UNIVERSITY FOR DEVELOPMENT STUDIES

SCHOOL OF PUBLIC HEALTH

DEPARTMENT OF GLOBAL AND INTERNATIONAL HEALTH

MATERNAL BODY MASS INDEX IN EARLY PREGNANCY AND THE RISK OF ADVERSE PREGNANCY OUT COMES IN THE TAMALE METROPOLITAN AREA OF THE NORTHERN REGION

A THESIS SUBMITTED TO THE DEPARTMENT OF GLOBAL AND INTERNATIONAL HEALTH OF THE SCHOOL OF PUBLIC HEALTH, UNIVERSITY FOR DEVELOPMENT STUDIES, IN PARTIAL FULFILMENT FOR THE REQUIREMENTS FOR THE AWARD OF MASTER DEGREE IN PUBLIC HEALTH.

BY

NASHIRU ABDULAI

UDS/MPH/0003/20

SEPTEMBER, 2022

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APRIL, 2023

DECLARATION

Student

I hereby declare that this dissertation/thesis is the result of my original work and that no part of it has been presented for another degree in this University or elsewhere:

Candidate

Signature…… Date…03-10-2022

Name: Nashiru Abdulai

Supervisors

We hereby declare that the preparation and presentation of the dissertation/thesis was supervised following the guidelines on supervision of dissertation/thesis laid down by the University for Development Studies.

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DEDICATION

I first dedicate this thesis to the All-Powerful God, who made it possible for this research to be effective. I also thank my parents, Mr. and Mrs. Abdulai, for their support in making this study possible. May the Lord grant you blessings! I dedicate this work as well to my devoted brothers, sisters, and friends, whose advice I valued during this endeavor.

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I also want to express my gratitude to the entire departmental faculty for their superb support. For their constant prayers and financial support during the research time, I am grateful to my parents, siblings, and other family members. God bless everyone who in any way contributed to the success of this research.

ABSTRACT

Background: Adverse pregnancy outcomes are part of the leading causes of infant mortality in the world. LBW contributes 60% to 80% of all neonatal deaths in the developing countries. Sub Saharan Africa has made less progress than any other region in the globe in lowering newborn deaths. Body mass index (BMI) is a major determining factor of the outcome of pregnancy. The different groups of BMI have been found to have different effects on pregnancy outcomes. These groups are underweight, normal, overweight and obese. High maternal BMI has been linked to adverse pregnancy outcomes, especially in developed countries. The rising prevalence of obesity in developing countries such as Ghana have however shown that this could not be related only to the increase incidence of adverse pregnancy outcomes, but due also to other factors such as the double burden of diseases. The main aim of this study was to examine the influence of BMI in early pregnancy and the risk of Preterm birth (PTB) and Low Birth Weight (LBW) as key adverse pregnancy outcomes among women within the Tamale Metropolitan Area.

Methodology: Data from 411 women who gave birth within the last 6–12 months in five (5) public healthcare facilities in the Tamale Metropolis were collected using a facility-based cross-sectional survey methodology. Two (2) health facilities were purposively selected and three (3) were randomly selected. Systematic random sampling was used to select participants from the health facilities, and structured questionnaire was used to collect data. The main exposure variable assessed was BMI status in early pregnancy, and the outcome variable was LBW (a birthweight of less than 2500g). Analysis were performed in SPSS version 21. Chi-squared tests was used to assess associations between variables and multivariate logistic regression test was used to examine the degree of association between variables while adjusting for confounders.

Results: PTB prevalence was 19.5% (95% CI: 15.6-23.4) and LBW prevalence was 9.2% (95% CI: 6.6-12.4). Mothers who were not overweight or obese during the early stages of pregnancy had 2.8(AOR = 2.78, 95% Cl: 1.24 - 6.25, p = 0. 001) and 5.4(AOR = 5.40, 95% Cl: 2.67 - 10.91, p = 0. 001) fold higher odds of having LBW babies and PTB respectively. Lower than four ANC visits by mothers increased the likelihood of PTB and LBW birth by 2.6 (AOR = 5.06, 95% Cl: 2.36 – 10.87, p = 0.001) and 5(AOR = 2.62, 95% CI: 1.09 – 6.30, p = 0.03) times than those with more visits. In comparison to male babies, female babies had a 4.4 (AOR = 4.36, 95% CI: 2.08 – 9.15, p = 0.001) times higher likelihood of being born LBW. When compared to mothers aged 35 and above, mothers under the age of 25 had 3.2 (AOR=3.22, 95% CI: 1.30 - 8.04, p=0.012), and 14.5 (AOR=14.53, 95% Cl: 4.28 - 49.30, p =0.001) times higher the likelihood of having PTB and LBW newborns. Women with less education had a 3.9 (AOR 3.93, p = 0.03) times higher risk of PTB than those with at least Senior high school degree.

Conclusion: Low prevalence of LBW and PTB is associated with high maternal BMI in early pregnancy. Low LBW and PTB are associated with high maternal age and more ANC visits. Low education, high gravidity and parity independently predicted PTB, and the female gender independently predicted LBW.

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LIST OF ABBREVIATIONS

ANC	Antenatal Care Services
BMI	Body Mass Index
CS	Cesarean section
CWC	Child Welfare Clinic
DALYs	Disability Adjusted Life Years
GDHS	Ghana Demographic and Health Survey
GHS	Ghana Health Service
GSS	Ghana Statistical Service
IPTp	Intermittent Prevention Treatment for Malaria
IPV	Intimate Partner Violence
IOM	Institute of Medicine
LBW	Low Birth Weight
LGA	Large for Gestational Age
MUAC	Mid-Upper-Arm Circumference
NCDs	Non-Communicable Diseases
PIH	Pregnancy-Induced Hypertension
PM	Pregnancy-related Malaria
SES	Socioeconomic Status
SGA	Small for Gestational Age
SP	Sulfadoxine Pyrimethamine
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
STIs	Sexually Transmitted Diseases
UHC	Universal Health Coverage
UNICEF	United Nations Children's Fund
WHO	World Health Organization

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CHAPTER ONE
INTRODUCTION

1.0 **Background to the study**

Body mass index (BMI) during early pregnancy has a key role in predicting the success of the pregnancy. One of the biggest problems currently facing public health is the dietary needs of pregnant women (Tsegaye & Kassa, 2018). High mother body mass index is linked to early pregnancy difficulties such preeclampsia, preterm and post-term labor, cesarean sections, and the delivery of kids with low birth weight (Nucci et al., 2018). Early pregnancy is defined as occurring between the last 12 weeks of a pregnancy and the first day of the last menstrual cycle (WHO,2004).

Expectant mothers' nutritional state is regarded to provide a good indicator of pregnancy-related problems and adverse long-term impacts on both the mother and the unborn child (WHO, 2015). Being overweight or obese increases one's risk of developing gestational diabetes mellitus (GDM), hypertensive syndrome, and pregnancy-related fetal growth abnormalities (Doi et al., 2020). On the other hand, pregnant women who are underweight are more likely to experience preterm PB and deliver babies who are short for gestational age (SGA) (Sebire et al., 2001)). Additionally, problems like anemia, early birth, low birth weight, and small for gestational age may affect women who present with poor weight growth (Tsegaye & Kassa, 2018). While preeclampsia, gestational diabetes, and the necessity for caesarean sections are more likely to occur in women who acquire a lot of weight (Mamun et al., 2011). Therefore, it is very important to research the effects of pre-pregnancy BMI and GWG on pregnancy and the baby and to develop a workable pregnancy weight-control strategy. Most recent studies on pre-pregnancy BMI and GWG levels came from Western or high-income nations (Gortmaker et al., 2011).

According to expanding evidence, the development and progression of PTB is a complex process influenced by a number of environmental and genetic factors (Blencowe et al., 2012). Therefore, it is beneficial to identify the etiological causes causing PTB or LBW in order to establish strategies for the effective prevention and treatment of newborn morbidity and mortality. Recent findings support the idea that pre-pregnancy mother's BMI is one of the potential risk factors for PTB and LBW (Doi et al., 2020; Lynch et al., 2014; Shaw & Shaw, 2014). Women's obesity and overweight rates have risen alarmingly in recent decades in many nations, particularly in emerging nations. Overweight and obesity trends vary depending on the nation, area, and income level, with women in underdeveloped nations more likely to experience it than males in industrialized nations (Ng et al., 2014). Additionally, epidemiological research has revealed that a high maternal BMI is linked to PTB and other detrimental maternal health outcomes, including gestational hypertension and cesarean birth (Lynch et al., 2014; Shaw & Shaw, 2014). An evidence of claiming how BMI is associated with adverse pregnancy outcomes in previous studies, understanding such information is a critical part of this work to verify if the same information is applicable to recent studies or populations especially in developing countries and how it can help shape the course of policies for maternal and child health.

Studies carried out in high-income nations indicate a connection between the maternal body mass index and complications during pregnancy, delivery, and the postpartum period for both the mother and offspring, including hypertensive disorders during pregnancy, cesarean delivery, perinatal and infant deaths, macrosomia and so on (Black et al., 2013). However, due to the dual burden of infectious diseases and noncommunicable diseases (NCDs), findings from studies conducted in high-income countries may not be immediately transferable to the context of Low and Middle Income Countries (LMICs) (Dalal et al., 2011) as this burden can have

different consequences on pregnancy much different way compared to the developing countries, and so it is obvious for studies in the developing countries to point differently in the matter of evidence which could be much more important to consider. For instance, some studies from South Africa and Sudan showed high maternal BMI thus overweight and obesity to be associated with increased risk of cesarean section, gestational diabetes mellitus and macrosomia in pregnant obese women and other adverse outcomes (Ng et al., 2014).

In Ghana, the mean BMI for females aged 15 to 49 was 24.8 kg/m2. The mean BMI is within the normal range (18.5-24.9) (Ghana Statistical Service et al., 2015b). In Ghanaian women (15 to 49), the prevalence of underweight decreased from 11.3% to 6.2% between 1993 and 2014, a decrease of about 45.1% (Ghana Statistical Service et al., 2015b). From 3.4% in 1993 to 15.3% in 2014, the prevalence of obesity more than quadrupled; it is anticipated to reach 20.1% and 22.9% in 2025 and 2030, respectively (Ghana Statistical Service et al., 2015b). Obesity rates are rising in Ghana at a rate that is comparable to global and African trends (Ng et al. 2013). Megatrends including globalization, rapid economic development, and urbanization, which are creating significant changes in lifestyle across Ghana, may be connected to the growing tendency (Van Der Linden et al., 2016).

It is estimated that LBW contributes 60% to 80% of all neonatal deaths in the developing countries (UNICEF/WHO, 2004). In essence, Sub-Saharan Africa has made less progress than any other region in the globe in lowering newborn death (Tamirat et al., 2021). It is therefore compelling to understand that the factors that account to this problem are differently distributed across the world with much different influencing factors. Infant mortality and morbidity are significantly affected by PTB, an essential unfavorable pregnancy outcome (Boghossian et al., 2016). PTB incidence is anticipated to be 11.1% worldwide, with China having the second-highest annual incidence at more than 1.1 million cases (Blencowe et al., 2012). The prevalence

of PTB appears to be increasing despite significant advancements in healthcare services. Statistics show that LBW babies with neonatal weights under 2,500g have a perinatal mortality rate as high as 70%, and the majority of these babies are born preterm (Pandolfo et al., 2014).

The incidence of LBW in Ghana for 2014 was 160 per 1000 births, Ghana has not recorded any reduction in low birth weight in the last decade (Ghana Statistical Service et al., 2015b). Over a decade now, there has been no significant reduction, it is a real problem to look at from such a direction because of the resources it is costing nations coupled with the increasing rates of the situation as time goes by. It is also remarkable to note the less attention being give maternal and child health in the country over the past decades, as evidence established in previous studies showed the complex nature of occurrence of adverse pregnancy outcomes, and not caused by a single factor of a health condition.

According to UNICEF, the prevalence of LBW babies in Ghana is 13.0% (UNICEF, 2013). Preterm birth, maternal age less than 20 years and greater than 35 years, stress during pregnancy and first parity may lead to LBW (Dahlui et al., 2016) and other factors such as low socio-economic status and use of services such as antenatal care and tetanus vaccination could influence birth weight (Blencowe et al., 2012). It is worthy to note that with these factors found to be the most influencing factors of LBW in Ghana, such factors obviously have not received much attention in addressing them and so the most possible reasons behind the no reduction in the prevalence of LBW over the past decade. The effects or consequences are dire on development because it requires a lot to deal with. Neonatal deaths cost much to a country's development than it would cost to injecting resources to check the problem. Babies born too soon are between 6 and 26 times more likely to die during the first four weeks of their lives than babies born at term (Katz et al., 2013). Ghana ranks 25th in the world for the number of

PTB, every year 114,300 babies are born before 37 weeks of pregnancy are completed (Blencowe et al., 2012).

1.2 Problem Statement

A pregnant mothers' nutritional status is regarded to provide a good indicator of pregnancy-related problems and adverse long-term impacts on both the mother and the unborn child (WHO, 2015). Being overweight or obese and underweight during pregnancy increases one's risk of adverse pregnancy outcomes (Doi et al., 2020).

In Ghana, the mean BMI for females aged 15 to 49 was 24.8 kg/m2, hence the mean BMI is within the normal range (Ghana Statistical Service et al., 2015b). However, in the Northern part of Ghana, a lower BMI is always observed, as cited in; (Abubakari et al., 2015a).

In Ghana, problems from PTB account for one in three neonatal deaths. Compared to newborns born at term, premature babies have a six to twenty-six (26) times higher risk of dying in the first four weeks of life (Katz et al., 2013). LBW incidence in Ghana is 160 per 1000 births, and for the past decade, Ghana has not recorded any reduction in the national prevalence rate of 10% low birth weight (Ghana Statistical Service et al., 2015b). The Tamale Metropolitan area is the capital of the Northern region, a study conducted in the Tamale Metropolis found neonatal mortality rate to be 13.4%, PTB complications from these deaths were 49.6%. Almost three-quarters (3/4) of the neonatal deaths were within the first week of birth, predictors of these deaths were PTB complications and birth weight (Abdul-mumin et al., 2021).

Therefore, this study was conducted to examine, in the Tamale Metropolitan Area, the influence of maternal BMI during early pregnancy on adverse pregnancy outcomes, particularly LBW and PTB.

1.3 Objectives of the Study

The objectives of the study described what the study intended to achieve.

1.3.1 Main Objective

The main objective of the study was to examine the association between BMI in early pregnancy and the risk of adverse pregnancy outcomes among women within the Tamale Metropolitan Area.

1.3.1 The Specific objectives of the Study

Specifically, the study sought:

i. To determine the prevalence of low birth weight and preterm births in the study sample within the Tamale Metropolis.
ii. To assess the association between maternal BMI in early pregnancy and adverse pregnancy outcomes in the study sample within the Tamale Metropolis.
iii. To examine other factors that associate with adverse pregnancy outcomes among the study subjects within the Tamale Metropolis.

1.4 Significance of the Study

The maternal body mass index (BMI) during pregnancy and its impact on pregnancy outcomes, notably preterm birth and low birth weight, require a deeper understanding. Numerous studies have shown that maternal BMI during pregnancy, both below and above normal, is a significant risk factor for stillbirths, pre-eclampsia, caesarean sections, and induction of labor. Women whose BMI is within the normal range have a lower risk of experiencing these unfavorable outcomes. In order to better understand maternal BMI and its relationship to unfavorable pregnancy outcomes in the Tamale Metropolis in the Northern Region. The study sought to add more knowledge to the understanding of maternal BMI and its relation to pregnancy outcomes in the Tamale metropolis.

Findings from the study may will help create awareness for the adoption of appropriate maternal practices for healthy BMI before and during pregnancy. It will also help reduce the incidence of adverse pregnancy outcomes, especially PTB and LBW babies.

1.5. Conceptual Framework for the Study

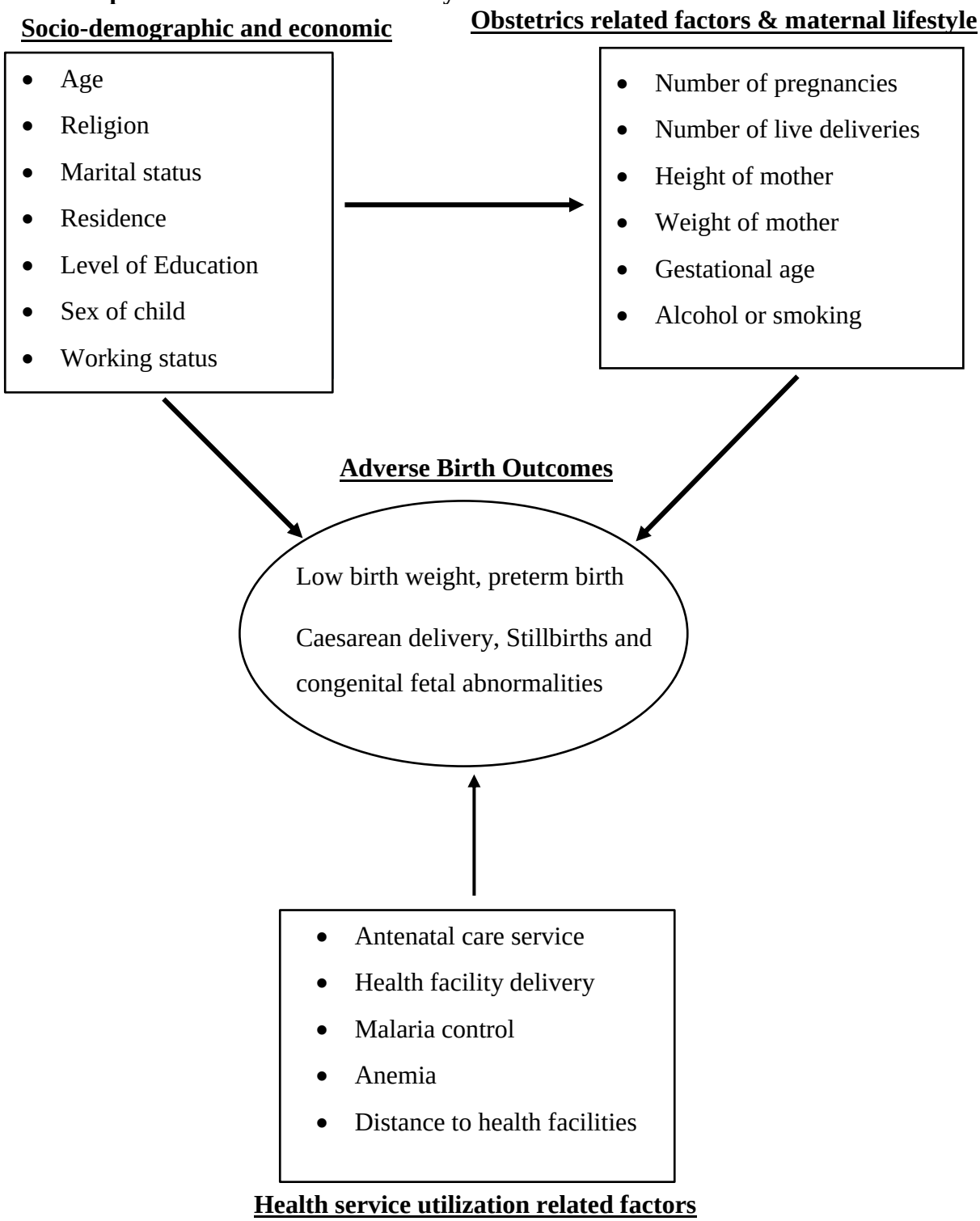

Fig 1. Conceptual framework of factors associated with adverse birth outcomes
(Source: Adapted from (Tamirat et al., 2021)

Socio-demographic characteristics including residence, maternal education, maternal age, marital status, sex of the child, working status, health service utilization and related factors (including women healthcare decision-making autonomy, health facility delivery, ANC service and distance to health facility), and obstetrics related characteristics were explanatory variables identified after review of literature.

