UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Gestational Weight Gain in Central Ethiopia: Patterns, Predictors, Birth Weight, Women's and Care Providers' Views. A Mixed Method Study

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Certificate of Original Authorship

I, Fekede Kumsa, declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy degree, in the Faculty of Health at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

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Signature removed prior to publication.

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List of Publications Included as Part of the Thesis

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2. Asefa F, Cummins A, Dessie Y, Foureur M, Hayen A: Patterns and Predictors of Gestational Weight Gain in Central Ethiopia: A Prospective Cohort Study. Reproductive Health. 2021; 18(1): 1-14
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5. Asefa F, Cummins A, Dessie Y, Foureur M, Hayen A. Midwives' and Obstetricians' Perspectives about Pregnancy Related Weight Management in Ethiopia: A Qualitative Study. PLoS One. 2020;15 (12):1-23

Abbreviations and Acronyms

AJOL	African Journal Online
ANC	Antenatal Care
BMI	Body Mass Index
CI	Confidence Interval
CINAHL	Cumulative Index of Nursing and Allied Health Literature
EDHS	Ethiopian Demographic and Health Survey
EPDS	Edinburgh Postnatal Depression Scale
GWG	Gestational Weight Gain
HFAIS	Household Food Insecurity Access Scale
HREC	Human Research Ethics Committee
IHRERC	Institutional Health Research Ethics Review Committee
IOM	Institute of Medicine
IPAQ	International Physical Activity Questionnaire
IQR	Interquartile Range
IUGR	Intra Uterine Growth Retardation
LBW	Low Birth Weight
MDD-W	Minimum Dietary Diversity-Women
MET	Metabolic Equivalent Task
MUAC	Mid-Upper Arm Circumference
OR	Odds Ratio
PPD	Postpartum Depression
PPWR	Postpartum Weight Retention
PRISM-P	Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols
RR	Relative Risk
SD	Standard Deviation
SGA	Small for Gestational Age
SSA	sub-Saharan Africa
USA	United States of America
USD	United States Dollar
UTS	University of Technology Sydney
VIF	Variance Inflation Factor
WHO	World Health Organization

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Abstract

Background: Adequate weight gain is needed to support a number of physiological changes during pregnancy. Gaining inadequate or excess gestational weight poses a health risk to the mother and baby. Inadequate gestational weight gain (GWG) increases the risk of fetal growth restriction, pre-term birth, and low birth weight. In contrast, women who gain excessive gestational weight are at an increased risk of hypertension in pregnancy, caesarean sections, postpartum weight retention, and development of long-term obesity. Given the scarcity of evidence that focuses on GWG in low-income countries including Ethiopia, it is necessary to undertake studies to understand the issue.

Aim: The aim of this study was to assess GWG status of the women, and examine the effect of GWG on a baby's birth weight, and explore pregnant women's and care providers' views on GWG in Central Ethiopia

Method: A concurrent mixed method study was carried out in 16 public health facilities (four tertiary hospitals and 12 health centres) in Addis Ababa, Ethiopia. A total of 395 pregnant women enrolled into the quantitative study before or at 16 weeks of gestation and were prospectively followed until they gave birth. Eight focus group discussions with pregnant women, and 36 in-depth interviews (15 with pregnant women, 11 with midwives and 10 with obstetricians) were conducted. The quantitative data were analysed using multinomial logistic regression and linear regression. The qualitative data were analysed using thematic analyses.

Results: Of the total of 395 pregnant women enrolled into the quantitative study, GWG was assessed for 369 (93%) women. More than two thirds of the pregnant women (67.2%) gained

inadequate gestational weight. Pre-pregnancy weight and employment status were statistically significant predictors of GWG. Infants whose mothers had inadequate weight gain were 245.8 gm lighter compared to those who gained adequate weight. Almost all pregnant women, midwives and obstetricians had limited knowledge of the recommended amount of GWG. Counselling about GWG and postpartum weight was lacking. Midwives and obstetricians did not consider gestational weight gain counselling as a priority issue. Most pregnant women did not want to gain weight during pregnancy; but did want to gain weight after birth.

Conclusions: Inadequate GWG and women's widespread misconception about GWG is a public health concern in Ethiopia. The limited knowledge of and low attention to pregnancy related weight management by midwives and obstetricians in Ethiopia needs appropriate intervention. Adapting a guideline for pregnancy weight management and integrating it into antenatal care is essential.

Chapter 1: Introduction

1.1. Overview

This thesis presents a detailed investigation of gestational weight gain, factors affecting gestational weight gain, effects of gestational weight gain on birth weight, and views and practices of pregnant women, midwives and obstetricians regarding gestational weight gain in Addis Ababa, Ethiopia.

The chapter includes an overview of the magnitude of gestational weight gain across the global population, factors affecting gestational weight gain and effect of inappropriate gestational weight gain on pregnancy outcomes. The objectives and significance of the project are also discussed in this chapter.

1.1. Background

Pregnancy is a time during which a woman is expected to gain substantial weight. Weight gain during pregnancy, which is also known as gestational weight gain (GWG), is a complex biological phenomenon that influences the outcomes of pregnancy [1, 2]. GWG is crucial to support additional energy needs for the number of physiological changes during pregnancy [3, 4]. The United States Institute of Medicine (IOM) recommends that the amount of GWG is based on the woman's pre-pregnancy body mass index (BMI). The IOM recommendations for singleton pregnancies are described in Table 1 [1]. Gaining weight beyond the recommended levels is considered as excessive GWG, while gaining below the recommended levels is considered to be inadequate GWG.

Table 1: Gestational weight gain recommendation according to the United State Institute of Medicine guideline for singleton pregnancies [1]

Pre-pregnancy BMI	GWG according to IOM recommendation			
	First trimester	Second trimester	Third trimester	Total
≤18.5 kg/m^2	0.5 to 2.0 kg	0.51 kg /week	1.0 kg /week	12.5 to 18.0 kg
18.6 to 24.9 kg/m^2	0.5 to 2.0 kg	0.42 kg /week	1.0 kg /week	1.5 to 16.0 kg
25.0 to 29.9 kg/m^2	0.5 to 2.0 kg	0.28 kg /week	0.6 kg /week	7.0 to 11.5 kg
≥ 30 kg/m^2	0.5 to 2.0 kg	0.22 kg /week	0.5 kg /week	5.0 to 9.0 kg

A meta-analysis of observational studies showed that about two-thirds of pregnant women gained weight outside the IOM recommendations [2]. However, there is substantial variation regarding the amount of GWG among different populations. The majority of pregnant women from high-income countries gain excessive gestational weight [5, 6]. For example, a study conducted in Canada showed that 71% of pregnant women gained excess gestational weight [7]. Similarly, studies conducted in Australia, New Zealand, and Ireland showed that 74% of pregnant women gain excessive gestational weight [8]. By contrast, 80% of women from Malawi [9], 63% of women from Niger [10], and 62.7% of women from Uganda [11] gain inadequate gestational weight. In Ethiopia, the setting of this thesis, nearly 70% of pregnant women gain inadequate weight, and fewer than 3% of pregnant women gain excessive weight [12, 13]. However, there is very little information about GWG, with GWG studies [12, 13] focusing on total GWG and giving little attention to GWG during each trimester.

Several factors broadly influence the amount of GWG. These include demographic, physiological, psychological, and behavioural factors of women [1, 14-16], and health system factors [17-19]. Gestational weight gain is influenced by a range of factors such as women's

education [20, 21], smoking [22], parity [23], age (both extremes, i.e. younger [8, 24] and older ages [12, 25, 26]), pre-pregnancy weight [12, 27, 28], dietary adequacy [29], household food security [30], intimate partner violence [31-33], physical activity [12, 34] and co-morbidities such as depression [14, 35, 36]. However, the direction of the association between GWG and some factors such as perinatal depression [14, 35, 36] and intimate partner violence [31-33] are inconsistent. Women's knowledge [37, 38], attitudes [39], and concerns [40] towards pregnancy related weight management also influence their weight gain status.

Factors such as care providers' knowledge and confidence in providing GWG counselling [41, 42], perceived sensitivity of GWG by care providers [43-45], and scepticism about the impact of counselling on women's behaviour [41] affects the ammount of GWG. In addition, the level of priority placed on GWG issues [41, 45, 46], shortage of time to discuss weight and nutrition during pregnancy care [47], and lack of familiarity with GWG guidelines [41, 46] are health care system related factors that could affect pregnant women's weight gain. However, the factors associated with GWG are not well understood in Ethiopia

Gestational weight gain outside of the IOM recommendations has serious undesirable health outcomes for women and their babies [2, 4, 48]. Women who gain excessive gestational weight are at higher risk of hypertension during pregnancy [5, 6, 49], gestational diabetes [4, 5], caesarean sections [5, 49, 50], postpartum haemorrhage [49], postpartum weight retention [51], and development of long-term obesity [52]. In contrast, those who gain inadequate weight are at high risk of bearing a baby with low birth weight (LBW) and pre-term birth [6, 53-55]. While there are a number of studies on factors affecting birth weight in Ethiopia, the influence of GWG on birth weight is not well understood in this setting.

There is a lack of data on GWG including factors associated with GWG and the effect of GWG on birth outcomes in the Ethiopian context [12, 13]. This is due to difficulties associated with collecting data throughout the pregnancy period in these settings [56], the lack of reliable data on maternal pre-pregnancy weight [1], and because GWG remains a neglected public health issue, particularly in Ethiopia [12]. Given the limited availability of GWG data, this thesis aims to provide data on the existing gaps including patterns of GWG, factors associated with GWG, and effect of GWG on birth outcomes, mainly birth weight. The thesis also explores pregnant women's and maternal health care providers' (midwives and obstetricians) perspectives on GWG and postpartum weight retention.

1.2. Significance of the thesis

This study aimed to identify patterns of gestational weight gain, factors affecting GWG, and related birth outcomes. Findings from this study may help to stimulate maternal health care providers and service planners to design preventive actions for women with inadequate and excess GWG to prevent adverse pregnancy outcomes. The findings of this study could also help health authorities to understand the local factors that influence sub-optimal GWG. Furthermore, since the IOM guideline is primarily intended for high-income countries, a number of contextual factors may limit the suitability of the guideline in low- or middle-income countries such as Ethiopia. Hence, this study contributes to the development of GWG guidelines that could address the context of low-income countries/populations comparable to Ethiopia.

1.3. Research Objectives

The overall objective of the research is to assess GWG status of the women, predictors of GWG, and examine the effect of GWG on infants' birth weight, and explore the pregnant women's and care providers' views on GWG in Central Ethiopia

Specific objectives

1. To determine patterns of GWG among pregnant women in Addis Ababa, Ethiopia
2. To examine factors associated with GWG among pregnant women in Addis Ababa, Ethiopia
3. To describe the association between GWG and low birth weight infants among pregnant women in Addis Ababa, Ethiopia
4. To explore women's and maternal health care providers perspective of GWG in Addis Ababa, Ethiopia

1.4. Overview of the Thesis

This thesis is structured in nine chapters. Chapter One is an introductory chapter that provides an outline of the general overview of GWG including research gaps, significance of the study, and research objectives. Chapter Two presents a review of the literature regarding global epidemiology of GWG. This chapter broadly discusses the magnitude of inadequate, adequate, and excess GWG, factors associated with GWG, and the effect of inappropriate GWG on pregnancy outcomes at a global level. Chapter Three outlines the research design and methods employed by the project. The details of participants, settings, sample size calculations, data collection, data analysis and ethical approval are discussed in this chapter. Chapter Four provides a systematic review and meta-analysis of relevant literature specific to sub-Saharan

Africa. It describes the proportion of inadequate, adequate, and excess GWG according to IOM recommendations and according to each study authors' own classifications. This chapter also reviews factors related to GWG, the association between GWG and infant's birth weight, gestational hypertension, caesarean section, and episiotomy in SSA settings. The systematic review was published in the PLoS One journal. Chapter Five provides the quantitative findings from the study of pregnant women in Addis Ababa, Ethiopia. This chapter presents study participants' characteristics, discusses the patterns of GWG, the proportions of inadequate, adequate and excessive GWG, and factors associated with GWG. The paper presented in Chapter five was published in the Reproductive Health journal Chapter Six presents the quantitative findings that detail the influence of gestational weight gain on pregnancy outcomes. This chapter shows the influence of GWG on pregnancy outcomes with the main focus of birth weight. Since existing literature reports that the majority of women in low income settings including Ethiopia gain inadequate gestational weight, this chapter primarily focuses on identifying the influence of inadequate gestational weight on birth weight. Chapter Seven presents and discusses the qualitative findings detailing pregnant women's awareness, views and practices regarding GWG and postpartum weight retention. In Chapter Eight, midwives' and obstetricians' perspectives regarding GWG are discussed including their knowledge, provision of counselling, advice and recommendations. The paper was published in the PLoS One journal. In Chapter Nine, the findings of the quantitative and qualitative studies are synthesised to discuss key implications and make recommendations for future research and clinical practices. The strengths and limitations of the thesis are also discussed in this chapter.

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Chapter 2: Literature Review

2.1. Overview

This chapter reviews research addressing demographic, behavioural, and psychosocial factors as predictors of inadequate or excessive weight gain during pregnancy. I have conducted both a narrative and systematic review of the literature. The narrative literature review aimed to highlight the proportions of inadequate, adequate, and excess GWG in high, middle and low-income countries, to identify important factors associated with GWG and effects of GWG on neonatal birth weight.

2.2. Literature search methods

For this narrative review, the Google search engine, Google Scholar, and the PubMed database were used. A literature search was performed using the following key terms: gestational weight gain, factors affecting gestational weight gain, determinant of gestational weight gain, predictors of gestational weight gain, effects of gestational weight gain on birth outcomes, effects of gestational weight gain on birth weight, pregnant women's views on gestational weight gain, and midwives', obstetricians' and care providers views' on gestational weight gain. All the searches were limited to papers published in English.

2.3. Magnitude of gestational weight gain

The magnitude of inadequate, adequate, and excess GWG varies among different populations in different settings [1-11]. As shown in Table 2, women from high income countries largely

suffer from excessive GWG, while women from low income countries suffer from inadequate GWG. However, in Sub-Saharan African (SSA) countries, there is very little information about GWG. Even the existing GWG studies have mainly focused on total GWG, giving little attention to the details of GWG at each trimester [4, 6, 12, 13].

Table 2: Proportion of inadequate, adequate, and excess GWG across different settings and time, compiled in 2021

Author and year	Country	Sample Size	Inadequate GWG	Adequate GWG	Excess GWG	Income status
Johnson et al 2009 [1]	USA	8,293	9.5%	17.5%	73%	High income
Torre et al 2011 [2]	USA	7,676	28.1%	32.7%	39.2%	High income
Ashley-Martin et al 2014 [3]	Canada	12,875	15%	27%	58%	High income
Begum et al 2012 [14]	Canada	571	11%	18%	71%	High income
Jarman et al 2016 [15]	Canada	1,541	17.6%	33%	49.4%	High income
Briony et al 2013 [11]	Australia	108	7.4%	46.3%	46.3%	High income
Restall et al 2014 [17]	Australia, New Zealand and Ireland	1,950	9%	17%	74%	High income
Fraga et al 2014 [16]	Brazil	1,074	23.2%	27.6%	49.2%	Upper middle income
Ward et al 2007 [18]	South Africa	89	15.7%	51.7 %	29.6%	Upper middle income
Wrottesley et al 2017 [19]	South Africa	538	24%	21%	55.5%	Upper middle income
Halle-Ekane et al 2015 [20]	Cameroon	350	36.9%	32.6%	30.6%	Lower middle income
Fouelifack et al 2015 [21]	Cameroon	462	28%	40%	32%	Lower middle income
Iyoke et al 2013 [22]	Nigeria	648	18.7%	61.7%	19.6%	Lower middle income
Adu-Afarwuah et al 2017 [24]	Ghana	1,320	62.7%	26.9%	10.4%	Lower middle income
Abubakari et al 2015 [23]	Ghana	419	49.64%	42.96%	7.4%	Lower middle income
Muyayalo et al 2017 [8]	Democratic Republic of Congo	199	58.8%	26.1%	15.1%	Low income
Wanyama et al. 2018 [25]	Uganda	192	62.5%	34.4%	3.1%	Low income
Chithambo et al 2017 [9]	Malawi	257	80.2%	19.8%	0%	Low income
Gondwe et al 2018 [26]	Malawi	1287	71.8%	23.0%	5.2%	Low income
Oue´draogo et al 2019 [27]	Niger	911	63.0%	24.0%	13.0%	Low income
Asefa et al 2016 [4]	Ethiopia	411	69.3%	28.0%	2.7%	Low income
Seifu et al 2017 [5]	Ethiopia	549	67.2%	29.2%	3.6%	Low income

2.4. Factors affecting gestational weight gain

The amount of weight that women should gain during pregnancy is determined by numerous factors. These factors broadly include women's own related factors (demographic factors, physiological factors, psychological, and behavioural factors) [28-31], and health system related factors (ANC, including advice and follow-up from health care providers) [32-34].

2.4.1. Maternal educational status and age

There is conflicting evidence in the literature regarding the association between level of maternal education and GWG status [35]. Some studies from USA and the Netherlands did not observe an association between maternal education and GWG [36-38]. A study conducted in Iran states that women with high level of educational had a significantly higher GWG compared with low-educated women [39]. In addition, another study from USA reported that women with low educational status (less than a high school education) had higher likelihood of gaining inadequate gestational weight [40]. A systematic review and meta-analysis on the association between maternal educational status and GWG reported that lower maternal education level is associated with increased risk of both inadequate and excessive GWG [41], while other studies from Sweden, USA, and Australia reported that women with lower levels of education (primary or secondary levels compared to tertiary education level) were at greater risk of gaining excessive gestational weight [42-44]. This could be explained by the fact that women with lower levels of education are more likely to have a body mass index (BMI) outside of normal range than women with a tertiary level of education [38]. Accordingly, women with lower levels of education had significantly higher pre-pregnancy BMI (overweight or obese) compared with women with a tertiary level of education [38, 41]. Women who attended a

tertiary level of education were older and had less children compared with those with a lower level of education [41]. Previous reports from Australia, New Zealand, Ireland, and Brazil showed that young mothers are at greater risk of gaining excessive gestational weight [17, 45]. Another study reported that women over age 40 are at greater risk for insufficient weight gain than younger women [40].

2.4.2. Parity

The existing evidence regarding the association of parity and GWG are inconsistent [46]. Some studies showed that nulliparous or primiparous women have a higher risk of gaining excessive gestational weight as compared to multiparous women [10, 38, 44, 47-49], while other studies found that multiparous women have a greater risk of excessive GWG compared with primiparous women [50-52]. However, Hill et al. (2016) found out that there is no statistically significant difference between primiparous and multiparous women regarding GWG [53].

2.4.3. Maternal pre-pregnancy weight

Several studies reported that pre-pregnancy BMI is strongly associated with GWG [4, 5] and maternal and child health outcomes [12, 54]. Having either a high BMI (overweight or obese) [55] or low BMI (underweight) [4, 5] at the inception of the pregnancy increases the likelihood of gaining gestational weight outside of IOM recommendations. Being overweight or obese at the conception of pregnancy increases the risk of excessive GWG [56]. In contrast, women who are underweight at the beginning of the pregnancy are at higher risk of inadequate GWG [4]. Studies from SSA have reported that more than three-quarters of women who were

underweight during the conception of the pregnancy gain gestational weight below IOM recommendations [4, 5, 9, 10].

2.4.4. Gestational weight gain and maternal depression

A woman experiencing perinatal depression may be less concerned about her overall health so she may not attend ANC, may also be addicted to different substances, and suffer from a disrupted appetite [28, 57-59]. Hence, perinatal depression may have a link with GWG, but the literature is very inconsistent. One study reported gaining inadequate gestational weight is highly associated with antenatal depression [28]. On the contrary, other studies have shown a positive association between perinatal depression and excessive GWG [60, 61]; another study reported that antenatal depression was not associated with either inadequate or excessive GWG [58]. Therefore, evidence of the effects of behavioural and psychological factors on GWG [62] in general, and the effect of perinatal depression on GWG [31] in particular, is inconclusive.

While depression is associated with unfavourable health outcomes at any point in life [63-65] when it occurs in the postpartum period there are adverse effects on the mother and the newborn [66], making this period critical. Postpartum depression (PPD) is particularly, associated with interrupted sleep patterns, impaired infant feeding [67], and poorer preventive health practices. The relationship between postpartum depression and pre-pregnancy weight has been reported by many studies [68-70]. However, the association of postpartum depression and GWG is yet to be studied.

2.4.5. Gestational weight gain and food security

Studies from high-income countries report that household food insecurity is associated with excessive GWG, which may be because women experiencing food insecurity eat cheaper and unhealthy food [71, 72]. However, this generalization is questionable in low-income countries where women suffer from nutritional deficiencies in households with food insecurity [73, 74]; and household food insecurity is strongly associated with maternal under-nutritional status such as being underweight [75, 76], as measured by decreased mid-upper arm circumference (MUAC) [73, 76], and anaemia [77]. Though some authors have [71, 72] argued that food insecurity causes excessive GWG by leading to maternal depression, it is not well identified whether food insecurity causes maternal depression or maternal depression causes food insecurity [78].

2.4.6. Gestational weight gain and physical activity

A minimum of 30 minutes of physical activity per day on most of days of the week, if not all, is recommended during pregnancy for weight management [79]. In addition, it has been reported that engaging in physical activity during pregnancy decreases the occurrence of excessive GWG [80]. Physical activity during pregnancy has been reported to be low in African countries [81]. Given that there is no questionnaire designed to measure pregnant women's physical activity in the African context, measuring physical activity during pregnancy is challenging [4, 81]. Hence, this could have led to limited evidence of the influence of physical activity on GWG in this setting. However, understanding patterns of physical activity throughout pregnancy and its effect on GWG has the potential to inform future interventions to minimise excessive weight gain in pregnancy and postpartum weight retention [82].

2.4.7. Gestational weight gain and intimate partner violence

Exposure to intimate partner violence during pregnancy has been reported to have an effect on women's own health and infant birth outcomes [83, 84]. Having a history of domestic violence by a male partner during pregnancy is associated with gaining less weight during pregnancy [83, 85]. However, the statistically significant associations between intimate partner violence during pregnancy and inadequate GWG were reported only among older women (≥35 years old) [86]. In another study, having a history of physical or sexual abuse is associated with both inadequate and excessive GWG [87]. These findings indicate that whether intimate partner violence is associated with inadequate or excess GWG or both is unclear. Despite a high burden of intimate partner violence in Ethiopia (emotional violence (24.0%), physical violence (24.9%) and sexual violence (11.1%)) [88], its effect on inappropriate GWG is not well studied.

2.5. Health care provider's and pregnant women's views on gestational weight gain

Given that ANC is an ideal opportunity for behavioural interventions [89], maternal health care providers are recommended to offer practical advice on how to be physically active and on healthy eating [90, 91]. Pregnant women also expect to receive goals for appropriate GWG early in pregnancy from their health care providers [32]. Evidence also suggests that women who have been counselled on GWG and dietary management have higher likelihood of gaining appropriate gestational weight [33, 92].

Several studies especially from high-income countries, however, revealed that women received little guidance from healthcare workers regarding healthy diet and physical exercise [93, 94],

and the appropriate amount of GWG [95, 96]. Even the messages they receive are inconsistent, vague, and do not strengthen their efforts to manage their weight [94, 97].

The inconsistent provision of advice is, perhaps, because midwives lack the essential knowledge and skills to provide proper nutritional advice [98-100], and many health care providers, including obstetricians, believe that nutritional advice is not effective in managing GWG or their interventions cannot bring about behavioural change among pregnant women [101, 102]. Maternal care providers perceive that discussing women's weight [97, 101-103] and GWG [102, 104] to be a sensitive topic for women. Midwives and obstetricians also perceive that GWG is a low priority for them given that they have many competing priorities in ANC service provision [100, 101, 103].

Women assume that midwives or obstetricians would inform them about GWG if it is vital [105]. Given that they receive inadequate advice, studies reveal that women have a low level of perceived risk for weight-related pregnancy complications [90] and lack of concern about their GWG [105], inadequate knowledge of nutritional and appropriate GWG [95, 97, 106]. However, all these findings were from high income countries; they do not reflect the context of low-income country setting.

Women who received inadequate ANC counselling [34] and with low dietary readiness [107] have a higher likelihood of gaining inappropriate GWG. A qualitative study from rural Ethiopia reported that women reduce their food intake during various occasions of the pregnancy due to pregnancy-related discomforts, and reduced appetite as a result of gastric irritation, nausea, vomiting, and morning sickness [108]. Given that, almost all of these studies have been conducted in high-income countries, we have not identified any previous study on women's

perception about GWG, or the attitude and practice of health professionals on GWG advice in Ethiopia

2.6. Effects of sub-optimal gestational weight gain on pregnancy outcomes

Gestational weight gain above or below the IOM recommendations has been associated with serious undesirable health outcomes for pregnant women and their babies [1-3, 12, 44, 109, 110].

2.6.1. Effects of excessive gestational weight gain on pregnancy outcomes

Women who gain excessive gestational weight are at increased likelihood of pregnancy related complications. Given that there is maternal fat accretion [31] and development of insulin resistance during pregnancy [111, 112], gaining excessive weight might lead to much more accumulation of fat mass which may reduce the physiological capacity to respond to an increase in insulin resistance [112, 113] and raised glucose production during pregnancy [112]. Hence, excessive GWG is associated with an increased likelihood of gestational diabetes as compared to gaining appropriate gestational weight [1, 113, 114]. In addition, excessive GWG increases the risks of hypertension during pregnancy [1, 2, 12], postpartum weight retention [3], and development of long-term obesity [115].

Given that there is a significant increase in weight of the woman during pregnancy, due to various physiological changes, [31, 113, 116, 117] her long-term weight status is determined by her retaining weight postpartum, this can lead to long-term obesity [118-120], metabolic complications and chronic diseases later in life [14]. Postpartum weight retention (PPWR) is

determined by a combination of factors, such as, physical activity during pregnancy [121], dietary intake, low income [14], exclusive breastfeeding [121], birth interval [3], smoking status, pre-pregnancy BMI [119, 121, 122], parity [3, 38, 53], and GWG [3, 118]. Of these, excessive GWG is mainly reported as the strongest predictor of PPWR [3, 118]. Despite the importance of PPWR in women's weight management, no study has been conducted so far on the effect of GWG on PPWR in Ethiopia.

2.6.2. Effects of inadequate gestational weight gain on pregnancy outcomes

Gaining insufficient gestational weight has been reported as a risk factor for various pregnancy outcomes such as intrauterine growth restriction [123], bearing a baby with LBW and pre-term birth [2, 52, 62, 124], small for gestational age [123], and infant mortality [125].

Inadequate GWG is associated with an increased odds of small for gestational age (SGA) when compared with women with adequate gestational weight gain [126]. Inadequate weight gain, more specifically in the third trimester, substantially increases the likelihoods of Intra Uterine Growth Restriction (IUGR) [123]. Intra Uterine Growth Restriction is associated with an increased risk of childhood morbidity cognitive impairment, different chronic diseases in adulthood, infant and childhood mortality [127]. A study reported that infants exposed to inadequate GWG were more likely to have their deaths attributed to disorders related to fetal malnutrition or respiratory disorders [125]. This indicate that GWG predicts the overall fetal and child wellbeing; and gaining inadequate gestational weight has far-reaching and serious consequences.

More importantly, inadequate GWG in combination with low pre-pregnancy weight is associated with higher rates of prematurity, and the birth of LBW infants [31]. Despite the fact that the burden of adverse pregnancy outcomes like maternal mortality (412 deaths per 100,000 live births) [88], incidence of LBW (28.3%) [128], and infant mortality (48 deaths per 1,000 live births) [88] in Ethiopia are amongst the highest on the globe; the contribution of inappropriate GWG to these adverse pregnancy outcomes is not well studied [129] in the region.

Conclusion

In summary, women from high-income countries predominantly gain excessive gestational weight. However, women from low-income countries, including sub-Saharan Africa, gain inadequate weight throughout pregnancy. The amount of GWG is determined by several factors. This broadly includes women's physiological factors, psychological, and behavioural factors. Pre-pregnancy maternal weight, household food security status, women's physical activity, women's awareness about healthy eating and dietary diversity, ANC providers' knowledge and the level of advice they give are also associated with GWG. However, the effect of some of these variables on GWG vary across different settings and inconsistent results have been reported. Both inadequate and excess GWG are associated with undesirable outcomes for mothers and babies.

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Chapter 3: Research Design and Methods

3.1.Overview

This chapter presents the research design and methods that were used in this study. A mixed methods research design was identified as the most appropriate method to address the study's aim which was to assess the GWG status of women, and examine the effect of GWG on infants' birth weight, and explore pregnant women's and care providers' views on GWG in Addis Ababa, central Ethiopia. The chapter is organised into the following sections: (1) doctoral research design, (3) theoretical perspectives, (4) settings, (5) ethics approval, (6) quantitative component, and (7) qualitative component.

3.2. Research questions

The research questions to be addressed in this thesis are:

1. What is the proportion of pregnant women who gained inadequate, adequate or excessive GWG, according the IOM guideline?
2. Which factors are associated with GWG?
3. What is the influence of pre-pregnancy weight, GWG and other maternal factors on birth weight?
4. What are pregnant women's perceptions and practices related to GWG and postpartum weight loss?
5. What are midwives' and obstetricians' views and practices related to GWG and postpartum weight management?

3.3. Overall project design

The systematic literature review aimed to identify available evidence on Gestational GWG, factors affecting GWG and the association of GWG with birth outcomes in Sub-Saharan Africa. The findings from the systematic review and meta-analysis demonstrated that more than half of the pregnant women in the majority of sub-Saharan African countries studied gained inadequate gestational weight. Nearly nine out of ten underweight women gained inadequate gestational weight. The proportions of babies born with LBW were high among women who gained inadequate weight compared to women who gained adequate and excess gestational weight.

Following this comprehensive review of the literature, a number of gaps were identified. Firstly, a large number of studies on GWG did not use standard GWG classifications, i.e., authors used their own classifications. Secondly, factors associated with GWG were classified inconsistently across studies. Thirdly, confounding factors were poorly controlled in most of the studies. Fourth, although there are many studies on the predictors of birth weight, only few studies addressed the relationship between GWG and birth weight. Finally, almost all studies conducted on GWG in sub-Saharan Africa including Ethiopia were quantitative. Qualitative studies exploring the perspectives of pregnant women and care providers on the issue of GWG were missing. Such studies could provide important insights into why women gain inadequate gestational weight in this setting, therefore, together with the quantitative investigation of GWG which led to the decision to conduct a mixed methods study.

The term mixed methods research usually refers to a type of research in which the researcher combines elements of qualitative and quantitative research approaches to provide a better

understanding of research problems rather than taking only one approach [1]. A mixed methods study design helps the researchers to acquire multiple perspectives, as a single theoretical approach could be insufficient to clarify a phenomenon of interest [2]. Mixed methods design involves combining multiple methods of data collection and analysis, integrating the findings and drawing inferences using both qualitative and quantitative approaches in a single study to get a better understanding of the research problem [3]. Therefore, the goal of mixed methods is to draw upon the strengths and minimise any limitations inherent in either a qualitative or quantitative approach [4]. Mixed methods research is most applicable to conditions where the idea behind the study is corroborating, cross-validating or confirming of the findings [2, 3].

This study combined deferent study designs which were quantitative (a prospective cohort) and qualitative (qualitative descriptive design) together with a variety of data collection approaches. These included a survey, review of medical records, in-depth interviews and focus group discussions. The analysis included descriptive statistics and regression analysis of the quantitative data and thematic analysis of the qualitative data. The purpose of mixed methods was to complement one another in order to gain a more comprehensive and holistic understanding of GWG from the perspectives of the care providers and pregnant women.

There are four key aspects of mixed method studies to address: the timing, priority or weighting, integrating, and theorising [3]. With regards to the timing of the project, a concurrent mixed method design was employed. At the beginning, baseline information were collected from 395 pregnant women who participated in a prospective cohort study. At the same time, a qualitative descriptive study was undertaken among pregnant women, midwives, and obstetricians. While following pregnant women's weight gain and waiting for birth outcomes data (for the quantitative study participants), the qualitative data analysis was

conducted. Both quantitative and qualitative data were analysed separately and the findings were integrated during the interpretation phase and presented in the discussion chapter (Figure 1). Although the qualitative data are primarily needed to explain and interpret the quantitative data, equal priority or weight was afforded to the quantitative and qualitative studies.

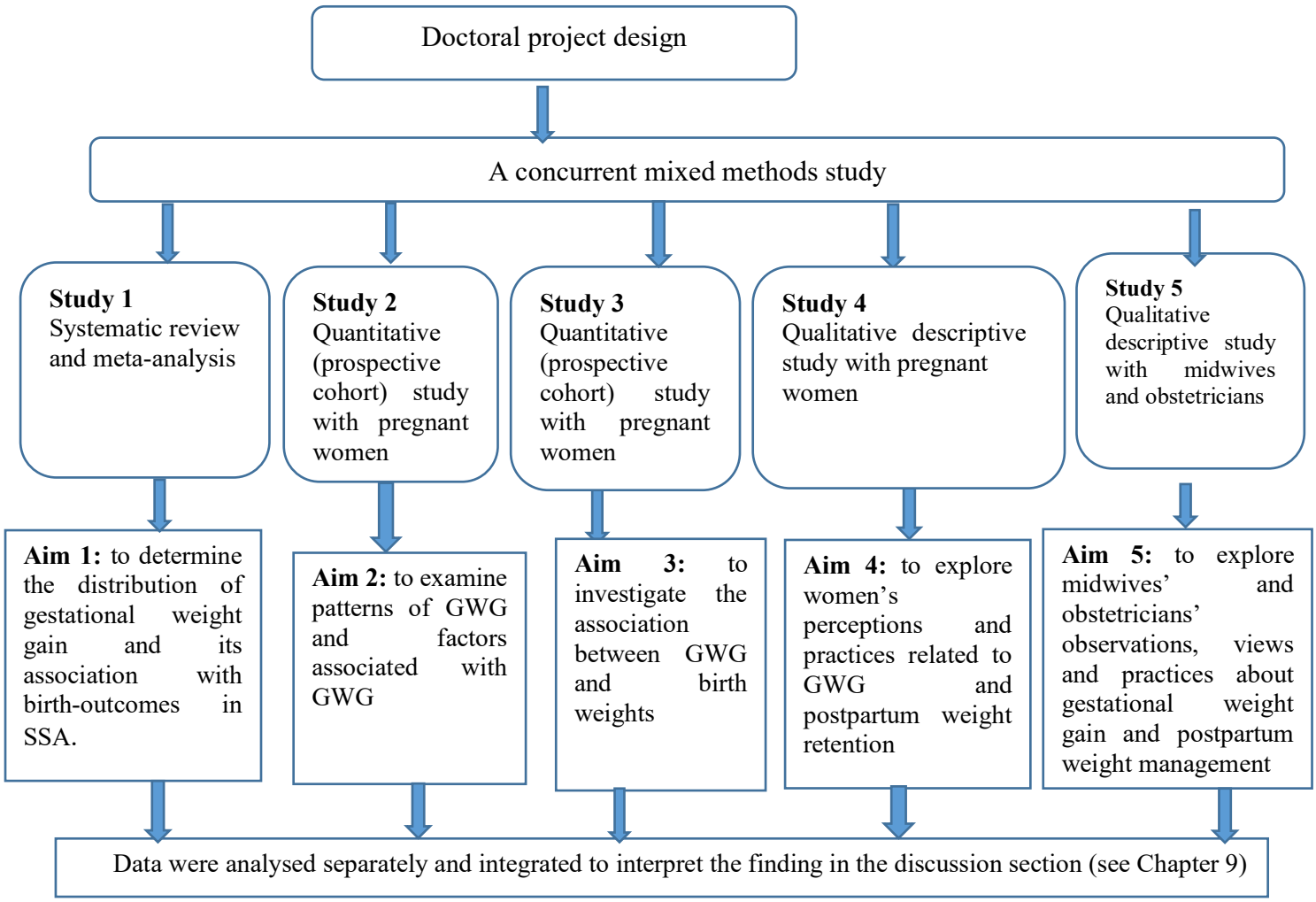

Figure 1: Overview of the thesis design along with study aims and methods used in Addis Ababa, Ethiopia, 2021.

3.4.Theoretical perspectives

Philosophical assumptions, also known as research paradigms, are perspectives or worldviews about ontology, epistemology, axiology, and methodology that underpin the interpretative frameworks selected by a researcher [5]. The choice of a philosophical assumption is critical because it enables transparency and influences the research process. The study described in this thesis has employed pragmatism as the research paradigm. Pragmatism provides the opportunity to use multiple methods, assumptions, different forms of data collection and analysis [5]. Pragmatism considers the research question and it's intended purpose to be more important than either the method used or the worldview that underpins the method [5, 6]. Thus, pragmatic philosophy rejects the postpositive and the constructivist paradigms [5]. The experience of the researcher and the ability to identify what is considered important makes the philosophy of pragmatism worthy of consideration to explore a practical topic in weight management among pregnant women in Ethiopia.

Pragmatism is a credible research ideology that does not align itself with a single reality or philosophy. Pragmatism is a useful approach to solving complex real-world problems [7]. Pragmatism as a research paradigm accommodates a mixed methods research approach [8, 9] providing guidance for the researcher to use a variety of approaches when quantitative or qualitative methods alone would be insufficient to answer a given research question [1]. Mixed methods research helps the researcher to consider multiple perspectives, viewpoints, and standpoints of qualitative and quantitative characteristics [10].

3.5. Reporting mixed methods research

The Good Reporting of a Mixed Methods Study guidelines [11] were used to guide the reporting of this mixed method study. Accordingly, the following elements were included: 1) justifying a rationale for using a mixed methods design; 2) description of the design purpose; 3) description of each method in terms of sampling, data collection and analysis; 4) describing where and how data integration occurred; 5) identifying strengths and limitations; and 6) describing any insights gained from data integration as prescribed in the good reporting of a mixed methods study guideline [12].

3.6. Study context

This study was conducted in Addis Ababa, which is the capital and largest city of Ethiopia. The city has a total population of 3,433,999 (1,624,999 male and 1,809,000 female) [13]. The city is situated in the heartland of the country and divided into 10 administrative sub cities. In the city, 42 hospitals (11 government, 6 non-governmental organisations, 25 private), 97 health centres, and 361 clinics provide medical care including maternal health care [14, 15]. Around 97% of pregnant women in Addis Ababa receive antenatal care (ANC)) from skilled care providers such as doctors or nurses/midwives at least once [16], of which 90% receive at least four episodes of ANC [17]. This is less than the current World Health Organizations (WHO) recommendations that women should receive eight episodes of ANC [18]. The 2016 WHO recommendations on ANC are not converted into practice to date.

In the public health facilities of Addis Ababa, women with uncomplicated pregnancies receive care from midwives at the health centre level while women with complicated pregnancies receive care from obstetricians and midwives at the hospital level. Health centres are part of

Ethiopia's primary health care system which is designed to provide preventive, curative and rehabilitative services including basic pharmacy and laboratory services. Typically, health centres have up to 10 beds for birthing women and emergency services, and they serve up to 25,000 people in rural areas and up to 40,000 in urban settings [19]. In the public health facilities of Addis Ababa, women with uncomplicated pregnancies receive antenatal care, labour, birth, and postnatal care services at the health centre level. Women with complicated pregnancies receive antenatal care, delivery, and postnatal care services at the hospital level.

Study participants were selected from 16 governmental health facilities, of which four were tertiary level hospitals (Zewditu Memorial Hospital, Yekatil 12 Hospital, St. Paul Hospital, and St. Peter TB Specialised Hospital), while the remaining 12 facilities were health centres (Mikililand, Keraniyo, Kolfe, Alembank, Wereda 03 of Kolfe Kereniyo Sub-city, Wereda 02, 03, 05 and 11 of Nifassilk Lafto Sub-city, Woerda 09 Kowas Meda, Addis Ketema, and Kotobe health centres). These health facilities were selected based on their caseload and geographic representation. Quantitative study participants (i.e., pregnant women) were recruited from health centres. This is because women with an uncomplicated pregnancy receive ANC service from health centres. For the qualitative study, pregnant women and midwives were recruited from both health centres and hospitals, while obstetricians were recruited from hospitals only, as obstetricians provide service only at hospital level.

3.7. Ethical Approvals

Ethical approval for the study was obtained from the Haramaya University Institutional Health Research Ethics Review Committee [IHRERC/200/2018], Addis Ababa Health Bureau Institutional Review Board [A/A/HB/2576/227] and the University of Technology Sydney,

Human Research Ethics Committee [UTS HREC18-2610] (Appendix 1a to c). Each facility directed their health workers to provide the necessary support to collect data and conduct the study as per the approved protocol. In addition, the health facilities granted permission to access women's medical records.

3.7.1. Informed consent

A participant information sheet was provided to all study participants (Appendix 2a to d). The information sheet outlined the purpose and procedures of the data collection and the potential risks and benefits of the study. Quantitative study participants were informed that the main risk from the research was they may feel uncomfortable or become distressed answering any questions about an experience of violence from a partner and/or food insecurity questions. Qualitative study participants were also informed that the main risk from the research is the inconvenience caused by allocating 45 to 60 minutes to be interviewed. Participants' safety and distress protocol was discussed with participants in case they became uncomfortable or distressed during the interview and support was required. Participants were also informed that their participation was voluntary; they reserved the right not to answer any questions they preferred not to; and were permitted to decline participation without any consequences.

3.7.2. Values and principles of ethical conduct

The project was conducted in accordance with the National Statement on Ethical Conduct in Human Research of the Australian [20], and the Ethiopian National research Ethics Guidelines [21], which are organised around respect for participants, research merit and integrity, justice and beneficence.

3.8.Pilot testing

The survey questionnaire was pre-tested on 20 women and feedback was used to guide the modifications necessary to optimise the questionnaire. Similarly, to ensure feasibility, clarity and acceptability of the topic guide by the study participants, pilot interviews were conducted with pregnant women (two in depth interviews and two focus group discussions) and midwives (three in depth interviews). Based on their feedback, amendments to the questions were made. The pilot testing was conducted in three health centres in the city (Addis Ababa). The actual data for the main study was not collected from these health centres.

3.9. Quantitative study

The primary aims of the quantitative study were to determine patterns of weight gain during pregnancy; to identify predictors of GWG; and to examine the association between weight gain during pregnancy and birth weight (primary outcomes), the gestational hypertension, gestational diabetes, episiotomy, and caesarean birth.

3.9.1. Study design and period

A prospective cohort study was conducted in Addis Ababa city administration from January 10, 2019 to September 25, 2019. Women were recruited at or before 16 weeks of gestation and followed until they gave birth. Sixteen weeks of gestation is the time at which pregnant women have their first appointment at the health centres in Ethiopia.

3.9.2. Sample size determination

The sample size was calculated using Open Epi statistical software. The proportion of important predictor variables were identified from a search of the relevant available literature. Details of the sample size calculation, including all assumptions, are displayed in Table 3. The maximum sample size was 395 for any of the sample size calculations; hence, this was the overall sample size selected.

Table 3: Details of sample size calculation for the quantitative study

Objectives	Sample size calculation assumption	Sample size	Study population
To determine patterns of gestational weight gain	**Single proportion formula** alpha=0.05, *P*=proportion of women who gained inadequate gestational weight in Ethiopia=69.3% [22], half-width of confidence 5%, with 20% loss to follow-up	**395**	Pregnant women who present to health facilities in Addis Ababa before or at 16 weeks of their pregnancy to attend ANC
To identify predictors of gestational weight gain	**Double proportion formula** alpha = 0.05; power 80%, exposed: non-exposed=1:4 (prevalence of underweight among women (exposure)=14% and proportion normal weight women 65% (non-exposed) [23]), proportion of inadequate GWG among underweight women=92.3%, proportion of inadequate GWG among normal weight women=75.8% [22], loss to follow-up rate=20%	Exposed (under-weight) = 69, Control (normal-weight) =276 **Total=345**	
	Double proportion formula alpha = 0.05; power 80%, exposed: non-exposed=1:3 (proportion of pregnant women who engage in light intensity-to vagarious intensity physical activities (exposure)=24% and proportion of pregnant women who engage not in physical activity (were in sedentary activities) =76% (non-exposed) [24]), proportion of inadequate GWG among who don't engage in physical activity =78.1%, proportion of inadequate GWG among women who engage in physical activity =58.6% [22], loss to follow-up rate=20%	Exposed (engage in physical activity) =77, Non-exposed (engage in no physical activity) =231 **Total=309**	
	Double proportion formula		

	alpha = 0.05 power 80%, exposed: non-exposed=1:1 (proportion of women who have regular ANC (exposure)=51.3% and proportion of women who have irregular ANC 48.7% (control) [22]), proportion of adequate GWG among women who have regular ANC =60.5%, proportion of adequate GWG among women who have irregular ANC =44.2% [25], loss to follow-up rate=20%	Exposed (proportion of women who have regular ANC) =189, Control (proportion of women who have irregular ANC) =189 **Total=378**
To describe the effect of gestational weight gain on low birth weight	**Double proportion formula** alpha = 0.05 power 80%, exposed: non-exposed ratio 1:2 (proportion of women who gain adequate GWG =28% (exposure), and proportion of women who gained inadequate GWG is 69% (non-exposed)[22]), proportion of LBW among women who gained adequate gestational weight=1.7%, proportion of LBW among women who gained inadequate gestational weight=17.5% [26], loss to follow-up =20%	Exposed (women who gained adequate GWG)=63, Control (women who gained inadequate GWG) =126 **Total=189**

3.9.3. Inclusion and exclusion criteria

Inclusion criteria

- Pregnant women who present to a health facility to attend ANC in the first 16 weeks of gestation
- Giving consent for follow up (willing to provide data throughout pregnancy and after giving birth at all contact points)

Exclusion criteria

- Women with a twin pregnancy were excluded from the study because weight gain recommendations for singleton and twin pregnancies are different.
- Women with additional comorbidities such as pre-existing diabetes and hypertension were excluded. I excluded them because I had a plan to assess the occurrence of gestational diabetes and hypertension in pregnancy as a result of GWG.

3.9.4. Participant recruitment

Women were recruited from nine health centres administered by Addis Ababa city. This is because women with uncomplicated pregnancies receive ANC from health centres. Health centres were selected considering the number of pregnant women visiting the health centre for antenatal care and their geographic location. Nine data collectors were recruited by considering their data collection experiences and professional background. Each data collector was assigned to a selected health facility to collect baseline information from pregnant women. One

research assistant was also recruited to assist the overall coordination of the data collection process. The research assistant was a public health professional primarily working on supervising data collectors and was paid for the service.

Pregnant women who visited the selected health facilities for ANC follow-up before or at 16 weeks of gestation participated in the study. Eligible women were consequently recruited until the required sample was reached. Nine data collectors were assigned to nine health centres. The head of ANC clinic unit or any member of the clinic who provided the service facilitated the selection process i.e., they identified women who met the eligibility criteria and provided the women with information about the study and notified the data collectors. The data collectors then subsequently approached the pregnant women with information about the study and invited participation in the study. They also assisted in setting an appointment date for the follow-up data collection (at the end of second and third trimesters). The service providers were not paid for this facilitation process. Data collectors were midwives or clinical nurses who had experience of data collection. They were casual employees of consulting firms with the specific purpose to collect data and they did not provide clinical or maternity services in any given health facility. They were assigned to the selected health facilities to collect data and paid for their service. The researcher and the research assistant oversaw the recruitment and data collection process.

3.9.5. Data collection process

The data collectors and the research assistant were selected based on their qualifications and field data collection experience. They were given training on the objectives of the study, data collection methods, and field supervision for two days. The researcher (FA) provided the

training for the data collectors and research assistant for two days. The research assistant and the researcher checked data for completeness on daily basis.

Baseline information

Baseline data were collected through structured questionnaires (Appendix 3) and face-to-face interviews. Information on socio-demographic characteristics such as age, educational status, marital status, occupational status, average monthly income, household asset, and partners' educational status were collected from the women. This information was adapted from the Ethiopian Demographic and Health Survey (EDHS) [16]. In addition, previous history of abortion, low birth weight and stillbirth, pregnancy intention, gravidity, time gap between the current and the previous pregnancy, food security and dietary diversity, physical activity, intimate partner violence, and depression related symptoms were collected at the baseline. Data collectors measured baseline weight, height, and mid-upper arm circumference.

Dietary diversity

Dietary diversity of the women was assessed using a minimum dietary diversity-women (MDD-W) guide that was set by Food and Agricultural Organisation (FAO) and USAID's Food and Nutrition Technical Assistance III Project (FANTA) [27]. The food groups assessed in MDD-W include: grains, white roots and tubers, and plantains; pulses; nut, and seeds; dairy; meat, poultry and fish; eggs; dark green leafy vegetables; other vitamin A-rich fruits and vegetables; other vegetables; and other fruits. MDD-W is a dichotomous indicator of whether or not women have consumed at least five out of ten defined food groups the previous day or night.

Household food security

The household food security was traced using the Household Food Insecurity Access Scale (HFIAS) [28]. Each of the questions in each domain of HFIAS, anxiety and uncertainty; insufficient quality; and insufficient food intake and its physical consequences, is asked with a recall period of four weeks (30 days). The HFIAS has been tested for its applicability in the Ethiopian context; its internal consistency was checked and the Cronbach's alpha value was 80% [29].

Physical activity

Women's physical activity level was measured using the International Physical Activity Questionnaire (IPAQ) [30]. The IPAQ assesses physical activity across a range of different domains including recreation-time, housework, job and transportation related physical activities. Each domain assesses walking, moderate and vigorous physical activity over seven days.

Edinburgh Postnatal depression scale

Edinburgh postnatal depression scale (EPDS) [31], which is a ten-item self-report screening questionnaire, was applied to assess depressive symptom. The EPDS has been validated in the Ethiopian setting [32, 33] with sensitivity of 71% and specificity of 66.2% [33], and internal consistency with Cronbach's α =0.77 [34]. It has also been used by many studies for detecting perinatal and postpartum depression in the country [32-35].

Intimate partner violence

Intimate partner violence was measured using a questionnaire used by the WHO multi-country study on women's health and domestic violence [36]. It includes physical violence, sexual violence, and emotional abuse by intimate partners. Physical violence is when a woman has been slapped or had something thrown at her that could hurt her, pushed or shoved, hit with a fist or something else that could hurt, kicked, drugged or beaten up, choked, or burnt on purpose, and the perpetrator threatened to use or actually used a gun, knife, or other weapon against her. Sexual violence is when a woman is physically forced to have sexual intercourse when she did not want to, she was afraid of what her partner might do, or she found it degrading or humiliating. The emotional abuse would be when a woman is insulted or made to feel bad about herself, belittled or humiliated in front of other people, the perpetrator had done things to scare or intimidate her on purpose, or to hurt someone she cared about. The Ethiopian EDHS 2016 also used this questionnaire [16]

Data collected from medical records

Some data such as gestational age (ultrasound result), blood pressure, haemoglobin level, random blood sugar, weight at the 24th and 36th weeks of gestation, mode of birth, presence of episiotomy, birth weight, and sex of the baby were reviewed from women's medical records. Sixteen women (5.2%) gave birth in the countryside (it was not feasible for the researcher to access birth registration of these women) and birth weight information was received from mothers by phone call. The data collection flow was depicted on Figure 2.

