COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

DEPARTMENT OF NUTRITION & DIETETICS

AN ASSESSMENT OF MAGNITUDE AND ASSOCIATED FACTORS OF LOW BIRTH WEIGHT AMONG NEWBORNS IN AYDER COMPREHENSIVE SPECIALIZED HOSPITAL, NORTHERN ETHIOPIA, 2024: A CROSS-SECTIONAL STUDY.

By: Netsanet Mezgebe

A RESEARCH THESIS SUBMITTED TO DEPARTMENT OF NUTRITION & DIETETICS, SCHOOL OF PUBLIC HEALTH, COLLEGE OF HEALTH SCIENCES, MEKELLE UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PUBLIC HEALTH (MPH) IN HUMAN NUTRITION.

September 2025

MEKELLE, TIGRAY, ETHIOPIA

MEKELLE UNIVERSITY COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF NUTRITION AND DIETETICS

Name of investigator	Netsanet Mezgebe
Name of major advisor	Kidanemaryam Berhe (kidane0920@gmail.com)
Name of co-advisor	Tedros Bereket (Tedros.bereket99@gmail.com)
Full title of the research project	Magnitude and Factors Associated With Low Birth Weight in Ayder Comprehensive Specialized Hospital, Northern Ethiopia, 2024: A Cross-Sectional Study
Duration of the study	From October 2024 to September 2025
Study area	Ayder Comprehensive Specialized Hospital, Ethiopia
Total cost of the project	63470 ETB
Address of the investigator	Phone; +251923399186 Email; netsanetmezgebe1@gmail.com

September, 2025

MEKELLE, TIGRAY, ETHIOPIA

Mekelle University

College of Health Sciences

School of Public Health, Department of Nutrition & Dietetics

Advisor's Approval Sheet

This is to notify that the research thesis entitled "Magnitude and Factors Associated With Low Birth Weight in Ayder Comprehensive Specialized Hospital, Northern Ethiopia, 2024: A Cross-Sectional Study" is submitted in partial fulfillment of the requirements for the degree of Master of Science (MSc) in Nutrition & Dietetics to the Graduate Program of the College of Health Sciences of Mekelle University and has been carried out by Netsanet Mezgebe under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the Research thesis to the department.

Approval of the Advisor

Name of the Major Advisor: Kidanemaryam Berhe (Assistant professor)

Signature: _____

Date: September, 2025

Approval of the Co-Advisor

Name of the Major Advisor: Tedros Bereket (MSC)

Signature: _____

Date: September, 2025

Assurance of Principal Investigator

I, the undersigned, agree to accept all responsibilities for the scientific and ethical conduct of research work and the provision of required progress reports as per the terms and conditions of the requirements of the department. I will provide a timely progress report to my advisors and seek the necessary advice and approval from my advisor in the course of the research work.

Name of the MSc student: Netsanet Mezgebe

Signature: _____

Date: _____

Approval of The Graduate Program Coordinator

Name of the coordinator: _____

Signature: _____

Date: _____

ACKNOWLEDGMENT

I would like to acknowledge the department of Nutrition & Dietetics, College of Health Sciences, Mekelle University for giving me the chance to conduct this study. I would like to express my deepest gratitude to my advisors Kidanemaryam Berhe (Assistant professor) and Tedros Bereket (Msc) for their constructive advice and valuable comments for the entire work of research proposal and thesis. Without their unreserved advice and guidance, the accomplishment of this study would have been impossible. Lastly, I would like to acknowledge Chief Clinical Director of Ayder Comprehensive Specialized Hospital (ACSH), Department of Gynecology and Obstetrics, and Labour ward staffs. Moreover, I would like to express my gratitude to mothers who consented to provide the necessary information needed for the study and the data collectors who put their sincere endeavor to collect high quality data.

Table of contents

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ACSH	Ayder Comprehensive Specialized Hospital
ANC	Antenatal Care
BMI	Body Mass Index
CI	Confidence Interval
HIV	Human Immunodeficiency Virus
IRB	Institutional Review Board
IUGR	Intra-Uterine Growth Restriction
LBW	Low Birth Weight
MRN	Medical Record Number
MU	Mekelle University
MUAC	Mid-Upper Arm Circumference
ODK	Open Data Kit
PIH	Pregnancy Induced Hypertension
USD	United States Dollar
WHO	World Health Organization

Abstract

Background - Internationally, low birth weight remains to be a major problem and is related with a range of short-and long-term consequences. Infants weighing less than 2,500 grams are approximately 20 times more likely to die than heavier babies. However, studies on magnitude and associated factors of low birth weight among newborns born in tertiary hospitals of Ethiopia like Ayder Comprehensive Specialized Hospital during crisis times like war are unavailable.

Objective – To assess the magnitude and identify factors associated with low birth weight among newborns born in Ayder Comprehensive Specialized Hospital (ACSH), Mekelle, Tigray, Ethiopia from October 2024 to December 2024.

Methods –A facility-based cross-sectional study was conducted among 279 mothers their respective newborns recruited by systematic random sampling technique. Data related to birth weight and associated factors were collected using a pre-tested, interviewer-administered structured questionnaire and checklist, developed through a review of relevant literature. The sources of data included interviews conducted with mothers, medical records, and direct anthropometric measurements. Data were collected by trained midwives. The Open Data Kit (ODK) Collect mobile application was used for data collection. Data analysis was carried out using SPSS version 27. Descriptive statistics like frequency, percent, measure of central tendency, and measure of dispersion were employed to describe characteristics of the participants. In addition, A multivariable logistic regression was fitted to identify factors associated with low birth weight and explain the association using odds ratio with its 95% confidence interval. Statistical significance was considered at $p<0.05$.

Result: The mean age of the women was 28.8 years. The magnitude of low birthweight in this study was 23.7%. The adjusted odds of low birth weight were 5.5 times higher among pregnant women with a MUAC of less than 23 cm (AOR=5.5; 95% CI: 2.2 to 13.4) compared to those with a MUAC of 23 cm or more. The adjusted odds of low birth weight were 11.6 times higher among pregnant women who gained less than 10 kg (AOR=11.6; 95% CI: 3.2 to 42.3) during pregnancy compared to those who gained 10 kg or more. Lastly, the adjusted odds of low birth weight were 2.5 times higher among women living in food-insecure households (AOR=2.5; 95% CI: 1.1 to 5.9) compared to those in food-secure households.

Conclusion and recommendation: The present study revealed that recent Tigray war has significantly increased the magnitude of low birthweight (LBW) compared to the pre-war status. The magnitude of LBW is remarkably higher among women with a mid-upper arm circumference (MUAC) below 23 cm (with malnutrition), those with small weight gain during pregnancy, and women living in food-insecure households. Nutritional screening during pregnancy, nutritional counseling, targeted nutritional support and micronutrient supplementation, and awareness campaigns on the importance of maternal nutrition should be implemented to reduce the occurrence of LBW, especially in war-affected areas like Tigray.

Key words: Factors, Low birth weight, Magnitude

1. INTRODUCTION

1.1 BACKGROUND

Birth weight is the first weight of a newborn measured immediately (i.e. within an hour) after birth regardless of pregnancy length. World Health Organization (WHO) describes low birth weight as birth weight below 2500 grams and it is furtherly classified as very low birth weight (<1500 grams), and extremely low birth weight <1000 grams)[1]. Low birth weight (LBW) may happen due to either preterm delivery (infants born before 37 weeks of pregnancy) or intrauterine growth restriction (IUGR). Intrauterine growth restriction is the result of problems with the placenta, the mother's health, or the baby's health [2–4]. Literatures have identified some determinants of LBW like teenage pregnancy, birth order, income, malnutrition, obstetric complications, preterm birth, chronic medical illness, multiple gestation, previous history of LBW, lack of adequate antenatal care, and smoking [3].

Internationally, low birth weight (LBW) remains to be a major problem and it is related with a range of short-and long-term consequences[5–8]. Worldwide, more than 20 million LBW babies, representing 15.5% of all births, are born per year and nearly all of them are from developing countries. The prevalence of LBW echoes socio-economic development and is a good proxy to measure the developmental status of a nation [9]. The level of LBW in developing nations is estimated to be more than 20-fold compared to developed nations [8]. According to Ethiopian demographic and health survey 2016, the prevalence of LBW in Ethiopia was about 29.1% [10]. Studies have witnessed that armed conflict increases the incidence of LBW by 3.2% [11].

The majority of LBW neonates in developing countries are due to IUGR whereas a premature baby born before term period is the most common cause of LBW in developed countries. Prematurity is associated with pregnancy-induced hypertension (PIH), gestational diabetes, acute infections during the course of pregnancy, hard physical work, twin or multiple pregnancy, preterm rupture of membranes, drug abuse, nutritional status, stress, anxiety, and other psychological factors [8,12].

Low birth weight continues to be a noteworthy public health problem globally. Overall, it is estimated that 15% to 20% of all births worldwide are LBW, representing more than 20 million

births a year. World Health Assembly (WHA) has set a policy target to lessen LBW by 30% at the end of 2025. This would translate into a 3.9% relative reduction per year between 2012 and 2025 and a reduction from approximately 20 million to about 14 million infants with low weight at birth [13].

The prevalence of LBW is estimated to be 28% in south Asia, 13% in sub-Saharan Africa, and 9% in Latin America [14]. It is worth noting that these rates are high, in spite of the fact that the data on LBW remain limited or unreliable, as many deliveries occur in homes or small health clinics and are not reported in official figures, which may result in an underestimation of the prevalence of LBW [13].

1.2 STATEMENT OF THE PROBLEM

Birth weight is a critical indicator of a child's vulnerability to illness, future health, development, and survival [15]. Low birth weight (LBW) is considered the single most important prognosticator of infant mortality, particularly during the early months of life[16]. Globally, more than two-thirds of neonatal deaths occur among LBW infants [15].

Newborns with LBW face a number of early and late complications. Early complications include recurrent apnea, hemorrhage in organs like brain and lung, jaundice, infections, retinopathy of prematurity, perinatal asphyxia, hypothermia, hypoglycemia, and anemia [17,18]. Late complications include hypertension, nephropathy, proteinuria, deafness, neurologic complications like cerebral palsy, developmental delay and poor intelligence, epilepsy and behavioral abnormalities [19].

Low birth weight children suffer from higher rates of subnormal growth, illnesses, and neurodevelopmental problems [5]. Low birth weight increases the risk of illness and premature death from cardiovascular disease, hypertension, and diabetes, in later life compared to adequate birth weights [6]. In addition, LBW exposes to poor intelligence and cognitive disability that in turn affects school performance and job opportunity as an adult [7]. Infants weighing less than 2,500 grams are approximately 20 times more likely to die than heavier babies [8].

According to a recent study in public hospitals of Ethiopia, the likelihood of LBW was found to be higher in mothers who had infrequent antenatal care (ANC) follow-up, chronic medical illnesses, short height, less weight gain during pregnancy, age <20 years, and preterm delivery [20]. Other studies also have found rural residence, maternal weight below 50 kgs, anemia during pregnancy, drinking alcohol as a factors that increase the probability of delivering a newborn with LBW [2,21].

Although numerous cross-sectional, case-control, and systematic review studies have been conducted on LBW in Ethiopia, none have addressed this issue during periods of crisis or in immediate post-crisis contexts such as war. Armed conflict severely disrupts health service delivery and essential human needs, including access to food, water, and psychological support. In war-affected regions like Northern Ethiopia, a higher prevalence of LBW is anticipated due to the prolonged conflict and siege that lasted for three years, beginning on November 4, 2020. Sustained warfare may adversely affect maternal health and fetal development.

Therefore, this study aims to determine the prevalence and identify factors associated with low birth weight among newborns delivered at Ayder Comprehensive Specialized Hospital (ACSH), located in Mekelle, Tigray Regional State, Northern Ethiopia, during the post-conflict period from October to December 2024.