Each of the variables in the diagram relate to each other in one way or the other, and through their relationship contribute to adverse birth outcome especially LBW and PTB. Sociodemographic factors, health service utilization factors and obstetric factors are independent variables which relate in different ways to determine adverse birth outcomes (Tamirat et al., 2021). For example, the age, marital status of a woman associates with the outcome of her pregnancy. Frequent antenatal care (ANC)service utilization associates with positive pregnancy outcome, and maternal lifestyle such as alcohol consumption during pregnancy has been related to adverse pregnancy outcome according to the literature reviewed. Weight, height, number of pregnancies etc from the diagram are some obstetric factors that are found to associate with adverse birth outcomes in the literature, which particularly this study focused on.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction to the Literature Review.

In this chapter, literature relevant to the topic of study was reviewed. The chapter looked at the studies relating to the study, it searched articles on measures of nutritional status. These have been briefly explained together with the various measures of nutritional status. The review looked at adverse birth outcomes and its forms, LBW and preterm birth. Adverse birth outcomes are as a result of many factors, some factors increasing its risks, can be avoided or prevented and others pose risk with time such as increased maternal age having a greater risk of adverse birth outcomes. Sociodemographic, obstetric, maternal lifestyle and health service utilization factors primarily influence adverse birth outcomes. The review essentially is based on the influence of BMI on adverse birth outcomes, so the different categories of BMI and their effect on adverse birth outcomes mainly LBW and preterm birth were generally looked at.

2.2. Body Mass Index (BMI)

Body mass index is the most significant and trustworthy anthropometric measurements regarded as a good indicator to evaluate people' chronic energy insufficiency, particularly in underdeveloped nations (Van Der Linden et al., 2016). It has a strong correlation with fat and fat-free mass, allowing one to assess the body's protein and fat reserves.

BMI is frequently used in the healthcare industry as an oblique approach to classify a person's body weight. It is used to calculate the relationship between weight and height. Although the calculation is less accurate in some populations, such as body builders and older persons, BMI has been demonstrated to be a very good indicator of body fat measures (Black et al., 2013). The following is how the BMI results for adults are interpreted.

In order to determine whether an adult is at a healthy weight, BMI is utilized as a screening technique. Research conducted by the US Department of Health's National Center for Health Statistics;

- BMI readings under 18.5 kilogram/metre squared (kg/m2) are regarded as underweight
- Healthy BMI ranges are between 18.5 kg/m2 and 24.9 kg/m2.
- A body mass index of 25.0 to less than 30.0 kg/m2 is considered overweight.
- A BMI of 30 kg/m2 or more is considered obese. Heart disease risk is increased in people with BMIs of 30 kg/m2 or higher.
- A BMI of 40 kg/m2 or more is considered extreme obesity.

People with substantial muscle mass and good training may have a high BMI but low body fat. For them, measurements such as skinfold thickness, waist circumference, or more direct techniques of calculating body fat may be more helpful than BMI (Van Der Linden et al., 2016) .

The groups and BMI are displayed in the following metrics.

Measurement	**Weight Category**
Lower than 18.5	Underweight
18.5 – 24.9	Normal weight
25.0 – 29.9	Overweight
30 and above	Obese

In order to provide data about population samples using European men as a baseline, the first index was developed. Due to the presumption that the masculine, European body was the ideal or standard physique and indicator of a person's fitness, this has since been used to evaluate individuals of all ages and races (Lavie et al., 2014).

The body mass index is subject to a number of restrictions. Age or gender are not factors in the measurement. Although men tend to carry more muscle than women do, this is not taken into consideration, nor are variations in racial and cultural groups. Although BMI can help medical practitioners better grasp a patient's health status, it is not the only diagnostic tool available. When determining body fat composition, doctors also take other health screenings, family history, genetics, food, lifestyle, and amount of physical activity into account (Pigatti Silva et al., 2019).

2.2.1. High BMI health risks

Due to the link between being overweight or obese and having certain health issues, BMI is used to assess the health of the general population. Obese or overweight individuals are more likely to develop the following conditions (Lavie et al., 2014). Coronary artery disease, hypertension, osteoarthritis, sleep apnea, and respiratory issues, as well as some malignancies stroke and Type 2 diabetes.

2.2.2. Associated health risks with low BMI

Low BMI may also be a sign of health problems. According to the BMI scale, those who are underweight are more likely to have the following conditions; cardiovascular disease, depression, difficulty conceiving (in women); dry skin, hair loss. Nutrient deficiencies and irregular menstruation in women, osteoporosis and inadequate immunity (Pigatti Silva et al., 2019).

2.2.3. Advantages of Normal BMI

The benefits of maintaining a healthy BMI range (18.5 to 24.9) include lowering your risk of developing all of the aforementioned health issues. Maintaining a normal BMI not only reduces your risk of developing high blood pressure, heart disease, or diabetes, but it can also help you

sleep better, have better blood flow, and have more energy throughout the day (Lavie et al., 2014)

Maintaining a healthy weight has several advantages beyond increased energy and lower clothing sizes. You are likely to benefit from these quality-of-life aspects as well by decreasing weight or maintaining a healthy weight.

i. Lessening of joint and muscular aches
ii. Increased energy and capacity to participate in activities of choice
iii. Improved blood pressure and body fluid regulation
iv. Less strain on the heart and circulatory system
v. Improved sleeping habits vi. lowering the risk of developing type 2 diabetes, blood sugar, and triglycerides in the blood
vi. Reduced danger of heart disease and several types of cancer.

Clinically significant improvements in blood glucose, lipids, and risk of developing type 2 diabetes are likely to come from lifestyle adjustments that enable you to maintain a 3-5% weight loss. Even more weight loss can lower blood pressure and enhance cholesterol levels (Pigatti Silva et al., 2019).

Nowadays, obesity is acknowledged as a significant, separate risk factor for heart disease. If you're overweight or obese, decreasing weight and keeping it off will lower your risk of developing heart disease(Pandolfo et al., 2014).

Body mass index (BMI) and waist circumference are two indirect measures of body composition. Another indicator of the distribution of body fat is the waist-to-hip ratio (WHR). However, WHR is no longer advised as it is less precise than BMI or waist circumference (Lavie et al., 2014).

2.3 Nutrient Status Measurements

A vital health indicator is nutritional status. It is described as the physiological status of the body as determined by the quantity and caliber of nutrients that it can take in. When someone has a bad nutritional status, it means they are suffering from malnutrition, which run the gamut from not getting enough nutrients, to getting too many (Gortmaker et al., 2011). Because nutrients are crucial to our health, it's necessary to understand how to assess nutritional status in order to establish whether a person is healthy, malnourished, or undernourished. There are five (5) established methods for assessing nutritional status. This will provide a general understanding of the steps necessary to do a nutritional evaluation, as stated in (Flegal et al., 2013).

2.3.1 Dietary Techniques

According to the British and Dietetics Association, 2012, dietary technique is a useful method for assessing a person's nutritional status. A clearer understanding of whether they are consuming enough foods (and in the proper proportions) from the major food groups can be gained by looking back on what they have eaten over a period of time (typically 24 hours). For instance, sources of cereals, fruits, vegetables, legumes, and meat. A person can obtain good dietary diversity, which is a sign of a healthy nutritional status, by regularly eating the proper amount of food from each group. The assessment of a person's diet can include look at things like how often they eat, how much salt they consume, how often they drink alcohol, and how much coffee they consume.

2.3.2. Anthropometry

A study of human body measurements is known as anthropometry. The body structure of organisms with a similar shape and size and whose dimensions are probably within a given range, is one of the factors that characterizes a species. Therefore, it can be a sign of poor

nutritional status when the specific measurement ranges are exceeded. As an illustration, someone who consumes excessive amounts of sugar and saturated fat may grow a huge belly, exceeding the "normal" measurement that would be anticipated in a healthy person. A nutritional evaluation can evaluate a child's head size to determine whether they have a smaller head than normal or not if they have limited access to food (Van Der Linden et al., 2016).

2.1.4. Biochemical Procedures

The sixty (60) distinct types of chemicals that make up the human body must stay within a set range in order to maintain our life and health. To establish whether we may have nutritional deficiencies, biochemists can measure the chemical status of our bodies, which can aid to identify our nutritional status. They assess the levels of several proteins, cells, and chemical markers, such as albumin, serum, pre-albumin, transferrin, hemoglobin, white blood cell count, urea ad production, lymphocytes, sodium, magnesium, and micronutrients. For instance, the normal range for the blood protein albumin is 3.4 to 5.4 grams per deciliter. One may have malnutrition if albumin is tested outside of this range (or a liver disease, or inflammatory disease). Likewise, if your lymphocyte count falls below (Lavie et al., 2014).

2.1.5. Clinical Methods

Physically examining a patient to find abnormalities is known as clinical assessment (Lavie et al., 2014). Asking the patient to list any symptoms they may be having might help determine whether a person has a nutritional deficit because it can show up on the body in a variety of various ways. Muscle wasting is the most evident symptom of malnutrition and can be seen in a number of body parts, including the shoulders, arms, thighs, and buttocks. A person with anorexia nervosa who fails to consume adequate calories out of fear of becoming overweight is an illustration of muscle atrophy (Lavie et al., 2014). There are many noticeable symptoms of dietary deficits, including:

i. **Anemia**: A typical sign of iron deficiency is anemia, which is characterized by pale complexion, exhaustion, shortness of breath, and dizziness.

ii. **Edema** is the body's retention of fluid and can be brought on by a person's diet lacking in protein or vitamin B1. Swollen, stretched, or glossy skin, skin that doesn't "bounce back" when touched, puffiness around the ankles, face, or eyes, an aching body, and more are signs of this condition.

iii. **Bitot's spots**, which are creamy-colored spots that develop on the eye's white (sclera), are an indication that a person is deficient in vitamin A. Having trouble seeing at night may be related to this.

iv. **A goiter** is a severely swollen throat caused by an enlarged thyroid. A lack of iodine is indicated by this.

v. **Frail hair and nails**: This is a sign of a deficiency in biotin, a vitamin B7 that aids in the body's ability to turn food into energy.

vi. **Mouth ulcers**, which may be caused by low iron or vitamin B levels, are another health concern.

vii. **Dandruff** may result from a diet deficient in nutrients, particularly zinc, vitamin B3 (niacin), vitamin B2 (riboflavin), and vitamin B6 low levels (pyridoxine).

viii. **Gum bleeding**: Low vitamin C levels can be the culprit.

For our health and welfare, nutrients are essential. Since they are so crucial to recognize, nutritionists and medical professionals can do so for their patients using the methods mentioned above, and they can then suggest dietary adjustments that will allow them to address the problem and regain their health (Van Der Linden et al., 2016).

2.3. Adverse Pregnancy Outcomes

The current study's list of unfavorable birth outcomes includes pregnancy loss or miscarriage, congenital abnormality or birth defect, preterm birth, low birth weight, perinatal mortality, macrosomia, and intrauterine growth restriction. Most risk factors that result in a bad pregnancy outcome can be changed (Tsegaye & Kassa, 2018). Low birth weight (LBW), which can be caused by intrauterine growth retardations or lower gestational ages, is specifically defined as a birth weight of less than 2500 g. Worldwide, between 15 and 20 percent of babies with birth weights under 2500 g are linked to numerous infant health issues like hypothermia, hypoglycemia, and early demises. Additionally, the long-term repercussions of LBW that affect a child's future health and survival are neurocognitive issues and developmental delays (Dahlui et al., 2016)

The majority of risk factors that contribute to poor delivery outcomes can be changed (Tsegaye & Kassa, 2018), thus, these risk factors can be altered or their likelihood of having a significant impact on the course of pregnancy can be decreased. Unfavorable birth outcomes are a serious health concern in poor nations like Ghana. It has a lot of negative effects, including morbidity and mortality in newborns and young children. Each year, 15 million babies are born prematurely around the world. More than a million of them pass away soon after birth, and a large number of others experience physical, neurological, or educational problems that last a lifetime (Liu et al., 2015). These statistics, along with the fact that many babies are born prematurely each year and that the dangers associated with preterm births are tremendous in terms of fatalities and permanent disabilities, demonstrated the seriousness of the consequences of poor birth outcomes. Which, in accordance with (Liu et al., 2015), expresses its dangers through a variety of conditions, including physical disabilities, neurological conditions, and cognitive impairments.

The likelihood of a negative pregnancy result rises with age. According to a 2012 study from Nigeria, perinatal mortality, intrauterine fetal death, and newborn death all rose with age (Tsegaye & Kassa, 2018). This may help to explain why older women tend to have more problematic pregnancies than younger ones. As maternal age increases, so does the possibility or risk of unfavorable birth outcomes. Numerous research results show that unfavorable pregnancy outcomes might have negative short- and long-term repercussions on both the mother and the baby. Preterm births and difficulties during pregnancy are the main causes of these deaths, which are estimated to account for around 2.9 million infant deaths in the first month of life worldwide whereby preterm births and pregnancy problems are the main causes of these fatalities (Blencowe et al., 2012). The estimated preventable effects of unfavorable birth outcomes on the kid, which may occasionally also affect the mother, are as follows. In the modern day, barriers to mother and child health are undoubtedly adverse birth outcomes, which present significant challenges. The term "pregnancy outcomes" refers to the life events that occur to the newborn between the time of viability (28 weeks) and the first week of life. The transition from life as a fetus inside the womb to life outside the womb is not always easy, and this can have negative repercussions on the mother, the child, or both. These outcomes, which include a normal live delivery, low birth weight, and premature birth in the child, differ from pregnancy to pregnancy (Nucci et al., 2018).

Preterm birth, stillbirth, and low birth weight are the main causes of neonatal illness, mortality, and long-term physical and psychological issues, and they are all considered adverse pregnancy outcomes. These outcomes are those that do not involve a normal live birth. (Blencowe et al., 2012).

Prematurity, low birthweight, and stillbirth are some of the unfavorable outcomes of pregnancy that pose serious issues for both developing and developed nations. More than one in ten births,

or around 15 million newborns worldwide each year, occur too early. More than a million of those infants pass away shortly after birth, and many more have physical, neurological, or educational problems that last a lifetime, frequently at enormous expense to families and countries (Pandolfo et al., 2014). About 4 million of the 136 million babies born each year are stillborn, and another 4 million perish during the first month of life (Liu et al., 2015). 12% of newborns are born prematurely, 8% have low birth weights, and 3% have severe birth abnormalities, according to research from 2006 worldwide (Krishnamoorthy et al., 2006).

Operational explanations cited in (Tsegaye & Kassa, 2018)**.**

i. Perinatal mortality is the term used to describe deaths occurring during pregnancy (including macerated and fresh stillbirths) and early neonatal deaths (first week of life). Perinatal mortality rate is the sum of both of macerated and fresh stillbirths per1000 total deliveries.

ii. Low birth weight refers to a newborn's weight being under 2.5 kilograms (kg).

iii. Miscarriage: The natural demise of an embryo or fetus before it is able to survive on its own.

iv. Preterm labor: Before 37 weeks of pregnancy, there are frequent uterine contractions that alter the cervix and lead to preterm birth.

v. Congenital anomaly: A congenital anomaly is any physical defect that is discovered at birth or during pregnancy and is characterized as having a birth weight over 4000 grams regardless of gestational age (Macrosomia).

Declining rates of infant fatalities are strongly correlated with achieving Sustainable Development Goal 3's ("Good Health and Well-Being") target. Since there are still a growing number of neonatal fatalities as a result of poor birth outcomes, it is evident from this that target

3 cannot be achieved. As these deaths are the result of preventable causes, the target forecast by 2030 calls for significant reductions in the global rates of maternal, neonatal, and children under five mortality.

Estimates from 2013 indicate that 6.3 million live births (stillbirths) and early neonates occurred in the world before the age of five (Liu et al., 2015). This figure, which fell from 9 million in 2000 despite an increase in live births, shows that nations have made significant strides in increasing child survival since the turn of the millennium. In the lead to the post-2015 era, a new set of country targets to reduce child deaths were formulated. The targets included; A Promise Renewed target of 25 or fewer under-5 deaths per 1000 livebirths by 2030 and or 20 or fewer deaths by 2030, the Plan target of 12 or fewer neonatal deaths per 1000 livebirths by 2030 (or 10 or fewer neonatal deaths by 2035). The targets were set and discussed within the framework of the Lancet Commission on Investing in Health and the Sustainable Development Goals (SDGs) to be met by 2030 and 2035. To achieve these targets and end preventable child deaths, substantial effort is needed. The global effect will be dependent on high coverage of most effective interventions on the major causes of death. The 6.3 million children who died before the age of 5 years around the 2013, about 3 million died of infectious causes and 2.7 million died around the neonatal periods. The findings of the causes indicated that the three leading causes were preterm birth complications, pneumonia and intrapartum-related complications. The causes with the slowest progress were congenital, preterm, neonatal sepsis, injury, and other causes. If the trends continue, about 4·4 million children younger than 5 years will still die by 2030 and Sub-Saharan Africa will have 33% of the births and 60% of the deaths as compared to 2013 (Liu et al., 2015).

