2).

Conclusions: Diabetes mellitus among pregnant mothers is associated with increased risk of pre-term delivery, macrosomia and maternal complications of pre-eclampsia and caesarian delivery. Early detection and management of DM should be one of the key activities to improve maternal and child mortality and morbidity.

Key words: Effect of diabetes, Diabetes in pregnancy, Birth outcome, Southern Ethiopia

Introduction

Diabtes mellitus in pregnancy can happen in two ways; one is pre-existing diabetes and the other is gestational diabetes mellitus (GDM). Pre-existing diabetes is also known as pre-gestational diabetes and refers to diabetes detected before pregnancy and diagnosed as type I DM, type II DM, or other rare types of DM. World Health Organization(WHO) defines GDM as 'any degree of glucose intolerance with onset or first recognition during pregnancy '[1,2]. The hormonal changes during pregnancy expose women to problem of carbohydrate metabolism and some pregnancy specific hormones can escalate the resistance to insulin [3].

According to international diabetes federation, magnitude of elevated blood sugar level during pregnancy in women 20–49 years was estimated to be 16.2% and affecting 20.9 million live births globally, in 2015, and about 75% of cases were expected to occur in countries of developing economies. In 2015, the estimate of high blood glucose level during pregnancy in Africa was 10.5% affecting 3.3 million live births [4].

Common feature of DM of any type is hyperglycemia and poorly controlled hyperglycemia is important cause of maternal and fetal complications among pregnant mothers. Regardless of the cause, hyperglycemia occurs among pregnant mothers can end in adverse obstetric and neonatal outcomes [5,6]. The magnitudes of abortion, preterm delivery, preeclampsia, perinatal mortality and congenital malformations are higher for pregnant mothers with DM compared to non-diabetic mothers [7, 9]

Elevated insulin level in the fetus that occurs in both pre-existing diabetes and GDM is associated with perinatal problems. These include; having big baby which can make difficulty of spontaneous vaginal delivery, neonatal hypoglycemia, preterm birth, hyper-bilirubinaemia and hypocalcaemia [10].

Pregnancy complications can be reduced by better control of blood glucose. Early identification, close monitoring and management of blood glucose level of expectant mothers having DM can meaningfully improve pregnancy and birth outcome [11].

Studies that address the effect of DM on pregnancy and birth outcome are scarce in Ethiopia. Understanding the contribution of DM in complications related to pregnancy and birth outcome

and documenting necessary information in the area is important to improve policy and programs related to maternal and newborn health. The aim of this study was to determine the effect of DM on maternal and birth outcome in Wolaita Zone, Southern Ethiopia.

Methods

Study setting

The study was conducted in three hospitals and four health centers in Wolaita Zone, Southern Ethiopia. Wolaita Zone is found in the South Central part of the country, 385 km distance from the capital, Addis Ababa. The Zone has total population of about 2 million in 2017 as projected from 2007 national census. There are 3 Hospitals, 70 health centers and 380 health posts in the study area and among these 12 Health Centers and all three hospitals provide diagnostic and management service for pregnant women with diabetes mellitus [12].

Study design and Population

Retrospective cohort study was done to compare maternal and birth outcome of mothers with DM and non-diabetic mothers who received maternity service in the study facilities over 18 months period from January1, 2017 to June 30, 2018. Exposed groups were women diagnosed with GDM during index pregnancy or who had pre-existing DM and women with neither GDM nor pre-existing DM were unexposed groups.

Sample size determination

Number of exposed and unexposed mothers has been calculated using Epi Info version 7 software. Two sided confidence level of 95%, power 80%, exposed to unexposed ration of 1:2, expected proportion of outcome in unexposed group was 31.8% and in exposed group found to be 46.6%. This was calculated according to the study conducted in Saudi Arabia by estimating the proportion of miscarriage among exposed and unexposed women [13, 14]. The final sample sizes used for the study were 136 exposed and 272 unexposed mothers with total sample size of 408.

Outcome measure

The study measured maternal and birth outcomes among exposed and unexposed groups. Maternal outcome was measured by obstetric complications including pre-eclampsia, caesarean

delivery, obstructed labour, postpartum hemorrhage, antepartum hemorrhage, maternal sepsis and maternal death. Neonatal outcome measures included in this study were macrosomia (birth weight≥4 kg), preterm delivery, still birth and early neonatal death.

Data Collection

Data were collected from the period of March to June 2018 from maternal registry and medical records of mothers who gave birth within 18 months period (January 1, 2017 to June 30, 2018) by using structured checklist. Data were extracted for exposed group and the medical records of randomly selected corresponding unexposed groups were reviewed with in the same period. Experienced and trained data collectors were involved in data collection process. The Supervisors ensured data completeness and consistency on daily basis.

Data analysis

Data entry and cleaning was done by Epi Info version 7 and data were analyzed using STATA version 14. Descriptive statistics was computed and presented. Means were compared for continuous variables. The number and percentage of outcome variables were calculated based on the exposure status. The demographic characteristics and the pregnancy outcomes of the women with DM were compared to the outcomes of all non-diabetic women who gave birth during the same period. Logistic regression analysis model was used to check the effect of diabetes mellitus on pregnancy and birth outcome. Risk Ratio was calculated and P-value of less than 0.05 was considered for statistical significance. Variance inflation factor (VIF) was used to check multicollinearity among variables and no multicollinearity was identified. Model fitness was evaluated by Hosmer-Lemeshow goodness-of-fit tests.

Ethical considerations

The study was approved by Institutional Review Board of College of Health Sciences, Addis Ababa University (Protocol number: 037/17/SPH, Data: June 2017). Wolaita Zone health department wrote letter of support to all study facilities and confirmed their willingness to conduct the research prior to the study. Permission was obtained from facility heads before reviewing medical records of mothers. Confidentiality of all the information obtained from medical records and registers was maintained.

Results

Socio-demographic and obstetric characteristics

The study included total of 408 mothers delivered in the study facilities from January 1, 2017 to June 30, 2018. Of these, 136 mothers had diabetes mellitus and 272 were non-diabetic women. Among mothers with diabetes mellitus, 23 (16.9%) had Type I DM, 36 (26.5%) had Type II DM, 72(52.9%) had GDM, and 5(3.8%) had been diagnosed with other rare type of diabetes.

Mean age (standard deviation) of mothers with DM was 28.9 ($\pm$5.0), and mean age (standard deviation) of mothers without DM was 26.1 ($\pm$4.8). Average number of pregnancies for mothers with DM was 2.6 ($\pm$1.2) whereas for mothers without DM was 1.9($\pm$1.1). The diabetic mothers were significantly older (p value=0.001); and they had significantly more pregnancies (p value=0.004) compared to the non-diabetic women. Almost all of mothers with DM and without DM (97.1% with DM and 99.3% without DM) were married and majority, were urban residents (Table 1).