1.3 SIGNIFICANCE OF THE STUDY

Updated information regarding LBW is essential for policy makers to take appropriate actions. This study will try to explore the prevalence and associated factors of low birth weight with implications to improve health workers' interventions, ensure cost-effectiveness, and accelerate the reduction of neonatal morbidity and mortality. Knowledge on associated factors of LBW is essential for designing cost effective intervention strategies aimed at reducing LBW rates. Additionally, having proper knowledge of associated factors of low birth weight helps to identify and prioritize mothers who are at risk. The findings of this study will create awareness about the problem and contribute towards formulating locally appropriate interventions to prevent low birth weight. In addition, the findings will be shared among various stakeholders to stimulate focused intervention programs. In addition, the findings of this study will serve as baseline. Because this study is conducted immediately after the recent crisis in Tigray and revealed the impact of war on weight of a newborn.

2. LITERATURE REVIEW

2.1 Prevalence of low birth weight

The prevalence of LBW in India and Nepal reaches up to 22% [22,23]. But in Iran the prevalence of LBW is reported to be 8.7% [24]. Similarly, reports from Brazil showed a prevalence of LBW that ranges from 7.6% to 9.6% [25,26]. According to reports from Ghana and Nigeria, the prevalence of LBW in Africa countries ranges from 8.3% to 16.9% [27–29].

In Ethiopia, the pooled prevalence of LBW is 17.3% [30]. The prevalence of LBW in Addis Ababa, the capital city of Ethiopia, is 8.8% [31]. Likewise, the prevalence of LBW in Northern Ethiopia was estimated to be around 15% [2]. However, this prevalence is reported to be lower in term deliveries that is about 10% [32]. Cross-sectional studies of Ethiopia conducted in Dire Dawa and Debremarkos cities found prevalences of LBW that are 21% and 21.6%, respectively, and higher compared to reports from Addis Ababa and Northern Ethiopia [3,33].

In Tigray, according to a study conducted in three public zonal hospitals of Tigray during 2015, the prevalence of LBW was 14.6% [2].

2.2 Factors associated with low birth weight

2.2.1 Obstetric and health related factors

Gestational age, frequency of antenatal care follow-up, anemia, mineral supplements, obstetric complications, physical trauma, parity, chronic medical illnesses and birth intervals are some of the obstetric and general health related factors that are identified as predictors of a weight of newborn during delivery. Accordingly, the chance of LBW is 5-18 times higher in preterm deliveries [2,3,21,33–35]. In addition, mothers who had infrequent antenatal care (ANC) follow-up are more than 3-fold likely to deliver a newborn with LBW [20,21,35–39]. For example, in the Dilla's study, the probability of LBW among term newborns was six times higher in mothers who had no ANC follow-up [39].

Relating to mineral supplements and anemia, mothers who didn't took iron/folate during the course of pregnancy are many folds more likely to give a live birth with LBW [20,32]. A case-control

studies conducted in southern and western parts of Ethiopia found about three times higher risk of LBW in mothers who didn't get iron-folate supplementation [40,41]. The study of Dilla, Southern Ethiopia also found a significantly higher chance of LBW that reaches up to 6-fold in mothers who were not supplemented with folate [39]. As well, mothers who had anemia were more likely to have a baby with LBW than those with normal hemoglobin level [32,37,40]. For instance, a cross-sectional study conducted in Northern Ethiopia found 14 times higher risk of delivering a LBW newborn among mothers who had anemia during pregnancy [21].

History of any pregnancy complication is also associated with 2-6 fold increased risk of LBW [33,34,38,41]. Hypertensive disorders during pregnancy are said to be associated with 6 to 9 fold risk of LBW [16,37]. A history of abortion is associated with increased risk of LBW [32]. Previous history of LBW is also associated increased accident of LBW in current pregnancy [42]. In Nigeria, a prospective study involving 854 mothers reported raised chance of LBW in mothers who had history of stillbirth, LBW, and/or premature delivery [29]. In one study, physical trauma during the course of pregnancy was found to raise the chance of LBW more than 10-folds [34].

Low birth weight prevalence is said to be higher in primiparous women, unwanted pregnancies, and during narrow birth intervals. According to a case-control study conducted in Debremarkos Referral Hospital, the odds of LBW was found to be five times higher in primiparous compared to multiparous [37]. Based on two studies from southern and northern parts of Ethiopia, LBW was found to be three to four times higher in pregnancies which are both unplanned and unwanted [36,39]. A study in Butajira, Ethiopia found more than tenfold increased risk of LBW baby following short birth interval which is defined as inter-pregnancy interval less than 24 months [43]. The study from South-East Ethiopia also found thrice risk of LBW following short birth interval [38].

2.2.2 Maternal Nutritional and behavioral factors, and Food security

Mothers with weight below 50 kg are two times more likely to deliver a baby with LBW [2]. Short maternal stature (i.e. <150cm) multiplies the chance of LBW by 3 to 9 folds [3,20,21,38]. Weight gain below 12 kg during the course of pregnancy elevates the probability if delivering a LBW baby

by about 5-fold [20]. One Ethiopia study also found odds LBW to be six times higher in underweight mothers (maternal body mass index <18 kg/m^2) [38].

As said by a case-control study conducted at Hawassa University Comprehensive Specialized Hospital, Mothers with mid-upper arm circumference less than 22cm were three times more prone to deliver a baby with LBW [41]. Likewise, a study from southern part of Ethiopia found about six times higher risk of LBW baby in mothers whose MUAC is <23 cm [43].

Mothers who drink alcohol frequently, chew a chat and smoke a cigarrete are more likely to give a birth to a low-birth-weight child. The chance of giving a LBW baby is said to be more than six times higher in mothers who drink alcohol [21]. The study from Dire Dawa city of Ethiopia also revealed that mothers who smoke cigarette are four times more likely deliver a baby with LBW [3]. History of chat chewing also rises the probability of LBW up to six folds [38].

According to a systematic review study, maternal food insecurity increases the risk of having LBW baby by 3% [44].

2.2.3 Effect of War

A systematic review conducted by Kien Le et. al, has found that first trimester exposure to armed conflict decreases birth weight by 2.8% and increases the incidence of LBW by 3.2%. This study also has highlighted that most mothers who live in war affected areas are prone to poverty and lower educational status which in turn increase the prevalence of LBW [11]. Another case-control study also disclosed that maternal exposure to armed conflict increases the odds of very LBW by about 4-folds [45].

2.2.4 Water, Sanitation, Hygiene (WASH)

A cohort study conducted with the aim of examining the effect of pre-birth WASH conditions on preterm birth and LBW has disclosed that the odds of LBW/Preterm birth was 50% higher in women who use compound latrine (shared latrine). This study also has exhibited that spending more than two hours fetching a water was associated with 33% more odds of having LBW baby. Another finding of this study is that open defecation increased the odds of LBW by 22% [46].

2.2.5 Comorbidity

Multiple studies demonstrate a significant association between maternal HIV infection and low birth weight (LBW) [32,47]. A comprehensive meta-analysis of 52 cohort studies found that HIV-infected mothers had 1.73 times higher odds of delivering LBW infants compared to uninfected women [47]. Beyond HIV, other maternal chronic conditions significantly increase LBW risk, including cardiovascular disease, anemia, hypertension, urinary tract infections, and gestational diabetes [48].

Additionally, mothers with chronic medical illness and infections during pregnancy are 5-15 times more likely to deliver a baby with LBW [2,20].

2.2.6 Sociodemographic and economic factors

Studies have identified residence, age, educational status, sex of the newborn, marital status, income, and occupation as factors that can affect birth weight of a newborn.

The chance of delivering a newborn with LBW is higher in mothers who reside in rural areas [2,35]. Supporting this, Ethiopia studies conducted in Debremarkos and Bale zone found twice risk of delivering a newborn with LBW in mothers from rural areas than those who live in urban areas [33,38]. A cross-sectional study conducted among 472 term newborns from Dilla, Southern Ethiopia also showed risk of LBW that is up to six times higher in rural areas compared to urban [39].

In younger mothers, the likelihood of LBW is about 2-6 times higher [20,32,35,38]. E.g. a case-control study conducted in Bale zone, South-East Ethiopia unveiled a 3-fold chance of delivering a LBW baby in pregnant mothers who are below 20 years old [38]. Female sex of the newborn is also found to be associated with increased risk of LBW [16].

Concerning educational status, illiterate mothers are six times more prone to have a LBW baby [38]. As well, the odds of LBW is 2.5 times higher in divorced women compared to married women [39]. Regarding income and occupation, the study in Bale zone of Ethiopia also revealed about four times odds of delivering a LBW among mothers who earn below 26 USD per month. This

study also disclosed a significantly lower odds LBW baby in mothers who are merchant compared to mothers who work employed [38].

2.3 Conceptual framework

This conceptual framework demonstrates factors that affect low birth weight which are categorized as sociodemographic and economic characteristics, obstetric and reproductive health related factors, and nutritional and behavioral factors. The framework is constructed based on the reviewed literatures. Sociodemographic factors that can affect low birth weight are age of the mother, educational status, marital status, occupation, income and residence. Obstetric and health related factors that can be associated with low birth weight are gestational age, ANC follow-up status, pregnancy desirability, pregnancy related complications like antepartum hemorrhage and placenta previa, hypertensive disorders of pregnancy, birth interval, Iron/Folate supplementation, parity, bad obstetric history (i.e. history of abortion, still birth, preterm delivery, and low birth weight), any physical trauma during pregnancy, history of chronic medical illnesses, HIV status, and infections during pregnancy. Nutritional and behavioral factors associated with low birth weight are food security, pregestational weight and BMI, height of the mother, gestational weight gain, mid-upper arm circumference, chat chewing, tobacco smoking, and alcohol drinking [2,3,34–43,11,44–46,49,16,20,21,30–33].

.

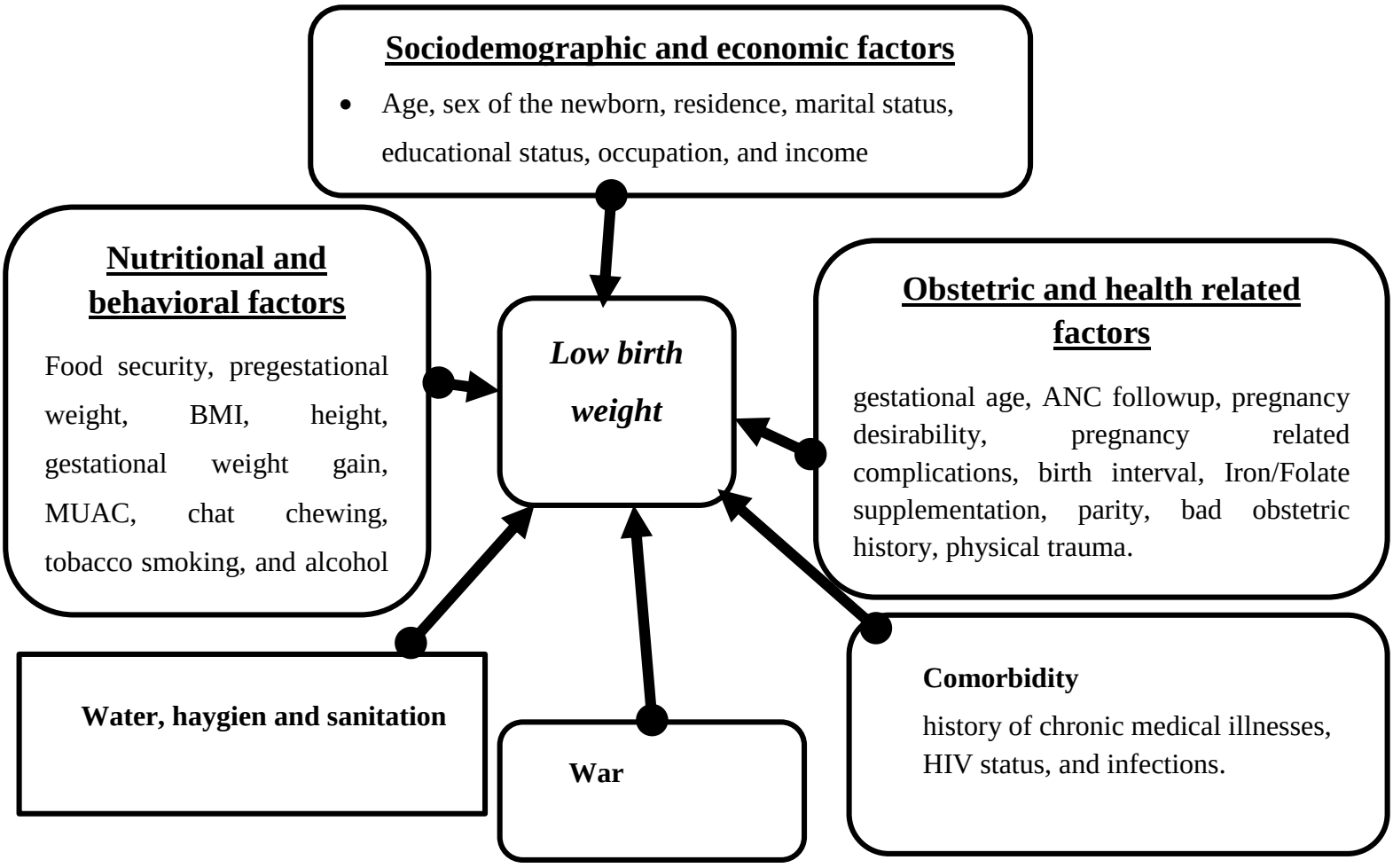

Figure 1: Conceptual framework for the study of magnitude and associated factors of low birth weight among newborns delivered in ACSH, Mekelle, Ethiopia adopted from different literature [2,3,34–43,11,44–46,49,16,20,21,30–33].