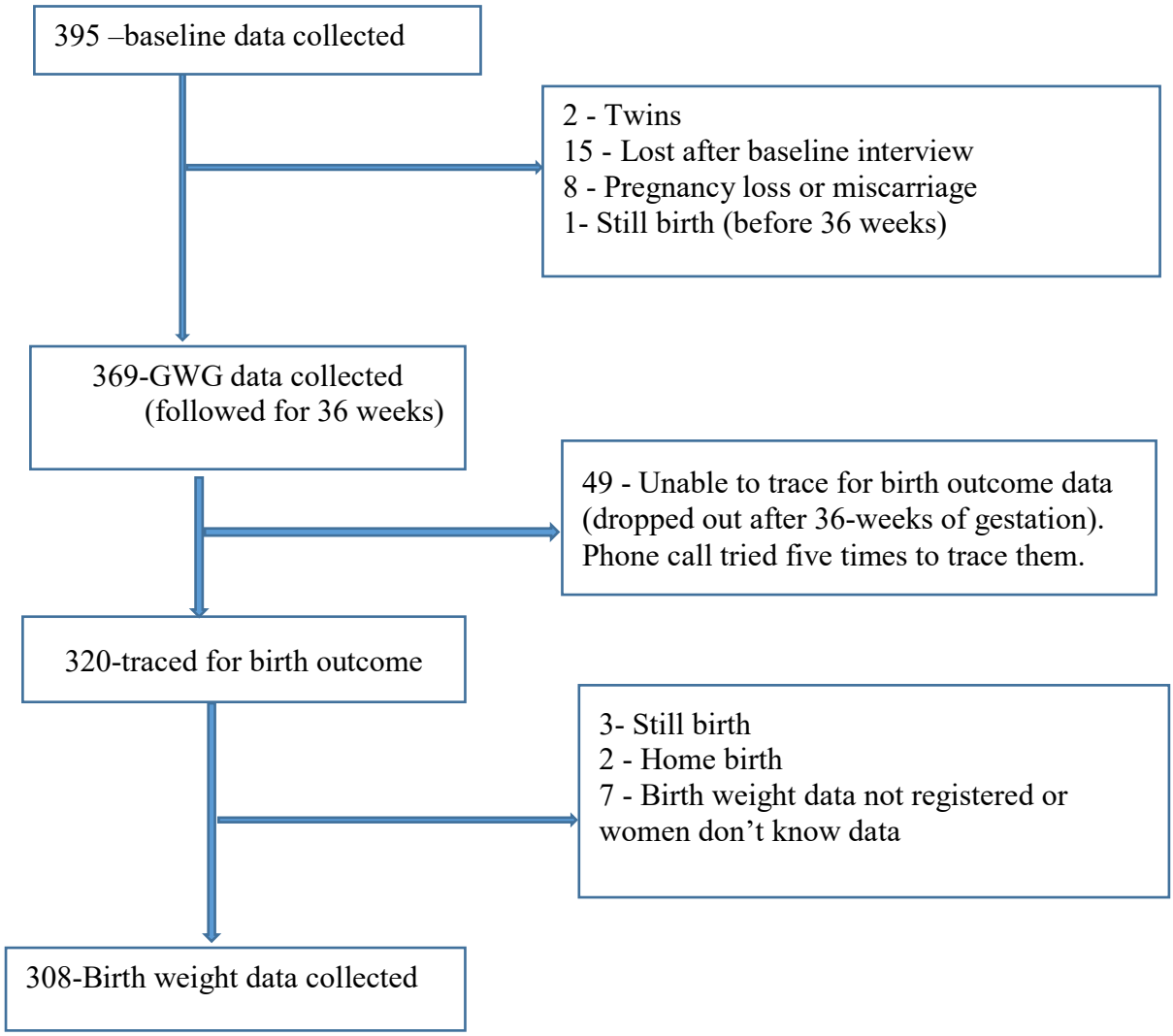

Figure 2: Flowchart showing data collection process among pregnant women in Addis Ababa, Ethiopia, 2019

3.9.6. Data security

All data were stored in CloudStor, a password-protected cloud-based data storage facility available through the University of Technology Sydney (UTS). The hard copies of the questionnaire were locked in a cabinet within a locked office at the Haramaya University to

ensure confidentiality and security of information in accordance with ethical standards. While the project was in progress, the data were stored on the researcher's password protected computer provided by the UTS. Only the researcher had access to the data.

3.9.6. Data analysis

Data were double entered into Census and Survey Processing System (CSPro) version 7, checked for consistence and accuracy, cleaned and then exported to Stata version 14 for analysis. Descriptive statistics including frequencies, means, median, standard deviations (SD) and interquartile (IQR) range were computed to describe the data. The women's BMI was categorized into four categories based on the WHO BMI cut-off points as underweight (BMI < 18.5 kg/m^2); normal weight (18.6 to 24.9 kg/$m^{2)}$; overweight (25.0 to 29.9kg/$m^{2)}$; and obese (≥ 30.0 kg/m^2). Total weight gain was calculated by subtracting the baseline weight from their weight at the 4th ANC visit (at the end of 36 weeks of gestation). Weight gain in the second trimester was calculated by subtracting baseline weight from their weight at the 24th week of gestation. Similarly, weight gain in the third trimester was calculated by subtracting baseline weight from their weight at the 36th week of gestation. Given different women (i.e., underweight, normal weight, overweight, and obese women) were recommended different amounts of weight gain by the IOM, the adequacy of their weight gain was checked according to the IOM recommendations and categorised as inadequate, adequate, or excessive. Ninety-five percent confidence intervals (95% CI) were calculated for the prevalence of inadequate, adequate, or excessive gestational weight gain in accordance with the IOM guidelines. Birth weight was analysed as a categorical and continuous variable. Birth weight was classified as <2.5 kg (low birth weight), 2.5 kg to 3.9 kg (normal birth weight), or ≥4.0 kg (macrosomia).

Principal component analysis was employed to compute wealth index [37] from a set of household assets questions such as electricity, refrigerator, table, chair, watch, phone, bed with mattress, electric mitad (an Ethiopian oven which is made up of clay and metal, and used to make tiny bread called 'enjera'), car, house, improved water, and improved toilet, which were adapted from the Ethiopian demographic and health survey [16]. If more than 95% or less than 5% of the sample owned a variable / asset, it was omitted from the study because it would not help to differentiate between rich and poorer households. To rank the household wealth status of the study women into quintiles, a factor score of this variable was used.

Women's physical activity levels were converted to the metabolic equivalent task per minute (MET-minutes) which is the total time spent on activity to energy expenditure. Based on the amount of MET-minutes, the physical activity of the women was categorised as high, moderate, and low levels [30].

A pairwise deletion was done during the analysis for missing data. A specific variable was excluded when it had a missing value, but the case was still used when analysing other variables with non-missing values. Hence, the analyses were performed on subsets of the data depending on where the values were missing without completely omitting a case with missing some variables from the analyses.

To identify predictors of GWG, bivariate and multivariable analysis was conducted using a multinomial logistic regression model, because the outcome variable (i.e., GWG) consisted of three categories (inadequate, adequate and excessive GWG). Pregnant women with inadequate or excessive GWG were compared to women with adequate GWG. Variables with P-value <0.25 in the bivariate analysis were included in the multivariable analysis. The variables in the

multivariable analysis include educational status, wealth index, occupational status, BMI, MUAC, perinatal depression, and asking permission from partners for health care seeking. Crude odds ratios (COR) and adjusted odds ratios (AOR) were calculated to determine the association between the explanatory variables and GWG.

The influence of GWG on birth weight was assessed with a linear regression model. The assumptions for linear regression were checked before the model was run. Shapiro Wilk's test ($p = 0.166$) showed that birth weight was normally distributed for the predictor variables. Scatter plots showed that observations were linear. Multi collinearity was checked using the variance inflation factor (VIF). The mean VIF value was 1.46. The VIF value for each predictor variable was < 3, which showed that there was no multi-collinearity among variables.

Multivariable linear regression analysis was performed to determine the independent effect of gestational weight gain on birth weight, adjusting for other potential factors (educational status, average household monthly income, and previous history of abortion, consuming meat or chicken in the last 24 hours, pre-pregnancy weight, maternal number of haemoglobins, occurrence of gestational hypertension, and sex of the baby). P-value < 0.05 with 95% CI used to declare statistical significance.

3.10. Qualitative component

The primary aim of the qualitative study was to explore pregnant women's and care providers' (midwives and obstetricians) perspectives, awareness, and practices of gestational weight gain and postpartum weight retention.

3.10.1. Design

A qualitative descriptive study design was used. A qualitative descriptive design provides a comprehensive understanding of given circumstance, a rich description of the participants' experiences or actions from the participants' perspectives [38]. A qualitative descriptive approach provides the who, what, where, and when of the pregnant women, midwives and obstetricians about pregnancy related weight management and postpartum weight retention in Ethiopia. Given midwives, obstetricians, and pregnant women's perspectives have not been explored in the Ethiopian context, a qualitative descriptive approach is an appropriate form of inquiry to describe how the midwives, obstetricians, and pregnant women feel and what they do to manage GWG and postpartum weight retention [39].

3.10.2. Participant recruitment

Any pregnant women who visited the study health facilities (health centre or hospital) for ANC, midwives who were working in ANC clinics, and obstetricians who provide care for pregnant women in the study settings were invited to participate in the study. The health facilities and all qualitative study participants were purposively selected. Pregnant women were selected from two public hospitals and eight public health centres; midwives were recruited from seven health centres and one hospital; and obstetricians were selected from four hospitals. Midwives were recruited from the same health centres pregnant women were selected for the quantitative study. Obstetricians were selected from tertiary hospitals at which most of the obstetricians in the city provide obstetric care and teaching services. The researcher performed the recruitment of the participants and data collection for the qualitative data.

Maternal health care providers identified pregnant women and then notified the researcher who subsequently approached the women with information about the study and invited participation in an in-depth interview and focus group discussion. The researcher undertook the recruitment process at a time that was convenient to the woman, after the woman had received all necessary services from the health facility at the antenatal clinic visit. The researcher also approached midwives and obstetricians with all necessary information about the study and invited participation in the in-depth interview.

3.10.3. Data collection

Pregnant women

Eight focus group discussions (n=56) with pregnant women were conducted. One to one in-depth interviews were conducted with 15 pregnant women (n=15). Focus group discussions were conducted primarily to explore cultural practices that influence GWG and PPWR. On the other hand, information such as women's feeding practices, ability to purchase food items, and talking about their weight, would be sensitive topics for women to discuss in a group setting. Hence, in-depth interviews were conducted to explore these issues. Prior to the focus group discussions and in-depth interviews, the participants were provided with the participant information leaflet and written consent was obtained. Participants were provided with an ID number to protect their identity while collecting the data. The focus group was guided by the open-ended questions detailed in Appendix 4. The in-depth interviews and focus group discussions were conducted by the researcher using the local language, Amharic. Interviews and focus group discussions were held in a private room within the health facility (hospital or health centre). All interviews and FGDs were audio recorded. Data collection continued until data saturation was reached. Saturation was deemed to have occurred when the same key

messages and codes were being heard when transcribing and beginning analysis. The data were shared with my supervisors who compared and contrasted their findings with the researcher (FA) until all agreed codes and themes were finalised.

Midwives and Obstetricians

One to one interview was held with 11 midwives (n=11) and 10 obstetricians (n= 10). Prior to the interview the participants were provided with the participant information leaflet and consent was obtained. No personal identifiers were collected and participants were identified by number such as Mid. 1 for midwife 1, or Obst. 1 for obstetrician 1. The questions that guided the interviews are provided in Appendix 8. These interview guides were developed after reviewing the literature and terms used to elicit midwives' and obstetricians' views about GWG, perceptions and counselling experiences in relation to weight gain in pregnancy, the sensitivity of discussing pregnant women's weight, and confidence while counselling pregnant women about nutrition as well as experiences around postpartum weight management. The interviews were conducted in local language, in a private quiet room, and audio recorded.

3.10.4. Data analysis

The audio recorded interviews and focus group discussions were transcribed verbatim in the local language, Amharic, then translated to English by a professional translator. Any inconsistences in the interviews and focus group discussions, transcripts and translations were checked by comparing the text with each recorded interview and focus group discussions, by the researcher, who is a fluent Amharic and English language speaker. The English version of the data were imported into NVivo software version 11 [40] to retrieve and code the data, and

to facilitate the theme building process. The data were analysed using thematic analysis [41, 42] to assess repeated views, perspectives, and practices across the entire data-set. Different themes and sub-themes were developed from the data. The analysis was conducted following the six phases of thematic analysis according to Braun and Clarke's (2006) recommendations [42]. First, the analysis began by reading and rereading for the primary researcher to become familiar with the transcribed data, and noted the main ideas from data. Second, the researcher examined transcripts line by line to identify dominant ideas and to draft codes. Third, the researcher categorised similar codes into similar categories to search for possible themes and sub-themes. Fourth, the research team (primary researcher and supervisors) checked for the identified themes and sub-themes in relation to the coded extracts and the full data set. Fifth, themes and sub-themes were refined, and their names were revised according to the different code extracts and the entire data set. Finally, the final report was developed by selecting the most representative extracts from the entire data-set. Participants were de-identified to maintain their anonymity. Pregnant women (e.g., participant 1, participant 2 up to participant 71), midwives, and obstetricians were provided with unique ID number. The quotes were presented in terms of participant numbers such as Obst.1 (obstetrician 1) for obstetricians, Mid.1 (midwife 1) for midwives, or P 1 (participant 1) for women.

3.10.5. Data trustworthiness

Trustworthiness also known as rigor of a study in qualitative research refers to the degree of confidence in data, methods used, and interpretation to ensure the quality of a study. Trustworthiness offers the basis for applying a research procedure to demonstrate the truth, and allows for external judgements to be made about the consistency of findings and the procedures. Research trustworthiness ensures the analysis process was reported accurately at

every stage: preparation, organisation and reporting [43]. Four criteria are widely used to assure data trustworthiness in qualitative research: credibility, dependability, transferability and confirmability.

Credibility is presenting the true picture of the findings, which has been demonstrated through adoption of well-established research methods [43]. Various strategies were utilised to achieve credibility. Firstly, data were collected from different participants (pregnant women, midwives and obstetricians) to accommodate multiple viewpoints. Service users (pregnant women's) viewpoints and experiences regarding GWG were verified against service providers (midwives and obstetricians). The findings from the qualitative studies were checked against the findings from the quantitative studies. Secondly, different data collection method, in-depth interviews and focus group discussions, were performed. Thirdly, quotes were used to demonstrate links between participants' words and interpretations. Fourthly, data and interpretations were checked and verified by the doctoral supervision team.

Dependability of the study was enhanced by documenting the research teams' discussions and decisions throughout the progress of the research project. In addition, the transcripts were checked multiple times against the audio recordings to ensure accuracy. Similarly, reading and rereading of transcripts, as well as coding and recoding of texts heighten the dependability of the findings. The specific details of data collection, analysis, and interpretation of the studies were clearly described.

The transferability of the finding was established using a number of approaches, which ensures the findings may be potentially applicable in another similar context. These approaches included providing detailed description of the phenomena of the study, study setting, study

participants and rationale for the study. The use of purposive sampling enabled transferability because they allowed the research team to develop new insights by providing a broad range of information from participants.

The confirmability was established with procedures in place to minimise the bias of researchers in relation to interpreting the data and reporting the findings [44]. Audio recorded interviews and focus group discussions were transcribed and translated by a professional translator. The transcripts and audio recorded files were crosschecked by the researcher who is bilingual. The data analysis was computed by the researcher, and reviewed and overseen by a doctoral supervision team.

3.10.6. Reflexivity

Reflexivity refers to the influences that the researcher had on the research processes [45, 46]. Reflexivity facilitates insight into the researchers' experience and knowledge on the research subject matter, the personal and social experience of researchers and participants [46, 47]. Reflexivity helps to sustain objectivity of the research by addressing or admitting potential biases [48].

The researcher (FA) is a public health professional with specialty track in Epidemiology. He started his career as a clinical officer serving in a hospital in 2008. After serving for one year as a clinician in the hospital, he joined the university as a graduate assistant in 2009. After that, he served as a graduate assistant and assistant lecturer in the university. He attended his postgraduate study in Public Health with specialty in Epidemiology (MPH) and then served the university as a lecturer and at different administrative positions. This was the time when he started researching gestational weight gain and identified there were research gaps related to

GWG Ethiopian settings. He then did some research focusing on GWG [22, 26] before he joined the PhD program.

The researcher conducted in-depth interviews with pregnant women, midwives and obstetricians, and focus group discussion with pregnant women. To begin each in-depth interview and focus group discussion, the researcher openly introduced himself as a PhD candidate and explained the purpose of the research. All interviews were arranged around the convenient time of the participants. Trust relationship was created with participants at the initial stages of the interview and focus group discussion. Participants were informed that they are free to skip any question that they were uncomfortable with. However, participants freely shared their views, perceptions, experiences regarding pregnancy related weight managements. The researcher was careful to avoid asking questions that would constrain or bias the participants' answers. However, given the existing evidence [22, 49] showed that majority of pregnant women in the setting experiences inadequate gestational weight gain, the open ended question primarily focused on exploring why pregnant women gains inadequate gestational weight in Ethiopia. In addition, some women may be reluctant to talk openly when a male researcher is conducting in-depth interviews and FGDs with pregnant women, and this may have potentially influenced the data collection [50]. There was no established relationship between any of the participants and the researcher prior commencement of the research.

Transcriptions and translations were conducted by professional translators. The translations were crosschecked with the transcripts and audio recorded files by the researcher.

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Chapter 4: Gestational Weight Gain and its Effect on Birth Outcomes in sub-Saharan Africa: Systematic Review and Meta-analysis

4.1.Chapter overview

This chapter presents a systematic review and meta-analyses of the relevant literature focusing on GWG among pregnant women in SSA countries. The review was conducted to identify gaps in the literature and to inform the study development. The findings of this systematic review and meta-analysis primarily focus on: the magnitude of inadequate, adequate, and excessive gestational weight gain; factors affecting gestational weight gain; and the effects of gestational weight gain on birth outcomes in sub-Saharan Africa. This Chapter contains an accepted version of the published systematic review.

Publication details

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Abstract

Introduction: An increased metabolic demand during pregnancy is fulfilled by gaining sufficient gestational weight. Women who gain inadequate-weight are at a high-risk of premature birth or having a baby with low-birth weight. However, women who gain excessive-weight are at a high-risk of having a baby with macrosomia. The aim of this review was to

determine the distribution of gestational weight gain and its association with birth-outcomes in Sub-Saharan Africa.

Methods: For this systematic review and meta-analysis, we performed a literature search using PubMed, Medline, Embase, Scopus, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases. We searched grey-literature from Google and Google Scholar, and region-specific journals from the African Journals Online (AJOL) database. The search was limited to papers published since 1990 (when the United States Institute of Medicine guideline was published) to 2019 in sub-Saharan Africa and published in English. We critically appraised the included studies using the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies. Two independent reviewers evaluated the quality of the studies and extracted the data. We calculated pooled relative-risks (RR) with 95% confidence intervals.

Results: Of 1450 retrieved studies, 26 met the inclusion criteria. Sixteen studies classified gestational weight gain according to the United States Institute of Medicine recommendations. The percentage adequate amount of gestational weight ranged from 3% to 62%. The percentage of inadequate weight was >50% among nine studies. Among underweight women, the percentage of women who gained inadequate gestational weight ranged from 67% to 98%. Only two studies were included in the meta-analyses to evaluate the association of gestational weight gain with pre-eclampsia and macrosomia. No difference was observed among women who gained inadequate and adequate gestational weight regarding experiencing pre-eclampsia (RR, 0.71; 95% CI: 0.22, 2.28, P=0.57). Excessive gestational weight gain was not significantly associated with macrosomia compared to adequate weight gain (RR, 0.68; 95% CI: 0.38, 1.22, P=0.20).

Conclusion: A substantial proportion of sub-Saharan African women gain inadequate gestational weight particularly among underweight women. Future interventions would need to design effective pre-pregnancy weight management strategies.

Key words: Gestational weight gain, Birth outcomes, Sub-Saharan Africa, Systematic review, Meta-analyses

4.2. Introduction

Desirable gestational weight gain (GWG) supports the increased metabolic demands required for positive pregnancy outcomes [1]. Guidelines regarding appropriate levels of GWG have been promoted worldwide [2]. A variety of guidelines about the GWG exist; their approach in GWG management also varies [3, 4]. More than a half (54%) of the GWG guidelines are similar to the 2009 United State Institutes of Medicine (IOM) recommendations [3]. The IOM recommends that women gain between 0.5 and 2.0 kg in the first trimester of pregnancy. In the second and third trimester, the weight gain recommendation is 0.44 to 0.58 kg per week for women who were underweight during the pre-pregnancy period (body mass index (BMI) $\leq$18.5 /m^2); 0.35 to 0.50 kg per week for women of normal-weight (BMI is 18.5 to <25 kg/m^2); 0.23 to 0.33 kg per week for over-weight women (BMI 25 to 30 kg/m^2); and 0.17 to 0.27 kg per week for obese women (BMI $\geq$30 kg/m^2). In total, the IOM recommends weight gain of 12.5 to 18 kg for underweight women; 11.5 to 16 kg for normal weight women, 7 to 11 kg for overweight women and 5 to 9 kg for obese women [5].

The amount of weight gained during pregnancy is determined by factors including the mother's age [2, 6, 7], parity [2, 6, 7], income status [2, 8], educational status [7], social class [6], and pre-pregnancy maternal weight [2, 9]. Other factors include antenatal care (ANC) [2, 6], physical activity during pregnancy [10], and perinatal depression [11-13].

A desirable GWG is essential for optimal outcomes for both the mother and her baby [14]. Inappropriate GWG can pose health risks for mother and baby [15, 16]. Women who do not gain enough weight during pregnancy are at risk of having a baby with low birth weight (LBW) [17, 18] and pre-term birth [19]. Women who gain excessive weight are at an increased risk of hypertension in pregnancy, as well as an increased risk of pre-eclampsia [20-22], gestational diabetes [15, 20], caesarean sections [20, 22, 23], postpartum haemorrhage [22], postpartum weight retention [24], and development of long-term obesity [25].

The World Health Organization (WHO) defines low birth weight as a birth weight less than 2500g [26]. Globally, LBW contributes to 60% to 80% of all neonatal deaths [27]. About 95% of the 20.6 million LBW infants born each year are in low-income countries [26, 27]. Inadequate GWG in combination with low pre-pregnancy weight is associated with higher rates of LBW and prematurity [28].

To date, there are few systematic reviews and meta-analyses of research in sub-Saharan Africa (SSA) on the weight of pregnant women [29-31]. None addressed how much weight is gained during pregnancy by women in this population, or the effect on birth outcomes. Therefore, this systematic review and meta-analysis presents available evidence on the amount of GWG, factors affecting GWG and the association of GWG with birth outcomes, in sub-Saharan Africa.

4.3.Methods

4.3.1. The protocol and registration

The method of this systematic review and meta-analysis was reported using the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement recommendations [32] (Appendix 5). We followed the flowchart from the PRISMA-P 2015 guideline recommendation to demonstrate the selection process from initially identified records to finally included studies [33]. The protocol for this review was registered on the International Prospective Register of Systematic Reviews (PROSPERO) registration number CRD42018085499 [34].

4.3.2. Search strategy

We identified literature from PubMed, Medline, Embase, Scopus, and CINAHL databases (Appendix 6). We also accessed the African Journals Online (AJOL) database for papers published in country-specific or region-specific journals. A supplementary search was conducted to find grey literature from the Google search engine and Google Scholar. In addition, we contacted six authors to request additional information missing from their papers. However, only one author [35] responded to the email request. The search was limited to papers published since 1990 (when the IOM guideline was published [36]) to 2019 in sub-Saharan Africa and published in English. We employed the Medical Subject Headings (MeSH) terms, Emtree, CINAHL headings and combined keywords to identify studies in these databases. The search terms emerged from the following keywords (GWG, Weight gain during pregnancy, Birth outcome, Birth weight, Low birth weight, sub-Saharan Africa).

4.3.3. Eligibility criteria

We included cross-sectional, case-control, cohort, and randomized controlled trials. We included studies that defined GWG as inadequate, adequate, or excess according to IOM recommendations, or mean GWG in total or in each trimester, and that explicitly reported for underweight, normal weight, overweight, and obese women (based on pre-pregnancy BMI). We also included studies that classified GWG based on the researchers' categories and studies that assessed the association of GWG with birth outcomes. We excluded the studies if they were duplicates; anonymous reports; not published in English language; systematic reviews and meta-analyses, or studies that were unable to provide information about the adequacy of GWG. The primary outcome of interest in this study is GWG. Other outcomes were factors affecting GWG and the association between GWG and birth outcomes.

4.3.4. Study selection procedure

We located an initial set of studies by using the search terms and applying filters to the databases. We exported the identified studies to Covidence, a systematic review software [37], and we excluded duplicates. Two reviewers independently screened the studies based on titles and abstracts as per the inclusion criteria. During the screening process, we resolved any disagreements between the two reviewers through discussion. However, in the case of further disagreement, other authors made the final decisions.

4.3.5. Quality assessment

Two independent appraisers appraised the quality of the included studies. We used the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies [38]

is to appraise the studies critically and to report the level of the strength of a study's quality. The quality assessment tool uses a number of criteria to rate the strength of the studies. These criteria include the presence of selection bias, the strength of the study design, withdrawals, and dropout rate, data collection practices, blinding (as part of a controlled trial) and how confounders were controlled. Each examined practice paper marked as "strong," "moderate," or "weak". During appraisal, attention was given to the clear description of objectives, inclusion criteria, precision of measurement of the outcome (the time and how pre-pregnancy BMI and GWG were measured), and the appropriateness of statistical analyses.

4.3.6. Data extraction process

We used an excel spreadsheet for data extraction. Two reviewers extracted the data using a data extraction format which includes authors, year of publication, study design, sample size, the country of the study, objectives of the study, how GWG was measured, time at which pre-pregnancy BMI was measured, and the pre-pregnancy weight status of the women (underweight, normal-weight, overweight, and obese). We extracted data on GWG (mean for each category of pre-pregnancy weight, the percentage of inadequate, adequate, or excess), factors affecting GWG and effects of GWG on birth-outcomes. Where the GWG categorisation did not follow the IOM categories, we used the categorisation used in the study.

4.3.7. Data analysis

Findings from each study were described by the country of the study, population characteristics, women's pre-pregnancy BMI, study design, study objectives, and outcomes. Outcomes, GWG, were reported using the IOM classification. For studies that used arbitrary classifications (for example, ≤ 8.0 kg (inadequate GWG), 8.1 to 16.0 kg (adequate GWG), and

≥16.1 kg (excessive GWG) [39]; or <7 kg (inadequate GWG), 7 to 12 kg (adequate GWG), and >12 kg (excessive GWG) [40]), we used the authors' own classifications.

We used forest plots to report the results graphically. We checked the presence of heterogeneity among studies using the chi-squared test where statistical significance with a p-value <0.05. The I^2 statistic was used to quantify the level of heterogeneity among the studies. We assumed substantial heterogeneity among studies when the value of I^2 was ≥50 %. We used the Mantel–Haenszel fixed effects model to conduct meta-analyses where the studies did not have substantial heterogeneity (i.e. I^2 statistic < 50 %). We used random effects model while assessing the effect of gaining inadequate gestational weight on pre-eclampsia although the I^2 value is <50%, because we have observed considerable heterogeneity among included studies. We pooled the percentages of inadequate, adequate, and excess GWG metaprop programme [41], Stata version 14. We stratified women into underweight, normal-weight, overweight, and obese women to pool their GWG. The association between GWG and birth outcomes (LBW, Macrosomia, APGAR-score, caesarean section, obstetric haemorrhage, pre-eclampsia, and episiotomy) was determined using the Review Manager Software (RevMan version 5.3 for windows) [42]. We calculated risk ratios with 95% confidence intervals. However, due to high heterogeneity among studies and the limited number of studies (Appendix 7a and 7b), we reported only the association between GWG and macrosomia and pre-eclampsia. Factors associated with GWG were classified differently among different studies. We used narrative synthesis to describe factors associated with GWG.

4.4. Results

4.4.1. Results of the screening process

The search retrieved 1450 studies. A total of 1086 articles were reviewed after removal of 364 duplicates. Based on title and abstract screening, we excluded 964 articles, and we conducted a full-text review on the remaining 121 studies left. We included 26 studies in the review (Figure 3).

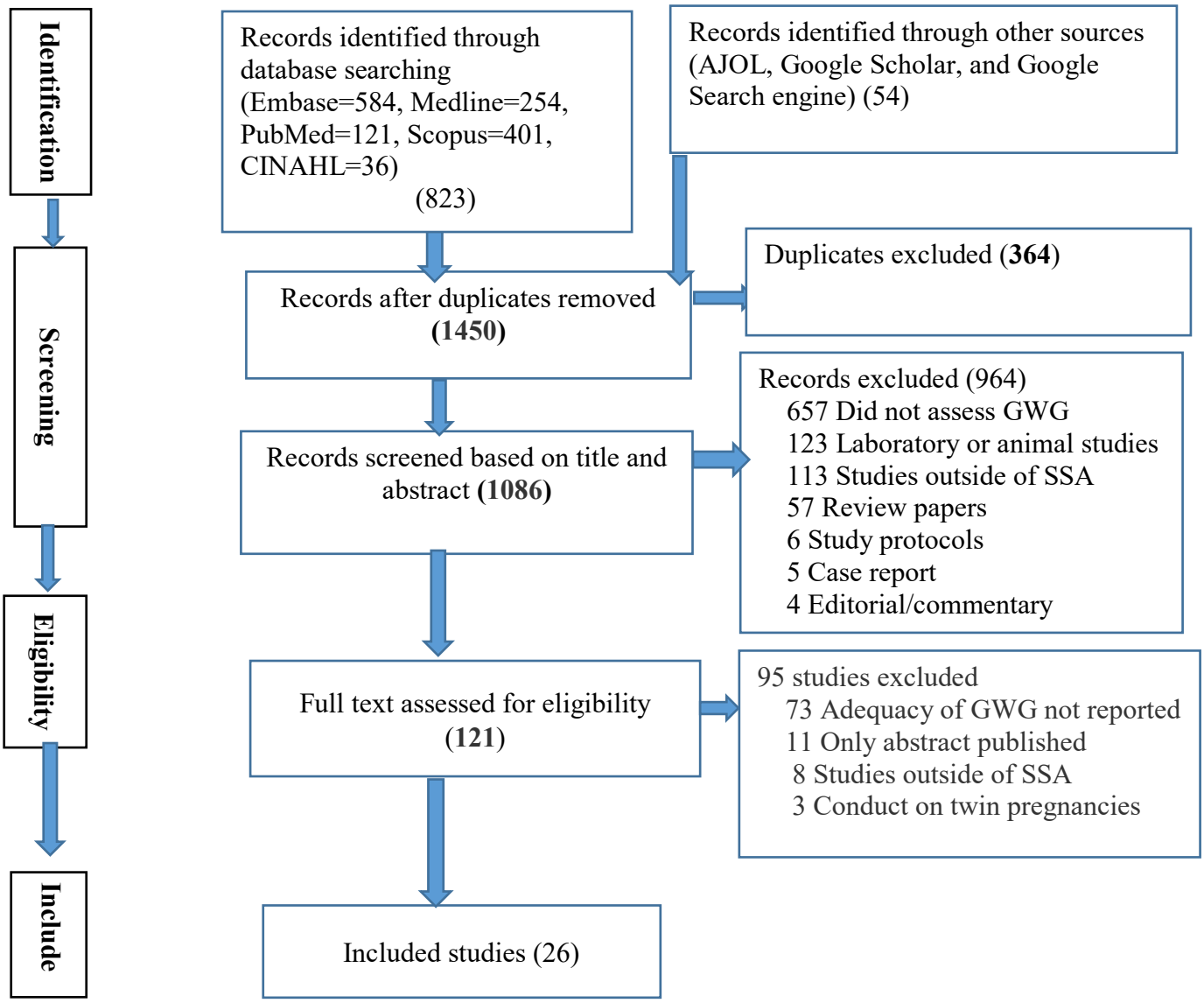

Figure 3: PRISMA flow diagram for article selection and screening, 2019

4.4.2. Study characteristics

Table 3 describes the characteristics of the studies included in this review. Five studies were from Nigeria [6, 7, 43-45]; four from Cameroon [46-49]; four each from Ethiopia [2, 35, 50, 51] and Ghana [39, 52-54]; two studies from South Africa [55, 56] and Malawi [28, 57]; and one each from Uganda [9], Kenya [58], Niger [59], Benin [40], and the Democratic Republic of Congo [60]. Based on a country's income status [61], two studies were from upper middle-income countries [55, 56]; fourteen from lower middle-income countries [6, 7, 39, 43-49, 52-54, 58] and ten from low-income countries [2, 9, 28, 35, 40, 50, 51, 57, 59, 60].

Sixteen studies [2, 7, 9, 28, 35, 43, 46, 48, 52-57, 59, 60] classified the outcome (GWG) according to the IOM recommendations, but for seven studies [6, 39, 40, 44, 45, 49, 51] standard criteria were not used to measure and classify the outcome, that is the authors classified weight gain using their own method. Three studies reported according to the International Fetal Newborn Growth Standards for the 21st Century (INTERGROWTH-21st) guidelines [53, 58, 59], of which two studies [53, 59] used both IOM 2009 and INTERGROWTH-21st guidelines. The authors of one study (Mbu et al., 2013, page 649) stated that they used the IOM classification, but they also reported normal weight gain as *"*women with BMIs between 18.5 kg/m² and 30 kg/m² and who gained 9 to 16 kg; excessive weight gain for those who gained weight above these ranges" [47]. Eight studies reported GWG separately for each category of woman's pre-pregnancy weight [2, 7, 9, 35, 43, 54, 55, 57], and the author of one study provided these data upon email request [35]. Four studies [9, 45, 46, 49] used self-reported pre-pregnancy weight while three studies [53, 55, 60] used weight after 20 weeks of gestation and one study [57] used weight at 24 weeks of gestation. It was not clear when and how pre-pregnancy weight was measured in two studies [47, 59] (Table 4).

Table 4: Characteristics of the 26 studies reporting on gestational weight gain in relation to pre-pregnancy weight in sub-Saharan Africa, 2019

Author and year	Country	Study design	Study settings	Sample size	Objective of the study	GWG Measure	Time at which pre-pregnancy BMI measured	Underweight (UW), normal-weight (NW), Overweight(OW and Obese (O) women Number (%)
Abubakari et al 2015 [52]	Ghana	Cross-sectional study	Urban, peri-urban and rural Both primary and referral hospitals	419	To assess the association between pre-pregnancy BMI, GWG, maternal socio economic and demographic factors and birth weight	IOM 2009	First trimester	UW=16 (3.8) NW=242 (57.8) OW=105 (25.0) O=56 (13.3)
Addo 2010 [39]	Ghana	Cross-Sectional study	Urban vs rural is not clearly stated Private specialist Hospital	1755	To find out the effects of pregnancy weight gain in different BMI groups on maternal and neonatal outcomes	Operationally defined (Low weight gain ≤ 8.0 kg, Normal weight gain 8.1 to 16.0 kg, High weight gain ≥16.1 kg)	Between 10 and 13 weeks of Gestation	UW=77 (4.4) NW=832 (47.4) OW =609 (34.7) O=314 (17.9)‡
Adu-Afarwuah et al 2017 [53]	Ghana	Randomized Controlled Trial	Semi-urban Primary hospitals and poly clinic	1320	To determine the association of SQ-LNSs with differences in GWG or maternal anthropometric characteristics, including risk of overweight or obesity	IOM 2009 and INTERGROWTH-21st guidelines	Before 20 weeks of gestation	UW=50 (3.8) NW=743 (56.3) OW=354 (26.8) O=143 (10.8)
Agbayizah 2017 [54]	Ghana	Cross-sectional study	Urban Semi-urban Rural General Hospital	322	To assess the prevalence of inadequate, adequate and excessive GWG and its associated factors	IOM 2009	Before 20 weeks of gestation	UW=3 (1.0) NW=164 (50.9) OW =119 (36.9) O=56 (11.2)
Agbota et al 2019 [40]	Benin	Longitudinal (cohort) study	Semi-urban and Rural; institution where the study collected was not clearly indicated	260	To assess the effect of maternal anthropometric status before conception and during pregnancy on fetal and postnatal growth, up to 12 months of age	Operationally defined (<7 kg, 7 to 12 kg and >12 kg)	Before 7 weeks of gestation	UW=23 (8.9) NW=175 (67.3) OW =43 (16.5) O=19 (7.3)
Akindele et al 2017 [45]	Nigeria	Case–control study	Urban Major public hospitals (type of the hospitals are not indicated)	240	To determine the incidence of macrocosmic new-born, their maternal socio-biologic predictors, the neonatal complications attributable to the mode of delivery, and their early neonatal outcome	Operationally defined (<15 kg and ≥15 kg)	Self-reported pre-pregnancy weight	UW, NW & OW = 172 (71.7) O=68 (28.3)

Table 4: Characteristics of the 26 studies reporting on gestational weight gain in relation to pre-pregnancy weight in sub-Saharan Africa, 2019 (continued)

Author and year	Country	Study design	Study settings	Sample size	Objective of the study	GWG Measure	Time at which pre-pregnancy BMI measured	Underweight (UW), normal-weight (NW), Overweight(OW and Obese (O) women Number (%)
Asefa et al 2016 [2]	Ethiopia	Cross-sectional study	Urban Both primary and referral hospitals	411	To assess GWG and associated factors	IOM 2009	Before 16 weeks of gestation	UW=39 (9.5) NW=296(72) OW=60(14.6) O=16(3.9)
Chithambo 2017 [57]	Malawi	Longitudinal study (Cohort)	Rural Community based	257	To identify factors associated with the rate of GWG	IOM 2009	Before 24 weeks of gestation	UW=18 (7.0) NW=201 (78.2) OW=38 (14.8) O=0
Elie et al 2015 [49]	Cameroon	Cross-sectional study	Urban University teaching hospital	232	To identify risk factors for macrosomia babies	Operationally defined (<16 kg and ≥16 kg)	Before 20 weeks of gestation but from maternal recall before she realized pregnancy	UW=0 NW=114 (49.1) OW & O =118(50.9)
Esimai et al 2014 [7]	Nigeria	Longitudinal (cohort)study	Urban vs rural is not clearly stated Primary health facilities	590	To determine correlates of gestational weight gain and infant birth weight	IOM 2009 with some operational definition (<7 kg low, >7 kg high)	First 2 months of pregnancy	UW=47 (8.0) NW=482 (81.7) OW=46 (7.8) O=15 (2.5)
Fouelifack et al 2015 [46]	Cameroon	Retrospective Cohort	Urban Referral hospital	465	To assess associations of BMI and GWG with pregnancy outcomes	IOM 2009	Self-reported pre-pregnancy weight	UW=17 (3.7) NW=228(49) OW=152(32.7) O=65(14)
Gondwe et al 2018 [28]	Malawi	Retrospective cohort nested with randomized controlled trial	Semi-urban and semi-rural Private hospital and public health centre	1287	To examined whether maternal pre-pregnancy BMI and GWG are associated with birth outcomes	IOM 2009	Before 20 weeks of gestation	UW=76 (5.9) NW=1071 (83.2) OW & O=140 (10.9)
Halle-Ekane et al 2015 [48]	Cameroon	Cross-sectional study	Urban District hospitals	350	To determine the prevalence of excessive GWG, its risk factors, and effects on pregnancy outcomes	IOM 2009	Before 13 weeks of gestation	UW=8 (2.3) NW=176 (50.3) OW=115(32.8) O=51(14.6)

Table 4: Characteristics of the 26 studies reporting on gestational weight gain in relation to pre-pregnancy weight in sub-Saharan Africa, 2019 (continued)

Author and year	Country	Study design	Study settings	Sample size	Objective of the study	GWG Measure	Time at which pre-pregnancy BMI measured	Underweight (UW), normal-weight (NW), Overweight (OW) and Obese (O) women Number (%)
Ismail et al 2016 [58]	Kenya	longitudinal (cohort) study	Urban (institution where the study collected was not clearly indicated)	Varies[§]	To describe patterns in maternal gestational weight gain in healthy pregnancies with good maternal and perinatal outcomes	Mean GWG at each month of follow-up and INTERGROWTH-21st[†]	Before 14 weeks of gestation	All were normal weight women
Iyoke et al 2013 [43]	Nigeria	Retrospective cohort	Urban Teaching hospitals	648	To compare GWG and obstetric outcomes between obese and normal weight women	IOM 2009	First trimester	UW=NA NW=324 (50.0) OW=NA O=324 (50.0)
Mbu et al 2013 [47]*	Cameroon	Cross-sectional study	Urban Maternity hospital (type of the hospital is indicated)	220	To determine pregnancy outcomes among women who gained normal and excess gestational weight	IOM 2009 with modifications	Not clearly stated	Not clearly stated
Muyayalo et al 2017 [60]	Democratic Republic of Congo	Prospective Cohort	Urban Referral hospitals	199	To determine proportion of post-partum weight retention and its average level; to identify its risk factors; to determine the proportion of obese women 6 weeks after delivery.	IOM 2009	Before 20 weeks of gestation	UW=11 (5.5) NW=111 (55.8) OW=56 (28.1) O=21 (10.6)
Nomomsa et al 2018 [50]	Ethiopia	Cross-sectional study	Urban Both primary and referral hospitals	411	To assess the association of GWG and LBW	IOM 2009	Before 16 weeks of gestation	UW=39 (9.5) NW=296(72) OW=60(14.6) O=16(3.9)
Onwuka et al 2017 [6]	Nigeria	Longitudinal (cohort) study	Urban Teaching hospitals	200	To determine the pattern of GWG and its association with birth weight	Operationally defined (<10 kg inadequate, 10 to 15 kg adequate, >15 kg excess)	Before 14 weeks of gestation	UW=7 (3.5) NW=102 (51.0) OW =35 (17.5) O=56 (28.0)
Onyiriuka 2006 [44]	Nigeria	Cross-sectional study	Urban Referral Hospital	408	To determine the incidence of delivery of high birth weight (macrosomia)	Operationally defined (<10 kg, 10 to 12 kg, 13 to 15 and >15 kg)	First trimester	Not reported

Table 4: Characteristics of the 26 studies reporting on gestational weight gain in relation to pre-pregnancy weight in sub-Saharan Africa, 2019 (continued)

Author and year	Country	Study design	Study settings	Sample size	Objective of the study	GWG Measure	Time at which pre-pregnancy BMI measured	Underweight (UW), normal-weight (NW), OW and Obese (O) women Number (%)
Ouédraogo et al 2019 [59]	Niger	Cross-sectional study	Community-based survey	1386	To estimate the prevalence and the determinants of low GWG and low mid-upper arm circumference	IOM 2009 and INTERGROWTH-21st guidelines	Not clear (women included regardless of their gestational age)	Not reported
Seifu 2017 [35]	Ethiopia	Cross-sectional study	Urban Health centre, primary and referral hospitals	549	To compare GWG and its associated factors among HIV-positive and HIV-negative women	IOM 2009	Before 16 weeks of gestation	UW=107 (19.5) NW=371 (67.6) OW=65 (11.8) O=6 (1.1)
Tela et al 2019 [51]	Ethiopia	Cross-sectional study	Urban Private clinics	309	To determine the prevalence of macrosomia and investigate the associated risk factors	Operationally defined (<16 kg, ≥16 kg)	Around 12 weeks of gestation	UW=28 (9.0) NW=173 (56.0) OW =76 (24.6) O=32(10.4)
Wanyama et al. 2018 [9]	Uganda	Cross-sectional study	Urban Health centre	192	To determining the prevalence of inadequate, adequate and excessive GWG	IOM 2009	Self-reported pre-pregnancy weight	UW=28 (14.6) NW=143 (74.5) OW=21 (10.9) O=0
Ward et al 2007 [56]	South Africa	Longitudinal (cohort) study	Urban vs rural is not clearly stated Primary health care clinic	89	To evaluate the association between pre-pregnancy BMI and maternal pregnancy weight gain and pregnancy outcome	IOM 1990	14 weeks of Gestation	UW=14 (15.7) NW=45 (50.6) OW & O=28 (31.5)
Wrottesley et al 2017 [55]	South Africa	Prospective cohort study	Urban Teaching hospitals	538	To assess patterns of habitual dietary intake and their associations with first trimester BMI and GWG	IOM 2009	Before 20 weeks of gestation	UW=0 NW=182 (33.8) OW=190 35.3) O=166 (30.9)

*intentionally included equal number of women who gained excessive gestational weight and who gained adequate gestational weight to compare their birth outcomes; †International Fetal Newborn Growth Standards for the 21st Century -INTERGROWTH-21st (This study is a multicentre study including one SSA country, Kenya. However, the GWG according to the INTERGROWTH-21st standard was not explicitly reported for Kenya) ; ‡ the summation of the described numbers of UW, NW, OW and O women is greater than the described total sample size. §Varies across Gestational ages (355 for 14-18^{+6} weeks, 356 for 19-23^{+6} weeks, 360 for 24-28^{+6} weeks, 355 for 29-33^{+6} weeks, 388 for 34-40^{+0} weeks)

4.4.3. Critical appraisal results

In two studies, loss to follow-up was not well described. In one of these studies [7], a cohort of 1000 women was recruited, but the authors reported the results of 590 women, but there was not an adequate description of loss to follow-up of the remaining 410 women. Poor control of confounding factors was also an issue affecting the quality of the studies [6, 9, 39, 43, 44, 47-49]. These studies either did not control for confounding factors at all or did not include all necessary variables into the analysis (partially controlled) or did not report how confounding was controlled. According to our quality assessment, 16 studies had moderate quality, while the remaining 10 studies had weak quality. Except for one study [53], all included studies were observational studies (Table 5).

4.4.4. Gestational weight gain classifications

Gestational weight gain according to IOM classification

Sixteen studies reported the percentage of GWG according to IOM recommendations. The percentage of women with inadequate GWG ranged from 15.7% to 96.6% [7, 56]. The percentage of women with adequate GWG ranged from 3% to 62% [7, 43]. Nine of the 16 studies reported the percentage of women with inadequate GWG as >50% [2, 7, 9, 28, 35, 53, 57, 59, 60] and the percentage of women with adequate GWG as <30% [2, 7, 28, 35, 53-55, 57, 59, 60]. The smallest percentage of inadequate GWG (15.7%) [56] and the highest percentage of excessive GWG (55.5%) [55] were from South Africa. In 11 of the 16 studies, the percentage of women with excessive GWG was <20% [2, 7, 9, 28, 35, 43, 52, 53, 57, 59, 60] (Table 6).

Table 5: Summary of the quality of included studies according to the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies, 2019

Author and year	Selection bias	Study design	Confounder	Blinding	Data collection method	Withdrawal and dropout	Overall strength
Abubakari et al 2015 [52]	Strong	Weak	Strong	NA	Strong	Strong	Moderate
Adu-Afarwuah et al 2017 [53]	Strong	Strong	Strong	Weak	Strong	Strong	Moderate
Addo 2010 [39]	Moderate	Weak	Weak	NA	Moderate	Strong	Weak
Agbayizah 2017 [54]	Moderate	Weak	Moderate	NA	Strong	Strong	Moderate
Agbota et al 2019 [40]	Strong	Weak	Strong	NA	Strong	Strong	Moderate
Akindele et al 2017 [45]	Moderate	Weak	Strong	NA	Strong	Strong	Moderate
Asefa et al 2016 [2]	Moderate	Weak	Strong	NA	Moderate	Strong	Moderate
Chithambo 2017 [57]	Strong	Weak	Strong	NA	Strong	Strong	Moderate
Elie et al 2015 [49]	Strong	Weak	Weak	NA	Strong	Strong	Weak
Esimai et al 2014 [7]	Moderate	Weak	Moderate	NA	Strong	Weak	Weak
Fouelifack et al 2015 [46]	Moderate	Weak	Moderate	NA	Moderate	Strong	Weak
Gondwe et al 2018 [28]	Strong	Weak	Strong	NA	Strong	Strong	Moderate
Halle-Ekane et al 2015 [48]	Strong	Weak	Weak	NA	Strong	Strong	Weak
Ismail et al 2016 [58]	Strong	Weak	Strong	NA	Strong	Strong	Moderate
Iyoke et al 2013 [43]	Moderate	Weak	Weak	NA	Strong	Strong	Weak
Mbu et al 2013 [47]	Weak	Weak	Weak	NA	Moderate	Weak	Weak
Muyayalo et al 2017 [60]	Moderate	Weak	Strong	NA	Moderate	Strong	Moderate
Nemomsa et al 2014 [50]	Moderate	Weak	Strong	NA	Moderate	Strong	Moderate
Onwuka et al. 2017 [6]	Moderate	Weak	Weak	NA	Strong	Strong	Weak
Onyiriuka 2006 [44]	Strong	Weak	Weak	NA	Strong	Strong	Weak
Ouédraogo et al 2019 [59]	Strong	Weak	Strong	NA	Strong	Strong	Moderate
Seifu 2017 [35]	Moderate	Weak	Moderate	NA	Moderate	Strong	Moderate
Tela et al 2019 [51]	Moderate	Weak	Moderate	NA	Moderate	Strong	Moderate
Wanyama et al. 2018 [9]	Moderate	Weak	Weak	NA	Strong	Strong	Weak
Ward et al 2007 [56]	Moderate	Weak	Moderate	NA	Moderate	Strong	Moderate
Wrottesley et al 2017 [55]	Strong	Weak	Strong	NA	Strong	Strong	Moderate

*Not-applicable

Table 6: Studies describing proportions of inadequate, adequate and excess gestational weight gain in Sub-Saharan Africa according to the United State Institute of Medicine recommendations, 2019

Authors and year	Sample Size	Inadequate GWG n (%)	Adequate GWG n (%)	Excess GWG n (%)
Abubakari et al 2015 [52]	419	208 (49.6)	180 (43.0)	31 (7.4)
Adu-Afarwuah et al 2017 [53]	1030	646 (62.7)	277 (26.9)	107 (10.4)
Agbayizah 2017 [54]	322	73 (22.7)	94 (29.2)	155 (48.1)
Asefa et al. 2016 [2]	411	285 (69.3)	115 (28.0)	11 (2.7)
Chithambo et al. 2017 [57]	257	206 (80.2)	51 (19.8)	0 (0.0)
Esimai et al 2014 [7]	590	570 (96.6)	18 (3.1)	2 (0.3)
Fouelifack et al 2015 [46]	462	131 (28.0)	186 (40.0)	145 (32.0)
Gondwe et al 2018 [28]	1287	924 (71.8)	296 (23.0)	67 (5.2)
Halle-Ekane et al 2015 [48]	350	129 (36.9)	114 (32.6)	107 (30.6)
Iyoke et al 2013 [43]	648	121 (18.7)	400 (61.7)	127 (19.6)
Muyayalo et al 2017 [60]	199	117 (58.8)	52 (26.1)	30 (15.1)
Ouédraogo et al 2019 [59]	911	574 (63.0)	218 (24.0)	119 (13.0)
Seifu et al. 2017 [35]	549	369 (67.2)	160 (29.2)	20 (3.6)
Wanyama et al. 2018 [9]	192	120 (62.5)	66 (34.4)	6 (3.1)
Ward et al 2007 [56]	89	14 (15.7)	46 (51.7)	29 (29.6)
Wrottesley et al 2017 [55]	538	128 (24.0)	113 (21.0)	297 (55.5)

Substantial heterogeneity was detected among studies while pooing the prevalence inadequate, adequate, and excess weight gain. The pooled estimate of the inadequate GWG in SSA was 52% (95% CI: 37%, 66%) (Figure 4). The prevalence of adequate GWG was 31% (95% CI: 23%, 39%) (Figure 5), and the prevalence of excessive GWG was 18% (95% CI: 13%, 23%) (Figure 6).

