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MATERNAL AGE AT BIRTH AND PREGNANCY OUTCOMES IN LIBERIA

BY

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DECLARATION

I, Samuel P. G. Gaye III, hereby declare that this dissertation, submitted to the School of Graduate Studies, represents my original research conducted under the supervision of Prof. Delali Margaret Badasu at the Regional Institute for Population Studies, University of Ghana, Legon. I confirm that this work has not been submitted, either partially or in full, for any degree elsewhere. All sources of information have been appropriately acknowledged.

Signature…… Date: November 28, 2025

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Signature … Date: November 28, 2025

Prof. Delali Margaret Badasu

(Supervisor)

DEDICATION

I dedicate this thesis to my parents and siblings, whose unwavering support and generosity have been instrumental in making this journey possible. I am deeply grateful to all my loved ones who have offered their assistance and encouragement in various ways, playing a significant role in the successful completion of this endeavour.

All praise and thanks be to God!

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I sincerely thank the Almighty for His constant love and blessings that have guided me throughout this research journey. I am sincerely appreciative of my supervisor, Professor Delali Margaret Badasu, whose invaluable guidance and mentorship have significantly enhanced the quality of this study. I extend my heartfelt thanks to all the participants and stakeholders who generously dedicated their time and shared their insights, as this research would not have been feasible without their contributions. Lastly, I wish to convey my appreciation to everyone who played a role, no matter how small, in this research endeavour. I am deeply grateful for your unwavering support and encouragement, which have been invaluable. I feel truly blessed to have your support.

ABSTRACT

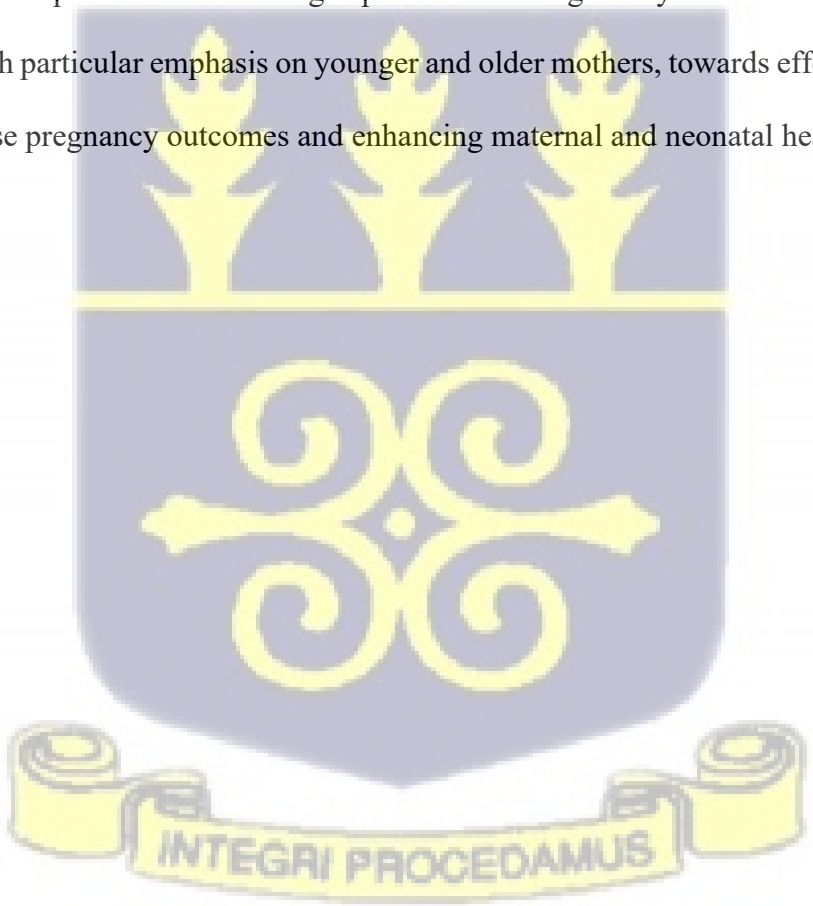
Background: Liberia has been experiencing high rates of maternal and neonatal morbidity and mortality, which are, in part, attributable to persistent adverse pregnancy outcomes, including stillbirths, miscarriages, and low birth weight. These challenges are further exacerbated by socioeconomic disparities, limited access to quality healthcare, and a deficiency in context-specific research. Addressing these issues is imperative, particularly as trends in maternal age evolve in response to changes in fertility patterns and socio-cultural factors. This study sought to examine the prevalence of adverse pregnancy outcomes and the influence of maternal age at birth on these outcomes among women of reproductive age in Liberia.

Methods: The study utilized a population-based retrospective cross-sectional design, drawing on secondary data from the 2019/2020 Liberia Demographic and Health Survey (LDHS). A sample of 8,065 women of reproductive age was used for the study. Adverse pregnancy outcomes were defined as experiencing at least one of the following: stillbirth, miscarriage (terminated pregnancy), or low birth weight (LBW). Descriptive statistics were employed to summarize the participants' background characteristics and the prevalence of adverse pregnancy outcomes. To determine factors associated with composite adverse pregnancy outcomes, multiple logistic regression analysis was performed, with the results reported at a 95% confidence interval.

Results: The results of the study have indicated an overall prevalence of any adverse pregnancy outcomes of 24.2%, with significant variation by age group ($p < 0.001$). Women aged 20-24 (adjusted odds ratio [aOR] = 2.23, 95% CI: 1.77 - 2.83), 40-44 (aOR = 4.94, 95% CI: 3.73 - 6.54), and 45-49 years (aOR=5.12, 95% CI: 3.92 - 6.71) had significantly higher odds of adverse outcomes compared to those aged 15-19 years. Higher odds were also observed among women with primary (aOR=1.23, 95% CI: 1.07 - 1.41), secondary (aOR=1.39, 95% CI: 1.20 - 1.60), and

higher education (aOR=1.42, 95% CI: 1.04 - 1.92). Employment (aOR=1.23, 95% CI: 1.08 - 1.39) and marital status, including married (aOR=1.45), widowed (aOR=2.12), divorced (aOR=1.81), and separated women (aOR=1.69), were associated with increased risk, while those in the NorthCentral Region had lower odds (aOR = 0.61).

Conclusion: The findings of the study show significant associations between maternal age, education, marital status, and employment with adverse pregnancy outcomes in Liberia. Maternal age was found to be a strong determinant of adverse pregnancy outcomes, with both adolescent and advanced maternal age at birth groups experiencing markedly higher risks. These findings recommend the implementation of age-specific and regionally tailored maternal health programmes, with particular emphasis on younger and older mothers, towards effectively reducing the risk of adverse pregnancy outcomes and enhancing maternal and neonatal health in Liberia.



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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The public health significance of adverse pregnancy outcomes is profound, as these events continue to be leading causes of maternal and neonatal morbidity and mortality globally. In 2020, an estimated 287,000 women died during pregnancy or childbirth, underscoring the urgent need for enhancements in maternal healthcare (WHO, 2022). Despite advancements, many adverse outcomes are preventable through timely access to skilled healthcare and supportive policies. Understanding the risk factors associated with these outcomes, particularly maternal age at birth, is crucial for public health interventions that aim at improving maternal and neonatal health.

Adverse pregnancy outcomes, such as preterm birth, low birth weight, and neonatal mortality, pose significant risks to the health of both mothers and infants. They also lead to lasting impacts on families and strain healthcare systems. Globally, preterm birth remains the primary cause of neonatal morbidity and mortality (Blencowe et al., 2013). Infants born prematurely face heightened risks of respiratory complications, developmental delays, and chronic diseases later in life, such as diabetes and cardiovascular issues (Liu et al., 2016). Similarly, low birth weight is associated with long-term health challenges, affecting not only the immediate well-being of infants but also their lifelong health trajectories (Victora et al., 2008).

Maternal morbidity and mortality are closely intertwined with these adverse outcomes. Conditions such as postpartum haemorrhage and pre-eclampsia pose significant threats to maternal health and can also result in poor neonatal outcomes. Many of these adverse events are preventable with early detection and management, however, there exists a stark disparity in maternal and neonatal

mortality rates. Low- and middle-income countries disproportionately bear the brunt of these challenges, with sub-Saharan Africa accounting for over half of all maternal deaths globally, often attributable to limited access to quality maternal healthcare services (Kassebaum et al., 2014).

In recent decades, there has been a notable shift in maternal age at birth, influenced by social, economic, and cultural factors. In many high-income regions, women are delaying childbirth to pursue educational and career opportunities. For instance, in Italy, the mean age at delivery increased from 25.2 years in 1981 to 31.7 years in 2015 (Santoro et al., 2017). Similar trends are observed in the United States and China (Martin et al., 2019). Although delayed childbearing can confer benefits such as financial stability, it also carries inherent risks. Women who give birth at the age of 35 and older are more likely to experience complications, including preeclampsia and caesarean delivery (Ramos et al., 2016). Conversely, teenage pregnancies are associated with significant risks. Young mothers often face complications such as preterm birth and neonatal mortality, exacerbated by socio-economic factors (Ganchimeg et al., 2013). The relationship between maternal age and adverse outcomes remains complex, with ongoing debates regarding whether these outcomes stem from biological factors or socio-economic disparities.

In Africa, the relationship between maternal age and pregnancy outcomes is significant. A study indicated that both teenage and advanced maternal age at childbirth is linked to increased risks of adverse pregnancy outcomes. A study conducted in South Africa revealed that women aged 35 and older experienced higher rates of preterm delivery (19.2% compared to 14.7%) and low birth weight (27.9% versus 18.8%) than their younger counterparts (Mavhandu-Mudzusi et al., 2018). Similarly, in Cameroon, older women were more likely to encounter complications such as preeclampsia and foetal distress (Fotsin et al., 2019).

Teenage pregnancies remain prevalent in many African countries, contributing to poor pregnancy outcomes. A study in Zambia found that adolescents aged 10-19 were at higher odds of experiencing complications such as obstructed labour and low birth weight compared to women aged 20-24 (Michelo et al., 2015). These findings highlight the vulnerability of younger mothers, who often encounter biological challenges alongside social and economic barriers to accessing quality maternal healthcare.