Table 1 Comparison of maternal demographic characteristics between non-diabetic women, and women with diabetes mellitus from January 1, 2017 to June 30, 2018 in Wolaita Zone, Southern Ethiopia

Characteristics		Exposed (n=136) N (%)	Unexposed (n=272) N(%)
Age	16-20	7(5.1)	40(14.7)
	21-25	29(21.3)	103(37.9)
	26-30	58(42.6)	87(32.0)
	31-35	27(19.9)	29(10.7)
	>35	15(11.0)	13(4.8)
Marital status	Married	132(97.1)	270(99.3)
	Single	4(2.9)	2(0.7)
Residence	Urban	112(82.4)	201(73.9)
	Rural	24(17.6)	71(26.1)
Gravidity	One	28(20.6)	115(42.3)
	Two	39(28.7)	93(34.2)
	Three	39(28.7)	35(12.9)
	Four	15(11.0)	16(5.9)
	Five or more	15(11.0)	13(4.5)
Parity	Nullipara	35(25.7)	135(49.6)
	Para one	37(27.2)	73(26.8)
	Multipara (2-4)	55(40.4)	53(19.5)
	Grand multipara (≥5)	9(6.6)	11((4.0)

Maternal and fetal complications

One case of maternal sepsis occurred in mother with diabetes mellitus and one maternal death happened in both exposed and unexposed group which resulted in total pregnancy related maternal loss of two. Total of three early neonatal deaths reported for mothers with diabetes mellitus.

The proportion of pre-eclampsia and antepartum hemorrhage were higher among mothers with diabetes mellitus than non-diabetic mothers (9.6% versus 3.3%) and (4.4% versus 0.7%) respectively.

The study also documented that, higher proportion of women with diabetes mellitus had obstructed labor (5.9% versus 3.3%). Still birth rate for diabetic mother was higher, 4.4% than non-diabetic mothers, 1.8%. Table 2 below shows the proportion of maternal and birth complications among exposed and unexposed group.

Table 2: Maternal and birth complications of women with diabetes mellitus and non-diabetic women from January 1, 2017 to June 30, 2018 in Wolaita Zone, Southern Ethiopia

Characteristics		Exposed (n=136) N (%)	Unexposed (n=272) N(%)
Pre-eclampsia	Yes	13(9.6)	9(3.3)
	No	123(90.4)	263(96.7)
Still birth	Yes	6(4.4)	5(1.8)
	No	130(95.6)	267(98.2)
Macrosomia	Yes	16(11.8)	11(4.0)
	No	120(88.2)	261(96.0)
Pre-term delivery	Yes	15(11.0)	10(3.7)
	No	121(89.0)	262(96.3)
Antepartum Hemorrhage	Yes	6(4.4)	2(0.7)
	No	130(95.6)	270(99.3)
Post-partum hemorrhage	Yes	1(0.7)	1(0.4)
	No	135(99.3)	271(99.6)
Obstructed labour	Yes	8(5.9)	9(3.3)
	No	128(94.1)	263(96.7)
Caesarean delivery	Yes	28(20.6)	19(7.0)
	No	108(79.4)	253(93.0)
Early neonatal death	Yes	3(2.2)	0(0.0)
	No	133(97.8)	272(100.0)

Effect of diabetes mellitus on maternal and birth outcome

Pregnancy of diabetic mothers was significantly complicated by pre-eclampsia when compared with non-diabetic mothers, (RR= 2.8: 95% CI; 1.2-7.4). The neonates of diabetic mothers were significantly macrosomic, the risk is almost three fold, (RR= 2.9: 95%CI; 1.4-7.1). Although there was increased risk of having still birth and obstructed labour for exposed group of mothers, the differences were not statistically significant (Table 3). Multivariate model indicated that the risk of pre-term delivery is 2.5 times higher among mothers with diabetes mellitus when compared to non-diabetic mothers, (ARR= 2.5: 95% CI; 1.1-6.2) (Table 4). Mothers with diabetes mellitus were 2.9 times more likely to be delivered by caesarean section than non-diabetic mothers (ARR= 2.9: 95%CI; 1.3-6.2) (Table 5).

Table 3: Bivariate logistic regression analysis showing risk ration of maternal and birth outcome of mothers with diabetes mellitus and non-diabetic mother from January 1, 2017 to June 30, 2018, Wolaita Zone, Southern Ethiopia

Characteristics		Exposed (n=136) N (%)	Unexposed (n=272) N(%)	RR, 95% CI	p-value
Pre-eclampsia	Yes	13(9.6)	9(3.3)	**2.8(1.2, 7.4)***	0.0084
	No	123(90.4)	263(96.7)	1	
Still birth	Yes	6(4.4)	5(1.8)	1.7 (0.9, 2.9)	0.1303
	No	130(95.6)	267(98.2)	1	
Macrosomia	Yes	16(11.8)	11(4.0)	**2.9(1.4, 7.1)***	0.0031
	No	120(88.2)	261(96.0)	1	
Pre-term delivery	Yes	15(11.0)	10(3.7)	**3.1(1.3, 7.4)***	0.0035
	No	121(89.0)	262(96.3)	1	
Obstructed labour	Yes	8(5.9)	9(3.3)	1.4(0.8, 2.4)	0.2201
	No	128(94.1)	263(96.7)	1	
Caesarean delivery	Yes	28(20.6)	19(7.0)	**2.9 (1.5, 6.4)***	0.0001
	No	108(79.4)	253(93.0)	1	

Table 4: Multivariate logistic regression analysis showing risk ratio of pre-term delivery among mothers with diabetes mellitus and non-diabetic mother from January 1, 2017 to June 30, 2018, Wolaita Zone, Southern Ethiopia

Characteristics		Preterm delivery		ARR, 95% CI	p-value
		Yes	No		
Diabetes mellitus	Yes	15(11.0)	121(89.0)	**2.5 (1.1, 6.2)***	0.03
	No	10(3.8)	262(96.2)	1	
Pre-eclampsia	Yes	5(22.7)	17(77.3)	**4.2 (1.4, 12.9)***	0.01
	No	20(5.2)	366(94.8)	1	
Age category	<35	18(5.5)	306(94.5)	0.9(0.6, 1.5)	0.8
	≥35	7(8.3)	77(91.7)	1	
Parity	Nullipara	9(5.3)	161(94.3)	1.4(0.6, 3.3)	0.5
	Para one	6(5.5)	104(94.5)	1.7(0.3, 3.7)	
	Multipara	10(7.8)	118(92.2)	1	
Gravidity	Primigravida	7(5.0)	136(95.0)	0.7(0.4, 1.4)	0.4
	Multigravida	18(4.9)	347(95.1)	1	
Previous abortion	Yes	7(15.2)	39(84.8)	3.1 (0.8, 10.8)	0.1
	No	11(5.0)	208(95.0)		

Table 5: Multivariate logistic regression analysis showing risk ratio of caesarean delivery among mothers with diabetes mellitus and non-diabetic mother from January 1, 2017 to June 30, 2018, Wolaita Zone, Southern Ethiopia

Characteristics		Caesarean Delivery		ARR, 95% CI	p-value
		Yes	No		
Diabetes mellitus	Yes	28(20.6)	108(79.4)	**2.9(1.3, 6.2)***	0.006
	No	19(7.0)	253(93.0)	1	
Pre-eclampsia	Yes	5(22.7)	17(77.3)	1.3 (0.3, 5.1)	0.7
	No	42(10.9)	344(89.1)	1	
Age category	<35	36(11.1)	288(88.9)	0.8(0.6, 1.3)	0.4
	≥35	11(13.1)	73(86.9)	1	
Parity	Nullipara	12(7.1)	158(92.9)	0.6(0.3, 1.4)	0.2
	Para one	14(12.7)	96(87.3)	1.7(0.3, 3.7)	
	Multipara	21(16.4)	107(86.3)	1	
Gravidity	Primigravida	10(7.0)	133(93.0)	1.7(0.8, 3.2)	0.1
	Multigravida	37(14.0)	228(86.0)	1	
Previous abortion	Yes	8(17.4)	38(82.6)	1.8 (0.7, 5.3)	0.2
	No	29(13.2)	190(86.8)	1	
Macrosomia	yes	5(18.5)	22(81.5)	1.5(0.5, 4.5)	0.4
	No	42(11.0)	339(89.0)	1	

Discussion

This study revealed maternal and birth outcome of diabetic and non-diabetic mothers received maternity service in three hospitals and four health centers from January 1, 2017 to June 30, 2018 in Wolaita Zone, Southern Ethiopia. Total of 136 diabetic mothers and 272 non-diabetic mothers were included in the study. The finding indicated that women with diabetes mellitus were older and had higher number of pregnancies when compared to non-diabetic pregnant women.