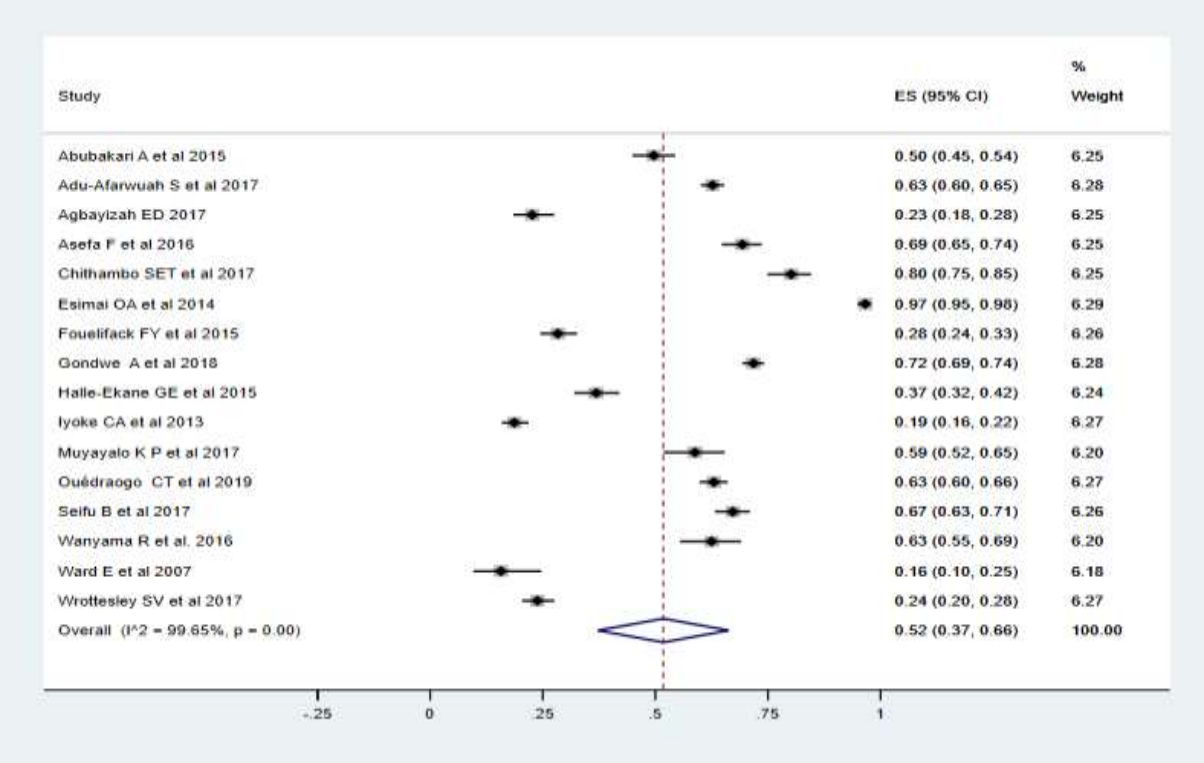

Figure 4: Gestational weight gain below the recommended level in sub-Saharan Africa

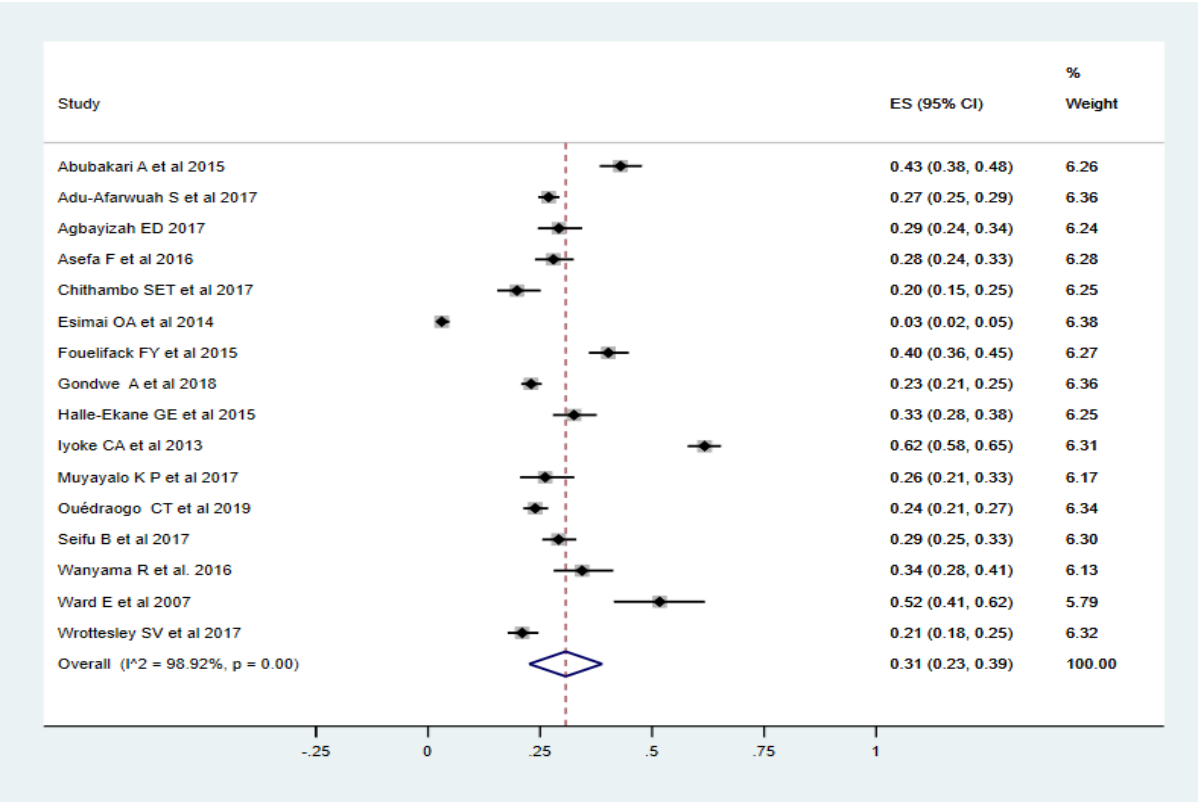

Figure 5: Gestational weight gain within the recommended level in sub-Saharan Africa

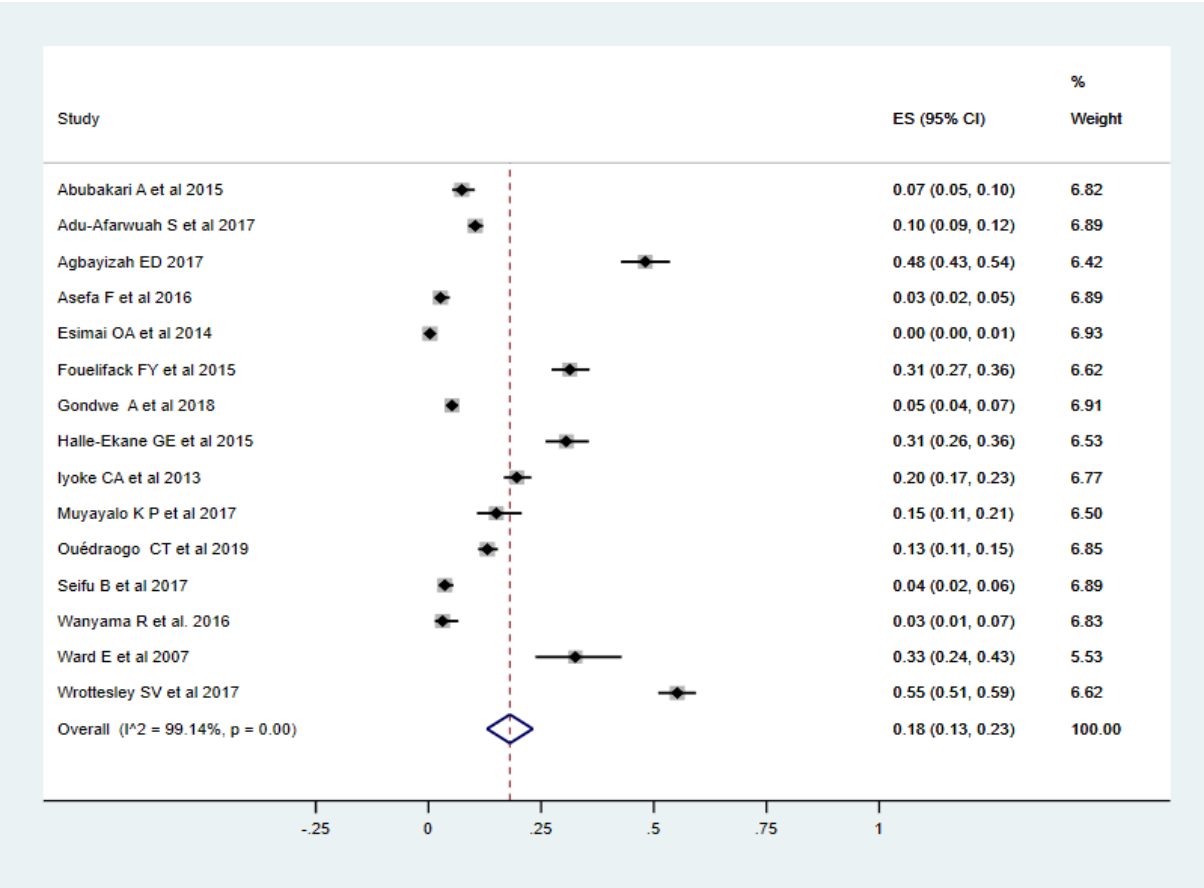

Figure 6: Gestational weight gain above the recommended level in sub-Saharan Africa

Of the eight studies [2, 7, 9, 35, 43, 54, 55, 57] that reported GWG separately for each category of women's pre-pregnancy weight, two studies had no underweight women [43, 55] or obese women [9, 57], while one study had no overweight women [43]. According to the six studies that had underweight women [2, 7, 9, 35, 54, 57], more than 67% of underweight women were reported to have gained inadequate gestational weight. In four studies [2, 7, 9, 57], more than two-thirds of normal weight women gained inadequate gestational weight, but in three studies [43, 54, 55], nearly one -third of normal weight women gained inadequate gestational weight. As pre-pregnancy BMI of the women increased, the percentage of those with adequate GWG increased (7.7% among underweight women and 62.5% among obese women [2]; 2.1% among underweight women and 93.3% among obese women [7]) (Table 7).

Table 7: Proportions of inadequate, adequate and excess gestational weight gain according to pre-pregnancy weight of the women in Sub-Saharan Africa, 2019

Authors and year	Pre-pregnancy weight status of the women	Inadequate GWG n (%)	Adequate GWG n (%)	Excess GWG n (%)	Total N
Agbayizah 2017 [54]	Underweight	2 (66.7)	1 (33.3)	0 (0.0)	3
	Normal weight	52 (31.7)	62 (37.8)	50 (30.5)	164
	Overweight	9 (7.6)	25 (21.0)	85 (71.4)	119
	Obese	10 (27.8)	6 (16.7)	20 (55.5)	36
	Total	73 (22.7)	94 (29.2)	155 (48.1)	322
Asefa et al 2016 [2]	Underweight	35 (89.7)	3 (7.7)	1 (2.6)	39
	Normal weight	222 (75.0)	71(24.0)	3 (1.0)	296
	Overweight	23 (38.3)	31 (51.7)	6 (10.0)	60
	Obese	5(31.2)	10 (62.5)	1(6.3)	16
	Total	285(69.3)	115 (28.0)	11(2.7)	411
Chithambo et al 2017 [57]	Underweight	16 (88.9)	2 (11.1)	0(0.0)	18
	Normal weight	163 (81.1)	38 (18.9)	0(0.0)	201
	Overweight	27 (71.1)	11 (28.9)	0(0.0)	38
	Obese	0(0.0)	0(0.0)	0(0.0)	0
	Total	206 (80.2)	51 (19.8)	0(0.0)	257
Esimai et al 2017 [7]	Underweight	46 (97.9)	1 (2.1)	0(0.0)	47
	Normal weight	479 (99.4)	2 (0.4)	1 (0.2)	482
	Overweight	45(97.8)	1 (2.2)	0(0.0)	46
	Obese	0(0)	14 (93.3)	1 (6.7)	15
	Total	570 (96.6)	18 (3.1)	2 (0.3)	590
Iyoke et al 2013 [43]	Underweight	NA*	NA*	NA*	NA*
	Normal weight	109 (33.6)	126 (38.9)	89 (27.5)	324
	Overweight	NA*	NA*	NA*	NA*
	Obese	12 (3.7)	274 (84.6)	38 (11.7)	324
	Total	121 (18.7)	400 (61.7)	127 (19.6)	648
Seifu 2017 [35]	Underweight	84 (78.5)	20 (18.7)	3 (2.8)	107
	Normal weight	268 (72.2)	94 (25.4)	9 (2.4)	371
	Overweight	15 (23.1)	44 (67.7)	6(9.2)	65
	Obese	2 (33.3)	2 (33.3)	2 (33.3)	6
	Total	369 (67.2)	160 (29.1)	20 (3.7)	549
Wanyama et al 2018 [9]	Underweight	20 (71.4)	8 (28.6)	0 (0.0)	28
	Normal weight	98 (68.5)	43 (30.1)	2 (1.4)	143
	Overweight	2 (9.5)	15 (71.4)	4 (19.1)	21
	Obese	0(0.0)	0(0.0)	0(0.0)	0
	Total	120 (62.5)	66 (34.4)	6 (3.1)	192
Wrottesley et al 2017 [55]	Underweight	0(0.0)	0(0.0)	0(0.0)	0
	Normal weight	54 (29.7)	54 (29.7)	74 (40.6)	182
	Overweight	38 (20.0)	32 (16.8)	120 (63.2)	190
	Obese	36 (21.7)	27 (16.3)	103 (62.0)	166
	Total	128 (23.8)	113 (21.0)	297 (55.2)	538

NA*-Not applicable- because the authors (Iyoke et al) intended to compare GWG among normal weight and obese women, and they intentionally excluded underweight and overweight women

The overall pooled estimate of inadequate gestational weight gain among underweight women was 86% (95% CI: 76%, 96%), 61% (95% CI: 40%, 83%) among normal weight women, 38%

(95% CI: 4%, 73%) among overweight weight women, and 21% (95% CI: 7%, 34%) among obese women (Figure 7).

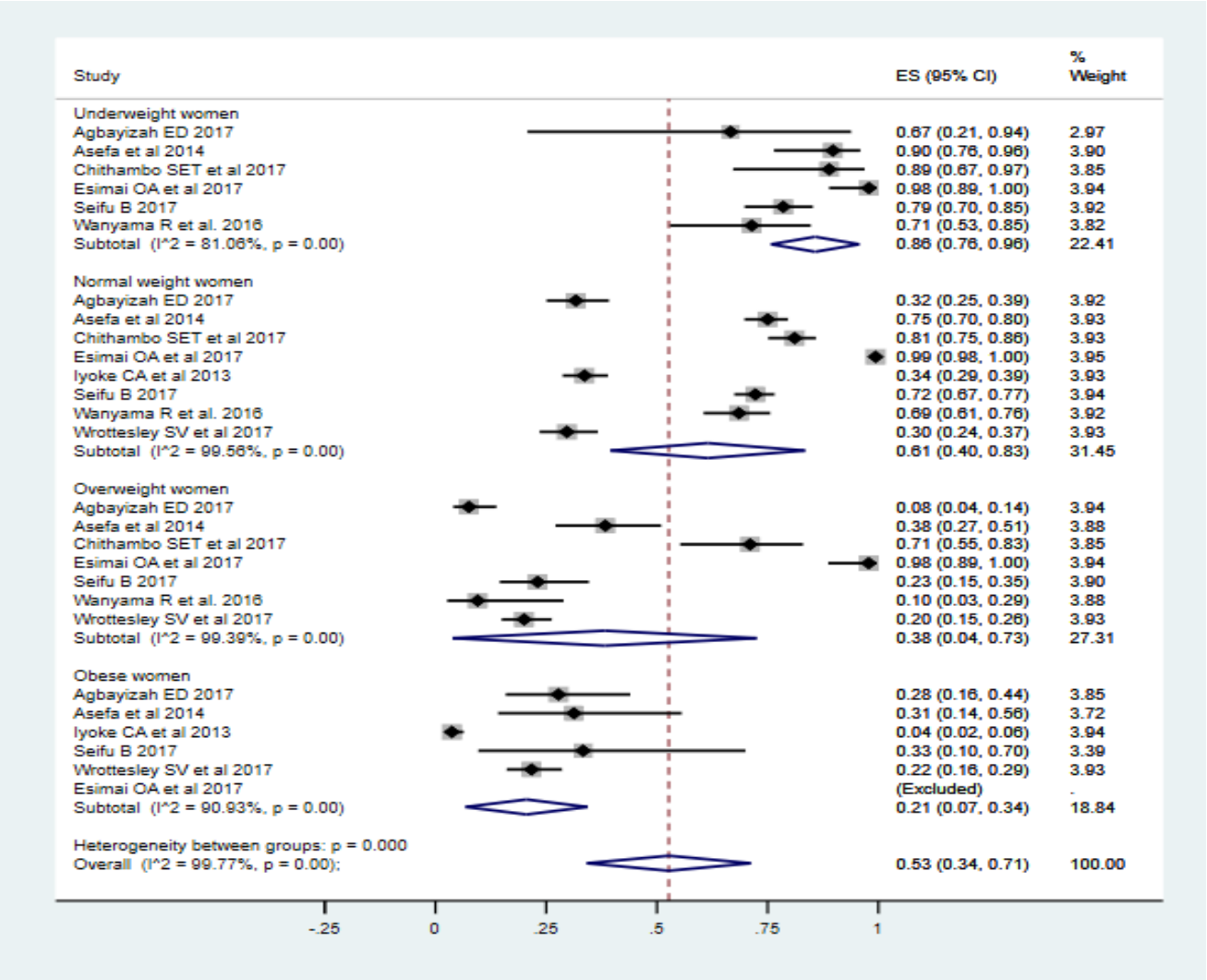

Figure 7: Gestational weight gain below the recommended level among underweight, normal weight, overweight and obese women in sub-Saharan Africa

The overall pooled estimate of adequate gestational weight gain among underweight women was 13% (95% CI: 4%, 22%), among normal weight women 26% (95% CI: 12%, 39%), among overweight weight women 36% (95% CI: 19%, 53%), and among obese women 50% (95% CI: 15%, 86%) (Figure 8).

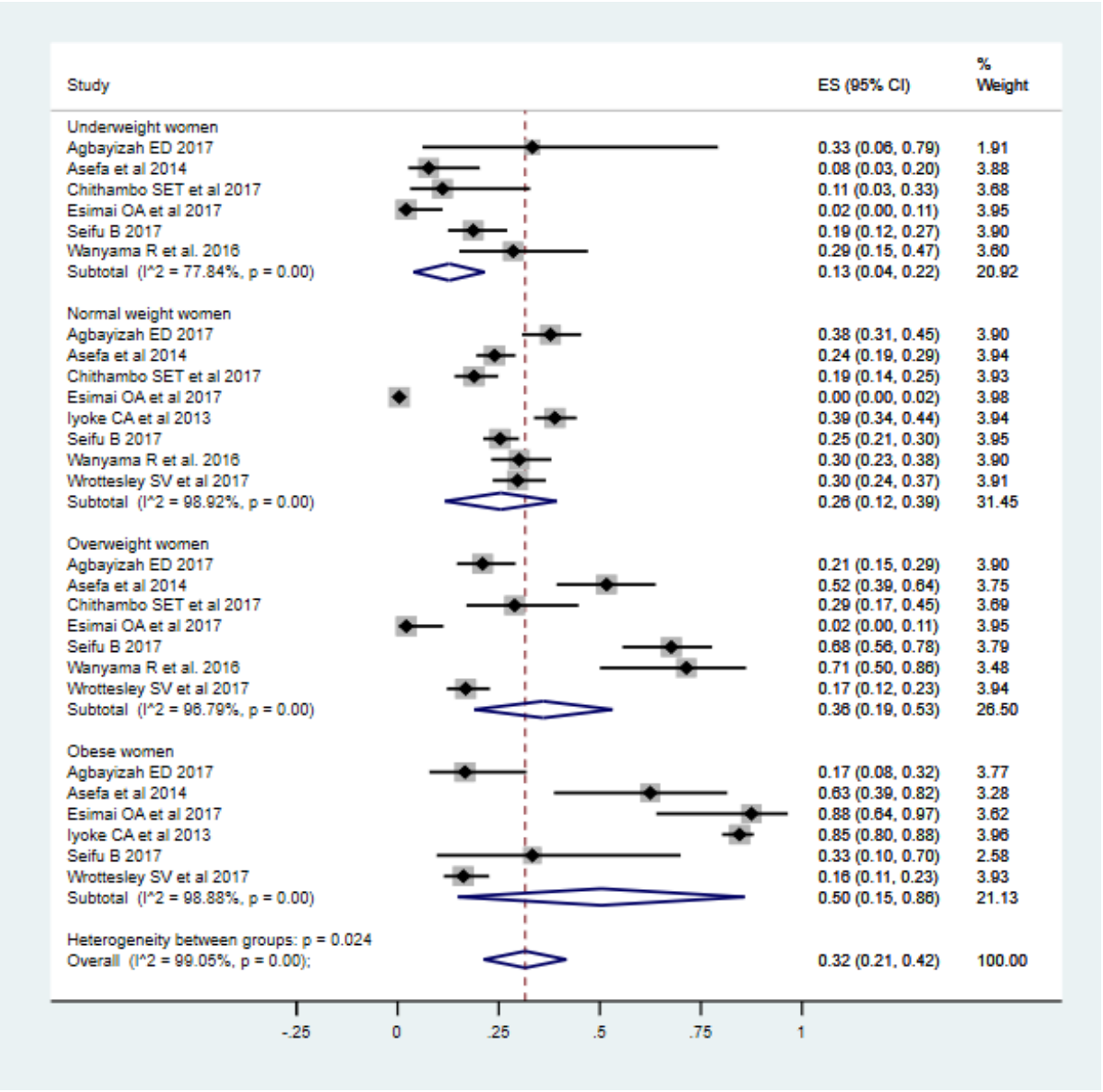

Figure 8: Gestational weight gain within the recommended level among underweight, normal weight, overweight and obese women in sub-Saharan Africa

The pooled estimate of excessive gestational weight gain was 3% (95% CI: 0%, 5%) among underweight women, 13% (95% CI: 8%, 17%) among normal weight women, 35% (95% CI: 6%, 63%) among overweight weight women, and 30% (95% CI: 16%, 54%) among obese women (Figure 9).

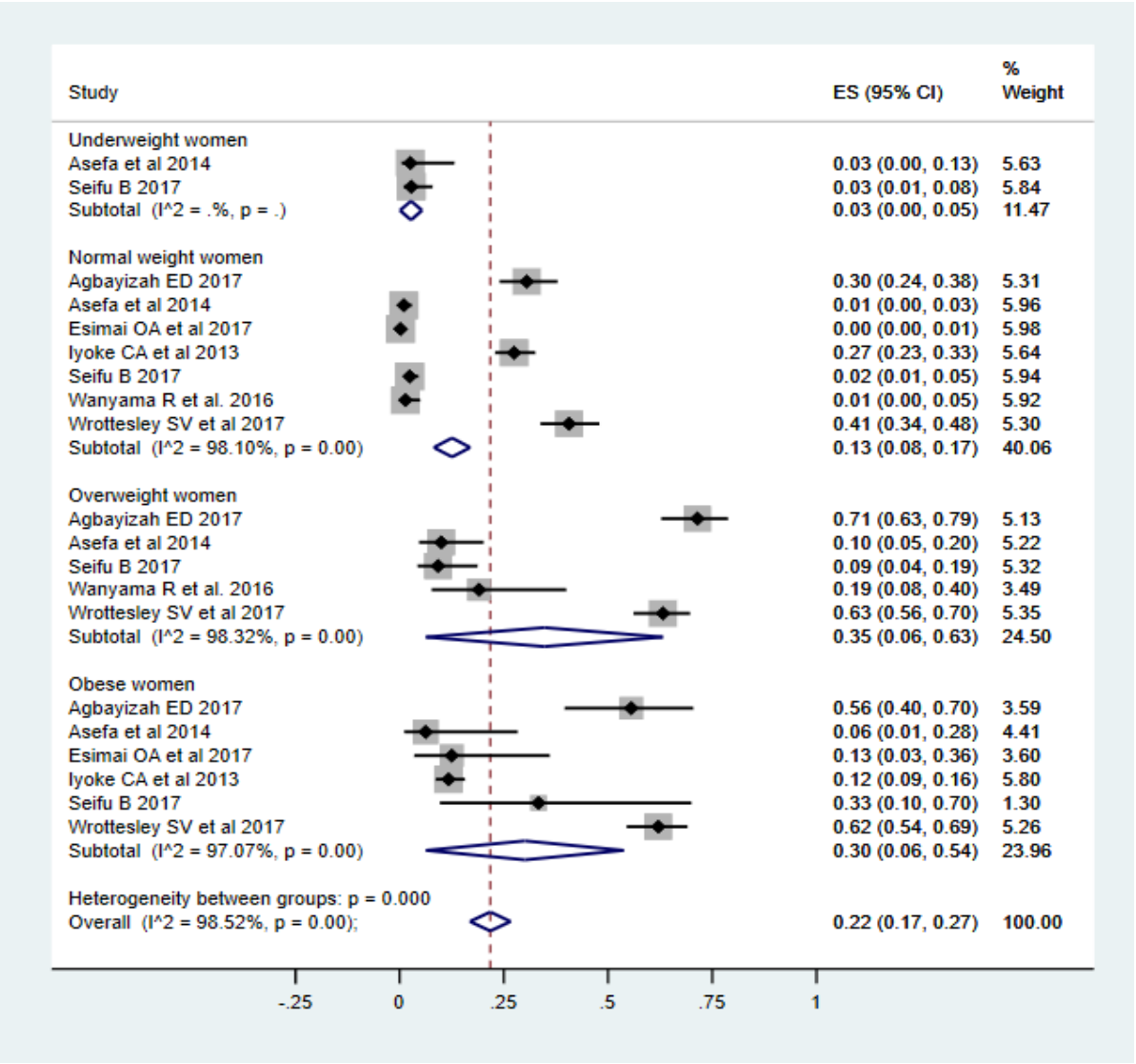

Figure 9: Gestational weight gain above the recommended level among underweight, normal weight, overweight and obese women in sub-Saharan Africa

Mean gestational weight gain

According to one study, mean GWG (± standard deviation) was 1.52±1.65 kg during 14 to 18^{+6} weeks; 2.57±1.46kg during 19 to 23^{+6} weeks; and 2.48±1.29 kg during 24 to 28^{+6} weeks. Similarly, GWG during 29 to 33^{+6} weeks, and 34 to 40^{+0} weeks was 2.18 ±1.39 kg and 2.42±2.41 kg, respectively [58]. According to the study from Uganda weekly mean GWG of

0.32 kg, 0.30 kg and 0.28 kg were reported among underweight, normal-weight, and overweight women, respectively [9]. In another study, the mean GWG was 9.14±3.46 among underweight women, 9.26±3.14 kg among normal-weight women, 8.03±3.64 kg among overweight women, and 6.44±3.46 kg among obese-women [2]. Onwuka et al also reported a mean GWG of 10.21±2.90 kg among underweight women, 11.50±2.82 kg among normal-weight women, 10.30±3.98 kg among overweight women, and 9.54±3.65 kg among obese women [6].

Gestational weight gain according to INTERGROWTH-21st standard

Two studies reported GWG according to the INTERGROWTH-21st standard [53, 59]. One study reported that 27.5% of pregnant women gained gestational weight less than the third centile which is considered insufficient; 82.7% gained gestational weight less than the 50th centile; and 2.0% gained gestational weight above the 97th centile which is considered excess [59]. The other study reported that 26.8% of women with normal weight gained gestational weight less than the third centile, and none gained above the 97th centile [53].

Gestational weight gain according to authors' classifications

Seven studies classified GWG according to the authors' own classifications. Akindele et al reported that 72.9% of women gained < 15 kg [45]; Onyiriuka reported that 42.9% of women gained < 10 kg [44]; Nkwabong reported that 75% of women gained <16 kg. [49]; Onwuka et al reported that 36.0% of women gained <10 kg [6], and Addo reported 14.8% of women gained ≤ 8.0 kg [39] (Table 8).

Table 8: Proportions gestational weight gain in sub-Saharan Africa according to authors' classification, 2019

Authors and year	Sample size	GWG classifications in kilogram	N (%)
Addo 2010 [39]	1755	≤8	259 (14.8)
		8.1 to 16	1385 (78.1)
		≥16	111 (6.3)
Agbota et al 2019 [40]	253	<7 kg	65 (25.7)
		7 to 12 kg	132 (52.2)
		>12 kg	56 (22.1)
Akindele et al 2017 [45]	240	<15	175 (72.9)
		≥15	65 (27.1)
Elie et al 2015 [49]	232	<16	174 (75.0)
		≥16	58 (25.0)
Onwuka et al 2017 [6]	200	<10	72 (36.0)
		10 to15	107 (53.5)
		≥15	21 (10.5)
Onyiriuka 2006 [44]	408	<10	175(42.9)
		10 to 13	95 (23.3)
		13.1 to 15	129 (31.6)
		≥15	9 (2.2)
Tela et al 2019 [51]	309	<16 kg	276 (89.3)
		≥16 kg	33 (10.7)

4.4.5. Factors associated with gestational weight gain

Four studies reported factors associated with gaining weight according to IOM recommendations [2, 35, 53, 57]. These factors include pre-pregnancy weight [2, 35], having at least four ANC visits [2], engaging in physical activity [2, 35], income [2, 35], type of food consumption [2], knowledge about the importance of fruit [35], education [7, 35], type of food supplementation [53], and seasonality [57]. These factors are described below.

4.4.5.1.**Maternal pre-pregnancy weight**

According to two studies from Ethiopia [2, 35], women's early pregnancy BMI was associated with adequate GWG. Asefa et al reported that overweight and obese women were three times more likely to gain adequate gestational weight as compared to underweight women [2]. Similarly, Seifu reported that overweight and obese women were fourteen times more likely to have adequate GWG than those who were underweight [35].

4.4.5.2.Food consumption and physical activity

Mothers' knowledge of the inclusion of fruits as a main food type during pregnancy was associated with gaining adequate gestational weight [35]. The women who ate fruit, vegetables, and meat at least once a week were more likely to gain adequate gestational weight compared with women who did not consume these foods at least once a week [2]. According to Adu-Afarwuah et al, the percentage of women with adequate GWG was significantly higher in the group of women who received lipid-based nutrition supplementation than in a group who received multiple micronutrients and iron and folic acid supplementation [53]

Asefa et al reported that undertaking physical activity at least once a week for no less than 30 minutes was associated with higher likelihood of gaining adequate gestational weight [2]. Saifu also reported that engaging in physical activity up-to six hours a week was associated with gaining adequate gestational weight [35].

4.4.5.3.Income, occupation, and social class

One study reported that having a monthly family income of > $US100 was associated with gaining adequate gestational weight, while another study reported monthly income >$US150 as a factor associated with adequate GWG [2, 35]. According to Onwuka et al, women from a higher social class were more likely to gain weight of 10 to15 kg [6]. Being employed was reported as associated with gaining gestational weight of >7 kg [7].

4.4.5.4. Maternal age and parity

One study reported that being an adolescent (≤18 years of age) was associated with gaining gestational weight greater than 7 kg [7]. Another study reported that being younger than 35 years of age was associated with gaining gestational weight of 10 to 15 kg [6]. These two studies reported that being nulliparous was associated with gaining gestational weight of >7 kg [7] and 10 to 15 kg [6]. However, these associations are crude associations (not adjusted for confounders). According to Ouédraogo et al one increase in the number of pregnancies that a woman had was associated with increased odds of GWG below the 50^{th} centile (OR, 1.11, 95% CI: 1.03, 1.20) [59].

4.4.5.5.Antenatal care visits

Attending ANC four or more times was associated with gaining adequate gestational weight [2]. In addition, another study identified that having had regular ANC visits was associated with gaining gestational weight of 10 to 15 kg [6].

4.4.6. Effect of GWG on birth outcomes

4.4.6.1. Low birthweight

An association between GWG and LBW was reported in some studies from SSA [43, 50, 52, 62].

Nemomsa et al reported that 17.5% of women who gained inadequate gestational weight gave birth to LBW babies, while 1.7% of women who gained adequate gestational weight gave birth to LBW babies [50]. Gondwe et al also reported that 15.6% of women who gained inadequate gestational weight gave birth to LBW babies, 7.6% of women who gained adequate gestational weight gave birth to LBW babies [28], and none of the women who gained excess gestational weight in Nemomsa et al [50] and Gondwe et al [28] gave birth to LBW babies. In another study, 8.6% of women who gained inadequate weight, 11.5% of women who gained adequate weight, and 6.9% of women who gained excess gestational weight gave birth to LBW babies [46]. In another study, the proportion of LBW was 9.7% and 2.3% among women who gained < 10 kg and 10 to 15 kg, respectively [6].

4.4.6.2. Fetal macrosomia

Seven studies reported an association between GWG and fetal macrosomia [6, 44-48, 51]. Of these, five studies defined macrosomia as birth weight of ≥ 4 kg [6, 44-46, 51], while two studies did not clearly show how they defined macrosomia [47, 48]. Of the total seven studies, three studies classified GWG according to IOM [46-48], while the remaining four studies classified GWG according to their authors own classification [6, 44, 45, 51]. The percentage of macrosomia was 30.9% [47], 11.0% [46], and 9.3% [48] among women who gained

excessive gestational weight a, while it was 3.9% [48], and 3.2% [46] among women who gained inadequate gestational weight. In other studies, the percentage was 83.1% [45], 66.7% [44], and 38.1% [6] among women who gained >15 kg, while it was 2.8 % [6] and 20% [44] among women who gained <10 kg. Tela et al reported that 54.5% of women who gained ≥16 kg gave birth to macrosomic babies while 16 % of women who gained <16 kg gave birth to macrosomic babies [51]. There was no statistically significant difference regarding giving birth to a macrosomic baby among women who gained adequate and excess gestational weight (RR, 0.68; 95% CI: 0.38, 1.50, P=0.20), but this was based on two studies only (Figure 10).

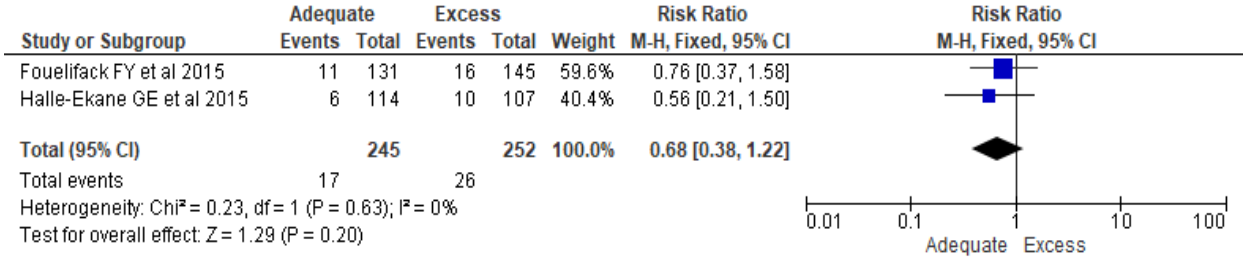

Figure 10: The association of excess gestational weight gain and macrosomia in sub-Saharan Africa

4.4.6.3. Caesarean section and episiotomy

The percentage of caesarean section in two studies was 17% [48] and 26% [46] among women who gained inadequate gestational weight. The percentage was 10% [47], 16.7% [48], and 37% [46] among women who gained adequate weight; and 17.8% [48], 27.3% [47] and 50.3% [46] among women who gained excess gestational weight. According to Halle-Ekane et al, the percentages of episiotomy were 13.2%, 8.8% and 7.5% among women who gained inadequate, adequate and excess gestational weigh, respectively [48].

4.4.6.4. Pre-eclampsia

Pre-eclampsia was reported among 3.1% [48] and 7.5% [46] of women who gained inadequate gestational weight, 1.8% [48] and 6.4% [47] among those who gained adequate gestational weight, 15% [48], 18.2% [47], and 12.4% [46] among women who gained excess gestational weight. However, no significant difference was observed among women who gained inadequate compared with women who gained adequate gestational weight regarding predisposition to pre-eclampsia (RR, 0.71; 95% CI: 0.22, 2.28, P=0.57) (Figure 11).

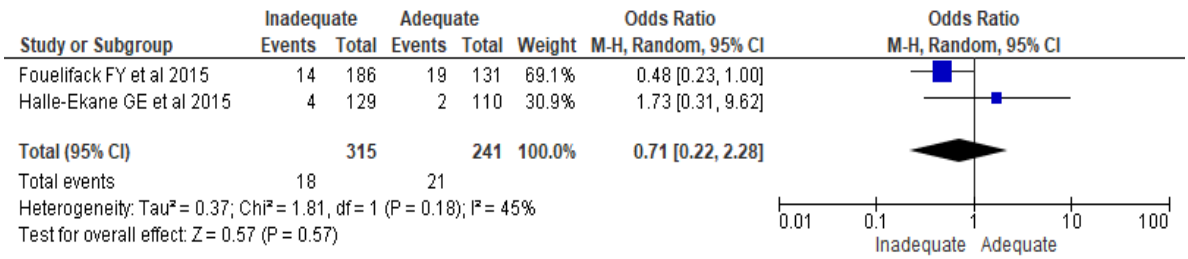

Figure 11: The association of inadequate GWG and pre-eclampsia in sub-Saharan Africa

4.5. Discussion

The percentage of inadequate GWG was >50% among nine of the 16 studies that classified GWG according IOM recommendations, and the percentage of inadequate GWG was particularly high among underweight women, ranging from 67% to 98%. High percentages of inadequate GWG were reported from low-income SSA countries (80% and 71.8% from Malawi [28, 57], 69.3% and 67.2% from Ethiopia [2, 35], 63% from Niger [59], 62.7% from Uganda [9], and 58.8% from Democratic Republic of Congo [60]) compared to middle-income countries (28% and 36.9% from Cameroon [46, 48], 15.7% and 24% from South Africa [55, 56]). Unlike in other high-income [20, 24, 63, 64] and middle-income [65] countries where many pregnant women experience excessive GWG, all of the studies from low-income Sub-

Saharan countries [2, 9, 28, 35, 57, 59, 60] reported that more than 58% of pregnant women experienced inadequate GWG. This could be due to the inability of women to consume adequate food because of accessibility and affordability problems [66]. Pregnant women in low-income SSA countries suffer from a wide range of nutritional problems due to poverty, food insecurity and frequent infections [67]. Among seven of the sixteen studies, the percentages of women who gained excessive gestational weight were <10%. Five of these seven studies were from low-income countries (Ethiopia, Uganda and Malawi), and the percentage of excessive GWG among these studies were reported to be <6%. Seven studies where more than 10% the women gained excessive were from middle-income countries of Sub-Saharan Africa (Ghana, Nigeria, Cameroon, and South Africa). In South Africa, the percentage of women with excessive GWG was as high as 55%, which is even higher than for some studies from high-income countries such as Canada (49%) [68] and Australia (46%) [69]. The high percentage of excessive GWG may be explained by South Africa being an upper-middle income country [61], and 66% of participants in the South African study [55] were either overweight or obese. The finding of high levels of GWG in middle-income countries suggests the importance of low-income SSA countries designing strategies to prevent excessive GWG before it becomes a public health problem as these countries transition to middle-income countries.

While we pooled the percentages of inadequate, adequate, and excess GWG, substantial heterogeneity have been detected among studies, which may be explained by a number of factors. Firstly, the GWG classifications were inconsistent. Some authors classified GWG using the IOM recommendations while others used their own classifications. Secondly, studies were in different SSA countries that had very different income levels, including upper middle-

income, lower middle-income, and lower-income countries. For example, a study from South Africa [55] reported that 55% of pregnant women gained excess gestational weight, whereas no women from Malawi [57] and <3% of pregnant women from Ethiopia [2, 35] and Uganda [9] gained excess gestational weight. Thirdly, some studies were conducted in urban settings and in tertiary hospitals [43, 46], while others were conducted in semi-urban and rural [28, 52, 53, 57] settings in primary health care facilities. A study conducted in Nigeria in primary health care facilities [7] reported that 96.6% of pregnant women gained inadequate gestational weight. A study conducted in rural Malawi [57] showed that 80.2% of the pregnant women gained inadequate weight. By contrast the percentage of inadequate gestational weight gain was <30% among studies conducted in urban settings and tertiary hospitals [43, 46]. Finally, the difference in the pre-pregnancy weight of the participants may have affected the heterogeneity among studies. A study from South Africa [55] reported no underweight women, 66.2% of study participants were overweight and obese, and 55% of the participants gained excessive gestational weight. By contrast, studies from Malawi [57] and Uganda [9] had no obese women, and reported ≤ 3% of their participants gained excessive gestational weight.

This review identified that a number of factors that were associated with GWG including pre-pregnancy weight [2, 35], number and frequency of ANC visits [2], engaging in physical activity [2, 35], income [2, 35], type of food consumption [2], knowledge about the importance of fruit [35], education [7, 35], and type of food supplementation [53]. However, the inconsistent classification of the factors and poor control for confounding effects among the included studies made the findings of this review inconclusive.

The pre-pregnancy weight of women is associated with the amount of weight gained during pregnancy. Other studies have also reported that pre-pregnancy BMI is strongly associated with GWG [70-72]. This is because pre-gestational BMI is closely linked to maternal nutrition, lifestyle and socio-cultural factors, which could have an impact on the amount of GWG [73]. In this review, studies that have reported higher percentage of excessive GWG (for example, >30%) had a higher percentage of overweight and obese women (>46%) [46, 48, 54, 55]. Studies that have reported lower percentage of excessive GWG (<6%) had lower percentage of overweight and obese women (<15%) [2, 7, 9, 28, 35, 57]. These findings are supported by other studies that reveal a high BMI (overweight or obese) at the inception of pregnancy is associated with gaining weight above the IOM recommendations [71, 72]. In this review, the percentage of inadequate GWG ranged from 67% to 98% among underweight women [2, 7, 9, 35, 54, 57]. It may be difficult for underweight women to gain a sufficient amount of gestational weight, particularly if they tend to be underweight due to metabolic or food security factors [2]. Despite the association between pre-pregnancy weight and GWG, interventions on GWG managements took place mainly during pregnancy and focussed on reducing in GWG [74-77]. This implies that future interventions would need to focus on pre-pregnancy weight management strategies and its effectiveness. Weight management strategies should be inclusive by encouraging the reduction in GWG for women who are susceptible to excessive weight gain or encouraging weight gain for women who are susceptible to inadequate weight gain.

An association between GWG and birth weight has been reported by several studies [17, 78-80], and women who gain inadequate gestational weight are at an increased risk of having a baby with LBW or a pre-term birth [21, 81-83]. In the studies in this review, the majority of

LBW babies were born to women who gained inadequate gestational weight. By contrast, a large percentage of women who gained excessive gestational weight (30%) gave birth to macrosomic babies. However, the association between GWG and birth weight (LBW and macrosomia) were not statistically significant in the review that could be because of the small numbers of studies (only two studies) and small sample size (for example, only 6 of 196 [46], and 5 of 134 [48] pregnant women who gained inadequate gestational weight gave birth to macrosomic babies). Several studies have reported that gaining GWG outside of IOM recommendations is associated with different adverse pregnancy outcomes such as caesarean section [23, 70], episiotomy, low Apgar score at first and fifth minutes [84-86], antepartum haemorrhage, and pre-eclampsia [21]. However, given the inclusion of a limited number of studies in the meta-analyses, large differences in the settings among studies, and the inconsistent classification of GWG, these factors were not significantly associated with GWG outside of IOM recommendations in this analysis.

There were several issues relating to the quality of studies in the review. Firstly, the measurement of pre-pregnancy weight of the women was problematic, with four studies [9, 45, 46, 49] using self-reported pre-pregnancy weight. However, there is a typically a difference between self-reported weight and actual measured weight [87-89]. Women may be misclassified as gaining inadequate, adequate, or excess, based on self-reported pre-pregnancy weight [90]. Three studies [53, 55, 60] in this review used the weight of the women at 20 weeks of gestation and one study [57] used the weight of the women at 24 weeks of gestation as a proxy for pre-pregnancy weight. At this stage of pregnancy, there could be significant physiologic changes that may have resulted in weight gain, which may affect the measurement of GWG. In two studies [47, 59], it was unclear when or how the pre-pregnancy weight of the

women was measured. The arbitrary classification of the outcome [6, 39, 40, 44, 45, 49, 51] and unclear classification of BMI and GWG were identified as a major quality issue in the review. Thirdly, there was poor control of confounding factors in many studies [6, 9, 39, 43, 44, 47-49]. These studies either did not control for confounding factors at all or did not include all necessary variables into the analysis (partially controlled). The identification of a number of quality issues in most of the included studies suggest the need for methodologically rigorous studies in sub-Saharan Africa to answer GWG related research questions including what factors affect GWG and the association between GWG and birth outcomes.

This review has a number of limitations. Firstly, the studies included in the review were highly heterogeneous and only two studies were eligible for the meta-analyses. Secondly, some of the included studies did not use standard GWG classifications. Thirdly, the pre-pregnancy weight of the women was assessed using different methods and at different stages (for example, pre-pregnancy or at 20 weeks). Fourthly, factors associated with GWG were classified inconsistently across studies. Finally, confounding factors were poorly controlled in most of the included studies.

Conclusion

The percentage of inadequate GWG was as high as 80% in low-income sub-Saharan countries while it was as low as 15% in upper middle-income SSA countries. In all studies from low-income Sub-Saharan countries, the percentage of inadequate GWG was greater than 58%. The percentage of inadequate GWG ranged from 67% to 98% among underweight women. Studies with a higher percentage of women with excessive GWG had a higher percentage of women who were overweight or obese, and those with a lower percentage of women with a lower

percentage of excessive GWG had a lower percentage of women with high BMI (overweight or obese). Future interventions would need to give attention to design effective pre-pregnancy weight management strategies. Sub-Saharan African countries may need to develop regional GWG guidelines.

Competing Interests

The authors declare that they have no any competing interests.

Authors' Contributions

FA conceived the study, performed the overall review and drafted the manuscript. MF, AH, and AC have overseen each step and critically revised the design of the study, review techniques, interpretation of the findings and draft of the manuscript. YD has critically revised the study and contributed to the interpretation of the findings. All authors read this manuscript and finally approved for submission.

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Chapter 5: Patterns and Predictors of Gestational Weight Gain in Addis Ababa, Central Ethiopia: A Prospective Cohort Study

5.1. Chapter Overview

This chapter presents the quantitative findings focusing on the prevalence of inadequate, adequate, and excessive gestational weight gain, and factors affecting gestational weight gain in Addis Ababa, Ethiopia. The paper has been published in the *Reproductive Health Journal*.

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Abstract

Introduction

Gaining excessive or inadequate gestational weight is associated with many adverse maternal and fetal outcomes. Inadequate gestational weight gain (GWG) increases the risk of fetal growth restriction, pre-term birth, and low birth weight. It is a public health concern in sub-Saharan Africa. The aim of this study was to assess the patterns and predictors of GWG in Addis Ababa, Ethiopia.

Methods

We conducted a prospective cohort study among pregnant women who attended antenatal care (ANC) in health centres in Addis Ababa, from January to September 2019. Data were collected by a structured questionnaire and checklists and analysed using Stata. Weight at or before 16 weeks gestation was used as a proxy for pre-pregnancy weight. Women's height and baseline weight were measured by data collectors, and we obtained weight at the end of the 24th and 36th weeks of gestation from women's medical records. GWG was categorized as inadequate, adequate and excessive based on the United States Institute of Medicine criteria. Predictors of GWG were identified using multinomial logistic regression.

Results

A total of 395 pregnant women were enrolled in the study. GWG was assessed for 369 (93%) women. The median GWG was 8.7 kg with inter quartile ranges (25th, 75th percentiles) of 7.0 kg and 11.6 kg. Inadequate GWG occurred for 248 (67.2% [95%CI: 62.2%, 72.0%]) of the participants; 103 (27.9% [95%CI: 23.4%, 32.8%]) gained adequate weight; and 18 (4.9% [95% CI: 2.9%, 7.6%]) gained excessive weight. Three quarters (75%) of underweight women gained inadequate gestational weight, whereas 43% of overweight or obese women gained inadequate gestational weight. Being underweight (AOR=3.30 [95%CI: 1.32, 8.24]) **or** normal weight (AOR=2.68 [95%CI: 1.37, 5.24]) before pregnancy increased the odds of gaining inadequate gestational weight compared to overweight or obese women. Not having paid employment was associated with higher odds of gaining inadequate gestational weight compared to women employed outside the home (AOR=2.17 [95%CI: 1.16, 4.07]).

Conclusions

Most pregnant women in Addis Ababa gain inadequate gestational weight. In particular, underweight women or women with no paid imployement were at higher risk of gaining inadequate gestational weight. Promoting adequate GWG in Addis Ababa among underweight and normal weight women is an important public health initiative.

Keywords: Gestational weight gain; Predictors; Body mass index; Ethiopia

Plain English summary

Pregnant women are expected to gain weight due to various biological changes. Gaining inadequate or excessive weight during pregnancy poses a health risk to the mother and baby. Inadequate weight gain is a public health concern in low-income countries, including Ethiopia. This study assessed patterns and predictors of weight gain during pregnancy in Addis Ababa, Central Ethiopia. The study was conducted from January to September 2019. Women attending public health facilities were followed from before or at 16 weeks of gestation until 36 weeks of pregnancy. A total of 395 pregnant women enrolled in the study. Weight gain was assessed for 369 (93%) women. More than two-third of the participants (67.2%) gained inadequate weight during pregnancy. Three quarters (75%) of underweight women gained inadequate weight, whereas 43% of overweight or obese women gained inadequate weight during pregnancy. Promoting adequate weight gain during pregnancy for underweight and normal weight women in Addis Ababa is an important public health initiative.

5.2. Introduction

Gestational weight gain (GWG) is defined as the amount of weight gain from conception until the birth of the baby. The recommended amount of GWG varies based on pre-pregnancy body mass index (BMI) of the women. According to the 2009 United State Institute of Medicine (IOM) recommendations women with BMI ≤18.5 kg/m^2 are recommended to gain 12.5 to 18 kg; women with BMI 18.6 to 24.9 kg/m^2 are recommended to gain 11.5 to 16 kg; women with BMI 25.0 to 29.9 kg/m^2 are recommended to gain 7 to 11.5 kg; and women with BMI ≥ 30.0 kg/m^2 are recommended to gain 5 to 9 kg [1].

Most studies have reported that fewer than a third of pregnant women gain adequate gestational weight [2-11]. The majority of women in high income countries such as the United States (73%) [2] and Canada (71%) [6] gain an excessive amount of gestational weight. In contrast, inadequate GWG is a major public health concern in low-income Sub-Saharan African countries [12, 13] where studies showed that 69% of pregnant women from eastern Ethiopian, Harar [5], and 62.7% of pregnant women from low-income settings such as urban Uganda, Kampala [14] gained inadequate gestational weight. Pregnant women who gain inadequate weight are at a higher risk of bearing a baby with low birth weight (LBW) and pre-term birth [3, 15-17]. In Ethiopia, the prevalence of LBW (17%) [18] and preterm birth (26%) [19] are among the highest worldwide. On the other hand, women who gained excessive gestational weight are at a higher risk of developing gestational hypertension [2, 3], gestational diabetes [2], caesarean birth [20], high postpartum weight retention [4], and long-term obesity [21].

The amount of GWG is associated with numerous factors. These include health system related factors (Antenatal are (ANC) including advice and follow-up from health care providers) [22-24], and women's own related factors (physiological factors, psychological, and behavioural factors) [1, 25-27]. Women's age [5], pre-pregnancy maternal weight [5, 28, 29], multi-parity [6, 7], women's awareness of healthy eating and dietary diversity [30], attending ANC [5], and engaging in physical activity [5, 31] are all related to the amount of GWG.

Studies from high-income countries report that household food insecurity is associated with excessive GWG [32, 33]. However, this needs further investigation in low-income countries where women suffer from nutritional deficiencies in households with food insecurity [34, 35]. Furthermore, household food insecurity is strongly associated with low nutritional status such as being underweight [36, 37], decreased mid-upper arm circumference (MUAC) [34, 37], and anaemia [38]. Though some authors [32, 33] have argued that food insecurity causes excessive GWG leading to maternal depression, it is unclear whether food insecurity causes maternal depression or maternal depression causes food insecurity [39].

Having a history of intimate partners' violence during pregnancy is associated with gaining less weight during pregnancy [40, 41]. Despite the high levels of intimate partner violence in Ethiopia (emotional violence 24.0%, physical violence 24.9% and sexual violence 11.1%) [42], its effect on GWG is not well studied.

Few studies have been conducted in Ethiopia focusing on GWG [5, 43, 44]. Published studies have retrospectively assessed GWG and prospective studies are recommended [13]. Retrospective studies have not addressed some important predictor variables such as physical

activity, food insecurity, perinatal depression, and intimate partner violence during pregnancy. The aim of the current study was to assess the patterns and predictors of GWG in Addis Ababa, central Ethiopia.

5.3. Methods

5.3.1. Study design

A prospective cohort study design was employed from January 10, 2019 to September 25, 2019.

5.3.2. Study setting

This study was conducted in Addis Ababa, which is the capital and largest city in Ethiopia. In the city, there are 42 hospitals (11 government, 6 non-government organisations, and 25 private), 97 Health Centres, and 361 clinics that provide medical care including maternal health care [45, 46]. Around 97% of pregnant women in Addis Ababa receive ANC from skilled care providers such as doctors, nurses or midwives, at least once [42], of which 90% receive at least four ANC contacts [47]. Participants were recruited from nine health centres namely Mikililand, Kolfe, Keraniyo, Alembank, Kotobe, Woreda 09 Kewas Meda, and Woreda 02, 05 and 11 of Nifas Silk Lafto Subcity health centres.

5.3.3. Sample size determination

We calculated the sample size using Open Epi Version 2.3 considering both the single proportion formula (to assess the proportion of GWG) and the double proportion formula (to

assess predictors of GWG). The larger sample size was achieved by using the single proportion formula considering the proportion of women with inadequate gestational weight from a study conducted in Harar, Ethiopia ($p = 0.69$) [5], a half-width of confidence 5%, an alpha value of 0.05, and 20% loss to follow-up. The final sample size was 395.

5.3.4. Participants

Participants were pregnant women who came to the selected health centres for ANC in their first trimester (before 16 weeks gestation).

5.3.5. Sampling procedure

The women were selected from nine health centres. The health centres were selected based on the number of ANC visits and geographic location in the city. Women who met the inclusion criteria were consecutively selected from each health facility until the required sample size was met.