Adverse pregnancy outcomes including stillbirth, low birth weight, and miscarriage constitute a significant public health concern, particularly in low- and middle-income countries. These outcomes have been associated with a variety of factors, including socioeconomic status, educational attainment, parity, access to skilled care, and pre-existing maternal health conditions. Among these factors, maternal age has emerged as a consistent predictor, with both adolescent and advanced maternal ages linked to heightened risks of complications during pregnancy and childbirth. Although this association has been examined in other contexts, limited empirical evidence exists regarding the impact of maternal age on pregnancy outcomes specifically within the Liberian context, where socio-cultural and health system factors may yield unique patterns. This study, therefore, aims to investigate the relationship between maternal age and adverse pregnancy outcomes in Liberia, utilising nationally representative data from the 2019/2020 Liberia Demographic and Health Survey (LDHS).

1.2 Statement of the Problem

Adverse pregnancy outcomes, including stillbirth, low birth weight, and miscarriage, continue to represent a significant public health challenge in Liberia. In Sub-Saharan Africa, the burden of adverse birth outcomes remains disproportionately high, with recent pooled analyses indicating a regional prevalence of approximately 30% (Tamirat et al., 2021). These complications not only

threaten the lives of mothers and newborns but also impose considerable emotional, social, and financial burdens on families, thereby straining an already resource-constrained health system (WHO, 2022). Among the key risk factors contributing to these outcomes is maternal age, particularly pregnancies occurring during adolescence (15–19 years) or at advanced maternal age at child birth (35 years and above) (Frick, 2021; Lean et al., 2017). In Liberia, teenage pregnancies are prevalent, often driven by poverty, low levels of educational attainment, and inadequate access to reproductive health services. According to the Liberia Demographic and Health Survey (LDHS, 2020), nearly one-third of women initiate childbearing during adolescence. These young mothers are at increased risk of complications such as obstructed labour, premature delivery, low birth weight, and neonatal mortality, which can be attributed to biological immaturity and limited access to antenatal care (Ganchimeg et al., 2013; Michelo et al., 2015). Conversely, women who conceive at advanced maternal age are more likely to experience adverse outcomes such as pregnancyinduced hypertension, stillbirth, gestational diabetes, and chromosomal anomalies (Ogawa et al., 2017; Mehari et al., 2020; Frick, 2021).

These risks are further exacerbated by Liberia's socio-economic conditions, including geographic disparities in healthcare access, limited emergency obstetric services, and inconsistent quality of maternal care (LDHS, 2020). Despite the well-established global and regional associations between maternal age and adverse pregnancy outcomes, there is a notable absence of empirical studies focusing specifically on Liberia. Most of the existing evidence is on high-income or other African countries, which may not adequately reflect Liberia's unique socio-cultural and healthcare landscape (Yeboah et al., 2023; Laaser et al., 2023). This lack of context-specific data constitutes a critical gap in maternal health research and policy. In the absence of localised evidence, it becomes challenging for health planners and stakeholders to design and implement interventions

that effectively address the needs of at-risk age groups. There is an urgent need to investigate how maternal age at child birth contributes to adverse pregnancy outcomes in Liberia, particularly among adolescent and older mothers. By identifying the age groups most at risk and exploring the socio-demographic and health-related factors influencing these outcomes, this study aims to generate evidence that will inform targeted maternal health interventions, reduce adverse outcomes, and enhance maternal and neonatal survival in Liberia.

1.3 Research Questions

1. What are the prevalence and types of pregnancy outcomes among women in Liberia?
2. What is the association between maternal age at child birth (15-49 years) and adverse pregnancy outcomes in Liberia?
3. How do socio-economic factors influence birth outcomes among women in Liberia?
4. How do healthcare factors influence birth outcomes among women in Liberia?

1.4 Objectives of the Study

1.4.1 Aim of the Study

The general objective of the study was to examine the influence of maternal age at child birth on pregnancy outcomes in Liberia.

1.4.2 Specific Objectives

1. To describe the prevalence of adverse pregnancy outcomes (still birth, low birth weight and miscarriage) among women of reproductive age in Liberia.
2. To examine the association between maternal age at child birth, defined as age 15-49 years, and pregnancy outcomes in Liberia.

3. To examine the relationship between socio-economic factors and pregnancy outcomes among women in Liberia.
4. To examine the relationship between healthcare factors and pregnancy outcomes among women in Liberia.

1.5 Rationale of the Study

In Liberia, there has been a noticeable increase in delayed childbearing, with more women giving birth at advanced maternal ages (Laaser et al., 2023). This demographic shift raises concerns regarding potential pregnancy complications, as advanced maternal age is globally recognised as a risk factor for adverse obstetric outcomes. However, a significant knowledge gap persists concerning the specific impact of advanced maternal age on pregnancy outcomes in Liberia (Yeboah et al., 2023). Currently, the effect of maternal age on pregnancy complications and outcomes within the unique socio-cultural and healthcare landscape of Liberia remains poorly understood, thus highlighting the need for localised research.

In the global context, numerous studies have documented the heightened risks associated with advanced maternal age, including increased rates of obstetric complications such as preterm birth, and low birth weight (Dokubo et al., 2018). These findings indicate that maternal age plays a crucial role in determining pregnancy risks, emphasising the importance of age-specific healthcare interventions. Nevertheless, while these global studies provide valuable insights, they cannot be directly applied to Liberia due to differences in healthcare systems, socio-economic conditions, and cultural practices.

This study seeks to address this critical knowledge gap by assessing the relationship between advanced maternal age and pregnancy outcomes in Liberia, utilising data from the 2020 Liberia Demographic and Health Survey (LDHS). The research findings will contribute to the

understanding of how maternal age influences pregnancy outcomes in Liberia, providing evidence that can guide healthcare providers and policymakers in addressing the specific health needs of older mothers. The study has significant policy implications, as its results will inform the development and adoption of evidence-based policies and healthcare strategies aimed at mitigating risks and improving maternal and child health outcomes for women giving birth at advanced ages in Liberia.

1.6 Significance of the Study

This study is significant as it addresses critical gaps in understanding the relationship between maternal age at child birth and pregnancy outcomes in Liberia, a country characterised by distinct socioeconomic and healthcare challenges. Currently, there is limited research on how maternal age, particularly advanced maternal age, impacts pregnancy outcomes within this context. By filling this knowledge gap, the study provides essential insights tailored to the unique health needs of women in Liberia, thereby informing local healthcare policies and strategies. Utilising a life course approach, the research offers a nuanced understanding of how maternal age interacts with various social determinants of health, such as educational status, household income, and access to antenatal care, in shaping pregnancy outcomes. This analysis highlights the compounded effects of these factors, offering policymakers and healthcare providers a clearer understanding of howto better support women of advanced maternal age during pregnancy. This is particularly important in a setting like Liberia, where healthcare access can vary significantly across different regions and population groups, exacerbating maternal health risks. The study's findings have significant implications for public health interventions and policy formulation in Liberia. Policymakers can utilise the evidence to develop targeted interventions aimed at reducing the risks associated with advanced maternal age, such as improving access to specialised antenatal care for older mothers.

Healthcare providers can also benefit from these findings, employing them to refine counselling practices and clinical care approaches that address the unique risks faced by women who give birth later in life. Community leaders and public health advocates may further leverage the insights to raise awareness and promote equitable healthcare access across different demographic groups in Liberia. Moreover, this research contributes to the global body of knowledge on maternal health by highlighting the specific conditions, challenges, and needs within Liberia. These findings can also be valuable for countries with similar healthcare contexts, potentially informing strategies and interventions beyond Liberia's borders. The study's emphasis on maternal health in low-resource settings adds a critical perspective to global discussions on how maternal age at childbirth influences pregnancy outcomes, particularly in regions where maternal health services are underresourced. Ultimately, this study seeks to improve maternal and child health outcomes in Liberia by influencing healthcare delivery and policy. By focusing on the relationship between maternal age and pregnancy outcomes, it aims to reduce adverse pregnancy outcomes and enhance the wellbeing of both mothers and their children. If the findings are adopted and integrated into Liberia's maternal health policy, they could lead to more equitable healthcare access, improved health outcomes, and a reduction in pregnancy-related complications among women of all ages, especially those of advanced maternal age.

1.7 Organization of the Study

The thesis is structured into five chapters, each addressing a fundamental component of the study. Chapter One offers an introduction to the study, encompassing the background, problem statement, purpose, and objectives of the research. It delineates the theoretical framework underpinning the study, defines the scope of the research, highlights its significance, and provides an overview of the organisational structure of the chapters.

Chapter Two presents a comprehensive review of the existing literature, concentrating on the relationship between maternal age and pregnancy outcomes. It integrates both global and regional studies to contextualise the Liberian experience. The chapter explores key theoretical frameworks, such as the social determinants of health (SDOH) and the life course approach, while examining factors such as socioeconomic status, healthcare access, and cultural influences that affect maternal and child health.

Chapter Three presents the methodology employed in this study, encompassing the study design, data sources, and analytical methods utilised. It describes the sample derived from the 2019/2020 Liberia Demographic and Health Survey (LDHS), which constitutes a secondary dataset. No primary data collection was undertaken; consequently, no data collection instruments were developed for the purposes of the study.

Chapter Four is on the presentation of the study's findings. It systematically presents the results, followed by an in-depth interpretation and discussion that relates the findings to the research objectives and existing literature in chapter five. The chapter offers insights into the relationship between maternal age and pregnancy outcomes, situating the findings within the broader body of knowledge.

Chapter six concludes the study by summarising the key findings and drawing conclusions based on the research results. The chapter provides recommendations for policy, practice, and future research, with a focus on enhancing maternal and child health outcomes in Liberia, particularly in relation to maternal age.

1.8 Definition of Concepts of Maternal Age at Child Birth: Maternal age refers to the age of a woman at the time she gives birth. For this study, the maternal age is categorized into three

groups: adolescent mothers (15-19 years), adult mothers (20-34 years), and advanced maternal age mothers (35-49 years).