Among the key adverse birth outcomes being considered for the purpose of this study are LBW and PTB.

2.3.1 Preterm Birth and Low Birth Weight.

Weight at birth can be categorized into three groups: normal (birth weight between 2.5 and 4.0 kg), too light (birth weight under 2.5 kg), and too heavy (macrosomia; birth weight over 4.0 kg) (Dahlui et al., 2016). The infant's life will be negatively impacted by the last two circumstances. Research has demonstrated that anomalous birth weight has long-term risks, including a high prevalence of adult coronary heart disease and type 2 diabetes, in addition to short-term effects including high infant mortality and adolescent growth failure among survivors ((Dahlui et al., 2016). This may be due to fetal or perinatal responses, which may include changes in metabolism, hormone production, and tissue sensitivity to hormones that may hinder the relative development of various organs, resulting in persistent changes in physiologic and metabolic homeostatic set points. Low birth weight (LBW) was also shown to have debilitating long-term consequences on childhood development, school achievement and adult capital, including achievement in height, economic productivity and birth weight of offspring (Carmo et al., 2019).

Short gestation (37 weeks) or slowed intrauterine growth (or a mix of the two) are the two main causes of low birth weight (WHO). Low birth weight is a condition that affects 11% of all babies worldwide, which is six times more common in underdeveloped nations than it is in developed ones (UNICEF, 2013). According to UNICEF, Ghana has a 13.0% prevalence of low birth weight infants. The LBW rate in Sub-Saharan Africa is approximately 15% (UNICEF/WHO 2004). Every year, 114,300 babies are born in Ghana before their mothers reach 37 weeks of pregnancy, placing the country 25th in the world for the number of preterm births (Blencowe et al., 2012).

Preterm delivery (before 37 weeks of gestation), or constrained fetal (intrauterine) growth, are two causes of a baby's low birth weight (WHO, 2014). Fetal and neonatal mortality and

morbidity are strongly correlated with LBW (Tsegaye & Kassa, 2018). As a result, LBW identifies a diverse group of newborns: some are born prematurely, some are born with growth restrictions, and still others are born both prematurely and with growth restrictions (Tsegaye & Kassa, 2018).The newborn suffers from LBW, which is generally acknowledged as a disadvantage. The greatest cause of mortality, illness, and disability is short gestation (preterm birth). The infant will be smaller and more likely to suffer from illness, impairment, and mortality the shorter the gestation period. The mortality range has been demonstrated to vary by a factor of 100 across the birth weight spectrum and to increase steadily with decreasing weight (Doi et al., 2020). A person with LBW due to constrained prenatal growth is affected for the rest of their lives and is more likely to develop adult disorders such type 2 diabetes, hypertension, and cardiovascular disease as well as have poorer childhood development. Having smaller children when they become mothers is another risk that girls face (Tsegaye & Kassa, 2018).

A significant public health indicator for a long time has been LBW. LBW is not a substitute for any specific aspect of maternal or perinatal health outcomes. The indicator provides a useful global snapshot of a complex public health issue that encompasses long-term maternal malnutrition, ill health, and poor pregnancy health care. Therefore, LBW is a crucial metric for assessing how far we have come towards achieving these globally recognized objectives. Since LBW is a significant indicator of health on an individual basis, it is crucial to measure it precisely at delivery and organize and arrange baby care accordingly. Monitoring a baby's growth in the weeks following birth is especially crucial for smaller babies. This is especially crucial for babies at a high risk for insufficient growth and poor feeding (Dahlui et al., 2016).

Countries should be urged to provide accurate and dependable infant weighing as soon after birth as possible in this regard. While the epidemiology of LBW has been thoroughly

investigated in affluent nations, accurate data on LBW are still few in less developed nations. The main cause is that, according to (WHO,2004), more than 40% of births occur at home without the assistance of a trained caregiver, and that under these conditions, weights are infrequently taken of newborns. Only around 60% of births globally are registered, making it difficult for many underdeveloped nations to adequately track such a crucial event (UNICEF, 2004).

Even when infants are weighed at birth, which is relatively simple to do, their weight is not always documented, reported, or tabulated appropriately. Therefore, it is advised to use caution when comparing data from various nations, locations, and historical periods. A more comprehensive description of the pregnancy result is required than only birth weight, according to recent research on the effects of intrauterine and early life events on a child's development, cognitive growth, and lifetime illness status (Tamirat et al., 2021). It has become increasingly clear that the cut-off number of 2,500 g may not be suitable for all circumstances, even though LBW continues to be effective in concentrating attention on a healthy start to an independent existence. There are certain nations with high LBW incidence that do not necessarily have high fatality rates, such Sri Lanka. (Liu et al., 2015).

Of all newborn deaths, low birth weight accounts for 60% to 80% (Ng et al., 2014). In Sub-Saharan Africa more than any other location in the globe, progress in lowering newborn mortality has been more slowly (Tamirat et al., 2021). In Ghana, the incidence of low birth weight in 2014 was 160 per 1000 live births. Over the past ten years, Ghana has not seen a decline in the rate of low birth weight (Ghana Statistical Service et al., 2015b). Birth weight may also be affected by other factors like as low socioeconomic level, usage of antenatal care services, and tetanus immunization. Preterm birth, maternal age between 20 and 35, stress during pregnancy, and first parity are only a few of the potential causes of LBW (Tsegaye &

Kassa, 2018). In comparison to newborns born at term, premature babies have a six to twenty-six times greater risk of dying in their first four weeks of life (Black et al., 2013). Every year, 114,300 babies are born in Ghana before their mothers reach 37 weeks of pregnancy, placing the country 25th in the world for the number of preterm births (Blencowe et al., 2012).

2.3.2 Body Mass Index and Adverse Pregnancy Outcomes.

Scottish researchers conducted a retrospective cohort analysis (Doi et al., 2020) revealed that women who were overweight and obese had a higher risk of having a difficult pregnancy and giving birth, and that this risk increases as BMI rises. Women with greater BMI had a considerably higher risk of having a cesarean section, gestational diabetes, and hypertension compared to women of normal weight. This study provided proof that, compared to women with normal BMI, those with greater BMI are more likely to experience worse pregnancy and delivery outcomes. A different study (Vivian Ukah et al., 2019) it was determined that the amount of weight gained during pregnancy has a significant impact on the course of the pregnancy, thus individuals who gained between a certain amount and less than that amount were classified as having low weight gain. According to the study, when compared to pregnant women who gained the recommended amount of weight, those who gained less weight during their pregnancies had a higher risk of both maternal mortality and severe neonatal morbidity. While excess weight gain in overweight women did not increase the likelihood of any severe adverse perinatal outcomes, it did decrease the likelihood of perinatal deaths and severe neonatal morbidity, and it did the same for obese women with excess weight gain. This is in contrast to women with normal pre-pregnancy BMI who had excess gestational weight gain. The impacts of weight gain on the various BMI groups' negative pregnancy outcomes demonstrate the crucial role that weight gain plays during pregnancy.

Weight management during pregnancy and pre-pregnancy BMI may determine adverse health consequences in neonates, making overweight and obesity issues of public health concern. In the study, we discovered that inadequate weight variations were linked to poor newborn outcomes and premature deliveries, while those who gained weight normally during pregnancy in accordance with the Classification of the Institute of Medicine recommendations had better outcomes.(Nucci et al., 2018). Numerous studies, like this one, have shown how important weight increase is to the success of pregnancies—even more so than the women's pre-pregnancy BMI. However, the majority of studies looking at the recommended weight gain ranges for mothers in developing nations have consistently maintained that the majority of women who were underweight prior to becoming pregnant hardly meet the ranges, and as a result, they exhibit more unfavorable pregnancy outcomes. Based on the study (Mamun et al., 2011) regardless of pre-pregnancy BMI, excess weight gain in pregnancy was associated with increased risk for adverse obstetric and neonatal outcomes, including large for gestational age infants, caesarean delivery, low apgar score, and postnatal weight retention of mother. This finding is based on the Danish National Birth cohort, a very large sample of about 61,000 mothers and their infants.

Obstetric outcomes will be impacted by the rising frequency of obesity among women who are fertile (Van Der Linden et al., 2016). According to studies done in industrialized nations, a woman's BMI may be related to difficulties during pregnancy, delivery, and the postpartum period for both mother and child. However, due to the simultaneous burden of infectious diseases and noncommunicable diseases, as well as genetic, cultural, and lifestyle variations, it is impossible to draw any conclusions or make any generalizations about the results found in developed countries versus those in developing countries. Congenital anomalies, gestational

diabetes, hypertensive diseases, and postpartum hemorrhage are some examples of these consequences.

As stated by (Van Der Linden et al., 2016), there are not many research on the effect of a mother's weight on maternity and newborn outcomes in poor nations, and those that do tend to be cross-sectional in nature. According to research from South Africa and Sudan, having a high body mass index during pregnancy increases the likelihood of having a cesarean section and developing gestational diabetes mellitus, both of which have negative effects on the health of the baby. However, different studies in the same context or region may produce different results depending on the study design, sample size, and time of the study as well as by virtue of the same reasons which underlie all of the studies. These studies have provided some insight into the likely impact or relationship between BMI and unfavorable pregnancy outcomes in developing countries.

According to the prospective cohort study (Van Der Linden et al., 2016) According to a study that was carried out in Accra, Ghana, women with high BMI, who are overweight, have a twofold increased risk of developing pregnancy-induced hypertension and a threefold increased risk of cesarean sections, while those who are obese have a twofold increased risk of cesarean sections, a six fold higher risk of pregnancy-induced hypertension, and a sevenfold higher risk of both chronic and high blood pressure. However, when it came to child outcomes, there was no correlation between having a high BMI and the chance of miscarriage, stillbirth, or neonatal mortality. Instead, high birth weights above normal were noted (macrosomic). Contrary to other studies' findings in high-income nations, there was no significant correlation between BMI and the risk of miscarriage, stillbirth, or newborn mortality, and that risk actually tended to decline as BMI rose (Aune et al., 2014). This demonstrates one aspect of the

association between BMI and obstetric outcomes in Ghana, demonstrating that high BMI groups are at an increased risk for poor obstetric outcomes.

Inadequate delivery outcomes resulted in more than 75% of newborn fatalities occurring in the first few weeks of life. Preterm births and low birth weight are the most frequent unfavorable pregnancy outcomes in Sub-Saharan Africa, and they are linked to a number of short- and long-term issues in obstetric outcomes in Ghana, indicating high BMI groups (Tamirat et al., 2021).

According to the study's findings, antenatal care follow-ups should be encouraged, women's socioeconomic circumstances should be taken into consideration, and multiple pregnancies, improving access to healthcare in rural areas, and women's participation in healthcare decision-making should all receive special attention. The study sought to clarify the evidence for the factors that contribute to poor birth outcomes in Sub-Saharan Africa. These suggestions primarily aim to provide women more control over their diets and health, as one of the major issues inhibiting individuals in the SSA from eating healthily and maintaining appropriate weights both before and during pregnancy is poverty.

A cross-sectional research conducted at a facility (Abubakari et al., 2015b) on maternal determinants of birth weight conducted in the Northern region revealed that the participants (mothers) were generally well-nourished before pregnancy, with the percentage of underweight women being 3.82%, normal pregnancies being 57.76%, overweight pregnancies being 25.06%, and obesity at 13.37%. However, almost half of them (49.6%) were unable to put on the recommended amount of weight, as per the Institute of Medicine. Newborns whose moms acquired too much weight were 431g heavier than infants whose mothers gained weight normally, while infants whose mothers gained less weight were 479g lighter. Compared to infants of normal moms, those of overweight and obese women weighed approximately 595g

more. This shown that babies born to overweight and obese women were substantially heavier than those born to kids from BMI groups, 2.98 +/-0.68 kg was the typical birth weight recorded.

But, the research (Abubakari et al., 2015b) which was looking for the factors that affected low birth weight (LBW) discovered that pre-pregnancy BMI, gestational weight increase, the baby's sex, and the mother's geography (rural/urban) were the factors that were most significant. The two main factors influencing birth weight were discovered to be pre-pregnancy BMI and weight growth during pregnancy. In Sub-Saharan African nations and other developing nations, nutrition advice for women or mothers prior to conception and advice on how much weight to gain during pregnancy should be given during antenatal clinics are frequently disregarded. As a result, mothers or women who get pregnant unprepared with a healthy BMI. Being overweight during pregnancy is a risk factor that can be altered for better pregnancy outcomes. If counseling and assistance are given a lot of attention, this can be accomplished. This is particularly significant because the study discovered that inadequate weight increase during pregnancy is linked to a high risk of low birth weight and that excessive weight gain during pregnancy is linked to greater birth weight kids, which is also a risk. According to the study, a sizable portion of pregnant women were over-nourished, which is a glaring indication of the double burden of malnutrition that developing and transition nations are currently bearing.

2.3.3. Body Mass Index and Low Birth Weight

There is strong evidence that maternal obesity during pregnancy increases the likelihood of issues such childhood obesity, diabetes, cardiovascular illnesses, several types of cancer, and metabolic syndrome in the offspring at various stages of life (Ng et al., 2014). The risks of having a baby with low birth weight and intrauterine growth restriction are somewhat raised, but otherwise maternal underweight has a protective impact against these pregnancy problems (IUG) (Liu et al., 2015). Reducing maternal obesity before conception is probably the best method to lessen the health burden of undesirable fetal and birth outcomes as many of the physiological changes of pregnancy related with maternal obesity are present from early pregnancy on (Mamun et al., 2011). This explains the potential causes of maternal obesity, which increases the likelihood of having LBW babies and IUG deliveries whereas maternal underweight, on the other hand, does not cause pregnancy difficulties (Liu et al., 2015) suffers from pregnancy difficulties in the earliest stages, which typically result with unfavorable fetal and delivery outcomes. The greatest strategy to prevent negative pregnancy and fetal outcomes, such low birth weight (LBW), is to make sure that maternal fat is minimized before conception and maternal underweight is addressed (Mamun et al., 2011)

Pre-pregnancy It is linked to LBW and tiny for gestational age, and underweight is still a serious health issue. Nevertheless, not every study demonstrates a statistically significant connection (Van Der Linden et al., 2016). Results of the research (Ng et al., 2014) demonstrated a direct link between increased fetal growth and maternal fat or overweight. Babies whose mothers are overweight or obese during pregnancy are more likely to have macrosomia or be big for gestational age, which raises the risk of a number of birth issues, including shoulder dystocia and surgical deliveries, among others (Khashan & Kenny, 2009). Birth defects such as Short-for-Gestational Age (SGA) and LBW are more likely to occur in underweight mothers

(Doi et al., 2020). Therefore, the probability of unfavorable neonatal outcomes may be influenced by any of the maternal BMI range's extremes. As a result, having an underweight BMI puts you at risk for LBW to some extent, although research from studies such (Ng et al., 2014). However, it is clear that maternal obesity and overweight have been linked to increased fetal growth even though they have not demonstrated statistical significance. Due to the fact that both BMI extremes are linked to poor pregnancy and birth outcomes, it is best to ensure that mothers have or maintain a normal BMI both before and during pregnancy in order to promote better pregnancy and neonatal outcomes.

It is known that pregnancy weight gain affects the likelihood that LBW babies will be born (Nucci et al., 2018). The Institute of Medicine suggested appropriate weight increase levels for pregnant women in 1990 and 2000; weight growth that fell within or exceeded these ranges could have negative effects. Weight gain between 12.5kg and 18kg is advised for pregnancies with underweight BMIs, 11.5kg to 16kg for pregnancies with normal BMIs, 7.0kg to 11.5kg for pregnancies with overweight, and 5.0kg to 9.0kg for pregnancies with obese BMIs. In summary, these ranges should serve as a reference for maternal weight increase during pregnancy because it is crucial to determining the success of birth and the wellbeing of the fetus. Out of these ranges weight increase has been linked to both short-term and long-term negative effects on children's health and maternal health. To improve the quality of birth, health practitioners should educate moms or expectant women and make sure they acquire weight within the approved ranges. It is preferable to provide guidance to pregnant women in underdeveloped nations where they are more likely to gain inadequate weight and to ensure that they are healthy weights before to becoming pregnant. Another issue is that preconception counseling is rarely practiced in poor nations since it is frequently disregarded and not given

the proper attention. Because of this, it is extremely difficult for women in developing nations to implement these guidelines.

Cognitive problems that are present at birth in LBW children have an impact on their academic achievement and future employment prospects (Mohammed et al., 2019). Their mental abilities are still developing slowly, which has an impact on their capacity for cognitive function. Typically, they are unable to access employment possibilities that would enable them to live better lives throughout adulthood and life. In addition to having health issues, LBW infants who survive frequently suffer from malnutrition and weakened immune systems, which increase their risk of catching infections (Black et al., 2013).

2.3.4. Body Mass Index and Preterm Birth

The impact or link of BMI on PTB is examined in this section. Preterm birth, which is the main cause of infant mortality, neonatal morbidity, and long-term disability among infants who are not born with birth defects, is defined as the delivery of a live newborn before 37 weeks of pregnancy (Liu et al., 2015). With a decrease in gestational age, these risks of newborn death and long-term impairment grow. This explains why having a baby at a preterm birth affects them differently. Babies who are born very or excessively preterm have a higher risk of dying, having malformations, and having various impairments than babies who are born at a preterm birth.

(Mamun et al., 2011) found that children born to women who were overweight or obese had a higher likelihood of being born before term than children born to mothers who were of a healthy weight. Based on the study (Pandolfo et al., 2014) preterm birth is more likely in people who are obese, but it's unclear whether having a higher BMI is associated with certain forms of preterm delivery. It's unclear whether being overweight or obese increases the risk of having a baby very early or excessively preterm, however it is generally accepted based on the available

data that a higher BMI increases the risk of having a child that is born prematurely. Neonatal morbidity and mortality are primarily brought on by PTB (Liu et al., 2015). In South Asia and Sub-Saharan Africa, more than 60% of premature births take place (Tamirat et al., 2021). Preterm birth, fetal death, stillbirth, perinatal death, neonatal mortality, and infant death are all considered to be intimately associated to high maternal BMI. But different studies have shown different things, and some have even found lower PTB risk for groups with higher BMIs. The disparity has always been there and is always related to variables that may include a small sample size, study design, regional variation, or country income categories (Doi et al., 2020). The stronger link between BMI and preterm birth in underdeveloped nations like Ghana is the more important thing to watch for.