5.3.6. Participant recruitment

Antenatal clinic staff who provided the ANC facilitated the participant selection process. They also assisted in setting appointment dates for the follow-up data collection (at the end of the 24^{th} and 36^{th} weeks of gestation).

5.3.7. Inclusion and exclusion criteria

Inclusion criteria

- Pregnant women who present to a health facility to attend ANC in the first 16 weeks of gestation
- Giving consent for follow up (willing to provide data throughout pregnancy and after giving birth at all contact points)

Exclusion criteria

- Women with a twin pregnancy were excluded from the study because weight gain recommendations for singleton and twin pregnancies are different.
- Women with additional comorbidities such as pre-existing diabetes and hypertension were excluded. I excluded them because I had a plan to assess the association between gestational diabetes and pregnancy induced hypertension and GWG.

5.3.8. Data collection

We collected data through face-to-face interviews to collect data on socio-demographic and social economic characteristics, dietary diversity and food security, intimate partner violence, physical activity and depression related symptoms. Variables such as gestational age (ultrasound result), blood pressure, random blood sugar, anaemia status, and HIV status were obtained from medical records of the women. Baseline data were collected from 395 women.

Gestational weight gain was assessed for 369 women. Detail of data collection flow is described in Figure 12

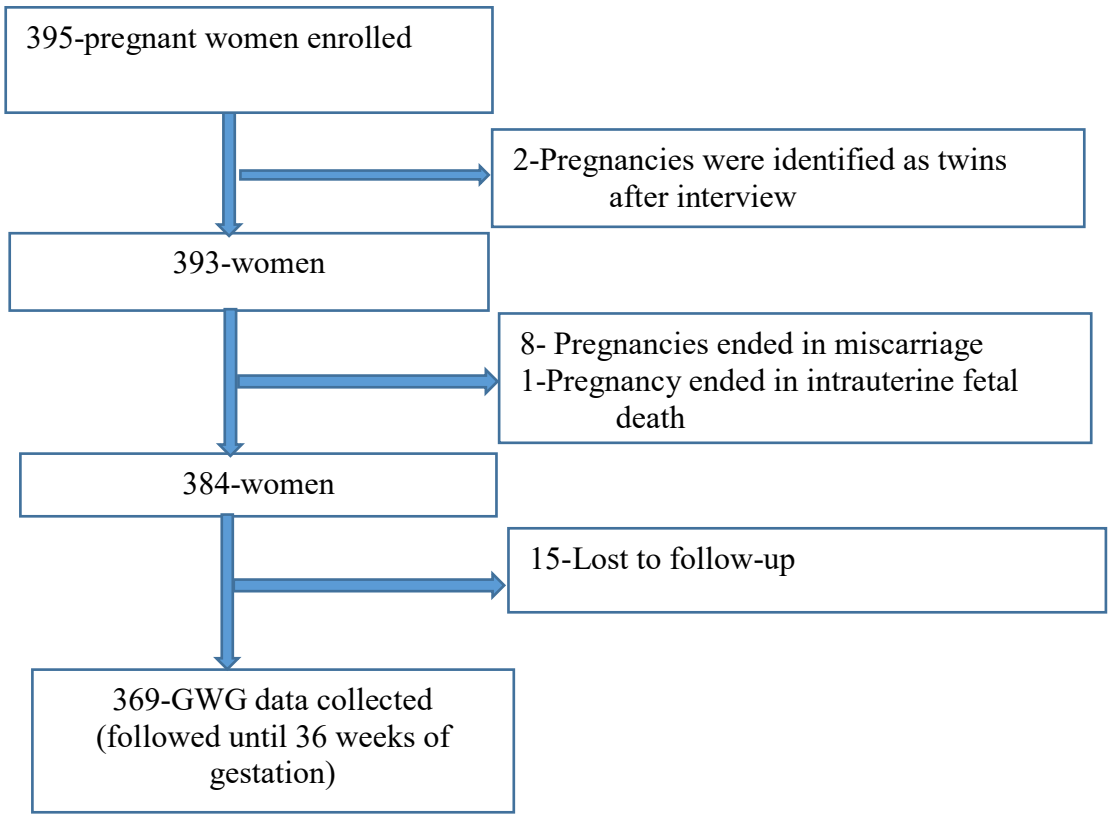

Figure 12: Flow chart of study participants' follow-up to assess gestational weight gain among pregnant women in Addis Ababa, Ethiopia, 2019.

5.3.9. Study variables

A range of tools were used collect data (Appendix 3). Principal component analysis was employed to compute a wealth index [48] from a set of household assets questions such as electricity, refrigerator, table, chair, watch, phone, bed with mattress, electric mitad (an

Ethiopian oven made up of clay and metal), car, house, improved water, and improved toilet, which were adapted from the Ethiopian demographic and health survey [42].

Gestational age was estimated by the last menstrual period and verified by ultrasound, which was a routine practice of the health facilities. The gestational age of our study participants ranged from four to 16 weeks (8.9% were between four and seven weeks of gestation; 41.1% were between eight and 12 weeks of gestation; and 50% were between 13 and 16 weeks of gestation).

The height of the women was measured when barefoot using a height measuring board in a standing position and recorded to the nearest 0.1 centimetres. The maternal weight was measured by a digital weight scale with minimum clothing and the reading was recorded to the nearest 100 grams. We asked women if they knew their pre-pregnancy weight, however only 172 (43.5%) of the participants were aware of their pre-pregnancy weight. Therefore, we used weight at or before 16 weeks as a proxy for pre-pregnancy weight in all women. Women's height and baseline weight were measured by data collectors, while weight at the end of 24^{th} and 36^{th} weeks of gestation was collected from women's medical records.

Body Mass Index (BMI) was calculated by dividing weight by height, squared. The women's BMI at or before 16 weeks of gestation (for those whose ages were ≥ 20 years old) was categorized into four categories based on the World Health Organization BMI cut-off points as underweight (BMI ≤18.5 kg/m^2); normal weight (18.6 to 24.9 kg/$m^{2)}$; overweight (25.0 to 29.9kg/$m^{2)}$; and obese (≥ 30.0 kg/m^2). BMI-for-age (at or before 16 weeks of gestation) was calculated for adolescent women (women aged 18 and 19 years old); and BMI was categorized

using WHO reference cut-off points as thin (Z-score <-2 standard deviation (SD)), normal (-2 SD ≤ Z-score ≤ +1SD), overweight (+1SD < Z-score ≤ +2SD) and obese (Z-score > +2SD).

Gestational weight gain was a dependent variable in this study, while all other variables were treated as independent variables. Total weight gain was calculated by subtracting the pre-pregnancy weight from their weight at the 4th ANC visit (at the end of 36 weeks of gestation). It was categorized as inadequate, adequate and excessive according to the IOM classification. Mid upper arm circumference was measured using an adult MUAC non-stretchable measuring tape and the reading was taken to the nearest 0.1cm. A MUAC measurement below 23cm was categorised as low (or wasting) and above 23cm was categorized as normal.

Dietary diversity of the women was assessed using a minimum dietary diversity-women (MDD-W) set from the Food and Agricultural Organisation (FAO) and USAID's Food and Nutrition Technical Assistance III Project (FANTA) [49]. The food groups assessed in MDD-W include: grains, white roots, tubers and plantains; pulses; nuts and seeds; dairy; meat, poultry and fish; eggs; vegetables; other vitamin A-rich fruits and vegetables; other vegetables; and other fruits. The MDD-W is a dichotomous indicator of whether or not women have consumed at least five out of ten defined food groups the previous day or night. The proportion of women who reach this minimum can be used as a proxy indicator for higher micronutrient adequacy. Household food insecurity was assessed using the Household Food Insecurity Access Scale (HFIAS). In each domain of the HFIAS questions ask about anxiety and uncertainty; insufficient quality; and insufficient food intake and any physical consequences, with a recall period of four weeks (30 days) [50].

Women's physical activity level was measured using the International Physical Activity Questionnaire (IPAQ-long form). The IPAQ assesses physical activity across a range of different domains including recreation-time, housework, being employed and transportation related physical activities. Each domain assesses walking, moderate and vigorous physical activities over a seven days period. Women were asked if they had completed these activities continuously for at least 10 minutes. Responses to IPAQ questions on the frequency and duration of physical activity were converted to the metabolic equivalent task per minute (MET-minutes) [51]. A MET is the ratio of specific physical activity metabolic rates to the resting metabolic rate, with one MET defined as the energy needed by an individual while at complete rest, which is equivalent to 1 kilocalorie per kilogram per hour [52].

The level of physical activity for each woman was categorized as;

- High – the woman accumulated at least 1500 MET-minutes per week from vigorous-intensity activity on at least 3 days; or accumulated at least 3000 MET-minutes per week on seven or more days of any combination of walking, moderate- or vigorous-intensity activities;
- Moderate- the woman engaged in three or more days of vigorous-intensity activity of at least 20 minutes per day; five or more days of moderate-intensity activity and/or walking of at least 30 minutes per day; or five or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of at least 600 MET-minute per week,
- Low – the woman reported no activity or some, but not enough to meet the high and moderate categories [51].

Perinatal depression symptoms were measured using the Edinburgh postnatal depression scale (EPDS) [53], which is a ten-item questionnaire. It has been validated and used by many studies for detecting perinatal depression in Ethiopia [54-57].

Intimate partner violence was measured with a questionnaire used by the WHO multi-country study on women's health and domestic violence [58]. It includes physical violence, sexual violence and emotional abuse by intimate partners. This questionnaire has also been used in the Ethiopian Demographic and Health Survey (EDHS) 2016 [42], making the survey suitable to use in the current study setting.

5.3.10. Statistical analysis

Data were entered into CSPro version 7.1, and exported to STATA (V.14, Stata Corp, 2015) for analysis. Frequencies and proportions were estimated to describe the variables. Missing data were handled by performing pairwise deletion in the analysis. A particular variable was excluded when it had a missing value, but the case could still be used when analysing other variables with non-missing values. Hence, the analyses were performed on subsets of the data depending on where values are missing without completely omitting a case that had some missing variables from the analyses. BMI-for-age was calculated for adolescent pregnant women using WHO AnthroPlus software. We conducted bivariable and multivariable analyses using a multinomial logistic regression model, because the outcome variable (i.e., GWG) consisted of three categories (inadequate, adequate and excessive GWG). Pregnant women with inadequate or excessive GWG were compared to women with adequate GWG (reference category). Variables with P-value <0.25 in the bivariate analysis were included in the

multivariable analyses. The variables in the multivariable analyses included educational status, wealth index, occupational status, BMI, MUAC, perinatal depression and asking permission from partners for health care seeking. Crude odds ratios (COR) and adjusted odds ratios (AOR) were calculated to determine the association between the explanatory variables and GWG.

5.4. Results

We enrolled 395 women into the study. Of these women, we recorded GWG for 369 women with a follow-up rate of 93.4%. The number of pregnant women selected from each facility is given in Table 9.

Table 9: Number of women participated from different health centres, Addis Ababa, Ethiopia, 2019

Name of health centre	Number of participating women	Percentage
Milililand	34	8.6
Kolfe	81	20.5
Keraniyo	37	9.4
Woerda 09 Kowas Meda	28	7.1
Alembank	47	11.9
Kotobe	110	27.9
Woreda 11 of Nifas Silk lafto Sub city	8	2.0
Woreda 02 of Nifas Silk lafto Sub city	42	10.6
Woreda 05 of Nifas Silk lafto Sub city	8	2.0
Total	395	100

5.4.1. Socio-demographic characteristics

The mean age of the women was 25.3 (standard deviation = 3.9) years, and 80.5% were between 20 and 29 years of age. Most of the respondents (96.5 %) were married; 9.7% never

attended formal education; and 50.6 % were not employed outside of the home. All were urban residents. Seventy two percent of the respondents had an estimated income of <200USD per month. Ninety percent of the pregnancies were intended; almost half (49.6%) of the women were nullipara (Table 10).

5.4.2. Body mass index and gestational weight gain of the study participants

The mean BMI of the respondents (with age ≥ 20 years old) at or before 16 weeks of gestation (which was a proxy for pre-pregnancy weight) was 21.83 kg/m^2 (SD = 3.28 kg/m2). Eighteen percent (18.1%) had a BMI of ≤ 18.5 kg/m^2, 63.7 % had a BMI between 18.5 and 24.9 kg/m^2, 17.3% had a BMI between 25 and 29.9 kg/m^2, and 0.9 % had a BMI ≥ 30 kg/m^2. According to the BMI-for-age of adolescent pregnant women (aged 18 and 19 years old): 5.0% were thin; 80.0% were normal weight; 10.0% were overweight; and 5.0% were obese. Women were asked if they knew their pre-pregnancy weight, however, only 172 (43.5%) of the participants were aware of their pre-pregnancy weight. The median GWG was 8.7 kg with inter quartile ranges (IQR) (25th, 75th percentiles) of 7 kg and 11.6 kg; underweight women gained a median weight of 10.0 kg with IQR of 12.5 kg and 7.6 kg while overweight or obese women gained a median weight of 7.0 kg with IQR of 8.2 kg and 5 kg (Table 11).

Table 10: Baseline demographic characteristics of the study participants in Addis Ababa, Ethiopia, 2019

Variable	Frequency	Percentage
Age in years (n=395)		
< 20	20	5.0
20 to 29	318	80.5
30 to 39	56	14.3
≥ 40	1	0.2
Marital status (n=395)		
Never married	14	3.5
Married	381	96.5
Educational status (n=394)		
No formal education	38	9.7
Primary education (1-8)	162	41.1
Secondary education (9-12)	112	28.4
Tertiary education	82	20.8
Partners' educational status (n=395)		
No formal education	32	8.1
Primary education (1-8)	99	25.1
Secondary education (9-12)	147	37.2
Tertiary education	117	26.6
Occupational status (n=395)		
No paid employment	200	50.6
Government/private employee	126	31.9
Merchant	39	9.9
Student	8	2.0
Daily labourer	12	3.0
Other*	10	2.6
Estimated average monthly income (n=364)		
≤ $ 200 USD	263	72.3
> $ 200 USD	101	27.7
Type of pregnancy (n=388)		
Intended	351	90.5
Unintended	37	9.5
Gravidity (395)		
Nullipara	196	49.6
Multipara	199	50.4

*farmer, waitress, selling coffee and tea on the street, freelance researcher

Table 11: Patterns of gestational weight gain by specific body mass index at specific trimester in Addis Ababa, Ethiopia, 2019

Weight status	Second trimester GWG (Median and IQR (25^{th}, 75^{th} percentiles) (n=328)	Third trimester GWG (Median and IQR (25^{th} 75^{th} percentiles) (n=324)	Total GWG (Median and IQR (25^{th} ,75^{th} percentiles) (n=369)
Underweight women	5 kg (3.5, 6.0)	4.5 kg (3.0, 6.6)	10 (7.6, 12.5)
Normal weight women	4 kg (3.0, 5.7)	5 kg (3.0, 6.1)	9 kg (7.0, 12.0)
Overweight or obese women	3.9 kg (1.0, 5.7)	4 kg (2.0, 5.0)	7 kg (5.0, 8.2)
Total	4 kg (2.9, 6.0)	4.5 kg (3.0, 6.0)	8.7 kg (7.0, 11.6)

Of 369 women for whom GWG was assessed, 67.2% (95 % CI: 62.2, 72.0) gained inadequate gestational weight; 27.9% (95 % CI: 23.4, 32.8) gained adequate gestational weight; and 4.9% (95 % CI: 2.9, 7.6) gained excessive gestational weight. Three quarters (75%) of underweight women gained inadequate gestational weight whereas 43% of overweight or obese women gained inadequate gestational weight

5.4.3. Dietary diversity, food security, and anaemia status

Within the previous 24 hours before the interview, 95.6% of the participants consumed foods prepared from grains; 28.4% consumed meat and meat product; only 6.4% consumed fish and fish products. Women's dietary diversity score varied from 1 to 10, with 17.2% having a low dietary diversity score. Thirteen percent of the study participants were living in food-insecure households; 3% had anaemia (2.4% had mild anaemia; 0.3% each had moderate and severe anaemia); and 18% had low MUAC value (<23cm) (Table 12).

Table 12: Dietary diversity, food security, anaemia status of the study participants in Addis Ababa, Ethiopia, 2019)

Variable	Frequency	Percentage
Food group consumed in the last 24 hours (n=395)		
Foods from grains	377	95.7
White roots, tubers and plantains	273	69.3
Pulses (bean, peas and lentils)	264	67.0
Milk and milk products	138	35.0
Meat and meat product	112	28.4
Any fresh or dried or shellfish	25	6.4
Eggs	89	22.6
Vegetable	229	58.1
Fruits	229	58.1
Any foods made with oil or fat	341	86.6
Minimum dietary diversity (n=395)		
Low dietary diversity	68	17.2
High dietary diversity	327	82.8
Food Security (n=391)		
Food secure	340	87.0
Mildly food insecure	19	4.9
Moderately food insecure	26	6.6
Severely food insecure	6	1.5
MUAC* (n=387)		
Low MUAC (<23cm)	70	18.1
High MUAC (≥23cm)	317	81.9
Had anaemia (n=385)		
Yes	11	3.0
No	374	97.0

*Mid-upper arm circumference

5.4.4. Respondents' physical activity status

Of the total study participants, 5.3% reported doing vigorous-intensity physical activity that lasted for at least 10-minutes continuously while at work. Whereas 14% reported doing moderate-intensity physical activity for at least 10-minutes continuously while at work.

Moderate-intensity inside chores and activities were the most commonly practiced physical activities (98.2%) among women. Vigorous- and moderate-intensity leisure-time activities were the least commonly practiced among women (Figure 13).

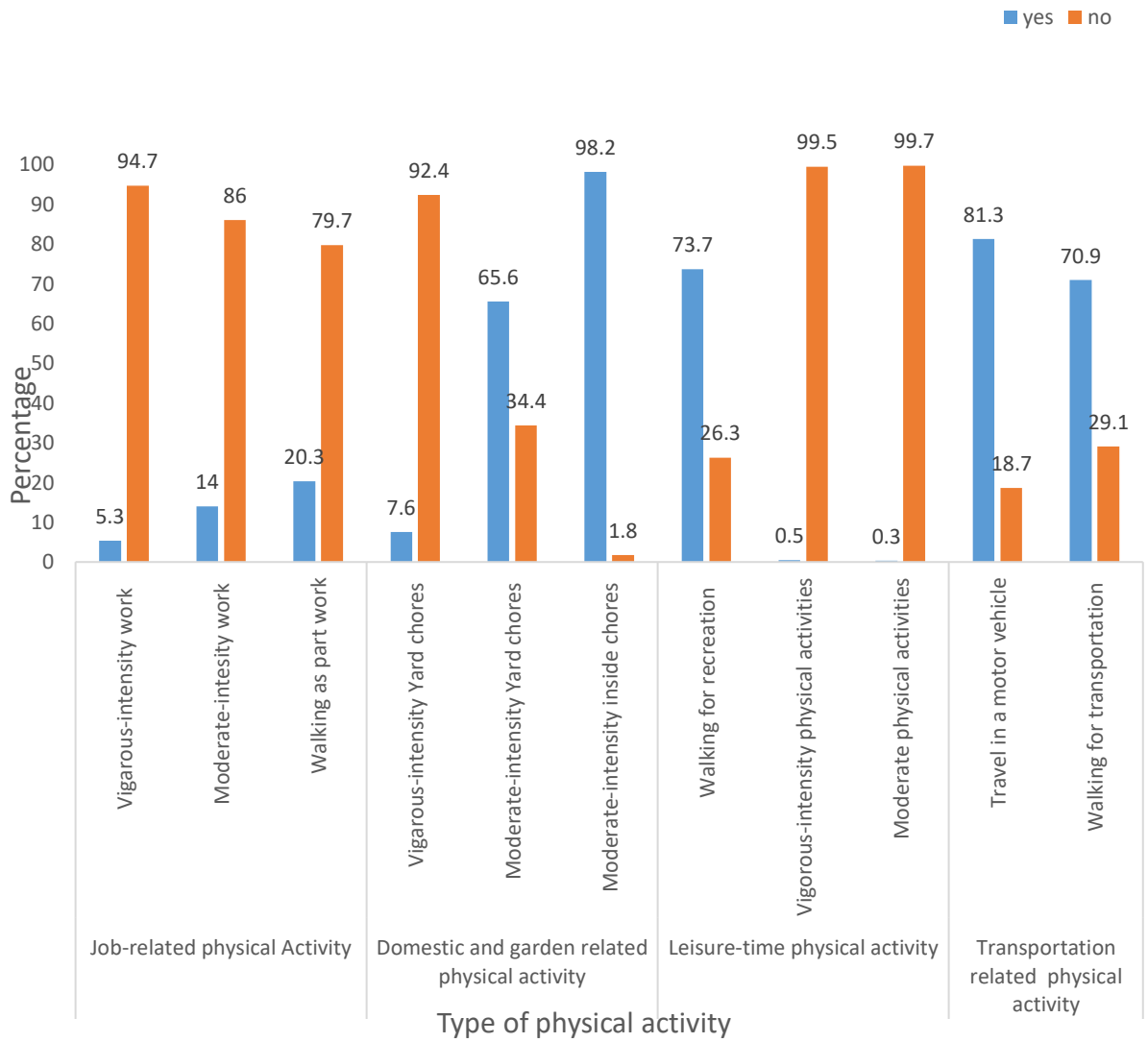

Figure 13: Proportion of women who engage in physical activity by specific domains and intensity level in Addis Ababa, Ethiopia, 2021.

The MET minutes per week (median (interquartile range)) of the women were 742 (330, 2145) for job related physical activities; 360 (180, 630) for domestic and garden work; 231 (132, 346) for recreation and leisure related physical activities; and 231 (132, 396) for transportation related physical activities. The proportion of women who engaged in a high, moderate and low level of physical activity was 10.9%; 42.0% and 47.1%, respectively.

5.4.5. Intimate partner violence and perinatal depression

Of the total respondents, 18.2% experienced intimate partner violence (any physical, sexual or emotional violence) during their current pregnancy; 6.6% experienced physical violence; 7.3% sexual violence; and 8.1% emotional violence. Forty one percent (41%) asked permission from their partners to seek health care. Ten percent (10%) of the respondents had symptoms related to perinatal depression.

5.4.6. Proportions of gestational weight gain in relation to different variables

As described in table 12, seventy seven percent (77%) of women who did not attend formal education gained inadequate gestational weight, while 56% of women who attended tertiary education gained inadequate gestational weight. Seventy six percent (76%) of women with no paid employment outside of home (home duties) gained inadequate gestational weight, however 55% of women who were employed by a government or private institution gained inadequate weight. Fourteen percent (14%) of women with perinatal depression gained excessive gestational weight compared to women with no perinatal depression (4%) (Table 13).

Table 13: proportions of inadequate, adequate and excessive GWG in relation to other variables in Addis Ababa, Ethiopia, 2019

	Proportions of GWG		
Variables	Inadequate GWG n(%)	Adequate GWG n(%)	Excess GWG n(%)
Educational status			
No formal education	27 (77.1)	7 (20.0)	1(2.9)
Primary education (1-8)	100 (65.8)	44 (28.9)	8(5.3)
Secondary education (9-12)	77 (74.0)	22 (21.2)	5 (4.8)
Tertiary education	43 (55.8)	30 (39.0)	4 (5.2)
Wealth quartile			
Lowest	53 (74.7)	15 (21.1)	3 (4.2)
Second	45 (59.2)	30 (39.5)	1 (1.3)
Middle	53 (70.7)	18 (24.0)	4 (5.3)
Fourth	53 (69.7)	18 (23.7)	5 (6.6)
Highest	44 (62.0)	22 (31.0)	5 (7.0)
Occupational status			
Employee	66 (55.5)	46 (38.7)	7 (5.9)
Do not have paid employment	140(76.1)	37 (20.1)	7 (3.8)
Merchant	26 (66.7)	10 (25.6)	3 (7.7)
Other	16 (59.3)	10 (37.0)	1 (3.7)
Weight status			
Underweight	51 (75.0)	15 (22.1)	2 (2.9)
Normal weight	169 (71.6)	59 (25.0)	8 (3.4)
Overweight or obese	28 (43.1)	29 (44.6)	8 (12.3)
MUAC			
Low MUAC (<23cm)	49 (75.4)	12 (18.5)	4 (6.1)
High MUAC (≥23cm)	194 (65.6)	88 (29.7)	14 (4.7)
Perinatal depression			
Yes	26 (72.2)	5(13.9)	5 (13.9)
No	222 (66.7)	98 (29.4)	13 (3.9)
Asking permission from partners for health care seeking			
Yes	112 (73.2)	34 (22.2)	7 (4.6)
No	136 (63.3)	68 (31.6)	11 (5.1)
Age in years			
< 20	12 (66. 7)	6 (33.3)	0
20 to 29	198 (66.7)	82 (27.6)	17 (5.7)
30 to 40	38 (70.4)	15 (27.8)	1 (1.8)
Partners' educational status (369)			
No formal education	25 (83.3)	5(16.7)	0
Primary education (1-8)	62 (65.3)	27 (28.4)	6 (6.3)
Secondary education (9-12)	91 (67.9)	37 (27.6)	6 (4.5)
Tertiary education	70 (63.6)	34 (30.9)	6(5.5)
Minimum dietary diversity			
Low dietary diversity	47 (70.1)	17 (25.4)	3 (4.5)
High dietary diversity	201(66.5)	86 (28.5)	15 (5.0)
Food insecurity			
Food secure	212 (67.1)	89 (28.2)	15 (4.7)
Food insecure	33 (67.4)	13 (26.5)	3 (6.1)
Intimate partner violence			
Yes	44 (62.8)	24 (34.3)	2 (2.9)
No	204 (68.2)	79 (26.4)	16 (5.4)
Type of pregnancy (363)			
Intended	221(67.0)	91 (27.6)	18(5.4.)
Unintended	23 (69.7)	10 (30.3)	0

Table 13: proportions of inadequate, adequate and excessive GWG in relation to other variables in Addis Ababa, Ethiopia, 2019 (continued)

Variables	Proportions of GWG		
	Inadequate GWG n(%)	Adequate GWG n(%)	Excess GWG n(%)
Parity (369)			
Nullipara	116 (64.8)	55 (30.7)	8 (4.5)
Para one	80 (74.1)	25 (23.1)	3 (2.8)
Para two	36 (67.9)	13 (24.5)	4 (7.6)
≥ Para three	16 (55.2)	10 (34.5)	3(10.3)
Level of physical activity (369)			
Low	120 (68.6)	47 (26.8)	8 (4.6)
Moderate	104 (67.5)	41 (26.6)	9 (5.9)
High	24 (60.0)	15 (37.5)	1 (2.5)

5.4.7. Predictors of gestational weight gain

Three factors, namely, women's pre-pregnancy BMI, occupational status, and wealth index were significantly associated with inadequate GWG. Compared to overweight or obese women, being underweight (AOR =3.30 [95 % CI: 1.32, 8.24]) and normal weight (AOR =2.68 [95 % CI: 1.37, 5.24]) increased the odds of gaining inadequate gestational weight. Similarly, Not having paid employment (home duties), AOR =2.17 [95 % CI: 1.16, 4.07]), was associated with higher odds of gaining inadequate gestational weight compared to women employed by the government or private institutions. The odds of inadequate GWG in the second lowest wealth quartile was 61% less than in lowest wealth quartile women (Table 14).

Table 14: Predictors of gestational weight gain in Addis Ababa, Ethiopia, 2019

Variable	Inadequate vs Adequate			Excess vs Adequate		
	Crude Odds Ratio (COR)	Adjusted Odds Ratio (AOR)	P-value for AOR	Crude Odds Ratio (COR)	Adjusted Odds Ratio (AOR)	P-value for AOR
Educational status						
No formal education	2.69 [1.04, 6.98]	2.16 [0.70, 6.66]	0.178	1.07 [0.10, 11.13]	1.20 [0.09, 16.86]	0.894
Primary education (1-8)	1.59 [0.88, 2.85]	1.34 [0.63, 2.84]	0.442	1.36 [0.38, 4.94]	1.60 [0.32, 7.83]	0.569
Secondary education (9-12)	2.44 [1.26, 4.75]	1.63 [0.74, 3.60]	0.159	1.70 [0.41, 7.09]	1.66 [0.33, 8.41]	0.542
Tertiary education	Reference	Reference		Reference	Reference	
Wealth quartile						
Lowest	Reference	Reference		Reference	Reference	
Second	0.42 [0.20, 0.89]	0.39 [0.17, 0.86]	0.021	0.17 [0.02, 1.74]	0.09 [0.01, 1.10]	0.060
Middle	0.83 [0.38, 1.82]	0.91 [0.39, 2.12]	0.832	1.11 [0.21, 5.76]	1.32 [0.22, 7.94]	0.762
Fourth	0.83 [0.38, 1.82]	1.12 [0.46, 2.72]	0.806	1.39 [0.28, 6.79]	1.95 [0.33, 11.46]	0.459
Highest	0.57 [0.26, 1.22]	0.83 [0.34, 2.01]	0.679	1.14 [0.24, 5.49]	1.63 [0.27, 9.93]	0.598
Occupational status						
Employee	Reference	Reference		Reference	Reference	
Do not have paid employment	2.64 [1.56, 4.45]	2.17[1.16, 4.07]	0.016	1.24 [0.40, 3.86]	1.00 [0.26, 3.83]	0.998
Merchant	1.81 [0.80, 4.12]	2.14 [0.81, 5.61]	0.123	1.97 [0.43, 8.93]	1.58 [0.26, 9.68]	0.623
Other	1.12 [0.46, 2.68]	0.76 [0.29, 2.01]	0.585	0.66 [0.07, 5.95]	0.65 [0.06, 6.92]	0.723
Weight status						
Underweight	3.52 [1.62, 7.65]	3.30 [1.32, 8.24]	0.011	0.48 [0.09, 2.57]	0.25 [0.03, 1.97]	0.188
Normal weight	2.97 [1.63, 5.39]	2.68 [1.37, 5.24]	0.004	0.49 [0.17, 1.44]	0.39 [0.11, 1.37]	0.141
Overweight or obese	Reference	Reference		Reference	Reference	
MUAC*						
Low MUAC (<23cm)	1.85 [0.94, 3.63]	1.94 [0.87, 4.32]	0.103	2.10 [0.59, 7.42]	6.63 [1.38, 31.89]	0.018
High MUAC (≥23cm)	Reference	Reference		Reference	Reference	
Perinatal depression						
Yes	2.30 [0.86, 6.15]	2.56 [0.88, 7.46]	0.086	7.54 [1.92, 29.61]	12.50 [2.72, 57.54]	0.001
No	Reference	Reference		Reference	Reference	
Asking permission from partners for health care seeking						
Yes	1.65 [1.02, 2.67]	1.44 [0.83, 2.50]	0.191	1.27 [0.45, 3.58]	1.98 [0.59, 6.70]	0.270
No	Reference	Reference		Reference	Reference	
Age in years						
< 20	0.83 [0.30, 2.28]	--	--	--	--	--
20 to 29	Reference	--	--	Reference	--	--
30 to 40	1.05 [0.55, 2.01]	--	--	0.32 [0.04, 2.60]	--	--
Partners' educational status						
No formal education	2.43 [0.86, 6.90]	--	--	--	--	--
Primary education (1-8)	1.12 [0.61, 2.05]	--	--	1.26 [0.36, 4.35]	--	--
Secondary education (9-12)	1.19 [0.68, 2.09]	--	--	0.92 [0.27, 3.12]	--	--
Tertiary education	Reference		--	Reference	--	
Minimum dietary diversity						
Low dietary diversity	1.18 [0.64, 2.18]	--	--	1.01[0.26, 3.88]	--	--
High dietary diversity	Reference	--	--	Reference	--	--
Food insecurity						
Food secure	Reference	--	--	Reference	--	--
Food insecure	1.07 [0.54, 2.12]	--	--	1.37 [0.35, 5.39]	--	--
Intimate partner violence						
Yes	0.71 [0.41, 1.24]	--	--	0.41 [0.09, 1.92]	--	--
No	Reference	--	--	Reference	--	--

Table 14: Predictors of gestational weight gain in Addis Ababa, Ethiopia, 2019 (continued)

Variable	Inadequate vs Adequate			Excess vs Adequate		
	Crude Odds Ratio (COR)	Adjusted Odds Ratio (AOR)	P-value for AOR	Crude Odds Ratio (COR)	Adjusted Odds Ratio (AOR)	P-value for AOR
Type of pregnancy						
Intended	Reference	--	--	Reference	--	--
Unintended	0.95 [0.43, 2.07]	--	--	--	--	--
Parity						
Nullipara	Reference	--	--	Reference	--	--
Para one	1.52 [0.87, 2.63]	--	--	0.83 [0.20, 3.37]	--	--
Para two	1.31 [0.63, 2.67]	--	--	2.12 [0.55, 8.12]	--	--
≥ Para three	0.76[0.32, 1.78]	--	--	2.06 [0.47, 9.13]	--	--
Level of physical activity						
Low	1.60 [0.77, 3.30]	--	--	2.55 [0.29, 22.10]	--	--
Moderate	1.59 [0.76, 3.32]	--	--	3.29 [0.38, 28.24]	--	--
High	Reference	--	--	Reference	--	--

* Mid-upper arm circumferences

5.5. Discussion

We found that more than two thirds of women gained inadequate gestational weight. In contrast, fewer than 5% of women gained excess gestational weight. Being underweight or normal weight before pregnancy increased the odds of gaining inadequate gestational weight. Similarly, not having paid employment (home duties) was associated with higher odds of gaining inadequate gestational weight compared to women employed by government or private institutions. The odds of inadequate GWG for women in the second lowest wealth quartile was 61% less than women in lowest wealth quartile.

Inadequate gestational weight gain was high in our study. This may be due to some women in Ethiopia decreasing food consumption during pregnancy fearing that overeating may enlarge the fetal head or make the baby overweight and that will lead to a caesarean birth [59, 60]. Wang et al. recently used data from the demographic health survey program to estimate the average levels of GWG in all low- and middle-income countries (LMIC) and found that the average level of GWG is lower than the United State Institute of Medicine recommendations

in most LMIC countries [13]. Our findings are consistent, however, with other studies in sub-Saharan Africa, including the proportions of women with inadequate gestational weight gain of 71.8% in Malawi [61], 63% in Niger [62], and 62.7% in Uganda [14]. A higher proportion of women with inadequate GWG in these low-income sub-Saharan Africa settings, including Ethiopia, could be as a result of a wide range of nutritional problems, economic instability, poverty, food insecurity, and frequent infections which are common in sub-Saharan Africa [63]. In addition, a significant proportion of women were underweight at the time of conception in sub-Saharan Africa [5, 12, 64]. Moreover, more than a half of pregnant women in sub-Saharan African settings lack awareness of the risks associated with inappropriate GWG [65]. Given the adverse maternal and child health outcomes associated with inadequate GWG [43, 66-68], our findings indicate that inadequate GWG is a public health concern in Addis Ababa, Ethiopia and highlights the need for effective maternal health interventions to influence weight gain during pregnancy.

Our findings contrast with high-income countries where a higher proportion of women with excessive GWG have been reported, where the majority of women experience excessive GWG [2, 6, 7]. Adequate gestational weight gain was found in fewer than one-third of our study participants, which is similar to many other studies [2-11]. This would indicate that the practical applicability of the IOM guideline needs further investigation. The IOM guidelines are explicitly intended as recommendations for women in the United States which may be applicable for women in other high-income countries. The IOM guidelines were primarily intended to prevent excessive GWG. However, previous studies conducted in LMIC have used the IOM guidelines to facilitate comparisons across countries, as there are no specific guidelines for gestational weight gain for LMIC. This highlights the urgent need for GWG recommendations dedicated to LMIC or consideration of data from LMIC.

The prevalence of inadequate GWG was 75% among underweight women, compared with 43% among overweight or obese women. Studies from sub-Saharan African countries have also reported that more than three-quarters of women who were underweight at the time of conception gain gestational weight below the IOM recommendations [5, 64]. In our study, being underweight increased the odds of gaining inadequate gestational weight three-fold, while being normal weight increased the odds of gaining inadequate gestational weight two-fold, compared to overweight or obese women. This is due to the fact that pre-pregnancy BMI is closely linked to maternal nutrition, lifestyle, and socio-cultural factors, which could have an impact on the amount of GWG [69]. Women who are underweight or normal weight before pregnancy are required to gain more weight than their overweight or obese counterparts to achieve a healthy GWG. Overweight and obese women, on the other hand, are required to gain comparatively little weight to achieve adequate GWG as they are able to use a portion of their stored energy to support the growth of the fetus. As such, adequate GWG may be attained easily for these women. This would potentially provide further evidence for strategies to support the promotion of adequate gestational weight gain in Ethiopian underweight and normal weight women.

We identified that not being in paid employment was associated with higher odds of inadequate GWG compared to women employed outside the home by government or private institutions. This could be due to half of our study participants not having paid employment at the time of data collection. This high proportion of women's unemployment is associated with women's educational status. About half of our study participants attended no formal education or only attended primary education. Maternal education would help women to generate income through employment, as educated women are more likely to have paid work than uneducated

women [70]. A study from China also reported that unemployment, housework or temporary work increased the odds of inadequate GWG compared to regular paid employment outside the home [71]. Improving women's employment status would be important to prevent inappropriate GWG.

While studies from high-income countries reported that household food insecurity is associated with excessive GWG [32, 33], household food insecurity was not significantly associated with GWG in our study. Women's dietary diversity, intimate partner violence, and physical activity were not significantly associated with GWG. This may be due to the fact our sample size was relatively small to detect the association.

Previous studies have reported that perinatal depression is associated with gaining inadequate gestational weight [25] or excessive GWG [72, 73], while another study reported perinatal depression was not associated with either inadequate or excessive GWG [74]. In our study, perinatal depression was not associated with inadequate GWG, but associated with excessive GWG. However, since few women in our study gained excessive gestational weight and those findings had a wide confidence interval, this is not strong evidence to conclude that perinatal depression is associated with excessive GWG.

About half of our study participants (47.1%) reported that they engaged in low-level physical activity. Physical activity was not significantly associated with GWG in our study. The women in our study used the highest amount of energy on household activities. This could be due to 50% of our study participants being unemployed (identified themselves as undertaking home duties), which could have accounted for the low energy expenditure on occupational activity.

Another possible reason could be most pregnant women may feel safer and comfortable doing household activities than engaging in occupational or sports activities during pregnancy [75].

The strength of this study was GWG was followed prospectively. This study has some limitations. Firstly, the IOM GWG recommendations are the recommendations of high-income countries. These recommendations may not be suitable in low-income settings such as Ethiopia. Secondly, we measured pre-pregnancy BMI before or at 16 weeks of gestation, at which time there may already have been an increase or decrease of gestational weight. In addition, women's last weight was measured at 36 weeks of gestation; hence there may be some weight gain after 36 weeks of gestation. Finally, this study was conducted in the capital city of Ethiopia in the public health facilities; the situation in other parts of the country and private health facilities may be different

Conclusion

Nearly two-thirds of our study participants gained inadequate gestational weight. Pre-pregnancy BMI and occupational status of the women were strong predictors of GWG. Preconception or early pregnancy GWG-related counselling and intervention(s) regarding the best GWG management approach would be a public health priority. The practical applicability of the IOM guidelines and the effect of GWG (according to IOM recommendations) on pregnancy outcomes need further investigation in Ethiopian context. Preparing a GWG guideline and integrating sufficient information about weight management into ANC guidelines is essential.

Declarations

Ethics approval and consent to participate

Ethics approval for the study was obtained from the Haramaya University Institutional Health Research Ethics Review Committee [IHRERC/200/2018], Addis Ababa Health Bureau Institutional Review Board [A/A/HB/2576/227] and the University of Technology Sydney, Human Research Ethics Committee [UTS HREC18-2610].

Consent for publication

Informed consent was obtained from all participants for publication.

Availability of data and materials

The datasets used for the analysis are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

FA has conceived the study, performed data collection and analyses, and drafted the manuscript. AH, MF, YD and AC have also conceived the study and critically revised the design of the study, participated in the analyses, interpretation of the findings and draft of the manuscript. All authors read this manuscript and finally approved for submission.

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Chapter 6: Influence of Gestational Weight Gain on Baby's Birth Weight in Addis Ababa, Central Ethiopia: A Prospective Cohort Study

6.1.Chapter overview

The evidence presented in the previous chapter (chapter five) is of the patterns and determinants of GWG. The question of the consequences and implications of this GWG, particularly inadequate GWG, on birth outcomes emerges. While there are several studies on factors affecting birth weight in Ethiopia, the influence of GWG on birth weight is not well understood in this setting. The aim of this chapter is to provide a description of the influence of GWG on pregnancy outcome, mainly birth weight. This chapter contains factors associated with birth weight including GWG. This paper has been submitted to BMJ Open for publication.

Abstract

Background: Gestational weight gain (GWG) is an important indicator of fetal wellbeing during pregnancy. Inadequate or excessive GWG could have undesirable effects on birth weight. However, information regarding the influence of GWG on birth weight is lacking from the Ethiopian setting.

Objective: The aim of this study was to determine the influence of GWG and other maternal related factors on birth-weight in Addis Ababa, Ethiopia.

Design and methods: A prospective cohort study was conducted among pregnant women who received antenatal care in health centres in Addis Ababa, from January 10 to September 25, 2019. Data were collected using a structured questionnaire and medical record reviews. We conducted multivariable linear regression analysis to determine the independent effect of gestational weight on birth weight.

Results: Of the 395 women enrolled in the study, the outcome of pregnancy was available for 329 (83.3%) of the participants. The mean birth weight was 3130 gm (standard deviation, 509 gm). The proportion of low-birth weight (<2500 gm) was 7.5% (95% CI: 4.8% to 11.0%). Babies born to underweight women were 155gm (95% CI: 2 to 309 gm, p=0.047) lighter than infants born to normal weight women. Similarly, babies whose mothers gained inadequate weight were 246 gm (95% CI: 112 to 379 gm, p<0.001) lighter compared to those who gained adequate weight. Moreover, infants whose mothers had a previous history of abortion or miscarriages or developed gestational hypertension in the current pregnancy were 144 gm (95% CI: 2 to 287 gm, p=0.047) and 317 gm (95% CI: 77 to 556 gm, p=0.010) lighter, respectively, compared to those whose mothers had not.

Conclusions: Pre-pregnancy weight, GWG, having had previous history of abortion or miscarriages, and developing gestational hypertension during a current pregnancy was independently associated with birth weight. Pregnancy related weight management should be actively promoted through intensive counselling during routine antenatal care contacts.

Key words: Pre-pregnancy weight; Gestational weight gain; Birth weight; Pregnancy outcomes

Strengths and limitations of this study

- ✓ We prospectively followed weight of the women in order to assess GWG and its influence on birth weight.
- ✓ The IOM GWG recommendations are the recommendations of high-income countries, may not be suitable in low-income settings such as Ethiopia.
- ✓ We measured pre-pregnancy BMI before or at 16 weeks of gestation, at which time there may already have been an increase or decrease of gestational weight.
- ✓ This study was conducted in the capital city of Ethiopia in the public health facilities; the situation in other parts of the country and private health facilities may be different.

6.2. Introduction

Gestational weight gain (GWG) is attributable to pregnancy related changes that women experience such as the increase in size of the uterus and the developing foetus, placenta, amniotic fluid, an increase in breast size, extracellular fluid and blood volume. The American Institute of Medicine (IOM) has published recommendations for GWG of 12.5 to 18 kg for underweight women, 11.5 to 16 kg for normal weight women, 7 to 11 kg for overweight women, and 5 to 9 kg for obese women [1].

Gestational weight gain is a powerful indicator of maternal [2] and fetal [1] nutrition during pregnancy. Adequate GWG supports the growth and development of the fetus [3]. Both extremes, excessive or inadequate GWG, could result in undesirable pregnancy outcomes [4-7]. Excessive GWG is associated with pre-eclampsia [8-10], caesarean birth [8, 10, 11], macrosomia, large for gestation age and high birth weight [7]. On the other hand, inadequate

weight gain is associated with intrauterine growth restriction [12], low for gestational age, pre-term birth [13-15], and low birth weight [6, 7].

Birth weight is one of the most important health indices in the growth, development and future survival of a newborn baby [16]. Birth weight is high if it is >4000 gm [17] or low if it is <2500 gm [18]. Low birth weight (LBW) is a proxy measure of intrauterine malnutrition. Intrauterine malnutrition has life-long consequences for the fetus [19]. Identifying the influence of GWG on birth weight at the local level is importance to provide an appropriate nutrition intervention during the pregnancy to reduce the risk of intrauterine malnutrition, and to improve GWG and birth weight outcome. This could help to break the vicious intergenerational cycle of malnutrition [20].

Factors influencing birth weight have been reported as including but not limited to, maternal characteristics such as maternal age [21], pre-pregnancy body mass index (BMI) [22], nutritional status, smoking [23, 24], and physical activity [25-27]. Factors related to the amount of growth and weight gain during pregnancy, and overall health of the mother and the fetus [28, 29] also affect the amount of birth weight. While there are a number of studies on factors affecting birth weight in Ethiopia, the influence of GWG on birth weight is not well understood in this setting. This study aimed to determine the influence of GWG and other maternal related factors on birth weight in Addis Ababa, a central Ethiopian population.

6.3.Methods

6.3.1. Study design

We conducted a prospective cohort study, recruiting women who were pregnant between January 2019 and September 2019.

6.3.2. Study setting

This study was conducted in Addis Ababa, which is the capital and largest city in Ethiopia. Participants were selected from nine health centres. Details of the study setting and numbers of women recruited from each facility were reported in the previous published paper [30]

6.3.3. Sample size determination

We calculated the sample size using Open Epi Version 2.3 using double proportion formula. The assumptions for the sample size calculation were alpha value 0.05; power 80%; exposed to non-exposed ratio 1:2 (proportion of adequate GWG = 28% (exposure); and proportion of inadequate GWG = 69% (non-exposure)) [31]; proportion of LBW among women who gained adequate gestational weight =1.7%; proportion of LBW among women who gained inadequate gestational weight =17.5% [21], loss to follow-up =20%. The required sample was 189 (exposed =63, and control =126). However, since this study was part of another large study, we recruited a sample size of 395 [30].

6.3.3. Participants

Pregnant women who came to maternal health centres before or at 16 weeks gestation for antenatal care (ANC) were invited to participate and those who agreed were recruited. We limited eligibility to women with a singleton pregnancy and no co-morbidities such as diabetes and hypertension.

6.3.4. Measurements

We used structured questionnaires with trained interviewers and face-to-face semi-structured interviews. The questionnaires collected information on socio-demographic characteristics, previous history of abortion (termination of pregnancy before the 28th week of gestation), low birth weight and stillbirth, pregnancy intention (planned/unplanned), gravidity, food security and dietary diversity, physical activity, intimate partner violence, and depression related symptoms. Data collectors measured baseline weight and height of the women, and mid-upper arm circumference. Women's medical records were also reviewed both during baseline data collection and after birth to collect data such as gestational age (ultrasound result), blood pressure, level of haemoglobin, random blood sugar result, weight at the 4th ANC visit, mode of birth, episiotomy, birth weight, and sex of the baby. Women were followed from prior to or at their 16th week of gestation until they gave birth to assess their gestational weight gain and the baby's birth weight. Sixteen women (5.2%) gave birth in a rural location and we were unable to access the birth records. For these women, the birth weight information was ascertained through a phone call to the mother.

We calculated GWG by subtracting women's baseline weight from their weight at the 4th ANC visit. The adequacy of GWG (inadequate, adequate or excessive) was determined using the IOM criteria. Birth weight was analysed as a categorical and continuous variable. Birth weight was classified as <2.5 kg (low birth weight), 2.5 kg to 3.9 kg (normal birth weight), ≥4.0 kg (macrosomia). The primary outcome variable in this study was birth weight. However, other pregnancy outcome variables such as the occurrence of gestational hypertension, modes of birth, episiotomy, and birth outcomes (live birth, miscarriage, stillbirth or intra-uterine fetal death) were also considered as outcome variables.

We assessed the household food insecurity using the Household Food Insecurity Access Scale (HFIAS) [32] and the dietary diversity of the women was assessed using the minimum dietary diversity-women (MDD-W) tool [33]. Women's physical activity level was measured using the International Physical Activity Questionnaire (IPAQ-long form) [34]. Perinatal depression symptoms were measured using the Edinburgh postnatal depression scale (EPDS), and intimate partner violence was measured using a questionnaire used by the World Health Organization (WHO) multi-country study on women's health and domestic violence [36].

6.3.5. Statistical analysis

We double entered into CSPro version 7.1. We exported data to STATA (version 14, Stata Corp, 2015) for cleaning and analysis. Missing data were handled by performing pairwise deletion in the analysis. A particular variable was excluded when it had a missing value, but the case can still be used when analysing other variables with non-missing values. Hence, the analyses were performed on subsets of the data depending on where values are missing without completely omitting a case with missing some variables from the analyses. Descriptive statistics including frequencies, means, and standard deviations were computed to describe the data. The influence of GWG on birth weight was assessed using a linear regression model. Variables with P-value <0.25 in the bivariate analysis were included in the multivariable analyses. The assumptions for linear regression were checked. Scatter plots showed that observations were linear. Multi collinearity was checked using the variance inflation factor (VIF). The mean VIF value was 1.46. The VIF value for each predictor variable was < 3, which showed that there was no multi-collinearity among variables.

We performed multivariable linear regression analysis to determine the independent effect of gestational weight gain on birth weight, adjusting for other potential factors (educational status, average household monthly income, and previous history of abortion (termination of pregnancy before the 28th week of gestation), consuming meat or chicken in the last 24 hours, pre-pregnancy weight, maternal haemoglobin level, occurrence of gestational hypertension, and sex of the baby).

6.4. Results

Of the 395 women enrolled in the study, the outcome of the pregnancy was available for 329 (83.3%) of the participants. Eight of the 329 pregnancies ended in miscarriage (fetal loss before 28 weeks); three ended in stillbirths (fetal loss at or after 28 weeks); the remaining were live births (Figure 14).

The mean age of the women was 25.3 (standard deviation, 3.9) years. As shown in Table 15, half of the participants 199 (50.4%) were multipara, of which 40.7% had previous history of abortion or miscarriage; 4.5% had previous history of stillbirth; and 3.3% had previous history of LBW. Twenty-one (5.8%) developed gestational hypertension during their current pregnancy. Eighty two percent (82%) gave birth via spontaneous vaginal birth (SVD), with 47.5% associated with episiotomy. The majority of infants had normal birth weight (89.6%) and 7.5% had low birth weight. Twelve babies (3.9%) were born pre-term (Table 15).

As shown in Table 16, 85.6% of women who gained inadequate gestational weight gave birth vaginally, while 74.4% of women who gained adequate gestational weight gave birth vaginally; 9.3% of women who gained inadequate gestational weight gave birth to LBW babies, while 4.5% of women who gained adequate gestational weight gave birth to LBW babies. Four

percent of the women who gained inadequate gestational weight developed gestational hypertension while 11% and 6% of women who gained adequate and excess gestational weight, respectively, developed gestational hypertension (Table 16).