- Advanced Maternal Age (AMA): Advanced maternal age is defined as the age of a woman who is 35 years or older at the time of giving birth. This age group is often associated with a higher risk of complications during pregnancy and childbirth.
- Adverse Pregnancy Outcomes: Adverse pregnancy outcomes encompass a range of negative health events related to pregnancy, such as preterm birth, low birth weight, preeclampsia, gestational diabetes, gestational hypertension, stillbirth, and neonatal mortality.
- Prevalence: Prevalence refers to the proportion of a population found to have a particular condition or characteristic at a specific time. In this context, it measures how common different maternal age groups and adverse pregnancy outcomes are among women giving birth in Liberia.
- Socio-economic Factors: Socio-economic factors include the social and economic conditions that influence an individual's or population's health status. These factors may include income level, education level, employment status, and living conditions.
- Healthcare Factors: Healthcare factors refer to the availability, accessibility, quality, and utilization of healthcare services that impact health outcomes. This includes access to prenatal care, the presence of skilled birth attendants, availability of emergency obstetric services, and overall healthcare infrastructure.
- Birth Outcomes: Birth outcomes encompass the results of pregnancy and childbirth, focusing on the health and well-being of both the mother and the newborn. Positive birth

outcomes are characterized by full-term birth, healthy birth weight, and no maternal or neonatal complications, while negative birth outcomes include preterm birth, low birth weight, and maternal or neonatal morbidity and mortality.

- Liberia Demographic and Health Survey (LDHS): The Liberia Demographic and Health Survey (LDHS) is a nationally representative survey that collects data on a wide range of health indicators, including maternal and child health, fertility, family planning, and nutrition. The 2020 LDHS provides the data used in this study to analyse maternal age and pregnancy outcomes.
- Urban and Rural Areas: Urban areas in this study refer to densely populated regions with developed infrastructure and better access to healthcare services, such as Monrovia. Rural areas are characterized by lower population density, limited healthcare infrastructure, and typically lower socio-economic conditions, including regions like Lofa, Nimba, and Bong counties.
- Primiparous and Multiparous Women: Primiparous women are those giving birth for the first time, while multiparous women have had one or more previous births. This distinction is important as it may influence the type and severity of pregnancy outcomes.

CHAPTER TWO

LITERATURE REVIEW, THEORETICAL FRAMEWORK AND THE CONCEPTUAL FRAMEWORK FOR THE STUDY

2.1 Introduction

This chapter deals with the review of related literature, serving as a link between past works and the current study on maternal age at child birth and pregnancy outcomes in Liberia. Title searches, articles, journals, research documents, and applicable support references were gathered from online sources such as EBSCOHOST, CINAHL, HINARI, and Google Scholar. Using keyword combinations such as maternal age, pregnancy outcomes, obstetric and perinatal outcomes, and Liberia, relevant to this study were reviewed.

2.2 Adverse pregnancy outcomes among women of reproductive age

Pregnancy outcomes, also known as birth outcomes, refer to the result of pregnancy, encompassing the events from the age of viability (28 weeks) through the first weeks of a newborn's life. These outcomes can vary widely, including live births (whether full-term or preterm), stillbirths, spontaneous abortions, induced abortions, and early neonatal deaths (Yeshialem et al., 2019). Adverse pregnancy outcomes generally describe complications that impact the health of the mother, the newborn, or both during pregnancy, labour, delivery, or the postpartum period. These complications commonly include antepartum haemorrhage, hyperemesis gravidarum, postpartum haemorrhage, stillbirth, low birth weight, premature rupture of membranes, obstructed labour, hypertensive disorders, preterm birth, uterine rupture, and puerperal sepsis (Tadese et al., 2022).

Ensuring women receive appropriate healthcare both before and during pregnancy is critical for reducing the risk of such adverse outcomes.

The World Health Organization estimates that approximately 810 women lose their lives each day due to preventable complications arising from pregnancy, childbirth, or the postpartum period (Tadese et al., 2022). In 2017, over 295,000 women died during or after pregnancy and childbirth, with 94% of these deaths occurring in low- and lower-middle-income countries, including Ethiopia. Sub-Saharan Africa was responsible for nearly 66% (196,000) of the global maternal deaths, while Southern Asia accounted for approximately 20% (58,000) (Tadese et al., 2022). However, maternal mortality only captures part of the broader challenge. For every woman who dies from pregnancy-related causes, an estimated 20 to 30 others suffer from serious short- and long-term disabilities, such as obstetric fistula, infections, uterine rupture, or pelvic inflammatory disease (Tadese et al., 2022).

Pregnancy outcomes are also influenced by maternal age. Both extremes of reproductive age carry heightened risks for adverse outcomes. Teenage mothers, for example, face an increased risk of preterm birth, low birth weight, low Apgar scores, and postnatal mortality (Fall et al., 2015). The debate continues as to whether these risks are primarily due to biological immaturity or are more influenced by socio-economic disadvantages, behavioural factors, and limited access to highquality antenatal care (Carolan, 2013). On the other hand, delayed childbearing, particularly for "elderly primigravidas," has been associated with a higher likelihood of maternal and obstetric complications. Concerns about the impact of age on pregnancy outcomes were first raised in the 1950s (Cooke & Davidge, 2019), and since then, numerous studies have explored the effects of maternal aging on birth outcomes (Cooke & Davidge, 2019; Kortekaas et al., 2020;

Frick, 2021).

2.2.1 Low birth weight

Low birth weight (LBW) continues to be a significant public health concern globally and is regarded as a multifaceted indicator of maternal malnutrition, poor health, and insufficient prenatal care. The World Health Organization (WHO) defines LBW as a birth weight of less than 2500 grams (5.5 pounds) (WHO, 2023). At the population level, the proportion of infants born with LBW serves as a reflection of long-term maternal malnutrition, illness, and inadequate healthcare during pregnancy, rendering it an important marker of overall health and well-being within communities. LBW is a primary outcome indicator in the Global Nutrition Monitoring Framework and is also included in the WHO Global reference list of 100 core health indicators (WHO, 2023). Globally, the prevalence of LBW remains elevated, with estimates from UNICEF and WHO indicating that in 2020, 1 in 7 newborns—approximately 19.8 million infants—were born with LBW, representing 15% of all births (WHO, 2023). The prevalence of LBW varies across regions, influenced by socioeconomic factors, access to healthcare, and maternal health. For instance, in Nigeria, a study involving 780 pregnant women indicated a 6.3% prevalence of LBW (Oladeinde et al., 2015). Similarly, a cross-sectional study in Kerman province, Iran, reported a prevalence of 9.4% (Momeni et al., 2017). In Indonesia, the prevalence of LBW reached as high as 15.9%, while Pakistan exhibited the highest prevalence among developing nations at 35.1% (Mahumud et al., 2017). Additional studies reveal significant variations in LBW prevalence both within and across countries. A systematic review conducted in Iran estimated the national prevalence at 8.5%, with the highest rates observed in Hamedan (19.1%) and the lowest in Tonekabon (4.2%) (Sabbaghchi et al., 2017). In Ethiopia, a meta-analysis encompassing 28 studies revealed a pooled prevalence of 14.1%, with notable regional variations (Katiso et al., 2020). In Garmsar, Iran, the prevalence was reported at 4.7% for infants born in 2013 (Safari et al., 2016). In India, it was found that nearly 20% of newborns are born with LBW, with a higher frequency observed among females compared

to males (Bharati et al., 2011). In Sub-Saharan Africa, LBW prevalence also varies among countries. Specifically, LBW rates were recorded at 15.7% in Senegal, 13.4% in Burkina Faso, 12.1% in Malawi, 10.2% in Ghana, and 10% in Uganda (He et al., 2018). These variations are reflective not only of differences in maternal health and access to healthcare but also of the influence of regional economic and environmental conditions. Understanding the global and regional prevalence of LBW is essential for enhancing maternal and child health. Addressing the root causes, which range from maternal nutrition to access to healthcare, can aid in reducing the incidence of LBW and its associated short- and long-term health complications.

2.2.2 Still birth

Stillbirth, which is defined as the death of a baby after 28 weeks of gestation but before or during delivery, remains a significant public health concern globally. The World Health Organization estimate that approximately two million stillbirths occur each year worldwide, equating to one stillbirth every 16 seconds. Notably, over 40% of these stillbirths transpire during labour, emphasising the preventable nature of many cases through timely access to quality obstetric care (WHO, 2024a). The psychological and economic repercussions associated with stillbirth are profound, particularly impacting women and their families. These losses frequently result in maternal depression, financial strain, and social stigma issues that remain inadequately addressed within global policies and programmes. In 2014, the World Health Assembly approved the "Every Newborn Action Plan (ENAP)", with the goal of lowering the global stillbirth rate to 12 or fewer per 1,000 births by 2030. While numerous high-income and upper-middle-income countries have made significant strides toward this target, many countries in sub-Saharan Africa, continue to lag.

Without accelerated efforts, an estimated 15.9 million babies could be stillborn by 2030, with subSaharan Africa accounting for nearly half of these losses (WHO, 2024a). Several studies

highlight the persistent high prevalence of stillbirths in low- and middle-income countries. For instance, a cross-sectional study in the Amhara region of Ethiopia revealed a stillbirth prevalence significantly exceeding the global average, with 2.3% of pregnancies resulting in stillbirth (Chan et al., 2022). Similarly, a Nigerian study involving 4,416 births reported a stillbirth rate of 39.6 per 1,000 births, with nearly half of these categorised as intrapartum stillbirths, often preventable with timely intervention (Okonofua et al., 2019). In low- and middle-income countries, the predominant causes of stillbirth include obstructed labour, hypertensive diseases of pregnancy, infections such as syphilis and malaria, and maternal undernutrition (Yakoob et al., 2010). Data from a ten-year retrospective study conducted in China indicated a stillbirth rate of 13.2 per 1,000 births, with preeclampsia, eclampsia, and foetal anomalies identified as significant contributors (Zhu et al., 2021). Other studies have reported similarly high rates; for instance, a Pakistani cohort recorded a stillbirth prevalence of 48.4 per 1,000 births, with 65.5% of cases classified as macerated stillbirths, underscoring the urgent need for improved prenatal care and timely medical interventions (Njoku et al., 2016). Systematic reviews further corroborate the disparities in stillbirth rates between high- and low-income settings. A meta-analysis of 70 studies conducted across 50 countries indicated that stillbirth prevalence ranged from 0.50 per 100 births in developed settings to 1.17 in less developed ones, highlighting the critical need for targeted interventions in low-resource contexts (Say et al., 2006). These findings necessitate global action to prevent stillbirths and enhance maternal and neonatal outcomes, particularly in countries with a high burden of stillbirths.