In this study, one case of maternal sepsis occurred in mother with diabetes mellitus and one case of maternal death occurred in each of exposed and unexposed group which resulted in total maternal mortality of 2 cases out 408. Total of three early neonatal deaths reported for mothers with diabetes mellitus. Although it is not possible to do statistical analysis, all of early neonatal deaths occurred in mothers with diabetes mellitus. Higher risk of fetal loss, perinatal death, and still birth for women with DM were documented in a conducted in the United Kingdom [15]. It was reported that neonatal mortality was found to be higher among infants of diabetic mothers than non-diabetic women [16]. Another evidence also indicated that DM is linked with increased risk of stillbirth and neonatal mortality [17].

The study indicated that the proportion of pre-eclampsia and antepartum hemorrhage were higher among mothers with diabetes mellitus than non-diabetic mothers. Based on our study, the pregnancy of diabetic mothers was 2.9 times more likely complicated by pre-eclampsia than non-diabetic mothers. Another study also reported that, pre-eclampsia and postpartum hemorrhages are more likely to be found in pregnancies complicated by diabetes [18].

Compared to non-diabetic group, the likely hood of women with DM to be delivered by caesarean section was doubled. Study from Saudi Arabia showed 50% of women with diabetes had caesarean section delivery; while the analogous figure for non-diabetic women was less than 20% [13]. This may be associated with high blood sugar of diabetic mothers can be moved to the fetus by crossing placenta and this can elicit increased insulin level in the fetus and this in turn can result in increased fetal growth. Evidences reported that, having big baby and caesarean delivery were linked with increased maternal blood sugar level [19]. The finding of this study showed that, newborns of diabetic mothers had considerably higher birth weight compared to

those of non-diabetic mothers; this indicated that the neonates of mothers with diabetes mellitus were significantly macrosomic; the risk is almost two fold.

The risk of pre-term delivery is 2.5 times higher among mothers with diabetes mellitus when compared to non-diabetic mothers. Although there was increased risk of having still birth for exposed group of mothers, the differences were not statistically significant. Hyperinsulinemia in the fetus can affect lung maturation by hampering surfactant production from alveolar cells and can result in respiratory problems. Respiratory distress among newborns of mothers with DM can occur six times more likely compared with their counterparts [20]. A study conducted in Saudi Arabia revealed that pre-existing diabetes mellitus is associated with increased risk for macrosomia, stillbirth and preterm delivery [13].

There were limitations during the process of conducting this study. The issue of data incompleteness was one of the limitation s of the medical record review , but the potential limitation was minimized by careful abstraction of data from all potential medical records. Medical records of mothers who received maternity care in health facilities were included and assessed for the presence DM and its effect, so those did not receive care at health facilities were not included in our study.

Conclusion and Recommendations

The result of this study showed that women with diabetes mellitus were older and had higher number of pregnancies when compared to non-diabetic pregnant women. Diabetes mellitus among pregnant mothers is associated with increased risk of pre-term delivery, macrosomia and maternal complications of pre-eclampsia and caesarian delivery. So, diabetic mothers and their offspring are at increased risk of adverse pregnancy outcomes compared with non-diabetic mothers. Early detection and management of diabetes mellitus should be one of the key activities to improve maternal and child mortality and morbidity.

Abbreviations: DM: Diabetes mellitus, GDM: Gestational diabetes mellitus, RR: Relative risk; CI: Confidence interval; VIF: Variance inflation factor; WHO: World Health Organization

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Availability of data and materials: The data sets used and/ or analyzed are available from the corresponding author on reasonable request.

Authors' contributions: EW conceived and designed the study, involved in data collection, performed analysis and interpretation of data, and drafted the manuscript. WD and AR assisted with the study design, analysis and interpretation. All authors participated in critical appraisal and revision of the manuscript. All authors approved and read the final manuscript before submission.

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Original Article

Barriers for detection and management of gestational diabetes mellitus in southern Ethiopia: A qualitative study

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) complicates the health of mother and child not only in the short term but also in the long term basis. Addressing GDM through early detection and proper management is vital to improve maternal and child health. Identifying existing barriers for detection and management is important for policy improvement. This study aims to explore barriers for detection and management of GDM in Wolaita Zone, Southern Ethiopia.

Methods: A qualitative study was conducted. Health professionals working in antenatal clinic, delivery, and other maternal health services were selected purposively. A total of 18 in-depth interviews were done. The transcripts were imported into NVIVO version 12 software packages. A qualitative thematic analysis approach was used to analyze the data.

Results: Screening of women for GDM was done based on the risk factor assessment within 24–28 weeks of gestational age. The participants mentioned that they made diagnosis of GDM based on the World Health organization criteria. Barriers for detection and management of GDM include; lack of standard guidelines and protocols, lack of awareness among mid-level health care providers on GDM, inadequate trained health care providers, shortage of supplies and equipment and late antenatal care visits.

Conclusions: Policy makers and health care leadership need to address challenges by availing standard guidelines and protocols, providing on job training for health care providers, fulfilling supplies and consumables and working on early antenatal visits of pregnant mothers.

1. Introduction

Gestational diabetes mellitus (GDM) affects the health of mother and child not only in the short term but also in the long term basis. Women with GDM have increased risk of developing obstetric complications [1,2]. The occurrence of type II diabetes mellitus in future life among mother with GDM is higher [3,4].

Newborns of mothers with GDM are at higher risk of different complications like being delivered preterm, being macrosomic or suffering from hypoglycemia, jaundice or respiratory distress. Maternal complications of hypertension, obstructed labour, post-partum hemorrhage and caesarean section delivery are more likely to happen because of GDM [5].

Evidences indicated that controlling blood glucose level with lifestyle modifications and/or drug treatment like insulin during pregnancy considerably reduces the risk of adverse pregnancy outcomes. It is common to have normal glucose level among women with GDM after giving birth, but short term and long term complications that can happen in both mother and child can worsen the condition. Detection and management of mothers with this problem has opportunities and challenges [6,7].

Management of GDM like appropriate antenatal screening and diagnosis, early initiation of treatment options, and follow-up after child birth and preventive care are essential. It is suggested to use consistently valid simple screening and diagnostic criteria for detection of GDM [8].

In some countries with poor obstetric service and lack of appropriate newborn care, GDM may have particularly severe consequences for the health and well-being of the mother and child. GDM therefore accounts an unrecognized challenge to maternal and neonatal health in low and middle income countries. Tackling the problem related to GDM by timely detection and

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suitable management therefore could have good opportunity to improve maternal and child health.

To be able to plan appropriate strategies to address these issues will require better understanding of the existing gaps in detection and treatment of GDM.

This study aims to explore detection and management modalities of GDM in Wolaita Zone, Southern Ethiopia.