Obesity has been reported to increase the risk of preterm delivery, however the relationships between obesity and subtypes of preterm birth are not well understood to determine how they affect early and late preterm deliveries (Pandolfo et al., 2014), while a previous study found that being overweight or obese during pregnancy increased the chance of preterm delivery, especially extremely preterm delivery (less than 28 weeks of gestation), it did not specifically highlight the level of risk for each group (Aune et al., 2014). Pregnancies that end before 32 weeks of gestation and those that end between 32 and 36 weeks of gestation, respectively, are referred to as extremely and moderately preterm births. More research is therefore required to better understand the level of risk associated with preterm birth in different population BMI groups.

The symptoms of PTB vary widely. Following premature membrane rupture or preterm labor, PTB may develop naturally or for therapeutic purposes. Furthermore, PTB can manifest "early" (before 34 weeks' gestation) or "late" (between 34 and 36 weeks' gestation). When compared to early PTB, pregnancy problems that require medical inductions contribute more heavily to

late PTB (Doi et al., 2020). Pregnancy complications or issues represent a level of risk for preterm delivery because they are frequently linked to higher BMI categories and may result in medical conditions that could induce preterm birth. PTB may result from specific pregnancy problems that occur in obese pregnant women. For instance, among obese women, severe hypertensive disorders of pregnancy are common, and they are one of the most common medical reasons for preterm delivery (Doi et al., 2020). Thus, according to this finding, obesity increases the risk of medically indicated preterm delivery partly or significantly through obesity-related maternal disorders like preeclampsia and gestational diabetes, another common condition among obese women that has been linked to both medically induced and spontaneous preterm birth.

Preterm births (PB) and the delivery of infants that are too small for gestational age are more likely in obese pregnant mothers (Sebire et al., 2001). Furthermore, women who present with insufficient weight gain may encounter issues like anemia, premature birth, low birth weight, and small for gestational age (Tsegaye & Kassa, 2018). While preeclampsia, gestational diabetes, and the necessity for caesarean sections are more likely to occur in women who have gained too much weight. (Mamun et al., 2011). Studies that consider pregnancy weight gain as well as pre- or early-pregnancy BMI when analyzing birth outcomes. Because of this, it is especially important to research how pre-pregnancy BMI and GWG affect pregnancy and the infant and to create better guidelines or plans for women before and during pregnancy. The majority of the most recent research on pre-pregnancy BMI and GWG levels originates from Western or high-income countries (Gortmaker et al., 2011) this undoubtedly will not apply the same in low- and middle-income and emerging countries.

Growing data indicates that the occurrence and progression of PTB is a complicated process driven by a range of environmental and genetic factors (Blencowe et al., 2012). By clarifying

the etiological mechanisms causing PTB or LBW, techniques for the effective prevention and treatment of newborn morbidity and mortality can be developed. The body mass index (BMI) of pregnant women prior to conception, however, has received support as one of the potential risk factors for PTB and LBW (Doi et al., 2020; Lynch et al., 2014; Shaw & Shaw, 2014). In many nations, especially emerging ones, the prevalence of obesity and overweight among women has risen alarmingly in recent decades. Overweight and obesity have various patterns depending on countries, regions, and income levels, with women in developing countries being more prone to it than males in industrialized nations (Ng et al., 2014). Additionally, epidemiological research have revealed that maternal obesity and overweight have been linked to PTB and detrimental maternal health outcomes, such as gestational hypertension and cesarean birth (Lynch et al., 2014; Shaw & Shaw, 2014)

Similar to how underweight women prior to becoming pregnant are the main risk factor for LBW and PTB, various observational studies have demonstrated this (Vivian Ukah et al., 2019) . Nevertheless, it seems counterintuitive that pre-pregnancy BMI and PTB have an association. This is according to several research. Research have found that women with high BMIs prior to being pregnant have a much higher risk of preterm birth (PTB), but other studies have found the opposite, suggesting that these women may actually be at a higher risk of preterm birth protection (Pandolfo et al., 2014)

Studies carried out in high-income nations indicate a link between the maternal body mass index and complications during pregnancy, delivery, and the postpartum period for both the mother and the child, including hypertensive disorders during pregnancy, cesarean delivery, perinatal and infant deaths, macrosomia, etc (Black et al., 2013). Because infectious diseases and noncommunicable diseases have a double burden in Low and Middle Income Countries (LMICs), findings from studies conducted in high-income countries might not be immediately

applicable to the setting of LMICs (Dalal et al., 2011). Pregnant obese women who are overweight or obese are more likely to undergo cesarean sections, develop gestational diabetes mellitus, and have macrosomia, according to studies from South Africa and Sudan (Ng et al., 2014). 60% to 80% of all newborn deaths are attributable to low birth weight (UNICEF/WHO, 2004). Compared to other regions of the world, Sub-Saharan Africa has experienced slower reductions in newborn mortality. (Tamirat et al., 2021). Ghana has not seen a decrease in the incidence of low birth weight in the past ten years, with the rate in 2014 being 160 per 1000 newborns (Ghana Statistical Service et al., 2015b).

In order to determine the case of BMI's effect on PTB, LBW, and other unfavorable pregnancy outcomes in the Ghanaian population, specifically in the Northern Region, Tamale, this study is required. This will help people understand which BMI categories are protective of adverse birth outcomes and which provide a risk for such outcomes, enabling them to focus more intently on those categories that, in line with the study's aims, have a negative impact on birth outcomes.

3.0. Other Maternal Factors Influencing Adverse Birth Outcomes

There is also evidence that links biological, social, and environmental factors strongly and consistently to unfavorable pregnancy outcomes. Numerous studies have identified a link between socioeconomic level, income disparity, and demographic characteristics and the success of pregnancies. In addition, a range of socioeconomic factors, including maternal education, marital status, and intention to become pregnant, have been connected to unfavorable pregnancy outcomes (Lynch et al., 2014). Education level has been found to be strongly correlated with unfavorable pregnancy outcomes; bad pregnancy outcomes are more likely to occur in mothers with some education than in mothers with no education or higher education. These variations are explanations for causes resulting from mothers' varied levels

of understanding and adoption of healthy behaviors. Mothers of various age groups also differ in their ability to reduce the likelihood of unfavorable pregnancy outcomes. Teenage moms are more likely to experience preterm birth, LBW, and other unfavorable newborn outcomes, according to some research. Studies have shown that older women are at a lower risk of having an unfavorable pregnancy outcome than young mothers. Mothers' employment prospects are a significant factor in influencing the likelihood of negative effects of pregnancy. Unemployed mothers are more likely to have little to no income, which lowers their socioeconomic position and makes it more difficult for them to access basic necessities like healthy nutrition throughout pregnancy. This leaves them susceptible to nutritional inadequacies, which cause malnutrition and, as a result, pregnancy problems and poor newborn outcomes (Black et al., 2013).

Mothers' negative pregnancy outcomes are also discovered to be related to another aspect, such as early initiation of intercourse. According to one study, for instance, women who started having sex before the age of 14 have a two-fold increased risk of having an unfavorable pregnancy outcome compared to women who started having sex after the age of 18 (Van Der Linden et al., 2016) . Early sex starters are more likely to have immature sex organs that are unable of performing as well as those that are developed and prepared for reproductive function. This behavior might cause serious genital issues throughout later sex life, fertilization, and delivery. This is associated with a higher risk of unfavorable birth and neonatal outcomes.

Another key factor that affects a mother's chance of having a difficult pregnancy and having a baby with unfavorable neonatal outcomes is how frequently she uses health services before, during, and after giving birth. SSA research (Tamirat et al., 2021; Tsegaye & Kassa, 2018) discovered that compared to women who had no visits or no follow-up visits, those who had antenatal care visits for their most recent pregnancies were related with a lower risk of negative delivery outcomes. The likely answer is that ANC services or preconception services provide

counseling and instruction from medical professionals who are knowledgeable about pregnancy and child care to the pregnant or would-be pregnant woman.

The various maternal factors that affect the likelihood that a mother may have a child with poor outcomes are organized into the groups listed below.

3.1. Sociodemographic Factors Influencing Adverse Birth Outcomes.

Age, marital status, education, employment, place or region, and other criteria are among them. Studies have linked the probability of unfavorable pregnancy outcomes to maternal age. It has been discovered that a higher chance of an unfavorable pregnancy outcome is connected with older mother age. As a woman ages, her probability of having a child with a negative outcome rises because advanced maternal age is significantly linked to higher odds of an unfavorable pregnancy outcome. (Van Der Linden et al., 2016) found that mothers in the 35–44 age group were more likely than mothers in the lower age group to experience a negative pregnancy outcome. The factors listed in the study in could be the cause, according to some (Yeshialem et al., 2017) which discovered that older women, regardless of their gestation, have a higher risk of developing pre-eclampsia and needing a caesarean delivery. Negative birth outcomes, such as low birth weight, stillbirths, and other poor neonatal outcomes, are associated with pre-eclampsia and caesarean delivery (Van Der Linden et al., 2016).

Adolescent mothers were shown to be at higher risk in an examination of the impact of maternal age on unfavorable pregnancy outcomes comparing subtypes of adolescents (Tamirat et al., 2021)). This can be explained by the fact that adolescent pregnancy is frequently accompanied by immature physiologic changes in the mother, which raises the possibility of unfavorable pregnancy outcomes. Inferior pregnancy and newborn outcomes are possible as a result of immature reproductive organs' potential for major conception complications and other issues.

The primary conclusions of a study showed that older first-time mothers are substantially more likely to experience pre-eclampsia and need a caesarean surgery than mothers who are between the ages of 21 and 34 (Yeshialem et al., 2017). These findings that pre-eclampsia is more common in elderly primigravidae are in line with several findings that first-time moms who are very old at birth (older than 40 years) are at higher risk of developing the condition (Van Der Linden et al., 2016). Because they interfere with the fetus's ability to develop normally and the mother's health, these unfavorable circumstances and pregnancy problems increase the chance of unfavorable pregnancy outcomes.

Nevertheless, (Montori et al., 2021), there was a tendency for older women to have a higher risk of preterm birth when looking at the impact of maternal age on unfavorable pregnancy outcomes. Variations in environment, pregnancy problems, and other clinical issues, as discovered in the study by, may be substantially responsible for the variables explaining the disparities in findings with regard to mother age (Van Der Linden et al., 2016). Additionally, complications during pregnancy, intrauterine growth retention, and maternal nutrition are linked to premature birth, low birth weight (LBW), and other adverse pregnancy outcomes. Since older mothers are found to have an increased risk of these issues, premature birth, LBW, and other adverse neonatal outcomes are likely to be more common in older mothers, as found in (Montori et al., 2021)

More specifically, compared to women with minimal education, those with primary education or higher are less likely to experience unfavorable pregnancy outcomes (Van Der Linden et al., 2016). During pregnancy or in a mother's lifestyle, education is crucial. There are several explanations that could be offered for this, but the best one is to approach it from the perspective of knowledge and health-seeking behavior. Higher educated women are more inclined to exercise better health habits and to seek ANC services earlier in pregnancy. This conduct will

ensure a healthier pregnancy result and help to manage any potential difficulties more effectively. However, mothers without any formal education have a higher risk, possibly because mothers with lower educational levels might not comprehend and adopt to the health service's recommended practices easily. As a result, they may be more likely to run into issues that increase their risk of experiencing negative pregnancy outcomes like preterm birth, LBW, stillbirths, etc.

Age at first sexual contact, age difference with partner at first sexual contact, length of relationship, residence, marital status, education status, family income, and maternal age all significantly correlate with poor pregnancy outcomes (Van Der Linden et al., 2016). On the same scales, married women are more likely than unmarried women to experience intimate relationship abuse. Negative pregnancy outcomes like LBW and premature birth have been linked to the likelihood of intimate partner violence (Tamirat et al., 2021). Therefore, since the health of the mother, who may be stressed by partner violence, is linked to the health of the fetus, intimate partner violence has the potential to have an impact on the unborn fetus.

When compared to women who live in urban regions, women who live in rural areas have a twice as high risk of having an unfavorable pregnancy result. Access to improved healthcare facilities that provide high-quality treatments is less likely in rural places. Poor road networks make it difficult to travel on the roads, making access inefficient and very low. This condition is more likely to pose a serious threat to maternal health during pregnancy because it makes it difficult to quickly access vital healthcare services. Also mentioned in are cultural hurdles studies have found that women who live in rural locations use fewer health services than those who do in metropolitan areas (Nagahawatte & Goldenberg, 2008). The beliefs and behaviors of the people make up their culture, which encompasses their entire way of life. It can be challenging for medical personnel to monitor a pregnant woman throughout her whole

pregnancy and ensure that it is progressing normally because some cultures have concerns about the pregnant woman receiving early ANC intervention.

Additionally, it was discovered that women who had their partner at first sex with an age difference of less than five years had higher probabilities of having an unfavorable pregnancy outcome than those who had their partner at that same age. This may result in physical and biological issues with the woman's reproductive system and may lead to intercourse with a much older partner. This could increase the possibility of unfavorable effects among mothers who are younger than their spouses. Additionally, it has been discovered that women who started having sex before the age of 14 have higher odds of an unfavorable pregnancy outcome than those who started having sex before the age of 18 (Van Der Linden et al., 2016). Adolescent sexual activity is more likely to be unprotected and exposed to dangerous sexual practices that can lead to the acquisition of sexually transmitted illnesses including HIV/AIDS, syphilis, gonorrhea, etc. According to reports, many STDs can complicate pregnancy and cause issues that may be harmful to both the mother and the fetus. Study results as evidence (Van Der Linden et al., 2016) demonstrated that having less education is highly connected with having a bad pregnancy. Compared to moms with higher education, mothers with only a primary education had a higher likelihood of experiencing an unfavorable pregnancy result.

3.2. Obstetric Factors and Maternal Lifestyle Influencing Adverse Birth Outcomes.

Individuals' actions, such as dietary choices, physical activity (PA), smoking, and stress reduction, can be either healthy or unhealthy. These behaviors are reflected in their lifestyle. A person's unhealthy lifestyle may be linked to higher morbidity, and by changing it, you may be able to reduce both the morbidity and mortality of chronic diseases like hypertension and diabetes mellitus (Van Der Linden et al., 2016). In order to help pregnant women to have better outcomes throughout pregnancy, lifestyle modification is a crucial issue to take into

consideration both before and after conception. The health of the unborn child is negatively impacted by lifestyle choices like drinking alcohol while pregnant, smoking, and experiencing depression while pregnant. The health of the mother and the fetus may be impacted by a pregnant woman's lifestyle. The mother's body serves as the developing fetus's source of nutrition and protection. It has been discovered that a woman's lifestyle prior to conception may be a factor in neonatal health issues. When a woman is pregnant, unhealthy lifestyle choices like drunkenness, smoking, having low physical activity, and eating poorly can harm her health and even cause issues for both her and her unborn child (Doi et al., 2020).

PA is a key lifestyle moderator that has advantages for better health as well as preventing body weight gain without relying on diet (Sassi et al., 2009). After a certain amount of time, both an increase in weight during and after pregnancy is linked to women being overweight or obese. (Mamun et al., 2011). Additionally, it has been shown that prenatal difficulties may be linked to higher gestational weight gain (GWG). Additionally, it has been discovered that GWG is associated with postpartum weight retention, newborn macrosomia, and pregnancy-related problems (Van Der Linden et al., 2016)

Participating in PA during pregnancy has been shown to dramatically reduce the risk of gestational hypertension, preeclampsia, and CS by 5.9%, 2.3%, and 16%, respectively. Smoking by pregnant women increases the risk of ectopic pregnancy, infertility, preterm birth, small for gestational age, low birth weight, and stillbirth for the mother. Smoking by pregnant women also increases the risk of preterm birth, small for gestational age, low birth weight, and stillbirth for the unborn child (Van Der Linden et al., 2016).

At every stage of pregnancy, it is crucial for pregnant women's diets to include nutrients that are high in energy in order to support the health of the developing fetus. Pregnancy-induced

hypertension (PIH), as well as other issues like intrauterine growth restriction, premature birth, and birth problems such neural tube defects, can be brought on by unhealthy lifestyles and dietary choices (Abdallah et al., 2021). Furthermore, a pregnant woman who consumes an excessive amount of food may develop metabolic conditions such gestational diabetes, weight gain, and obesity. Maternal nutrition status may affect fetal growth unfavorable birth outcomes through a variety of possible routes. An increased risk of gestational diabetes, preeclampsia, big size for gestational age, fetal macrosomia, and cesarean birth exists in obese and severely obese women. Bacterial vaginosis, a significant risk factor for preterm birth, is also linked to higher fat intake.

A research (Navarro et al., 2020) discovered that a mother's likelihood of having a higher maternal age increases with the amount of maternal healthy lifestyle characteristics she possesses or practices. Low levels of a healthy lifestyle were linked to an increased risk of LBW, where as poor maternal diet, smoking, and alcohol consumption were linked to an increased risk of LBW as well. This provides more proof that mother lifestyle affects the results of birth. A healthy lifestyle predicts a successful birth since these characteristics do not adversely affect the mother's health or the growth and development of the fetus. Positive offspring outcomes, such as a lower chance of LBW and childhood obesity, have been linked to an overall healthy maternal lifestyle during pregnancy. The risk of LBW and childhood overweight and obesity at ages 5 and 9 were reported to be lower in kids who had mothers who led generally healthy lifestyles during pregnancy. Children of mothers who did not follow any of the healthy lifestyle characteristics had a higher risk of incident overweight and obesity than children of mothers who did. These five healthy lifestyle variables include a high-quality food, non to moderate alcohol consumption, no smoking, and physical activity. Similar results were found in other research regarding the links between an overall healthy lifestyle for the mother

during pregnancy and a lower risk of childhood obesity in the kids, as opposed to the offspring of mothers who did not match any of the low-risk criteria. (Van Der Linden et al., 2016)

A study (Tamirat et al., 2021) found that the probability of having a child with a negative birth result is raised in twin pregnancies. Pre-eclampsia and antepartum hemorrhages, which are common during pregnancy and frequently result in adverse birth outcomes, may be to blame for this. As a result, twin pregnancies are characterized as high-risk pregnancies that require extra care, birth preparation, and counseling for the expectant mothers.