2.2.3 Miscarriages (terminated pregnancies)

Miscarriage, also referred to as spontaneous abortion, constitutes one of the most prevalent early pregnancy complications, with an incidence rate of approximately 15–20% of all clinically recognised pregnancies (Kumar & Kumar, 2014). The majority of miscarriages occur prior to 12

weeks of gestation, with fewer than 5% transpiring after the detection of foetal heart activity. Miscarriage is influenced by several factors, including maternal age, genetic abnormalities, maternal health conditions, infections, and lifestyle choices. A population-based cohort study conducted in Manitoba, Canada, estimated the annual miscarriage rate to be 11.3%, reflecting its considerable prevalence (Strumpf et al., 2021). Similarly, a study in Norway indicated an increased risk of miscarriage associated with maternal age, reaching 53% among women aged 45 and older (Magnus et al., 2019). Patki and Chauhan (2016) further identified a prevalence of 7.46% for recurrent spontaneous miscarriages (RSM) in India, defined as the loss of three or more pregnancies. In poor resource countries, the prevalence of miscarriage is often elevated due to restricted access to healthcare. For instance, in Nigeria, 49% of pregnant women reported having experienced a miscarriage (Abiola et al., 2013). In Ghana, the national prevalence was recorded at 19.1%, with heightened risks observed among women with late or no antenatal care from the 2017 Demographic Health Survey dataset (Chireh et al., 2021). Miscarriage is also a significant issue in India, where the rates in urban areas increased from 6.4% in 2015-16 to 8.5% 2019-21 rounds of the National Family Health Survey (Kuppusamy et al., 2023). On a global scale, miscarriage imposes substantial psychological distress on women and their partners, thereby presenting a serious burden for healthcare providers (Kumar & Kumar, 2014). Appropriate counselling and support can alleviate this burden, providing considerable psychological benefits to women following a miscarriage. In contrast, induced abortion—a common and safe healthcare procedure when conducted in accordance with WHO guidelines accounts for a significant proportion of unintended pregnancies. However, unsafe abortions often arise in contexts where women encounter barriers to accessing quality abortion care, further complicating maternal health (WHO, 2024). In conclusion, miscarriage remains a prevalent issue worldwide, with variations evident across regions and socio-economic contexts. Its public health significance is emphasised by the physical and

psychological toll on affected women, thereby highlighting the necessity for improved healthcare access and emotional support, particularly in resource-limited settings.

2.3 Association between maternal age at birth and adverse pregnancy outcomes

The association between maternal age and adverse pregnancy outcomes has garnered significant attention in recent research, particularly as societal trends indicate a marked increase in the average age of mothers at childbirth. Advanced maternal age (AMA), typically defined as women aged 35 years and older, is associated with a myriad of adverse pregnancy outcomes, including preterm birth, low birth weight, stillbirth, gestational diabetes, and pre-eclampsia (Lean et al., 2017; Frick, 2021). This review synthesises findings from various studies to elucidate the complex dynamics between maternal age and pregnancy complications.

Numerous studies consistently show that women of advanced maternal age at child birth are at greater risk of experiencing adverse pregnancy outcomes compared to younger women (Kortekaas et al., 2020; Frick, 2021). For instance, Lean et al. (2017) conducted a systematic review and metaanalysis, revealing that AMA is significantly associated with increased incidences of low birth weight, stillbirth, and gestational diabetes. The analysis indicated that the likelihood of caesarean delivery and the development of pre-eclampsia also escalate with advancing maternal age. Similar findings were corroborated by Frick (2021), who emphasised that the correlation between maternal age and complications underscores the necessity for enhanced prenatal care targeting older mothers.

Further supporting these findings, Liu and Zhang (2014) investigated the impact of maternal age through a retrospective cohort study, which classified participants into various age groups. Results indicated that women aged 35 and older exhibited significantly higher rates of gestational diabetes, pre-eclampsia, and preterm births. The authors noted that risks were especially pronounced in

women aged 40 and above, who experienced heightened instances of adverse maternal and neonatal outcomes, including stillbirth.

Interestingly, both very young (<20 years) and older maternal ages are linked to adverse pregnancy outcomes. Liu and Zhang (2014) found that younger mothers are more prone to preterm births and low birth weight infants, while older mothers face increased risks for complications such as gestational diabetes and pre-eclampsia. Khalil et al. (2013) further emphasised that maternal age significantly influences pregnancy outcomes across the spectrum, necessitating tailored prenatal care strategies for women at both ends of the age spectrum. In a national cohort study conducted in Denmark, Frederiksen et al. (2018) examined singleton pregnancies and reported that women aged 40 and older experienced one or more adverse outcomes at a rate of 10.9%, compared to 5.46% among women aged 20–34 years. The study also highlighted that older mothers were at an elevated risk for chromosomal abnormalities and miscarriages, reinforcing the critical need for careful monitoring within this demographic. The substantial increase in risks of adverse outcomes in women with advanced maternal age underscores the importance of specialised prenatal care. Shan et al. (2018) indicated that tailored prenatal interventions can assist in monitoring and managing the elevated risks faced by older mothers, thereby ensuring better health outcomes for both mothers and infants. Furthermore, Montori et al. (2021) suggested that proactive measures, including routine screening for gestational diabetes and hypertensive disorders, are essential for this population.

Moreover, evidence from a systematic study by Muglu et al. (2019), which focused on late and post-term pregnancies in women of advanced maternal age, reinforced the necessity for meticulous monitoring. The study revealed significantly higher risks of stillbirth and neonatal complications

in women of advanced maternal age who delivered late or post-term, indicating that age-specific guidelines for managing labour and delivery are crucial.

In summary, the literature strongly supports the significant influence of maternal age on adverse pregnancy outcomes. Women of advanced maternal age at child birth face elevated risks of complications such as gestational diabetes, and pre-eclampsia while younger mothers are at increased risk for preterm births and low birth weight. Given the rising trend in maternal age, it is imperative for healthcare providers to implement tailored prenatal care strategies to mitigate these risks and improve maternal and neonatal health outcomes. As the average age at childbirth continues to rise, ongoing research and policy efforts are vital in addressing the unique challenges faced by mothers across different age groups.

2.3.1 Maternal Age and Stillbirth

Studies consistently indicate that advanced maternal age (AMA), typically defined as 35 years or older, is linked to a heightened risk of stillbirth. For instance, a systematic review by Lean et al. (2017) revealed that women in this age group face a significantly greater likelihood of stillbirth compared to their younger counterparts. Frick (2021) reported similar findings, highlighting that AMA is linked to elevated rates of stillbirth and other adverse pregnancy outcomes. Furthermore, a national cohort study by Muglu et al. (2019) revealed that women aged 35 and older who delivered late (at 41 weeks) or post-term (at 42 weeks or more) experienced significantly higher stillbirth rates in high-income countries. This evidence underscores the necessity for targeted antenatal care for older pregnant women to effectively monitor and manage the risks associated with stillbirth.

2.3.2 Maternal Age and Low Birth Weight

The influence of maternal age on child birth weight is complex. Liu and Zhang (2014) found that adolescent mothers, aged 15-19, were more likely to have low birth weight (LBW) infants compared to those aged 25-29. Additionally, women aged 35 and older also exhibited increased risks of having LBW infants. Montori et al. (2021) supported this assertion, indicating that advanced maternal age was associated with a higher prevalence of LBW, particularly in women over 40. Lean et al. (2017) further corroborated these findings, highlighting that infant born to mothers of advanced maternal age not only faced a greater risk of LBW but also had a higher likelihood of experiencing other complications, such as preterm birth. A large multi-country observational study conducted by Mombo-Ngoma et al. (2016) demonstrated that girls aged ≤16 years in sub-Saharan Africa exhibited significantly higher risks of preterm delivery and low birth weight in comparison to older women. This finding provides robust evidence that adolescent pregnancy constitutes a major risk factor for adverse birth outcomes in the region, thereby reinforcing the necessity for tailored antenatal interventions aimed at this specific age group. Collectively, these findings illustrate that both younger and older maternal age groups are at risk for adverse birth weight outcomes, underscoring the necessity for tailored prenatal interventions to enhance infant health.

2.3.3 Maternal Age and Miscarriage (Terminated Pregnancies)

The influence of maternal age on miscarriage is particularly significant, with advanced maternal age serving as a strong predictor of increased risk. Khalil et al. (2013) reported that women aged 40 years and older had an odds ratio of 2.32 for experiencing miscarriage compared to younger women. This finding is supported by Frick (2021), who observed that the risks of miscarriage during the first and second trimesters were notably higher in older women. Additionally,

Frederiksen et al. (2018) elucidated that women aged over 40 years are more likely to experience miscarriage and chromosomal abnormalities, which contribute to adverse pregnancy outcomes. Collectively, these studies emphasise the urgent need for healthcare providers to closely monitor older women during their pregnancies to reduce the risks of miscarriage and its associated complications.

In conclusion, the reviewed literature highlights the critical impact of maternal age on various adverse pregnancy outcomes. As the average maternal age continues to rise globally, these findings underscore the necessity for enhanced prenatal care tailored to the unique needs of both younger and older mothers. Addressing these age-related risks is essential for improving maternal and neonatal health outcomes.

2.4 Relationship between socio-economic, healthcare factors and pregnancy outcomes among women

2.4.1 Socio-economic factors and pregnancy outcomes among women

Adverse pregnancy outcomes such as low birth weight, and stillbirth, present substantial public health challenges globally. Socio-economic factors are pivotal in influencing maternal and infant health. Variables such as access to healthcare services, employment status, educational attainment, and income level, markedly affect pregnancy outcomes. Women from lower socio-economic backgrounds frequently encounter obstacles that may lead to adverse maternal health, including insufficient prenatal care, nutritional deficiencies, and elevated stress levels. An understanding of the interplay between socio-economic factors and adverse pregnancy outcomes is essential for the formulation of effective public health interventions. By addressing these disparities, it is feasible to enhance maternal and child health and foster healthier pregnancies across diverse populations.