2. Methods

2.1. Study setting

The Southern Nations, Nationalities, Peoples Region (SNNPR) is one of the nine regions in Ethiopia and it consists of many different languages and ethnic groups within own diverse culture. The area of the region covers 10% of the national landmass and its boundary shows there is Kenya to the south, Sudan to the southwest, Gambela regional state to the west and Oromia regional state to the north and North-East. The region is composed of 13 zones and 104 Districts, of which Wolaita Zone is the one and situated in the south central part of the region 385 km distance from Addis Ababa and 165 km south west of the regional capital, Hawassa. The population of the zone is estimated to be 2 million (51% were females) (Population for census 2007). Wolaita zone is one of the most densely populated areas in the country with an average of 640 people living per square kilometer.

The study area in general has 12 administrative districts and three town administrations. Likewise this area share 3 Hospitals, 70 health centers and 380 health posts, among these 12 Health Centers and all three hospitals provide diagnostic and management care for pregnant women with diabetes mellitus. Total number of pregnant women in the zone is 66,646 [9]. Data were collected in two months period from January to February 2018.

2.2. Study design

A qualitative study with descriptive approach was used. This approach involves trying to understand the essence of issue by examining the experience of health care providers and leadership who have been involving in maternal and child care.

2.3. Participant selection and sample size

All study participants were selected purposively. Health professionals working in antenatal care, delivery, and other maternal health services were included. Those working in the area of health care leadership were also included in the study. Total of 18 in-depth interviews were conducted with health care providers and leadership.

2.4. Data collection

Conducting in-depth interview was chosen as the data collection method to capture practices and experiences related to detection and management of gestational diabetes. This method elicits candid responses in a private setting regarding professional topics of discussion. It is useful to have each participant has more time and opportunity to share feelings, perspectives, and experiences concerning the problem. The interviewers had plenty of time to probe and obtain in-depth responses since respondents tend to express themselves more freely.

Again this method is appropriate for this study since we are interviewing someone with specific knowledge and experience concerning the issue and it is better suited to sitting down one-on-one. It also allows considerable opportunity to probe answers and for intensive investigation of individual experiences and thoughts. Semi structured check list was used to collect data. Data collectors with past experience were trained in (on study overview, objectives, participant selection, detailed tool review, interview approach, and role play of interview skills). Supervision was conducted throughout data collection time. The interview was audio-recorded by using digital recorder. Transcriptions and translations were spot-checked for accuracy by supervisors.

2.5. Data analysis

Prior to analyzing the data, in-depth interviews were transcribed and translated into English. A qualitative thematic analysis approach was used to analyze the data. The transcripts were transferred into NVIVO version 12 software packages. Data coding was done in each categories by using the software. Once coding was complete, code reports were produced for each code, cleaned and prepared for synthesis. During synthesis and write up meaning units were identified in relation to the aim of the study. Emerging meaning units that were extracted from each topic of the analysis coded and then combined together to form categories depending on their differences and similarities.

2.6. Ethical considerations

Ethical clearance was obtained from Institutional Review Board of College of health Sciences, Addis Ababa University. Permission was obtained from Wolaita Zone Health Department and respective health facilities. All participants were informed about the purpose and advantage of the study, being the anonymity and the right to refuse at any stage of the interview and procedure. Confidentiality of the responses was assured, and verbal consent was obtained prior to data collection.

3. Results

3.1. Background of participants

This qualitative analysis was made using the transcripts of 18 in-depth interview participants. The participants were physicians, nurses and midwives who were involved in providing maternal and child health services in Wolaita Zone, Southern Ethiopia. All participants told us their socio-demographic information. Accordingly, all informants 6 of the participants were females and the rest were males with in age range 26–48. Regarding their profession, obstetricians [6], general practitioners [4], midwifes [3], and clinical nurses [3] and health officers [2] were involved and their experience ranged from 4years to 16 years.

3.2. Detection of GDM

Participants were asked about detection method of GDM in their respective health facilities. All participants mentioned that screening of women for GDM based on the risk factor assessment known as selective screening. According to participants, health care provider screen pregnant mothers with one or more risk factors within 24–28 weeks of gestational age. The participants also mentioned that they made diagnosis of GDM based on WHO criteria. The participant from Wolaita Sodo University teaching referral hospital indicated detection method of GDM as follows;

> *"Here in our hospital we use selective screening method to detect GDM. We understand that GDM has negative consequences both for mother and fetus if not detected early. We screen selectively by asking past history of having big baby, family history of diabetes*

and obesity. We will focus our screening from 24-28 weeks of gestational age. Physicians working in antenatal care screen mothers by testing blood sugar level" (Male physician, aged 36)

The reason for selecting selective screening was explored in the interviews. The main reason given by the respondents as to why selective screening was preferred and used was the issue of cost-effectiveness, but some participants strongly suggest universal screening of all pregnant mothers during antenatal by considering the seriousness of the problem.

The participant from Sodo Christian Hospital noted that;

"We do screening selectively, by considering history of still birth, having big baby, age greater than 35 and family history of type II diabetes. In general we follow selective screening technique because of cost but it is better to do universal screening for all pregnant mothers during antenatal care for better detection" (Female midwife, aged 28).

Another participant also reported that the problem is becoming common and including GDM screening as baseline investigation for all pregnant mothers is important. According to the participant, mothers are not screened consistently in the facility like other investigations and he said;

"This case is very common in our health facility; we commonly detect GDM during ANC care. But screening is not routine and consistent, not assessed as base line. We screen mothers when there is complication and high level of suspicion, otherwise we do not consider it as baseline assessment during ANC. It is better if we include it as baseline assessment for all antenatal attendants" (Male Obstetrician, aged 40).

Respondents were nearly unanimous that they screen the women at 24–28 weeks of gestation and they also emphasised that it is not always possible to screen the women in this period of pregnancy because of late antenatal visit.

" According to the recommendation, we try to do screening at 24–28 weeks of gestational age but the problem most mothers are not visiting ANC clinic at early time, some may visit health facilities during late third trimester, this is also one challenge" (Male midwife, aged 32)

3.3. Barriers and challenges to early detection and management of GDM

Participants pointed some barriers and challenges for detection and management of GDM. These include; lack of standard guidelines and protocols, lack of trained health care providers, shortage of supplies and equipment and late antenatal care visits.

Participants were asked a series of questions about guidelines and clinical standards relevant to detection and management of GDM. Many of the respondents noted that lack of standard protocols and guidelines for detection and management of GDM is one barrier. They explained that in absence of standards, screening of women will take place based on subjective judgement of providers. One of the participants explained the issue as follows;

"*In our hospital, we don't have guideline specific to GDM screening and management unlike other obstetric complications. No standard available regarding GDM, I hope the government will provide these things in future*" (Female Midwife, aged 32)

Another participant from health canter echoed that lack of standard protocol is challenge for detection and management of GDM, and he said;

"*There is no standard or guideline for screening of GDM in our health centre. Low attention is given providers, it is not considered as serious problem; I think this is the reason why for lack of awareness creation activities, lack of guidelines and standards and so on*" (Male Nurse, aged 27)

Lack of trained health care providers was mentioned as one problem for detection and management of GDM, according to the participants. They mentioned that there is lack of awareness among health care providers particularly mid-level providers in facility and the major reason for this was lack of on job training on detection and management of GDM. Training, seen as a critical component of strengthening detection and management of GDM was sorely lacking, and respondents called for training at all levels.