A study in African Sub-Saharan region showed that the majority of women (87.7%) had births that were separated by more than 24 months, and 15.2% were born in the sixth and higher birth orders. A higher birth interval is linked to a lower chance of unfavorable birth outcomes (Tamirat et al., 2021).

A research project showed that drinking alcohol while pregnant raised the likelihood of having low birth weight babies by about a 2-fold. During the third trimester of pregnancy, smoking's effects appear to be amplified. Similar to this, smoking throughout the last trimester by the mother, particularly at a dose of >8 cigarettes per day, caused a significant drop in birth weight (Abdallah et al., 2021). Within the study found women in lower SES categories are more likely to smoke during pregnancy. Particularly, women with less education are said to have lower socioeconomic status (SES). Use of tobacco raises the chance of preterm birth and other undesirable birth results. More than 3000 compounds, many of which have unknown physiological effects, are present in cigarette smoke. However, smoking causes the production of carbon monoxide, a potent vasoconstrictor that is linked to placental deterioration and reduced uteroplacental blood flow. In both cases, fetal growth limitation, premature births, and other undesirable birth outcomes are the results (Nagahawatte & Goldenberg, 2008).

A study conducted in some secondary and tertiary health institutions in the Tamale Metropolis of the Northern region, by Kwame (2017), could not confirm the significant role that gestational age has been known to play in the birth weight of infants. Previous studies have shown a strong association between gestational age and birth weight outcomes.

In a study found that as parity rises, the likelihood of LBW increases dramatically (Mohammed et al., 2019). Additionally, it discovered that gestational age, the number of ANC visits, and hemoglobin level were each independent predictors of LBW. This might be described in light of potential pregnancy issues and how they might affect how the pregnancy turns out. The more ANC visits, the more likely it is that the pregnancy's progress will be carefully monitored by medical personnel. Another important finding from the study was that after every additional ANC visit, Intermittent Prevention Treatment for Malaria- Sulfadoxine Pyrimethamine (IPTp-SP) dose, and gram of hemoglobin, the likelihood of a woman giving birth to an LBW baby dropped. The value of antenatal care service (ANC) in promoting maternal and child health is so enormous that there is compelling evidence that receiving high-quality ANC when pregnant is essential for the welfare of both the expectant mother and the growing fetus. This is made possible by interventions like identifying and treating infections like HIV, syphilis, and other sexually transmitted infections (STIs) at the ANC, as well as managing obstetric complications like preeclampsia, tetanus toxoid immunization, intermittent preventive treatment for malaria during pregnancy (IPTp), and other obstetric complications like preeclampsia. However, poor and tardy ANC attendance correlates with higher probabilities of LBW, which can be explained by the reasons why the practices mentioned above are not followed.

Within the study, over and above the prevalence of preeclampsia and gestational diabetes, intimate partner violence (IPV), which is most frequently committed by a husband or partner, affects 4%–8% of pregnancies (Nagahawatte & Goldenberg, 2008). Being more prevalent and

severe in lower socioeconomic categories, IPV has a significant correlation with poverty. Because they might be unable to leave violent relationships due to financial reliance, women may be stigmatized by low SES. Preterm birth is one of many negative pregnancy outcomes for both the mother and the fetus that are linked to IPV. The physiological reaction to stress and despair may help to explain some of the association between IPV and premature birth. Numerous IPV situations are likely to involve sexual assault and sexually transmitted diseases, which may help explain why rates are rising.

3.3. Health Service Utilization Related Factors

The factors that have an impact on how often people utilize health services and how this affects the likelihood of unfavorable birth outcomes are included in the factors connected to health care consumption. This is easily demonstrated in many ways when taking into consideration the importance of decision-making, since women who do not participate in decision-making regarding their healthcare are more likely to experience unfavorable birth outcomes. Women's decision-making in healthcare refers to their capacity to choose between various healthcare providers and treatment alternatives. This is primarily because women who lack the capacity or participation in health decision-making typically record low usage of antenatal care services and do not give birth in institutions because most decisions regarding their health are made outside of their control rather by someone they consider crucial to them, who when it comes to commencing or seeking ANC services, people rely on to make decisions for them (Tamirat et al., 2021). The study also found that a woman's low involvement in decision-making may predict her exposure to intimate partner violence because such women aren't fully independent or dependent on their own decisions to determine their needs for healthcare and other issues affecting them. As a result, anything such a woman engages in or does in the form of making

her own decision about her needs for which the partner or significant others are not aware or informed could have a negative impact on her risk of experiencing intimate partner violence.

Nevertheless, some research conducted in Sub-Saharan Africa (Tamirat et al., 2021; Tsegaye & Kassa, 2018), discovered that women who had recent pregnancies attended by prenatal care providers had a decreased chance of unfavorable birth outcomes than those who did not. Prenatal care visits aid in identifying the majority of at-risk pregnancies, such as those with intrauterine development retardation, dietary advice, and vitamin supplementation. Prenatal care visits also made it possible to screen for conditions that could harm the fetus, including syphilis, malaria, intestinal helminthiasis, and HIV/AIDS. Therefore, raising the standard of prenatal care and encouraging expectant mothers to receive the WHO's recommended focused treatment would help to meet the Sustainable Development Goals by preventing unfavorable birth outcomes.

At least one ANC visit lowers the risk of a stillbirth during pregnancy, which is associated with both ANC attendance and residence (Carmo et al., 2019), Because she can readily attend ANC services and be in contact with medical personnel because she lives close to the health center, this is more likely to have a beneficial impact on a mother from an unfavorable pregnancy outcome. Utilizing health services throughout pregnancy enables early detection of difficulties, which enables better management of the complications for better results. Low ANC attendance is caused by a number of variables, chief among them being residing far from a health institution, living in a rural region, and having less education. A negative pregnancy experience in the past is strongly linked to higher probabilities of skipping prenatal care. Less likely to attend are women who had had previous pregnancies that had unfavorable outcomes. The location where women live in has a big impact on how often they use ANC services. Within the study (Carmo et al., 2019), living far from a health facility was revealed to be a significant

contributing factor to a poor pregnancy outcome, as women who lived more than 2 kilometers away from a facility had a higher probability of missing ANC than those who lived closer to it. Due to lack of transportation, limited access, and transportation-related costs, distance is a known obstacle to the use of health care. Women who live in rural areas at a higher chance of not receiving any ANC than those who live in metropolitan areas. Education is usually cited as a key socioeconomic predictor of maternal health care since it has been linked to higher chance of good health care utilization. Women who have had an education have greater authority and capacity to make responsible decisions about their health.

Better mother nutrition and health seeking habits are facilitated by these socioeconomic factors, which also contribute to better knowledge of pregnancy risk symptoms and early beginning of antenatal care. These factors also have a positive impact on bad delivery outcomes (Tamirat et al., 2021). It also describes how people would be able to understand the advantages of engaging in actions that promote health and would afterwards make every effort to practice what is seen as healthy. More crucially, they must have access to the right diet, education, and medical care throughout their pregnancy and/or life.

In locations or countries where malaria is endemic, pregnant women are susceptible to the disease. Preterm and small-for-gestational-age births are just two examples of the negative effects this has on birth outcomes. These infants have a higher likelihood of being LBW, which increases their risk of infant mortality and lifelong morbidities. Erythrocytes from pregnant women who have malaria have been infected with Plasmodium falciparum, which causes these cells to express a special variant surface antigen known as VAR2CSA. In the placenta, this mediates sequestration. Inflammation and dysregulated placental development, which have an impact on the placenta's ability to absorb oxygen and transfer nutrients, may be caused by this process. Therefore, this affects the development of the fetus by impairing placental activities

(Ng et al., 2014), if the placental function is impaired, it becomes risky for the fetus in case the placenta because the placenta is what connects the mother's oxygen supply to the fetus. The fetus is no longer able to acquire the sufficient oxygen it needs for regular growth to take place.

Due to a variety of host and parasitic conditions, first-time mothers, or primigravidae, are more sensitive to or vulnerable to malaria during pregnancy. (Blencowe et al., 2012). Pregnancy-related malaria (PM) causes a placental infection that puts the placenta at risk for damage and insufficiency. Poor placental function is referred to as placental insufficiency, and PM frequently exhibits this condition. It is believed that this circumstance is a major factor in LBW. (Blencowe et al., 2012).

Currently, starting in the second trimester, it is advised that all pregnant women living in areas with high malaria transmission undergo three or more treatment sessions of IPTp with SP, with each round being provided at least one month apart (WHO, 2013). Following significant results that showed a decreased risk of preterm delivery and LBW as well as improved birth weight when three or more courses were provided, this supersedes the initial advice of two doses of SP (Pandolfo et al., 2014).

Every year, it is predicted that malaria in pregnancy (MiP) results in 900,000 LBW births and 100,000 infant fatalities from (WHO, 2019). Along with a significant risk of death, these infants also have greater morbidity, which puts their remaining LBW counterparts at risk for delayed cognitive and social development (Dahlui et al., 2016).

The frequency of PM and LBW in malaria-endemic areas continues to pose a serious threat to pregnancies despite attempts to prevent malaria in pregnancy for a variety of reasons. The majority of the time, because IPTp is only given during the second trimester, pregnant women are not protected throughout the first trimester and the final weeks of the third trimester because

they do not receive the medication. This condition shows that the population is not sufficiently covered by the IPTp during pregnancy. Because of these deficiencies, infections that arise and are not properly treated are more likely to increase the risk of preterm birth and LBW. (Pandolfo et al., 2014).

Sustainable Development Goal (SDGs) 3's Universal Health Coverage (UHC) aims to close various healthcare delivery gaps. In Sub-Saharan Africa, around 60% of births take place at home or without trained birth attendants, despite the fact that institutional deliveries are much more likely to provide safe settings for both the mother and the baby and help minimize neonatal and maternal death. (Yaya et al., 2018). In some cases, non-institutionalized births happen to women who did not attend ANC and lived in rural areas. Additionally, the distance from a health facility is related to the likelihood of a non-institutionalized birth, and more experienced women and those with higher parities are more likely to do so. (Yaya et al., 2018), discovered differences in the demographic, social, economic, and close-by characteristics related to the use of maternal health services. The SDGs are well known for promoting inequality reduction and ensuring population health. In view of the foregoing, in order to reach the most underprivileged and vulnerable groups of women, considerations other than the usage of maternity care services must be made in order to meet the objectives. The study found that women who have less education, are from lower socioeconomic classes, live in rural areas, are less likely to have access to the media (such as newspapers, radio, and television), and are less likely to use maternal health care services. This showed that a particular class of persons received a disproportionate amount of maternity healthcare services. Despite the fact that there are measures to increase coverage. The inequality in access and use of maternal and child health care services in Sub-Saharan Africa has persistently been substantial due to a number of factors,

including place of residence, media use, educational attainment, age of mothers, and wealth, among others.

5.0 Conclusion

Some aspects of the literature found categories of BMI such as overweight and obese during pregnancy having a protective effect on preterm delivery, and underweight in pregnancy having a greater risk of delivering babies with LBW but not preterm. Other parts of the literature however found overweight and obese BMI to be more related to the risk of preterm birth. The results across most studies found according to the literature are not consistent because of factors such as regional variation, country income, sample size and study design.

CHAPTER THREE

3.0 METHODS

3.1 Introduction to the Methods

These are the processes employed in the data collection relating to the topic of study. It consists entirely of all the strategies or techniques used for data collection and analysis.

3.2 Background to the Study area: The Northern Region of Ghana

The Northern region is one of the sixteen (16) regions of Ghana. It is located in the North of the country and is the largest of the sixteen regions. Until its split, it covered an area of 70,384 square kilometres or 31 percent of Ghana's area. The Northern region is divided into sixteen (16) districts. Eleven (11) are ordinary districts, one is a metropolitan and four (4) are municipal districts. The region's capital is Tamale, Ghana's largest city. The notable health facilities are Tamale Teaching hospital, Tamale West hospital, Tamale central hospital, SDA hospital, Yendi Municipal hospital and Savelugu Municipal hospital. More generally, the Northern region is one of the most disadvantaged regions in Ghana. According to national statistics (Ghana Statistical Service et al., 2015a), the Northern region has the highest rate of illiteracy among both men and women, and more than half of the population in the region is in the lowest wealth quintile. It is also the region with the highest rate of polygynous unions in the country. The Northern Region has the highest rate of women with no schooling between the ages of 15 and 49 (Ghana Statistical Service et al., 2015b). 5.8 children per woman and a birth interval of 36.7 months represent the greatest total fertility rate for the region (Ghana Statistical Service et al., 2015b). In the Northern Region, 11% of women had recent doctor visits, 59% of births to women took place in health facilities, and 59% of the most recent live births or stillbirths were delivered by a trained healthcare professional (Ghana Statistical Service et al., 2015b).

Figure 2: Map of Northern Region. Source: Ghana Health Service, http://ghs.gov.gh

3.2.1 Background to the Study Area: The Tamale Metropolis

The Tamale Metropolis is one of the sixteen (16) districts in the northern region, with Tamale as the capital. It shares boundaries with Savelugu Municipality to the North, East Gonja Municipal to the South, Central Gonja District to the South-West, Yendi Municipal Assembly

to the East, and Tolon District to the West (Ghana Statistical Service, 2014). In terms of public health infrastructure, the Metropolis has three hospitals, including one teaching hospital, and five health centres serving a population of 374,744. The health centres include Vittin RCH clinic, Bilpiela health centre, Kalpohin health centre, and St Lucy polyclinic. More than 80% of the population lives in urban areas.

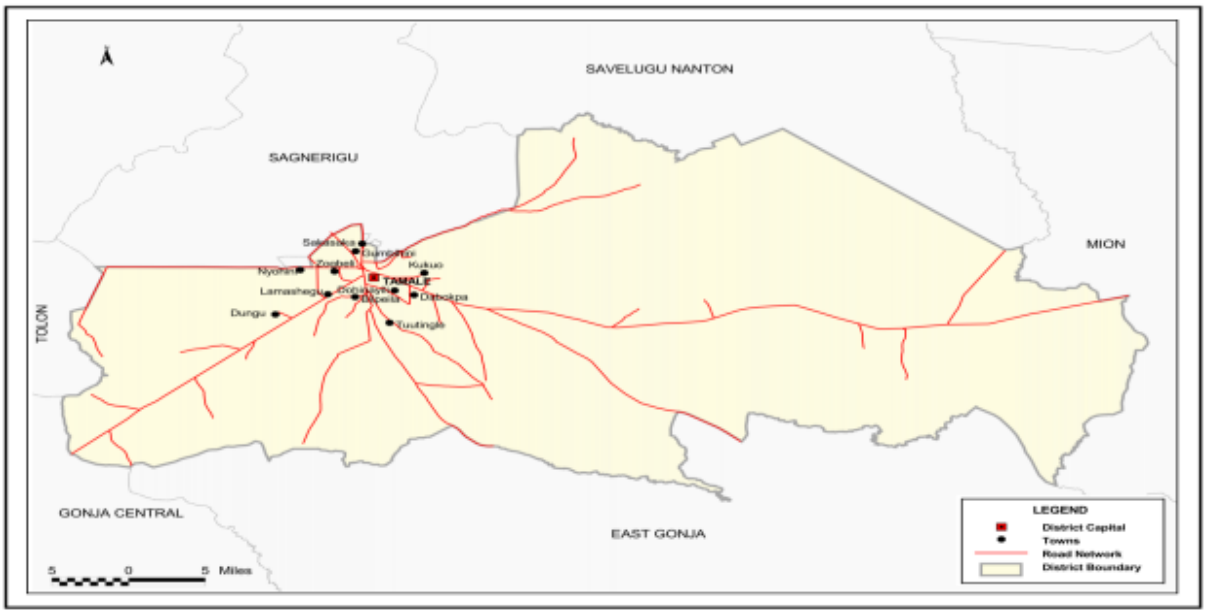

Figure 2: Map of Tamale Metropolis. Source: Ghana Statistical Service, 2014

3.2.2 Justification for Choice of Study Area

The Tamale metropolitan is the largest city in Northern region**.** The Metropolis has the most notable health facilities in the region, these consist of three hospitals, including one teaching hospital, and five health centres serving a population of 374,744. The Tamale Metropolis has a neonatal mortality rate of 13.4% (Abdul-mumin et al., 2021).

3.2. Study Design

The study employed a cross-sectional design. This is a type of observational study design, and in this type of study design the investigator measures the outcome and exposures in the study participants at the same time. The investigator does not influence the variables being studied, and it involves collecting data on one or more variables at one time. The design is often used

in prevalence studies, and as well as in studies that measure associations between two or more variables. Data are collected at a single point in time, therefore cross-sectional studies are relatively cheap and less time-consuming than other types of studies (Axame et al., 2022).

3.4 Study Setting

This is the specific location or environment in which the study is/was carried out**.** This study was facility-based or carried out in health facilities. The facility-based study assisted in identifying the health service delivery strengths of the sampled facilities for the study in the Metropolis (such as number of trained birth personnel, newborn death numbers, births at facility, etc.).

3.5 Study Population

The study population were women who gave birth to singleton babies in the past six (6) to twelve (12) months.

3.5.1 Inclusion Criteria

The study included all mothers who gave birth to singletons at the facility between the ages of six and twelve months, received postnatal and child welfare care services (CWC), had complete health records, and were willing to participate.

3.5.2 Exclusion Criteria

Mothers who gave birth to more than one baby (twins) at facility or outside facility, and those who did not receive CWC services, and those with incomplete medical or health records. Also, women who gave birth at facility, had complete health records, but were not willing to participate.

3.6 Sampling Technique

A two-stage sampling method was used to select the health facilities and the respondents in this study. In the first stage, the health facilities were selected. Two secondary public health facilities (Tamale Central and Tamale West hospitals) were purposively selected because they

provided ANC and delivery services to a significant proportion of reproductive women in the area. In addition to the two secondary-level facilities, three health centres (Datoyili health center, Bilpiela health centre, and Vittin health centre) were selected randomly to make up for the five in the Metropolis. The sample for the study was distributed to the facilities using the proportion-to-size technique.