A growing body of research has established a notable link between maternal education and pregnancy outcomes. For example, a case-control study conducted in Ethiopia found that women with lower educational attainment faced higher risks of complications, including preterm birth and low birth weight. This correlation highlights the importance of education in improving women's health literacy, enabling informed decisions regarding pregnancy and healthcare (Kebede et al., 2018). Further investigation using Mendelian randomisation indicated that higher maternal education was positively associated with better pregnancy outcomes, including higher birth weights and lower rates of adverse events. The study identified mediating factors such as improved maternal health behaviours, better access to healthcare, and enhanced socioeconomic status as key components of this relationship. Educated mothers were more likely to engage in healthier behaviours, such as attending prenatal appointments and maintaining proper nutrition, thereby reducing risks related to adverse pregnancy outcomes (Rogne et al., 2024). Additionally, research conducted in Canada revealed a strong positive correlation between maternal education and favourable birth outcomes. Women with higher educational attainment not only experienced higher birth weights but also lower rates of preterm births and stillbirths. This suggests that education equips mothers with better health literacy, allowing for effective utilisation of healthcare services and timely interventions when complications arise (Luo et al., 2006). Moreover, a study examining mothers living near highways in the United States highlighted that higher maternal education acted as a protective factor against adverse birth outcomes. Educated mothers were better positioned to access prenatal care and adhere to health guidelines, thereby mitigating the negative impacts of environmental stressors (Genereux et al., 2008). Education enhances health literacy, promotes healthier behaviours, and facilitates better access to healthcare, ultimately contributing to a reduction in adverse pregnancy outcomes. Addressing educational disparities should be a primary focus in public health strategies aimed at improving maternal and child health.

Adverse pregnancy outcomes are significantly influenced by socio-economic factors, particularly income and wealth status. Research has demonstrated that higher neighbourhood income levels correlate with improved birth outcomes. For instance, a study conducted in the United States found that families residing in higher-income areas experienced increased birth weights and reduced rates of preterm births. This positive association is attributed to enhanced access to healthcare resources, nutritional options, and supportive environments conducive to healthy pregnancies. The socioeconomic context plays a crucial role in maternal health, as increased income is linked to reduced stress and improved living conditions, underscoring the importance of addressing income disparities to enhance maternal and child health in lower-income neighbourhoods (Luo et al., 2006). Conversely, a study in Ethiopia highlighted those women living in poverty face significantly higher risks of adverse pregnancy outcomes. These risks are often associated with poor access to healthcare, inadequate nutrition, and elevated stress levels. Impoverished women frequently encounter barriers to adequate prenatal care, including financial constraints, transportation issues, and lack of nearby healthcare facilities. Such limitations can lead to delayed or insufficient prenatal care, which is critical for the early detection and management of complications.

Furthermore, malnutrition and food insecurity are prevalent among pregnant women living in poverty, contributing to foetal growth restrictions and increased risks of low birth weight. The study also noted that women experiencing poverty are more likely to suffer from chronic stress and mental health issues, such as anxiety and depression, which can adversely affect pregnancy outcomes (Nagahawatte, 2008). Additionally, research examining the combined effects of neighbourhood socio-economic status (SES) and environmental factors found that lower neighbourhood SES is significantly associated with adverse birth outcomes. Women residing in low-SES neighbourhoods, particularly those near highways, faced compounded risks due to

inadequate access to quality healthcare services and unhealthy environments. These studies emphasise the need for addressing both environmental and social inequalities to enhance maternal and child health outcomes (Genereux et al., 2008). Finally, a study conducted in Spain underscored the role of social determinants in shaping maternal health outcomes, revealing significant disparities in adverse pregnancy outcomes across neighbourhoods with varying SES. Areas characterised by higher levels of poverty and fewer resources were associated with poorer pregnancy outcomes, highlighting the influence of neighbourhood context on maternal and infant health (Garcia-Subirats et al., 2012).

Research investigating the relationship between maternal occupation and pregnancy outcomes has yielded significant insights into how occupational factors can influence adverse pregnancy outcomes. A study conducted in Finland analysed a substantial sample of births and found that certain maternal occupations were associated with elevated risks of complications such as low birth weight, and stillbirth. Occupations characterised by physical strain, extended working hours, and exposure to harmful substances such as chemicals and heavy lifting were particularly linked to negative outcomes. High-risk occupations included those in agriculture, manufacturing, and physically demanding service sectors. Conversely, some professions, especially those providing flexible working conditions, enhanced access to healthcare, and reduced physical strain, were associated with more favourable pregnancy outcomes. Women employed in education, healthcare, and professional services exhibited lower risks of preterm birth and low birth weight, which can be attributed to greater job autonomy, higher income, and supportive work environments. Furthermore, the study underscored the significant role of socioeconomic status and job security in determining pregnancy outcomes. Women in low-wage or temporary positions without job security experienced poorer outcomes compared to those in stable, well-paying jobs. The stress associated

with job insecurity and economic instability was linked to increased rates of adverse pregnancy outcomes (Ahmed et al., 2007).

Research indicates that place of residence significantly affects adverse pregnancy outcomes, with distinct disparities observed between urban and rural areas. Studies have demonstrated that mothers residing near highways face heightened risks of low birth weight, attributed to increased exposure to air pollution and environmental stressors (Genereux et al., 2008). In India, a study revealed that rural women experience significantly higher rates of adverse pregnancy outcomes compared to their urban counterparts. This disparity is primarily linked to limited access to healthcare services, lower educational levels, and poorer socioeconomic conditions in rural areas. Urban women typically benefit from better access to prenatal care and medical interventions; however, disadvantaged urban populations, such as those living in slums, still face risks comparable to those of rural residents (Dongarwar et al., 2020). Furthermore, research focusing on adolescent mothers has uncovered that those in rural areas encounter higher risks of adverse outcomes due to restricted healthcare access and poorer living conditions. While urban adolescent mothers generally fare better, those in low-income urban areas continue to experience significant risks (Amjad et al., 2019). Studies conducted in Iceland have also highlighted that women in rural and remote areas are at a higher risk for low birth weight, primarily due to inadequate access to specialised maternal healthcare (Haraldsdottir et al., 2015).

The association between religion, spirituality, and pregnancy outcomes is well-documented across various studies. Religion and spirituality significantly influence maternal and neonatal health, with cultural practices like home births, traditional medicine, and religious rituals impacting outcomes positively and negatively (Lang-Baldé et al., 2018; Ohaja et al., 2019). Spiritual practices offer emotional support and comfort during pregnancy and childbirth, helping women to manage stress

and challenges (Callister & Khalaf, 2010). Regular maternal religious attendance has been associated with reduced risks of adverse pregnancy outcomes largely due to the social support, healthy behaviours, and stress reduction fostered within religious communities (Burdette et al., 2012). However, integrating religious and cultural beliefs into maternal healthcare is essential for improving trust, communication, and overall care quality (Ohaja et al., 2019). These findings underscore the need for culturally sensitive approaches that respect traditional practices while promoting evidence-based care.

2.4.2 Healthcare factors and pregnancy outcomes among women

Healthcare factors play a vital role in determining pregnancy outcomes among women. Access to quality prenatal care, timely medical interventions, and health education significantly influence both maternal and foetal health. Numerous studies have demonstrated that women who maintain consistent prenatal visits are more likely to receive essential screenings and guidance, thereby reducing the risk of complications such as low birth weight (Kebede et al., 2018; Debelo et al., 2020). For example, Kebede et al. (2018) conducted a case-control analysis that emphasized the critical importance of adequate prenatal care. Their findings revealed that women who did not consistently attend prenatal check-ups were at an increased risk of complications, such as low birth weight. These results are consistent with the work of Debelo et al. (2020), which also highlighted the significance of timely prenatal care for older mothers. Their study suggested that consistent access to healthcare can reduce or eliminate the risks of poor pregnancy outcomes associated with advanced maternal age. Both studies reinforce the idea that inadequate prenatal visits impede early detection and management of potential health issues, underscoring the need for regular healthcare engagement. In exploring the geographical aspects of healthcare access, Haraldsdottir et al. (2015) found that maternal residence significantly influences birth outcomes. Their research revealed that

regions with a higher density of healthcare services reported improved pregnancy outcomes, particularly lower rates of low birth weight. Contrarily, Garcia-Subirats et al. (2012) examined geographic disparities while emphasizing the impact of neighbourhood characteristics. Their findings demonstrated that neighbourhoods with better access to healthcare services had lower rates of adverse outcomes, indicating that both the quantity of services and the local environment play crucial roles in maternal health. While Haraldsdottir et al. focused on service density, GarciaSubirats et al. (2012) expanded the discussion to include socio-economic factors that influence healthcare accessibility. Debelo et al. (2020) further investigated the implications of advanced maternal age on pregnancy outcomes, revealing that older mothers often face unique risks. This aspect is less emphasized in Kebede et al. (2018), which primarily addressed general prenatal care without specifically considering age-related factors. However, both studies converge on the necessity of timely healthcare access as a protective factor against adverse outcomes. While Kebede et al. focused on the risks associated with insufficient care, Debelo et al. (2020) highlighted the potential for tailored interventions for older mothers to improve outcomes. This suggests the need for differentiated strategies based on maternal age, which could be integrated into broader healthcare policies. Garcia-Subirats et al. (2012) provided a comprehensive analysis of how neighbourhood characteristics contribute to healthcare disparities, echoing the findings of Haraldsdottir et al. (2015) regarding geographical access while extending the discussion to encompass social determinants of health. Their study indicated that socio-economic conditions within neighbourhoods can exacerbate inequities in pregnancy outcomes, suggesting that merely increasing healthcare service density is insufficient without addressing the underlying socioeconomic factors. In conclusion, the literature indicates a complex interplay between healthcare factors and pregnancy outcomes. Consistent access to prenatal care, geographical disparities, and socio-economic influences all significantly affect maternal health. In some cases,

cultural beliefs may discourage women from seeking prenatal care or adhering to medical advice, further contributing to negative pregnancy outcomes (Kebede et al., 2018).