3. OBJECTIVES

3.1 General objective

- ✓ To determine magnitude and associated factors of low birth weight among newborns born in Ayder Comprehensive Specialized Hospital, 2024.

3.2 Specific objectives

- ✓ To determine the magnitude of low birth weight among newborns born in Ayder Comprehensive Specialzed Hospital 2024
- ✓ To identify factors associated with low birth weight in Ayder Comprehensive Specialized Hospital, 2024.

4. METHODS

4.1 Study area

This study was conducted in Ayder Comprehensive Specialized Hospital (ACSH) which is located in Mekelle city, Tigray regional state, Ethiopia. ACSH has a capacity of 500 beds and it is the only tertiary hospital for a population of 8.5 million in Tigray, Afar, and Amhara [50]. In ACSH, pregnant mothers are first evaluated in emergency outpatient department and then transferred to labor ward. After delivery, they will be admitted to obstetric ward. In all these service sites, mothers are evaluated and treated by obstetric and gynecologic residents and specialists. In addition, intern medical students and midwives are part of the service provision. In ACSH, more than 500 deliveries are entertained per month.

4.2 Study period

From October 2024 to December 2024.

4.3 Study design

An institution-based cross-sectional study was conducted during the specified period in the specified area.

4.4 population

4.4.1 Source population

- All mother who gave birth at ACSH

4.4.2 Study population

- Selected mothers who gave birth at ACSH from October 2024 to December 2024.

4.4.3 Sample unit

- Mother/Newborn pair

4.5 Eligibility criteria

- **Inclusion criteria**

- ✓ Mother/Newborn pair during immediate post-partum period.

❖ **Exclusion criteria**

- ✓ Twin pregnancy, and severe fetal congenital malformations [51].
- ✓ Critically ill mother who is uncooperative or unable to respond and non-suitable for anthropometric assessment.

4.6 Sample size and sampling procedure

4.6.1 Sample size

Sample size is calculated both for objective one (using single population proportion formula) and objective two (using two population proportion formula) by the help of Epi Info version 7.2 software. Input values like prevalence and proportions were taken from a previous cross-sectional study conducted in three zonal hospitals of Tigray, Northern Ethiopia and a case-control study conducted in public hospitals of Mekelle, Northern Ethiopia [2,20]. A 5% margin of error, 95% confidence interval, and 80% power were assumed during the calculation.

❖ The formula for single proportion is:

$$n = \frac{(z_{\alpha/2})^2 p(1-p)}{d^2} = \frac{(1.96)^2 0.15(1-0.15)}{0.05^2} = 196$$

Where;

- ✓ P = magnitude of low birth weight
- ✓ $z_{\alpha/2}$= critical Z value for 95% confidence level=1.96
- ✓ d =margin of error which is 0.05

❖ The two-proportion sample size calculation formula for objective two is:

$$n = \left[\frac{z_{\alpha/2}\sqrt{((p1 + p2)(q1 + q2)/2)} + z_{\beta}\sqrt{(p1q1 + p2q2)}}{p1 - p2}\right]^2$$

Description of formula for comparing two population proportions,

- ✓ p1=Magnitude of LBW proportion in a group,

- ✓ P2= Magnitude of LBW proportion in another group,
- ✓ q1=1-p1,
- ✓ q2=1-p2,
- ✓ $z_{\alpha/2=}$ critical Z value for 95% confidence level=1.96,
- ✓ $z_{\beta=}$critical Z value for power of 80%=0.84

The sample size results for both objectives are summarized below in **Table 1**.

Table 1*: Calculated sample size for assessing the magnitude and associated factors of LBW.*

Main objectives	***p***	***Formula***	***N***	***Adding 20%***
Prevalence	P=0.15, α=0.05	Single proportion	196	235
Associated factors	Power=0.8, ratio=1, α=0.05			
Maternal weight (<50 kg)	p1=0.53, p2=0.34	Two proportion	232	279
Gestational age (<37 weeks)	p1=0.22, p2=0.02	Two proportion	100	120
Residence (rural)	p1=0.64, p2=0.38	Two proportion	130	156
Chronic medical illness	p1=0.25, p2=0.04	Two proportion	106	128
Maternal height (<150 cm)	p1=0.64, p2=0.25	Two proportion	60	72
Age (<20 years)	p1=0.36, p2=0.06	Two proportion	70	84

Therefore, the final sample size required for this study was 279 mother/newborn pairs after adding 20% non-response rate.

4.6.2 Sampling technique

Mothers who gave live birth during the study period were recruited using systematic random sampling technique. On average, ACSH entertains more than 500 live birth deliveries, monthly. As a result, we expected around 1000 deliveries within two months in ACSH. As a result; k=1000/279≈3. The first mother was selected by simple random sampling after assigning integer values of 1, 2, and 3 consecutively for the first three mothers encountered during data collection. Then, mother/newborn pairs were recruited every third deliveries until the required sample size is achieved.

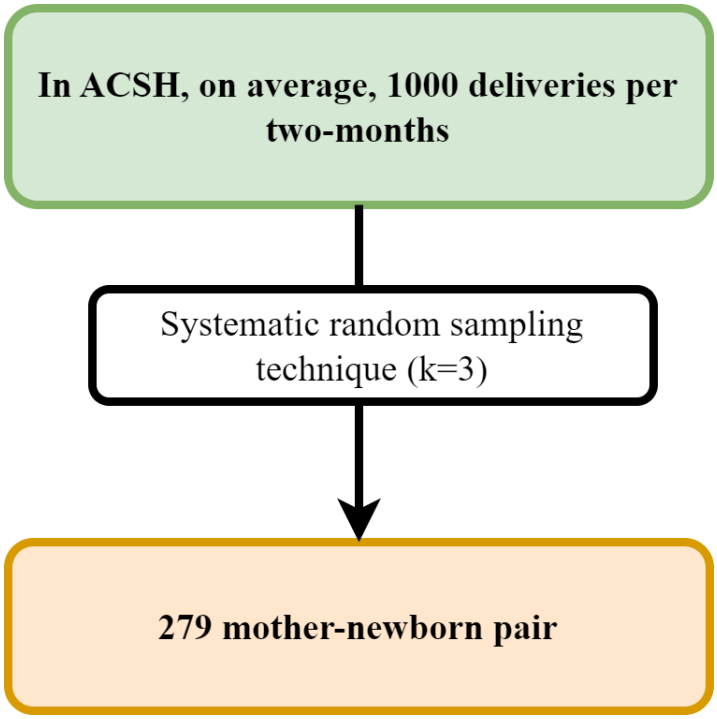

Figure 2: *Schematic representation of sampling procedure for conducting study among 279 mother-newborn pair in ACSH from October-December, 2024.*

4.7 Data collection procedure

Data were collected using an interviewer administered structured questionnaire and checklist. The structured questionnaire was used to collect primary data by interviewing a mother. The checklist was used to collect secondary data from medical records and primary data obtained by direct anthropometric measurements. The socio-demographic, economic, nutritional, and behavioral maternal factors were collected by interviewing mothers. Maternal anthropometric measurements like weight were conducted through physical assessment. ANC, gestational age, and any relevant medical illness were extracted by reviewing medical records. Birth weight of every child will be measured using balanced weight scale, immediately after birth. Data were collected by two trained MSc midwives.

4.8 Study variables

- **Dependent variable**

- ✓ Low birth weight of the neonate

- **Independent variables**

  - ✓ **Sociodemographic and economic factors** (residence, age, educational status, sex of the newborn, marital status, income, and occupation)

  - ✓ **Obstetric and health –related factors** (birth interval, gestational age, obstetric complications, chronic medical illness, history of abortion, number of ANC follow up, mineral supplements, hemoglobin, parity, and birth interval)

  - ✓ **Nutritional and behavioral factors (**drinking alcohol, cigarette smoking, chat chewing, gestational weight gain, height, and weight)

  - ✓ **WASH related factors** (Source of water, Type of latrine, Type of waste disposal, menstrual hygiene, etc)

  - ✓ **Food security factors**

4.9 Standard definitions

- **Low birth weight**: weight of a baby at birth below 2500 grams [13].
- **Normal birth weight**: weight of a baby at birth ranging from 2500 grams to 4000 grams [13]..
- **Macrosomia**: weight of a baby at birth above 4000 grams [13].
- **Birth interval**: length of time between two successive births.
- **Chronic medical illness:** having illnesses like hypertension, diabetes mellitus, congestive heart failure, chronic kidney diseases, and HIV during the course of the current pregnancy
- **MUAC :** MUAC <23 cm will used to categorize mothers as undernourished [52].

4.10 Household Food Insecurity Access Scale Score[53]

The HFIAS score is a continuous measure of the degree of food insecurity (access) in the household in the past four weeks (30 days). First, a HFIAS score variable was calculated for each household by summing the codes for each frequency-of-occurrence question. Before summing the

frequency-of-occurrence codes, the frequency-of-occurrence was coded as 0 for all cases where the answer to the corresponding occurrence question was “no” (i.e., if Q601=0 then Q601a=0, if Q602=0 then Q602a =0, etc.). So, the scale for each question ranges from 0 to 3 (i.e., 0 = None, 1 = Rarely, 2 = Sometimes, and 3 = Often). The maximum score for a household is 27.

HFIAS score=Q601a + Q602a + Q603a + Q604a + Q605a + Q606a + Q607a + Q608a + Q609a

Then, HFIA wase categorized into four level (1 = Food Secure, 2=Mildly Food Insecure Access, 3=Moderately Food Insecure Access, 4=Severely Food Insecure Access) as follows:

- HFIA category = 1 if [(Q601a=0 or Q601a=1) and Q602=0 and Q603=0 and Q604=0 and Q605=0 and Q606=0 and Q607=0 and Q608=0 and Q609=0]
- HFIA category = 2 if [(Q601a=2 or Q601a=3 or Q602a=1 or Q602a=2 or Q602a=3 or Q603a=1 or Q604a=1) and Q605=0 and Q606=0 and Q607=0 and Q608=0 and Q609=0]
- HFIA category = 3 if [(Q603a=2 or Q603a=3 or Q604a=2 or Q604a=3 or Q605a=1 or Q605a=2 or Q606a=1 or Q606a=2) and Q607=0 and Q608=0 and Q609=0]
- HFIA category = 4 if [Q605a=3 or Q606a=3 or Q607a=1 or Q607a=2 or Q607a=3 or Q608a=1 or Q608a=2 or Q608a=3 or Q609a=1 or Q609a=2 or Q609a=3]

Data related to HFIAS was directly collected by interviewing the mothers.

4.11 Data quality assurance

Pretest was conducted in Mekelle Hospital on 10% (34 mother/newborn pairs) of study participants which were not be included in the main study to test the clarity, consistency and completeness of the questionnaire. Data were collected by midwife nurses trained for two days on how to collect, interview and the overall objectives of the study by principal investigator. Supervision of the overall data collection process was the task of the principal investigator. Weighing scales were checked and calibrated at zero level for the validity of the measurement. The collected data were reviewed and checked for completeness each day.