Using a systematic random sampling technique, the respondents were selected during the second stage of the sampling procedure. The postnatal register was used to compile a list of women who had given birth in the six to twelve months prior to the survey at each of the chosen health facilities. Then a sampling interval was calculated using the sampling frame by dividing the total number of eligible women by the sample size required for the facility. As a starting point, a participant was chosen at random from the first ten names in the sampling frame. The sampling interval was then used to choose respondents until the desired sample size was reached.

3.6.1 Sample Size Determination

The sample size was calculated using the Taro Yamane formula; $n = \frac{N}{(1+Ne^2)}$, Where: n is the sample size required for the study, N is the estimated total population, e is the acceptable margin of error.

This formula is used if the population size is finite and known, thus if there is a limited value or the total population of interest is known. It was used here because the anticipated number of pregnancies for the Metropolis is known, which is 4,292 (Ghana Statistical Service et al., 2015b). Therefore, using a 0.05 margin of error and the anticipated number of pregnancies of 4,292. Approximately 366 people would be the total sample size and with a non-response adjustment of 10%, a total sample size of 402 was be obtained. However, the total sample size used was slightly increased to 411 for this study.

3.7 Study Variables

The study variables are the key variables of the study consisting of the exposure and outcome variables that were measured. These variables are the dependent and independent variables. LBW and PTB were the dependent variables; LBW was defined as birth weight less than 2.5 kilograms and PTB as term at birth or delivery occurring before 36 weeks. The first trimester BMI status, sociodemographic information, and use of ANC services served as the study's independent variables.

3.8 Indicators Assessed in the Study

These are the factors that were assessed or the particular form of information that was taken from the respondents. Information was taken from the participant's ANC book. For example, maternal weight and height as indicators were used in calculating BMI were taken from the book. ANC visits, SP administration were indicators or information taken to assess ANC utilization. Baby's weight, number of weeks at birth were indicators used to assess the outcome variables, thus LBW and PTB.

3.9 Data Collection Instruments

These are the tools used for the collection of data. A structured questionnaire with a set of standardized questions was used to collect data on the variables of interest from participants. Kobo collect application installed on android-powered smartphones was used to electronically collect the data. The tool gathered information on sociodemographic factors like age, educational attainment, occupation, marital status, obstetric history, and maternal and child anthropometric indices like mother's weight and height at birth and the weights of the kid. On the one hand, information from the ANC record book was gathered regarding the woman's height and weight as well as the gestation of her pregnancy at birth.

3.10 Data Collection Procedure

The procedure employed in the data collection was interview of eligible participants. The questions in the various sections were read to participants and responses or answers were retrieved from the ANC and postnatal records of the mother. Questions were translated into Dagbani and other local languages for participants who did not understand English language.

3.10.1 Collection of Primary Data

The questionnaire was used to take primary data, all data were taken from the facilities, retrieved from the ANC book and the child health records book at the facility. These data were already recorded in the book.

3.11 Data Quality Control

Two (2) research assistants received training before going to the field to take the data. They had good level of experience in data collection. The questions were pretested on forty (40) women (10% of the total sample size) from a healthcare facility outside the study setting. The questionnaire's validity in obtaining the necessary data was assessed during the pretesting phase and questions that were unclear were all amended. The completeness of the data collected was also well ensured.

3.12 Limitations of the Study

The limitations of this study cannot be overlooked. The study has faced many limitations, however key among these are; the investigator depended on secondary data which were compiled for routine health care purposes and not for research purposes, and therefore certain precautions observed in research might not have been applied. Another limitation was, since the data was not taken by the researcher, the tools used for the data collection might not have been standardized and as a result, some measurements might not be accurate. Because the study

assessed only two outcome variables, thus LBW and PTB among the many adverse pregnancy outcomes, it might be difficult to be conclusive about relationships.

3.13 Strengths of the Study

The study recorded some strengths and this contributed to the success of the study. These included; the records used largely contained completed information of participants, this helped minimised the amount of missing data. Largely, data were taken by trained health professionals and as a result the right procedures were more likely to be adhered to. The sample size was large enough and data proportioned to selected health facilities were adequate and representative.

3.14 Informed Consent

The purpose of the study was spelled out to the participants, the potential benefits and all other necessary information they needed to know. Confidentiality was guaranteed, and participants were informed that their health would not be in any danger due to this study. Before distributing the questionnaire, the participants' permission was requested, and they were given the opportunity to sign as confirmation. Participants were informed they could stop the process whenever it suited them and skip any questions they might find uninteresting.

3.15 Data Analysis Plan

For cleansing, data was moved from Kobo Collect into Microsoft Excel. The Statistical Package for Social Sciences (SPSS) was used to analyse the data. Tables were utilized as appropriate statistical tools to display frequencies and percentages.

Evaluation of relationships between the independent and dependent variables (LBW, PTB and maternal BMI). Statistical significance was defined as a p-value of 0.05 or lower. For the purpose of examining the connection between BMI, LBW, and PTB, two regression models were used. The bivariate relationship between BMI, LBW, and PTB was looked at in the first

model (Chi-squared tests). In the second model, the relationship between BMI and LBW and PTB was examined after potential confounding effects from sociodemographic and economic factors, obstetric factors, and other health-related variables were taken into consideration.

3.16 Ethical Consideration

The Tamale Metropolitan Health Directorate approved the conduct of the study after ethical clearance was granted by the Ghana Health Service ethics committee with protocol number GHS-ERC 033/11/22. The Metropolitan Director of Health Services granted written authorization with reference ID GHS/MHD/26 dated May 26, 2022 to the facility directors and the leaders of the various postnatal and child welfare clinics to review the participants' medical records.

CHAPTER FOUR

4.0 RESULTS/FINDINGS OF THE STUDY

4.1 Introduction to Results

The results and findings of the study are contained in this chapter. It has a detail description and presentation of all the findings of the study.

4.2 Socio-demographic and economic characteristics of respondents.

The analysis shown in **Table 1** below revealed that majority of the study respondents, 393 representing (95.6%) practiced Islam, and Christianity consisted of 18 participants representing 4.4% of the respondents. Regarding respondents' age, majority of the respondents were young, 288 representing (70.1%) between 18 – 34 years, and the older mothers (36-44years) were 123 representing (29.9%). With respect to occupation, a little above 50% of the respondents were traders and as well as together with all those employed, a total of 306 representing 74.5%. Dagombas were the major ethnic group in the study area, consisting of a significant proportion of 315 which represented (63.7%) of them had no formal education.

The Socio-Demographic Characteristics of the Respondents are Summarized in Table 1.

Table 1: Socio-demographic and economic characteristics of the respondents in the study (n = 411)

Variable	Frequency	Percentage (%)
Age group (years)		
18-24	49	11.9
25-34	239	58.2
At least 35	123	29.9
Highest level of education		
No formal education	262	63.7
Primary	88	21.4
Junior high school	18	4.4
Senior high school	13	3.2
Tertiary	30	7.3
Employment		
Not employed	105	25.5
Employed	306	74.5
Religion		
Christian	18	4.4
Islam	393	95.6
Ethnicity		
Dagbane	315	76.6
Gonja	52	12.7
Mampruli	30	7.
Dagaba	11	2.7
Others	3	1

Source: Field Survey 2022

4.2 Obstetrics and other Health-Related Characteristics of the Respondents

The findings shown in **Table 2** below revealed that majority of the respondents, 192 representing (46.7%) had live deliveries between one and two. Number of respondents with

gravidity between one and two were 192 representing 46.7%. On ANC initiation, majority of the respondents-initiated ANC during the first trimester, thus 363 representing 88.3%, and least 154 respondents made at least eight visits to ANC representing 37.5%. Majority of the respondents (390) had normal deliveries at health facilities representing 94.9%. Anaemia incidents during the second trimester peaked 305 among respondents representing 74.3%. On complications during pregnancy, 218 respondents experienced various complications such as waist pains, swollen feet, bleeding etc which represented 58.4%.

Table 2: Obstetrics and other Health-Related Characteristics of the Respondents

Variable	Frequency	Percentage
BMI category		
Underweight (< 18.5 kg/m^2)	2	0.5
Normal (18.5 – 24.9 kg/m^2)	211	51.3
Overweight (25 –29.9 kg/m^2)	168	40.9
Obese (30 –34 kg/m^2)	30	7.3
Gravidity		
1-2 pregnancies	192	46.7
3-4	148	36.0
>4	71	17.3
Parity Classification		
1-2 deliveries	192	46.7
3-4	148	36.0
>4	71	17.3
Gestation at first ANC		
first trimester	363	88.3
Second trimester		
third trimester	48	11.7
Frequency of ANC contacts		
Less than 8 visits	257	62.5
At least 8 visits	154	37.5
Mode of Delivery		
Caesarean	56	13.6
vaginal delivery	355	86.4
Place of delivery		
Home	21	5.1
Health facility	390	94.9
Anemia during 1st trimester		
Yes	280	68.1
No	123	29.9
Anemia during 2nd trimester		
Yes	305	74.2
No	102	24.8
Anemia during 3rd trimester		
Yes	115	28.0
No	289	70.3
Malaria episode during last pregnancy		
Yes	119	29.0
No	292	71.0
Experienced complications		
Yes	218	53.0
No	193	47.0
SP intake times in pregnancy		
Never	58	14.1
Once	19	4.6
Twice	94	22.9
Three or Four	240	58.4

Source: Field survey 2022.

4.3 Prevalence of LBW and PTB

From the analysis shown in **Table 3** below, the average birth weight and gestational age were 3.1±0.6 kg and 37.7±1.5 weeks respectively. The results also showed that thirty-eight children were born LBW, while eighty were born preterm. The prevalence of PTB and LBW were 19.5 % (CI: 15.6–23.4) and 9.2 % (CI: 6.6–12.4) respectively.

Table 3: Anthropometric; Prevalence of LBW and PTB and BMI Categories.

Characteristics	Frequency (n)	Percentage (%)
Proportion of LBW	38	9.2
Proportion of preterm delivery (< 37 weeks)	80	19.5
BMI classification		
Underweight (<18.5)	2	0.5
Normal (18.5-25	211	51.3
Overweight/obese (BMI > 25.0)	198	48.2

Source: Field survey 2022

4.4. Association Between Maternal Factors and LBW and PTB.

The table 4 and 5 below shows the bivariate analysis that compared maternal factors including age, educational status, employment, anemia, malaria episodes etc with the risk of LBW and PTB respectively. In table 4, sex of baby associated strongly with LBW, P value <0.000, age of mother during pregnancy associated with LBW, P <0.004. ANC frequency during pregnancy also associated with LBW, P<0.010, and gestational age of mother associated strongly with LBW, P<0.00.

Table 4. Association Between LBW and Maternal Factors

Category/variable	Low birthweight		χ^2 (p-value)
	No	**Yes**	
Child level factors			
Sex of baby			
Female	85	20	16.1(<0.000)
Male	288	18	
Maternal factors			
Age group (years)			
Under 25	51	13	11(<0.004)
25-34	208	16	
At least 35	123	9	
Level of education			
None	238	24	6.4(<0.040)
Low (Primary and JHS)	70	36	
High (At least SHS)	30	13	
Employment			
Employed	279	21	5(<0.024)
Unemployed	90	15	
BMI			
Not overweight/obese	184	29	10.1(<0.002)
Overweight/Obese	189	9	

Frequency of ANC			
<8	226	31	6.5(<0.010)
≥ 8	147	7	
Maternal Education			
None	238	24	
Low (Primary/JHS)	92	14	Fischer's Exact Test
High (At least SHS)	30	13	6.4(0.040)
Timing of first ANC			
First trimester	42	6	0.7 (<0.400)
After first trimester	331	32	
Gravidity classification			
1-2	168	24	4.6(<0.090)
3-4	138	10	
>4	67	4	
Parity Classification			
1-2	168	24	4.6(<0.090)
3-4	138	10	
>4	67	4	
Malaria episode during Pregnancy			
Yes	110	9	0.5(<0.452)
No	263	29	
SP intake during Pregnancy			
Yes	318	35	1(<0.248)
	55	3	

No			
Experienced complications			
Yes	204	14	4(<0.036)
No	169	24	
Anaemia in 1st trimester			
Yes	248	32	4.3(<0.038)
No	117	6	
Anaemia in 2nd trimester			
Yes	276	29	0.3(<0.613)
No	94	8	
Anaemia in 3rd trimester			
Yes	103	12	0.2(<0.655)
No	263	26	
Gestational age			
Preterm	13	27	40.7(<0.000)
Term	360	11	

Source: Field Survey 2022

Below is Table 5 showing the bivariate analysis that compared maternal factors with the risk of PTB. Sex of baby associated with PTB, P<0.010, age of mother associated strongly with PTB, P< 0.00. However, educational status of mother associated weakly with PTB, P<0.04, ANC frequency associated strongly with PTB, P<0.00, gravidity and parity associated with PTB, with P<0.001. Complications during pregnancy and employment status also associated with PTB, with P<0.001.

Table 5: Association Between Maternal Factors and PTB

Category/variable	Preterm birth		χ^2 (p-value)
	No	Yes	
Sex of baby			
Female	93	12	8 (<0.010)
Male	294	12	
Maternal factors			
Age group (years)			
Under 25	11	53	18(<0.000)
25-34	10	214	
At least 35	3	120	
Education level			
None	216	46	6.5(<0.040)
Low	77	29	
High	38	5	
Frequency of ANC			
< 8	190	67	
≥8	141	13	19.1(<0.000)
BMI Groups			
Not overweight/obese	147	66	
(BMI ≤25.0)			37.4(<0.001)
Overweight/Obese (BMI >25.0)	184	14	
Timing of first ANC			
First trimester	34	14	
After first trimester	297	66	3.3(<0.070)
Gravidity			
1-2	128	64	
3-4	137	11	44.3(<0.001)
Parity			
1-2	128	64	44.3(<0.001)

3-4	137	11	
Malaria episode during Pregnancy			
Yes	115	4	
No	272	20	1.9(<0.171)
SP intake during Pregnancy			
Yes	331	22	
No	56	2	0.7(<0.402)
Experienced complications			
Yes	213	5	10.6(<0.001)
No	174	19	
Anaemia in 1st trimester			
Yes	263	17	
No	118	5	0.7(<0.414)
Anaemia in 2nd trimester			
Yes	284	21	
No	100	2	3.5(<0.062)
Anaemia in 3rd trimester			
Yes	105	10	
No	276	13	2.7(<0.100)
Employment			
Employed	290	10	
Unemployed	92	13	11.9(<0.001)

Source: Field Survey 2022

4.5 Association Between BMI and Adverse Pregnancy Outcomes

Body Mass Index and Low Birth Weight

Examining the connection between BMI and low birthweight involved using two regression models. The bivariate relationship between low birthweight and BMI was investigated in the first model. The second model evaluated the relationship between BMI and low birthweight while accounting for possible confounding effects of sociodemographic and economic factors, obstetric factors, and other health-related factors.

The characteristics of LBW factors in logistic regression analysis were ANC visits less than 8, BMI less than 25.0, and sex of the baby. Adjusted odds ratio (AOR) = 2.78 (95% Cl: 1.24 - 6.25, p = 0.01); women who were neither overweight or obese in early pregnancy had a 2.8-fold higher chance of giving birth to LBW children. Compared to women who attended ANC at least 8 times, those who attended ANC for fewer than 8 visits were 2.6 times more likely to birth LBW babies. AOR = 2.62, 95% Cl: 1.09 - 6.30, and p = 0.03 Compared to male babies, female babies had a 4.4 times higher likelihood of being born LBW (AOR = 4.36, 95% CI: 2.08 - 9.15, p = 0.001). When compared to those ages, young women between 18 and 34 were 3.2 times more likely to deliver LBW children.

Table 6: Association between Body Mass Index and Low Birth Weight.

Variable	AOR (95% CI)	P value
BMI Groups		
Not Overweight/obese	2.83(1.27, 6.33)	<0.011
Overweight/obese	Reference	Reference
Age group		
18-24	3.22(1.30, 8.04)	0.012
25-34	0.97(0.41, 2.28)	0.952
At least 35	Reference	Reference
ANC Frequency		
≥ 8	Reference	Reference
<8	2.62(1.09, 6.30)	0.030
Sex		
Male	Reference	Reference
Female	4.36(2.08, 9.15)	<0.001

Source: Field Survey 2022

4.6 Body Mass Index and Preterm Birth.

A mother who was neither overweight or obese in the first trimester of pregnancy was a major risk factor for having a preterm delivery, according to logistic regression analysis, which looked at the features of factors of preterm birth. AOR = 5.40, 95% Cl: 2.67–10.91, p 0.0001. Preterm births were 5.1 times more likely to occur in women who attended ANC less than 8 visits compared to those who did so at least 8 times; AOR = 5.06, (95% Cl: 2.36 - 10.87), p 0.001. AOR = 14.53 (95% Cl: 4.28 - 49.30), p 0.001 shows that preterm births were 14.5 times more likely to occur in women under 25 than in those over 35. Preterm birth was 3.93 times more likely to occur in women with low education compared to those with at least.

Table 7 explored the association between BMI and preterm delivery while adjusting for potential confounding.

Table 7: Association between Body Mass Index and Preterm Birth

Variable	AOR (95% CI)	P value
BMI Groups		
Overweight/obese (BMI>25.0)	Reference	
		<0.001
Not Overweight/Obese (BMI ≤25.0)	5.40(2.67,10.91)	
Age group		
18-24	14.53(4.28, 49.30)	<0.001
25-34	5.57(1.94, 15.97)	
At least 35	Reference	Reference
ANC Frequency		
≥ 8	Reference	Reference
<8	5.06(2.36, 10.87)	<0.001
Educational level		
High (At least SHS)	Reference	Reference
		<0.001

None		<0.230
Low	2.02(0.64, 6.38)	<0.030
	3.93 (1.19, 13.00)	
Timing of ANC		
First trimester		<0.001
After first trimester	5.56(2.37, 13.05)	Reference
	Reference	

Source: Field survey 2022

CHAPTER FIVE

DISCUSSION OF FINDINGS

5.0. Introduction

The findings of the study are discussed in this chapter. The discussion aims to interpret and describe the meaning of findings and its implication for Maternal Body Mass Index in early Pregnancy and the risk of Adverse Pregnancy Outcomes.