2.5 Theoretical Framework

This section outlines the theoretical framework for the study, which serves as a foundational structure guiding the investigation. Theoretical frameworks provide clarity and context for the problem statement, research purpose, significance, and research questions (Grant & Osanloo, 2014). By offering a systematic approach to understanding the phenomena under investigation, they enhance the rigor and relevance of the research. The significance of employing a theoretical framework lies in its capacity to integrate existing knowledge and concepts, thereby situating the research within a broader academic context. The fundamental unit of a theoretical framework is a theory or model, which enables researchers to articulate their hypotheses and interpret findings meaningfully (Imenda, 2014; Tewell, 2015). In this study, the theoretical framework illuminates the complex relationships between maternal age, socioeconomic and healthcare factors, and pregnancy outcomes, ultimately contributing to more informed interventions and policy recommendations. The present study used the social determinants of health and life course approaches in determining the association between maternal age and adverse pregnancy outcomes.

2.5.1 Social determinants of health (SDOH)

The Social Determinants of Health (SDOH) framework offers a useful lens for exploring the connection between maternal age at child birth and adverse pregnancy outcomes. SDOH encompass the social and economic factors that shape health disparities among individuals and populations (Braveman & Gottlieb, 2014). Rather than concentrating on individual risk factors, such as genetics or personal behaviour, SDOH underscore the broader context—including income distribution, education, housing, food security, employment, and access to healthcare—that shapes

health outcomes (Braveman & Gottlieb, 2014). These determinants are often the result of public policies, which in turn reflect the prevailing political ideologies and socio-economic structures within a society (Mikkonen, 2010). According to the World Health Organization (WHO), social determinants can exert a greater influence on health outcomes than healthcare or lifestyle choices alone (Wilt et al., 2023). Health disparities, including maternal health risks, frequently result from an unequal distribution of resources and opportunities. This inequality is driven by social policies, economic arrangements, and political factors that disproportionately affect disadvantaged populations, rendering them more vulnerable to adverse health outcomes (Braveman & Gottlieb, 2014). The theory posits that health begins where individuals live, work, and socialise, emphasising that SDOH impact a broad range of health outcomes by shaping the environments in which individuals are born, grow, and age. In the context of maternal age and pregnancy outcomes, SDOH are critical for understanding how factors beyond biological age influence maternal health. Younger mothers, particularly those who are teenagers, often encounter socio-economic challenges such as limited access to education, lower income, and inadequate healthcare, which elevate their risk of adverse outcomes like low birth weight and neonatal complications. Conversely, older mothers may experience economic stability but face different challenges, such as access to fertility treatments, higher risks of pregnancy-related complications, and age-related health conditions. The distribution of these health-promoting factors—whether access to quality prenatal care, safe housing, or nutritious food—is shaped by public policy, directly influencing maternal outcomes. Chronic stress, a key factor linked to adverse outcomes, is more prevalent among individuals living in disadvantaged social and economic conditions (Gouin, 2011). Therefore, applying the SDOH framework to the study of maternal age at birth in Liberia facilitates a deeper understanding of how non-medical factors, such as economic stability, healthcare access, and social support, contribute to the risk of adverse pregnancy outcomes. Since up to 80% of an individual's health outcomes are

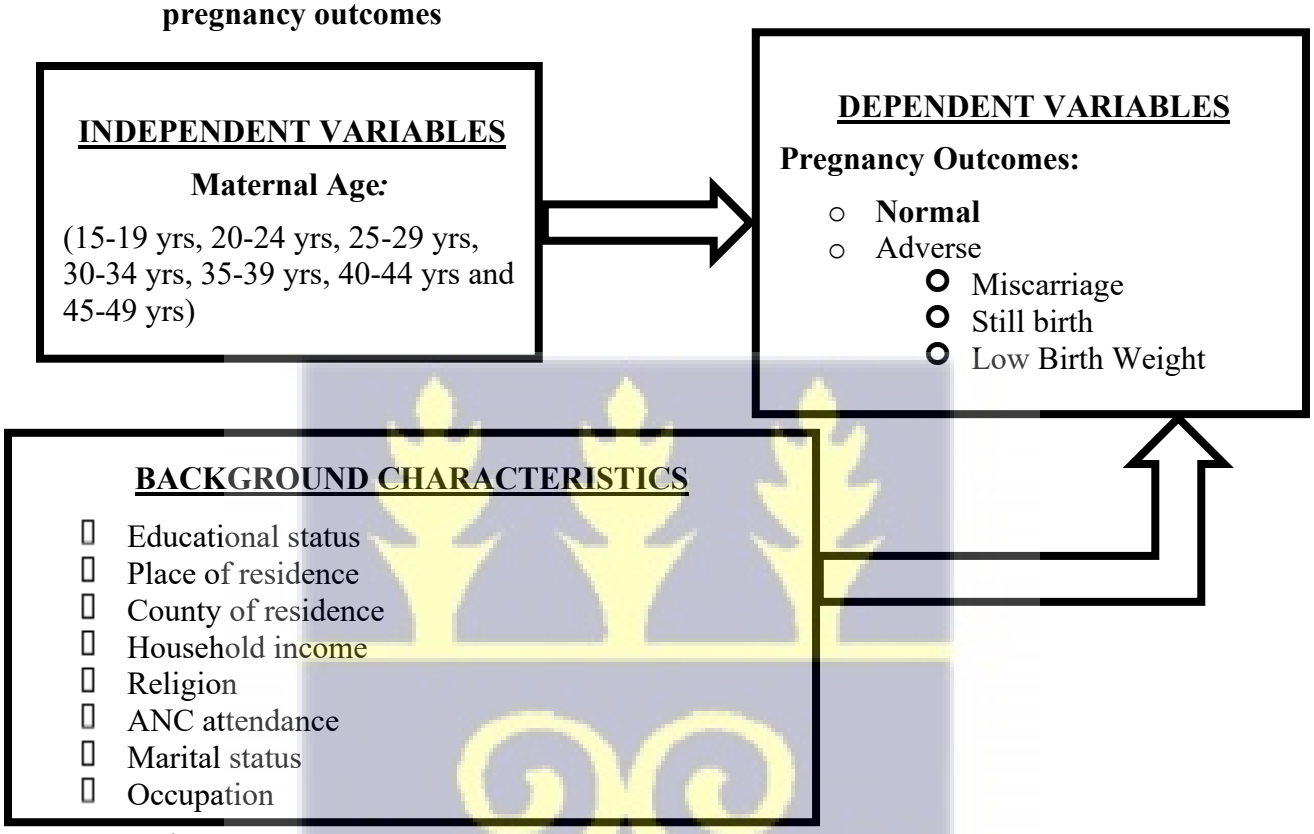
influenced by social, economic, and environmental factors rather than clinical care or genetics, it is crucial to explore how these determinants interact with maternal age (World Health Organization, 2013). Public policy decisions, both historical and contemporary, continue to shape the availability and quality of these determinants. Consequently, this framework not only aids in identifying risks but also highlights areas where targeted interventions can enhance maternal health outcomes, particularly among age groups considered at higher risk in low-resource settings such as Liberia.

2.6 Conceptual framework for the Study

This study's conceptual framework examines the relationship between maternal age at childbirth and adverse pregnancy outcomes in Liberia, employing the World Health Organization's framework on the determinants of maternal and newborn health. Maternal age at childbirth serves as the key independent variable, categorised into three groups: teenage (15–19 years), optimal reproductive age (20–34 years), and advanced maternal age (35-39 years, 40-44 years and 45-49 years. The dependent variable is a composite measure of adverse pregnancy outcomes, encompassing stillbirth, miscarriage (or terminated pregnancy), and low birth weight (LBW). These outcomes serve as significant indicators of maternal and neonatal health as evidenced in the 2019/2020 Liberia Demographic and Health Survey (LDHS). The framework also includes several control variables, such as socioeconomic status, educational level, marital status, employment, region of residence, access to antenatal care services, and place of delivery, which may confound or moderate the relationship between maternal age and pregnancy outcomes. This conceptual approach acknowledges that maternal age may influence outcomes both directly and indirectly through its interaction with socio-demographic and healthcare access factors. It provides a foundation for understanding age-related risk patterns and for informing maternal health interventions tailored to address vulnerable groups within the Liberian context. The incorporation

of these variables is substantiated by multi-country evidence in Sub-Saharan Africa, where antenatal care, autonomy, education, and wealth index have been found to significantly impact birth outcomes (Tamirat et al., 2021).

Figure 2. 1: Conceptual framework for studying the social determinants of adverse pregnancy outcomes



Source: Author's Construct.

2.7 Research Hypothesis

The study sought to test three main hypotheses.

1. Advanced maternal age (35 years and older) is significantly associated with an increased risk of adverse pregnancy outcomes, such as preterm birth, low birth weight, and miscarriage, among women of reproductive age in Liberia.
2. Higher income levels are significantly associated with better pregnancy outcomes compared to lower income levels among women of reproductive age in Liberia.

3. Higher education levels are significantly associated with better pregnancy outcomes compared to lower education levels among women of reproductive age in Liberia.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the methodology employed to address the research questions and test the hypotheses. It is organized to provide a clear and systematic description of the research process. The sections are as follows: (a) an overview of the study setting, including geographical location, population size and distribution, political environment, economic development, healthcare system, and population health status; (b) the research design, detailing the approach and structure of the study; (c) data sources and sampling methods, explaining the selection of participants and data collection procedures; (d) study variables, outlining the key independent and dependent variables under investigation; (e) data analysis techniques, describing the statistical tools and methods used to analyse the data; and (f) ethical considerations, addressing the measures taken to ensure the integrity and ethical standards of the research.

3.1 Research Design

The research design outlines the strategic approach taken to address the study's research questions and establish its overall framework. It encompasses theoretical foundations, research questions, data collection methods, and analytical approaches (Blair et al., 2023). For this study, a populationbased retrospective cross-sectional design was employed, utilizing secondary data from the 2019/2020 Liberia Demographic and Health Survey (LDHS). This design is well-suited for exploring the relationship between maternal age at birth and pregnancy outcomes in a large, representative population. By leveraging existing data, the study investigated the associations between maternal age and various pregnancy outcomes, considering biological, social, and cultural influences. The cross-sectional design enabled the concurrent measurement of maternal age and

pregnancy outcomes, offering a snapshot of the population at a specific moment. This approach allowed for the assessment of correlations without manipulating variables, making it ideal for analysing risk factors like maternal age in a real-world setting.