In Addition, the use of Open Data Kit (ODK) mobile application helped to reduce errors related to typing, avoid inconsistencies and invalid responses, and minimize delay in the provision of feedbacks. Moreover, it helped for continuous monitoring of data collection pace and data quality.

4.12 Data analysis procedure

ODK collect mobile application was used as data entry software to minimize data entry errors and coding problems. After completion of data entry, the data were exported into SPSS version 27 for analysis.

During analysis, both descriptive and inferential statistics were employed. Categorical variables were described using frequency, proportions, and graphs. After assessing assumption of normality using kolmogrov-smirnov test, continuous variables also were described using an appropriate combination of measures of central tendency and measures of dispersion. An association or a relationship between the categorical variables and low birth weight was assessed using Chi-square test of association. Predictors of low birth weight were identified by conducting binary logistic regression. Variables with $p<0.25$ during univariable analysis were selected for final multivariable analysis. Assumptions of logistic regression like absence of zero cells were assessed by cross-tabulating each independent variable with the dependent variable (i.e. low birth weight).

After conducting binary logistic regression, odds ratio and its 95% confidence interval was reported to show direction, magnitude, precision, and significance of association between predictors and low birth weight. Goodness of fit and Multicollinearity were assessed using Hosmer-Lemeshow test and Variance Inflation Factor (VIF) respectively. Hosmer-lemeshow test with $p>0.05$ was used to declare a model is good fit for the data. Variance Inflation Factor (VIF) below ten was used as cut-off value to consider absence of multicollinearity. Statistical significance declared at $p <0.05$. Finally, all results are presented in the form of text, table and graph

4.13 Ethical Consideration

Ethical clearance was obtained from institutional review board of Mekelle University, College of Health Sciences with an ethical clearance number: MU-IRB 2419/2024. Then, permission and informed consent were obtained from chief clinical director and mothers, respectively. Medical Record Number (MRN) were replaced by codes. Informed consent was obtained from the mothers verbally. Mothers had full power either to participate in or refuse the study. There was no harm for the participants and attention was given not to breach privacy.

5. RESULT

For this study, a total of 279 women were interviewed and related medical records of the mother and the newborn were reviewed. We didn't encounter non-respondents during the study. The magnitude of low birthweight (<2500 grams) in this study was 66 (23.7%).

5.1. Sociodemographic, anthropometric, and food security related characteristics

The mean age of the mothers was 28.8 ± 3.9 years. About 78% of the women belonged to the age group of 25 to 34 years. More than half (58.1%) of the newborns were male. Around one-fourth (26.2%) and about half (50.9%) of the women had attended primary and secondary education, respectively. Most of the women were from urban areas (94.3%) and were married (97.1%). Weight gain during pregnancy of less than 10 kg was observed in 52% of the pregnant women. The magnitude of low birth weight was 43.4% in pregnant women who gained less than 10 kg and 2.2% in those who gained 10 kg or more, and this difference was statistically significant ($p<0.001$). Women with a mid-upper arm circumference (MUAC) of less than 23 cm and 23 cm or above accounted for 22.6% and 77.4% of the respondents, respectively. The magnitude of low birth weight in women with a MUAC of less than 23 cm was 71.4%, whereas in those with a MUAC of 23 cm or above was 9.7%, and the discrepancy was statistically significant ($p<0.001$). Women in food-secure households accounted for 62.7% of the respondents. The remaining had mild (17.2%), moderate (13.6%), or severe (6.5%) food insecurity. As the severity of food insecurity increased, the magnitude of low birth weight also increased significantly ($p<0.001$). The incidence of low birth weight among women living in food-secure households was 10.3%. However, in cases of mild, moderate, and severe food insecurity, the magnitude of low birth weight was 22.9%, 65.8%, and 66.7%, respectively. For more detail, see **Table *2***.

Table 2: *Sociodemographic, anthropometric, and food security related characteristics of the women who delivered at ACSH (N=279).*

Variable	Category	Low birthweight (N=279)		Total	P-value*
		No (213)	Yes (n=66)		
Age category	20-24	25 (73.5)	9 (26.5)	34 (12.2)	0.454
	25-34	164 (75.6)	53 (24.4)	217 (77.8)	
	35+	24 (85.7)	4 (14.3)	28 (10.0)	
Sex of newborn	Male	128 (79.0)	34 (21.0)	162 (58.1)	0.217
	Female	85 (72.6)	32 (27.4)	117 (41.9)	
Religion	Christian	193 (76.0)	61 (24.0)	254 (91.0)	0.652
	Muslim	20 (80.0)	5 (20.0)	25 (9.0)	
Ethnicity	Tigray	211 (76.4)	65 (23.6)	276 (98.9)	0.692
	Other (2 Afar, 1 Amhara)	2 (66.7)	1 (33.3)	3 (1.1)	
Maternal Educational status	No formal education	1 (50.0)	1 (50.0)	2 (0.7)	0.111
	Primary education	52 (71.2)	21 (28.8)	73 (26.2)	
	Secondary education	106 (74.6)	36 (25.4)	142 (50.9)	
	College or above	54 (87.1)	8 (12.9)	62 (22.2)	
Residence	Rural	10 (62.5)	6 (37.5)	16 (5.7)	0.180
	Urban	203 (77.2)	60 (22.8)	263 (94.3)	
Marital status	Single	7 (100.0)	0 (0.0)	7 (2.5)	0.067
	Married	206 (76.0)	65 (24.0)	271 (97.1)	
	Divorced	0 (0.0)	1 (100.0)	1 (0.4)	
Occupation	Farmer	1 (25.0)	3 (75.0)	4 (1.4)	0.151
	Housewife/Unemployed	96 (75.0)	32 (25.0)	128 (45.9)	
	Self-employed	44 (75.9)	14 (24.1)	58 (20.8)	
	Private employed	37 (82.2)	8 (17.8)	45 (16.1)	
	Government employee	34 (81.0)	8 (19.0)	42 (15.1)	
	Student	1 (50.0)	1 (50.0)	2 (0.7)	
Weight gain during pregnancy	<10 kilograms	82 (56.6)	63 (43.4)	145 (52.0)	<0.001
	≥10 kilograms	131 (97.8)	3 (2.2)	134 (48.0)	
MUAC	<23 cm	18 (28.6)	45 (71.4)	63 (22.6)	<0.001
	≥23 cm	195 (90.3)	21 (9.7)	216 (77.4)	
Household food insecurity and access scale	Food Secure	157 (89.7)	18 (10.3)	175 (62.7)	<0.001
	Mildly Food Insecure Access	37 (77.1)	11 (22.9)	48 (17.2)	
	Moderately Food Insecure Access	13 (34.2)	25 (65.8)	38 (13.6)	
	Severely Food Insecure Access	6 (33.3)	12 (66.7)	18 (6.5)	

*The p-values are computed by conduction chi-square test of association between the categorical variables and the dependent variable (i.e., low-birthweight of the neonate).

5.2. Obstetric characteristics and comorbidities

Only 15 women (5.4%) were pregnant for the first time (primigravida). The rest were multigravida (81.4%) or grand multigravida (13.3%). One-fifth (20.8%) of the women had experienced an abortion. Except two, all women had antenatal care (ANC) contact. Pregnancy-related complications occurred in about one-fourth (24.7%) of the women. Chronic medical illness was found in 24 women (8.6%). Bad obstetric history was reported by 144 women (51.6%), with the most prevalent complications being preterm delivery (22.9%) and low birthweight (18.6%). The magnitude of low birthweight was significantly higher ($p<0.001$) among women with a history of low birthweight (50%) compared to those without such a history (17.6%). Women who had consumed alcohol during pregnancy represented 107 respondents (38.4%). The magnitude of low birthweight among those who drank alcohol during pregnancy was 31.8%, compared to 18.6% among those who did not, a difference that was statistically significant ($p=0.012$).

Table 3: *Obstetric and comorbidities related characteristics of the women (N=279).*

Variable	Category	Low birthweight (N=279)		Total	P-value*
		No (n=213)	Yes (n=66)		
Gravidity	Primigravida	12 (80.0)	3 (20.0)	15 (5.4)	0.705
	Multigravida	171 (75.3)	56 (24.7)	227 (81.4)	
	Grand multigravida	30 (81.1)	7 (18.9)	37 (13.3)	
Parity	Primiparous	46 (68.7)	21 (31.3)	67 (25.4)	0.250
	Multiparous	151 (78.6)	41 (21.4)	192 (72.7)	
	Grand multiparous	4 (80.0)	1 (20.0)	5 (1.9)	
Have you ever had abortion	No	169 (76.5)	52 (23.5)	221 (79.2)	0.923
	Yes	44 (75.9)	14 (24.1)	58 (20.8)	
ANC visits for the current Pregnancy	No	1 (50.0)	1 (50.0)	2 (0.7)	0.379
	Yes	212 (76.5)	65 (23.5)	277 (99.3)	
Number of ANC contacts (n=277)	1-3	6 (27.3)	16 (72.7)	22 (7.9)	<0.001
	4+	206 (80.8)	49 (19.2)	255 (92.1)	
Did you have pregnancy related complication	No	163 (77.6)	47 (22.4)	210 (75.3)	0.382
	Yes	50 (72.5)	19 (27.5)	69 (24.7)	
Type of pregnancy related complication (n=69)	APH	7 (77.8)	2 (22.2)	9 (13.0)	0.918
	PROM	20 (62.5)	12 (37.5)	32 (46.4)	0.050
	PIH	17 (68.0)	8 (32.0)	25 (36.2)	0.304
	GDM	10 (100.0)	0 (0.0)	10 (14.5)	0.073
Chronic medical illness	No	194 (76.1)	61 (23.9)	255 (91.4)	0.734

	Yes	19 (79.2)	5 (20.8)	24 (8.6)	
Type of illness (n=24)	Hypertension	3 (100.0)	0 (0.0)	3 (12.5)	0.332
	DM	10 (100.0)	0 (0.0)	10 (41.7)	0.073
	Anemia	3 (60.0)	2 (40.0)	5 (20.8)	0.386
	TB	0 (0.0)	1 (100.0)	1 (4.2)	0.072
	Respiratory disease	1 (50.0)	1 (50.0)	2 (8.3)	0.379
	Heart disease	0 (0.0)	1 (100.0)	1 (4.2)	0.072
	Liver disease	1 (100.0)	0 (0.0)	1 (4.2)	0.577
Malaria infection during the current pregnancy	No	213 (76.6)	65 (23.4)	278 (99.6)	0.072
	Yes	0 (0.0)	1 (100.0)	1 (0.4)	
Is pregnancy planned and wanted	Unplanned but wanted	40 (72.7)	15 (27.3)	55 (19.7)	0.481
	Planned and wanted	173 (77.2)	51 (22.8)	224 (80.3)	
Bad obstetric history	Yes	91(67.4)	44 (32.6)	135 (48.4)	0.001
	No	122 (84.7)	22 (15.6)	144 (51.6)	
Type of bad obstetric history	Stillbirth	17 (81.0)	4 (19.0)	21 (7.5)	0.605
	Low birth weight	26 (50.0)	26 (50.0)	52 (18.6)	<0.001
	Preterm delivery	44 (68.8)	20 (31.3)	64 (22.9)	0.103
	Congenital malformation	10 (90.9)	1 (9.1)	11 (3.9)	0.246
Ever drunk alcohol during the current pregnancy	No	140 (81.4)	32 (18.6)	172 (61.6)	0.012
	Yes	73 (68.2)	34 (31.8)	107 (38.4)	
Took Iron/folate during the current pregnancy	No	2 (66.7)	1 (33.3)	3 (1.1)	0.692
	Yes	211 (76.4)	65 (23.6)	276 (98.9)	

*The p-values are computed by conduction chi-square test of association between the categorical variables and the dependent variable (i.e., low-birthweight of the neonate).

5.3. Water, Sanitation, and Hygiene (WASH) related characteristics

The most commonly reported primary source of water for the women's households was water piped into the compound (40.1%), followed by water piped into the dwelling (29.7%) and water piped to a neighbor (21.9%). About 22% of women reported experiencing an insufficient amount of drinking water in the past month. Nearly three-fourths (73.8%) of women use a common latrine. Almost all (98.2%) of women reported that they change sanitary pads privately before their current pregnancy. The magnitude of low birthweight was significantly higher among women living in households with poor WASH-related facilities.