5.1. Body Mass Index.

The majority of research participants, 211 representing 51.3% in this study had a normal BMI (between 18.5kgm2 and 24.9kgm2) during their most recent pregnancy. It can be seen that the BMI status of pregnant women in emerging countries is rapidly shifting towards a high BMI status. This may seem unusual given that industrialized nations are known to have issues with high BMI. A study (Doi et al., 2020) displayed the growing global epidemic of obesity and overweight as a problem affecting more than just developed nations. As a result, there are now more pregnant women with high BMIs than there used to be.

It is estimated that 54% of pregnant women in underdeveloped nations like Iran have a lower BMI (Ng et al., 2014). However, in the USA, 2% of pregnant women have a BMI under 18.5 and more than 50% have a BMI over 25 (Gortmaker et al., 2011). This demonstrates that the BMI status of expectant women in poor nations has begun to resemble that of expectant women in affluent countries. Although there may be differences in BMI across populations, it is evident from this study that there are undoubtedly other factors driving this rapid drift than what was previously thought to be population-level differences. This is consistent with many reports on BMI that have found that BMI varies across populations.

About 49% of the study participants had pre-pregnancy BMI greater than or equal to 25, which is a changing trend in Ghana, specifically Tamale, which is located in the Northern part of the country where there are many health disparities compared to the southern part. This might imply that pregnant women's lower BMI status that was once associated with developing countries has significantly changed. A study (Abubakari et al., 2015b) has reported on the evidence that is currently available regarding maternal BMI in Ghana, stating that, like other developing nations, Ghana is going through a nutrition transition where undernutrition and overnutrition are present in mothers. This transition is caused by a number of factors, including urbanization, diet, reduced exercise or commuting to work. This data supports the trend in the Tamale Metropolis toward higher BMI status for women. In this study, the prevalence of overweight and obesity was 40.9% and 7.3%, respectively. These percentages compare to the data in (Abubakari et al., 2015b) similar trends are seen in overweight and obesity, however in this study, more women are moving toward an overweight state. According to the research, there were 26% and 14%, 14% and 4.2%, and 31,3% and 37.1% of childbearing women in Ghana who were overweight or obese, respectively.

In contrast to the Southern portion of Ghana, a lower BMI is nearly always seen in the Northern section of Ghana, particularly in its rural areas. However, there are not much differences in this pattern between the Metropolitan Northern and Southern parts. More specifically, in order to support the evolving trend of childbearing women in Northern Ghana having high BMI status, particularly at the research location. According to (Abubakari et al., 2015b), the prevalence of underweight was found to be 3.82%, normal to be 57.76%, overweight to be 25.06%, and obesity to be 13.37% in two districts (Tamale Metropolis and Savelugu-Nanton) based on a facility-based cross-sectional survey. In light of the accuracy of the evidence being established regarding the BMI status in Northern Ghana, this study is another extension of that body of evidence. As observed from this study, there is a changing shift of BMI among women in the

Northern region towards a high BMI status and this indicates that more women are likely to go into pregnancy with normal, overweight or obese BMI than it used to be recorded. This will obviously have implications on the outcomes of pregnancies, and more likely if similar trends would be recorded as with this study, then BMI will have protective effect against adverse pregnancy outcomes among women in the Northern Region.

5.2. Prevalence of Low Birth Weight and Preterm Birth

The prevalence of LBW and PTB in this study were 9.2% representing 38 babies and 19.5% representing 80 babies respectively. The study (Abubakari et al., 2015a) which took place in this research area, the mean birth weight in the Northern Region was 2.98 +/- 0.68 kg, which showed that the majority of infants had normal birth weights (62.69%) and 26.01% had LBW. The average birth weight in this study was 3.10.6 kg, which indicates that a higher percentage of infants (88%) had normal birth weights.

The lower prevalence of LBW observed in this study may be attributable to the fact that respondents with high BMI have less of an impact on both LBW and PTB. An investigation validated this conclusion which explained that the effect of high BMI on adverse pregnancy outcomes is not consistent across studies, some studies have found protective effect and other studies found negative effects (Doi et al., 2020).

Respondents with low BMI, those who were not overweight/obese in their pregnancy period were 2.8 times more at risk of LBW AOR = 2.78 (95 % Cl: 1.24 - 6.25), p = 0.010. This finding is similar to the finding of a recent study (Axame et al., 2022) in Volta region, Ghana.

The retrospective cohort study (Axame et al., 2022) in Ho in the Volta region of Ghana discovered a prevalence of LBW and PTB of 12.9% and 14.1% among 680 newborns. In this investigation, PTB prevalence was 19.5%, which is slightly higher than the findings from the retrospective cohort study in Ho, and LBW was much lower. The variations could be mostly

attributable to study designs, sample sizes, and geographic locations. The rates noted in these investigations are, however, generally comparable.

The implications of LBW and PTB on the infant is negative, thus adverse consequences on the life of the infant. Studies have shown that apart from short-term consequences of LBW, such as high infant mortality and childhood growth failure among survivors, it has a long-term risk in the form of high prevalence of adult coronary heart diseases and type 2 diabetes (Dahlui et al., 2016). Preterm birth is the main cause of death, morbidity and disability among infants. The shorter the gestation, the smaller the baby and the higher the risk of death, morbidity and disability. It has been suggested and proved that the mortality range can vary about 100-fold across the spectrum of birth weights and the mortality rises continuously with decreasing weight of the infant (Doi et al., 2020).

5.3. Association Between Body Mass Index and Adverse Pregnancy Outcomes.

The study (Doi et al., 2020) found that women who were overweight and obese had a higher risk of having an unfavorable pregnancy and delivery outcome, and that these conditions get worse with rising BMI. Pregnancy complications as swollen feet, headaches, and waist pains were more commonly related with higher BMI women (overweight and obese) in this current study when compared to the normal BMI group ($p = 0.000$). Pregnancy difficulties are more frequently caused by experiences with these issues throughout pregnancy (Lavie et al., 2014) which carry a high risk of undesirable pregnancy outcomes. However, the study's conclusions about the association between higher BMI categories and undesirable pregnancy outcomes, such as LBW and premature delivery, are in conflict with those findings (Doi et al., 2020), while underweight and normal BMI women had a higher risk for poor birth outcomes, such as preterm birth and low birth weight (LBW), despite the fact that issues during pregnancy substantially correlated with BMI, particularly with an upward trend in higher BMI categories.

Given that the study was conducted at healthcare facilities and the majority of the participants sought out ANC services there, one explanation for this finding could be that the problems faced by the women throughout pregnancy were better handled by medical personnel.

Because managing one's weight during pregnancy and one's BMI prior to becoming pregnant may have an impact on the health of the unborn child, overweight and obesity are issues of public health concern. Given the higher risk that excess weight carries for adverse birth outcomes and the fact that higher pre-pregnancy BMI groups are more likely to gain excess weight in pregnancy, the American Institute of Medicine's weight gain recommendations for overweight and obese women during pregnancy most likely provided a lower range of weight gain for higher BMI women than for underweight and normal pre-pregnancy BMI women. (Vivian Ukah et al., 2019). However, in this study higher BMI groups were less likely of delivering preterm and having LBW babies as compared to mothers who were not overweight nor obese. This can be explained in the light of the findings from the study (Abubakari et al., 2015b) in the Northern region which found inadequate weight gain among women in the Northern region. As a result, women with an overweight or obese BMI in the early stages of pregnancy tend to be better protected from the impact of weight on unfavorable birth outcomes since they could not put on enough weight to increase their risk of such inclinations. Furthermore, the study's results (Mamun et al., 2011) regardless of pre-pregnancy BMI, excess weight gain in pregnancy was linked to an increased risk for adverse obstetric and neonatal outcomes, such as large-for-gestational-age infants and caesarean delivery, according to research based on the Danish National Birth cohort (a very large sample of about 61,000 mothers and their infants).

According to the study, obstetric outcomes will be impacted by the rising prevalence of obesity in women of reproductive age. (Van Der Linden et al., 2016). Higher BMI is linked to

pregnancy problems, worse birth outcomes, and longer postpartum periods for both the mother and the infant, according to studies done in industrialized countries. Even in affluent nations, not all research had discovered a relationship, therefore it is impossible to draw any conclusions or make any generalizations because many other factors besides BMI have an impact on undesirable birth outcomes. The results of this study contradict the evidence for increased BMI; nevertheless, it is likely that these findings could be explained by superior healthcare facilities available during pregnancy, particularly the ability to detect and treat pregnancy-related difficulties and issues at an early enough stage (Mohammed et al., 2019).

According to (Van Der Linden et al., 2016), there are not many research on the effect of a mother's weight on maternity and newborn outcomes in poor nations, and those that do tend to be cross-sectional in nature. According to research from South Africa and Sudan, having a high body mass index during pregnancy increases the likelihood of having a cesarean section and developing gestational diabetes mellitus, both of which have negative effects on the health of the baby. However, different studies in the same context or region may produce different results depending on the study design, sample size, and time of the study as well as by virtue of the same reasons which underlie all of the studies. These studies have provided some insight into the likely impact or relationship between BMI and unfavorable pregnancy outcomes in developing countries.

In the prospective cohort study (Van Der Linden et al., 2016) done in Accra, Ghana, women with higher BMIs who are overweight are two times more likely to have cesarean sections than those who are underweight, and those who are obese are two times more likely to have cesarean sections as well as more than six times the likelihood of developing pregnancy-induced hypertension and chronic hypertension. However, when it came to child outcomes, there was no correlation between having a high BMI and the chance of miscarriage, stillbirth, or neonatal

mortality. Instead, high birth weights above normal were noted (macrosomic). The relationship between BMI and the risk of miscarriage, stillbirth, and neonatal death was not significant and tended to decline as BMI increased, subtly suggesting that high BMI is protective against undesirable birth outcomes, which is in contrast to the results of other studies in high-income countries that showed the likelihood of these events being more likely in women with higher BMI (Aune et al., 2014). The results of this study, however, provided a distinct interpretation of the association between BMI and obstetric outcomes in Ghana's Northern area. Greater BMI may protect against poor pregnancy outcomes since higher BMI cannot be solely to blame for poor pregnancy outcomes.

In a study (Tamirat et al., 2021), in the first few weeks of life, unfavorable birth outcomes caused more than 75% of baby fatalities. In Sub-Saharan Africa, low birth weight and preterm deliveries were the most prevalent unfavorable birth outcomes, which are reported to be linked to a number of short- and long-term issues. The study's findings made it evident that increasing antenatal care follow-ups and women's socioeconomic conditions are important, and that multiple pregnancies, enhancing access to healthcare in remote regions, and women's participation in healthcare decision-making should receive special focus. Most of the recommendations offered as well as the study's conclusions are considered as being related to this (Nagahawatte & Goldenberg, 2008) which is preventing most people in the SSA to access good nutrition and maintain healthy weights before and during pregnancy.

A facility-based cross sectional study (Abubakari et al., 2015b) maternal determinants of birth weight conducted in the Northern region indicated that the participants (mothers) were typically well-nourished before pregnancy; those who were underweight were 3.82 percent, normal weight was 57.76 percent, overweight was 25.06%, and obesity was 13.37%. However, almost half of them (49.6%) were unable to put on enough weight in accordance with Institute

of Medicine guidelines. Newborns with overweight mothers were 431g heavier than infants with normal weight mothers, and infants with underweight mothers were 479g lighter. Infants of fat and overweight moms were around 595g heavier than those of normal mothers. This showed that kids born to obese and overweight moms were substantially heavier than those born to BMI groups. The observed average birth weight was 2.98 ±0.68 kg indicating that most newborns in the northern part of the study had normal birth weights. However, the study was unable to determine whether any of the infants were preterm births or which BMI categories were more likely to have preterm delivery.

However, the study (Abubakari et al., 2015b) which was determining the factors that contributed to LBW discovered that pre-pregnancy BMI, gestational weight gain, newborn sex, and the mother's location (rural/urban) were the factors that contributed most significantly to the study's findings. The most significant predictors of birth weight were found to be pre-pregnancy BMI and weight growth throughout pregnancy. In Sub-Saharan African nations and other developing nations, antenatal clinic counseling on appropriate weight gain in pregnancy and ideal nutrition for women or mothers before becoming pregnant are frequently disregarded, resulting in mothers or women entering pregnancy unprepared with a favorable BMI. Being overweight during pregnancy is a risk factor that can be altered for better pregnancy outcomes. This can be done by emphasizing counseling and encouraging pregnant women to stay within the advised levels. This is particularly significant because the study discovered that inadequate weight increase during pregnancy is linked to a high risk of low birth weight and that excessive weight gain during pregnancy is linked to greater birth weight kids, which is also a risk. According to the study, a sizable portion of pregnant women were over-nourished, which is a glaring indication of the double burden of malnutrition that developing and transition nations are currently bearing.

5.3.1. Low Birth Weight and Body Mass Index

In this study, the majority of individuals (51.3%) had a normal BMI when pregnant. According to the results of the multivariate logistic regression analysis, respondents who were not overweight or obese had a 2.8-fold higher chance of giving birth to infants who were underweight (AOR = 2.78; 95% CI: 1.24–6.25). Participants who were normal or underweight in early pregnancy and weren't overweight or obese had a higher risk of giving birth to LBW than those who were. This discovery contradicts the evidence of (Ng et al., 2014) which discovered that maternal obesity during pregnancy raises the risk of difficulties leading to poor delivery outcomes, like LBW, miscarriages, caesarean births, etc. About the impact of high BMI on unfavorable birth outcomes, numerous other studies have reached similar conclusions. A prospective cohort study (Van Der Linden et al., 2016) Women who are overweight and obese in Ghana are more likely to experience negative delivery outcomes, such as pregnancy-induced hypertension and caesarean sections. The study looked at data from 1000 women and discovered that those who were obese had a two-fold elevated risk for caesarean sections and a risk of pregnancy-induced hypertension that was more than six (6 times) higher. For women with higher BMIs, this study found different results, which had a more favorable impact on negative consequences. These discrepancies in the findings of the association between high BMI and poor birth outcomes in Ghana may be due to regional variances, study methods, and sample sizes (Doi et al., 2020)

A cross-sectional facility-based investigation in the North (Abubakari et al., 2015b) discovered that maternal BMI prior to conception or during the first trimester of pregnancy, as well as weight gain throughout pregnancy, affect newborn birth weight. According to the study, the United States Institute of Medicine suggested healthy weight growth during pregnancy, and women who gained weight outside of or below these ranges ran the risk of having kids who

were either too heavy or too light due to their pregnancies. In the study, it was discovered that 50% of the women were unable to gain the recommended amount of weight (Low weight growth 49.64%). This most likely explains why, compared to women who were underweight and had a normal BMI during pregnancy, the overweight and obese women in this study rather posed a protective impact for LBW.

However, it can be explained or related to the fact that women who were underweight or had a normal BMI before pregnancy or entering pregnancy were unable to gain the recommended weight in accordance with the United States Institute of Medicine recommendations of weight gain during the pregnancy period. As a result, those who were overweight or obese before pregnancy did not also gain any more significant weight to put them at the worst case scenario of risk and instead were protected from harm (Abdollahian, 2013). Those underweight and normal were at more risk for LBW.

According to estimates, 54% of pregnant women in underdeveloped nations like Iran have a BMI that is lower than the Institute of Medicine's recommended range or experience a lesser gestational weight gain than pregnant women in industrialized nations (Ng et al., 2014). However, in the USA, for instance, more than 50% of pregnant women have a BMI above 25, and more than 2% have a BMI below 18.5 (Gortmaker et al., 2011). As a result, this demonstrates how BMI varies amongst populations. But in developing nations like Ghana, where the BMI status of women or pregnant women is shifting from a lower status to a higher status, and such status instead serves as a protective effect on undesirable birth outcomes, the new shift of this phenomena has begun to take shape. The (Doi et al., 2020), however, this evidence has been found to be incongruent with the results of this study, so the effect of underweight and higher BMI on adverse birth outcomes such as low birth weight does not apply to this study. There are a number of potential explanations for this finding, but one of the

most important may be the provision of better healthcare services to pregnant women, such as timely and appropriate complications management during pregnancy.

Although the study's results did not reach statistical significance, underweight BMI is linked to some degree of risk for poor delivery outcomes (Ng et al., 2014), yet what was clear from the study was that maternal obesity and overweight were linked to greater fetal growth (macrosomia). The study concluded that both BMI extremes are linked to poor pregnancy outcomes. The findings of this study, however, revealed that women who were neither overweight or obese were 2.8 and 5 times greater at risk of LBW and PTB, respectively. a piece of evidence that refutes the findings mentioned above. demonstrating that other elements, such as environment, access to care, and so on, may enhance or have an impact on how well BMI predicts pregnancy outcomes (Abdollahian, 2013).

It is known that pregnancy weight growth affects the likelihood that LBW babies will be born. The Institute of Medicine suggested appropriate weight increase levels for pregnant women in 1990 and 2000; weight growth that fell within or exceeded these ranges could have negative effects. Weight gain between 12.5kg and 18kg is advised for pregnancies with underweight BMIs, 11.5kg to 16kg for pregnancies with normal BMIs, 7.0kg to 11.5kg for pregnancies with overweight, and 5.0kg to 9.0kg for pregnancies with obese BMIs. In underdeveloped nations where expectant mothers seldom ever gain enough weight (Abubakari et al., 2015b), since weight gain during pregnancy does not only apply to studies conducted, especially in this study, where most of the participants do not experience appreciable weight gain during the pregnancy period, the guidelines or recommendations for weight gain cannot be used as a standard for women in developing countries, especially in the Northern region.

5.3.2. Preterm Birth and Body Mass Index.

The bivariate analysis of maternal BMI revealed a significant (p = 0.001) association between BMI status and the likelihood of preterm births. According to the results of the multivariate logistic regression analysis, there is a five-fold greater risk of preterm delivery if a woman is not overweight or obese during the first trimester of pregnancy (AOR = 5.40, 95% CI: 2.67 - 10.91), p = 0.01).