3.2 Study Area

This study utilised data from Liberia, a West African country bordered by Sierra Leone, Guinea, and Côte d'Ivoire, with a population of approximately 5.2 million according to the 2022 national estimates (LISGIS, 2022). Liberia is geographically situated between 4.21°N and 8.34°N, and 7.27°W and 11.31°W, exhibiting a roughly rectangular shape (Figure 3.1). The nation extends approximately 510 kilometres (317 miles) from northwest to southeast and is 275 kilometres (171 miles) wide. The coastline measures around 680 kilometres (423 miles) in length, with river mouths and inlets reaching widths of up to one kilometre (Hughes, 1992). Established as a West African republic by freed African Americans, Liberia's early settlers were sponsored by the American Colonization Society (ACS), which aimed to facilitate the relocation of freeborn and newly liberated African Americans. Liberia is divided into 15 counties, which are further subdivided into districts. The population is youthful, with nearly 60% under the age of 25, and women of reproductive age (15–49 years) constitute a significant portion of the adult female population. The country exhibits a mixed urban-rural demographic, with approximately 52% of the population residing in rural areas. Health indicators are concerning, with maternal mortality estimated at 742 deaths per 100,000 live births and neonatal mortality at 27 deaths per 1,000 live births (LDHS, 2020). Health infrastructure is unevenly distributed, leading to significant shortages of skilled birth attendants and essential maternal health services in rural regions. Liberia's economy is primarily driven by agriculture, mining, and forestry. The majority of the population is engaged in subsistence farming, particularly in rural areas, while urban areas focus on informal trading,

services, and public sector employment. Persistent poverty and economic inequality continue to affect access to healthcare and social services.

Source: Hughes, R. H. (1992).

Figure 3. 1: Map of Liberia

3.3 Data Source

Data sources refer to platforms, whether digital or physical, where information is stored in various formats, such as data objects or tables (Diène et al., 2020). This study relied on secondary data from the 2020 Liberia Demographic and Health Survey (LDHS 2020), a comprehensive, nationally representative, cross-sectional survey. Funded by the US Agency for International Development (USAID), the LDHS 2020 provides extensive data on population indicators, including maternal and child health, across all Liberian counties. This dataset was instrumental in examining the relationship between maternal age at birth and pregnancy outcomes within the Liberian context. The DHS data collection tools were developed and standardized by ICF International and were pre-tested to ensure reliability and validity across survey domains, including maternal and child health.

3.4 Sample Size and Recruitment of Participants

Sampling and recruitment of respondents are critical procedures in research, ensuring high-quality and credible results (Wheeler, 2015). The sampling frame for the 2019/2020 Liberia Demographic and Health Survey was derived from the 2008 National Population and Housing Census, which furnished a comprehensive list of enumeration areas utilised in the sample design. Clusters were systematically selected from this list to conduct the survey. Data collection was managed by trained female interviewers who possessed post-secondary education and fluency in the local language of the survey site. These interviewers underwent rigorous training, which included pre- and posttests, as well as practical simulations conducted in counties and towns distinct from the survey locations. To enhance the quality of survey implementation, a second interviewer was assigned to verify each interviewer's compliance with sample standards and data collection protocols.

National-level supervisors, including representatives from USAID, Liberia's National Population Commission, and various UN partner organisations, provided oversight throughout the process. Additionally, local leaders were informed about the survey's objectives and they assisted in the enumeration of households at the survey sites. Employing a stratified two-stage cluster sampling design, the survey successfully recruited and interviewed 2,315 women aged 15 to 49 who gave birth between January 2015 and December 2020, the five years preceding the survey. These women were questioned regarding their utilisation of prenatal, delivery, and postnatal care during their most recent childbirth. Information was also collected about the location and provider of each component of maternal, neonatal, and child healthcare. Additional data gathered included details on the marital status, age at marriage, sexual health concerns, reproductive preferences, family planning practices, and socio-demographic characteristics of both the women and their partners.

The survey achieved a high response rate of 97%. The methodology of the 2020 LDHS, including detailed survey results, is accessible online.

3.6 Variables and their Measurements

In statistical research, a variable is defined as an attribute of the subject under study, and selecting appropriate variables is crucial for effective experimental design (Mertler et al., 2021). The independent variable for this study is maternal age, categorized into two groups: women under 35 years and those aged 35 to 49 years. Maternal age significantly predicts pregnancy outcomes, with younger women generally experiencing lower risks of adverse outcomes.

The dependent variable in this study is adverse pregnancy outcomes, operationalised as a composite variable. This variable encompasses any occurrence of one or more of the following: (1) stillbirth, defined as the birth of a baby displaying no signs of life at or after 28 weeks of gestation; (2) miscarriage or terminated pregnancy, referring to the loss of pregnancy prior to viability; and (3) low birth weight, characterised as a birth weight of less than 2,500 grams. Women who reported experiencing any of these outcomes were classified as having experienced an adverse pregnancy outcome, whereas those who did not report any such occurrences were classified as having had none.

These outcomes are essential indicators of maternal and child health, facilitating the assessment of how maternal age influences pregnancy-related health. The control variables include educational status, categorized into five levels from no education to higher education, as education impacts health behaviours and access to care. Place of residence is classified as urban or rural, reflecting mainly differences in healthcare access, while the county of residence covers 15 counties in Liberia, accounting for regional disparities in healthcare and economic conditions. Household income status is classified into low, middle, and high-income levels, influencing access to

healthcare and nutrition. Religion is categorized into Christianity, Islam, traditional/indigenous, and other, as it affects health behaviours and attitudes toward healthcare. Antenatal care (ANC) attendance is categorized as having at least one visit or no visits, emphasizing its importance for monitoring pregnancy health. Marital status includes categories of married, never in union, divorced, and widowed/separated, reflecting social support and healthcare access. Lastly, employment status is classified as currently employed or not, indicating socioeconomic conditions that can impact health and pregnancy outcomes.

Table 3.1: Study variables

Variable	Measurements
Independent Variable:	
Age (year)	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, & 45-49.
Dependent Variables:	
Pregnancy outcomes	Normal pregnancy outcomes Adverse pregnancy Outcomes (Miscarriage, Stillbirth, Low Birth Weight)
Control Variables:	
Educational Status	No Education, Elementary School, Junior High School, Senior High School, Higher Education
Place of Residence	Urban and Rural
County of Residence	Bomi, Bong, Grand Bassa, Gbarpolu, Grand Cape Mount, Grand Gedeh, Lofa, Margibi, Grand Kru, Maryland, River Cess, Montserrado, Nimba, River Gee, Sinoe

Household Income	Low Income, Middle Income, High Income
Religion	Christianity, Islam, Traditional/Indigenous, Other
ANC Attendance	0-4, 5-8 and above 8
Marital Status	Never in union, Married, previously married (including divorced, widowed, & separated)
Employment status	Yes, No

3.7 Data Analysis

The data analysis was performed using STATA version 15.1. Descriptive statistics were used to summarize participants' background characteristics and adverse birth outcomes. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized using means. Bivariate analysis, employing the Chi-square test, was conducted to examine associations between potential covariates and composite adverse pregnancy outcomes, with significance evaluated at a 95% confidence interval.

Subsequently, multiple binary regression analysis was performed to identify factors influencing adverse pregnancy outcomes (Still birth, low birth weight or terminated pregnancy). The analysis computed for unadjusted odds ratios for each predictor variable, followed by adjusted odds ratios after controlling for potential confounders. The primary aim was to assess associations between maternal age at birth, socioeconomic and demographic factors, and prenatal care services—such as the number of prenatal visits, with composite adverse pregnancy outcomes. The critical values for hypothesis testing were derived from the odds ratios obtained through the regression analysis, with significance assessed at a 95% confidence level. To mitigate potential biases, including

sampling and information bias, sample weights from the dataset were applied throughout the analysis to ensure more accurate and generalisable findings.

3.8 Limitations of the Study

The limitations of this study stem from various factors related to the research design, data source, and methodological approach. Firstly, the use of a cross-sectional design restricts causal inference, as it provides only a snapshot of the population at a single point in time. This design does not allow for the determination of temporal relationships between maternal age and pregnancy outcomes, which hampers the ability to infer causation. Secondly, reliance on secondary data from the 2019/2020 Liberia DHS limits the study to the variables included in the survey, potentially overlooking other influential factors. Additionally, the retrospective nature of the LDHS data may have introduced recall bias, as respondents might have inaccurately reported events or experiences. Furthermore, the generalisability of the study may be constrained by socio-cultural and geographic factors unique to Liberia, limiting the applicability of the findings to other contexts. Lastly, although sample weighting was applied to enhance representativeness, residual confounding factors may still impact the analysis, as not all potential confounders could be controlled. These limitations suggest that caution should be taken when interpreting the results. They also highlight the need for further longitudinal studies to gain a clearer understanding of these associations.

CHAPTER FOUR

RESULTS

4.0 Introduction

This chapter is on the presentation of the results of the analysis of the data. First, this section presents the descriptive statistics of the background characteristics of the participants. Also, in this chapter, is the prevalence of any adverse pregnancy outcomes, bivariate, and multivariate analysis of the maternal factors associated with the pregnancy outcomes.

4.1 Socio-demographic characteristics of the Women

Table 4.1 presents the socio-demographic characteristics of the participants. The analysis was conducted using a weighted sample of 4,216 women aged 15–49 who had experienced a live birth in the five years preceding the 2019/2020 Liberia Demographic and Health Survey (LDHS) and for whom complete data were available concerning maternal age, pregnancy outcomes, and pertinent covariates. The age distribution reveals that the highest percentage of the participants were in the age group 15-19 years (21.28%), followed by those in the 20-24 age group (17.46%). Participants aged 25-29 and 30-34 accounted for 14.9% and 13.04% respectively, while the remaining 33.32% consisted of older age groups (35-49). In terms of educational level, more than a third (37.01%) had no formal education, while 29.62% had completed primary education. A significant proportion (30.33%) had attained secondary education, and only a small percentage (3.04%) had achieved higher education. With regards to residence, close to almost 6 out of every 10 (58.61%) of the participants resided in rural areas, while the remaining 41.39% lived in urban areas. Analysis of the regional distribution reveals that the highest percentage reside in the SouthCentral region (28.53%), followed by the North Central region (23.87%) and South-Eastern B region (18.43%). The dominant religious affiliation among the participants was Christianity

(85.28%), with 12.97% identified as Muslims. The majority (64%) of the participants were employed, while 36% reported that they do not have employment. With regard to wealth status, a little more than a quarter fell within the poorest (26.1%) and poorer (25.2%) categories. A little more than a tenth (12%) belong to the richest group. Data on marital status indicate that almost a third (32.5%) were never in a union while close to 28.7% were married and 29.0% were living with partners.