Table 4*: Water, Sanitation, and Hygiene (WASH) related characteristics among the women (N=279).*

Variable	Category	Low birthweight (N=279)		Total	P-value*
		No (213)	Yes (n=66)		
What is the main source of water for members of your household	Piped into dwelling	78 (94.0)	5 (6.0)	83 (29.7)	<0.001
	Piped into compound, yard or plot	96 (85.7)	16 (14.3)	112 (40.1)	
	Piped to neighbor	31 (50.8)	30 (49.2)	61 (21.9)	
	Public tap / standpipe	1 (20.0)	4 (80.0)	5 (1.8)	
	Protected well	2 (66.7)	1 (33.3)	3 (1.1)	
	Unprotected well	1 (33.3)	2 (66.7)	3 (1.1)	
	Delivered water -Tanker-truck	1 (50.0)	1 (50.0)	2 (0.7)	
	Delivered water -Cart	2 (40.0)	3 (60.0)	5 (1.8)	
	Surface water (river, stream, dam, lake, pond, canal, irrigation channel)	1 (20.0)	4 (80.0)	5 (1.8)	
Type of main water source	Protected	211 (77.9)	60 (22.1)	271 (97.1)	0.001
	Unprotected (surface water and unprotected well/spring)	2 (25.0)	6 (75.0)	8 (2.9)	
In the last month, has there been any time when your household did not have sufficient quantities of drinking water?	Yes, at least once	36 (59.0)	25 (41.0)	61 (21.9)	<0.001
	No, always sufficient	114 (85.1)	20 (14.9)	134 (48.0)	
	Don't know	63 (75.0)	21 (25.0)	84 (30.1)	
What type of toilet do you use in your household?	Communal facility	167 (81.1)	39 (18.9)	206 (73.8)	<0.001
	Pit latrine (state VIP or other)	29 (100.0)	0 (0.0)	29 (10.4)	
	Flush and piped seated toilet	1 (33.3)	2 (66.7)	3 (1.1)	
	Bucket	6 (50.0)	6 (50.0)	12 (4.3)	
	None available (open toilet)	10 (34.5)	19 (65.5)	29 (10.4)	
Proper toilet (communal, pit, and flush)	Yes	197 (82.8)	41 (17.2)	238 (85.3)	<0.001
	No	16 (39.0)	25 (61.0)	41 (14.7)	
During your last menstrual period were you able to wash and change in privacy?	No	1 (20.0)	4 (80.0)	5 (1.8)	0.003
	Yes	212 (77.4)	62 (22.6)	274 (98.2)	
During your last menstrual period, what hygiene materials did you use?	Cloth/reusable sanitary pads	89 (76.1)	28 (23.9)	117 (41.9)	<0.001
	Disposable sanitary pads	123 (82.0)	27 (18.0)	150 (53.8)	
	Toilet paper	0 (0.0)	5 (100.0)	5 (1.8)	
	Underwear alone	1 (14.3)	6 (85.7)	7 (2.5)	

*The p-values are computed by conduction chi-square test of association between the categorical variables and the dependent variable (i.e., low-birthweight of the neonate).

5.4. Predictors of Low Birth Weight

Based on multivariable logistic regression analysis, MUAC, weight gain during pregnancy, and household food security status were identified as significant predictors of low birth weight. The adjusted odds of low birth weight were 5.5 times higher among pregnant women with a MUAC of less than 23 cm compared to those with a MUAC of 23 cm or more. The adjusted odds of low birth weight were 11.6 times higher among pregnant women who gained less than 10 kg during pregnancy compared to those who gained 10 kg or more. Lastly, the adjusted odds of low birth weight were 2.5 times higher among women living in food-insecure households compared to those in food-secure households. Hosmer-Lemeshow test was insignificant (p=0.974) and revealed that the model was good-fit. Maximum VIF value was 2 saying that the multivariable model was not affected by any multicollinearity issue.

Table 5: *Predictors of low birthweight, a binary logistic regression analysis result (N=279).*

Variable	Category	COR [95% CI]	P-value	AOR [95% CI]	P-value
Frequency of ANC contact	1-3	11.2 [4.2, 30.1]	<0.001	2.1 [0.5, 9.0]	0.303
	≥4	1		1	
History of low birthweight	Yes	4.7 [2.5, 8.9]	<0.001	2.0 [0.9, 4.8]	0.105
	No	1		1	
Alcohol intake during pregnancy	Yes	2.0 [1.2, 3.6]	0.013	0.7 [0.3, 1.5]	0.371
	No	1		1	
Main water source	Protected	1		1	
	Unprotected	10.5 [2.1, 53.6]	0.005	0.7 [0.1, 6.4]	0.744
Weight gain during pregnancy	<10 Kg	33.5 [10.2, 110.3]	<0.001	11.6 [3.2, 42.3]	<0.001
	≥10 kg	1		1	
MUAC	<23 cm	23.2 [11.4, 47.1]	<0.001	5.5 [2.2, 13.4]	<0.001
	≥23 cm	1		1	
Proper toilet	Yes	1		1	
	No	7.5 [3.7, 15.3]	<0.001	0.7 [0.3, 2.2]	0.599
Household food security status	Secure	1		1	
	Insecure	7.5 [4.0, 13.9]	<0.001	2.5 [1.1, 5.9]	0.028

6. DISCUSSION

The purpose of this study was to determine the magnitude of low birth weight among newborns born in Ayder Comprehensive Specialized Hospital (ACSH) and identify factors associated with low birth weight. Accordingly, the magnitude of low birth weight (LBW) was 23.7% with 95% confidence interval ranging from 19% to 28.9%. Factors that are significantly associated with increased magnitude of low birth weight were maternal malnutrition (MUAC below 23 cm), small weight gain during pregnancy (<10 kg), and household food insecurity.

The magnitude of low birth weight (LBW) in our study (23.7%) is higher than the pooled prevalence of LBW in Ethiopia, which is 17.3% [30], as well as a previous study conducted in Tigray reporting 15% [2], and a study from Addis Ababa indicating 8.8% [31]. It is also higher than the magnitude reported in Iran (8.7%) [24] and in Brazil, where LBW magnitude ranged from 7.6% to 9.6% [25,26]. Similarly, studies from Ghana and Nigeria showed LBW prevalence ranging from 8.3% to 16.9% across African countries [27–29]. However, our findings are comparable to those from cross-sectional studies conducted in Dire Dawa and Debre Markos, Ethiopia, which reported LBW prevalences of 21% and 21.6%, respectively [3,33]. They are also in line with reports from India and Nepal, where LBW rates reach up to 22% [22,23]. The LBW prevalence in our study is approximately 9% higher than the aforementioned pre-war study in Tigray. This increase may be attributed to the detrimental effects of the recent Tigray conflict, which disrupted access to food, nutritional counselling, and maternal and child health services [54]. Evidence shows that first-trimester exposure to armed conflict reduces birth weight by 2.8% and increases the incidence of LBW by 3.2% [11]. Furthermore, a case-control study revealed that maternal exposure to armed conflict increases the odds of very low birth weight by approximately fourfold [45].These discrepancies may be explained by the impact of war, variations in socioeconomic status, differences in study design and sample size, and disparities in health system capacity.

In this study, maternal malnutrition (MUAC below 23 cm) associated with increased risk of low birthweight. This is consistent with studies from southern part of Ethiopia that reported three to six times higher odds of LBW among mothers whose MUAC is below 23 cm [41,43,49]. Mid-upper arm circumference (MUAC) below 23 cm and low birth weight (LBW) are consistently linked, and this relationship is strengthened by common nutritional issues in Mekelle and Southern

Ethiopia, including insufficient dietary diversification, food instability, and seasonal variations in food availability. Low MUAC or BMI value suggest low nutritional/energy intake (i.e., undernutrition) which negatively affect fetal growth [51]. Maternal undernutrition exposes to several diseases and inadequate transfer of nutrients from the mother to the fetus, which lead to LBW [55]. These findings suggest the importance of maternal nutrition and routine MUAC screening during pregnancy. Implementing MUAC-based assessments during antenatal care contacts might help to identify at-risk pregnancies early, allowing for timely nutritional interventions and decrease the magnitude of low birthweight.

The other significant risk factor of LBW identified by this study is small weight gain during pregnancy. The odds of low birth weight were 11.6 times higher among pregnant women who gained less than 10 kg during pregnancy compared to those who gained 10 kg or more. This finding is supported by a previous study conducted in public health facilities of Mekelle city, Tigray which found that weight gain below 12 kg during the course of pregnancy elevates the likelihood LBW baby by about 5-folds [20]. A study conducted in private clinics in Mekelle City also found that for every 1 kg increase in maternal weight during pregnancy, newborn birthweight increased by approximately 94 grams [56]. Our finding regarding small maternal weight gain as a significant risk factor for low birth weight (LBW) was consistent with the aforementioned two studies in Mekelle, Tigray. These studies were conducted in a similar sites and sociodemographic contexts, using facility-based designs and using gestational weight gain as a categorical variable [20,56]. The association between inadequate gestational weight gain and LBW is well-supported biologically and has a dose-response relationship [56]. These results highlight the importance of adequate weight gain during pregnancy in order to ensure proper fetal growth and lessen the severity of low birthweight.

The last but least finding of this study is that the adjusted odds of low birth weight is higher among women living in food-insecure households compared to those in food-secure households. In support to the present study finding, a study conducted in Silte zone, Southern Ethiopia, also revealed that household food insecurity increases the odds of LBW by about 7-folds [57]. The finding is also supported by a systematic review study that unveiled maternal food insecurity increases the risk of having LBW baby by 3% [44]. Women living in food-insecure households

are at risk for nutritional deficiencies including anemia, small weight gain during pregnancy, and stress which in turn negatively influence fetal growth and development [57]. Thus, increasing the incidence of LBW [55].

6.1. Strength and limitation of the study

Self-reporting methods used to collect household related characteristics may lead to recall bias. This study is conducted in Mekelle city, more particularly in Ayder Comprehensive Specialized Hospital. So, its generalizability to the whole Tigray region may be limited.

7. Conclusion

The present study assessed the magnitude of low birth weight (LBW) and its associated factors among newborns delivered at Ayder Comprehensive Specialized Hospital (ACSH) in Mekelle, Tigray. The LBW magnitude of 23.7% is significantly higher than majority of national and international reports. This higher magnitude of LBW indicates the compounded effects of the recent armed conflict in Tigray, which disrupted maternal health services, nutritional support, and food security. In the present study, three factors were significantly associated with increased odds of LBW: maternal malnutrition (MUAC <23 cm), inadequate gestational weight gain (<10 kg), and presence of household food insecurity.

8. Recommendations

Health Facilities and health professionals should:

- conduct MUAC screening (<23 cm) during antenatal care contacts to identify undernourished mothers early and treat promptly.
- Provide nutritional counselling focused on achieving enough weight gain during pregnancy.
- Monitor and document gestational weight gain at each ANC visit.

Federal and Regional Health Bureaus should:

- Give emphasis to maternal nutrition programs in post-conflict context.
- Screen food insecure households and mobilizes resources for food support targeting pregnant women.

Researchers

- A longitudinal study should be conducted in Tigray to assess the trend of LBW in post-conflict situation.

9. REFERENCES

[1] World Health Organization, World Health Assembly Global Nutrition Targets 2025: Low Birth Weight Policy Brief, World Health Organization, Geneva, Switzerland, 2014, http://www. who.int/nutrition/topics/globaltargets_stunting_policybrief. n.d.

[2] Gebremedhin M, Ambaw F, Admassu E, Berhane H. Maternal associated factors of low birth weight : a hospital based cross-sectional mixed study in Tigray , Northern Ethiopia. BMC Pregnancy Childbirth 2015:1–8. https://doi.org/10.1186/s12884-015-0658-1.

[3] Sema A, Tesfaye F, Belay Y, Amsalu B, Bekele D, Desalew A. Associated Factors with Low Birth Weight in Dire Dawa City , Eastern Ethiopia : A Cross-Sectional Study 2019;2019.