"*Firstly, on job training is important on screening and management of GDM. There is different training in other area but training on GDM doesn't exist. Specially, training is necessary for mid- level workers since they encounter mothers during antenatal care, there should be awareness on GDM detection*" (Male obstetrician, aged 34)

Another participants saw staff training as mandatory for service provision and specifically specialized training in detection and management of GDM including refresher training that did not currently exist; he said,

"*There is shortage of trained providers here. The reason is, there is no special on job training concerning GDM detection and management, so it is better to provide on job training for health care workers, we are providing care from our knowledge of academic training; as to me refreshment training is necessary to all providers,* we don't have training on GDM, *for example there is continuous training on issues like PICT, HBV, VDRL but no training provided on detection and management of GDM*" (Male general practitioner, aged 32)

Lack of supplies and equipment were also reported as challenges for screening and management of GDM. Shortage of supplies and infrastructures include space, laboratory reagents and glucose solutions were found to be challenges for detection and management of GDM.

"*There is also shortage of supplies like oral glucose preparation. We prepare oral glucose solution, but it is better to access glucose solution for screening of GDM. Lack of space/room is another challenge to follow high risk mothers in separate room. So it better to fulfil supplies and equipment for better care and management*" (Female general practitioner, aged 29).

Health care providers explained that most pregnant women do not attend antenatal care in the recommended gestational period for GDM screening; late antennal visit is common and this is another challenge for early detection of GDM. They also noted that larger proportions of women attend antenatal visits at health posts and health centers and providers in these facilities have relatively lower experience of detection and management of GDM. One of the participants noted the issue as follows;

"*Another big challenge is late antenatal visit; mothers attend antenatal care during late pregnancy and this is not ideal time of recommendation for screening. Some mothers visit health facilities during the time of delivery. Most ANC visit takes place at health centre and health centre is staffed with mid-level health care providers who have lower awareness of GDM screening*" (Male Obstetrician, aged 38)

Another participant also noted that late antenatal visit is challenge to screen mothers for GDM and he said;

"*For me detection rate of GDM is very low but the problem is common here. The other problem is there is no appropriate ANC follow up, our report might seem good concerning ANC follow up but in reality what I observe is there is huge gap and awareness problem among mothers on ANC. It is better to do awareness creation on community about the problem because the magnitude of the problem is increasing from time to time*' (Male Obstetrician, aged 42).

4. Discussion

This study aimed to explore barriers for detection and management of GDM in health facilities of Wolaita Zone, Southern Ethiopia. The participants were physicians, nurses and midwives who were involved in providing maternal and child health services in the study area. The findings revealed that screening of women for GDM was done by based on the risk factor assessment or selective screening. Health care providers screen pregnant mothers with one or more risk factors within 24–28 weeks of gestational age. The participants also mentioned that they made diagnosis of GDM based on WHO criteria. The WHO diagnostic criteria are generally accepted in many countries in the world including many African countries [10,11]. In most developing nations where funds are limited, it is common to screen pregnant women for GDM based on availability of risk factors in selective manner during antenatal care [12,13].

Findings from this study showed that health care providers use dietary modification and exercise as first stage of treatment and they use insulin if is not possible to control blood glucose level by diet and exercise. Blood glucose level monitoring, life style modifications like exercise and nutritional advice are important part of recommended management protocols for mothers with GDM. Treatment starts with medical nutrition therapy, exercise, and glucose monitoring and insulin can be used if these methods fail to maintain normal glucose level [14].

Our study reveals that providers in health facilities face many challenges related to screening and management of GDM. Lack of standards and guidelines and inadequate on job training on GDM are among repeatedly mentioned obstacles. According to our participants, health facilities that provide maternity care should have standard protocol for detection and management of GDM. However, all the participants noted that there is no standard protocol to screen and manage pregnant mothers with GDM. According to the participants, it is possible to find undiagnosed and untreated mothers or late diagnosis with possible complications.

Guidelines are important for effective screening and management of GDM during pregnancy and this is helpful to ensure good pregnancy outcome. In addition, it is important to prevent long term complications of GDM like preventing future progression to type II diabetes [15,16].

In countries like Ethiopia, a lot should be done to reduce maternal and neonatal mortality to acceptable level; there should be continuous improvement to avail better access of obstetric care. However, the situation is challenged by additional burden of non-communicable diseases worsening the health of mothers and newborns in low and middle income countries [17]. To increase awareness and improve detection of GDM in pregnancy, providing training for mid-level health care providers could be helpful and this has already been practiced in countries like India and screening is done by mid-level at first level care [18].

In addition, findings from this study also illustrate that health facilities have shortage of supplies, consumables and properly equipped laboratories and considered as barriers for early detection and management of GDM. So, health system planners and leadership should consider fulfilling essential supplies for screening of GDM.

The issue of pregnant women not attending antenatal care in the recommended gestational period for GDM screening was another challenge for early detection of GDM. According to participants the pregnant women do not always attend the antenatal care clinic in the optimal time for the GDM screening. World Health Organization (WHO) focused antenatal guideline recommends screening of mothers for GDM as baseline investigation for all mothers during antenatal visit [19].

5. Conclusion and recommendations

Selective screening based on one or more risk factors within 24–28 weeks of gestational age was used to detect GDM in study area. The diagnosis of GDM was made based on WHO criteria. Lack of awareness on treatment options of GDM among mid-level workers was reported. Providers face various challenges related to detection and management of GDM. Commonly reported challenged were lack of standard guidelines and protocols, lack of trained health care providers, shortage of supplies and equipment and late antenatal care visits. Policy makers and health care leadership need to address these challenges by strengthening the health care system by availing standard guidelines and protocols for detection and management of GDM, providing on job training for health care providers, fulfilling supplies and consumables and working on early antenatal visits of pregnant mothers.

Authors' contributions

EW conceived and designed the study, involved in data collection, performed analysis and interpretation of data, and drafted the manuscript. WD and AR assisted with the study design, analysis and interpretation. All authors participated in critical appraisal and revision of the manuscript. All authors approved and read the final manuscript before submission.

Data availability

Data are available from corresponding author up on request.

Conflicts of interest

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2019.04.005.

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Annex II: Study Instruments

I. Facility consent sheet for data abstraction

Diabetes mellitus among pregnant women and its effect on maternal and birth outcome in Wolaita zone, Southern Ethiopia.

This document invites this facility to participate in the study aimed to assess the Magnitude of Diabetes Mellitus among Pregnant Women and its Effect on Maternal and Birth Outcome in Wolaita Zone, Southern Ethiopia. The study has important contribution by providing information on diabetes mellitus among pregnant women and for future mitigation of the problem and to improve maternal and newborn health. Your facility was selected as candidate for this study randomly.

For the purpose of this study, different registers of the health facility like antenatal register, delivery register, patient charts etc will be used. The information gained from this facility will not be used for any purpose other than the objective of the study. Any information that is obtained in this assessment will be kept completely confidential.

We, the investigators encourage the participant/facility to ask any questions regarding the study that he/she might have at this time. If the facility has any further question in the future, Mr. Eskinder Wolka, who is the principal investigator of the study will be available to respond to them. The facility will be given a copy of this form to retain for his/her records.

Any individual who has questions regarding this study should contact Mr. Eskinder Wolka, PI of this research, Tel-0911967748.

II. Data extraction checklist

General instruction: This check list is prepared to collect data from different charts of mothers about pre-existing diabetes mellitus among pregnant women. Consult all necessary registers (antenatal care register, delivery register, postnatal register and other charts of mothers) to fill the check list below. Put the response for each question in the appropriate space given. As part of research team, you are responsible to adhere to ethical issues in maintaining confidentiality and hand over the charts to appropriate body and place immediately after taking the necessary information and acknowledge the staffs of health facility.