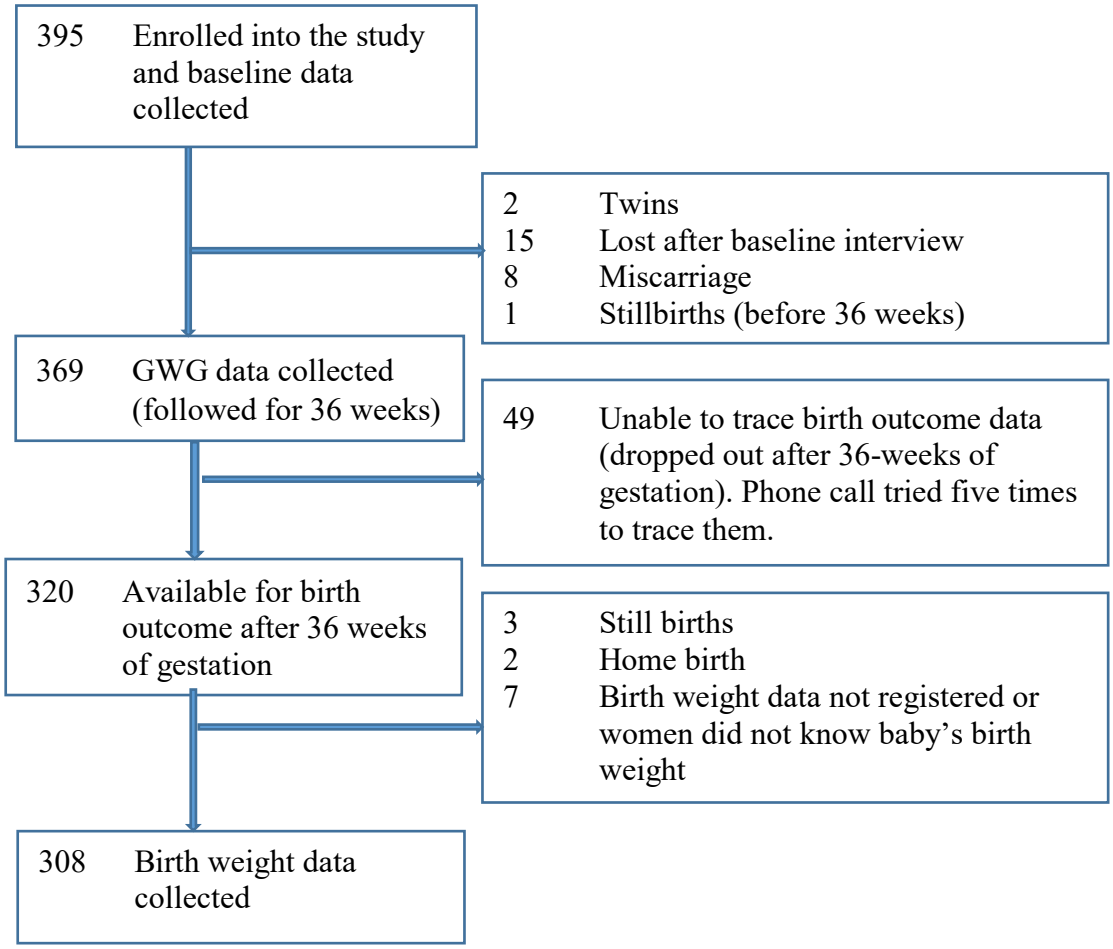

Figure 14: Flowchart showing data collection process from January to September 2019, Addis Ababa, Ethiopia

Table 15: Pregnancy and pregnancy outcome related data of the study participants, Addis Ababa, Ethiopia, 2019

Variable	Frequency	Percentage
Parity (n=395)		
Nullipara	196	49.6
Para one	115	29.1
Para two	54	13.7
≥ Para three	30	7.6
Inter–pregnancy interval (n=192)		
< 23 months	53	27.6
≥ 23 months	139	72.4
Previous history of abortion or miscarriages (n=199)		
Yes	81	40.7
No	118	59.3
Previous history of stillbirth (n=198)		
Yes	9	4.5
No	189	95.5
Mode of birth (n=314)		
Spontaneous vaginal birth	257	81.8
Caesarean section	57	18.2
Episiotomy (n=255)		
Yes	121	47.5
No	134	52.5
Sex of the baby (n=313)		
Male	146	46.6
Female	167	53.4
Gestational hypertension (n=359)		
Yes	21	5.8
No	338	94.2
Birth Weight (n=308)		
Low birth weight	23	7.5
Normal birth weight	276	89.6
Macrosomia	9	2.9
Pre-term births (births before 37 weeks) (n=308)		
Yes	12	3.9
No	296	96.1

Table 16: Table 2: Association between gestational weight gain and pregnancy outcomes, Addis Ababa, Ethiopia, 2019

Variables	Gestational weight gain			P-value for χ^2 test
	Inadequate GWG n (%)	Adequate GWG n (%)	Excess GWG n (%)	
Gestational hypertension (n=357)				
Yes	9 (3.8)	11 (11.0)	1 (5.9)	0.035
No	231(96.2)	89 (89.0)	16 (94.1)	
Total	240 (100)	100 (100)	17 (100)	
Mode of birth (n=313)				
Spontaneous vaginal delivery	179 (85.6)	67 (74.4)	11 (78.6)	0.064
Caesarean section	30 (14.4)	23 (25.5)	3 (21.4)	
Total	209 (100)	90 (100)	14 (100)	
Episiotomy (n=255)				
Yes	84 (47.5)	32 (47.8)	5 (45.5)	
No	93 (52.5)	35 (52.2)	6 (55.5)	0.990
Total	177 (100)	67 (100)	11 (100)	
Birth weight (n=307)				
LBW	19 (9.3)	4 (4.5)	0 (0.0)	
Normal birth weight	183 (89.7)	78 (87.6)	14 (100)	0.008
Macrosomia	2 (1.0)	7 (7.9)	0 (0.0)	
Total	204(100)	89(100)	14(100)	
Sex of the baby (n=312)				
Male	98 (46.9)	40 (44.9)	8 (57.1)	0.696
Female	111 (53.1)	49 (55.1)	6 (42.9)	
Total	209 (100)	87(100)	14(100)	
Pre-term baby (n=270)				
Yes	9 (5.1)	3 (3.9)	0 (0)	0.651
No	169 (94.9)	74 (96.1)	14 (100)	
Total	178 (100)	77(100)	14 (100)	

The mean birth weight was 3.13 kg with standard deviation (SD) of 0.51 kg. It was 3.04 kg (SD = 0.49 kg) among women who gained inadequate gestational weight; 3.30 kg (SD = 0.52 kg) among women who gained adequate gestational weight; and 3.25 kg (SD =0.53 kg) among women who gained excessive gestational weight; 3.02 kg (SD =0.46 kg) among underweight women; and 3.14 kg (SD=0.53 kg) among normal weight women. The proportion of LBW was 10.3% (95% CI: 4.0 % to 21.2%) among underweight women while it was 6.7% (95% CI: 3.6% to 11.2%) among normal weight women. Similarly, 27.8% women who developed gestational hypertension gave birth to LBW babies while only 5.7% women who did not develop gestational hypertension gave birth to LBW babies; 12.7% women with low MUAC (<23cm) gave to LBW babies compared to women with high MUAC (6.5%) (Table 17).

Table 17: Birth weight in relation to different factors in women of Addis Ababa, Ethiopia, 2019

Variable	LBW, n (%)	Normal birth weight, n (%)	Macrosomia, N (%)	Mean birth weight (standard deviation) (kg)
Women's age in years (n=308)				
< 20	1 (7.1)	13 (92.9)	0 (0.0)	2.96 (0.50)
20 to 29	18 (7.3)	220 (89.4)	8 (3.3)	3.13 (0.51)
≥30	4 (8.3)	43 (89.6)	1 (2.1)	3.14 (0.53)
Marital status (n=308)				
Married	22 (7.4)	267 (89.9)	8 (2.7)	3.13 (0.51)
Single	1 (9.1)	9 (81.8)	1 (9.1)	3.15 (0.46)
Educational status (n=308)				
No formal education	2 (8.0)	23 (92.0)	0 (0.0)	3.17 (0.49)
Primary	12 (9.7)	111(89.5)	1 (0.8)	3.01(0.48)
Secondary	8 (9.0)	75 (84.3)	6 (6.7)	3.15 (0.58)
Tertiary	1 (1.4)	67 (95.7)	2 (2.9)	3.23 (0.45)
Occupational Status (n=308)				
House duty	14 (9.2)	133 (87.5)	5 (3.3)	3.07 (0.54)
Employee	4 (4.0)	95 (94.0)	2 (2.0)	3.19 (0.44)
Merchant	2 (6.1)	29 (87.8)	2 (6.1)	3.26(0.55)
Others*	3 (13.4)	19 (86.4)	0(0.0)	3.00(0.47)
Average monthly income (n=284)				
< 5000 ETB**	16 (8.3)	173 (90.1)	3 (1.6)	3.10 (0.51)
5000 to 10,000 ETB	5 (8.1)	54 (87.1)	3 (4.8)	3.10 (0.49)
≥ 10,000 ETB	1 (3.3)	28 (93.4)	1 (3.3)	3.28 (0.46)
Pregnancy intention (n=304)				
Intended	22 (8.0)	246 (89.5)	7 (2.5)	3.12 (0.51)
Unintended	1 (3.4)	26 (89.7)	2 (6.9)	3.22 (0.48)
Parity (n=308)				
Nullipara	9 (6.2)	132 (91.0)	4 (2.8)	3.11 (0.50)
Multipara	14 (8.6)	144 (88.3)	5 (3.1)	3.14 (0.52)
Time gap between pregnancy (n=252)				
< 23 months	4 (9.8)	37 (90.2)	0 (0.0)	3.09 (0.51)
≥ 23 months	10 (8.6)	101 (87.1)	5 (4.3)	3.16 (0.53)
Dietary Diversity (n=308)				
Low dietary diversity	1 (1.9)	50 (96.2)	1 (1.9)	3.09 (0.49)
High dietary diversity	22 (8.6)	226 (88.3)	8 (3.1)	3.13 (0.52)
Physical Activity (n=308)				
Low	13 (9.0)	127 (88.2)	4 (2.8)	3.10 (0.50)
Moderate	7 (5.5)	115 (90.6)	5 (3.9)	3.15 (0.52)
High	3 (8.1)	34 (91.9)	0 (0.0)	3.15 (0.53)
MUAC*** (n=301)				
Low MUAC	7 (12.7)	46 (83.6)	2 (3.7)	3.02 (0.53)
High MUAC	16 (6.5)	223 (90.6)	7 (2.9)	3.15 (0.50)
Pre-pregnancy weight (n=307)				
Underweight	6 (10.3)	52 (89.7)	0 (0.0)	3.02 (0.46)
Normal weight	13 (6.7)	173 (89.2)	8 (4.1)	3.14 (0.53)
Overweight or obese	4 (7.1)	51 (91.1)	1 (1.8)	3.14 (0.50)
Gestational hypertension (n=298)				
Yes	5 (27.8)	12 (66.7)	1 (5.5)	2.93 (0.69)
No	16 (5.7)	257 (91.8)	7 (2.5)	3.14 (0.49)
Intimate partners violence (n=308)				
Yes	2 (3.5)	53 (93.0)	2 (3.5)	3.13 (0.50)
No	21(8.4)	223 (88.8)	7 (2.8)	3.12 (0.51)
Food insecurity (n=304)				
Food secure	19 (7.1)	239 (89.9)	8 (3.0)	3.12 (0.50)
Food insecure	4 (10.5)	33 (86.8)	1 (2.6)	3.12 (0.58)
Consuming meat or chicken in the last 24 hours (n=307)				
Yes	5 (5.7)	80 (92.0)	2 (2.3)	3.20 (0.50)
No	18 (8.2)	195 (88.6)	7 (3.2)	3.09 (0.51)

Perinatal depression (n=308)				
Yes	3 (9.1)	29 (87.9)	1 (3.0)	3.14 (0.51)
No	20 (7.3)	247 (89.8)	8 (2.9)	3.05 (0.49)

*students, daily labourer, farmer; ** Ethiopian Birr; *** MUAC = Mid Upper Arm Circumference

Predictors of infants' birth weight

Of the variables included into multivariable linear regression analysis, previous history of abortions or miscarriages, occurrence of gestational hypertension, pre-pregnancy weight, and GWG were significantly associated with infants' birth weight at p-value <0.05.

The ß–coefficient showed that infants born to underweight women were 155 gm (95% CI: 2 to 309 gm, p=0.047) lighter than infants born to normal weight women. Similarly, infants whose mothers had inadequate weight gain were 246 gm (95% CI: 112 to 379, p<0.001) lighter compared to those who gained adequate weight. In the same vein, infants whose mothers had previous history of abortion or miscarriages and developed gestational hypertension during current pregnancy were 144 gm (95% CI: 2 to 286 gm, p=0.047) and 317 gm (95% CI 77 to 556 gm, p = 0.010) respectively lighter compared to those whose mothers had not (Table 18).

Maternal age, educational status, monthly income, haemoglobin level, pregnancy intention, gravidity, dietary diversity, food insecurity, physical activity, intimate partners' violence, and perinatal depression were not significantly associated with birth weight.

Table 18: Bivariate and multivariable linear regression analysis for predictors of birth weight (in gram) in Addis Ababa, Ethiopia 2019

Variable	Bivariate regression			Multivariable regression		
	Crude-ß	95%CI	P-value	Adjusted-ß	95%CI	P-value
Women's age in years			0.446			
< 20	-176.0	-451.7 to 99.7	0.210	---	---	---
20 to 29	Ref					
≥30	6.0	-151.9 to 164.7	0.936	---	---	---
Educational status			0.065			
No formal education	- -57.6	-289.6 to 174.5	0.626	-73.3	- 321.5 to 174.8	0.561
Primary	-194.8	-343.7 to -45.9	0.010	-143.5	- 304.5 to 17.6	0.081
Secondary	-84.1	-243.2 to 74.9	0.299	-53.5	-221.1 to 113.6	0.528
Tertiary	Ref			Ref		
Occupational Status			0.258			
House duty	-116.57	-244.5 to 11.4	0.274	---	---	---
Employee	Ref					
Merchant	67.9	-131.9 to 267.8	0.504	---	---	---
Others*	-185.1	-419.6 to 49.5	0.122	---	---	---
Average monthly income			0.190			
< 5000 ETB**	-177.9	-372.5 to 16.6	0.073	- 111.9	-321.3 to 97.5	0.294
5000 to 10000 ETB	-175.9	-396.4 o 44.4	0.117	-165.5	-390.7 to 59.8	0.149
≥10000 ETB	Ref			Ref		
Pregnancy intention			0.294			
Intended	Ref					
Unintended	104.8	-91.4 to 301.1	0.294	---	---	---
Previous history of abortion or miscarriages			0.119			
Yes	-109.7	-247.8 to 28.5	0.119	- 144.2	-286.5 to -2.0	0.047
No	Ref			Ref		
Parity	15.9	-36.6 to 68.4	0.552			
Dietary Diversity			0.600			
Low dietary diversity	Ref					
High dietary diversity	-40.7	-193.4 to 112.0	0.600	---	---	---
Physical Activity			0.641			
Low	-51.7	-236.9 to 133.4	0.583	---	---	---
Moderate	4.1	-183.6 to 191.8	0.966	---	---	---
High	Ref					
Consuming meat or chicken in the last 24 hours			0.085			
Yes	111.4	-15.4 to 238.2	0.085	122.6	10.7 to 255.9	0.071
No	Ref			Ref		
Pre-pregnancy weight			0.173			
Underweight	-114.9	-264.7 to 34.8	0.132	-155.3	-308.6 to -2.1	0.047
Normal weight	Ref			Ref		
Overweight or obese	57.2	-94.5 to 209.0	0.458	1.1	- 165.8 to 168.1	0.990
Gestational hypertension			0.076			
Yes	-216.7	-455.9 to 22.5	0.076	-316.8	-556.2 to -77.2	0.010
No	Ref			Ref		
GWG ***			<0.001			
Inadequate	-252.9	-377.4 to -128.4	<0.001	-245.8	-379.3 to -112.4	<0.001
Adequate	Ref			Ref		
Excessive	47.8	-329.5 to 233.9	0.739	-54.2	-354.0 to 245.4	0.722
Sex of the baby			0.198			
Male	Ref			Ref		
Female	-75.0	-189.0 to 39.0	0.198	-110.8	-226.9 to 5.2	0.061
Maternal haemoglobin	-41.0	-81.2 to -0.9	0.045	-30.9	-71.7 to 9.8	0.137
Intimate partners violence			0.906			
Yes	8.8	-138.6 to 156.2	0.906	---	---	---
No	Ref					
Food insecurity			0.924			
Food secure	Ref					
Food insecure	-8.4	-183.5 to 166.6	0.924	---	---	---

Perinatal depression			0.355			
Yes	-86.9	-271.8 to 97.8	0.355	---	---	---
No	Ref					
Mid upper arm circumference (MUAC)						
Low MUAC (<23cm)	-132.5	-281.8 to 16.75		---	---	---
High MUAC (≥ 23cm)	Ref					

*students, daily labourer, farmer; **Ethiopian Birr; *** Gestational Weight Gain

6.5. Discussion

The overall mean birth weight was 3130 (SD, 509) gm. The proportion of LBW was 7.5% (95% CI: 4.8 % to 11.0%). It was 9.3% (95% CI: 5.7% to 14.2%) of women who gained inadequate gestational weight gave birth to LBW babies while 4.5% (95% CI: 1.2 % to 11.1%) of women who gained adequate gestational weight gave birth to LBW babies. In addition, women's pre-pregnancy weight, GWG, having had previous history of abortion, occurrence gestational hypertension were the significant predictors of birth weight.

The proportion babies born with low birth weight (7.5%) was lower than the findings from the nationwide study using the 2016 Ethiopia Demographic Health Survey data, which was 13.2% (95% CI:10.7% to 15.7 %) [37] and a meta-analysis conducted in 2018 in Ethiopia (pooled BW data from 1995 to 2017), which was 17.3% (95% CI: 14.1% to 20.4 %) [38]. Studies conducted in different parts of the country reported that factors such as maternal educational [37], employment status, income and maternal age [38] are significantly associated with baby's birth weight. However, these factors were not associated with birth weight in our study.

In our study, infants born to underweight women were 155 gm lighter than infants born to normal weight women. The proportion of LBW was higher (10%) among underweight women compared to that of normal weight women (6.7%). Our study confirmed most prior reports that women's pre-pregnancy weight is associated with birth weight [7, 21, 22, 39]. Maternal

undernutrition, which is characterised by low pre-pregnancy weight and inadequate gestational weight gain, can negatively influence fetal growth that could lead to lower birth weight.

Gestational weight gain was found to have a significant influence on birth weight. Based on our study, infants whose mothers gained inadequate gestational weight were significantly lighter than infants of mothers who gained adequate weight. Moreover, 9.3% of women who gained inadequate gestational weight gave birth to LBW babies compared to babies of women who gained adequate gestational weight (4.5%). Other studies in similar settings also reported that LBW was more common among women who gained inadequate gestational weight than among women who gained adequate weight [21, 40]. While there is strong need for extra nutritional intake during pregnancy, more than a quarter of pregnant women (27.3%) in Addis Ababa restrict their food intake to avoid weight gain [41]. This is mostly due to perceived severity of birth complications as a result of large for gestational age babies will make the birth more difficult and leads to caesarean birth [42, 43]. Decreased nutrient intake due to poor dietary practices together with socio-economic and environmental factors could affect fetal growth, which also leads to lower birth weight [44]. Poor nutritional status among pregnant women may be associated with reduced placental size, which may lead to a reduction of nutrient transfer to the fetus from the placenta. Furthermore, low nutritional status of mothers might reduce serum concentrations of hormones such as estrogen and leptin, which could result in impairment of the fetal growth [38]. Nutritional counselling during pregnancy may improve women's feeding behaviour and hence, their nutritional status which may help mothers to decrease the risk of delivering LBW babies [45, 46].

We found that the birth weight of newborns whose mothers had previous history of abortions or miscarriages were significantly lower than those whose mothers had no history of abortions

or miscarriages, an average decrease of 144 gm. This could be due to forty percent (40%) of multiparous women had previous history of abortions or miscarriages; 22% of these women experienced abortions or miscarriages at least two times. This would indicate that reproductive health and family planning use of women and their partners is low. A study conducted by the DKT Ethiopia (a non-profit organisation that promotes family planning), in 2018, on 880 women who received post-abortion care showed that 83.4% of aborted pregnancies were unplanned; and 91.6% of the women intentionally aborted their pregnancy [47]. This would suggest that the Ethiopian government needs to improve access to information and knowledge of reproductive choices and access to family planning services for both men and women.

Consistent with other studies [48-51], our study showed gestational hypertension was significantly associated with lower infant birth weights. Infants born to mothers with gestational hypertension were 317 gm lighter than infants born to mothers without gestational hypertension. Similarly, 27.8% of women with gestational hypertension gave birth to LBW babies while 5.7% of women without gestational hypertension gave birth to LBW babies. Although the relationship between gestational hypertension and an optimal intrauterine environment requires further exploration, some studies indicated that gestational hypertension is related to placental blood flow [52, 53], which affects fetal development including birth weight.

In our study, nearly a half of the women (47.5%) who gave birth through spontaneous vaginal birth had an episiotomy. The prevalence of episiotomy in Ethiopian was much higher than the recommended level by the WHO, which is 10% [54]. Another study from southern Ethiopia reported that the prevalence of episiotomy was 68% [55]. According to the 2016 Ethiopian emergency obstetric and newborn care assessment report, 9% of primary postpartum

haemorrhage and 8% of maternal sepsis are attributed to episiotomy [56]. The reasons for this high prevalence of episiotomy in Ethiopian setting may be due to the liberal use of episiotomy among care providers or other maternal related factors such as high prevalence of female genital mutilation. This may need further investigation.

A strength of this study was women were prospectively followed to their GWG and birth weight. This study has some limitations. Firstly, some participants were lost to follow-up from the study before their birth outcome assessed. Secondly, the IOM GWG recommendations are the recommendations of high-income countries, and these recommendations may not be suitable in low-income settings such as Ethiopia. Finally, this study was conducted in the capital city of Ethiopia in public health facilities; the situation in other parts of the country and private health facilities may be different.

Conclusion

We found that GWG was significantly associated with infants' birth weight. Infants whose mothers gained inadequate gestational weight were significantly lighter than the infants of mothers who gained adequate weight, an average decrease of 246 gm. Moreover, the birth weight of newborns whose mothers were underweight, had a previous history of abortion (termination of pregnancy before the 28^{th} week of gestation) or miscarriages, and had gestational hypertension, were significantly lower than those whose mothers were without this history. Program officers and policy-makers may need to design appropriate interventions on preventing LBW. Pregnancy related weight management should be actively promoted through intensive counselling during routine ANC consultations. The practical applicability of the IOM

guidelines and the effect of GWG (according to IOM recommendations) on pregnancy outcomes need further investigation in Ethiopian context.

Ethics approval

Ethics approval for the study was obtained from the Haramaya University Institutional Health Research Ethics Review Committee [IHRERC/200/2018], Addis Ababa Health Bureau Institutional Review Board [A/A/HB/2576/227] and the University of Technology Sydney, Human Research Ethics Committee [UTS HREC18-2610].

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research

Consent for publication

Informed consent was obtained from all participants for publication.

Availability of data and materials

The datasets used for the analysis are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

FA has conceived the study, performed data collection and analyses, and drafted the manuscript. AC. YD, MF, and AH have critically revised the design of the study, participated in the analyses, interpretation of the findings and draft of the manuscript. All authors read this manuscript and finally approved for submission.

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Chapter 7: Gestational Weight Gain and Postpartum Weight Retention in Central Ethiopia: a Qualitative Study Describing Pregnant Women's Perspectives

7.1. Chapter Overview

As discussed in Chapter four, a number of focus groups and in-depth interviews were undertaken with pregnant women in Addis Ababa, Ethiopia. The paper sought to better understand the pregnant women's view and cultural factors' that affected gestational weight gain (GWG) and postpartum weight management. This chapter is presented as a paper, which will be submitted to a journal for publication.

Abstract

Background: Weight gain is needed to support a number of physiological changes during pregnancy. Gaining inadequate or excess gestational weight poses a health risk to the mother and baby. Pregnant women's perspectives on weight gain during pregnancy and postpartum weight retention have not been explored so far in the Ethiopian context. The aim of this study was to explore pregnant women's perceptions and practices related to gestational weight gain and postpartum weight retention.

Methods: Pregnant women who were attending antenatal care in public health facilities of Addis Ababa, Ethiopia, participated in the study. We conducted 15 in-depth interviews and 8 focus group discussions. A total of 71 pregnant women took part in the study. We used a

qualitative descriptive study design. We analysed the data using thematic analysis with an inductive approach.

Findings: We identified five themes and associated sub-themes. None of the study participants were aware of the recommended amount of weight gain during pregnancy. Most participants did not wish to gain weight during pregnancy; but did want to gain weight after birth. Women reported the absence of counselling on gestational weight and postpartum weight management. Discussing weight with care providers was not embarrassing for the participants. Some participants had low level of concern about their weight.

Conclusions: Pregnant women had limited knowledge regarding their weight, and how to maintain healthy pregnancy and postpartum weight. Maternity care providers need to provide consistent counselling on risks associated with inappropriate gestational weight, and how to achieve healthy pregnancy weight.

Keywords: Antenatal care; Gestational weight gain; postpartum weight retention; women's awareness; weight counselling: Ethiopia

7.2. Introduction

Maternal weight is an important health indicator of the mother and the fetus throughout pregnancy [1-4]. The United States Institute of Medicine (IOM) recommends a minimum gestational weight gain (GWG) of 5 kg, 7 kg, 11.5 kg, and 12.5 kg for obese, overweight, normal-weight, and underweight women, respectively; however, weight gain should not exceed 9 kg, 11 kg, 16 kg, and 18 kg for each group, respectively [5]. Inadequate or excess

GWG could result in undesirable health outcomes [1, 2]. Women who gain inadequate weight are at high risk of bearing a baby with low birth weight (LBW) [6] and pre-term birth [7]. By contrast, women who gain excessive gestational weight are at high risk of hypertension during pregnancy [8-10], gestational diabetes [1, 8], caesarean section [8, 10, 11], high postpartum weight retention [12], and development of long-term obesity [13].

The amount of GWG can be affected by physiological, psychological, and behavioural factors [14-17]. Maternity healthcare providers could play a crucial role in influencing women's behaviours to gain appropriate gestational weight given the pregnancy offer them an opportunity to have regular contact with women [18, 19]. Maternal health care providers are recommended to offer practical advice on healthy eating and GWG [20, 21]. Evidence suggests that women who receive counselling on GWG and dietary management have higher likelihood of gaining appropriate gestational weight [22, 23]. In contrast, women who received inadequate perinatal counselling [24] have a higher likelihood of gaining inappropriate gestational weight.

Women assume that health care providers would inform them about GWG if it is important [25, 26]. However, several studies, conducted in high income setting, revealed that women received little guidance from healthcare workers regarding healthy dieting and physical exercise [27, 28], and healthy GWG [29, 30]. Women report that the messages they receive are inconsistent and vague [28, 31]. Given that they receive inadequate advice, studies reveal women have a low level of perceived risk for weight-related pregnancy complications [20] and lack of concern about their GWG [25], as well as inadequate knowledge of nutrition and GWG [29, 31, 32].

About 87% of the Ethiopian population have a low health literacy level [33]. Almost half (49%) of Ethiopian women of reproductive age, pregnant women inclusive, are reported as illiterate [34]. Women have poor knowledge about nutrition during pregnancy [35, 36]. In addition, 50 % of pregnant women engage in traditional practices such as food taboos or food restriction (mostly to prevent miscarriage or to avoid GWG) and abdominal massage (to avoid striae and to relieve back pain) during their pregnancy [37].

More than 67% of pregnant women in Ethiopia gain inadequate gestational weight [38, 39]. However, pregnant women's perspectives on weight gain during pregnancy and postpartum weight retention have not been explored in the Ethiopian context. Understanding women's perceptions, feelings, and practices about GWG could help to identify the appropriate support needed to help them achieve healthy GWG and postpartum weight loss. The aim of this study was to explore pregnant women's perceptions and practices related to GWG and postpartum weight loss.

7.3. Methods

7.3.1. Study design and period

We used a qualitative descriptive approach to describe the pregnant women's feelings, awareness, and practices towards GWG and postpartum weight retention. A qualitative descriptive design can provide a comprehensive understanding of given circumstance, a rich description of the participants' experiences or actions from the participants' perspectives [40]. Given pregnant women's perspectives have not been explored in the Ethiopian context, a qualitative descriptive approach is an appropriate form of inquiry to describe how the pregnant

women feel and manage GWG and postpartum weight retention [41]. The study was conducted from January 2019 to March 2019.

7.3.2. Ethical approval

We obtained ethical approval for the study from the Institutional Health Research Ethics Review Committee of the Haramaya University [IHRERC/200/2018, the Institutional Review Board of Addis Ababa Health Bureau [A/A/HB/2576/227] and the Human Research Ethics Committee of the University of Technology Sydney [UTS HREC18-2610].

7.3.3. Study sites

We conducted this study in Addis Ababa, the capital city of Ethiopia. The study participants were selected from two tertiary (referral) public hospitals and eight public health centres. Health centres are part of the Ethiopia's primary health care system, which is designed to provide preventive, curative, and rehabilitative services including basic pharmacy and laboratory services. Typically, health centres have up to 10 beds for birthing women and emergency services, and they serve up to 25,000 people in rural areas and up to 40,000 in urban settings [42]. The health facilities were purposively selected. In the public health facilities of Addis Ababa, women with uncomplicated pregnancies receive antenatal care, labour and birth, and postnatal care services at the health centre level, while women with complicated pregnancies receive antenatal care, delivery, and postnatal care services at the hospital level.

7.3.4. Participant recruitment

Pregnant women attending antenatal care (ANC) at different health centres and hospitals were our study participants. The maternal health care providers identified the women (after the women had received all necessary services from the health facility at that antenatal clinic visit) and then notified the researcher who subsequently approached the women with information about the study and invited them to participate. The researcher (FA) undertook the recruitment process. No separate criteria was used to assign women into in-depth interviews or FGDs. Any pregnant women who came to the health facilities on the planned date (for in-depth interview) and agreed to participate were assigned to the in-depth interviews. Similarly, pregnant women who came to the health facilities on the planned date (for focus group discussions (FGD)) and agreed to participate were assigned to the FGD. Focus group discussions were conducted primarily to explore cultural practices that influences GWG and PPWR. On the other hand, information such as women's feeding practices, affordability to purchase food items, and talking about their weight would be sensitive topic for women to talk in a group. Hence, IDIs were conducted to explore this information.

7.3.5. Data collection

After obtaining written informed consent, we conducted 15 in-depth interviews and 8 focus group discussions. The researcher (who is male in gender and a Master of Public Health graduate) conducted the interviews and FGDs using the local language, Amharic. Interviews and FGDs were held in a private room within the health facility (hospital or health centre). We developed the interview topic guide for in-depth interviews and FGDs after reviewing the literature [44-46]. We conducted the interview and FGDs using open-ended questions;

examples of the interview and FGD guide questions are provided in Table 19. To test the applicability of the questions, we conducted preliminary interviews with three women and two FGDs. Data collection continued until data saturation was reached. Data analyses started in Ethiopia while I was collecting data. This allowed me to collect data until it reached saturation.

Table 19: Examples topic guide for interviews and focus group discussions with pregnant women in Addis Ababa, Ethiopia, 2019

1.	Could you explain the appropriate amount of weight women need to gain during pregnancy?
2.	Do you have any concerns related to weight gain during pregnancy? If yes, what is the concern? If no, why?
3.	How do you describe your GWG management practices?
4.	Would you explain any information you have received from health care providers about nutrition or weight gain (for example today)?
5.	Could you tell me your views on weight after giving birth?

7.3.6. Reflexivity

The researcher (FA) is a public health professional with specialty track in epidemiology and male in gender. He has experience in conducting qualitative interviews. The researcher conducted both IDIs and FGDs with pregnant women. To begin each IDI and FGD, the researcher openly introduced himself as a PhD candidate and explained the purpose of the research. All interviews and FGDs were arranged around the convenient time of the participants. Trust was created with the participants at the initial stages of the interview and FGD. Participants were informed that they are free to skip any question that they were uncomfortable with. As some women may be shy to talk openly when a male researcher

conducted in-depth interviews and FGDs with pregnant women, this might have potentially influenced the data collection. There was no established relationship between any of the participants and the researcher prior commencement of the research. The interviews and FGDs were audio recorded. Transcriptions and translations were conducted by professional translators. The translations were cross-checked with the transcripts and audio recorded files by the researcher.

7.3.7. Data analysis

Each interview and FGD was audio recorded and transcribed verbatim in the local language, Amharic, before being translated to English by professional translator. The consistencies of the transcripts against the audio records were checked by the primary author. The data was compared and contrasted by all authors to ensure rigor. We analysed the data using thematic analysis. The transcribed data were imported to NVivo software version 12 (QSR International) to facilitate the analysis process. The author read through the interviews to understand the content and to obtain a sense of the whole message. Each text was then examined line by line to identify the meaning and then coded. Similar codes were categorized into similar categories and different themes and sub-themes emerged from the data. Participants were de-identified to maintain their anonymity and provided with unique ID number (e.g., participant 1, participant 2 up to participant 71). The quotes are presented using participants' unique ID such as P 1 (participant 1). Participant's unique ID numbers from P 1 to P 15 were assigned to in-depth interviews participants. The remaining unique ID participant's numbers, P 16 to P 71, were assigned to focus group discussion participants.

7.4. Results

7.4.1. Participants' characteristics

A total of 71 pregnant women participated in the study (15 women attended in-depth interviews and 56 women attended the focus group discussions). Of 71 study participants, 7% (5/71) were illiterate; 76% (54/71) were multiparous; and 27% (19/71) were attending their fourth antenatal visit (Table 20).

Table 20: Participants' characteristics (educational status, parity, gestational age and number of ANC visits at the time of interview) (n=71)

Variable	Frequency	Percentage
Educational status		
Illiterate	5	7
Primary (grade 1 to 4)	11	15
Primary (grade 5 to 8)	27	38
Secondary (9 to 12)	21	30
College and above	7	10
Parity		
Nulliparous	17	24
Multiparous	54	76
Gestational age (weeks)		
13 to 24 weeks	14	20
25 to 36 weeks	57	80
The number of ANC visits at the time of interview		
First visit	10	14
Second visit	26	37
Third visit	16	22
Fourth visit	19	27

7.4.2. Themes

We identified five themes and associated sub-themes in relation to GWG and postpartum weight retention: 1) knowledge of weight and weight gain; 2) concerns about gestational

weight; 3) gestational weight gain counselling; 4) eating habits; 5) views on postpartum weight. (Table 21)

Table 21: List of themes and sub-themes in relation to GWG and postpartum weight retention among pregnant women in Addis Ababa, Ethiopia, 2019.

Themes	Sub-themes
Knowledge of weight and weight gain	Knowledge of normal weight
	Knowledge of gestational weight gain
Concerns related gestational weight	Weight monitoring
	Sensitivity of talking about weight
Gestational weight gain counselling	---
Dietary habits	---
Views on postpartum weight	---

7.4.2.1.Theme 1: Knowledge of weight and weight gain

7.4.2.1.1. Knowledge of normal weight

Most of the study participants were not aware of the amount or normality of their weight either before or during pregnancy.

> *I do not have an awareness about this [about weight]. This is my 2nd pregnancy; I did not know my weight when I gave birth to my first child. I do not know my current weight either*. (P 7)

Only two participants had heard of the Body Mass Index (BMI) but incorrectly stated what it meant or how it can be calculated.

> *To say it [the weight] is normal, we need to calculate body mass index…body mass index is about our height and weight. [To calculate Body Mass Index], we add weight and height together and divide it by 2.* (P 43)

Other participants reported it is considered normal if their weight lies between some ranges, did not feel sick or they were able to perform their usual activities without difficulty.

> *I can do any activities without a problem. This indicates that my weight is normal. If it is over [above normal], I might feel something unhealthy, or might have some disease…but in general, I think it is good for someone to have weight between 50 and 60 kg.* (P 10)

7.4.2.1.2. Knowledge of gestational weight gain

Almost all of the study participants revealed that they were unaware of the recommended amount of weight gain during pregnancy.

> *I do not know how much [43] a pregnant woman should gain. They [health care providers] did not tell us the exact amount of weight we should gain.* (P 9)

7.4.2.2.Theme 2: Concerns related gestational weight

There were different views about concerns related to GWG. Some participants were unconcerned about gestational weight. As explained by some women, this lack of concern could be due to their limited awareness about weight.

> *I do not worry about weight gain during pregnancy. I do not care about gaining or losing [gestational] weight.* (P 15)
>
> *.... I do not know what my weight is. How could I be concerned about something that I am not aware of?* (P 9)

In contrary, lacking knowledge of the recommended amount of GWG could be a source of concern for some other women.

Yes I am concerned [about weight]. I never exceeded 60 kg or 62 kg before pregnancy. But now I am 73 kg… Oh! I am worried about my weight, thinking whether it is healthy or not. I reduced my intake of food and fluid because of my weight [to lose weight]. (P 27)

Most study participants raised their concern related to gaining too much gestational weight, which they fear it could increase the possibility of caesarean birth.

I fear gaining weight because it makes the baby fat [large], which could make the birth difficult during labour. So I do not want to gain weight... (P 32)

As a solution for their concern, most participants suggested that gaining a limited amount of weight is necessary. They believed gaining >4 kg during pregnancy would be considered excess.

I think gaining some amount of weight is good. However, it should not be too much. Gaining up to 4 kg is enough. It would be high if it exceeded 4 kg. (P 12)

However, some participants suggested that gaining weight was not needed at all.

It is good if she does not gain [any] weight [during pregnancy]. It complicates the labour. The womb may be unable to bear the fetus. It could force the woman to give birth via an operation [caesarean birth] (P 5)

In contrast, some study participants were concerned about gaining only a small amount of gestational weight. They felt that gaining low gestational weight could adversely affect the health of the baby.

If it [the weight gain] is very low, I would worry about it. I would worry for my baby, not for myself. It [the baby's weight] would be below the expected value. I fear that I would give birth to [an] unhealthy baby. That would worry me. (P 46)

7.4.2.2.1. Weight monitoring

Most women did not monitor their weight regularly either before or during pregnancy. Their weight was checked by health care providers during ANC follow-up only.

> *No, I do not check my weight regularly. I do not give that much attention to my weight.* (P 6)
>
> *...I have checked my weight here in the health facility... I do not check [my weight] outside [of the health facility]. (P 9)*

7.4.2.2.2. Sensitivity of talking about weight

Talking about their weight was not a sensitive topic for almost all women. Rather, they would be happy to discuss their weight and they believed that discussing weight could help them to have a healthy pregnancy weight.

> *What makes this [weight issue] sensitive? It is all about health. I am happy if she [the midwife] tells me about my weight and problems related to my weight. (P 6)*
>
> *...I do not feel bad if they [health care providers] tell me about weight… It helps me to have moderate weight. It helps me to control my weight. It prevents insufficient or excess weight gain. (P 52)*

7.4.2.3.Theme 3: Gestational weight gain counselling

Participants in all focus groups and in-depth interviews stated that counselling about GWG and postpartum weight retention was lacking. Almost all the participants stated that they never discussed their weight with health care providers.

> *...They [health care providers] never told me the correct amount of weight, how much [43] I need to gain, or what amount of weight I should not be exceeding. I never heard about this.* (P 35)

Participants reported that health care providers checked their weight at every prenatal visit, but typically they did not discuss the result. Women interpreted this lack of discussion to mean that they did not have any problem.

> *When we come here [to health facility] for pregnancy follow-up, they take our weight measurement… When they put me on the weighing scale, see [check] my weight and keep silent, I assume it is normal... I assume they would tell me if there is something wrong when they check my weight (P 48)*

When asked about who should initiate the discussion about weight, women believed that it is the responsibility of the health care provider to provide all the necessary information to women.

> We *came here trusting them that they can help us. They are more knowledgeable. So, they have to tell us what we should do and should not do. We come here because we do not know what we need to do. Do we come here if we know? No, we do not. So I think they must give us advice [about weight]. (P 34)*

Most participants explained that it was not their responsibility to ask health care providers about their weight.

> *Why should I ask them? …They have to tell me everything [necessary]…We come here to find a solution to our problems. It is to get information about healthy birth [or pregnancy]. (P 19)*

Almost all participants received advice on the danger signs in pregnancy and about food items they needed to eat.

They advised me to come back if I got sick. Specifically, they told me to come back [to the health facility] if I got a headache or blurred vision, if there is something like leakage of [vaginal] fluid... (P 48)

The most common nutritional advice they received was the importance of consuming fruits and cooked vegetables.

They advised me about the food I should eat like vegetables… fruits and some cereals. They also advised me to avoid eating uncooked foods like raw tomato and raw meat. (P 31)

7.4.2.4.Theme 4: Dietary habits

Different views were explored regarding dietary habits of the women during pregnancy. Some women discussed that they had nausea and their appetite decreased in early pregnancy.

I do not have appetite for foods…Totally I have no appetite, but I take small amount of foods for survival (P 15)

Two women described that food affordability affected their dietary habits. Although they wanted to have a balanced diet, a lack of money would affect their access to a variety of foods.

Everybody wants to eat balanced diets. But…sometimes you may not have money to buy balanced [variety of] foods. I am serious. You may not be able to afford all recommended foods. (P 22)

However, some participants changed their dietary practices. For example, women reported an increase in the frequency of their eating during pregnancy to help the growth and development of the baby.

There is a change in our eating practice during pregnancy. For example, we eat three times a day before pregnancy. Now, we have to eat at least 5 times a day. We eat not

only for ourselves, but also for the baby in the womb. You have to eat a variety of foods to help the development of the baby's mind. (P 35)

Fluid intake, fruit, and vegetable consumption increased during pregnancy by almost all study participants.

...during pregnancy we eat more vegetables, the foods that we do not give attention to at some other time [before pregnancy] ... We drink milk or other fluids for the sake of our baby. (P 31)

However, alcohol, uncooked foods such as raw tomato, salads, raw meat, and unboiled milk were avoided to prevent food poisoning and/or parasite infestation or any damage to the baby.

It is drinks [alcohol] that should be avoided during pregnancy (P 7)

I do not eat raw meat and raw vegetables, because it could cause Amoebiasis. I do not eat uncooked foods. (P 8)

One participant reported that the consumption of bananas should be decreased because she believed it could increase the weight of the baby.

It is said that banana makes the baby fat. So, I eat lower amount of bananas during pregnancy. (P 21)

A few participants mentioned that some foods like cabbage, papaya, linseed and honey could cause miscarriage and needed to be avoided.

Some individuals advised me to not eat cabbage…They believe that some kind of cabbage can cause miscarriage (P 7)

... Some fruits like papaya are not allowed to be eaten during pregnancy. Orange is not good if eaten too much. (P 16)

Foods like linseed, honey and medications are not taken during pregnancy…it is believed that linseed can cause miscarriage. But I do not know why honey is not eaten. (P 29)

7.4.2.5.Theme 5: Views on postpartum weight

The majority of the study participants believed women should gain weight during the postpartum period. They suggested that postpartum women need to have enough food to assist in recovery after birth.

> *They [the postpartum women] have to gain weight. As you know, mothers lose fluid during birth. There is a high blood loss. To replace the fluid and blood loss, we have to take enough food. We have to take food that repairs the body. High protein diets are very important.* (P 13)

Participants also described Ethiopian society as expecting a postpartum woman to gain weight. Lack of weight gain during the postpartum period was considered a lack of appropriate care and support.

> *If the postpartum woman did not get fat [did not gain weight], the society would believe that she did not get enough care and support ... (P 32)*

In addition, it seemed that women feared people would gossip if they lost weight.

> *If you do not gain weight after birth, people may talk about your weight loss.* (P 4)

On the other hand, gaining weight was viewed as being attractive and a sign of beauty by some women.

> *When you have gained weight, they say you look attractive; you are pretty. When I gave birth to my first baby I gained weight. They [the society] said you look pretty.* (P 59)

Some women believed that postpartum contraceptive use was one reason for weight gain during the postpartum period.

> *The use of [postpartum] contraceptive is another reason women gain weight. Contraceptive use increases some women's weight. Majority of the women gain weight after delivery due to the use of contraception.* (P 48)

Some participants believed they would lose weight due to breast feeding.

> *It is better if my weight continues as it is…Women lose weight later on due to breast feeding.* (P 3)

On the contrary, a few women believed that gaining weight after birth could expose a woman to different problems and suggested that postpartum women have to lose weight. However, even if they want to lose weight, the family would oblige them to stay in bed for a long time and eat a lot of food to gain weight.

> *As you know there are many problems that come with weight gain. So, some women want to lose their weight [after birth]. But, even if you want to lose weight, the family obliges you to sleep [stay in bed for a long time and not engage in activity] and eat too much food.* (P 8)

7.5. Discussion

We explored Ethiopia pregnant women's views and knowledge about GWG, concerns related to GWG, dietary habits and views on postpartum weight retention. Pregnant women lacked knowledge of their weight and the recommend amount of weight gain during pregnancy. Most participants did not want to gain weight at all or wanted a limited (3 to 5 kg) weight gain during pregnancy. Some study participants were not concerned about GWG. Discussing their weight with health care providers was not a sensitive topic for almost all participants. However, most reported that they never discussed weight gain with their health care providers. Some

participants' dietary practices were unchanged during pregnancy. Most participants increased their fluid intake and fruit and vegetable consumption during pregnancy. Women reported they avoided alcohol, uncooked food such as raw tomato, salad, raw meat, and unboiled milk during pregnancy to prevent parasite infestation or complications for the baby. The majority of the study participants believed women need to gain weight during the postpartum period.

Our study identified that participants were neither aware of their weight (whether it is normal or not) nor the recommended amount of weight gain during pregnancy. Some participants stated an arbitrary number to indicate the normality of their weight regardless of their BMI. Others stated that their weight is considered normal so long as they did not feel sick or they were able to perform their usual activities without difficulty. Although BMI is one of the widely used tools to confirm whether a person has an appropriate weight [47], none of our study participants were aware of their BMI. The lack of knowledge of weight related issues may be explained by the reported low health literacy level amongst the Ethiopian population (i.e., 87% have low health literacy level) including pregnant women [33]. Furthermore, the absence of weight counselling could be a reason for this lack of knowledge about pregnancy related weight. Initiating weight counselling as a standard to follow in ANC could contribute to improving women's understanding of healthy weight.

Most participants reported the absence of GWG counselling by health care providers. Studies from different countries suggest that pregnant women receive limited information about GWG from their care providers [25, 27-30, 45-51]. Factors such as the low-priority placed on GWG by care providers [52-54]; lack of confidence in communicating with women about adequate weight [52, 54-56]; or women not asking about their weight gain [25, 57] could contribute to the absence of GWG counselling. Women (in our study) believed that it is the responsibility of

care providers to initiate discussions about weight. Women interpreted the lack of counselling to mean that there was no problem with weight during pregnancy or the postpartum period. Although maternity care providers (in Addis Ababa) also believed that initiating discussions about GWG was their responsibility, they typically waited for women to enquire about their weight management [58]. This suggests that care providers' readiness and attitudes towards GWG would play a crucial role in GWG counselling. Therefore, care providers should be encouraged to provide counselling and need to be provided with tools to facilitate a healthy GWG.

In contrast to many other studies that have reported discussing weight or weight-related matters was a sensitive topic for pregnant women [45, 50, 59, 60] and difficult for health care providers [53-56, 61-65], discussing weight was not a sensitive issue for almost all our study participants. Pregnant women were happy to discuss their weight and GWG with health care providers. This offers an opportunity for Ethiopian maternity care providers to provide counselling about GWG and postpartum weight retention openly without feeling embarrassed in order to influence women's future health.

Our study participants described that their care provider paid more attention to counselling about the danger signs of pregnancy and what foods they could eat (e.g., increasing vegetable and fruit consumption) or foods to avoid (e.g., raw meat and vegetables), rather than discussing weight in pregnancy. However, some pregnant women described that their eating habits remained unchanged during pregnancy. Some participants avoided some food items in order to limit the incidence of miscarriage, or decreased the amount of food intake to reduce the amount of GWG. Women regarded restricting weight gain as a way to reduce the possibility caesarean birth due to a large baby. A study conducted in Addis Ababa also reported that more

than a quarter of pregnant women (27.3%) restricted their food intake [66] due to perceived severity of birth complications as a result of large babies [36, 37]. Most of our study participants did not want to gain weight at all or wanted a limited amount (3 to 5 kg) of weight gain during pregnancy. Studies show that more than 67% of pregnant women in Ethiopia gain inadequate gestational weight [38, 39]. It seems that most of the women overlooked the risks associated with gaining inadequate gestational weight such as LBW [6] and pre-term birth [7]. In Ethiopia, the prevalence of LBW (17%) [67] and preterm birth (26%)[68] are among the highest worldwide. Counselling women to reach their appropriate weight according to their pre-pregnancy BMI and encouraging them to obtain appropriate gestational weight may reduce their fears and the risks related to inappropriate weight gain.

Studies from high income countries reported that postpartum women want to return to their pre-pregnancy weight [30, 47]. However, most of our study participants reported that they wanted to gain weight during the postpartum period. Weight gain during the postpartum period can lead to higher weight in subsequent pregnancies and long term obesity and other health problems such as diabetes and cardiovascular diseases [69]. Participants reported weight gain during the postpartum period was due to the consumption of foods with a high energy density, which was to ensure that blood and fluid lost during birth is replaced; gaining weight during the postpartum period was considered as a sign of good care and support; gaining weight following the birth of the baby was a source of admiration for women. Family also forced postpartum women to consume higher energy density foods.

Strengths and Limitations

This study is the first of its kind in Ethiopia to explore pregnant women's perceptions and practices related to gestational weight gain and postpartum weight retention. However, the study has a number of limitations. Firstly, we recruited study participants from public health facilities only. Views of pregnant women attending ANC in the private health facilities or of women who did not attend ANC were not incorporated. Secondly, the study was conducted in urban settings only, therefore, the findings would only be applicable for urban Ethiopian settings. Thirdly, the complexity of interviewing in one language and translating the transcripts into another for analysis may have resulted in some issues being lost in translation [70]. However, we made a strenuous effort to check the accuracy of the translations by comparing the text with each recorded interview and FGD and the transcript. Finally, a male interviewing pregnant women could potentially affect women's responses. Some women may be shay to openly discuss with male interviewer.

Conclusions

Almost all study participants had limited knowledge regarding their weight, and how to manage healthy pregnancy and postpartum weight. Most participants did not want to gain weight during pregnancy; but wanted to gain weight after birth. Some participants had low levels of concern about GWG. Maternity care providers need to provide consistent counselling on weight, risks associated with inappropriate GWG and high post-partum weight retention, and how to manage healthy pregnancy and postpartum weight. Further research would be needed to identify the most effective counselling methods, which will help pregnant women to have healthy weight.

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Chapter 8: Midwives' and Obstetricians' Perspectives about Pregnancy Related Weight Management in Ethiopia: a Qualitative Study

8.1. Chapter overview

The evidence presented in the previous chapter is of the views and knowledge of pregnant women about gestational weight gain (GWG) and postpartum weight retention (PPWR). It showed that pregnant women had widespread misconceptions about weight during pregnancy and after birth. The question of care providers perspectives related to GWG and how they manage women's weight related issue emerged in women's comments, as reported in the previous chapter. We investigated this issue in the study reported in this chapter.

This chapter presents the experiences and perspectives of midwives and obstetricians in providing care for pregnant women about GWG and postpartum weight management. This paper was published in the PloS One journal.

Publication details

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Abstract

Background: Midwives and obstetricians are key maternity care providers; they are the most trusted source of information regarding nutrition and gestational weight gain. However, their views, practices and perceived barriers to managing pregnancy related weight gain have not been studied in Ethiopia. The aim of this study was to explore midwives' and obstetricians' observations and perspectives about gestational weight gain and postpartum weight management in Ethiopia.

Methods: We conducted face-to-face interviews with 11 midwives and 10 obstetricians, from January 2019 to March 2019. All interview data were transcribed verbatim. We analysed the data using thematic analysis with an inductive approach.

Results: We identified three themes and associated subthemes. Midwives and obstetricians had limited knowledge of the optimal gestational weight gain. Almost all participants were unaware of the presence of the Institute of Medicine recommendations for optimal weight gain in pregnancy. According to the study participants, women in Ethiopia do not want to gain weight during pregnancy but do want to gain weight after the birth. Counselling about gestational weight gain and postpartum weight management was not routinely provided for pregnant women. This is mostly because gestational weight gain counselling was not considered to be a priority by maternity care providers in Ethiopia.

Conclusions: The limited knowledge of and low attention to pregnancy related weight management by midwives and obstetricians in this setting needs appropriate intervention.

Adapting a guideline for pregnancy weight management and integrating it into antenatal care is essential.

Key-words: gestational weight gain; midwives; obstetricians; gestational weight gain counselling; post-partum weight counselling; Ethiopia

8.2. Introduction

Pregnant women are expected to gain weight due to physiological changes during pregnancy [1]. There are a number of GWG guidelines [2, 3]. However, most of them were adapted from and similar to the 2009 United State Institutes of Medicine (IOM) recommendations guideline [2]. None of these guidelines were developed for Ethiopia or contexts similar to Ethiopia. The IOM recommends weight gain of 5 to 9 kg for obese women; 7 to 11 kg for overweight women; 11.5 to 16 kg for normal weight women, and 12.5 to 18 kg for underweight women [1].

Gaining gestational weight outside of the IOM recommendations can pose health risks for the baby [4] and the mother [5, 6]. Pregnant women who gain inadequate weight are at high risk of bearing a baby with low birth weight (LBW) and pre-term birth [7-10]. On the other hand, excessive GWG increases the risks of caesarean birth [11], hypertension during pregnancy [5, 6, 10], postpartum weight retention [12], and development of long-term obesity [13]. Women are at a high risk of transitioning from normal weight to overweight or obesity following the pregnancy or during the postpartum period [13, 14]. Counselling pregnant women on gestational weight gain and dietary management increases the likelihood of gaining appropriate gestational weight [15, 16], and therefore helps to influence women's future health [13, 17].