[4] Girotra S, Mohan N, Malik M, Roy S, Basu S. Prevalence and Determinants of Low Birth Weight in India : Findings From a Nationally Representative Cross-Sectional Survey (2019-21) 2025;15:11–3. https://doi.org/10.7759/cureus.36717.

[5] Hack M, Klein NK, Taylor HG. Long-term developmental outcomes of low birth weight infants. Futur Child. 1995;1:176–96. n.d.

[6] ACC U. UN Administrative Committee on Coordination/Sub-Committee on Nutrition Geneva. Low birthweight: report from a meeting in Dhaka, Bangladesh on 14–17 June 1999; 2000 n.d.

[7] CONCEIVE NOWBT. Nutrition of women in the preconception period, during pregnancy and the breastfeeding period; 2012. n.d.

[8] Wardlaw T, Blanc A, Zupan J, Ahman E, United Nations Children's fund and World Health Organization. Low birthweight: country, regional and global estimates; 2005 n.d.

[9] Taylor HG, Minich NM, Klein N, Hack M. Longitudinal outcomes of very low birth

weight: Neuropsychological findings. J Int Neuropsycho Soc. 2004;113:163–742. n.d.

[10] Taddese A, Alemu T, Umeta M. Prevalence and Predictors of " Small Size " Babies in Ethiopia : In- depth Analysis of the Ethiopian Demographic and Health Survey , 2011 2011.

[11] Le K, Nguyen M. Armed conflict and birth weight. Econ Hum Biol 2020;39. https://doi.org/10.1016/j.ehb.2020.100921.

[12] Peña-Rosas JP, De-Regil LM, Garcia-Casal MN, Dowswell T. Daily oral iron supplementation during pregnancy. Cochrane Database Syst Rev 2015. https://doi.org/10.1002/14651858.CD004736.pub5.

[13] World Health Organization. Global Nutrition Targets 2025: Low birth weight policy brief. World Health Organization; 2014. n.d.

[14] World Health Organization (WHO). Global nutrition targets 2025: low birth weight policy brief; 2014. n.d.

[15] S. K. Sebayang, M. J. Dibley, P. J. Kelly, A. V. Shankar, and A. H. Shankar, “Determinants of low birthweight, small-forgestational-age and preterm birth in Lombok, Indonesia: analyses of the birthweight cohort of the SUMMIT trial,” Tropical Medicine & In n.d.

[16] Zenebe K, Awoke T, Birhan N. Low Birth Weight & Associated Factors Among Newborns in Gondar Town , North West Ethiopia : Institutional Based Cross-Sectional Study 2014;4:74–80.

[17] Al Hazzani F, Al-Alaiyan S, Hassanein J, Khadawardi E. Short-term outcome of very low-birth-weight infants in a tertiary care hospital in Saudi Arabia. Ann Saudi Med. 2011;31(6):581–5. n.d.

[18] Njim T, Atashili J, Mbu R, Choukem S. Low birth weight in a sub-urban area of

Cameroon : an analysis of the clinical cut- off , incidence , predictors and complications. BMC Pregnancy Childbirth 2015:1–8. https://doi.org/10.1186/s12884-015-0723-9.

[19] Zeleke BM, Zelalem M, Mohammed N. Incidence and correlates of low birth weight at a referral hospital in Northwest Ethiopia. Pan Afr Med J. 2012;12(1):4. n.d.

[20] Desta SA, Damte A, Hailu T. Maternal factors associated with low birth weight in public hospitals of Mekelle city , Ethiopia : a case-control study 2020:1–9.

[21] Aboye W, Berhe T, Birhane T, Gerensea H. Prevalence and associated factors of low birth weight in Axum town , Tigray , North. BMC Res Notes 2018:1–6. https://doi.org/10.1186/s13104-018-3801-z.

[22] Pal A, Manna S, Das B, Dhara PC. The risk of low birth weight and associated factors in West Bengal , India : a community based cross-sectional study 2020;0.

[23] Dk Y, Chaudhary U, Shrestha N. Risk Factors Associated with Low Birth Weight 2011.

[24] Mirahmadizadeh A, Soleimani A, Moradi F, Hesami E, Delam H, Job F. Prevalence and Risk Factors of Low Birth Weight in Fars Province , South of Iran , 2014 2017;5:1–5.

[25] Mendes QDS, Cacella DA, Cristina B, Balieiro FG, Magda M. Low birth weight in a municipality in the southeast region of Brazil 2015.

[26] Roberto P, Sousa M De, Sarno F. Low birth weight and its associated factors Baixo peso ao nascer e seus fatores associados 2018;16:1–6. https://doi.org/10.31744/einstein.

[27] Ugboma HAA, Onyearugha CN. Low birthweight delivery : Prevalence and associated factors as seen at a tertiary health facility 2013;16:1–4.

[28] Awintuen I, Id A, Kanmiki EW, Nonterah A, Tediosi F, Id JA, et al. Socio-demographic determinants of low birth weight : Evidence from the Kassena-Nankana districts of the Upper East Region of Ghana 2018:1–10.

[29] Takai IU, Bukar M, Audu BM. A prospective study of maternal risk factors for low birth weight babies in Maiduguri, North-Eastern Nigeria 2014;11. https://doi.org/10.4103/0331-8540.140353.

[30] Endalamaw A, Engeda EH, Ekubagewargies DT, Belay GM. Low birth weight and its associated factors in Ethiopia : a systematic review and meta- analysis 2018;6:1–12.

[31] Mulatu H, Zepre K, Betre M, Hailemicael G. Magnitude and Factors Associated with Low Birth Weight among New Born in Selected Public Hospitals of Addis Ababa, Ethiopia, 2016 2017;17.

[32] Gebregzabiherher Y, Haftu A, Weldemariam S, Gebrehiwet H. The Prevalence and Risk Factors for Low Birth Weight among Term Newborns in Adwa General Hospital , Northern Ethiopia 2017;2017.

[33] Alebel A, Wagnew F, Tesema C, Gebrie A, Ketema DB, Asmare G. Factors associated with low birth weight at Debre Markos Referral Hospital , Northwest Ethiopia : a hospital based cross - sectional study. BMC Res Notes 2019:1–6. https://doi.org/10.1186/s13104-019-4143-1.

[34] Hailu LD, Kebede DL. Determinants of Low Birth Weight among Deliveries at a Referral Hospital in Northern Ethiopia 2018;2018.

[35] Mengesha HG, Wuneh AD, Weldearegawi B, Selvakumar DL. Low birth weight and macrosomia in Tigray, Northern Ethiopia: Who are the mothers at risk? BMC Pediatr 2017;17:1–9. https://doi.org/10.1186/s12887-017-0901-1.

[36] Teklehaimanot N, Hailu T, Assefa H. Prevalence and factors associated with low birth weight in Axum and Laelay Maichew Districts , North Ethiopia : A

comparative cross sectional study 2014;3:560–6. https://doi.org/10.11648/j.ijnfs.20140306.21.

[37] Gebrehawerya T, Gebreslasie K, Admasu E, Gebremedhin M. Determinants of Low Birth Weight among Mothers Who Gave Birth in 2018;4:1–6. https://doi.org/10.4172/2572-4983.1000145.

[38] Demelash H, Motbainor A, Nigatu D, Gashaw K, Melese A. Risk factors for low birth weight in Bale zone hospitals , South-East Ethiopia : a case – control study 2015:1–10. https://doi.org/10.1186/s12884-015-0677-y.

[39] Mehare T. Prevalence and Associated Factors of Low Birth Weight among Term Newborns in Dilla Town , Southern Ethiopia 2020;2020:1–7.

[40] Girma S, Fikadu T, Agdew E, Haftu D, Gedamu G, Dewana Z. Factors associated with low birthweight among newborns delivered at public health facilities of Nekemte town , West Ethiopia : a case control study 2019:1–6.

[41] Siyoum M, Melese T. Factors associated with low birth weight among babies born at Hawassa University Comprehensive Specialized Hospital , 2019;7:1–7.

[42] Talie A, Taddele M, Alemayehu M. Magnitude of Low Birth Weight and Associated Factors among Newborns Delivered in Dangla Primary Hospital , Amhara Regional State , Northwest Ethiopia , 2017 2019;2019.

[43] Toru T. Assessment of Low Birth Weight and Associated Factors Among Neonates in Butajira General Hospital , South Ethiopia , Cross Sectional Study , 2019 2020;2020.

[44] Ribeiro A, Rocha DF, Azevedo FM, Morais DDC, Priore SE. Maternal food insecurity increases the risk of low birth weight babies: Systematic review and meta-analysis 2024;113:1–8. https://doi.org/10.1111/apa.17327.

[45] Cabra-bautista G, Marcela C, Rugeles G, Grillo-ardila CF. Exposure to armed

conflict as a factor associated with very low birth weight : Case-control population study 2022:10–1. https://doi.org/10.1002/ijgo.14082.

[46] Id KKB, Id WTS, Walser-kuntz E, Zimmerman MB. Impact of social capital , harassment of women and girls , and water and sanitation access on premature birth and low infant birth weight in India 2018:1–18.

[47] Xiao PengLei XP, Zhou YiBiao ZY, Chen Yue CY, Yang MeiXia YM, Song XiuXia SX, Shi Yan SY, et al. Association between maternal HIV infection and low birth weight and prematurity: a meta-analysis of cohort studies. 2015.

[48] Monjezi M, Rostami S, Boland MMK, Cheraghian B. Survey of the relationship between mother's chronic diseases and low birth weight in infants, Ahvaz, South of Iran, 2014. Jundishapur J Chronic Dis Care 2017;6.

[49] Chibsa SE, Hussen MA, Bayisa K. Determinants of low birth weight among newborns delivered at Mettu Karl comprehensive specialized hospital , southwest Ethiopia : a case – control study. Sci Rep 2025:1–7. https://doi.org/10.1038/s41598-024-54248-w.

[50] Ayder Comprehensive Specialized Hospital-Mekelle University Profile: 2020. Available from: http://www.mu.edu.et/chs/index.php/ayder-referral-hospital. n.d.

[51] Xi C, Luo M, Wang T, Wang Y, Wang S, Guo L, et al. Association between maternal lifestyle factors and low birth weight in preterm and term births : a case-control study 2020:1–9.

[52] Fakier A, Petro G, Fawcus S. Mid-upper arm circumference: A surrogate for body mass index in pregnant women. South African Medical Journal. 2017 Aug 1;107(7):606-10. n.d.

[53] Coates J, Bilinsky P, Coates J. Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access : Indicator Guide VERSION 3 Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access : Indicator

Guide VERSION 3 2007.

[54] Gebregziabher H, Kahsay A, Gebretsadik GG, Bereket T. Food crises and coping strategies in war - affected communities in Tigray , Ethiopia : A community - based cross - sectional study among households. BMC Nutr 2025. https://doi.org/10.1186/s40795-025-01068-4.

[55] Deriba BS, Jemal K. Determinants of Low Birth Weight Among Women Who Gave Birth at Public Health Facilities in North Shewa Zone : Unmatched Case-Control Study 2021;58:1–11. https://doi.org/10.1177/00469580211047199.

[56] Tela FG, Bezabih AM, Adhanu AK. Effect of pregnancy weight gain on infant birth weight among mothers attending antenatal care from private clinics in Mekelle City, Northern Ethiopia: A facility based follow-up study. PLoS One 2019;14:1–10. https://doi.org/10.1371/journal.pone.0212424.

[57] Seid S, Wondafrash B, Gali N, Ali A, Kedir S, Seid S, et al. Determinants of Low Birth Weight Among Newborns Delivered in Silte Zone Public Health Determinants of Low Birth Weight Among Newborns Delivered in Silte Zone Public Health Facilities , Southern Ethiopia : A Case-Control Study 2022;9935. https://doi.org/10.2147/RRN.S368436.

ANNEXES

Annex I . Information sheet

TITLE: Magnitued and Factors Associated With Low Birth Weight in Ayder Comprehensive Specialized Hospital, Northern Ethiopia, 2024: A Cross-Sectional Study

Institution: Mekelle University, College of Health Sciences, Department of Nutrition and Dietetics

Name of sponsor: Self - sponsor

Principal Investigator: Netsanet Mezgebe

Mobile: +251 923399186

E-mail: netsanetmezgebe1@gmail.com

Annex II. Consent form

Mekelle University, College of Health Sciences, School of Public Health, Department of Nutrition and Dietetics

Questionnaire for Assessment of prevalence and factors associated with Low Birth Weight in Ayder Comprehensive Specialized Hospital, Mekelle City, Tigray, North Ethiopia 2024.