Part I Socio-demographic characteristics

S.No	question	Response	Remark
101	Record ID	_____	
102	Mother's age (in years)	_____ years	
103	Address	1. Urban 2. Rural	
104	Current Marital status	1.single 2.married 3.divorced/separated 4.widowed	
105	Mother's educational status	1.illitrate 2.read and write only 3.Primary 4.Secondary	

		5. Above secondary	
106	Occupation of mother	1.House wife 2.Gov't employee 3.merchant 4.daily laborer 5.other(specify)_____	

Part II- Obstetric History

S.No	question	Response	Remark
201	Gravidity	1. One 2. Two 3. Three 4. Four 5. Five or more 9. No information	
202	Parity of the woman (of index pregnancy)	1. Nullipara (this was her 1st delivery) 2. Para 1 (one previous delivery before this one) 3. Multipara (2-4 previous deliveries) 4. Grand multipara (≥ 5 previous deliveries) 9. No information	
203	Gestational age	1. Preterm (< 37 weeks) 2. Term (37-42 weeks)	

		3. Post term (> 42 weeks) 9. No information	
204	Previous abortion (before index pregnancy)	1. Yes 2. No 9. No information	
205	Previous still birth (before index pregnancy)	1. Yes 2. No 9. No information	
206	Mode of delivery of index pregnancy	1. Spontaneous Vaginal Delivery(SVD) 2. Instrumental delivery 3. Caesarean section 9. No information	
207	Hypertensive disorders of pregnancy	1. Yes 2. No 9. No information	

Part III- Maternal and Birth Outcome

S.No	question	Response	Remark
301	Direct Maternal Complications	Yes No Antepartum hemorrhage 1 2 Postpartum hemorrhage 1 2 Retained placenta 1 2 Prolonged/obstructed labor 1 2 Ruptured uterus 1 2 Postpartum sepsis Severe pre-eclampsia /eclampsia 1 2 Severe abortion complications (severe hemorrhage, infection/sepsis, uterine perforation, organ injury) 1 2 Ectopic pregnancy 1 2 Other direct obstetric 1 2	

		complications	
302	Maternal condition	1. Alive 2. Dead 9. No information	
303	Newborn condition	1.Live birth 2.Still birth 3.Early neonatal death 4.Congenital malformation 9. No information	
304	If live birth, weight of newborn	1. 2500-4000gm 2. 1500-2499gm 3. <1500gm 4. >4000gm 9. No information	

Part IV- Diabetes Mellitus Related Questions

S.No	question	Response	Remark
401	Is the mother diabetic?	1. Yes 2. No 3. No information	
402	If "Yes", type of diabetes	1. Type I 2. Type II 3. Gestational DM 4. Other type	
403	Duration since diagnosis	1. <one year 2. 1-2 years	

		3. >2 years	
404	Family history of DM	1. Yes 2. No	
405	Previous history of GDM	1. Yes 2. No	

III. Information sheet, consent form and structured questionnaire

Information sheet

Greeting: Hello, my name is _____ I am one of the data collectors for the study entitled "Diabetes mellitus among pregnant women and its effect on maternal and birth outcome in Wolaita zone, Southern Ethiopia" The principal investigator of the study is Mr. Eskinder Wolka who is PhD student in School of Public Health, College of Health Sciences, Addis Ababa University. The information you will provide is very important to know the Prevalence of Gestational Diabetes among pregnant women and associated risk factors. It is also important to mitigate the problem in the future and to improve maternal and newborn health by government and other organizations accordingly. The study will be conducted through face to face interview and it also involves pregnant women on screening of gestational diabetes mellitus. For GDM screening, Oral glucose will be administered, capillary glucose level will be measured at 0hr and 2hr by taking blood samples using finger prick with a sterile lancet. There are no serious risks associated with your participation in this study except it takes about two hours and minor discomforts of screening procedures. Whatever information you provide will be kept strictly confidential and will not be shown to other persons. Participation in this study is voluntary and you can choose not to involve in any part of the study or you cannot answer some or any individual questions or all of the questions. However, we hope that you will participate fully in this assessment since your views are important.

If you have any questions regarding the study or would like to be informed of the result after its completion you can contact the principal investigator.

Address of the principal investigator:

Eskinder Wolka

Mobile phone: 0911967748

E-mail: eskwolka@yahoo.com , wolkaeskinder@gmail.com

Are you willing to participate in this study?

1. Yes…….Continue to the next part

2. No……..skip to next participant

Consent form

In signing this document, I am giving my consent to participate in the study entitled "Diabetes mellitus among pregnant women and its effect on maternal and birth outcome in Wolaita zone, Southern Ethiopia".

I have informed that the purpose of this study is to assess the prevalence of gestational diabetes among pregnant women and associated risk factors in Wolaita zone. I have understood that participation in this study is entirely voluntary. I have been told that my answers to the questions will not be given to anyone else and no reports of this study identify me in any way. I have also informed that my participation or non-participation or my refusal to answer question will have no effect on me. I have also informed that I will involve in screening of gestational diabetes by oral glucose tolerance test. In addition, I understood that participation in this study does not involve serious risks.

Participant signature_____

English version questionnaire to assess the Prevalence of Gestational Diabetes Mellitus among pregnant women in Wolaita Zone, Southern Ethiopia.

Study identification

001. Facility ID_____	003. Interviewer: Name_____ Sign____
002.Participant's ID_____	004.Supervisor: name_____ Sign____
003. Date of Interview _____	005 Time of interview :Started_____ Completed_____

Visiting table

	Visit 1	Visit 2	Visit 3(if any)
date			
Result*			

*Result code 1=Complete 2=Incomplete

3=Respondent not available 4= Other, specify_____

Part I: socio demographic and economic characteristics of mothers

S.No	Question	Response	Remark
101	How old are you?	_____ years	
102	Where is your residence?	1. Urban 2. Rural	
103	What is your marital status	1.Single 2.Married 3.Divorced 4. Separated 5. Widowed	
104	What is your religion?	1.Protestant 2.Orthodox 3.Catholic 4. Muslim 5.other(specify)_____	
105	Mother's ethnicity	1.Wolaita 2. Gamo 3. Amhara 3. Guraghe 6.other(specify)_____	

106	What was the last year of schooling that you finished?	1.illitrate 2.read and write only 3.primary 4.secondary 5. above secondary	
107	What is your occupation?	1.House wife 2.Gov't employee 3.Merchant 4. Non-government employee 5.Daily laborer 6.Other(specify)_____	
108	What is your spouse's education level?	1.illitrate 2.read and write only 3.primary 4.secondary 5. above secondary	
109	What is your spouse's occupation?	1.Gov't employee 2. Merchant 3. Non-government employee 4. Daily laborer 6.Other(specify)_____	
110	What is your monthly house hold income?	_____Birr 98. Don't know	

111	How many children do you have currently?	_____ no. of children	
112	Does your house hold have	yes no Radio……1 2 TV……1 2	

Part II: Maternal Obstetric and Medical history

201	Gravidity	1. One 2. Two 3. Three 4. Four 5. Five or more	
202	Parity	1. Nullipara (this was her 1st delivery) 2. Para 1 (one previous delivery before this one) 3. Multipara (2-4 previous deliveries) 4. Grand multipara (≥ 5 previous deliveries)	
203	Gestational Age	_____weeks	
204	Birth weight of previous child	_____gms	
205	Previous still birth	1. Yes 2. No	

206	Previous Abortion	1. Yes 2. No	
207	Previous history of caesarean section	1. Yes 2. No	
208	Previous history of gestational DM	1. Yes 2. No	
209	Family history of DM	1. Yes 2. No	

Part III: Gestational Diabetes screening and Other Measurements

301	Fasting blood glucose (mmol/L)		
302	Blood glucose 2-hr OGTT (mmol/L)		
303	MUAC (cm)		
304	Systolic BP (mmHg)		
305	Diastolic BP (mmHg)		
306	Hypertension (Yes/No)		
307	GDM (Yes/No)		

IV: Amharic Version Questionnaire for Interview Part

መረጃና የፊቃደኝነት ማረጋገጫ

እንደምን አደሩ፤እንደምንዋሉ?