Pregnancy related weight management is influenced by several factors [18, 19]. These factors include women's knowledge [18, 20], attitudes [19], and concerns [21] towards weight management during pregnancy; care providers' knowledge and confidence on GWG counselling [14, 22], perceived sensitivity of GWG by care providers [23-25], scepticism about the impact of counselling on women's behaviour [14], level of priority placed on GWG issues [14, 25, 26], shortage of time to discuss weight and nutrition during pregnancy care [27], and lack of familiarity with GWG guidelines [14, 26].

The 2016 Ethiopian Demographic and Health Survey reported that 13.4 % of women of childbearing age were underweight; 57.2% were normal weight; 21.7 % were overweight and 7.7% were obese; and almost half (49%) of these women were illiterate [28]. There are wide-ranging misconceptions and poor knowledge about nutrition during pregnancy [29]; and more than 70% (67-69% gain inadequate weight; 3-4% gain excess weight) of pregnant women in major cities of Ethiopia like Harar and Addis Ababa gain inappropriate gestational weight [30, 31].

Midwives and obstetricians are well positioned to advise pregnant women about how much weight to gain and how to manage nutrition and GWG appropriately during antenatal care (ANC) visits [17, 32]. However, despite the 2016 World Health Organization (WHO) ANC model recommending a minimum of eight ANC contacts [33], in Ethiopia the focused ANC model is still practised, resulting in around 90% of women in settings such as Addis Ababa receiving four ANC contacts (first contact before 16 weeks of pregnancy; second between 24 and 28 weeks of pregnancy; third at 32 weeks of pregnancy; and the fourth visit at 36 weeks of pregnancy) [34]. In the public health facilities of Addis Ababa, women with uncomplicated pregnancies receive care from midwives at the health centre level while women with

complicated pregnancies receive care from obstetricians at the hospital level. As key maternity care providers [35, 36], midwives and obstetricians are the most trusted source of information regarding nutrition and GWG [37].

Few studies have been conducted in Ethiopia focusing on GWG [4, 30, 31, 38]. No studies have addressed the issue of midwives' and obstetricians' views and practices regarding GWG and postpartum weight management. Given the influence of midwives [39, 40] and obstetricians [39, 41] on perinatal women, understanding their views, perceived barriers to managing GWG, and GWG management practices is important [42] . The aim of this study was to explore midwives' and obstetricians' views and practices related to GWG and postpartum weight management in this setting.

8.3.Methods

We used a qualitative descriptive study design. A qualitative descriptive approach provides a comprehensive understanding of given circumstance, a rich description of the participants' experiences or actions from the participants' perspectives [43]. Given midwives' and obstetricians' perspectives have not been explored in the Ethiopian context, a qualitative descriptive approach is an appropriate form of inquiry to describe how the midwives and obstetricians feel and manage GWG and postpartum weight retention. Therefore, we did not use a conceptual model or theory as a qualitative descriptive study aims to explore the who, what, and where of midwives' and obstetricians' perspectives about pregnancy related weight management in Ethiopia. A qualitative descriptive approach is foundational to qualitative research and is a valuable methodological approach in and of itself without the need for a theoretical framework [44]. Moreover, qualitative descriptive findings can inform new

interventions within the sociocultural context of the participants [45]. Ethics approval for the study was obtained from the Haramaya University Institutional Health Research Ethics Review Committee [IHRERC/200/2018], Addis Ababa Health Bureau Institutional Review Board [A/A/HB/2576/227] and the University of Technology Sydney, Human Research Ethics Committee [UTS HREC18-2610].

8.3.1. Study settings and participants

The study was conducted in Addis Ababa, the capital city of Ethiopia. Midwives and obstetricians, who provided maternity care services at the time of data collection in different health centres (seven health centres) and hospitals (four tertiary public hospitals) in the city, participated in the study.

8.3.2. Recruitment

Midwives were purposively recruited from the seven health centres and one of the hospitals, while obstetricians were recruited from the four hospitals. Midwives and obstetricians who did not provide ANC services at the time of data collection were not included in the study (i.e., some of the midwives provided only labour and birth or postpartum care services. Similarly, some obstetricians were only engaged in teaching and surgery). Eligible participants were invited to participate in the study by the primary author. They were informed about the objectives of the study and the data collection procedure. Eleven midwives and 10 obstetricians agreed to participate in the study.

8.3.3. Data collection

Following written informed consent, we conducted 21 in-depth interviews, 11 with midwives and 10 with obstetricians, from January 2019 to March 2019. The primary author conducted the interviews in the local language, Amharic. The primary author is not a midwife or obstetrician, he is a public health professional and postgraduate student and did not have any influence over the participants. The data collection was performed through face-to-face interviews. The interviews were held in a private room within the health facility (hospital or health centre), at a convenient time to the participants. Open ended questions were used to elicit their views, perceptions, and counselling experiences in relation to GWG and postpartum weight management. We developed the interview guide after reviewing the literature [14, 25, 46, 47]. The interview guide questions are provided in the additional file supplementary file (Appendix 8). To test the interview questions, we conducted preliminary interviews with three midwives. Data collection continued until data saturation was reached.

Due to the qualitative nature of the study, we did not collect detailed demographic data about the participants other than to note professional affiliation, gender, employment location, and years of work experience in maternity care (Table 22).

Table 22: Summary of participant characteristics, Addis Ababa, Ethiopia, 2019

Summary of participants	Midwives	Obstetricians	Total
Gender			
Female	11	1	12
Male	0	9	9
Years of experience			
1 to 5 years	2	7	9
5 to 10 years	9	3	12
10 to 15 years	1	0	1
Place of work			
Health centre	10	0	10
Tertiary referral hospital	1	10	11

8.3.4. Data analysis

All audio recorded interviews were transcribed verbatim into English. The accuracy of transcripts was checked by comparing the text with each recorded interview, by the author (FA), who is a fluent Amharic and an English language speaker. We used NVivo software version 11 (QSR International) [48] to manage written transcripts and to facilitate the coding process, categorising similar codes, and storage of the data. Due to practicality issues (i.e., data analysis was finalised in Australia), the data collected from the participants was not verified by the participants to determine whether the analysis of the data was consistent with the participants understanding of the comments made by them. Data analysis commenced simultaneous to data collection in Ethiopia. Qualitative data were collected until the same key messages and codes were being heard when transcribing and beginning analysis. At this point, it was decided that data saturation had occurred. The data were shared with the research supervisory team who compared and contrasted their findings with the researcher (FA) until all agreed codes and themes were finalised. This method of constant comparison by all authors ensures rigour.

We analysed the data using thematic analysis [49] to assess repeated views, perspectives, and practices across all data. Data was collected until saturation was reached, that is hearing the same themes over and over. Different themes and sub-themes were developed from the data as described in Table 23 where an example of the coding is provided. During the analysis, we followed the six phases of thematic analysis according to Braun and Clarke's (2006) recommendations [50]. First, we began the analysis by reading and rereading to become

familiar with the data and noted the main ideas from the data. Second, we examined transcripts line by line to identify dominant ideas and to draft codes. Third, we categorised similar codes into similar categories to search for possible themes and sub-themes. Fourth, we checked for the identified themes and sub-themes in relation to the coded extracts and the full data set. Fifth, we defined and named the themes and sub-themes while writing the overall findings that the analysis revealed. Finally, we developed the final report by selecting illustrative quotes. While using the quotes, participants were de-identified to maintain their anonymity and the quotes were presented in terms of participant numbers such as Obst.1 (obstetrician 1), or Mid.1 (midwife 1).

Table 23: Examples of themes, initial codes, and quotations, Addis Ababa, Ethiopia, 2019

Main themes	Initial codes	Examples of quotations
Knowledge of optimal gestational weight gain	Expected weight gain; average 12.5 kg; availability of guideline; need a guideline	*A mother is expected to gain 10 to 15 kg and averagely 12.5 kg…* (Obst.3) *The expected weight gain ranges from 0 to12 kg* (Mid.1) *…a mother should gain 10 to 12 kg during the whole pregnancy* (Mid.8) *I do not know exactly. I have not seen it. I did not see the recent literature on weight gain. I know only about the need for additional weight gain, but I am not sure about IOM guideline. (*Obst.6) *There is no guideline that focuses on GWG in our setup.* (Obst.9) *We need a guideline, which focuses on our traditional foods.* (Obst.10)
Gestational weight gain counselling experience	No counselling; selective counselling; low attention; focusing on problems; low priority; high workload; focusing on problems	*We give attention only if she is underweight. We do not stress on it even in school. We are not giving attention to normal weight mothers. We do not consider [weight as important] as we do for headache or blood pressure.* (Obst.2) *Most of the physicians neglect about the nutritional part and the subsequent weight gain. (*Obst.5) *Usually, we do not talk to women about weight gain. Mostly we do not tell them but we advise them when their weight gets lower. (*Mid.4) *Whether she is obese or not, we mention about nutrition. Other than this, we have never mentioned about weight gain intentionally.* (Mid.7) We *consider about the weight gain only for extremely underweight mothers. You know we are busy with jobs and focus only on severely morbid [obese] mothers. (*Obst.2) *We advise about nutrition in general, to eat what she has in her home. Otherwise, she could not afford. We simply advise her what she can get easily.* (Mid.6)
Ethiopian culture influences postpartum weight gain	Postpartum weight gain; weight related misconceptions; increased calorie intake; no physical exercise	*The main problem in our country is the dietary habit after birth. She eats porridge with butter. She will gain excessive weight. (*Obs.8) *They think that gaining weight after birth as the natural process. We also do not advise them not to gain weight during the ANC visits.* Obs.6) *There is a time called 'Aras' after birth. Actually, they need additional energy at this time; they increase the food intake but there is no physical activity, so they gain excessive weight*. (Obs.4)

8.4. Findings

We identified three themes and associated sub-themes: 1) knowledge of optimal GWG; 2) GWG counselling experience (sub-themes: GWG counselling was a low priority, not having enough time, confidence in providing GWG counselling, and protecting women from embarrassment); 3) Ethiopian culture influences postpartum weight gain.

8.4.1. Knowledge of optimal gestational weight gain

All participants believed that women need to gain weight during pregnancy. However, their knowledge of the amount of weight gain in pregnancy varied amongst participants and varied when compared with the IOM recommendations. Obstetricians recommended pregnant women gain between 6 kg and 25 kg as described here:

> *On average, a mother is expected to gain 12.5 kg throughout the pregnancy…[an] underweight mother is expected to gain up to 16 kg… For obese mothers, they are expected to gain 6 to 7 kg.* (Obst.2)
>
> *A mother is expected to gain 10 to 15 kg and on average 12.5 kg… if they have a BMI [body mass index] less than 18.5 [kg/m^2], we expect a mother to gain up to 25 kg. If she had BMI greater than 30 or 40 [kg/m^2], she may gain up to 7.5 kg.* (Obst.3)

We found similar variations in understanding amongst the midwives regarding the amount of GWG. Although obstetricians took account of women's BMI and explicitly explained the recommended amount of weight gain for underweight, normal weight, overweight and obese women, most midwives discussed the recommended amount of GWG for normal weight women only.

> *It is better if a mother gains 8 to 12 kilos [kg] in her pregnancy* (Mid.5)

…they are expected to gain 13 to 20 kg (Mid.3)

All study participants reported that there was no GWG guideline in Ethiopia, and the lack of a guideline contributed to their limited knowledge about GWG. When asked about the IOM guideline, only two obstetricians were aware of the presence of the IOM guideline. The sources of GWG information for study participants were pre-service training courses, books, and websites located using the Google search engine.

*There is no guideline that is prepared for us [in Ethiopia]. But we have gained this [GWG] information from our teachers, books, and sometimes we read from Google. (*Mid.7)

All participants underscored the necessity of preparing a GWG guideline considering the local (Ethiopian) context. In addition to details about GWG, almost all obstetricians and some midwives stated the importance of including information such as the calorie and the nutrient contents of common local foods in the guideline.

*I suggest that the [GWG] standards should be prepared according to our context… (*Obst.2)

The calorie content of foods should be [Ethiopian] specific. For example, we have to know the calorie content of single injera [an Ethiopian leaven flatbread with a slightly spongy texture] and shiro-wot [sauce made up of bean or pea powder mixed with different spices]. (Obst.3)

In addition, midwives expressed the need for training about GWG.

There has to be training. If there is no training, it [GWG counselling] will not be my responsibility…If a health professional does not know [GWG information], who is going to be responsible if the mother gains or loses weight (Mid. 3)

8.4.2. Gestational weight gain counselling experience

When asked about GWG counselling practices, many of the participants responded that they do not raise the issue of weight at all during ANC services, or that they do not provide women with specific information such as the appropriateness of the women's weight and the amount needing to be gained. Some participants believed that informing pregnant women about how much weight she has to gain or has gained was unnecessary. As discussed by this obstetrician,

> *I don't think it is necessary to tell her and mention the amount of weight she has to gain…You cannot provide advice about the weight gained or she has to gain...They [pregnant women] also do not have much interest about weight gain.* (Obst.2)

In some circumstances the care providers did provide counselling particularly when a pregnant woman did not gain weight or lost weight; presented with abnormal weight (underweight or obese); or presented with problems such as hypertension or gestational diabetes mellitus. Some obstetricians outlined when they regarded it was important to provide counselling about weight gain;

> *We consider discussing weight gain only for extremely underweight mothers… [We] focus only on severely morbid[ly obese] mothers. (*Obst.2)
>
> *Sometimes we consider [GWG counselling] …if there is special condition like [when the woman is] underweight or very obese...* (Obst.3)

Midwives also explained that they only counselled a woman about weight gain when there was a comorbidity as described here:

> *We mainly focus on medical cases. For example, if she is [a] DM [diabetes mellitus] or hypertensive patient... (*Mid. 9)

Almost none of the study participants provided counselling about gestational weight gain for women who had a normal weight. Described by the following midwives;

We do not even talk about weight as long as her weight keeps within the normal range. We say 'your condition is good' and pass. (Mid. 6)

*Most of the time, we do not advise them to measure their own weight and check it [regularly]… I do not think that they could do it because…Most of the time mothers work hard to overcome their life [challenges] and forget about the baby. (*Mid. 4)

Participants explained that counselling about gestational weight gain was a low priority and this led to four further sub-themes (gestational weight gain counselling was a low priority; not having enough time; confidence in providing GWG counselling; and protecting women from embarrassment).

8.4.2.1.Gestational weight gain counselling was a low priority

Most study participants reported that the main reason for not counselling about GWG was that GWG was not seen as a priority. As noted here;

*We focus on the vital sign measurements rather than weight gain. Therefore, we do not place much emphasis about maternal weight gain. It is not familiar [or common practice]. (*Obst.1)

Again, this obstetrician stated it was a low priority unless the woman is under or overweight;

It [GWG] is not something that attracts the attention of physicians…we give attention to the malnourished and extreme patient. (Obst.2)

Advising women about GWG was not the midwives' usual practice either as this midwife stated;

You may have other issues that you have to give priority to. You may give priority to BP [blood pressure] or any other danger signs. You do not waste time on this mother since it [weight gain] (Mid.2).

Although they did not currently consider GWG counselling as a priority activity, most (nine midwives and eight obstetricians) believed that it should be a priority activity as this midwife explained;

...nutritional counselling and weight gain issues must be a priority and [we] need to be focused. (Mid. 3)

8.4.2.2.Not having enough time

Some participants reported that time constraints were a reason for not counselling about GWG. Both midwives and obstetricians expressed a lack of time to counsel about GWG;

*It is lack of time. A single physician examines lots of clients in the ANC clinic every day. So, we focus only on pertinent issues. (*Obst.2)

And again here;

We have many clients; we do not even have time to discuss this [weight gain] (Mid. 2)

Some midwives suggested that counselling about postpartum weight was not part of their scope of practice.

…*we do not tell them this [postpartum weight loss] ...first, we are not taking this on as our job. Secondly, I do not know whether the society [will] accept you if you tell her to lose weight after childbirth. (*Mid.1)

A lack of women enquiring about postpartum weight advice, and high staff workload were raised as reasons for not counselling about postpartum weight management as this midwife described;

> *The reason why we do not counsel them [on postpartum weight] is first because of the work burden on the health professional…The patient also does not ask about it and [this requires you to] initiate talking about this. (*Mid.7)

8.4.2.3.Confidence in providing gestational weight gain counselling

Most midwives felt they were not confident to advice about nutrition and GWG. They reported that their nutritional counselling discussions were shallow and did not address specific nutritional advice. As these midwives described;

> *I do not think that I have full confidence …We do not tell her [a pregnant woman] that much in detail about her nutrition…* (Mid.2)

And again here

> *As to me, I do not think that I am competent enough. Rather I might highlight to counsel them about issues related to nutrition. But this is not enough for the mothers. (*Mid.3)

Although obstetricians felt that they were relatively confident to advise about nutrition, they commented on the importance of involving nutritionists in perinatal counselling.

> *It will be more effective if a nutritionist handled the case, because they may have detailed knowledge of the issue. Otherwise, if the nutritionist is not available … You may talk about the percentage of food groups needed, but not the amount of calories needed specifically from the nutritional groups. (Obs.3)*

8.4.2.4. Protecting women from embarrassment

Some study participants reported that the low economic status of women who attend ANC at public health facilities was perceived as a barrier to counselling on specific nutrition requirements. They felt that pregnant women would be embarrassed if they (women) could not afford to purchase what was advised to meet their nutritional requirements. Therefore, they counselled women to eat what they could access at home.

> *We advise about the importance of nutrition in general, to eat what she has in her home. Otherwise, she could not afford [it]. We simply advise her to eat what she can easily get.* (Mid.6)

> *I feel sad because …you cannot say take this much kilocalorie of apple or egg [the amount of calories found in an apple or egg] … Even we feel ashamed when we talk about food. So, we prefer to say [eat] any food in your home to cover this.* (Mid.9)

The most common nutritional counselling provided to pregnant women was to ensure the woman was aware of the need for an increase in the frequency of meals.

> *I advise them to have frequent meals, like three times a day and additional snacks…* (Obs.3)

8.4.3. Ethiopian culture influences postpartum weight gain

From the midwives and obstetricians' perspectives, culturally, Ethiopian women consider that gaining weight after birth is a normal phenomenon. If a woman does not gain weight or if she loses weight during the postpartum period, the Ethiopian culture considers it as a sign of poor postpartum care. These obstetrician and midwife explained;

*They [women] consider gaining weight after delivery is a normal condition…. (*Obst.10)

If she does not gain weight, culturally it is taken as if she did not get good care in [the] early postpartum period… (Mid.7)

All study participants observed that most women gain weight during the postpartum period. After giving birth, compared to during pregnancy, almost all participants perceived eating more food of high energy density as the most common cause of postpartum weight gain.

They gain more weight than [during the] pregnancy period…in our country, the situation is different. They consume more food during the post-partum [period] and may gain 20 to 30 kg. (Obst.3)

Usually they use [or consume] gruel, porridge and butter; and these foods have protein. This is our culture... (Mid.2)

Participants stated the societal perception behind increasing food intake during the postnatal period is to replace blood and energy lost during the birth; to facilitate the healing process; and to increase milk production.

Culturally it is believed that a woman loses lots of energy and excessive blood [while giving birth], and the society tries to replace the energy. They give [women] a high calorie diet until she returns to the pre-pregnancy state… (Obst.2)

It is perceived that she [has] had an injury and there is a bunch of meals provided from the society [friends and neighbours], in addition to the food prepared in the home. (Obst.3)

*The main problem is myths. The myth is [that] the amount of food consumed and milk production is related… (*Obst.6)

All participants stated that there is a cultural expectation that a postpartum woman stays inside her home for some time (up to three months of the postnatal period), which could be one of the reasons for lack of exercise and this contributes to postpartum weight gain as this midwife described;

> *...according to our country's culture, mothers are advised to get rest [stay at home] for at least 3 months. (*Mid. 9)

> *Most of them don't lose weight due to lack of exercise. Especially, those who deliver through CS [caesarean section] [due to] fear that the sutures will be detached, they fear to engage in exercise. (*Obst.9)

8.5. Discussion

The present study explored the views, practices and observations of midwives and obstetricians regarding GWG and postpartum weight management. Study participants had limited knowledge regarding the optimal amount of gestational weight gain. Almost all participants were unaware of the existence of the IOM GWG recommendations. The participants discussed the need for a GWG guideline that is appropriate for Ethiopia. They observed the presence of widespread misconceptions among women about pregnancy weight management; that woman did not want to gain weight during pregnancy but want to gain weight after birth. Participants reported that they did not provide counselling for pregnant women about weight management. The most common reason for the lack counselling was lack of attention to GWG and postpartum weight loss issues.

All participants reported that pregnant women need to gain weight due to physiological changes throughout pregnancy. However, they observed that women were not interested in gaining weight during pregnancy. Other studies in the major cities of Ethiopia like Harar and Addis Ababa have reported that more than 67% of pregnant women in Ethiopia gain below the IOM recommendations [30, 31]. This may be due to women decreasing food consumption during pregnancy perceiving that overeating or eating foods with high energy density may cause a large for gestational age baby that will make the birth difficult [29, 51] or that the IOM guidelines are not appropriate for this setting.

The amount of GWG recommendations stated by the study participants varies with each other and with the IOM recommendations. This could partly be explained by the lack of appropriate GWG guidelines for Ethiopia so that obstetricians use a variety of foreign sources such as textbooks and websites. By contrast, almost all midwives described a target weight gain for normal weight women only, and there was uncertainty among midwives regarding the description of the expected amount of GWG for underweight, overweight or obese women. Our finding is consistent with other studies in which midwives lack knowledge of the appropriate amount of GWG, even in high-income country settings [14, 22, 52]. This indicates that there is a need for improving understanding regarding the recommended amount of GWG, the importance of GWG and providing midwives and obstetricians with guidance to manage GWG [25].

Almost all study participants were not aware of the existence of or the recommendations in the IOM guideline. They suggested the need for developing GWG guidelines for Ethiopia. Obstetricians stated the need for information about the nutrition and energy density of local foods, and the amount of energy intake needed during pregnancy, to be included in such a

guideline. In addition, midwives lacked the confidence to offer nutritional counselling. Another study set in Ethiopia [53] recommended short-term in-service training for midwives to help them carry out nutrition and GWG counselling tasks.

Almost all study participants revealed that they routinely measure the weight of pregnant women but do not counsel appropriately on GWG. They either never raise the issue of weight at all or do not provide women with specific information such as how much weight they gained or need to gain. Some participants felt that telling women how much weight to gain is unnecessary. Most participants did not encourage women with normal weight to monitor their own weight. However, some counselled women about gestational weight when a woman either did not gain weight or had a loss of weight; had abnormal weight; or presented with conditions such as hypertension or gestational diabetes mellitus. Studies also revealed that physicians and prenatal specialists are more likely to counsel women who are at higher risk of or with disease than low-risk women [26, 27]. Midwives and obstetricians need to be encouraged to provide counselling about gestational weight gain management consistently for all pregnant women.

The main reasons for lack of counselling about GWG in our study was a lack of knowledge and guidance in advice to provide women. Our participants also stated counselling around appropriate weight gain was a low priority. This finding is consistent with several other studies [14, 25, 26]. This indicates that midwives and obstetricians need to be well informed about the impact of inappropriate GWG on the health of the mother and baby so that they can appropriately prioritise the issue. Other reasons for lack of counselling was the high workload midwives and obstetricians experienced, and pregnant women in this setting did not generally enquire about their weight. However, while most of our study participants believed that initiating discussions about GWG was primarily their responsibility, they typically waited for

the woman to raise this issue. Continuing education for midwives and obstetricians to develop skills in counselling women about nutrition during pregnancy and the postpartum period could help to improve the quality of maternal care provided for pregnant women in Ethiopia and ultimately reduce the workload for clinicians. An alternative approach could be to increase the health literacy of women and families in the community about the issue of GWG and the need to ensure pregnant and postnatal women receive optimal nutrition. Both of these recommendations would require resources and intervention at the level of government.

Midwives described a lack of confidence in advising women about GWG and nutrition as a barrier to their practice. This is consistent with other studies in which maternity care providers reported a lack of confidence in communicating about nutrition and weight as a major barrier to the management of GWG [14, 25, 54]. One study has shown that new midwifery graduates in Ethiopia have limited competency in nutrition counselling [53], which may be linked to inadequate nutrition education provided in midwifery programmes [52]. In contrast, although obstetricians felt that they were relatively confident to give nutritional advice, they underscored the necessity of involving nutritionists in antenatal counselling and the need for a GWG guideline. Studies also suggested a multidisciplinary approach, such as involving a nutritionist, in counselling and guidance of appropriate GWG [26, 32].

The most common nutritional advice that study participants provided for pregnant women was to increase their frequency of meals and to eat foods that were affordable or easily accessible at home. Counselling on specific nutrients and nutrition recommendations appeared to be even more difficult when the midwife or obstetrician believed the woman could not afford to buy specific foods. Affordability of appropriate nutrition is an issue that needs to be addressed by

the Ethiopian government through improving pregnant women's income so that they can access and afford recommended foods during pregnancy.

In our study, all participants perceived that the postpartum weight management of Ethiopian women was inappropriate (i.e., most of the women aimed to gain weight during the post-partum period). According to the participants, the main factors that led women to gain weight during this period were an increase in food consumption and lack of physical exercise. Postpartum ceremonies include the family, relatives and even neighbours who prepare foods with high energy density such as porridge and gruel with butter for puerperal women. An increased intake of food during the postnatal period is aimed at replacing blood and energy lost during the birth; to facilitate the healing process for any injury that happened during childbearing; and to increase milk production. The participants believed that women's energy needs and their intake during the postpartum period were not balanced.

Participants stated that postpartum women do not engage in exercise and typically stay inside for up to three months of the postnatal period in Ethiopia. Confinement to the home is a common practice in other cultures too [55, 56], but the length of time is usually shorter (up to 40 days). Although a reasonable amount of rest is important to facilitate the transition to mothering, a prolonged time of decreased activity may lead to postpartum weight retention [57]. Therefore, postpartum women should be encouraged to take gentle exercise as early as appropriate following the birth [58].

Participants perceived that weight gain was encouraged during the post-partum period by most of the Ethiopian people and that women considered gaining weight after birth is a normal phenomenon. Losing weight or not gaining weight during the postpartum period was perceived

as lack of proper care after birth. None of the participants provided proper postpartum weight management counselling for women. The participants reported several reasons related to lack of postpartum weight counselling. Some of these reasons including a lack of attention to weight (postpartum weight); having a high workload; and a belief that women do not ask about their weight were similar to the reasons for lack of GWG counselling. Other reasons were the perception that postpartum weight counselling was not a common practice; postpartum weight counselling was not considered as their role; and fear that discussion of postpartum weight loss would be unacceptable to the Ethiopian society.

Failure to address women's weight management during pregnancy, birth and postpartum period is a missed opportunity to influence a woman's future health [13, 59, 60]. According to the American College of Obstetricians and Gynaecologists, ensuring proper communication of postpartum issues with women is a responsibility of maternity care providers including obstetricians [17]. Since postpartum care or counselling is an ongoing process [17, 60], counselling on postpartum weight management should be started during pregnancy. Midwives and obstetricians require some ongoing education in regard to counselling around postpartum weight retention and information for pregnant women should be made available to ensure they understand the risks and benefits of inactivity and excessive weight gain in the postpartum period.

Strengths and Limitations

Using a qualitative approach, we were able to explore midwives and obstetricians' views and practices around GWG, and barriers to counselling on GWG and postpartum weight management. This study is the first of its kind in Ethiopia. The complexity of interviewing in

one language and translating the transcripts into another for analysis may have resulted in some issues being lost in translation [61]. However, we made a strenuous effort to check the accuracy of the translations by comparing the text with each recorded interview and the transcript. Another potential limitation is that this study was conducted in the capital city of Ethiopia; the situation in other parts of the country may be different.

Conclusions

This study explored the perspectives of midwives and obstetricians in Ethiopia regarding GWG and postpartum weight retention. The study found the awareness and practices of participants in relation to counselling pregnant women about appropriate weight gain were inconsistent. According to the midwives' and obstetricians' observations, there are widespread misconceptions about pregnancy weight management among women. Midwives lacked confidence to counsel women about GWG and nutrition whereas obstetricians considered other health issues to be a higher priority. The Ethiopian Ministry of Health (with concerned stakeholders such as the Ethiopian Society of Obstetricians and Gynaecologists, and the Ethiopian Midwives Association) need to consider designing an education package or short-term in-service training concerning GWG for both midwives and obstetricians; adapting (preparing) a GWG guideline and integrating sufficient information about weight management into ANC guidelines as essential.

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Chapter 9: Discussion

9.1.Overview of the chapter

This chapter synthesises the findings presented in this thesis with the literature. Findings from the quantitative and qualitative phases of the study are compared, contrasted and merged in this chapter. The strengths and the limitations of the whole study will be presented. Recommendations for future research have then been made. Finally, this chapter has presented the conclusion of this thesis.

9.2. Contribution of the thesis

Findings from this study may help maternal health service providers and planners to understand the local factors that influence sub-optimal GWG so that they are able to design interventions for women with inadequate and excess GWG to prevent adverse pregnancy outcomes. Furthermore, since the IOM guideline is primarily intended for high-income countries, a number of contextual factors may limit the suitability of the guideline in low- or middle-income countries such as Ethiopia. Hence, this study contributes to the development of GWG guidelines that could address the context of low-income countries and populations comparable to Ethiopia.

This thesis provided several contributions to the existing body of literature.

1. There were few studies available in Ethiopia that focus on the GWG. The existing studies assessed GWG retrospectively. This study, however, assessed GWG prospectively.

2. This study assessed the association between GWG and some predictor variables such as household food security, dietary diversity, physical activity, and intimate partners' violence. These variables were not addressed by the previously existing studies.
3. There was no prior study that explored women's views and perspectives regarding GWG and PPWR in Ethiopia qualitatively. This study explored women's views and perspectives regarding GWG and PPWR.
4. Although midwives and obstetricians are key player in pregnancy related weight management, no previous study addressed these care providers in Ethiopia. This study explored midwives' and obstetricians' views and practices regarding pregnancy related weight management.
5. This study addressed GWG issue from different perspectives (pregnant women, midwives and obstetricians) using different method (prospectively following pregnant women's GWG, exploring pregnant women's views using IDIs and FGDs, and exploring midwives' and obstetricians' views using IDIs).
6. This study assessed the effect of GWG on birth outcomes including mode of birth, episiotomy, and birth weight.

9.3. Overview of the findings

9.3.1. Findings from the systematic review

The findings from the systematic review and meta-analysis demonstrated that more than half of the pregnant women in the majority of sub-Saharan African countries gained GWG. All studies from low-income Sub-Saharan countries reported that more than 58% of pregnant women experience inadequate GWG. Nearly nine out of ten underweight women gained inadequate gestational weight. Six out of thirteen studies reported women with excessive GWG

at less than 10%. Four of the six studies were from low-income countries (Ethiopia, Uganda and Malawi); and the proportions of excessive GWG among these studies were reported to be <4%. The study from Malawi had no women who gained excessive gestational weight. Of the seven studies that have reported the percentage of excessive GWG as > 10%, six of them were from the middle-income countries of Sub-Saharan Africa (Ghana, Nigeria, Cameroon, and South Africa). The proportions of babies born with LBW were high among women who gained inadequate weight compared to women who gained adequate and excess gestational weight.

9.3.2. Findings from quantitative studies

Of 369 women for whom GWG was assessed, more than two thirds of pregnant women gained inadequate gestational weight while fewer than 5% of women gained excess gestational weight. Being underweight or normal weight before pregnancy increased the odds of gaining inadequate gestational weight. Similarly, not having a paid job increased the odds of gaining inadequate gestational weight compared to women employed by government or private institutions.

The overall mean birth weight was 3130 gm. Babies born to underweight women were 155.3 gm lighter than infants born to normal weight women. Similarly, babies whose mothers had inadequate weight gain were 245.8 gm lighter compared to those who gained adequate weight. Furthermore, babies whose mothers had previous history of abortion or miscarriages and developed gestational hypertension during current pregnancy were 144.2 gm and 316.8 gm respectively lighter compared to those whose mothers had not.

9.3.3. Findings from qualitative studies

This study showed that pregnant women lacked knowledge of their weight and the recommend amount of weight to gain during pregnancy. Most participants did not want to gain weight at all or wanted a limited amount of weight gain during pregnancy. The majority of the study participants believed women needed to gain weight during the postpartum period. Most reported that they never discussed weight gain with their health care providers.

Similarly, midwives and obstetricians had limited knowledge regarding the recommended amount of GWG. Almost all were unaware of the existence of the IOM GWG recommendations. Gestational weight gain and postpartum weight counselling was a low priority for the midwives and obstetricians. Despite obstetricians and midwives being aware that there was a widespread misconception among women about gestational weight gain management (i.e., lack of interest in gaining weight during pregnancy and supporting weight gain after birth), they were reluctant to provide counselling on weight related issue claiming that they had other competing priorities.

The next section provides a table representing the synthesis of the findings with the literature (Table 24).

Table 24: Summary of both the quantitative and qualitative findings, 2019

Type study	Research questions	Main findings	Synthesis of the findings
Quantitative study	What proportions of pregnant women gained inadequate, adequate and excessive GWG according the IOM guideline?	• 67.2% gained inadequate weight • 27.9% gained adequate weight • 4.9% gained excessive weight	The proportion of inadequate GWG was high, and consistent with studies from low-income sub-Saharan African countries [1]. The causes for this inadequate GWG could be multifactorial. However, this finding was inconsistent with studies from high income settings where a majority of pregnant women experience excessive GWG.
	What was the range of GWG?	• Median GWG was 8.7 kg among all women • Median GWG was 4 kg in the second trimester • Median GWG was 8.5 kg in the third trimester • Median GWG was 10 kg among underweight women • Median GWG was 9 kg among normal weight women • Median GWG was 7 kg among overweight or obese women	Given underweight women are recommended to gain 12.5 to 18 kg of weight, the median GWG among underweight women was below the recommended value. Similarly, the median GWG of normal weight women was below the recommended amount of 11.5 to 16 kg.
	Which factors are associated with GWG?	• Being underweight or normal weight increased the odds of gaining inadequate gestational weight compared to overweight or obese women. • Not having paid employment increased the odds of gaining inadequate gestational weight compared to women employed by the government or private institutions • The odds of inadequate GWG in the second lowest wealth quartile was 61% less than in lowest wealth quartile women • Having had signs and symptoms of perinatal depression increased odds of excessive GWG	Consistent with several previous studies, pre-pregnancy weight was a strong predictor of GWG. Underweight women had higher odds of gaining inadequate GWG. Future interventions should focus on the most effective and cost-effective ways of helping women to manage their weight before pregnancy as pre-pregnancy weight is an important determinant of GWG and healthy pregnancy outcomes for mothers and babies.
	What is the influence of pre-pregnancy weight, GWG and other maternal factors on birth weight?	• Infants whose mothers had inadequate weight gain were 245.8 gm lighter compared to those who gained adequate weight. • Infants born to underweight women were 155.3 gm lighter than infants born to normal weight women.	Pre-pregnancy weight and gestational weight gain significantly influence baby's birth weight. Underweight women are at higher risk of gaining inadequate gestational weight and bearing low birth weight babies. Maternal under-nutrition also has an intergenerational effect and undernourished girls have a greater likelihood of becoming undernourished mothers who in turn have a greater chance of giving birth to low birth weight babies perpetuating an intergenerational cycle of underweight women who gain inadequate weight and give birth to low birth weight babies.

		• Infants whose mothers had previous history of abortion or miscarriages 144.2 gm lighter to those whose mothers had not • Infants whose mothers who developed gestational hypertension during current pregnancy were 316.8 gm lighter compared to those whose mothers had not	
Qualitative study	What are pregnant women's perceptions and practices related to GWG and postpartum weight loss?	• Five main themes emerged: ✓ Knowledge of weight and weight gain ✓ Concerns about gestational weight ✓ Gestational weight gain counselling ✓ Eating habits ✓ Views on postpartum weight	Although BMI is a widely used tool to confirm whether a person has an appropriate weight [2], none of our study participants were aware of their BMI and how much weight they are recommended to gain during pregnancy or postpartum. Women were weighed routinely during pregnancy. Clear explanations are needed for women on what their weight means for themselves and for the baby, why weight information is needed and how it will be used to plan for GWG management activities. This could help to address the widespread misconception in which women lack interest in gaining weight during pregnancy due to perceived severity of birth related complications if the baby was large. It should be noted that women need information and education to understand the balance between controlling weight gain during pregnancy and gaining inadequate gestational weight. It is important to ensure women have the knowledge and skills to help dispel common myths and assumptions about what to eat and what not to eat during pregnancy and about weight loss during postpartum period.
	What are midwives' and obstetricians' views and practices related to GWG and postpartum weight management?	• Three main themes emerged: ✓ Knowledge of optimal gestational weight gain ✓ Gestational weight gain counselling experience ✓ Ethiopian culture influences postpartum weight gain	Maternity care providers had limited knowledge of the optimal amount of gestational weight gain and most were reluctant to provide GWG and postpartum weight retention counselling. These factors might have played a significant role on women's weight management behaviour. Pregnant women lacked knowledge of how much weight they are supposed to gain and more than two-thirds of our study participants gained inadequate gestational weight. In contrast, although women are supposed to lose weight during the postpartum period, a majority were interested in gaining weight during this period. However, care providers did not counsel women to correct this misconception.

9.4.**Data integration**

Integration is the process of bringing data from multiple research methods together to access knowledge or insights unavailable to a single methodological technique [3]. There are diverse approaches that can be used to integrate mixed methods research procedures and data. In this project, data integration was implemented at the design, methods, interpretation, and reporting stages [4].

A mixed method research design can help a researcher to answer a research question from a number of perspectives [5]. The main rationale for undertaking the concurrent mix of methods in this study was to gain a more comprehensive and holistic understanding of GWG using different designs, participants, data collection, and analysis techniques. I conducted a prospective cohort study to follow pregnant women to examine their actual weight gain status; the findings as summarised in table 24 were, as expected, similar to the findings in the literature. Therefore, at the design stage, I decided to conduct a qualitative study to discover the experiences and knowledge of gestational weight gain from the perspective of women, midwives, and obstetricians. As described in Chapter Three, the majority of women in Ethiopia gain inadequate gestational weight [1]. To explore the possible reasons for the inadequate GWG, I conducted in-depth interviews and focus group discussions with pregnant women to explore women's knowledge, views, and behavioural related factors, which could help to explain their actual weight gain status; and I also employed in-depth interviews with midwives and obstetricians to investigate how much they support the pregnant women regarding GWG.

In this thesis, methods of data collection for each study were conceptually linked. For example, midwives for the qualitative in-depth interview were chosen from the health centres where pregnant women for the quantitative study were located. This enabled us to explore women's GWG experience within the service where the midwives provided maternity care. Integration of data at the interpretation and reporting level occurred through narrative and joint displays. The integration through joint displays occurred by presenting the major findings from each objective in a table which allowed inferences to be drawn to address the aim of the study.

9.4.1. Proportions of gestational weight gain

The findings from this study indicate that inadequate GWG is a public health concern in Ethiopia. The majority (67.2%) of the study participants gained inadequate gestational weight according to the IOM recommendations. This is consistent with other studies in low-income sub-Saharan Africa where the majority of pregnant women gain inadequate gestational weight [6-8].

The high prevalence of GWG below the IOM recommendations in the current study may be a consequence of several factors. Firstly, my qualitative findings demonstrate that most pregnant women in my study were not interested in gaining gestational weight due to perceived severity of birth related complications if the baby was large. Previous studies in Ethiopia have also showed that pregnant women avoid some foods to prevent fetal weight gain [9-11] to avert birth complications as a result of big babies.

Secondly, women do not get GWG counselling from maternity care providers. Women assume that care providers would counsel them about GWG if it is vital [12]. Getting inadequate or no counselling about GWG would lead a woman to a low level of perceived risk for weight-related pregnancy complications [13], lack of concern about their GWG [12], inadequate knowledge of nutritional and appropriate GWG [14-16]. My qualitative study highlighted that pregnant woman lacked knowledge of their weight and the recommended amount of weight to gain during pregnancy. Another study also showed that more than a half of pregnant women in sub-Saharan African settings lack awareness of risks involved with inappropriate GWG [17]. Finally, similar to other low-income Sub-Saharan African countries, pregnant women from Ethiopia suffer from a wide range of nutritional problems, food insecurity, economic instability, poverty, and frequent infections [18] which could contribute to their inadequate GWG. Evidence suggests that previous interventions on GWG management targeted the reduction of GWG [19-22]. Given the majority of pregnant women in low-income countries gain inadequate gestational weight, gestational weight management strategies should be inclusive, i.e., they need to encourage weight gain for women who are susceptible to inadequate weight gain; not only encouraging reduction in GWG.

On the other hand, fewer than 5% of pregnant women in our study gained excessive gestational weight. However, more than a half of the pregnant women in high-income [23-26] and middle-income [27] countries experience excessive GWG. This could be because the pre-pregnancy BMI of the women, overweight and obese, are more prevalent in high- or middle-income countries [28]. For example, a study from South Africa [29] reported 66.2% of study participants were overweight or obese and there were no underweight women. These authors found 55% of the participants gained excessive gestational weight. However, studies from Malawi [30] and Uganda [8] which

had no obese women reported that the proportion of excessive gestational weight was ≤ 3%. In the current study, only 1% of study participants were obese and 16% were overweight. This may indicates that Ethiopia is in a nutritional transition phase and the prevalence of obesity as well as excessive GWG may increase in the near future. Therefore, this is an opportune time to develop appropriate strategy for the prevention of overweight and obesity, and hence excessive gestational weight gain before it becomes a significant public health problem in the country.

9.4.2. Factors affecting gestational weight gain

In this study the association between GWG and socio-demographic factors were examined. Factors such as age of the women, women's and their partners' educational status, occupational status, average monthly income, wealth index, were all examined. In addition, women's reproductive characteristics such as parity, type of pregnancy (intended or unintended), time gap between the current and the previous pregnancy (for multigravida women), previous history of abortion or miscarriage were also measured. Other variables such as, nutritional related factors, dietary diversity and food security; physical activity level; perinatal depression; intimate partners violence; pre-pregnancy BMI; maternal mid-upper arm circumference; and haemoglobin level were also measured. Only a few variables were significantly associated with GWG in multivariable regression; these variables were pre-pregnancy BMI of the women, women's occupational status, wealth index and perinatal depression.

This study revealed that pre-pregnancy weight of the women was strongly associated with GWG. Other studies have also reported similar findings that pre-pregnancy BMI is strongly associated

with GWG [31-33]. This study revealed that being underweight or normal weight before pregnancy increased the odds of gaining inadequate gestational weight compared to overweight or obese women. The percentage of inadequate GWG was particularly high among underweight women (75% of underweight women gained inadequate gestational weight compared to 2% obese women). The systematic review of the literature also showed that 71% to 98% of underweight women gained inadequate gestational weight [1]. This indicates that the amount of weight gain during pregnancy could be significantly affected by the condition of the women before pregnancy.

These findings are not surprising since most women did not have any understanding of the amount of GWG and did not discuss weight with their health care provider. Midwives and obstetricians rarely took the time to educate women about GWG and most were unaware of the correct amount of weight to advice. Previous GWG interventions on GWG managements [19-22] targeted pregnant women. It may be useful if future interventions were implemented in the pre-pregnancy stage in order to better manage the gestational weight of women. If women had preconception counselling in regard to BMI and the effect on any future pregnancies, they may then ask their care providers about GWG. Interventions during pre-pregnancy could help to break the vicious intergenerational cycle of malnutrition and improve GWG. Health care providers should use any opportunity, as appropriate, to provide women with information about the health benefits of managing weight prior to pregnancy for themselves and the baby they may conceive. This information may also need to include the health risks related to being underweight, overweight or obese before pregnancy poses to themselves and to their unborn child.

9.4.3. Effect of gestational weight gain on birth weight

The amount of weight gained during pregnancy can affect the immediate and future health of a woman and her infant. This study identified that babies whose mothers gained inadequate weight gain were 245.8 gm lighter compared to those who gained adequate weight. Moreover, 9.3% of women who gained inadequate gestational weight gave birth to LBW babies compared to that of women who gained adequate weight (4.5%). Previous studies in low-income settings also reported that LBW was more common among women who gained inadequate gestational weight than among women who gained adequate weight [6, 34]. Despite the fact that there is high demand for extra nutritional intake during pregnancy, more than a quarter of pregnant women (27.3%) in Addis Ababa restrict their food intake to avoid weight gain [11]. Decreased nutrient intake due to poor dietary practices, together with socio-economic and environmental factors could affect fetal growth, which also leads to lower birth weight [35].

This study revealed that women without paid employment were at higher odds of gaining inadequate GWG compared to women employed by government or private institutions. This could be due to the finding that half of the study participants were not in paid employment, i.e., they only engaged in household duties. This high proportion of women's unemployment could be associated with the low levels of education for Ethiopian women. About half of the study participants either attended only primary education or had no formal education. Maternal education could help women to generate income through employment, as educated women are more likely to have paid work than uneducated women [36]. Addressing the gender inequalities in the education of women in this setting would improve Ethiopian women's employment status. Improving women's

education and their income could be an important factor in preventing inadequate GWG [37]. Moreover, women's education level was associated with knowledge of appropriate gestational weight gain [38].

9.4.4. Pregnant women's, midwives' and obstetricians' knowledge of gestational weight gain

The qualitative part of this study explored both the pregnant women and maternity care providers' lack knowledge of the recommended amount of GWG. Most of the care providers stated that pregnant women are recommended to gain 12.5 kg on average. This shows that midwives and obstetricians mainly relied on older recommendations (in 1960s) in which Hytten and Leitch suggested the mean GWG of 12.5 kg for primiparous women [39]. They lacked updated information regarding GWG and almost all of the midwives and obstetricians were not aware of the existence of or the recommendations in the IOM guideline. This lack of, or limited knowledge of, GWG related issues could play its part in leading a larger proportion of pregnant women in Ethiopia to gain inappropriate gestational weight.

The lack of knowledge among maternity care providers regarding the recommended amount of GWG remains a major issue that impedes the improvement of GWG and related pregnancy outcomes. Midwives clearly outlined the need for short-term in-service training on GWG management to improve their weight-related communication skills. These findings concur with another study [41] in which short-term in-service training was recommended for midwives to help them carry out nutrition and GWG counselling tasks with optimum competency.

Moreover, designing a broader education package concerning GWG for both midwives and obstetricians and incorporating it into the curriculum and ANC protocol is essential. Developing a GWG guideline which could address the Ethiopian context and making it readily available for maternity care providers could help to improve health care providers' understanding of GWG issues. For pregnant women, evidence informed brochure or a phone 'app' would provide information and enhance women's knowledge about the amount of optimal GWG and effects of gaining inadequate gestational weight. This information may still need to be supplemented with verbal consultation given a significant number of women Ethiopia have limited literacy or are illiterate. Future research would need to focus on identifying the most effective and efficient ways of counselling pregnant women about GWG; preparing the most important information about GWG and evaluating content of the information women would be of importance.

9.4.5. Pregnant women's, midwives' and obstetricians' views of gestational weight gain

Both pregnant women and care providers stated that pregnant women were weighed routinely during ANC follow-up. Care provider did not tell women about their weight or what the weight of women supposed to be. The United State Institute of Medicine recommend that weighing women during ANC should be accompanied with conversation about weight and nutrition during pregnancy, education, and counselling women on the importance of nutrition and appropriate GWG as a package of care [41].

However, this study found that most pregnant women received limited or no information about weight and GWG from their health care providers. Both midwives and obstetricians who stated

they do not provide GWG counselling. Studies from different countries reported similar findings in which pregnant women lack proper counselling about GWG from their care providers [12, 15, 42-51]. All the participants in the qualitative studies (pregnant women and care providers) in the current study expressed that it is the responsibility of care providers to initiate discussion about GWG. However, midwives and obstetricians reported they only counsel women about gestational weight when a pregnant woman faced a weight problem, such as inadequate weight gain or loss of weight; had abnormal weight; or presented with conditions such as hypertension or gestational diabetes mellitus. The midwives and obstetricians in this study did not raise the issue of weight for any of the normal weight women. Given GWG is a modifiable risk factor for the mother and fetal health, priority should be given for the prevention of inappropriate GWG rather than retrospectively acting on the effects of inappropriate GWG.

Factors such as the low-priority placed on GWG by care providers [52-54], waiting for women to initiate discussion about weight issues [12, 55], or lack of confidence in communicating to women about adequate weight [52, 54, 56, 57] could contribute to the absence of GWG counselling. This suggests that care providers' readiness and attitudes towards GWG would play a crucial role in GWG counselling. Therefore, care providers should be encouraged to provide counselling and need to be provided with tools which could facilitate a healthy GWG. Health policy-makers should focus on improving the GWG counselling skills of midwives and obstetricians. A multidisciplinary approach would be required to plan for woman-centred pregnancy weight management services to address all women in pregnancy irrespective of their pre-pregnancy weight. In-service education was highlighted by the study participants as a method to improve their knowledge, confidence,

and counselling practice to support healthy pregnancy weight gain and to help the pregnant woman to make an informed decision regarding GWG.

9.4.6. Pregnant women's, midwives' and obstetricians' views of postpartum weight

Obstetricians and midwives described that pregnant woman in Ethiopia gain weight during the postpartum period. Pregnant women also verified this as mostly they were interested to gain weight during the postpartum period. Women assumed gaining weight during the postpartum period was a normal phenomenon. Lack of weight gaining or losing weight during the postpartum period was perceived as lack of proper care after birth. This is inconsistent with studies from high-income countries where postpartum women want to return to their pre-pregnancy weight after birth [42, 45]. Weight gain during the postpartum period can lead to higher weight in subsequent pregnancies and long-term obesity and other health problems such as diabetes and cardiovascular disease [41]. However, it seems that women in the current study were not aware of problems related to postpartum weight gain. Culturally, Ethiopian postpartum women consume high energy density foods such as porridge and gruel with butter, which was aimed to replace blood and energy lost during the birth, to increase breast milk production, and to facilitate the healing process for any injury that happened during childbearing. An increased intake of food during the postnatal period contribute to the weight gain during postpartum period.

Care providers do not provide any counselling regarding postpartum weight either during pregnancy or during the postpartum period. They explained that postpartum weight counselling was not considered as their role hence they gave low attention to weight issues in general and postpartum weight in particular. Failure to address women's weight management during

pregnancy, and postpartum period is a missed opportunity to influence a woman's future health [58-60]. The American College of Obstetricians and Gynaecologists suggested that maternity care providers are responsible to ensure proper communication of postpartum issues with women [61]. Provided that postpartum care or counselling is an ongoing process [60, 61], counselling on postpartum weight management should be started prior to and during pregnancy. These findings highlight the need for establishing healthy eating and exercise habits prior to, during, and after pregnancy. Information should be made available for pregnant women to ensure they understand the risks and benefits of weight gain in the postpartum period.

9.5. Strengths and Limitations

9.5.1. Strengths of the study

This study has some strengths. One of the strengths of this thesis is the use of the mixed methods design that draws on both qualitative and quantitative methodologies to provide a comprehensive and holistic understanding of the GWG from a range of perspectives. This enabled a discovery of GWG patterns through the quantitative phase as well as a qualitative exploration of the direct experiences and perspectives from the women, midwives and obstetricians. In addition, pregnant women were prospectively followed to assess their GWG.

9.5.2. Limitations of the study

The study has some limitation. Firstly, the IOM recommendation for GWG were used, which was developed for women from high-income countries and primarily intended to prevent excessive

GWG. These recommendations are required to be tested and validated in low-income settings including Ethiopia. Secondly, the pre-pregnancy BMI of the women was measured before or at 16 weeks of gestation, at which time there may already have been an increase or decrease of gestational weight. Thirdly, the complexity of interviewing in one language and translating the transcripts into another for analysis may have resulted in some issues being lost in translation [62]. However, we made a strenuous effort to check the accuracy of the translations by comparing the text with each recorded interview and the transcript. Finally, generalisability of findings may be limited by the study population. This study was conducted in the capital city of Ethiopia in the public health facilities; the situation in other parts of the country and private health facilities may be different.

9.6. Recommendations

The following recommendations are made from the findings of this PhD thesis:

I. A national GWG guideline needs to be developed addressing the Ethiopian cultural context.
II. Routine GWG and postpartum weight counselling need to be provided to all pregnant women irrespective of their pre-pregnancy weight.
III. Clear and accurate information should be provided for pregnant women with a well-designed brochure and a smartphone ‘app’ (for those who have access to smartphone) in addition to verbal consultation to enable women to make an informed decision on how much weight they should and could gain during pregnancy.