INTRODUCTION

Greetings! My name is _____. I am here representing a team to conduct data collection among mothers who gave birth to a live baby.

The main Objective of the study is to assess prevalence of low birth weight and identify the maternal risk factors associated with low birth weight in Ayder Comprehensive Specialized Hospital which is the only tertiary hospital in Tigrai, Ethiopia. During the study your response will be kept confidentially, there is no name identified and there will be no any visible risk with you and your newborn baby being you are participant except some time consuming (around 30 minutes). There is no payment for your participation but we greatly thank for your participation and you have the right to refuse from participation at any time.

Are you voluntary to participate?

1. Yes I have understand the above information and I am volunteer to participate

2 .No, if you are not voluntary to participate please stop here.

If you are voluntary to participate in the study; we kindly request you to provide your truthful response for the interview. Thank you for your participation.

Annex III. Questionnaire

English version questionnaire

Name of Data collector: ---------- Date: ----------Qualification: ----------

Data Collector agreement

"I certify that I have filled the questionnaire in accordance with the training that is given to meand instructions stated in it. I have confirmed that the information in it is correct."

Signature---------- Date----------

Name of the health facility: ----------

Checked by supervisor for completeness; Supervisors Name: ---------- Signature—

Note the inclusion criteria from clinical records:

- Is the child born single 1: YES 2: NO
- Is the child free of any visible major birth defect 1: YES 2: NO

If —No to any of the inclusion criteria, stop the collection of data.

	Section I New born characteristics		
Code	Question	Response	Skip
101	Birth weight of baby in grams?	_____	
102	What is sex of new born?	1 Male 2 female	
103	What is the gestational age at delivery, in weeks?	GA (weeks): _____	

SECTION II Maternal Socio-demographic factors			
Code	Question	Response	Skip
201	Age of the mother at delivery	---------year.	
202	Religion	1 Orthodox. 2 Muslim 3. Protestant 4. Others	
203	Ethnicity	1. Tigraway 2. Amhara 3. Afar 4. Other (specify_____)	
204	Maternal Educational status	1. Not read and write 2. Read and write 3. Primary education 4. Secondary education and above	
205	Where are you living?	1. Rural 2. Urban	
206	Marital status	3. Single 4. Married 5. Divorced 6. Widowed	
207	What is your occupation?	1 House wife 2. Merchant 3. Governmental employed 4 If other specify----------	
208	Monthly income of the family	_____ETB	
Section III Maternal Obstetric and health- related factors			
Code	Question	Response	Skip
301	Number of previous births (include term and premature deliveries)		**Skip** If she is primi to 302
302	What is the pregnancy interval of the previous birth? (months)	_____	If she is primi Skip to 303
303	Have you ever had abortion	1 yes 2 No	If no skip to 305

304	How many abortion did you have	Number of abortions___	
305	Did you have ANC visits for the current Pregnancy?	1. Yes 2. No	If no skip to 307
306	Number of ANC visits attended	_____	
307	Did you have pregnancy related complication	1. Yes2. No	If no skip to309
308	What type of Pregnancy related complication? Multiple and additional answers are possible	1. APH 2. PROM 3. PIH 4. DM 5.Other (specify_____)	
309	Did you have history of any chronic medical illness pregnancy?	1 yes 2 no	If no skip to311
310	What type of illness? **N.B**. Multiple and additional answers are possible	1 Hypertension 2 DM 3 Anemia 4 TB 5 Other (specify_____)	
311	Did you have malaria infection during the current pregnancy?	1. Yes 2. No	
312	Was the current pregnancy planned and wanted ?	1. Unplanned and unwanted 2. Unplanned but wanted 3. Planned and wanted	
313	HIV status of the mother	1. NR 2. R	
314	Do you have any of the following bad obstetric histories (Multiple answer possible)	1. Still birth 2. Low birth weight 3. Preterm delivery 4. Congenital malformation	
315	Do you have any history physical trauma or assualt during pregnancy	1. Yes 2. No	

Section IV; Maternal Behavioral factors			
Code	Question	Response	Skip
401	Have you ever drink alcohol containing during the current pregnancy ?	1. Yes 2. No	If no skip to403
402	If yes How often do you have a drink alcohol containing during the current pregnancy (specify both freqeuncy and amount)	1. Daily 2. Weekly 3. Monthly 4. During Holidays	

403	Have you ever used tobacco during the current pregnancy? (specify both freqeuncy and amount)	1. Yes (Amount _____) 2. No	If no skip to 501
404	How often do you used tobacco during the current pregnancy	1.Once or twice 2. monthly 3.weekly 4.daily	
405	Do you chew a chat?	1. Yes 2. No	
	Section V; Maternal Nutritional factors		
Code	Question	Response	Skip
501	Have you ever had taken Iron/folate during the current pregnancy?	1. Yes 2. No	If no skip to 503
502	If yes how many tablet have you ever taken?	1. <60 tablets (< 2 months) 2. 60-90 tablets (2-3 months) 3. >90 tablets (>3 months)	
Checklist for anthropometric measurements			
503	First trimester weight	Weight of mothers: _____	
504	Third trimester weight	1. Yes 2. No	
505	Height		
506	MUAC		
Section VI: Household food security status			
601	In the past four weeks, did you worry that your household would not have enough food?	0. No 1. Yes	No (skip to Q602)
601a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
602	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	No (skip to Q603)
602a	How often did this happen?	1 = Rarely 2 = Sometimes 3 = Often	
603	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	No (skip to Q604)
603a	How often did this happen?	1 = Rarely	

		2 = Sometimes 3 = Often	
604	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	No (skip to Q605)
604a	How often did this happen?	1 = Rarely 2 = Sometimes 3 = Often	
605	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	No (skip to Q606)
605a	How often did this happen?	1 = Rarely 2 = Sometimes 3 = Often	
606	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	No (skip to Q607)
606a	How often did this happen?	1 = Rarely 2 = Sometimes 3 = Often	
607	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	No (skip to Q608)
607a	How often did this happen?	1 = Rarely 2 = Sometimes 3 = Often	
608	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	No (skip to Q609)
608a	How often did this happen?	1 = Rarely 2 = Sometimes 3 = Often	
609	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	No (skip to Q608)
609a	How often did this happen?	1 = Rarely 2 = Sometimes 3 = Often	
Section VII: Water, Hygiene, and Sanitation			
701	What is the main source of water for members of your household	1. Piped into dwelling 2. Piped into compound, yard or plot 3. Piped to neighbour 4. Public tap / standpipe 5. Protected well 6. Unprotected well 7. Protected spring	

		8. Unprotected spring 9. Rainwater collection 10. Delivered water -Tanker-truck 11. Delivered water -Cart 12. Surface water (river, stream, dam, lake, pond, canal, irrigation channel) 13. Other (specify)	
702	In the last month, has there been any time when your household did not have sufficient quantities of drinking water when needed?	1. Yes, at least once 2. No, always sufficient . 3. Don't know	
703	What type of toilet do you use in your household?	1. Communal facility 2. Pit latrine (state VIP or other) 3. Flush and piped seated toilet 4. Bucket 5. None available (open toilet)	
704	During your last menstrual period were you able to wash and change in privacy while at home?	0. No 1. Yes	
705	During your last menstrual period, what hygiene materials did you use?	1. Cloth/reusable sanitary pads 2. Disposable sanitary pads 3. Toilet paper 4. Underwear alone 5. Other (specify)	

Tigrigna version questionnaire

□□□□ □□□□ □□□□□

□□□ □□□□□ □□□□□□. □□□□□

□□□ □□□□□□□ □□□□ □□□□ □□□□□ □□□□□□□□□ □□□□ □□□□□□□

□□□□□□: □□□□ □□□□ □□□□□ □□□□ □□□□□ □□□□□ □□ □□ □□□□□ □□□□ □□□□ □□□□□

□□□□ □□ □□□□ □□□□ □□□□□□ □□□□□□ □□□□□□□□□

□□□□□□□□□/□□□□□□□□_____□□□□ □□□□ □□ □□□□□ □□□□□□ □□□□□□ □□□□□□ □□□□□□ □□□□□□□□□□□□ □□□□□ □□□□ □□□□□□ □□□□ □□□□□□□ □□ □□□□ □□□□ □□□□□□ □□ □□□□ □□□□□□□□ □□□□□□□□ □□□□ □□□□ □□□□ □□□□□□ □□□□□□ □□□□□□□ □□□□□ □□□□□□□□□□ □□□□□□□□ □□□□□□□□□ □□□□□ □□□□□□ □□ 2016 □/□ □□□□□□ □□□□□□ □□ □□□□ □□□□□ □□ □□ □□□□□□□ □□□□□ □□□□□□□□□□ □□□□□ □□□□ □□□□ □□ □□□□□ □□□□□ □□□□□ □□□□ □□□□ □□□□□ □□□□ □□□□□□□□□ □□□□□□ □□□□□□□□□□□□□□□□ □□□□ □□□□□□□ □□□□□ □□□□ □□ □□□□ □□□□□ □□□□□□ □□□□ □□ □□□□□□ □□□□ □□ □□□□□ □□□□□□□□□□ □□□□ □□□□□□□ □□□□□□□□ □□□□□□□□□□ □□□□ □□□□□ □□□□□□ □□□□ □□□□ □□□□□ □□ □□□□□ □□□□ □□□□□□ □□□□□□□□□□ □□□□□□□□□□□□□□□□ □□□□□ □□□□□□□□ □□□□□□ □□□□ □□ □□□□ □□ □□□□□ □□□□□□ □□ □□□□□ □□□□□□□□□□□□ □□□□□□ □□□□□□ □□ □□□□□□□□□□□ □□ □□ □□□□□□ □□□□□□ □□□□□□□

□□□□ □□□□□□ □□ □□□□□□□ □□□□□ □□□□□□□:0923399186

□-□□□ - netsanetmezgebe1@gmail.com

□□□□□□□□□□□□□□? □□_____ □□□

□□□□_____ □□□□□□□□□

□□□ □□□□□ _____

□□□□□ _____□□□ _____□□□ _____

□□□□□□□□ _____□□□ _____□□□ _____

□□□□ □□□□

□□□ □□□□□□ □□□ □□□ □□□□ □□□ □□□□□ □□□ □□□□□□

□□ 2013 □□ □□ □□□□ □□□□□ □□ □□□ □□□ □□□□ □□□ □□□□ □□□□ □□ □□ □□□□ □□□ □□□ □□□□ □□□□□ □□□□□ □□□□::

□□□□ □□ □□□ □□□□□ □□□□□□ □□□□ □□□□ □□ □□□□□□ □□ □□□□□ □□□□(□□ □□□□□□□□ □□□□□ □□□□□□□) □□□□□ • □□□ □□□□□□ □□□ □□ □□□ 1:□□ 2:□□□□□ • □□□ □□□□□□ □□ □□□ □□□□ □□□□ □□□□ □□ □□ □□□ 1:□□ 2: □□□□□ □□□ □□□ □□□ □□□ □□ □□□□□□ □□□□□ □□ □□ □□ □□□□□ □□□□□□ □□ □□□□ □□□□			
101	□□□□ □□ □□□ □ □□□ □□□□ □□?	_____	
102	□□ □□□ □□□ □□□□ □□?	1. □□ 2. □□	
103	□□□ □□ □□□□ □□□ □□□□(□□□ □□□)?	□□□ □□□ □□□□□: _____	
□□□ II □□□□□ □□□□□ □□□□ □□			
□□	□□□□□ □□□□□□□	□□□□□ □□□□□	□□□
201	□□□ □□	□□□ : _____	
202	□□□□□□ □□□□ □□?	1. □□□□□□ 2. □□□□□ 3. □□□□ 4. □□□□□□□	