እኔ.....እባላለሁ፡፡ በነፍሰጡር እናቶች የስኳር በሽታ ስርጭትና በእናትዩዋና ፅንሱ ላይ ያለዉን ተፅዕኖ በሚመለከት በወላይታ ዞን ጥናት እየተደረገ ስሆን እኔ ከመረጃ ሰብሳቢዎች አንዱ ነኝ፡፡ ጥናቱን በዋናነት የሚመሩት በአዲስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ በህብረተሰብ ጤና አጠባበቅ ትምህርት ቤት የPhD ተማሪ የሆኑት አቶ እስክንድር ወልቃ ናቸዉ፡፡ እርስዎ የምሰጡት መረጃ የበሽታዉን ስርጭትና ለሽታዉ የምያጋልጡ ነገሮችን ለማወቅ በጣም ጠቃሚ ነዉ፡፡ ይህ ደግሞ በሽታዉን ለመከላከልና የእናቶችና የጨቅላ ህጻናት ጤና ለማሻሻል፤ መንግስታዊና መንግስታዊ ላልሆኑ እንድሁም ለሎች በጉዳዩ ለምሰሩ ተቋማት አጋዥር ይሆናል፡፡ ስለሆነም ይህ ጥናት የሚካሂደዉ አንዳንድ ጥያቄዎችን በመጠየቅና በእርግዝና ጊዜ ልመጣ የምችለዉን የስኳር በሽታ ምርመራ በማድረግ ነዉ፡፡ የስኳር በሽታ ምርመራ ለማድረግ 75 ግራም የምጠጣ ግሉኮስ ተሰጥቶ ከጣትዎ ደም ናሙና ተወስዶ ምርመራ ይደረጋል፡፡ በዚህ ጥናት በመሳተፍዎ የሚመጣ ከባድ ጉዳት የለም ነገር ግን ከጣትዎ ደም ናሙና ስወሰድ የሚሰማ የህመም ስመት፤ መጠይቁና የደም ናሙና ዉጤት እሰከሚታወቅ 2 ሰዓታት ያህል ሊፈጅ ይችላል፡፡ በዚህ ጥናት ለመሳተፍ በቅድሚያ የተሳታፊዉን ፍቃደኝነት እንጠይቃለን፡፡ ስሞት ወይም እርስዎን የሚገልጽ መረጃ በጥናቱ ዉስጥ አይካተትም፤የሰጡኝን መረጃ ሁሉ በምስጢር ለመጠበቅ ቃል እገባለሁ፡፡ መልስ መስጠት የማይፈልጉ ጥያቄ ካለ ለመመለስ አይገደዱም፡፡ በፈለጉት ጊዜ መጠይቁን የማቋረጥ መብት የተጠበቀ ይሆናል፤ ሆኖም ግን ትክክለኛ መረጃ መስጠት በሽታዉን ለመከላከልና የእናቶችና የጨቅላ ህጻናት ጤና ለማሻሻል ከፍተኛ ጥቅም ስለሚኖረዉ የርስዎ ተሳትፎ እጅግ በጣም ያስፈልጋል፡፡ በተጨማሪም ከጥናቱ ጋር በተያያዘ ማብራሪያ ከፈለጉ ወይም ጥያቄ ካሎት ጥናቱን በዋናነት የሚመሩትን ቀጥሎ በተገለጸዉ አድራሻ ማግኘት ይችላሉ፡፡

አቶ እስክንድር ወልቃ ስልክ ቁጥር 0911967748 **ኢ-ሜይል አድራሻ** eskwolka@yahoo.com **ወይም** wolkaeskinder@gmail.com

በዝህ መሰረት በጥናቱ ለመሳተፍ ፍቃደኛ ነዎት;

1. **አዎን** 2. **አይደለሁም**

የስምምነት ፍርማ

እኔ ከዚህ በታች የፈረምኩት ከላይ የተገለጸዉን በነፍሰጡር እናቶች የስኳር በሽታ ስርጭትና በእናትዩዋና ፅንሱ ላይ ያለዉን ተፅዕኖ በሚመለከት ስለሚደረገዉ ጥናት የጥናቱን ዓላማ ተረድቼ በጥናቱ ለመሳተፍ መስማማቴን በፍርማዬ አረጋግጣለሁ፡፡

ፍርማ----------

<u>የመጠይቅ መለያ</u>

ተ.ቁ	ጥያቄ		
001	የጤና ተቋም መለያ ቁጥር	----/----	
002	የመጠይቅ መለያ ቁጥር/ኮድ	----/----/----/----/----	
003	መረጃ የተሰበሰበት ቀን	……/……/……..	
004	የመረጃ ሰብሳብ ስምና ፊርማ		
005	የተቆጣጣሪዉ ስምና ፊርማ		
006	መጠይቁ የተጀመረበት ሰዓት		
	መጠይቁ የተጠናቀቀበት ሰዓት		

<u>ክፍል አንድ: ማህባረዊና ኢኮኖሜያዊ ሁኔታዎች የሚደስስ መጠይቅ</u>

መመሪያ፡- ለሁሉም ምርጫ ጥያቄዎች መልሱ አክብብ ለክፍት ጥያቄዎች በተሰጠዉ ቦታ መልሱን ጻፍ!!!

ተ.ቁ.	ጥያቄ	መልስና የኮድ ምድብ	የሚዘለሉ
101	ዕድሜዎት ስንት ነዉ ?	_____ በአመት	
102	የሚኖሩበት ቦታ የት ነዉ?	3. ከተማ	

		4. ገጠር	
103	የጋብቻ ሁኔታ	1. ያገባች 2. ያለገባች 3. የተፈተች 4. የተለየያች 5. በሟ የሞታባት	
104	ሀይማኖትዎ ምንድነው?	1. ፕሮትስታት 2. ኦቶዶክስ 3. ካቶሊክ 4. ሙስሊም 99. ሌላ ይገለጽ(----------)	
105	ብሔርዎ ምንድነው?	1.ወላይታ 2. ጋሞ 3. አማራ 3. ጉራጌ 99. ሌላ ይገለጽ(----------)	
106	የትምህርት ደረጀዎ?	1. ያልተማረች 2. ማንበብና መጻፍ 3. የመጀመሪያ ደረጀ 4. የሁለተኛ ደረጀ 5. ከፍተኛ ትምህርት	