IV. A context specific nutrition education package on increasing dietary intake needs to be provided for pregnant women to reduce the risk of inadequate gestational weight gain and low birth weight.

V. Gestational weight gain management protocols need to be included in routine ANC guidelines

VI. There is a need for short-term in-service education for both midwives and obstetricians on GWG management to help them carry out nutrition and GWG counselling tasks with optimum competency.

VII. A broader education package needs to be developed for midwives and obstetricians and embedded into their educational curriculum to ensure that they are proficient in GWG management activities

VIII. More research needs to be undertaken on a large sample size covering different parts of the country (both urban and rural settings) and in both private and public health facilities to provide more detailed information about GWG and postpartum weight retention

IX. Given pregnant women were interested to gain weight after birth, further research is needed to examine the amount of weight that the postpartum women retain with its short- and long-term health effects.

9.7. Conclusions

While ANC follow-up provides the opportunity to communicate with and support the pregnant woman at a critical time in the course of a woman's life, improvement is still needed in providing services for pregnant women in Ethiopia regarding gestational weight gain and postpartum weight loss. The information regarding the perspectives and experiences of pregnant women and

maternity care providers regarding GWG, and reviewing pregnancy outcomes related to GWG, may help to provide the opportunity to improve preconception, antenatal and postnatal care in order to have healthy pregnancy outcomes for Ethiopian pregnant women.

The results of this study could inform maternity care providers, health care administrators, and policymakers in Ethiopia regarding gestational weight gain, and GWG related services that women require from care providers. Consistent with many previous studies, babies born to women with inadequate gestational weight gain were lighter than babies born to women who gained adequate weight. There is widespread misconception among pregnant women in Ethiopia where women feel that gaining weight during pregnancy is unhealthy. On the contrary, they assume gaining weight after birth is a normal phenomenon. Despite inadequate gestational weight gain being a public health concern in Ethiopia, low attention was given to pregnancy weight matters. Gestational weight gain and postpartum weight counselling was of low priority for the midwives and obstetricians.

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Appendices

Appendix 1a: Haramaya University Ethics Approval Letter

Haramaya University, College of Health and Medical Sciences
Institutional Health Research Ethics Review Committee (IHRERC)
Address: Tel.0254662011, P.O.Box 235, Fax 025668081, Harar-Ethiopia
E-mail neggalemash@gmail.com

Institutional Health Research Ethics Review Approval Form

Name of the institution **Haramaya Universitys College of Health and Medical sciences**

Name of PI: **Fekede Asefa Kumsa** **Tel +251913072716** E-mail: sinbona@gmail.com P.O.Box 235, Harar, Ethiopia

Title of the proposal /project: **Gestational Weight Gain in Addis Ababa, Central Ethiopia: Patterns, Determinants, Birth Weight, Postpartum Weight Retention, Women's and Care Provider's View**

To: Chief Executive Director, College of Health and Medical Sciences, Haramaya University, Harar Campus

The IRERC has reviewed the aforementioned project proposal with special emphasis on the following points:

1. Are all ethical principles considered?
   - 1.1 Respect for persons — Yes [√] No [ ]
   - 1.2 Beneficence — Yes [√] No [ ]
   - 1.3 Justice — Yes [√] No [ ]
2. Are the objectives of the study ethically achievable? Yes [√] No [ ]
3. Is/ Are method(s) ethically sound? Yes [√] No [ ]

Based on the above mentioned ethical assessment the Institutional Research Ethics Review Committee has

a) **Approved: the proposal for:** i. Regional/National Review [ ]
   ii. Implementation [√]

   Expiry date of the review

   31 Date | 08 Month | 2019 Year

b) **Conditionally approved** [ ]

c) **Not approved** [ ]

Finally we would like to take this opportunity to request your good office to facilitate his request for the proposed study.

With best regards

Chairperson: Negga Baraki — Name — Signature — 03/09/2018 Date

Secretary: for Berhe G/Michael — Name — Signature — 03/09/2018 Date

Haramaya University College of Health and Medical Sciences — Harar Ethiopia — Institutional Health Research Ethics Review Committee (IHRERC)

N.B
For any information question and clarification don't hesitate to contact the Committee with the addresses specified in the heading.

Ref.No. IHRERC/200/2018

September 03/2018

To: Chief Executive Director, College of Health and Medical Sciences (COHMS), Haramaya University, Harar Campus, Ethiopia

From: Institutional Health Research Ethics Review Committee (IHRERC), College of Health and Medical Sciences, Harar Campus, Ethiopia

Nega Berelu
Chair-person of the IHRERC

Harar Ethiopia
Institutional Health Research Ethics Review Committee (IHRERC)

Subject: Ethical approval of a PhD dissertation proposal by Fekede Asefa Kumsa

It is known that various research proposals are passing through the IHRERC for ethical reviews. To this effect **Mr. Fekede Asefa Kumsa** who is Academic Staff of the COHMS and now studying for his PhD at the University of Technology of Sydney, Australia, has submitted a PhD dissertation proposal entitled **"Gestational Weight Gain in Addis Ababa, Central Ethiopia: Patterns, Determinants, Birth Weight, Postpartum Weight Retention, Women's and Care Provider's View"** through a letter written on July 18/2018 and directed to office of the IHRERC from your office. The IHRERC has scrutinized the proposal for ethical issues and made the investigator to correct and incorporate essential elements. The investigator has incorporated all elements as enquired by the committee. The committee has, therefore, approved the herewith attached and stamped 112 pages proposal unanimously through full consensus of all existing seven members of the IHRERC in its regular meeting convened on August 28/2018. The IHRERC congratulates the investigator for the concerted efforts he made to fulfill the recommendations of the Committee.

Finally the IHRERC requests your esteemed Office, to inform officially the investigator to commence his data collection process by contacting for permission of the concerned authorities in the respected study area/ settings. However, since the IHRERC is bestowed to make follow-up of the research process, the investigator is informed with a copy of this letter to report any changes in the research procedure and submit an activity progress report to the IHRERC **every three months.** A copy of the final report is also expected.

At the back of this letter is signed and stamped copy of the approval format of the IHRERC.

With Regards

CC

- **Fekede Asefa Kumsa** (including one copy of the approved proposal)

Appendix 1b: Addis Ababa Health Bureau Ethics Approval Letter

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City Government of Addis Ababa Health Bureau

Ref.No [illegible]/229
Date 9/1/2011

- Gandhi Memorial Hospital
- Zewuditu Memorial Hospital
- Yekati 12 Medical College Hospital
- Nifas Silk Lafto Sub-City Health Office
- Kolfe Keranio Sub-City Health Office
- Kirkos Sub-City Health Office
- Akaki Kality Sub-City Health Office
- Gulelle Sub-City Health Office
- Lideta Sub-city Health Office
- Bole Sub-city Health Office
- Arada Sub-city Health Office
- Addis Ababa Sub-city Health Office
- Yeka Sub-city Health Office

Addis Ababa

Subject: Request to access Health Facilities to conduct approved research

This letter is to support **Fekede Asefa Kumsa** **to** conduct research, which is entitled as" Gestational Weight Gain in Addis Ababa, Central Ethiopia: Patterns, Determinants, Birth Weight, Postpartum Weight Retention, Women's and Care Provider's View." The study proposal was duly reviewed and approved by Addis Ababa Health Bureau IRB, and the principal investigator is informed with a copy of this letter to report any changes in the study procedures and submit an activity progress report to the Ethical Committee as required.

Therefore we request the Health facility and staffs to provide support to the Principal investigator.

With Regards

Kasayenewu Amare
Ethical Clearance committee

The Addis Ababa City Administration Health Bureau

Cc

- **Fekede Asefa Kumsa**
- **To Ethical Clearance Committee**

Addis Ababa

Appendix 1c: University of Technology Sydney Ethics Approval Letter

HREC Approval Granted - ETH18-2610
Inbox

Research.Ethics@uts.edu.a Thu, Jan 3, 2019, 11:19 AM
to Andrew.Hayen, Fekede.Kumsa, FekedeAsefa.Kumsa, Research.Ethics

Dear Applicant

Thank you for your response to the Committee's comments for your project titled, "Gestational Weight Gain in Addis Ababa, Central Ethiopia: Patterns, Determinants, Birth Weight, Care provider's and Women's Views". The Committee agreed that this application now meets the requirements of the National Statement on Ethical Conduct in Human Research (2007) and has been approved on that basis. You are therefore authorised to commence activities as outlined in your application.

You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy (http://www.gsu.uts.edu.au/policies/research-management-policy.html).

Your approval number is UTS HREC REF NO. ETH18-2610.

Approval will be for a period of five (5) years from the date of this correspondence subject to the submission of annual progress reports.

The following standard conditions apply to your approval:
• Your approval number must be included in all participant material and advertisements. Any advertisements on Staff Connect without an approval number will be removed.

• The Principal Investigator will immediately report anything that might warrant review of ethical approval of the project to the Ethics Secretariat (Research.Ethics@uts.edu.au).

• The Principal Investigator will notify the UTS HREC of any event that requires a modification to the protocol or other project documents, and submit any required amendments prior to implementation. Instructions can be found at https://staff.uts.edu.au/topichub/Pages/Researching/Research%20Ethics%20and%20Integrity/Human%20research%20ethics/Post-approval/post-approval.aspx#tab2.

• The Principal Investigator will promptly report adverse events to the Ethics Secretariat (Research.Ethics@uts.edu.au). An adverse event is any event (anticipated or otherwise) that has a negative impact on participants, researchers or the reputation of the University. Adverse events can also include privacy breaches, loss of data and

damage to property.

• The Principal Investigator will report to the UTS HREC annually and notify the HREC when the project is completed at all sites. The Principal Investigator will notify the UTS HREC of any plan to extend the duration of the project past the approval period listed above through the progress report.
• The Principal Investigator will obtain any additional approvals or authorisations as required (e.g. from other ethics committees, collaborating institutions, supporting organisations).

• The Principal Investigator will notify the UTS HREC of his or her inability to continue as Principal Investigator including the name of and contact information for a replacement.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.
You should consider this your official letter of approval. If you require a hardcopy please contact Research.Ethics@uts.edu.au.

If you have any queries about your ethics approval, or require any amendments to your research in the future, please do not hesitate to contact Research.Ethics@uts.edu.au.

Yours sincerely,
Dr Tim Luckett
(Acting) Chairperson
UTS Human Research Ethics Committee
C/- Research & Innovation Office
University of Technology, Sydney
E: Research.Ethics@uts.edu.au

REF: E38

Appendix 2a: Participant Information Sheet for Survey Participant

Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views [UTS HREC18-2610]

WHO IS DOING THE RESEARCH?

My name is Fekede Kumsa and I am a PhD student at UTS. My supervisor is Professor Andrew Hayen Phone: +61[redacted]-, email: Andrew.Hayen@uts.edu.au and my in-country supervisor is Dr Yadeta Dessie Phone: +25[redacted] email: [redacted]@yahoo.com

WHAT IS THIS RESEARCH ABOUT?

This research is to describe gestational weight gain among pregnant women in Addis Ababa, central Ethiopia, with a focus on its patterns, determinants, birth weight of infants, women's and care provider's views.

FUNDING

Funding for this project has been received from Haramaya University

WHY HAVE I BEEN ASKED?

You have been invited to participate in this survey because you are a pregnant woman attending an Antenatal Clinic (ANC) in Addis Ababa and you are in your first trimester of pregnancy. Your health history, social experiences and weight gain during this pregnancy may provide important information that will contribute to our understanding of weight gain in pregnancy for women in Central Ethiopia and you are therefore eligible to participate in the study.

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate in the survey, I will ask you to answer a set of questions including details about your income and household assets, reproductive experiences, depression status, household food security, types foods you ate in the last 24 hours, dietary diversity, physical activity, intimate partner violence and behavioral factors that will take approximately 30 minutes to complete but will not take more than 35 minutes. The survey questions will only be asked once in the first trimester (today). I would also like to measure your weight at different times (today, and at the end of the 24th and 36th weeks of the pregnancy). Measuring your weight is part of your routine antenatal care and will take only a minute of your time. In total, including the follow-up time, participation in this research will take a maximum of 40 minutes of your time. We will meet in a separate private room to ask the survey questions and your weight and height will be measured in the ANC room.

Your health information (anaemia status, preeclampsia, gestational diabetes, HIV status, mode of birth, baby's birth weight, Apgar scores, and any complication related to pregnancy) will be copied from your antenatal care and birth records by research staff.

ARE THERE ANY RISKS/INCONVENIENCE?

Some of the questions such as those about any experience of violence from a partner and food insecurity questions could feel uncomfortable to answer. If you find these questions difficult or distressing, you can choose not to answer. You do not have to answer any question that you do not want to answer. If you feel distressed while being asked any question, I will pause the survey at which point you can decide whether you would like to continue or not. If you decide not to continue the survey, I will stop asking you the survey questions and will link you with your health care provider for further help and counselling if needed.

DO I HAVE TO SAY YES?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the health institution. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting Fekede Kumsa ( ).

If you decide to leave the research project, we will not collect additional personal information from you and any of your information that has already been collected will be discarded.

CONFIDENTIALITY

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially. There will be no information that will identify you in particular. The findings of the study will be general for the study community and will not reflect anything particular of individual persons or housing. The questionnaire will be coded to exclude showing names. No reference will be made in oral or written reports that could link participants to the research. We plan to publish the results in national or international journals or present at conferences. In any publication or presentation, information will be provided in such a way that you cannot be identified.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact us on Fekede Kumsa, [redacted]@gmail.com , [redacted] or [Professor Andrew Hayen Phone: 61[redacted] or Dr Yadeta dessie [redacted]
[redacted]@yahoo.com
You will be given a copy of this form to keep.

NOTE:
The Haramaya University Institutional Health Research Ethics Review Committee [IHRERC/200/2018], Addis Ababa Health Bureau Institutional Review Board [A/A/HB/2576/227] and the University of Technology Sydney Human Research Ethics Committee [UTS HREC18-2610] have approved this study. If you have any concerns or complaints about any aspect of the conduct of this research, please contact Haramaya University Institutional Health Research Ethics Review Committee (IHRERC) on phone +251254662011 or P.O.Box 235, Harar or the UTS Ethics Secretariat on phone .: +61 2 9514 2478, or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

CONSENT FORM: RESEARCHER ADMINISTERED SURVEY FOR WOMEN

Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views [UTS HREC18-2610]

I _____ [participant's name] agree to participate in the research project "Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views", UTS HREC approval reference number, being conducted by Fekede, [redacted]@student.uts.edu.au and +251[redacted]. I understand that funding for this research has been provided by UTS Centre for Midwifery, Child and Family Health and Haramaya University

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I agree to be:

☐ Interviewed for the purpose of answering survey questions

I agree that the research data gathered from this project may be published in a form that:

☐ Does not identify me in any way

I am aware that I can contact Andrew Hayen or Yadeta Dessie or Fekede Kumsa if I have any concerns about the research.

_____ ____/____/____

Name and Signature [participant] Date

_____ ____/____/____

Name and Signature [researcher or delegate] Date

Appendix 2b: PARTICIPANT INFORMATION SHEET: WOMEN'S IN-DEPTH INTERVIEW

Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views [UTS HREC18-2610]

WHO IS DOING THE RESEARCH?

My name is Fekede Kumsa and I am a PhD student at UTS. My supervisor is Professor Andrew Hayen Phone: +61 email: Andrew.Hayen@uts.edu.au and my in-country supervisor is Dr Yadeta Dessie Phone: +251 email: @yahoo.com

WHAT IS THIS RESEARCH ABOUT?

This research is to describe weight gain in pregnancy in Addis Ababa, central Ethiopia, with a focus on its patterns, determinants, birth weight of infants, women's and care provider's views.

FUNDING

Funding for this project has been received from UTS Centre for Midwifery, Child and Family Health (for transcription of audio recorded data) and Haramaya University

WHY HAVE I BEEN ASKED?

You have been invited to participate in this in-depth interview because you are a pregnant woman who is attending the Antenatal Clinic of a health facility in Addis Ababa and your experiences and views about weight gain in pregnancy are the focus of this study.

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate in this in-depth interview, I (or a research assistant) will meet to ask you questions about a range of issues related to weight gain in pregnancy. We will be using a list of topics as a guide for the interview to provide pertinent information that is helpful for the study. The topics to be discussed during the interview include: your perception and experiences in relation to weight gain in pregnancy, challenges in maintaining healthy weight gain in pregnancy, how pregnant women are managing weight gain and sensitivity of discussing your weight with health care providers, your eating and physical activity status. I would like to record the discussion to help us capture all points we raise. Your personal information will be deleted during the analysis, as only grouped information from all participants will be used. The interview will take about 45 to 60 minutes depending on the depth of our discussion.

ARE THERE ANY RISKS/INCONVENIENCE?

You may feel some discomfort in talking about your concerns with weight gain in pregnancy, or your views on the sensitivity of discussing your weight with health care providers, your weight, and factors that affect managing weight gain during pregnancy. If this happens to you, you can decide whether you would like to continue or not. If you decide not to continue with the in-depth

interview, you are free to leave and I will link you with your health care provider for further help and counselling.

DO I HAVE TO SAY YES?

No, you do not have to say yes. Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the health institution. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason.

If you decide to leave the research project, we will not collect additional personal information from you, although personal information already collected will be retained to ensure that the results of the research project can be measured properly. You should be aware that data collected up to the time you withdraw would form part of the research project results.

CONFIDENTIALITY

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially. There will be no information that will identify you in particular. The findings of the study will be general for the study community and will not reflect anything particular of individual persons or housing. No reference will be made in oral or written reports that could link participants to the research. We plan to publish the results in national or international journals or present at conferences. In any publication or presentation, information will be provided in such a way that you cannot be identified.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisors can help you with, please feel free to contact us on Fekede Kumsa, [redacted]@gmail.com, [redacted] or Professor Andrew Hayen Phone: +61[redacted] or Dr Yadeta Dessie [redacted]: [redacted]@yahoo.com]

You will be given a copy of this form to keep.

NOTE:

The Haramaya University Institutional Health Research Ethics Review Committee [IHRERC/200/2018], Addis Ababa Health Bureau Institutional Review Board [A/A/HB/2576/227] and the University of Technology Sydney Human Research Ethics Committee [UTS HREC18-2610] have approved this study. If you have any concerns or complaints about any aspect of

the conduct of this research, please contact Haramaya University Institutional Health Research Ethics Review Committee (IHRERC) at office on phone +251254662011 or P.O.Box 235, Harar, or the UTS Ethics Secretariat on phone : +61 2 9514 2478, or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

CONSENT FORM-WOMEN'S IN-DEPTH INTERVIEW

Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views [UTS HREC18-2610]

I _____ [participant's name] agree to participate in the research project "Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views", UTS HREC18-2610, being conducted by Fekede Kumsa, [redacted]@student.uts.edu.au and +251[redacted]. I understand that funding for this research has been provided by UTS Centre for Midwifery, Child and Family Health (for transcription of the audio recorded data) and Haramaya University
I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.
I agree to be:
☐ Audio recorded
☐ Interviewed

I agree that the research data gathered from this project may be published in a form that:
☐ Does not identify me in any way

I am aware that I can contact Andrew Hayen or Yadeta Dessie or Fekede Kumsa if I have any concerns about the research.

_____ ____/____/____
Name and Signature [participant] Date

_____ ____/____/____
Name and Signature [researcher or delegate] Date

Appendix 2c: PARTICIPANT INFORMATION SHEET-WOMEN'S FOCUS GROUP DISCUSSION

Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views [UTS HREC18-2610]

WHO IS DOING THE RESEARCH?

My name is Fekede Kumsa and I am a PhD student at UTS. My supervisor is Professor Andrew Hayen Phone: +61 email: Andrew.Hayen@uts.edu.au and my in-country supervisor is Dr Yadeta Dessie Phone: +251 email: @yahoo.com

WHAT IS THIS RESEARCH ABOUT?

This research is to describe weight gain during pregnancy women in Addis Ababa, central Ethiopia, with a focus on its patterns, determinants, birth weight of infants, women's and care provider's views.

FUNDING

Funding for this project has been received from UTS Centre for Midwifery, Child and Family Health (for transcription of audio recorded data) and Haramaya University

WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because you are a pregnant woman who is attending the Antenatal Clinic of a health facility in Addis Ababa and your experiences and views about weight gain in pregnancy are the focus of this study.

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate in this focus group discussion, I (or a research assistant) will meet with you and other pregnant women in a small group together to discuss a range of issues related to weight gain in pregnancy. We will be using a list of topics as a guide for our discussion to provide information that is helpful for the study. The topics to be discussed include: your perception and experiences in relation to weight gain in pregnancy, challenges in maintaining healthy weight gain in pregnancy, how pregnant women are managing weight gain and sensitivity of discussing your weight with health care providers, your eating and physical activity status. I would like to record the discussion to help us capture all points we raise. Your personal information will be deleted during the analysis, as only grouped information from all participants will be used. The interview will take about 60 to 90 minutes depending on the depth of our discussion.

ARE THERE ANY RISKS/INCONVENIENCE?

You may feel some discomfort in talking about your concerns with weight gain in pregnancy, or your views on the sensitivity of discussing your weight with health care providers, your weight, and factors that affect managing weight

gain during pregnancy. If this happens to you, you can decide whether you would like to continue or not. If you decide not to continue with the group discussion, you are free to leave and I will link you with your health care provider for further help and counselling.

DO I HAVE TO SAY YES?

No, you do not have to say yes. Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the health institution. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason.

If you decide to leave the research project, we will not collect additional personal information from you, although personal information already collected will be retained to ensure that the results of the research project can be measured properly. You should be aware that data collected up to the time you withdraw would form part of the research project results.

CONFIDENTIALITY

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially. There will be no information that will identify you in particular. The findings of the study will be general for the study community and will not reflect anything particular of individual persons or housing. No reference will be made in oral or written reports that could link participants to the research. We plan to publish the results in national or international journals or present at conferences. In any publication or presentation, information will be provided in such a way that you cannot be identified.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisors can help you with, please feel free to contact us on [Fekede Kumsa, [redacted]@gmail.com, [redacted] or Professor Andrew Hayen Phone: +61[redacted] or Dr Yadeta Dessie [redacted] [redacted]@yahoo.com]

You will be given a copy of this form to keep.

NOTE:

The Haramaya University Institutional Health Research Ethics Review Committee [IHRERC/200/2018], Addis Ababa Health Bureau Institutional Review Board [A/A/HB/2576/227] and the University of Technology Sydney Human Research Ethics Committee [UTS HREC18-2610] have approved this study. If you have any concerns or complaints about any aspect of the

conduct of this research, please contact Haramaya University Institutional Health Research Ethics Review Committee (IHRERC) on phone +251254662011 or P.O.Box 235, Harar, or the UTS Ethics Secretariat on phone : +61 2 9514 2478, or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

CONSENT FORM- WOMEN'S FOCUS GROUP DISCUSSION

Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views [UTS HREC18-2610]

I _____ [participant's name] agree to participate in the research project "Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views", UTS HREC18-2610, being conducted by Fekede Kumsa, [redacted]@student.uts.edu.au and +251[redacted]. I understand that funding for this research has been provided by UTS Centre for Midwifery, Child and Family Health (for transcription of the audio recorded data) and Haramaya University

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.
I agree to be:
☐ Audio recorded

I agree that the research data gathered from this project may be published in a form that:
☐ Does not identify me in any way

I am aware that I can contact Andrew Hayen or Yadeta Dessie or Fekede Kumsa if I have any concerns about the research.

_____ ____/____/____
Name and Signature [participant] Date

_____ ____/____/____
Name and Signature [researcher or delegate] Date

Appendix 2d: PARTICIPANT INFORMATION SHEET: HEALTH CARE PROVIDER KEY INFORMANT INTERVIEW

Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views [UTS HREC18-2610]

WHO IS DOING THE RESEARCH?

My name is Fekede Kumsa and I am a PhD student at UTS. My supervisor is Professor Andrew Hayen Phone: +61 -, email: Andrew.Hayen@uts.edu.au and my in-country supervisor is Dr Yadeta Dessie Phone: +251 : email @yahoo.com

WHAT IS THIS RESEARCH ABOUT?

This research is to describe gestational weight gain among pregnant women in Addis Ababa, central Ethiopia, with a focus on its patterns, determinants, birth weight of infants, women's and care provider's views.

FUNDING

Funding for this project has been received from UTS Centre for Midwifery, Child and Family Health and Haramaya University

WHY HAVE I BEEN ASKED?

You have been invited to participate in this key informant interview because you are a midwife or an obstetrician who is providing services in the Antenatal Clinic of a health facility in Addis Ababa and your counselling experiences and views about weight gain in pregnancy are the focus of this study.

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate in this key informant interview, I (or a research assistant) will meet with you to ask about your views on a range of issues related to weight gain in pregnancy. We will be using a list of topics as a guide for the interview to provide pertinent information that is helpful for the study. The topics to be discussed include: your perceptions and counselling experiences in relation to weight gain in pregnancy, the sensitivity of discussing pregnant women's weight, and your confidence while counselling pregnant women about nutrition. I would like to record the interview to help us capture all points we raise. Your personal information will be deleted during the analysis, as only grouped information from all participants will be used. The interview will take about 45 to 60 minutes depending on the depth of our discussion.

ARE THERE ANY RISKS/INCONVENIENCE?

The risk of participating in this study is minimal. Participation will take 45 to 60 minutes of your time.

DO I HAVE TO SAY YES?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the health institution. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting Fekede Kumsa ( ).

If you decide to leave the research project, we will not collect additional personal information from you, although personal information already collected will be retained to ensure that the results of the research project can be measured properly. You should be aware that data collected up to the time you withdraw would form part of the research project results.

CONFIDENTIALITY

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially. There will be no information that will identify you in particular. The findings of the study will be general for the study community and will not reflect anything particular of individual persons or housing. No reference will be made in oral or written reports that could link participants to the research. We plan to publish the results in national or international journals or present at conferences. In any publication or presentation, information will be provided in such a way that you cannot be identified.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact me us on Fekede Kumsa, @gmail.com , or Professor Andrew Hayen Phone: +61 or Dr Yadeta dessie : @yahoo.com

You will be given a copy of this form to keep.

NOTE:

The Haramaya University Institutional Health Research Ethics Review Committee [IHRERC/200/2018], Addis Ababa Health Bureau Institutional Review Board [A/A/HB/2576/227] and the University of Technology Sydney Human Research Ethics Committee [UTS HREC18-2610] have approved this study. If you have any concerns or complaints about any aspect of the conduct of this research, please contact Haramaya University Institutional Health Research Ethics Review Committee (IHRERC) on phone +251254662011 or P.O.Box 235, Harar or the UTS Ethics Secretariat on phone : +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote the

UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

CONSENT FORM: HEALTH CARE PROVIDER KEY INFORMANT INTERVIEW

Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views [UTS HREC18-2610]

I _____ [participant's name] agree to participate in the research project "Gestational Weight Gain in Central Ethiopia: Patterns, Determinants, Birth Weight, Women's and Care Provider's Views", UTS HREC18-2610, being conducted by Fekede, [redacted]@student.uts.edu.au and +251[redacted]. I understand that funding for this research has been provided by UTS Centre for Midwifery, Child and Family Health (for transcription of the audio recorded data) and Haramaya University

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I agree to be:

☐ Audio recorded

☐ Interviewed

I agree that the research data gathered from this project may be published in a form that:

☐ Does not identify me in any way

I am aware that I can contact Andrew Hayen or Yadeta Dessie or Fekede Kumsa if I have any concerns about the research.

_____ ____/____/____

Name and Signature [participant] Date

_____ ____/____/____

Name and Signature [researcher or delegate] Date

Appendix 3: Survey Questionnaire

1. Part I :Questions concerning socio-demographic characteristics

Name Health Institution_____. Name of data collector_____			
Name of participant_____. MRN_____. Phone number _____			
Date of interview_____. date of next appointment (25th week of GA)_____			
Code	Variables	Response	Skip
1.1.	Age	----------years	
1.2.	What is your marital status?	1.Never married 2.Married 3.Divorced 4.Widowed	
1.3.	What is your educational status?	1. Illiterate 2. Primary education (1-8) 3. Secondary education (9-12) 4. College and above	
1.4.	What is your partner's educational status?	1. Illiterate 2. Primary education (1-8) 3. Secondary education (9-12) 4. College and above	
1.5.	What is your occupational status?	1. Housewife 2. Government /Private employee 3. Merchant 4. Student 5. Daily laborer 6. Others specify _____	
1.6.	Your average household monthly income	_____ETB	

1.7.	You are living in	1. Your own house 2. Rental 3. Other (specify)	
1.8.	What is the main material of the floor of the dwelling	1. Natural floor (earth/sand/dung) 2. Rudimentary floor (wood plank, 3. Finished floor (polished wood, plastic tile, ceramic tile, cement, carpet) 4. Other specify ----------	
1.9.	What is the main material of the roof of the dwelling	1. Natural roofing (thatched or mud/sod) 2. Rudimentary roofing (plastic sheet/bamboo/wood plank/cardboard) 3. Finished floor (corrugated iron, plastic tile, ceramic tile, cement, roofing shingle) 4. Other specify ----------	
1.10.	Does your household have:		

		Yes	No
Electricity	.....	1	2
Watch/clock	.....	1	2
Radio	.....	1	2
Television	.....	1	2
Non-mobile telephone	.....	1	2
Refrigerator	.....	1	2
Table	.....	1	2
Chair	.....	1	2

		Bed with cotton/sponge/spring mattress ..... 1 2 Electric Mitad ..... 1 2 Kerosene/pressure lamp 1 2
1.11.	Does any member of your household own	Yes No a. Watch 1 2 b. Mobile telephone 1 2 c. Bicycle 1 2 d. Motorcycle/scooter 1 2 e. Animal-drawn cart 1 2 f. Car/truck 1 2 g. Boat with motor 1 2 h. Bagage 1 2
1.12.	What is the main source of water for member of the household?	a. Bottled water 1 b. Piped water Piped into the doweling 2 Piped into yard 3 Piped into neighbour 4 Public tab 5 c. Dung well 6 d. Spring 7 e. Other (specify) 8
1.13.	Where the source of water located	1. In own doweling 2. In own yard 3. Elsewhere
1.14.	What kind of toilet do the member of the household usually use?	a. Flush or pour flush toilet Flush to piped sewerage system 1 Flush to septic tank 2

		Flush to pit latrine	3
		Flush to somewhere else	4
		b. Pit latrine	5
		c. Other (specify)	6
1.15.	Do you share this toilet with other household	1. Yes 2. No	

2. Part: II Reproductive health history

2.1.	Type of pregnancy	1. Intended 2. Unintended 3. Mistimed	
2.2.	Date of LMP	_____DD/MM/YYYY	
2.3.	Gestational age	----------weeks (ultrasound report)	
2.4.	Gravidity	_____number	
2.5.	For multi gravidas, would you tell me the time between previous and current pregnancy?	_____in months	
2.6.	Parity	_____number	
2.7.	For multiparas, have you had history of a low birth weight baby (<2500g)	1. Yes 2. No	
2.8.	Previous history of abortion (before 28 weeks of gestation)	1. Yes 2. No	If no go to 2.10
2.9.	If yes in the above question, how many times?	_____numbers	
2.10.	Previous history of stillbirth (after 28 weeks of gestations)	1. Yes 2. No	If no, go to part III
2.11.	If yes in the above question, how many times?	_____numbers	

3. Part :II Perinatal depression: Edinburgh postnatal depression scale

3.1.	In the past seven days, I have been able to laugh and see the funny side of things:	1. As much as I always could 2. Not quite as much now	

		3. Definitely not so much now 4. Not at all	
3.2.	In the past seven days, I have looked forward with enjoyment to things:	1. As much as I ever did 2. Rather less than I used to 3. Definitely less than I used to 4. Hardly at all	
3.3.	In the past seven days, I have blamed myself unnecessarily when things went wrong:	1. Yes, most of the time 2. Yes, some of the time 3. Not very often 4. No, never	
3.4.	In the past seven days, I have been anxious or worried for no good reason:	1. No, not at all 2. Hardly ever 3. Yes, sometimes 4. Yes, very often	
3.5.	In the past seven days, I have felt scared or panicky for no very good reason:	1. Yes, quite a lot 2. Yes, sometimes 3. No, not much 4. No, not at all	
3.6.	In the past seven days, Things have been getting on top of me:	1. Yes, most of the time I haven't been able to cope at all 2. Yes, sometimes I haven't been coping as well as usual 3. No, most of the time I have coped quite well 4. No, I have been coping as well as ever	
3.7.	In the past seven days, I have been so unhappy that I have had difficulty sleeping:	1. Yes, most of the time 2. Yes, sometimes 3. Not very often 4. No, not at all	
3.8.	In the past seven days, I have felt sad or miserable	1. Yes, most of the time 2. Yes, quite often 3. Not very often	

		4. No, not at all	
3.9.	In the past seven days, I have been so unhappy that I have been crying:	1. Yes, most of the time 2. Yes, quite often 3. Only occasionally 4. No, never	
3.10	In the past seven days, the thought of harming myself has occurred to me:	1. Yes, quite often 2. Sometimes 3. Hardly ever 4. Never	

4. Part IV: Food security related questiones: Household Food Insecurity Access Scale (HFIAS)

	Questions	Response options (encircle one)	skip
4.1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No 1=Yes	If 0, go to question 4.2
4.1.1.	How often did this happen?	1 = Rarely (1x or 2x in the past four weeks) 2 = Sometimes (3x to 10x in the past four weeks) 3 = Often (>10x in the past four weeks)	
4.2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No 1=Yes	If 0, go to question 4.3
4.2.1.	How often did this happen?	1 = Rarely (1x or 2x in the past 4 weeks) 2 = Sometimes (3x to 10x in the past four weeks) 3 = Often (>10x in the past four weeks)	
4.3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No 1=Yes	If 0, to Q 4.4.

4.3.1.	How often did this happen?	1 = Rarely (1x or 2x in the past four weeks) 2 = Sometimes (3x to 10x in the past four weeks) 3 = Often (>10x in the past four weeks)	
4.4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No 1=Yes	If 0, go to question 4.5
4.4.1.	How often did this happen?	1 = Rarely (1x or 2x in the past four weeks) 2 = Sometimes (3x to 10x in the past four weeks) 3 = Often (>10x in the past four weeks)	
4.5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No 1=Yes	If 0, go to question 4.6
4.5.1.	How often did this happen?	1 = Rarely (1x or 2x in the past four weeks) 2 = Sometimes (3x to 10x in the past four weeks) 3 = Often (>10x in the past four weeks)	
4.6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No 1=Yes	If 0, go to question 4.7
4.6.1.	How often did this happen?	1 = Rarely (1x or 2x in the past four weeks) 2 = Sometimes (3x to 10x in the past four weeks) 3 = Often (>10x in the past four weeks)	

4.7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No 1=Yes	If 0, go to question 4.8
4.7.1.	How often did this happen?	1 = Rarely (1x or 2x in the past four weeks) 2 = Sometimes (3x to 10x in the past four weeks) 3 = Often (>10x in the past four weeks)	
4.8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No 1=Yes	If 0, go to question 4.9
4.8.1.	How often did this happen?	1 = Rarely (1x or 2x in the past four weeks) 2 = Sometimes (3x to 10x in the past four weeks) 3 = Often (>10x in the past four weeks)	
4.9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food	0 = No 1=Yes	If 0, go to part V
4.9.1.	How often did this happen?	1 = Rarely (1x or 2x in the past four weeks) 2 = Sometimes (3x to 10x in the past four weeks) 3 = Often (>10x in the past four weeks)	
5. Part V: Dietary diversity score questions			
Now I am going to ask you about different food you ate in the last 24 hours. Respond by saying yes or no. (please ask if there have been any parties/celebrations)			
5.1.	Any (INSERT ANY LOCAL FOODS, bread, rice noodles, biscuits, or any other foods made from millet, sorghum, maize, rice, wheat), or(INSERT ANY OTHER LOCALLY VAILABLE GRAIN)?	1. Yes 2. No	

5.2.	Any potatoes, yams, manioc, cassava or any other foods made B from roots or tubers?	1. Yes 2. No
5.3.	Any vegetables?	1. Yes 2. No
5.4.	Any fruits?	1. Yes 2. No
5.5.	Any beef, pork, lamb, goat, rabbit wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ meats?	1. Yes 2. No
5.6.	Any eggs?	1. Yes 2. No
5.6.	Any fresh or dried fish or shellfish?	1. Yes 2. No
5.7.	Any foods made from beans, peas, lentils, or nuts?	1. Yes 2. No
5.8.	Any cheese, yogurt, milk or other milk products?	1. Yes 2. No
5.9.	Any foods made with oil, fat, or butter?	1. Yes 2. No
5.10	Any sugar or honey?	1. Yes 2. No
5.11.	Any other foods, such as condiments, coffee, tea?	1. Yes 2. No
6. Part VI. Physical activity related questions: International Physical Activity Questionnaire(IPAQ)		
PART I: JOB-RELATED PHYSICAL ACTIVITY		

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.			
6.1.	Do you currently have a job or do any unpaid work outside your home?	1……. yes 2……..NO	If 2, go to 6.8.
6.2.	During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, heavy construction, or climbing up stairs as part of your work? Think about only those physical activities that you did for at least 10 minutes at a time.	1_____ days per week 2_____ No vigorous job-related physical activity	If 2, to question 6.4
6.3.	How much time did you usually spend on one of those days doing vigorous physical activities as part of your work?	_____ hours per day _____ minutes per day	
6.4.	Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads as part of your work? Please do not include walking.	1_____ days per week 2……No moderate job-related physical activity	If 2, to question 6.6
6.5.	How much time did you usually spend on one of those days doing moderate physical activities as part of your work?	_____ hours per day _____ minutes per day	
6.6.	During the last 7 days, on how many days did you walk for at least 10 minutes at a time	1_____ days per week 2……No job-related walking	If 2, to 6.8

	as part of your work? Please do not count any walking you did to travel to or from work.		
6.7.	How much time did you usually spend on one of those days walking as part of your work?	_____ hours per day _____ minutes per day	
PART II: TRANSPORTATION PHYSICAL ACTIVITY These questions are about how you travelled from place to place, including to places like work, stores, movies, and so on.			
6.8.	During the last 7 days, on how many days did you travel in a motor vehicle like a train, bus, car, or tram?	1. ____ days per week 2. No traveli1ng in a motor vehicle	If 2, go to 6.10
6.9.	How much time did you usually spend on one of those days traveling in a train, bus, car, tram, or other kind of motor vehicle?	_____ hours per day _____ minutes per day	
6.10	Now think only about the bicycling and walking you might have done to travel to and from work, to do errands, or to go from place to place. During the last 7 days, on how many days did you bicycle for at least 10 minutes at a time to go from place to place?	1. ____ days per week 2. No bicycling from place to place	If 2, go to 6.12
6.11	How much time did you usually spend on one of those days to bicycle from place to place?	_____ hours per day _____ minutes per day	

6.12	During the last 7 days, on how many days did you walk for at least 10 minutes at a time to go from place to place?	1. ____ days per week 2. No bicycling from place to place	If 2, go to 6.14
6.13	How much time did you usually spend on one of those days walking from place to place?	_____ hours per day _____ minutes per day	
PART III: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY This section is about some of the physical activities you might have done in the last 7 days in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.			
6.14	Think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, chopping wood, shovelling snow, or digging in the garden or yard?	1. days per week 2. No vigorous activity in garden or yard	If 2, go to 6.16
6.15	How much time did you usually spend on one of those days doing vigorous physical activities in the garden or yard?	_____ hours per day _____ minutes per day	
6.16	Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate activities like carrying light loads, sweeping, washing windows, and raking in the garden or yard?	1. _____ days per week 2. _____No moderate activity in garden or yard	If 2, go to 6.18

6.17	How much time did you usually spend on one of those days doing moderate physical activities in the garden or yard?	_____hours per day _____ minutes per day	
6.18	Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate activities like carrying light loads, washing windows, scrubbing floors and sweeping inside your home?	1. _____ days per week 2. No moderate activity inside home	If 2, go to 6.20
6.19	How much time did you usually spend on one of those days doing moderate physical activities inside your home?	_____hours per day _____minutes per day	
PART IV: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY This section is about all the physical activities that you did in the last 7 days solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.			
6.20	On how many days did you walk for at least 10 minutes at a time in your leisure time?	1. days per week 2. No walking in leisure time	If 2, go to 6.22
6.21	How much time did you usually spend on one of those days walking in your leisure time?	_____hours per day _____minutes per day	
6.22.	Think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like aerobics, running, fast bicycling, or fast swimming in your leisure time	1. days per week 2. No vigorous activity in leisure time	If 2, go to 6. 24
6.23	How much time did you usually spend on one of those days doing vigorous physical activities in your leisure time?	_____ hours per day _____ minutes per day	

6.24	Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis in your leisure time?	1.____days per week 2.____No moderate activity in leisure time	If 2, go to 6.26
6.25	How much time did you usually spend on one of those days doing moderate physical activities in your leisure time?	_____hours per day _____ minutes per day	
PART V: TIME SPENT SITTING The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.			
6.26	During the last 7 days, how much time did you usually spend sitting on a weekday?	_____hours per day _____ minutes per day	
6.27	During the last 7 days, how much time did you usually spend sitting on a weekend day?	_____ hours per day _____ minutes per day	

7. Part VII. Intimate partner violence questioner

7.1.	During this pregnancy has any of the following **physical violence happened to you by an intimate partner**			Yes	No
		a.	Was slapped or had something thrown at you that could hurt you	1	2
		b.	Was pushed or shoved	1	2
		c.	hit with fist or something else that could hurt you	1	2
		d.	Was kicked, drugged or beaten up	1	2
		e.	Was choked or burnt on purpose	1	2

		f. Perpetrator threatened to use or actually used a gun, knife or other weapon against you. 1 2
7.2.	During this pregnancy has any of the following sexual violence **happened to you by an intimate partner**	Yes No a. Was physically forced to have sexual intercourse when you did not want to 1 2 b. Had sexual intercourse when you did not want to because you were afraid of what partner might do 1 2 c. Was forced to do something sexual that you found degrading or humiliating 1 2
7.3.	During this pregnancy has any of the following **emotional abuse happened to you by an intimate partner**	Yes No a. Was insulted or made to feel bad about yourself 1 2 b. Was belittled or humiliated in front of other people 1 2 c. Perpetrator had done things to scare or intimidate you on purpose, e.g. by the way he looked at you r, by yelling or smashing things 1 2 d. Perpetrator had threatened to hurt someone you cared about 1 2

7.4.	During this pregnancy has any of the following **controlling behaviour happened to you by an intimate partner**		Yes	No
		He tried to keep you from seeing friends	1	2
		He tried to restrict contact with you family of birth	1	2
		He insisted on knowing where you were at all time	1	2
		He ignored you and treated you indifferently	1	2
		He got angry if you spoke with another man	1	2
		He was often suspicious that you were unfaithful	1	2
		He expected you to ask permission before seeking health care for yourself	1	2

8. Part VIII. Measurements and behavioral questions

8.1.	Have you measured your weight before pregnancy?	1. Yes (_____KG) 2. No	
8.2.	MUAC	_____cm	
8.3.	Weight	---------- in kg	
8.4.	Height	----------in metre	
8.5.	BP	_____mm/hg	
8.6.	Haemoglobin		
8.7	HIV status	1. Reactive 2. Non-reactive 3. Undetermined	Take from ANC registration
8.8.	Have you ever used any alcohol before this pregnancy	1. Yes 2. No	If no, go to 8.10
8.9.	If yes to the above question, on average how many days you drink per week	_____days	
8.10	Do you drink alcohol during this pregnancy	1. Yes 2. No	If no, go to 8.12
8.11.	If yes to the above question, on average how many days you drink per week	_____days	
8.12.	Have you ever smoked cigarettes before this pregnancy	1. Yes 2. No	If no, go to 8.14
8.13	If yes to the above question, on average how many days you smoke per week	_____days	

8.14.	Do you smoke cigarettes during this pregnancy	1. Yes 2. No	If no, go to 8.16
8.15.	If yes to the above question, on average how many days do you smoke per week	_____days	
8.16	Have you ever chewed khat before this pregnancy	1. Yes 2. No	If no, go to 8.18
8.17	If yes to the above question, on average how many days you chew per week	_____days	
8.18	Do you chew khat during this pregnancy	1. Yes 2. No	If no, go to 8.20
8.19	If yes to the above question, on average how many days do you chew per week	_____days	
8.20	Are you happy with your marital relationship	1. Yes 2. No	
8.21	How do you grade your quality of life	1. Excellent 2. Very good 3. Good 4. Bad 5. Worst	

1. አጠቃላይ መጠይቅ

የጤና ተቋሙ ስም----------የመረጃ ሰብሳቢዉ ስም----------		
የተሳታፊ ስም----------የካርድ ቁጥር----------ስልክ ቁጥር----------		
መጥየቁ የተደረገበት ቀን----------የቀጠሮ ቀን (24th to 25th weeks GA)----------		
ክፍል 1፡ አጠቃላይ መጠይቅ		
ተ.ቁ	**ጥያቄ**	**መልስ**
1.1.	እድሜሽ ስንት ነዉ	----------በዓመት
1.2.	የጋብቻዎት/ሽ ሁኔታ ምን ይመስላል	1. ያገባች 2. ያላገባች 3. ባሏ የሞተባት 4. የተለያዬች/የፈታች
1.3.	ያጠናቀቅሺዉ ከፍተኛ የትምህርት ደረጃ?	1. አልተማርኩም 2. አንደኛ ደረጃ (1-8) 3. ሁለተኛ ደረጃ(9-12) 4. ኮሌጅና ከዝያ በላይ
1.4.	የትዳር ጓደኛሽ ያጠናቀቀዉ ከፍተኛ የትምህርት ደረጃ?	1. አልተማረም 2. አንደኛ ደረጃ (1-8) 3. ሁለተኛ ደረጃ(9-12) 4. ኮሌጅና ከዝያ በላይ 5. አላዉቅም
1.5.	ስራሽ ምንድን ነው?	1. የቤት እመቤት 2. የመንግስት/የግል መ/ቤት ሰራተኛ 3. ነጋዴ 4. ተማሪ 5. የቀን ሰራተኛ 6. ሌላ(ይጠቀስ)----------
1.6.	በአማካይ የቤተሰብ የወር ገቢ ስንት ነዉ	----------ብር
1.7.	የምትኖሩበት ቤት	1. የራስሽ 2. የኪራይ 3. ሌላ ይጠቀስ----------
1.8.	የቤትሽ ወለል ከምን የተሰራ ነው	5. የተፈጥሮ ወለል (አፈር/በከብቶች እበት የተለሰነ) 6. ረድመንተሪ (ሽንቦቆ/የእንጨት ርብራብ) 7. ያለቀለት ወለል (ያለቀለት እንጨት፤ ስሚንቶ ሴራሚክስ ምንጣፍ) 8. ሌላ ይጠቀስ----------
1.9.	የቤትሽ ጣራ ከምን የተሰራ ነው	1. የተፈጥሮ ጣራ (ሳር፤ አፈር)

		2. ረድመንተሪ ጣራ (ላስትክ፣ሸምቦቆ፣ካርቶን) 3. ያለቀለት ጣራ (ያለቀለት እንጨት፤ ስሚንቶ ሴራሚክስ) 4. ሌላ ይጠቀስ----------
1.10.	ቤትሽ ዉስጥ እነዝህን ቁሳቁሶች አሉሽ	<u>አዎ</u> <u>አይ</u> 1. መብራት 1 2 2. የጊርጊዳ ሰዓት 1 2 3. ራዲዮ 1 2 4. ቴሌቪዥን 1 2 5. የቤት ስልክ 1 2 6. ፍሪጅ 1 2 7. ጠረጴዛ 1 2 8. ወንበር 1 2 9. አልጋ ከነፍራሹና ትራሱ 1 2 10. የኤሌክትሪክ ምድጃ 1 2 11. ክሮሲን/ማብራት ስሊንደር 1 2
1.11.	ማንኛዉም የቤተሰብ አካል የሆነ ሰው የሚከተሉትን ቁሳሶች አሉት	<u>አዎ</u> <u>አይ</u> 1. የእጅ ሰዓት 1 2 2. የሞባይል ስልክ 1 2 3. ቢስኪሌት 1 2 4. ሞተር ሳይክል/ስኩተር 1 2 5. ጋሪ 1 2 6. መኪና/ተሸከርካሪ 1 2 7. ባጃጅ 1 2
1.12.	የቤተሰብ አባል ለመጠጥ የሚዉል ዉሃ ምን ይጠቀማል	የታሸገ ዉሃ 1 የቧንቧ ዉሃ ቤት ዉስጥ የገባ 2 ጊቢ ዉስጥ የገባ 3 ከጎረቤት 4 ከቦኖ 5 የጉድጓድ ዉሃ 6 የዝናብ/የታንከር/የወንዝ 7 ሌላ(ይጠቀስ) 8
1.13.	የቤተሰብ አባል የሚጠቀመዉ የመጸዳጃ አይነት ምንድን ነዉ	a. በዉሃ የሚሰራ መጸዳጃ (flash atrine) ወደ የፍሳሽ ቱቦ የሚፈስ 1 ወደ ሴፕትክ ታንክ የሚፈስ 2 ወደ ጉድጓድ ሽንት ቤት የሚፈስ 3

		ወደ ሌላ ቦታ የሚፈስ 4 b. የግድጓድ መጸዳጃ (pit latrine) 5 c. ሌላ (ይጠቀስ) 6
1.14.	ይህን መጸዳጃ ከሌላ ቤተሰብ ጋር ትጋራላቹ	1. አዎ እንጋራለን 2. አንጋራም

2. ክፍል 2. የስነ ተዋልዶ ጥያቄ

2.1.	ለመጨረሻ ጊዜ የወር አበባ ያየሽዉ መቼ ነው (LMP)	----------ቀን/ወር/ዓ.ም
2.2.	እርግዚናዉ ምን ያህል ሆነዉ(ወደ ሳምንት ቀይረዉ/ሪዉ)	----------በሳምንት (የአልተራሳዎንድ ሪፖርት)
2.3.	ይሄ እርግዝና	1. ተፈልጎ የተረገዘ 2. ያልተፈለገ 3. ያለጊዜዉ የተረገዘ
2.4.	እስካሁን ስንቴ አርግዘሻል	----------በቁጥር
2.5.	**(ከአንድ በላይ ካረገዘች)**፤ በዝህ እና በባለፈዉ እርግዝና መሀል ያለዉ ጊዜ ምን ያክል ነው	----------በወር
2.6.	እስካሁን ስንቴ ወልደሻል **(በህይወት የተወለደ ልጅ)**	----------በቁጥር
2.7.	**(ከዚህ በፊት ወልዳ የምታዉቅ ከሆነ)**፤ ክብደቱ ትንሽ ወይም ከ2.5 ኪሎግራም በታች ልጅ ወልደሻል	1. ኣዎ 2. ኣይ
2.8.	ዉርጃ ኣጋጥሞሽ ያዉቃል (ከ 28 ሳምንት በታች ዕድሜ ያለው እርግዝና)	1. ኣዎ 2. ኣይ
2.9.	**ዉርጃ ካጋጠማት**፤ ስንት ጊዜ	----------በቁጥር
2.10.	ሆድ ዉስጥ ሞቶ የተወለደ ልጅ ነበር (ከ 28 ሳምንት በላይ ዕድሜ ያለው እርግዝና)	1. ኣዎ 2. ኣይ
2.11.	**ሆድ ዉስጥ ሞቶ የተወለዳ ካለ**፤ ስንት ጊዜ	----------በቁጥር

3. ክፍል 3፡ ከእርግዚና በፊት በሚከሰተዉ የኣህምሮ ጭንቀት የሚጠይቅ መጠይቅ

አሁን ከስነ አዕምሮ ጋር የተገናኙ ጥያቄዎችን እጠይቅሻለሁ፡፡		
3.1.	ባለፉት ሰባት ቀናት ውስጥ መሳቅና የነገሮችን በአስደሳች ጎን ማየት ችለሻል?	1. ሁሌ እንደማደረገው 2. ከበፊቱ ያነሰ ነው 3. ከበፊቱ በጣም ያነሰ ነው 4. በጭራሽ እንደዛ ኣልተሰማኝም
3.2.	ባለፉት ሰባት ቀናት ውስጥ መጪውን ሁኔታ በደስታ ማየት ችለሻል?	1. አዎ ሁሌም እንማደርገው 2. በፊት ከማደርገው አነስ ያለ 3. በፊት ከማደርገው በጣም ያነሰ 4. በጭራሽ እንደዛ ማየት አልቻልኩም