		5. □□□	
203	□□ □□□□ □□□□□ □□□ □□?	1. □□□□□□ 2. □□□□□□ 3. □□□□□□ 4. □□□	
204	□□□□ □□□□□□ □□□□ □□?	1. □□□□ □□□□ □□□□□□ 2. □□□□ □□□□ □□□□ 3. □□□□□□□□/□□□□□□ 4. □□□□ □□□ □/□□ □□□□□	
205	□□□□□ □□□ □□?	1. □□□ 2. □□□	
206	□□□□ □□□□ □□□□ □□?	1. □□□□ □□□ 2. □□□□□□□□ 3.□□□□□□ 4. □□□ □□□□ □□□□	
207	□□□□□□□□□□?	1 □□□□□□□□ 2 □□□ 3 □□□□□ □□□□□ 4 □□□□□□_____	
208	□□□□ □□□ □□□□	_____□□□	
□□□III □□□□ □□□□ □□□□			
□□	□□□□□ □□□□□□□	□□□□□ □□□□□	□□□
301	□□□ □□ □□□□ □□□□		
302	□□□ □□□□ □□ □□□ □□ □□□□ □□□ □□□□□□ □□□□□□?	_____	□□ □□□□□ □□□ □□□□□□ □□ 303□□□
303	□□□□□ □□□ □□□□□ □□□□ □ ?	1:□□ 2: □□□□□	□□□□□ □□□□□□ □□305□□□
304	□□□□ □□ □□□□□□ □□□□ □□	□□□ □□□□□ □□□----------	
305	□□□□ □□□ □□□□ □?	1:□□ 2: □□□□□	□□□□□ □□□□□□ □□307□□□
306	□□□□ □□ □□□□□□ □□□□ □□	□□□ □□□□ □□□----------	
307	□□ □□ □□ □□□□ □□ □□□ □□□□□ □□□□□ □□ □□□ □□□ □□ □?	1:□□ 2: □□□□□	□□□□□ □□□□□□ □□308□□□
308	□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□	1 ,□□□ □□□ □□ □□□□ 2 ,□□□ □□□ □□□□□□ □□□□ 3,□□□ □□ 4,□□□ □□□ 5,□□□ □□□_____	

309	□□□ □□□□□ □□□□□ □□□□□□ □□□□□ □?	1:□□ 2: □□□□□□	□□□□□□ □□□□□□□ □□ 310□□□
310	□□□□□ □□ □□□□□□□ □□□□□ □□□□□□□□ □□□□	1□□□ □□ 2 □□□ □□□□ 3 □□ □□□□□ 4□□ □□□□ □□□□ 5 □□□ □□□_____	
311	□□ □□ □□ □□□□ □□ □□□□□ □□□□□ □?	1. □□ 2. □□□□□□	
312	□□□□□ □□□□□ □□ □□ □□□□	1. □□□□□□□□ □□□□□□□□ 2. □□□□□□□ □□ □□□□□□ 3. □□□□□□□ □□□□□□□	
313	□□□□□ □□ □□ □ □□	1. □□□□□ 2. □□□□	
314	□□□ □□ □□ □□□□ □□ □□□□□ □□□□□□ □□□□□ □□□□□ □□□□ □□ □□□□ □□□□□ □□□□□ □□□□□ □□□□?	1. □□□□ □□□□□□ □□□□ 2. □□□□ □□□□□ □□□□ □□□□ 3. □□□□ □□□□□ □□ □□□□□□ □□□□□□ □□□□	
315	□□□ □□ □□ □□□□□ □□□□□ □□ □□□□□□ □□□□ □□ □□□□□ □□□□□ □?	1. □□ 2. □□□□□□	
	□□□ **IV** □□ □□ □□□□□ □□□□		
□□	□□□□□□ □□□□□□□□□	□□□□□□ □□□□□□	□□□□
401	□□ □□□□ □□□□ □□□□□ □□□□ □□□□ □□□□□ □□□□□□?	1. □□ 2. □□□□□□	□□□□□□ □□□□□□□ □□403□□□
402	□□□□□ □□ □□□□□□□ □□□□□ □□ □□□□□□ □□□□□	1.□□□□□□□ 2. □□□□□□ 3. □□□□□□ 4. □□ □□□□□ □□□_____	
403	□□ □□□□ □□□□ □□□□ □□□□□ □ □□□□□??	1. □□ 2. □□□□□□	□□□□□□ □□□□□□□ □□501□□□
404	□□□□□ □□ □□□□□□□ □□□□□ □□ □□□□□ □□□□□□ □□□□□	1.□□ □□ 2 □□□□□□ 3 □□□□□□ 4 □□□□□□□ □□□_____	
405	□□ □□□□□ □?	1. □□ 2. □□□□□□	
□□□ **V:** □□□ □□□□□ □□□□□□ □□			
□□	□□□□□□ □□□□□□□□□	□□□□□□ □□□□□□	□□□□

501	□□ □□ □□□□□ □□□□ □□□□□ □□□□□ □□□□□ □□□□□ □□□□□ □□□□□ □□□□□	1:□□ 2: □□□□□□	□□□□□□ □□□□□□□ □□ 503 □□□
502	□□□□□ □□ □□□□□□□ □□□□□ □□□□□ □□□□□	1. <60 □□□□□ 2. 60-90 □□□□□ 3. >90 □□□□□	
503	□□ □□ □□□□□□ □□□□□ □□□□□ □□□□□ □□□□□ □□		
504	□□ □□ □□□□□ □□□□□ □□□□□ □□□□□ □□□□□ □□	----------	
505	□□□		
506	MUAC (□□□ □□□□□ □□□ □□)	----------	
□□□ □□□□ □ □□□□ □□□□□ □□□ □□□ □□			
601	□□ □□□□ □□□□□ □□□ □□□ □□□ □□□ □□□ □□□□□□ □□□ □□□ □□□□□ □?	0. □□□□ 1. □□	□□□□□ □□□□□□□ □□ 602 □□□
601a	□□ □□□□ □□ □□ □□□□ ?	1 = □□□ □□□ □□□□□ (□□ □□□□ □□□□□ □□□ □□□□ □□ □□□ □□) 2 = □□□□ □□ (□□ □□□□ □□□□□ □□ □□□□ □□□ □□□□ □□ □□□□) 3 = □□□□□□ □□ (□□ □□□□ □□□□□ □□□ □□□ □□□□ □□	
602	□□ □□□□ □□□□□ □□□ □□□ □□ □□□ □□□ □□□ □□□ □□ □□□□ □□□□ □□□□/□□□ □□□□□□ □□□□ □□□ □□□□□□□□ □□ □□□ □?	0. □□□□ 1. □□	□□□□□ □□□□□□□ □□ 603 □□□
602a	□□ □□□□ □□ □□ □□□□ ?	1 = □□□ 2 = □□□□ □□ 3 = □□□□□□ □□	
603	□□ □□□□ □□□□□ □□□ □□□ □□ □□□ □□□ □□□ □□□ □□□ □□□□ □□□□ □□□□ □□□□□ (□□□) □□□□ □□□ □□□□□□□ □□ □□□ □?	0. □□□□ 1. □□	□□□□□ □□□□□□□ □□ 604 □□□
603a	□□ □□□□ □□ □□ □□□□ ?	1 = □□□	

		2 = □□□□ □□ 3 = □□□□□□ □□	
604	□□ □□□□ □□□□□ □□□ □□□ □□ □□□ □□□ □□□ □□□ □□ □□□ □□□□ □□□ □□□□□ □□□□ □□□ □□□□□□□ □□□□□□ □□□□□□□ □□□ □□□□□ □?	0. □□□□ 1. □□	□□□□□ □□□□□□ □□ 605 □□□
604a	□□ □□□□ □□ □□ □□□□ ?	1 = □□□ 2 = □□□□ □□ 3 = □□□□□□ □□	
605	□□ □□□□ □□□□□ □□□ □□□ □□□ □□ □□□□□ □□□ □□ □□□ □□□ □□□ □□□ □□□ □□□ □□□□ □□□ □□□□□ □□ □□□ □ ?	0. □□□□ 1. □□	□□□□□ □□□□□□ □□ 606 □□□
605a	□□ □□□□ □□ □□ □□□□ ?	1 = □□□ 2 = □□□□ □□ 3 = □□□□□□ □□	
606	□□ □□□□ □□□□□ □□□ □□□ □□□ □□ □□□□□ □□□ □□ □□□ □□□ □□□ □□□ □□ □□□□ □□□□ □□□ (□□ □□ □□□ □□) □□□□□ □□ □□□ □ ?	0. □□□□ 1. □□	□□□□□ □□□□□□ □□ 607 □□□
606a	□□ □□□□ □□ □□ □□□□ ?	1 = □□□ 2 = □□□□ □□ 3 = □□□□□□ □□	
607	□□ □□□□ □□□□□ □□□ □□□ □□□□□ □□□□ □□□ □□ □□□□□ □□ □□□ □□□ □□□ □□□□ □□□ □□□□ □□□□□□ □□ □□□ □?	0. □□□□ 1. □□	□□□□□ □□□□□□ □□ 608 □□□
607a	□□ □□□□ □□ □□ □□□□ ?	1 = □□□ 2 = □□□□ □□ 3 = □□□□□□ □□	

608	□□ □□□□ □□□□□ □□□ □□□ □□□ □□ □□□□□ □□□ □□ □□□ □□□ □□□ □□□ □□□□ □□□□□□ □□□□□ □□□□□ □□ □□□ □?	0. □□□□ 1. □□	□□□□□ □□□□□□ □□ 609 □□□
608a	□□ □□□□ □□ □□ □□□□ ?	1 = □□□ 2 = □□□□ □□ 3 = □□□□□□ □□	
609	□□ □□□□ □□□□□ □□□ □□□ □□□ □□ □□□□□ □□□ □□ □□□ □□□ □□□ □□ □□□ □□□□□/□□□□ □□□□ □□□□□□ □□ □□□ □?	0. □□□ 1. □□	
609a	□□ □□□□ □□ □□ □□□□ ?	1 = □□□ 2 = □□□□ □□ 3 = □□□□□□ □□	
□□□ □□□□: □□□ □□□□			
701	□□□ □□□□/□□□ □□ □□ □□□□□□□ □□□□ □□?	1. □□ □□□□ □□ □□□ □□□□□ □□ □□ 2. □□ □□□ □□□□□□ □□ □□ 3. □□ □□□□□ □□□□□□ □□ □ 4. □□□□ □□ / □□□□ □□□ 5. □□□□ □□□□□ □□ 6. □□□□ □□□□□□ □□ 7. □□□□ □□□□□ □□□ 8. □□□□ □□□□□□ □□□ 9. □□□□ □□ □□□ 10. □□-□□□□ □□□□□ □□□ 11. □□ - □□□□/□□ 12. □□ □□□ □□□ □□□□ □□ (□□ □□□ □□□ □□□ □□□ □□□□ □□□) 13. □□□ (□□□)	
702	□□ □□□□ □□□ □□□□ □□ □□□□ □□□ □□□ □□□ □□ □□□ □□□ □□□□□□ □□□ □□□ □?	1. □□ □□□ □□□ □□□□ 2. □□□□□ □□ □□ □□□ □□ □ 3. □□□□□□	
703	□□ □□ □□□□ □□□□ □□□ □□□□?	1. □□ □□□/□□□□ □□□ 2. □□ □□□□ (□□ □□□ □□□□ □□□) 3. □□ □□□ □□□ □□ □□□□ □□□ 4. □□□□	

		5. □□ □□□□ □□□□□□□ (□□□□ □□□□ □□□□)	
704	□□□ □□ □□□□□□ □□□□□ □□□□□ □□ □□□□ □□□□□□□ □□□□□ □□□□□ □□□□□□□ □□□□□□□□□□□□ □□□□□□□ □□□□□ □?	0. □□□ 1. □□	
705	□□□ □□ □□□□□□ □□□□□ □□□□□ □□□□□ □□□□□ □□ □□□□ □□□□□ □□□□□□?	1. □□□□/□□□□□□ □□□□ □□□□□□ □□□□□ □□□□ 2. □□□□ (□□ □□ □□□□□□□ □□□□□/□□□□□ □□□□) 3. □□□□□ □□□□ □□□□ (□□□□) 4. □□□□ (□□ □□□□ □□□□) □□□□ 5. □□□□ (□□□□□)	