107	የሥራዎ ሁኔታ?	1.የቤትእመቤት 2.የመንግስት ሠራተኛ 3. ነጋዴ 4. መንግታዊ ያልሆነ ተቀጣሪ 5. የቀን ሠራተኛ 99. ሌላ ይገለጽ(----------)	
108	የባለቤትዎ ትምህርት ደረጀ	1. ያልተማረ 2. ማንበብናመጻፍ 3. የመጀመሪያ ደረጀ 4. የሁለተኛ ደረጀ 5. ከፍተኛ ትምህርት	
109	የባለቤትዎ ሥራ ሁኔታ?	1. የመንግስት ሠራተኛ 2. ነጋዴ 3. መንግታዊ ያልሆነ ተቀጣሪ 4. የቀን ሠራተኛ 99. ሌላ ይገለጽ(----------)	
110	የቤተሰብ አማካይ የወር ገቢ ስንት ነው?	_____ብር 98. አላዉቅም	
111	ስንት ልጆች አሉሽ?	_____	
112	ቤታችሁ ዉስጥ ቀጥሎ የተዘረዘሩ አሉ?	yes no ሬዲዮ.....1 2 ተሌቪዠን..... 1	

		2	

ክፍል ሁለት፡የእርግዝናና የፅንስ ጥያቄዎች

201	እስካሁን ስንት ነበር ያረገዝሽዉ?	6. አንዴ 7. ሁለት 8. ሶስት 9. አራት 10. አምስትና ከዛ በላይ	
202	በህይወት የተወለዱት ስንት ናቸዉ?	1. ዜሮ (የመጀመሪያ እርግዝና ነዉ) 2. አንድ (ከዚህ በፊት አንድ ወለድኩ) 3. 2-4 ከዚህ በፊት ወለድኩ 4. ≥ 5 ከዚህ በፊት ወለድኩ	
203	አሁን ካረገዝሽ ስንት ሳምንት ነዉ?	_____ሳምንት	
204	ከዚህ በፊት የወለድሽዉ ህጻን ስወለድ ክብደት ስንት ነበር?	_____ግራም	
205	ከዚህ በፊት የሞተ ህጻን ,ወልደሽ ታዉቅያለሽ?	3. አዎን 4. የለም	
206	ከዚህ በፊት ዉርጃ አጋጥሞሽ ያዉቃል?	3. አዎን 4. የለም	
207	ከዚህ በፊት በኦፐራስዮን ወልደሽ	1. አዎን	

	ታውቅያለሽ?	2. የለም	
208	ከዚህ በፊት በእርግዝና ጊዜ የሚመጣ የስኳር በሽታ አሞሽ ያውቃል?	1. አዎን 2. የለም	
209	በቤተሰብ ዉስጥ የስኳር በሽታ ታሞ የምያቅ አለ?	1. አዎን 2. የለም	

ክፍል ሶስት: በእርግዝና ጊዜ የሚመጣ የስኳር በሽታና ለሎች ምርመራዎች

301	ቁርስ ሳይበላ የተለካ የደም ስኳር መጠን (FBS) (mmol/L)		
302	ግሉኮስ ከጠጡ ከ 2 ሰዓት በኃላ የደም ስኳር መጠን (Blood Glucose 2-hr OGTT (mmol/L)		
303	የላይኛዉ ክንድ የመሃል ዙር ልከት(MUAC (cm)		
304	የደም ግፊት(Systolic BP (mmHg)		
305	የደም ግፊት(Diastolic BP (mmHg)		
306	የደም ግፊት((አለ/የለም)		
307	በእርግዝና ጊዜ የሚመጣ የስኳር በሽታ (አለ/የለም)		

V. In-depth interview guide

General information:

Greeting, my name is _____ I am one of the members of the research team in the school of Public health CHS, AAU which is currently carrying out a study on Diabetes mellitus among pregnant women and its effect on pregnancy and birth outcome in Wolaita Zone, Southern Ethiopia. As part of this study, we are collecting your information on socio-demographic variables and your experience. We are collecting this information to identify the existing situation with regard to gestational diabetes mellitus.

The purpose of this study is to explore the screening and management experience of gestational diabetes mellitus. According to the result of the study different capacity building strategies will be designed and implemented to narrow the gap. The interview will take about 45 minutes. Be assured that your name will not be revealed and any other identifying information will be kept confidential and will not be shared with anyone else without your consent. For easy retrieval of your ideas we are going to record your interview.

Your participation is voluntary and you have the right not to participate fully or partially. Your decision about not to participate is respected and will not affect you in anyway.

Do you have any questions on what we talked so far? You can contact the principal investigator, **Eskinder Wolka through +251911967748** for any questions you might have. Now, do you agree to participate in the survey? Yes_____ No _____If no, respect his/her decision. If yes continue the interview.

Name of data collector……. Signature……. Date……..

Consent form

I confirm that I have been given a full explanation of the study and I have understood all about the information given. Therefore, I voluntarily agree to take part in the study.

Signature: _____ Date: _____

Part I: Background information

Name of health facility_____

Discipline/profession _____

Position _____

Age of participant _____

Sex of participant_____

When were you employed in this facility _____?

For how long have you worked in the maternity unit/this position_____?

Part II: Interview Guide

1. What do you understand about Gestational diabetes mellitus?

2. What is your experience regarding gestational diabetes mellitus detection and management? In other facility? In this facility?

3. Are you aware of any WHO/FMOH/RHB policies or strategies relevant to prevention, management or care of Gestational Diabetes mellitus

   If so, what are the documents and how you use them?

4. Are there any guidelines/clinical standards/protocols relevant to detection, management or care of Gestational diabetes?

   Probe: could you explain in detail

5. In your opinion, what are some of the main things that make it difficult to detect and manage gestational Diabetes

    - Availability of guidelines and policies to guide what care and services are provided
    - Awareness among the staff about appropriate care
    - Technical competency and training of staff
    - Number and availability of trained staff
    - Leadership and supervision of staff
    - Designated space /room/infrastructure
    - Availability of basic supplies
    - Availability of equipment, machines, technologies
    - Awareness among women/families about the availability and benefit of services

6. How do you explain the positive and negative aspects of care in detecting and managing gestational diabetes mellitus

7. What do you think are the challenges and barriers in dealing with diagnosis and management of gestational diabetes mellitus?

8. What do you recommend for future to improve early detection and management practice of gestational diabetes mellitus?

9. Do you have anything else you'd like to share with us about Gestational Diabetes?

Annex III Sample size distribution across selected health facilities

A) Total sample selected from each facility for the first objective (sampling interval K=6),

Selected Health facility	Sampling Frame	Required Sample
Wolaita Sodo University Referral Hospital	1800	302
Sodo Christian General Hospital	480	80
Dubo Primary Hospital	360	60
Sodo Health Center	320	54
Wadu Health Center	180	31
Boditi Health center	216	36
Areka Health Center	220	37
Total	3576	600

B) Total sample selected from each facility for the second objective

Selected Health facilities	Annual patient Load (N)	Required Sample(n)
Wolaita Sodo University Referral Hospital	1600	324
Sodo Christian General Hospital	420	85
Sodo Health Center	280	57
Wadu Health Center	120	24
Boditi Health center	186	38
Areka Health Center	176	36
Total	2,782	564

C) Total sample selected from each facility for the third objective

Selected Health facility	Exposed group	Unexposed group
Wolaita Sodo University Referral Hospital	72	144
Sodo Christian General Hospital	31	62
Sodo Health Center	9	18
Wadu Health Center	8	16
Boditi Health center	7	14
Areka Health Center	9	18
Total	136	272

14. Declaration

Letter for declaration

I, the under signed, declared that this is my original work, has never been presented in this or any other University, and that all the resources and materials used for the dissertation, have been fully acknowledged.

Name: Eskinder Wolka Woticha

Signature:_____

Date:_____

Place:_____

Date of Submission:_____

This dissertation has been submitted for examination with my approval as University Supervisor.

Name: Dr. Wakgari Deressa (PhD)

Signature: _____

Date: _____