3.3.	ባለፉት ሰባት ቀናት ውስጥ ነገሮች ወደ አላስፈላጊ ሁኔታ ሲያመሩ ያለምክንያት እራስሽን ወቅሰሻል?	1. አዎ አብዛኛዉን ጊዜ 2. አዎ አልፎ አልፎ 3. እንብዛም አይደለም 4. በጭራሽ አላደረኩም
3.4.	ባለፉት ሰባት ቀናት ውስጥ ያለምንም በቂ ምክንያት ተሸብረሽ ወይም ተጨንቀሽ ታዉቂያለሽ?	1. በጭራሽ 2. ከቁጥር ለማይገባ ጊዜ 3. አዎን፤ አልፎ አልፎ 4. አዎ በጣም ብዙ ጊዜ
3.5.	ባለፉት ሰባት ቀናት ውስጥ ያለምንም በቂ ምክንያት የፍርሃትና የድንጋጤ ስሜት ተሰምቶሽ ያውቃል?	1. አዎ አብዛኛዉን ጊዜ 2. አዎ አልፎ አልፎ 3. እንብዛም አይደለም 4. በጭርራሽ አልተሰማኝም
3.6.	ባለፉት ሰባት ቀናት ውስጥ ነገሮች ከቁጥጥርሽ ውጭ ሆኖብሽ ያውቃል?	1. አዎ ብዙ ጊዜ ነገሮችን በአጠቃሊይ መቋቋም ኣልቻልኩም ነበር 2. አዎ አልፎ አልፎ ነገሮችን እንደበፊቱ መቋቋም አልቻልኩም ነበር 3. አይ ብዙ ጊዜ በጥሩ ሆኔታ ነገሮችን ተቋቁሜ ነበር 4. አይ ልክ እንደበፊቱ በጥሩ ሁኔታ ነገሮችን ተቋቁሜ ነበር
3.7.	ባለፉት ሰባት ቀናት ውስጥ በጣም ደስተኛ ባለመሆንሽ እንቅልፍ እምቢ ብሎሽ ያውቃል?	1. አዎ በጣም ብዙውን ጊዜ 2. አዎ ብዙውን ጊዜ 3. በጣም ብዙ ጊዜ ባይሆንም 4. በጭራሽ አላጋጠመኝም
3.8.	ባለፉት ሰባት ቀናት ውስጥ የሀዘንና የብስጭት ስሜት ተሰምቶሽ ያውቃል?	1. አዎ በጣም ብዙውን ጊዜ 2. አዎ ብዙውን ጊዜ 3. በጣም ብዙ ጊዜ ባይሆንም 4. በጭራሽ ተሰምቶኝ ኣያዉቅም
3.9.	ባለፉት ሰባት ቀናት ውስጥ በጣም ከማዘንሽ የተነሳ አልቅሰሽ ታውቂያለሽ?	1. አዎ አብዛኛውን ጊዜ 2. አዎ ብዙ ጊዜ 3. አልፎ አልፎ ብቻ 4. በፍጹም ኣልቂሼ ኣላዉቅም
3.10.	ባለፉት ሰባት ቀናት ውስጥ እራስሽን ለመጉዳት አስበሽ ታውቂያለሽ?	1. በጣም ብዙ ጊዜ 2. አልፎ አልፎ 3. እምብዛም አይደለም 4. በጭራሽ/መቼም

4. ክፍል 4፡ ከምግብ ዋስትና ጋር የተያያዘ መጠይቅ፡፡ (በቤት ዉስጥ የምግብ ችግር መለኪያ ስኬል)

አሁን ከምግብ ዋስትና ጋር የተገናኘ ጥያቄ እጠይቅሻለሁ			
ተ.ቁ	መጠይቅ	መልሱን ያክብቡ	ይለፉት

4.1.	ላለፉት አራት ሳምንታት በቤት ውስጥ በቂ ምግብ የለም ብለሽ ተጨንቀሽ ነበር?	1. አዎ 2. አልተጨነኩም	መልሷ 2 ከሆነ ተ.ቁ 4.2 ይለፉ
4.1.1.	ችግሩ ለምን ያህል ጊዜ ተከስቶ ነበር?	1. በጣም ጥቂት ጊዜ (1-2 ጊዜ) 2. ኣልፎ ኣልፎ (3-10 ጊዜ) 3. ብዙ ጊዜ (10 ጊዜ በላይ)	
4.2.	ባለፉት አራት ሳምንታት አንቺ ወይም ማንኛውም የቤተሰብ አባል በምግብ እጥረት ምክንያት የፈለጋችሁትን ምግብ ማገኘት ወይም መመገብ አልቻላቹም ነበር?	1. አዎ 2. ኣልነበረም	መልሷ 2 ከሆነ ተ.ቁ 4.3 ይለፉ
4.2.1.	ችግሩ ለምን ያህል ጊዜ ተከስቶ ነበር?	1. በጣም ጥቂት ጊዜ (1-2 ጊዜ) 2. ኣልፎ ኣልፎ (3-10 ጊዜ) 3. ብዙ ጊዜ (10 ጊዜ በላይ)	
4.3.	ባለፉት አራት ሳምንታት አንቺ ወይም ማንኛውም የቤተሰብ አባል በአቅርቦት እጥረት ምክንያት የተወሰነ ምግብ ብቻ ትመገቡ ነበር?	1. አዎ 2. ኣልነበረም	መልሷ 2 ከሆነ ተ.ቁ 4.4 ይለፉ
4.3.1.	ችግሩ ለምን ያህል ጊዜ ተከስቶ ነበር?	1. በጣም ጥቂት ጊዜ (1-2 ጊዜ) 2. ኣልፎ ኣልፎ (3-10 ጊዜ) 3. ብዙ ጊዜ (10 ጊዜ በላይ)	
4.4.	ባለፉት አራት ሳምንታት አንቺ ወይም ማንኛውም የቤተሰብ አባል የሚትፈልጉትን ምግብ ማገኘት ባለመቻላቹ የማትፈልጉትን ምግብ ተመግባቹ ነበር?	1. አዎ 2. ኣልነበረም	መልሷ 2 ከሆነ ተ.ቁ 4.5 ይለፉ
4.4.1.	ችግሩ ለምን ያህል ጊዜ ተከስቶ ነበር?	1. በጣም ጥቂት ጊዜ (1-2 ጊዜ) 2. ኣልፎ ኣልፎ (3-10 ጊዜ) 3. ብዙ ጊዜ (10 ጊዜ በላይ)	
4.5.	ላለፉት አራት ሳምንታት አንቺ ወይም ማንኛውም የቤተሰብ አባል በቂ ምግብ ባለመኖሩ ምክንያት ሲትመገቡ ሳትጠግቡ የቀራችሁበት ጊዜ ነበር?	1. አዎ 2. ኣልነበረም	መልሷ 2 ከሆነ ተ.ቁ 4.6 ይለፉ
4.5.1.	ችግሩ ለምን ያህል ጊዜ ተከስቶ ነበር?	1. በጣም ጥቂት ጊዜ (1-2 ጊዜ) 2. ኣልፎ ኣልፎ (3-10 ጊዜ) 3. ብዙ ጊዜ (10 ጊዜ በላይ)	
4.6.	ላለፉት አራት ሳምንታት እርስዎ ወይም ማንኛውም የቤተሰብ አባል በቂ ምግብ ባለመኖሩ ምክንያት በቀን ውስጥ ጥቂት ምግብ ይመገቡ ነበር?	1. አዎ 2. ኣልነበረም	መልሷ 2 ከሆነ ተ.ቁ 4.7 ይለፉ
4.6.1.	ችግሩ ለምን ያህል ጊዜ ተከስቶ ነበር?	1. በጣም ጥቂት ጊዜ (1-2 ጊዜ) 2. ኣልፎ ኣልፎ (3-10 ጊዜ) 3. ብዙ ጊዜ (10 ጊዜ በላይ)	
4.7.	ላለፉት አራት ሳምንታት በቤት ውስጥ ብዙ ጊዜ በሀብት እጥረት ምክንይት የሚበላ ምግብ ጠፍቶ ነበር?	1. አዎ 2. ኣልነበረም	መልሷ 2 ከሆነ ተ.ቁ 4.8 ይለፉ
4.7.1.	ችግሩ ለምን ያህል ጊዜ ተከስቶ ነበር?	1. በጣም ጥቂት ጊዜ (1-2 ጊዜ) 2. ኣልፎ ኣልፎ (3-10 ጊዜ) 3. ብዙ ጊዜ (10 ጊዜ በላይ)	

4.8.	ላለፉት አራት ሳምንታት እርስዎ ወይም ማንኛውም የቤተሰብ አባል በቂ ምግብ ባለመኖሩ ምክንያት እየራበው የሚተኛ ነበር?	1. አዎ 2. አልነበረም	መልሷ 2 ከሆነ ተ.ቁ 4.9 ይለፉ
4.8.1.	ችግሩ ለምን ያህል ጊዜ ተከስቶ ነበር?	1. በጣም ጥቂት ጊዜ (1-2 ጊዜ) 2. ኣልፎ ኣልፎ (3-10 ጊዜ) 3. ብዙ ጊዜ (10 ጊዜ በላይ)	
4.9.	ላለፉት አራት ሳምንታት እርስዎ ወይም ማንኛውም የቤተሰብ አባል በቂ ምግብ ባለመኖሩ ምክንያት ሙሉ ቀንና ማታ ሳትመገቡ የቀራችሁበት ጊዜ አለ ?	1. አዎ 2. ኣልነበረም	መልሷ 2 ከሆነ ተ.ቁ 5.1 ይለፉ
4.9.1.	ችግሩ ለምን ያህል ጊዜ ተከስቶ ነበር?	1. በጣም ጥቂት ጊዜ (1-2 ጊዜ) 2. ኣልፎ ኣልፎ (3-10 ጊዜ) 3. ብዙ ጊዜ (10 ጊዜ በላይ)	

5. . ክፍል 5፡ የሚመገቡት የምግብ ኣይነት መለኪያ መጠይቅ

ተ.ቁ	**መጠይቅ**	**ምርጫ(አክብብ)**
	አሁን, በ24 ሰኣት ውስጥ ቤተብሽ የተለያዩ አይነት ምግቦች ተመግበው እንደሆን እጠይቆሻለሁ:: አንቺም በእያንዳንዱ የምግብ ምድቦች ተመግቢያለሁ ወይም አልትመገብኩም በማለት መልሺልኝ:: (በቤት ውስጥ የተለየ የምግብ ድግስ ተደርጐ ከነበር እባከዎን ይጠይቁ)	
5.1.	እህል (ጤፍ ስንዴ ገብስ በቀሎ ሩዝ እንዲሁም የነዚህ ውጤት የሆኑት ገንፎ ፓስታ ማካሮኒና ሌሎችም	1-አዎ----------2----------ኣይ
5.2.	ስራስር (ድንች፣ማንኛዉም የስር ተክል፣ካሳቫ	1-አዎ----------2---------ኣይ
5.3.	ቅጠላቅጠል/አትክልት	1-አዎ----------2----------ኣይ
5.4.	ፍራፍሬ	1-አዎ----------2----------ኣይ
5.5.	ስጋ/የዶሮ/የወፍ ዘሮች የሚበሉ ስጋ	1-አዎ---------2----------ኣይ
5.6.	እንቁላል	1-አዎ----------2----------ኣይ
5.7.	አሳና የባህር ምግቦች	1-አዎ----------2----------ኣይ
5.8.	የቅባት እህል/ባቄላ መሰል ጥራጥሬ	1-አዎ----------2----------ኣይ
5..9.	ወተትና የወተት ውጤቶች	1-አዎ----------2----------ኣይ
5.10.	ዘይት/ፈሳማ	1-አዎ----------2----------ኣይ
5.11.	ስኳር/ማር	1-አዎ----------2----------ኣይ

6. ክፍል 6፡ ከኣካል እንቅስቃሴ ጋር የተያያዘ መጠይቅ:: (ኣለም ኣቀፍ የኣካል እንቅስቃሴ መለኪያ ማጠይቅ)

ክፍል 1፤ ከስራ ጋር የተገናኘ እንቅስቃሴ የመጀመሪያ ክፍል ስለስራሽ ነው:: ይህም ማንያዉም ከቤት ዉጭ የሚሰራ ስራ፤ በክፍያ የሚሰራ፤ የእርሻ፤ የበጎ ፍቃድ፤ እንዲሁም ያለክፍያ ከቤት ዉጭ የሚሰሩ ስራዎችን ያካትታል:: **(በቤት ኣካባቢ ያለክፍያ የሚሰሩ ስራዎች ማለትም የቤት ዉስጥ ስራ፤ አጥር ማጠር፤ የጥገና እንዲሁም የቤተሰብ እንክብካቤን ኣያጠቃልልም::)**			
6.1.	በዚህን ጊዜ በክፍያም ሆነ ያለክፍያ የሚሰራ ስራ አልሽ	ሀ. አልኝ----------1 ለ. የለኝም---------2	መልሱ 2 ከሆነ ወደ 6.8. (እለፍ

6.2.	ባለፉት ሰባት ቀናት ዉስጥ ለስንት ቀን ከበድ ያሉ እንቅስቃሴወች ማለትም ከበድ ያለ ነገር ማንሳት፤ ቁፋሮ፤ ከባድ ግንባታ ወይም ዳገት መዉጣት የመሳሰሉትን እንደ አንዱ የስራሽ አካል ላከናወንሽ **ብያንስ ለ 10 ደቂቃ የሰራሻቸዉን የአካል እንቅስቃሴ በማሰብ መልሽልኝ፡፡**	1. ------ቀናት በሳምንት 2. ከሰራ ጋር የተገናኘ ከባድ የአካል እንቅስቃሴ የለም	መልሱ 2 ከሆነ ወደ - ክፍል 6.4. እለፍ
6.3.	የስራሽ አንዱ አካል የሆነዉን ይህን ከባድ የአካል እንቅስቃሴ ከቀናቶቹ በአንዱ ምን ያክል ትቆይበታለሽ	1---------ሰዓት በቀን 2.----------ደቂቃ በቀን	
6.4.	**አሁንም ብያንስ ለ 10 ደቂቃ የሰራሻቸዉን የአካል እንቅስቃሴ በማሰብ፤** ባለፉት ሰባት ቀናት ዉስጥ ለስንት ቀን መካከለኛ እንቅስቃሴ ማለትም አነስ ያለ ነገር ማንሳትን እንደ አንዱ የስራሽ አካል ላከናወንሽ **እባክሽ በእግር ማሄድን አትጨምሪ**	1. ------ቀናት በሳምንት 2. ከሰራ ጋር የተገናኘ መካከለኛ የአካል እንቅስቃሴ የለም	መልሱ 2 ከሆነ ወደ ክፍል 6.6 እለፍ
6.5.	የስራሽ አንዱ አካል የሆነዉን ይህን መካከለኛ የአካል እንቅስቃሴ ከቀናቶቹ በአንዱ ምን ያክል ትቆይበታለሽ	1---------ሰዓት በቀን 2.----------ደቂቃ በቀን	
6.6.	ባለፉት ሰባት ቀናት ዉስጥ ለስንት ቀን ቢያንስ ለ 10 ደቂቃ እንደ ስራሽ አንዱ አካል በእግርሽ ተጓዝሽ **እብክሽ ወደ ስራ ወይም ከስራ መልስ በእግር የተጓሽዉን አትቁጠሪ**	1. ------ቀናት በሳምንት 2. ከሰራ ጋር የተገናኘ የእግር ጉዞ የለም	መልሱ 2 ከሆነ ወደ 6.8 እለፍ
6.7.	የስራሽ አንዱ አካል የሆነዉን ይህን የእግር ጉዞ ከቀናቶቹ በአንዱ ባብዛኛው ምን ያክል ትጓጓለሽ	1---------ሰዓት በቀን 2.----------ደቂቃ በቀን	
ክፍል 2፤ ከመጓጓዣ ጋር የተገኛኘ እንቅስቃሄ እነዝህ ጥያቄዎች ከቦታ ቦታ እንቅስቃሴን ማለትም፤ ከስራ ቦታ፤ ከእቃ ማከማቻ፤ ፊልምና የመሳሰሉትን ያካትታሉ			
6.8.	ባለፉት ሰባት ቀናት ዉስጥ ለስንት ቀን በሞተር በሚንቀሳቀሱ ተሸከርካሪዎች እንደ ባቡር፣አዉቡስ፣ በታክሲ ወይም የቤት መኪና ተጓዝሽ	1. ----------ቀናት በሳምንት 2. በሞተር በሚንቀሳቀሱ ተሸከርካሪዎች አልተንቀሳቀስኩም	መልሱ 2 ከሆነ ወደ ተ.ቁ 6.10 እለፍ
6.9.	ከቀናቶቹ በአንዱ ምን ያክል በሞተር በሚንቀሳቀሱ ተሸከርካሪዎች እንደ ባቡር፣ አዉቡስ፣ በታክሲ፤ የቤት መኪና ወይም ማንኛዉም በሞተር በሚንቀስ ተሸከርካሪ ተጓዝሽ	1---------ሰዓት በቀን 2.----------ደቂቃ በቀን	
6.10.	**አሁን በብስኪሌት ወይም የእግር ብቻ በመጠቀም ወደስራ ወይም ከስራ መልስ፤ በቤት አካባቢ፤ ወይም ከቦታ ወደቦታ ጉዞሽን አስቢ፡፡** ባለፉት ሰባት ቀናት ዉስጥ ለስንት ቀን ቢያንስ ለ 10 ደቂቃ ቢስኪሌት በመጠቀም ከቦታ ወደቦታ ተጓዝሽ	1. ------ቀናት በሳምንት 2. በስኪሌት ከቦታ ቦታ አልተንቀሳቀስኩም	መልሱ 2 ከሆነ ወደ ተ.ቁ 6. 12 እለፍ
6.11.	ባብዛኛው ጊዜ ከቀናቶቹ በአንዱ ቢስኪሌት በመጠቀም ከቦታ ወደ ቦታ ምን ያክል ትጓጓለሽ	1----------ሰዓት በቀን 2.----------ደቂቃ በቀን	
6.12.	ባለፉት ሰባት ቀናት ዉስጥ ለስንት ቀን ቢያንስ ለ 10 ደቂቃ በእግር ከቦታ ወደቦታ ተጓዝሽ	1. -------ቀናት በሳምንት 2. በእግ ከቦታ ቦታ አልተንቀሳቀስኩም	መልሱ 2 ከሆነ ወደ 6.14 ለፍ
6.13.	ባብዛኛው ጊዜ ከቀናቶቹ በአንዱ በእግር ከቦታ ወደ ቦታ ምን ያክል ትጓጓለሽ	1----------ሰዓት በቀን	

		2.----------ደቂቃ በቀን	
ክፍል 3፤ የቤት ዉስጥ ስራ፤ ጥገናዎች እና የቤተሰብ እንክብካቤ ይሄ ክፍል ባለፉት 7 ቀናት ዉስጥ በቤትሽ አካባቢ ያደረግሽዉን እንቅስቃሴ ማለትም የቤት ዉስጥ ስራ፤ የአተክልት፤ አጥር፤ ጠቅላላ ጥገና እና የቤተሰብ እንክብካቤ የመሳሰሉትን ይመለከታል፡፡			
6.14.	**ቢያንስ ለ 10 ደቂቃ ያደረግሽዉን የአካል እንቅስቃሴ አስቢ፡፡** ባለፉት 7 ቀናት ዉስጥ ለስንት ቀን ከበድ ያሉ እንቅስቃሴ ማለትም ከበድ ያለ ነገር ማንሳት፤ እንጨት መቁረጥ/መፍለጥ የአተክልት ወይም የአጥር ቁፋሮ፤ ከወንሽ	1. ------ቀናት በሳምንት 2. ከባድ የአካል እንቅስቃሴ የለም	መልሱ 2 ከሆነ ወደ ተ.ቁ 6.16 ለፍ
6.15.	ከቀናቶቹ አንዱን በመዉሰድ አብዛኛው ጊዜ ይህን ከባድ እንቅስቃሴ ምን ያክል ትቆይበታለሽ	1----------ሰዓት በቀን 2.----------ደቂቃ በቀን	
6.16.	**አሁንም ብያንስ ለ 10 ደቂቃ የሰራሻቸዉን የአካል እንቅስቃሴ ብቻ አሲቢ፡፡** ባለፉት ሰባት ቀናት ዉስጥ ለስንት ቀን ጊቢሽ ዉስጥ መካከለኛ የአካል እንቅስቃሴ ማለትም አነስ ያለ ነገር ማንሳትን፤ ግቢ መጥረግ፤ መስኮት ማጠብ፤ ሳር ማጨድ/አተክልት መኮርከም፤ ከወንሽ	1. ------ቀናት በሳምንት 2. ጊቢ ዉስጥ መካከለኛ የአካል እንቅስቃሴ የለም	መልሱ 2 ከሆነ ወደ ተ.ቁ 6. 18 እለፍ
6.17.	ከቀናቶቹ አንዱን በመዉሰድ አብዛኛው ጊዜ ጊቢሽ ዉስጥ ይህን መካከለኛ የአካል እንቅስቃሴ ምን ያክል ትቆይበታለሽ	1----------ሰዓት በቀን 2.----------ደቂቃ በቀን	
6.18.	**አሁንም ብያንስ ለ 10 ደቂቃ የሰራሻቸዉን የአካል እንቅስቃሴ ብቻ አሲቢ፡፡** ባለፉት ሰባት ቀናት ዉስጥ ለስንት ቀን ቤትሽ ዉስጥ መካከለኛ የአካል እንቅስቃሴ ማለትም አነስ ያለ ነገር ማንሳትን፤ ቤት መጥረግ፤ መስኮት ማጠብ፤ ወለል ማጽዳት፤ ከወንሽ	1. ------ቀናት በሳምንት 2. ጊቢ ዉስጥ መካከለኛ የአካል እንቅስቃሴ የለም	መልሱ 2 ከሆነ ወደ 6.20እለፍ
6.19.	ከቀናቶቹ አንዱን በመዉሰድ አብዛኛው ጊዜ ቤትሽ ዉስጥ ይህን መካከለኛ የአካል እንቅስቃሴ ምን ያክል ትቆይበታለሽ	1----------ሰዓት በቀን 2.----------ደቂቃ በቀን	
ክፍል 4፤ የመዝናኛ፤ እስፖርት፤ እንዲሁም የትርፍ ጊዜ የአካል እንቅስቃሴ ይህ ክፍል ባለፉት ሰባት ቀናት ዉስጥ ለመዝናኛ፤ ለእስፖርት፤ እንቅስቃሴና የትርፍ ጊዜ የአካል እንቅስቃሴ ያደረግሽዉን ቢቻ ይመለከታል፡፡ እባክሽ ከዝህ በፊት የነገርሽኝን እንቅስቃሴ አታካትቺ፡፡			
6.20.	ብዙ ቀናት በትርፍ ጊዜሽ ብያንስ ለ 10 ደቂቃ በ እግርሽ ትጓዢ ነበር	1. ------ቀናት በሳምንት 2. በትርፍ ጊዜዬ በእግር አልንቀሳቀስም	መልሱ 2 ከሆነ ወደ ተ.ቁ 6. 22 እለፍ
6.21.	ከቀናቶቹ አንዱን በመዉሰድ አብዛኛው ጊዜ ይህን የእግር ጉዞ ምን ያክል ትቆይበታለሽ	1----------ሰዓት በቀን 2.----------ደቂቃ በቀን	
6.22.	አሁንም ብያንስ ለ 10 ደቂቃ የሰራሻቸዉን የአካል እንቅስቃሴ ብቻ አሲቢ፡፡ ባለፉት ሰባ ቀናት ዉስጥ ለስንት ቀን በመዝናኛ ጊዜሽ ከባድ የአካል እንቅስቃሴ ማለትም ኤሮቢክስ፤ ሩጫ፤ በፍጥነት ቢስኪሌት መጋለብ፤ የፍጥነት ዋና ከወናሽ	1. ------ቀናት በሳምንት 2. በትርፍ ግዜሄ ከባድ የአካል እንቅስቃሴ አላደረኩም	መልሱ 2 ከሆነ ወደ ተ.ቁ 6.24እለፍ
6.23.	ከቀናቶቹ አንዱን በመዉሰድ አብዛኛው ጊዜ በትርፍ ጊዜሽ ይህን ከባድ የአካል እንቅስቃሴ ምን ያክል ትቆይበታለሽ	1----------ሰዓት በቀን	

		2.----------ደቂቃ በቀን	
6.24.	አሁንም ብያንስ ለ 10 ደቂቃ የሰራሻቸዉን የኣካል እንቅስቃሴ ብቻ አሲቢ፡፡ ባለፉት ሰባት ቀናት ዉስጥ ለስንት ቀን በመዝናኛ ጊዜሽ መካከለኛ የአካል እንቅስቃሴ ማለትም በመካከለኛ ፍጥነት ቢስኪሌት መጋለብ፤ የመካከለኛ ፍጥነት ዋና፤የሜዳ ቴንስ የመሳሰሉትን እንቅስቃሴ አደረግሽ	1. ------ቀናት በሳምንት 2. በትርፍ መካከለኛ የአካል እንቅስቃሴ አላደረኩም	መልሱ 2 ከሆነ ወደ ተ.ቁ 6.26እለፍ
6.25.	ከቀናቶቹ አንዱን በመዉሰድ አብዛኛው ጊዜ በትርፍ ጊዜሽ ይህን መካከለኛ የአካል እንቅስቃሴ ምን ያክል ትቆይበታለሽ	1----------ሰዓት በቀን 2.----------ደቂቃ በቀን	
ክፍል 5፤ በመቀመጥ የምታሳልፊው ጊዜ የመጨረሻ ጥያቄ በስራ ቦታ፤ ቤትሽ ዉስጥ፤ ትምህርት ቤት እንዲሁም በመዝናኛ ጊዜ በመቀመት የምታሳሊፊዉን ይመለከታል፡፡ ይህም ወንበር ላይ ስትቀመጪ፤ ጓደኞችሽን ስትጎበኚ፤ ስታነቢ፤ ጋደም ብለሽ ተለቪዢን ስታዪ ምታሳሊፊዉን ጊዜ የሚያካትት ነዉ፡፡			
6.26.	ባለፉት ሰባት የስራ ቀናት አብዛኛው ጊዜ ምን ያክል በመቀመጥ አሳለፍሽ	1----------ሰዓት በቀን 2.----------ደቂቃ በቀን	
6.27.	ባለፉት ሰባት ቀናት አብዛኛው ጊዜ ምን ያክል ቅዳሜና እሁድን በመቀመጥ አሳለፍሽ	1----------ሰዓት በቀን 2.----------ደቂቃ በቀን	

7. በትዳር ጓደኛ/ፊቅረኛ የተደረገ ጥቃት

7.1.	በዝህ እርግዝና ጊዜ የትዳር ጓደኛሽ የሚከተሉትን የአካል ጥቃት አድርሶብሻል		አዎ	አይደለም
		1. በጥፊ መቶሻል ወይም የሚጎዳ ነገር ወርዉሮብሻል	1	2
		2. ገፍቶሻል ወይም ገፍትሮሻል	1	2
		3. በእጅ መይም በሚጎዳ ነገር ጨምድዶ ይዞሻል	1	2
		4. ረግጦሻል፤ መሬት ላይ ጎትቶሻል ወይም መቶሻል	1	2
		5. አንቆሻል ወይም ሆን ብሎ ኢቃጥሎሻል	1	2
		6. በጠመንጃ፤ በቢላዋ ወይም በሌላ ጦር መሳሪያ አስፈረርቶሻል	1	2
7.2.	በዝህ እርግዝና ጊዜ የትዳር ጓደኛሽ የሚከተሉትን የግብረስጋ ግንኙነት ጥቃት አድርሶብሻል		አዎ	አይ
		1. አንቺ ሳትፈሊጊ በሀይል አስገድዶ ግንኙነት እንድታገርጊ አድርጓል	1	2
		2. አንቺ ባትፈሊጊም እሱ የሚያደርገዉን በመፍራት ግንኙነት አድርገሻል	1	2
		3. ክብረነክ በሆነ መልኩ ግንኙነት እንዲትፈጽሚ ተገደሻል	1	2
7.3.	በዝህ እርግዝና ጊዜ የትዳር ጓደኛሽ የሚከተሉትን የስነልቦና ጥቃት አድርሶብሻል		አዎ	አይ
		1. ሰድቦሻል ወይም ስለራስሽ መጥፎ እንድታሲብ አድርጎሻል	1	2
		2. በሰዎች ፊት አሳንሶሻል ወይም አዋርዶሻል	1	2
		3. ሆነ ተብሎ ዛቻ ወይም ማስፈራራት ደርሶብሻል ለምሳሌ..በማፈጠጥ፤ በመቆጣት	1	2

		4. የምትጠነቀቂለትን ሰው እንደሚጎዳ በመዛት	1 2
7.4.	በዝህ እርግዝና ጊዜ የትዳር ጓደኛሽ የሚከተሉትን ቁጥጥር አድርሶብሻል		አዎ አይ
		1. ጓደኞችሽን እንዳታገኚ ከልክሎሻል	1 2
		2. ወለጅ ቤተሰቦሽን እንዳታገኚ ከልክሎሻል	1 2
		3. ሁሌ የት እንዳሳለፍሽ ለማወቅ ይጥራል	1 2
		4. ላንቺ ጉዳይ የለዉም	1 2
		5. ከሌላ ወንድ ጋር ስያይሽ ይናደዳል	1 2
		6. ሁሌ ታምኝ እንዳልሆንሽ ይጠራጠራል	1 2
		7. ለህክምና የሱን ፈቃድ እንድጠይቂ ይፈልጋል	1 2

8. ክፍል 8. የባህርይ ጥያቄዎችና በመለካት መቀመጥ ያለባቸዉ ጥያቄዎች

8.1.	ከእግዝና በፊት ክብደትሽን ተመዝነሽ ታዉቂአለሽ? (ከእርግዝና በፍት በሶስት ወራት ዉስጥ)	1. አዎ (መጠኑን …….በኪሎግራም) 2. አይ	
8.2.	MUAC	----------ሴንቲሜተር	ከ ANC registration ይወሰድ ወይም ይለካ
8.3.	ክብደት	…….በኪሎግራም	
8.4.	ቁመት	……..በሜትር	
8.5.	የደም ጊፊት	……በmmHg	
8.6.	ሄሞግሎቢን	……በmmol/L	
8.7.	የኤቻይቪ ሁኔታ	1. ኤቻይቪ ፖዘቲቭ 2. ኤቻይቪ ኔጋቲቭ 3. ያልታወቀ	ከ ANC registration ይወሰድ
8.8.	ከዚህ እርግዝና በፊት የአልኮል መጠጥ ጠጥተሽ ታዉቂያለሽ	1. አዎ 2. አይ	መልሱ አይ ከሆነ ወደ 8.10 ይለፉ
8.9.	ከላይ ላለው ጥያቄ መልሱ አዎ ከሆነ፤ በአማካይ በሳምንት ለስንት ቀን ትጠጭያለሽ	----------ቀን	
8.10.	በዚህ እርግዝና ጊዜ ትጫልለሽ	1. አዎ 2. አይ	መልሱ አይ ከሆነ ወደ 8.12 ይለፉ
8.11.	ከላይ ላለው ጥያቄ መልሱ አዎ ከሆነ፤ በአማካይ በሳምንት ለስንት ቀን ትጠጭያለሽ	----------ቀን	

8.12.	ከዚህ እርግዝና በፊት ሲጋራ አጭሰሽ ታዉቂያለሽ	1. አዎ 2. አይ	መልሱ አይ ከሆነ ወደ 8.14 ይለፉ
8.13.	መልዎ አዎ ከሆነ፤ በአማካይ በሳምንት ለስንት ቀን ታጨሻለሽ	----------ቀን	
8.14.	በዚህ እርግዝና ጊዜ ታጨሻለሽ	1. አዎ 2. አይ	መልሱ አይ ከሆነ ወደ 8.16 ይለፉ
8.15.	መልዎ አዎ ከሆነ፤ በአማካይ በሳምንት ለስንት ቀን ታጨሻለሽ	----------ቀን	
8.16.	ከዚህ እርግዝና በፊት ጫት ቅመሽ ታዉቂያለሽ	1. አዎ 2. አይ	መልሱ አይ ከሆነ ወደ 8.18 ይለፉ
8.17.	ከላይ ላለው ጥያቄ መልሱ አዎ ከሆነ፤ በአማካይ በሳምንት ለስንት ቀን ትቅሚያለሽ	----------ቀን	
8.18.	በዚህ እርግዝና ጊዜ ትቅሚአለሽ	1. አዎ 2. አይ	መልሱ አይ ከሆነ ወደ 8.20 ይህዱ
8.19.	አዎ ከሆነ፤ በአማካይ በሳምንት ለስንት ቀን ትቅሚያለሽ	----------ቀን	
8.20.	በትዳርሽ ምን ያህል ደስተኛነሽ	1. በጣም ደስተኛ ነኝ 2. ደስተኛ ነኝ 3. ብዙም ደስተኛ አይደለሁም 4. ደስተኛ አይደለም 5. አይደለሁም	
8.21.	በአጠቃላይ በኑሮሽ ሁኔታ ደስተኛነትሽን እንድት ትለክያለሽ	1. እጅግ በጣም ጥሩ 2. በጣም ጥሩ 3. ጥሩ 4. መጥፎ 5. በጣም መጥፎ	

አመስግናለሁ

Appendix 4: Topic guide for pregnant women's in-depth interview and Focus group discussion

1.	Do you know the appropriate amount of weight women need to gain during pregnancy? If yes, would you please tell me in detail?
2.	Is weight gain during pregnancy a concern for you? If yes, what is/are the concern(s)? If no, why not?
3.	How do you see your GWG management practices?
a.	What do you do to manage GWG? Do you check your weight regularly?
b.	How would you describe your eating practices during pregnancy? What do you regard as healthy eating? Have you made any change regarding your eating compared to before becoming pregnant: an increase or decrease in the amount? What foods would you regard as taboo during pregnancy?
c.	What types of physical activities or exercise have you engaged in before and/or during pregnancy?
4.	What types of information did you receive from health care providers about nutrition or weight gain (for example today)?
a.	When you come for your pre-natal visits, does your care provider talk with you about your weight, how much weight you have gained and how much you should gain?
b.	What type of information do you need from health care providers?
c.	To what extent is discussing about weight management sensitive for you?
5.	What is your view on weight after birth? Should women lose or gain weight after birth?
a.	Do you want to lose or gain weight after birth?
b.	Is weight after birth something you are concerned about? Why/why not?
c.	Have you ever discussed this issue (weight in after birth) with health care providers?

Appendix 5: PRISMA-P 2015 checklist: recommended items to include in a systematic review: recommended items to address in a systematic review protocol*.

Section/topic	Item #	Checklist item	Self-Evaluation
ADMINISTRATIVE INFORMATION			
Title			
Identification	1a	Identify the report as a protocol of a systematic review	YES, identified (page 1)
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	Not applicable
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number	PROSPERO "CRD42018085499" (page 4)
Authors			
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	YES, it was provided (page 1)
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	YES, this was provided (page27)
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	Not applicable
Support			
Sources	5a	Indicate sources of financial or other support for the review	Not applicable
Sponsor	5b	Provide name for the review funder and/or sponsor	Not applicable
Role of sponsor/funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	Not applicable
INTRODUCTION			
Rationale	6	Describe the rationale for the review in the context of what is already known	Yes, this was done (page 3)
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	Yes this was clearly stated (page 5)

Section/topic	Item #	Checklist item	Self-Evaluation
METHODS			
Eligibility criteria	8	Specify the study characteristics (e.g., PICO, study design, setting, time frame) and report characteristics (e.g., years considered, language, publication status) to be used as criteria for eligibility for the review	Yes, this was done (page 4)
Information sources	9	Describe all intended information sources (e.g., electronic databases, contact with study authors, trial registers, or other grey literature sources) with planned dates of coverage	Yes this was well described (page 4)
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	Yes this provided as additional file
Study records			
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	Yes this was described
Selection process	11b	State the process that will be used for selecting studies (e.g., two independent reviewers) through each phase of the review (i.e., screening, eligibility, and inclusion in meta-analysis)	Yes this was stated (page 4, 6 and 8)
Data collection process	11c	Describe planned method of extracting data from reports (e.g., piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	Yes this was described (page 4, 6 and 8)
Data items	12	List and define all variables for which data will be sought (e.g., PICO items, funding sources), any pre-planned data assumptions and simplifications	Yes this was provided (page 5)
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	Yes this was done (page 5)
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	Yes this was done (page 9)
Data			
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	Yes this was described (Page 7)

Section/topic	Item #	Checklist item	Self-Evaluation
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data, and methods of combining data from studies, including any planned exploration of consistency (e.g., I^2, Kendall's tau)	Yes this was stated (Page 7)
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	Yes this was described (pages 7 and 26)
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	Yes this was described (Page 7)
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (e.g., publication bias across studies, selective reporting within studies)	Yes this was described
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (e.g., GRADE)	Yes (EPHPP) (pages 5 and Table 2)

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

From: Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart L, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015 Jan 2;349 (jan02 1):g7647

Appendix 6: Search strategies with corresponding database and numbers of articles accessed

	Database	Combined search phrase	Search results
1	PubMed (date 16/12/2019)	((((((((((pregnan*[Title/Abstract]) OR Gestation*)) AND ((weight gain[Title/Abstract]) OR Weight change[Title/Abstract])) AND ((Sub-Saharan[Title/Abstract]) OR Subsaharan Africa[Title/Abstract]) OR Low income country[Title/Abstract]) OR Developing country[Title/Abstract]) OR Angola[Title/Abstract]) OR Benin[Title/Abstract]) OR Botswana[Title/Abstract]) OR Burkina Faso[Title/Abstract]) OR Burundi[Title/Abstract]) OR Cameroon[Title/Abstract]) OR Cape Verde[Title/Abstract]) OR Central African Republic[Title/Abstract]) OR Chad[Title/Abstract]) OR Comoros[Title/Abstract]) OR Congo[Title/Abstract]) OR Côte d'Ivoire[Title/Abstract]) OR Djibouti[Title/Abstract]) OR Equatorial Guinea[Title/Abstract]) OR Eritrea[Title/Abstract]) OR Ethiopia[Title/Abstract]) OR Gabon[Title/Abstract]) OR Gambia[Title/Abstract]) OR Ghana[Title/Abstract]) OR Guinea[Title/Abstract]) OR Guinea-Bissau[Title/Abstract]) OR Kenya[Title/Abstract]) OR Lesotho[Title/Abstract]) OR Liberia[Title/Abstract]) OR Madagascar[Title/Abstract]) OR Malawi[Title/Abstract]) OR Mali[Title/Abstract]) OR Mauritania[Title/Abstract]) OR Mauritius[Title/Abstract]) OR Mozambique[Title/Abstract]) OR Namibia[Title/Abstract]) OR Niger[Title/Abstract]) OR Nigeria[Title/Abstract]) OR Réunion[Title/Abstract]) OR Rwanda[Title/Abstract]) OR (Sao Tome[Title/Abstract] AND Principe[Title/Abstract])) OR Senegal[Title/Abstract]) OR Seychelles[Title/Abstract]) OR Sierra Leone[Title/Abstract]) OR Somalia[Title/Abstract]) OR South Africa[Title/Abstract]) OR Sudan[Title/Abstract]) OR Swaziland[Title/Abstract]) OR Tanzania[Title/Abstract]) OR Togo[Title/Abstract]) OR Uganda[Title/Abstract]) OR Western Sahara[Title/Abstract]) OR Zambia[Title/Abstract]) OR Zimbabwe[Title/Abstract]))) AND ("1990/01/01"[PDat] : "2019/12/31"[PDat]))) AND ("1990/01/01"[PDat] : "2019/12/31"[PDat]) AND Humans[Mesh]) Filters: Publication date from 1990/01/01 to 2019/12/31; Humans; English	<u>121</u>
2	Scopus (date 12/12/19)	(("Gestation*" OR "Pregnancy") AND ("weight gain")) AND ("angola" OR "benin" OR "botswana" OR "Burkina faso" OR "cameroon" OR "cape verde" OR "central African republic" OR "chad" OR "comoros" AND "congo" OR "cote d'ivoire" OR "djibouti" OR "equatorial guinea" OR "eritrea" OR "ethiopia" OR "gabon" OR "gambia" OR "ghana" OR "guinea" OR "guineabissau" OR "kenya" OR "lesotho" OR "liberia" OR "madagascar" OR "malawi"OR "mali" OR "mauritania" OR "mauritius" OR "mozambique" OR "namibia" OR "niger" OR "nigeria" OR "réunion" OR "rwanda" OR "sao tome and principe" OR "senegal" OR "seychelles" OR "sierra leone" OR	401

		"somalia" OR "south africa" OR "sudan" OR "swaziland" OR "tanzania" OR "togo" OR "uganda" OR "western sahara" OR "zambia" OR "zimbabwe" OR "Sub Saharan Afrrica" OR "Developing countries") AND (LIMIT TO (PUBYEAR , 2019) OR LIMIT TO (PUBYEAR , 2018) OR LIMIT- TO (PUBYEAR , 2017) OR LIMIT TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2007) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2005) OR LIMIT-TO (PUBYEAR , 2004) OR LIMIT-TO (PUBYEAR , 2003) OR LIMIT-TO (PUBYEAR , 2002) OR LIMIT-TO (PUBYEAR , 2001) OR LIMIT-TO (PUBYEAR , 2000) OR LIMIT-TO (PUBYEAR , 1999) OR LIMIT-TO (PUBYEAR , 1998) OR LIMIT-TO (PUBYEAR , 1997) OR LIMIT-TO (PUBYEAR , 1996) OR LIMIT-TO (PUBYEAR , 1995) OR LIMIT-TO (PUBYEAR , 1993) OR LIMIT-TO (PUBYEAR , 1992) OR LIMIT-TO (PUBYEAR , 1991) OR LIMIT-TO (PUBYEAR , 1990)) AND (LIMIT-TO (LANGUAGE , "English")) AND (EXCLUDE (DOCTYPE “re”) OR EXCLUDE (DOCTYPE “bk”) OR EXCLUDE (DOCTYPE “ch”) OR EXCLUDE (DOCTYPE “no”) OR EXCLUDE (DOCTYPE “sh”))	
3	Medline (Ovid)	# Searches (date 15/12/2019)	Results 254
		1 exp Pregnancy/ or Gestation*.mp.	953412
		2 weight gain.mp. or exp Weight Gain/	72455
		3 1 and 2	11743
		4 Angola.mp. or exp Angola/	1543
		5 Benin.mp. or exp Benin/	3719
		6 Botswana.mp. or exp Botswana/	2527
		7 Burkina Faso.mp. or exp Burkina Faso/	4356
		8 Burundi.mp. or exp Burundi/	947
		9 Cameroon.mp. or exp Cameroon/	7540
		10 Cape Verde.mp. or exp Cape Verde/	551
		11 Central African Republic.mp. or exp Central African Republic/	1176
		12 Chad.mp. or exp Chad/	1260
		13 Comoros.mp. or exp Comoros/	485
		14 Congo.mp. or exp Congo/ or exp "Democratic Republic of the Congo"/	14587
		15 Cote d'Ivoire.mp. or exp Cote d'Ivoire/	3798
		16 Djibouti.mp. or exp Djibouti/	404
		17 Equatorial Guinea.mp. or exp Equatorial Guinea/	456

18	exp Africa/ or exp Eritrea/ or exp Ethiopia/ or Eritrea .mp. or exp Developing Countries/	312978
19	Gabon.mp. or exp Gabon/	2041
20	Gambia.mp. or exp Gambia/	3095
21	Ghana.mp. or exp Ghana/	10972
22	Guinea.mp. or exp Guinea-Bissau/ or exp Guinea/ or exp Equatorial Guinea/ or exp Papua New Guinea/ or exp New Guinea/	161589
23	Kenya.mp. or exp Kenya/	20693
24	Lesotho.mp. or exp Lesotho/	712
25	Liberia.mp. or exp Liberia/	1844
26	Madagascar.mp. or exp Madagascar/	5130
27	Malawi.mp. or exp Malawi/	7187
28	Mali.mp. or exp Mali/	3895
29	Mauritania.mp. or exp Mauritania/	692
30	Mauritius.mp. or exp Mauritius/	1039
31	Mozambique.mp. or exp Mozambique/	3660
32	Namibia.mp. or exp Namibia/	1691
33	exp Niger/ or Niger.mp.	13201
34	Nigeria.mp. or exp Nigeria/	35607
35	Reunion.mp. or Reunion/	3262
36	Rwanda.mp. or exp Rwanda/	3275
37	Senegal.mp. or exp Senegal/	7493
38	Seychelles.mp. or exp Seychelles/	718
39	Sierra Leone.mp. or exp Sierra Leone/	2346
40	Somalia.mp. or exp Somalia/	2140
41	South Africa.mp. or exp South Africa/	51239
42	exp Sudan/ or exp South Sudan/ or Sudan.mp.	9060
43	Swaziland.mp. or exp Swaziland/	894
44	Tanzania.mp. or exp Tanzania/	14346
45	Togo.mp. or exp Togo/	1654
46	Uganda.mp. or exp Uganda/	15646
47	Western Sahara.mp.	62
48	Zambia.mp. or exp Zambia/	5947
49	Zimbabwe.mp. or exp Zimbabwe/	7396
50	4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or	539283

	37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49		
	51 3 and 50	325	
	52 Limit 51 to (english language and yr="1990-2019")	254	
	Searches (15/12/2019)	Results	
Embase (Excerpta medica)	#		584
	1 gestational OR pregnancy	1037996	
	2 weight AND gain	143224	
	3 'africa south of the sahara'	13664	
	4 'africa'	307658	
	5 'developing country'	96957	
	6 'sub-Saharan'	28917	
	7 'angola'	2230	
	8 'benin'	11982	
	9 'botswana'	4482	
	10 'burkina faso'	7609	
	11 'burundi'	1246	
	12 'cameroon'	14134	
	13 'cape verde'	675	
	14 'central african republic'	1674	
	15 'chad'	19859	
	16 'comoros'	534	
	17 'congo'	21555	
	18 'ivory cost'	27	
	19 djibouti	604	
	20 'equatorial guinea'	702	
	21 'eritrea'	3576	
	22 'ethiopia'	23108	
	23 'gabon'	3648	
	24 'gambia'	5116	
	25 'ghana'	19338	
	26 'kenya'	50276	
	27 'lesotho'	1040	
	28 'liberia'	2575	
	29 'madagascar'	6894	
	30 'malawi'	11131	
	31 'mali'	9306	
	32 'mauritania'	959	

33	'mauritius'	2325
34	'mozambique'	5748
35	'namibia'	2756
36	'niger'	28404
37	'nigeria'	89631
38	'rwanda'	5125
39	'senegal'	15802
40	'seychelles'	974
41	'sierra leone'	3196
42	'somalia'	2529
43	'south africa'	192120
44	'sudan'	15233
45	'swaziland'	1839
46	'tanzania'	21679
47	'togo'	4507
48	'uganda'	28921
49	'western sahara'	91
50	'zambia'	9518
51	'zimbabwe'	13251
52	#1 AND #2	13048
53	#3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46 OR #47 OR #48 OR #49 OR #50 OR #51	692514
54	#52 AND #53 AND [english]/lim AND [1990-2019]/py	584

5	CINAHL (Date 16/12/2019)	Limiters/Expanders	Last Run Via	Results
S8	S1 AND S7	**Limiters** - Published Date: 19900101-20191231; Language: English **Expanders** - Apply related words; Also search within the full text of the articles; Apply equivalent subjects	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL	36

		Search modes - Boolean/Phrase	
S7	S2 OR S3 OR S4 OR S5 OR S6	**Expanders** - Apply related words; Also search within the full text of the articles; Apply equivalent subjects **Search modes** - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - 47,065 Advanced Search Database - CINAHL
S6	AB Zambia OR AB Zimbabwe OR AB sub-Saharan Africa OR AB Developing Country	**Expanders** - Apply related words; Also search within the full text of the articles; Apply equivalent subjects **Search modes** - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - 17,262 Advanced Search Database - CINAHL
S5	AB Senegal OR AB Seychelles OR AB Sierra Leone OR AB Somalia OR AB South Africa OR AB Sudan OR AB South Sudan OR AB Swaziland OR AB Tanzania OR AB Togo OR AB Uganda OR AB Western Sahara	**Expanders** - Apply related words; Also search within the full text of the articles; Apply equivalent subjects **Search modes** - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - 14,940 Advanced Search Database - CINAHL
S4	AB Liberia OR AB Madagascar OR AB Malawi OR AB Mali OR AB Mauritania OR AB Mauritius OR AB Mozambique OR AB Namibia OR AB Niger OR AB NIgeria OR AB Rwanda	**Expanders** - Apply related words; Also search within the full text of the articles; Apply equivalent subjects **Search modes** - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - 8,637 Advanced Search Database - CINAHL
S3	AB Djibouti OR AB Equatorial Guinea OR AB Eritrea OR AB Ethiopia OR AB Gabon OR AB Gambia OR AB Ghana OR AB Guinea OR AB Guinea-Bissau OR AB Equatorial Guinea OR AB Kenya OR AB Lesotho	**Expanders** - Apply related words; Also search within the full text of the articles; Apply equivalent subjects **Search modes** - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - 10,567 Advanced Search Database - CINAHL
S2	AB Angola OR AB Benin OR AB Botswana OR AB Burkina Faso OR AB Burundi OR AB Cameroon OR AB Cape Verde OR AB Central African Republic OR AB Chad OR AB Comoros OR AB Democratic Republic of the Congo OR AB Cote d'Ivoire	**Expanders** - Apply related words; Also search within the full text of the articles; Apply equivalent subjects **Search modes** - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - 3479 Advanced Search Database - CINAHL
S1	AB Gestational weight gain OR AB pregnancy weight gain OR AB weight gain during pregnancy	**Expanders** - Apply related words; Also search within the full text of the articles; Apply equivalent subjects **Search modes** - Boolean/Phrase	**Interface** - EBSCOhost Research Databases **Search Screen** - 2,014 Advanced Search **Database** - CINAHL

Appendix 7a: summary result of meta-analyses (Effect of excessive GWG on Birth outcome)

S.N	Type of Outcome	No. Studies	Total number of excess GWG	Excess GWG with outcome	Total number of adequate GWG	adequate GWG with outcome	RR 95% CI	I^2
1.	Caesarean section	2	252	93	245	88	0.9[0.79, 1.21]	0%
2.	Obstetric haemorrhage	2	315	21	245	21	1.10[0.19, 6.29]	77%
3.	Pre-eclampsia	2	252	34	246	21	2.47[0.24, 25.78]	89%
4.	Macrosomia	2	252	26	245	17	1.47[0.82, 2.63]	0%
5.	Low birth weight	2	156	10	246	17	0.64[0.31, 1.34]	0%

Appendix 7b: summary result of meta-analyses (Effect of inadequate GWG on Birth outcome)

S.N	Type of Outcome	No. Studies	Total number of Inadequate GWG	Inadequate GWG with outcome	Total number of adequate GWG	Adequate GWG with outcome	RR 95% CI	I^2
1.	Caesarean section	2	315	56	245	88	0.58 [0.21, 1.68]	90%
2.	Obstetric haemorrhage	2	315	21	345	21	1.10[0.19, 6.29]	77%
3.	Pre-eclampsia	2	316	18	241	21	0.62[0.34, 1.13]	41%
4.	Macrosomia	2	315	11	245	17	0.50[0.24,1.04]	0%
5.	Low birth weight	2	471	66	246	17	2.45[0.15, 45.33]	93%

Appendix 8: Topic guide for Care Providers' in-depth interview

1. How do you explain GWG?
2. Do you know the appropriate amount GWG?
   a. If yes, would you please tell me in detail?
   b. Are you aware of different weight gain recommendations for pregnant women based on pre-pregnancy weight?
      If so, where did you learn about these recommendations?
3. Do you have a GWG guideline?
   a. If yes, would you tell me about it?
      What are the contents of the guideline?
   b. If there is no guideline, to what extent you need the guideline?
      What type of information you want to be included to the guideline?
   c. Have you ever heard of or seen IOM guidelines for weight gain?
      If yes, would you tell me details of the IOM GWG recommendations?
4. What information you provide for pregnant women?
   a. Do you advise women about GWG
   b. Do you specifically tell them the amount of weight they gained and the amount they are expected to gain? If no, why not?
   c. Do you encourage women to follow their own weight? If no, why not?
5. How do feel discussing GWG with women?
   a. How sensitivity it is?
   b. Is it priority activity for you? Why or why not?
6. Are you confident enough in providing advices on GWG and nutrition?.
   a. If no, what should be done next?
7. Would you please tell me your view on post-partum weight management?
   a. What women's postpartum weight management looks like? Would you tell me from you observation?
   b. What advise you provide for pregnant women during ANC follow up regarding postpartum weight management? If there is no advise, why not?