This result went against past research showing that being overweight or obese during pregnancy increased the risk of having a baby too soon (Pandolfo et al., 2014). Preterm birth risk was seen to rise in populations with high BMI levels (overweight and obese). Throughout the study, the risk (Pandolfo et al., 2014) were BMI 25 to < 30 (0.21%; OR, 1.26; 95% CI, 1.15-1.37), BMI 30 to <35 (0.27%; OR, 1.58; 95% CI, 1.39-1.79) as compared to normal BMI. The evidence of another contradictory study (Pigatti Silva et al., 2019) in Brazil, according to a secondary analysis of a multicenter cross-sectional study involving 20 sites, being underweight prior to conception was linked to a decreased risk of PTB, whereas being overweight and obese was linked to a higher risk. All of these researches have conclusively shown that higher BMI groups are more likely than normal BMI groups to experience negative birth outcomes.

The evidence of the study (Tamirat et al., 2021), south Asia and sub-Saharan Africa are thought to account for more than 60% of premature births. While other studies had found lower risk of PTB in higher BMI groups and suggested reasons for the discrepancies, which have related to factors due to small sample size, study design, regional variation, or country income categories, this was discovered to be associated with higher maternal BMI groups. However, the finding was not consistent across studies because other studies had found lower risk of PTB in higher BMI groups (Doi et al., 2020). The results of this study can be connected to some of these

variables since participants with higher BMIs were discovered to be more protective of LBW and PTB than participants who were not overweight or obese. Preterm birth is at risk due to pregnancy issues or disorders, which are frequently linked to higher BMI categories (Doi et al., 2020), due to the fact that these difficulties, if poorly managed, almost usually result in medical disorders during pregnancy and premature births. One of the most common medical reasons for premature birth, for instance, is severe hypertensive disorders during pregnancy, which are common in obese women. Similar to that, this study discovered that certain pregnancy-related issues, such as waist pains, headaches, swollen feet, dizziness, etc., which in some cases are likely to result in complications, were more associated with certain BMI groups (p value = 0.00) and that there was a trend toward an increase among higher BMI groups. The higher BMI groups were individuals who were at lower risk of PTB, therefore these ailments or issues had no bearing on them.

Pregnant women who are underweight have a higher risk of PTB and giving birth to infants who are too tiny for gestational age (Pandolfo et al., 2014). Women who did not gain enough weight could develop issues like anemia, premature birth, low birth weight, and tiny for gestational age. (Tsegaye & Kassa, 2018). While preeclampsia, gestational diabetes, and the necessity for caesarean sections are more likely to occur in women who have gained too much weight (Mamun et al., 2011). The findings of this study shifted priority to pre-pregnancy BMI since it was connected with PTB, in stark contrast to the studies that give weight gain during pregnancy such significant consideration.

There is mounting evidence that PTB incidence and development are complicated processes impacted by a wide range of environmental and genetic factors (Blencowe et al., 2012). Although such evidence is reliable, it may also serve to direct strategies for reducing newborn morbidity and mortality due to PTB. However, research that focused more on the influence of

the mother's pre-pregnancy body mass index (BMI) on PTB (Doi et al., 2020) (Shaw & Shaw, 2014) are essential to take into account given that the prevalence of obesity and overweight among women in developing nations has been rising at an alarming rate in recent decades. In addition, epidemiological studies have demonstrated a link between PTB and unfavorable maternal health outcomes such prenatal hypertension and cesarean delivery in overweight and obese mothers (Van Der Linden et al., 2016).

5.4. Other factors associated with adverse birth outcomes.

In this study, the ANC contacts less than eight times, the baby's sex, the young age of the mother, her poor level of education, and the prompt commencement of ANC were also risk factors for unfavorable delivery outcomes. According to the results of the multivariate logistic regression analysis, respondents who had fewer than eight ANC contacts were 5 times and 2.6 times more likely to develop PTB and have LBW children, respectively. The AORs for these risks were 5.06 (95%CI: 2.36 - 10.87, p =0.001) and 2.62 (95%CI: 1.09 - 6.30, p =0.030). In order to improve pregnancy outcomes, the WHO suggested four or more visits to ANC prior to delivery. Research conducted in Sub-Saharan Africa (Tamirat et al., 2021; Tsegaye & Kassa, 2018) discovered that compared to women who just made fewer visits, those who had antenatal care appointments for their most recent pregnancies had a lower chance of negative delivery outcomes, like LBW. In addition to identifying complications and at-risk pregnancies for early interventions like nutrition counseling and the supplementation of foods fortified with nutrients, antenatal care visits also assist medical professionals in identifying diseases like intestinal helminthiasis, syphilis, malaria, and HIV/AIDS. This enhances fetal and pregnancy outcomes.

Under SDG 3, Universal Health Coverage (UHC) closes a variety of healthcare delivery gaps. Although over 60% of deliveries in Sub-Saharan Africa take place in hospitals, these births are

extremely likely to be safe for both the mother and the baby, helping to avoid neonatal and maternal death (Yaya et al., 2018). Non-institutionalized births can occasionally happen among rural women who did not attend ANC; the distance from a health facility also has an impact on this; and more experienced women with higher parities are more likely to give birth outside of hospitals. The study (Yaya et al., 2018) identified differences in the use of maternal health services according to the demographic, social, economic, and local characteristics. It is well known that the SDGs encourage the lowering of inequalities and provide universal access to health. Given the foregoing, it is necessary to take into consideration other strategies in addition to maternal health care use in order to reach the most underprivileged and vulnerable groups of women in order to meet the established objectives. AOR = 4.36, (95% Cl: 2.08 - 9.15, p = 0.001) indicates that female babies had a 4.4-fold increased risk of being born low-birth weight compared to their male counterparts. This finding is consistent with findings from a previous study (Ezugwu et al., 2010) undertaken in Nigeria that discovered a gender difference between men and women in terms of LBW, albeit it was not statistically significant (p=0.005). Timely beginning of ANC in the first trimester; hence, mothers who started ANC in the first trimester were shown to have a 5.6-fold higher risk of giving birth preterm than those who started after the first trimester, AOR=5.56 (95%CI: 2.37 - 13.05, p = 0.001). The WHO protocol, which suggested early ANC initiation, is in conflict with this finding. This study's result might be explained by the fact that respondents who began ANC in the first trimester were compelled to seek ANC services early in their pregnancies due to issues or complications such waist pains, bleeding, swollen feet, etc. The bivariate analysis revealed that pregnancy problems were linked to both LBW and preterm birth (p=0.001 and p=0.036, respectively).

Preterm birth was 14.5 times more common among participants under the age of 25 compared to older women over the age of 35; (AOR = 14.53, 95% Cl: 4.28 - 49.30, p = 0.001). This result

runs counter to the data showing that older maternal age considerably increases the likelihood of an unfavorable pregnancy outcome (Van Der Linden et al., 2016). Adolescent mothers had a higher risk of a poor pregnancy outcome when maternal age was taken into account among different subtypes of adolescents (Tamirat et al., 2021)). This may be explained by the fact that most adolescent pregnancies carry a risk of immature physiologic processes and inexperience, both of which have a higher propensity for unfavorable pregnancy outcomes. Inferior pregnancy and newborn outcomes are possible as a result of immature reproductive organs' potential for major conception complications and other issues.

Although not statistically significant (p=0.230) showed that persons with no education were twice as likely to have PTB as those with at least SHS level education (p=0.030). Those with poor education had a more than threefold increased risk of premature births compared to those with at least SHS education (Van Der Linden et al., 2016), a negative pregnancy outcome was found to be strongly related with poor or no formal education in this study. Mothers with primary education were 1.6 times more likely to experience a negative pregnancy outcome than those with higher education, while mothers without any education were over three times more likely. Possible explanations include the possibility that mothers with less education may find it difficult to understand and follow the health service's advised practices for better pregnancy outcomes. SDG 3's Universal Health Coverage (UHC) aims to close various healthcare delivery gaps. Although a hospital delivery is very likely to provide a secure environment for both the mother and the baby, as well as helping to reduce neonatal and maternal mortality, only approximately 60% of births in (Yaya et al., 2018). Non-institutionalized births can occasionally happen among rural women who did not attend ANC; the distance from a health facility also has an impact on this; and more experienced women with higher parities are more likely to give birth outside of hospitals. The study (Yaya et al., 2018), women with lower

educational levels, limited access to media (such as newspapers, radio, and television), low socioeconomic status, and rural residents, among other factors, were shown to be less likely to use maternal health care services. This showed that a particular class of persons received a disproportionate amount of maternity healthcare services. The discrepancy in access and use due to a number of variables, such as illiteracy, have remained persistently high despite attempts to increase the coverage of maternal and child health care services in Sub-Saharan Africa.

Additionally, better socioeconomic characteristics, such as a higher level of education and a wealthy economic index, have a favorable effect on undesirable birth outcomes. Some of the reasons for this are that they encourage maternal nutrition and health seeking behaviors as well as improve knowledge of pregnancy danger signs and the timing of the start of antenatal care (Tamirat et al., 2021). Furthermore, it describes how people would be able to see the advantages of engaging in actions that promote health and would do their best to adopt these behaviors. What matters most is their capacity to get the right diet, health information, and care throughout their pregnancy and/or life. Gravidity and parity were covariates that predicted PTB in the bivariate study, while job status predicted both PTB and LBW. This study's association between gravidity and PTB (P = 0.001). This conclusion may be explained by the fact that primigravidae, or first-time moms, are more sensitive or vulnerable to malaria during pregnancy due to a combination of a wide variety of host and parasite variables (Blencowe et al., 2012). Pregnancy-related malaria (PM), also known as placental malaria, causes the placenta to become infected and is a risk factor for placental damage and insufficiency. The main reason for LBW is said to be this (Blencowe et al., 2012). Preterm births are the primary cause of LBW deliveries, hence decreasing preterm birth rates tends to result in decreasing LBW deliveries and vice versa (Pandolfo et al., 2014). The number of live deliveries a woman

had raised her risk for preterm birth, and parity is adversely associated with preterm birth (p = 0.001). However, it was shown that parity, or the number of children a mother has given birth to, is linked to a lower risk of preterm birth (Lin et al., 2021). Thus, the more live deliveries a woman had, it reduced her risk for preterm birth. However, the difference in findings observed with this study (Lin et al., 2021) is that, it compared results of parity and risk of preterm birth among maternal age groups.

The chance of a mother having both a preterm birth and an LBW infant was similarly influenced by her employment level, leading to p values below 0.001 and 0.024, respectively. This could be explained in terms of family income or the mother's income. Unemployment forces the situation for a low standard of living and makes it difficult to afford better healthcare and better nutrition because it makes it difficult to have the money necessary to meet these needs without a good paying job. The research (Van Der Linden et al., 2016) discovered that one of the major predictors with a strong correlation to unfavorable pregnancy outcomes was household income.

The chapter's discussion of the study's findings concluded with an emphasis on the prevalence of LBW and PTB, which were 9.2% and 19.5%, respectively. It examined the participants' various BMI ranges, proportional differences among and between groups, and relationships to the main outcome variables, PTB and LBW. In particular, LBW and PTB were suggested as additional variables linked to poor delivery outcomes.

CHAPTER SIX

CONCLUSION AND RECOMMEDATIONS

6.0. Introduction

The study is concluded in this chapter by summarizing its important findings and providing recommendations based on them.

6.1. Key findings

1. The prevalence of PTB and LBW are 19.5 % (CI: 15.6–23.4) and 9.2 % (CI: 6.6–12.4) respectively.
2. Mothers who were not overweight/obese in early pregnancy were 2.8 times and 5.4 times more likely of delivering LBW babies and having PTB respectively, (AOR = 2.78, 95 % Cl: 1.24 - 6.25, p = 0.01), (AOR = 5.40, 95 % Cl: 2.67 - 10.91, p < 0. 001).
3. Mothers who attended ANC less than 8 visits were 2.6 times and 5 times more likely of delivering LBW baby and having PTB respectively, (AOR = 2.62, 95 % Cl: 1.09 - 6.30, p = 0.03), (AOR = 5.06, 95 % Cl: 2.36 - 10.87, p < 0.001).
4. Female babies were 4.4 times more likely to be born LBW as compared to male babies (AOR = 4.36, 95 % Cl: 2.08 - 9.15, p <0.001).
5. Young mothers under 25 years were 3.2 and 14.5 times more likely of delivering LBW babies and having PTB respectively as compared to those ages 35 and above (AOR=3.22, 95% CI: 1.30 - 8.04, p=0.012), (AOR = 14.53, 95 % Cl: 4.28 - 49.30, p < 0.001)
6. Women with low education were 3.9 times at more risk of PTB as compared to those having at least SHS level, AOR =3.93, p = 0.03.

6.2 Conclusions and Recommendations

Low prevalence of LBW and PTB is linked to high maternal BMI in the early stages of pregnancy. Reduced LBW and PTB are related to increased ANC frequency and older mother age. Both poor education and being a woman independently predicted PTB and LBW. PTB was independently predicted by both high parity and gravidity.

The succeeding recommendations are given in light of the study's findings:

1. To help and support women of reproductive age in understanding the significance of the relationship that exists between their diet or health condition and the outcome of their pregnancies, the health staff should increase awareness and launch effective sensitization efforts in communities.
2. Pregnant women should be strongly encouraged to use antenatal care services, and a high number of visits at least eight visits should be promoted prior to birth.
3. Appropriate stakeholders should pay more attention to policies and programs that prioritize the education of girls through awareness-raising efforts as well as by identifying and engaging communities that are resource-challenged so that programs that aim to reduce poverty will be directed to underprivileged communities.
4. The District Health Management Team (DHMT) should periodically target family heads, decision-makers in families, and opinion leaders in communities to raise awareness of the need of pregnant women seeking and receiving adequate and consistent ANC care from the time of conception until delivery.
5. Records should be monitored and cases that report with poor nutritional status at facility should be identified, tracked and attended to for improvement before delivery
6. Educate young girls to delay first pregnancy.

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APPENDIX A: STUDY QUESTIONNAIRE

MATERNAL BODY MASS INDEX IN EARLY PREGNANCY AND THE RISK OF ADVERSE PREGNANCY OUTCOMES

INFORMED CONSENT

Good morning/afternoon/evening. I am a final year student of the University for Development Studies. I am conducting a study on the topic "Maternal Body Mass Index in Early Pregnancy and the Risk of Adverse Pregnancy Outcomes". I would like to have an interview with you on the topic and would very much appreciate your participation in this study. You and your child have been selected to be part of the study to respond to a questionnaire which will take about 30 minutes to of your time. All of the answers you will give will be confidential and will not be seen by anyone. If I should come to any question you don't want to answer, just let me know and I will go on to the next question.

Your participation in the study is purely voluntary and so you are at liberty to opt out. We would however be grateful if you agree to participate since your views are important. Now please tell me if you agree to take part in the study.

Agreed: ---------- [ ]

Declined: ---------- [ ]

IDENTIFICATION

Date of interview: _ _/ _ _/ 2022 (dd/mm/yyyy)

Name of Region ……

District Name ……..

Sub-district Name ……

Health facility Name ……

Child's Name ……

Questionnaire No ……

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

(Target Group: Women who gave birth to a live baby in the past six or twelve months).

1. Age of woman:…… (years)
2. Ethnicity of respondent?
3. What is your Religion?
    a. Christianity
    b. Islam
    c. African Traditional Religion
    d. Others (specify)
4. Aside from your own housework, what do you do to earn income?
    a. Trader/Vendor
    b. Agricultural worker (e.g. farmer)
    c. Office worker (Civil Servant)
    d. Service worker (e.g. Hairdresser, seamstress)
    e. Education/research (Teacher)
    f. Healthcare (e.g. Nurse)
    g. Nothing
    h. Others, specify_____
5. Marital Status:
    a. Married
    b. Divorced
    c. Window
    d. Others, specify_____

6. Mother's highest educational level completed
    a. None
    b. Primary
    c. Middle/ J.H.S
    d. S.H.S/Vocational training
    e. Tertiary
    f. Others, (specify)_____

SECTION B: PAST OBSTETRIC ANDMATERNAL LIFESTYLE HISTORY

1. Number of pregnancies----------
2. Number of live deliveries----------
3. At what gestational age (months of pregnancy) did you start the antenatal clinic visits?.....
4. 4. Have you had any problems with the last pregnancy? [1] Yes [2] No
5. If yes what was/were the problem(s)

   [1] Bleeding [2] dizziness [3] abdominal pains [4] waist pains

   [5] Headache [6] swollen feet [7] others (specify) ……..

6. Record from the mother's antenatal card the number of times she visited a health care center for prenatal care services during pregnancy with [child's name]……
7. Where did you deliver (Name of child)?
    a. At home
    b. CHPS Compound
    c. Clinic
    d. Maternity home
    e. Health centre
    f. Hospital

g. Traditional Birth Attendant

8. Was mother taking some amount of alcohol/smoking before and during the last pregnancy?

   1. Yes 2. No

SECTION C: HEALTH STATUS ASSESSMENT

1. Blood pressure at recruitment (first trimester)…….
2. Blood pressure at 36 weeks gestation……..
3. 3. From the ANC card record the number of times respondent took Sulfadoxinepyrime tham in (SP) from the ante-natal clinic drug during this pregnancy?

   1. Never 2. Once 3. Twice 4. Three

4a. Mention three signs of malaria: 1.Fever 2. General body pains 3. Headache

4. Can't tell 5. Other (specify) ……..

4b. Did you suffered from malaria during your last pregnancy? 1. Yes 2. No

4c. If response to 4b is yes, how many times did you suffer from malaria?

1. Once 2. Twice 3. Three 4. More than three 5. Not applicable

5. Complete the table below for maternal Hb during the pregnancy with (Child's Name) using mother's ANC book

Stage of pregnancy

Hemoglobin level in g/dl

First trimester		
Second trimester		
Third trimester		

6. From the antenatal card of the mother, record the following:

Maternal height at recruitment: ……cm

Maternal weight on visit ANC visit (In the first 12 weeks) …… Kg

Maternal weight at 28 weeks (Second Trimester) …… Kg

Maternal weight at 36 weeks (Third Trimester) …… Kg

Gestational age at delivery…… (Completed weeks)

Body Mass Index (BMI) at recruitment: ……kg/m2

Mode of delivery of index child: 1. Normal 2. Caesarean delivery

SECTION D: INFANT ANTHROPOMETRY

Sex of child: (1). Male (2). Female

Baby's birth weight…… (Kg)

NAME OF SUPERVISOR……

DATE……..