Table 4.1: Socio-demographic characteristics of the participants (n = 4,216) Variable

Age Groups	**Number**	**Percent**
15-19	1,716	21.3
20-24	1,408	17.5
25-29	1,202	14.9
30-34	1,052	13.0
35-39	1,103	13.7
40-44	857	10.6
45-49	727	9.0
Educational Level		
No Education	2,985	37.0
Primary	2,389	29.6
Secondary	2,446	30.3
Higher	245	3.0
Place Of Residence		
Urban	3,338	41.4
Rural	4,727	58.6
Region		
North-Western	1,158	14.4
South-Central	2,301	28.5
South-Eastern A	1,195	14.8
South-Eastern B	1,486	18.4
North Central	1,925	23.9
Religion		
Christian	6,878	85.3
Muslim	1,046	13.0
Traditional Religion	42	0.5
No Religion	98	1.2
employment status		
No	2,900	36.0

Yes	5,165	64.0
Wealth Index		
Poorest	2,104	26.1
Poorer	2,029	25.2
Middle	1,723	21.4
Richer	1,242	15.4
Richest	967	12.0
Marital Status		
Never in union	2,621	32.5
Married	2,315	28.7
Living with partner	2,339	29.0
Previously married	790	9.8

Source: Liberia Demographic and Health Survey Dataset, 2019/2020

4.2 Pregnancy outcomes by age groups of women of reproductive age

The findings presented in Table 4.2 summarises the prevalence of normal and adverse pregnancy outcomes (defined as stillbirths, LBW, or terminated pregnancies) among different age cohorts. The result showed a consistent increase of adverse pregnancy outcomes across age groups of women. Women aged 15-19 years had the lowest prevalence (7.8%), while the highest prevalence of adverse pregnancy outcomes was observed among women aged 40-44 years (36.2%). Nearly a third of women aged 30-34 years (30.3%) and a third (33.4%) of women aged 35-39 years also experienced adverse pregnancy outcomes. This suggests that the risk of adverse pregnancy outcomes significantly increases with maternal age, as supported by the high chi-square value (466.366) and a significant p-value (<0.001). Overall, the average percentage of adverse pregnancy outcomes in this study was 24.2% among the women of reproductive age.

Table 4.2: Prevalence of pregnancy outcomes by age groups of participants (n = 4,216).

Pregnancy Outcomes

Age groups	Normal pregnancy outcome	Adverse pregnancy outcome	
15-19 yrs	92.2		7.8
20-24 yrs	81.5		18.5
25-29 yrs	74.5		25.5
30-34 yrs	69.7		30.3
35-39 yrs	66.6		33.4
40-44 yrs	63.8		36.2
45-49 yrs	64.8		35.2
Totals	**75.8**		**24.2**
Chi-Square		466.366	
P-Value		<0.001	

Source: Liberia Demographic and Health Survey Dataset, 2019/2020 Chi-Square test at statistical significance of <0.005.

4.3 Association between maternal age at birth and adverse pregnancy outcomes

The unadjusted odds ratio of experiencing adverse pregnancy outcomes was nearly three times higher (OR=2.696; 95% CI: 2.158-3.367) for women aged 20-24 years compared to those aged 15-19 years. As maternal age increases, the risk of adverse pregnancy outcomes also rises. The odds increased to more than four times for women aged 25-29 years (OR=4.083; 95% CI: 3.2795.084), five times for those aged 30-34 years (OR=5.180; 95% CI: 4.155-6.457), almost six times for women aged 35-39 years (OR=5.959; 95% CI: 4.798-7.401), and nearly seven times for women aged 40-44 years (OR=6.745; 95% CI: 5.385-8.449). Although there was a slight decrease in risk for women aged 45-49 years, the odds ratio remained high (OR=6.469; 95% CI: 5.123-8.170), indicating they were still 6.5 times more likely to experience adverse outcomes compared to the youngest age group. The unadjusted binary regression results reveal a clear trend of increasing odds of adverse pregnancy outcomes as maternal age rises. Women in older age groups (30-49 years)

were at a significantly higher risk compared to the youngest mothers (15-19 years), with the highest risk observed in the 40-44-year age group. Each age group had a statistically significant association with adverse pregnancy outcomes ($p < 0.001$), emphasising the importance of maternal age as a significant factor in pregnancy outcome.

Table 4.3: Unadjusted binary regression between maternal age at birth and adverse pregnancy outcomes

Maternal age groups	OR	95% Conf. I.		P-value
15-19 yrs = refer.	1.00			
20-24 yrs	2.696	2.158	3.367	<0.001
25-29 yrs	4.083	3.279	5.084	<0.001
30-34 yrs	5.180	4.155	6.457	<0.001
35-39 yrs	5.959	4.798	7.401	<0.001
40-44 yrs	6.745	5.385	8.449	<0.001
45-49 yrs	6.469	5.123	8.170	<0.001

Source: Liberia Demographic and Health Survey Dataset, 2019/2020
Binary logistic regression was conducted, with a statistical significance threshold set at 0.05. The reference category is normal pregnancy outcome.

4.4 Relationship between socio-economic, healthcare factors and pregnancy outcomes among women.

4.4.1 Bivariate analysis between maternal factors and adverse pregnancy outcomes Table 4.4 compares pregnancy outcomes based on various background characteristics among women of reproductive age. For education levels, women with no education had a higher proportion of adverse outcomes (27.5%) compared to those with primary (21.5%) and secondary education (22.4%). Notably, women with higher education experienced even more adverse outcomes (28.6%). The association between education and pregnancy outcomes is statistically significant

(Chi-Square = 34.092, P < 0.001). Regarding place of residence, the difference between urban (24.1%) and rural areas (24.3%) is minimal and not statistically significant (Chi-Square = 0.012, P = 0.902), indicating residence has little impact on outcomes. Regional variation is significant, with the North-central region showing the lowest adverse outcome rate (19.9%) and the North-western (27.9%) and South-eastern A (27.2%) regions the highest (Chi-Square = 36.008, P < 0.001). For religion, women with no religious affiliation had the lowest adverse outcome rate (14.3%), while those practicing traditional religion had the highest (28.6%). The differences between religious groups are significant (Chi-Square = 10.258, P = 0.036). Employment status shows a significant impact, with unemployed women experiencing fewer adverse outcomes (17.3%) than employed women (28.1%) (Chi-Square = 118.839, P < 0.001). In terms of marital status, women never in a union had the lowest adverse outcome rate (12.4%), while widowed (40.7%) and divorced (38.5%) women had much higher rates. This association is highly significant (Chi-Square = 313.367, P < 0.001). Lastly, wealth index and antenatal care (ANC) visits showed no statistically significant differences in pregnancy outcomes, with similar proportions across groups (P > 0.05), suggesting these factors have less influence on pregnancy outcome compared to others like education, region, religion, employment, and marital status.

Table 4.4: Background characteristics and adverse pregnancy outcomes among women of reproductive age.

Variables	Pregnancy Outcomes		Chi-Square	P-value
	Normal	Adverse		

Source: Liberia Demographic and Health Survey Dataset, 2019/2020

4.4.2 Multiple binary regressions between maternal factors and pregnancy outcomes

The findings from the multiple logistic regression analysis revealed significant associations between maternal age groups and pregnancy outcomes after adjusting for background

characteristics such as education, region, marital status, and employment. The odds of experiencing adverse outcomes increased with maternal age. Compared to women aged 15-19 years (reference group), those aged 20-24 had 2.23 times higher odds (adjusted odds ratio [aOR] = 2.23, 95% CI: 1.77 - 2.83, $p < 0.001$), while the odds progressively increased across the age groups, peaking at 5.12 times higher for women aged 40-44 years (aOR = 5.12, 95% CI: 3.92 - 6.71, $p < 0.001$). Women aged 45-49 years had slightly lower odds compared to those aged 40-44 (aOR = 4.94, 95% CI: 3.73 - 6.54, $p < 0.001$), though the association remained significant.

Women with secondary education (aOR = 1.39, 95% CI: 1.20 - 1.60, $p < 0.001$) and higher education (aOR = 1.42, 95% CI: 1.04 - 1.92, $p = 0.026$) had significantly increased odds of adverse pregnancy outcomes compared to those with no education, while women with primary education also had significantly increased odds (aOR = 1.23, 95% CI: 1.07 - 1.41, $p = 0.004$).

The results also showed that women in the North-Central region had significantly 39% lower odds of adverse pregnancy outcomes compared to the North-Western region (aOR = 0.61, 95% CI: 0.51 - 0.74, $p < 0.001$). However, no significant associations were found in the South-Eastern A and B regions. Marital status was another key factor. Married women had significantly higher odds of adverse outcomes compared to women never in union (aOR = 1.45, 95% CI: 1.20 - 1.75, $p < 0.001$), as did women living with a partner (aOR = 1.56, 95% CI: 1.31 - 1.85, $p < 0.001$), widowed women (aOR = 2.12, 95% CI: 1.45 - 3.09, $p < 0.001$), divorced women (aOR = 1.81, 95% CI: 1.06 - 3.08, $p = 0.030$), and separated women (aOR = 1.69, 95% CI: 1.34 - 2.13, $p < 0.001$). Finally, employment status was associated with adverse outcomes, where employed women had significantly higher odds (aOR = 1.23, 95% CI: 1.08 - 1.39, $p = 0.001$) compared to unemployed women. Overall, maternal age, education, region, marital status, and employment status remained significant predictors of adverse pregnancy outcomes in the adjusted model.

Highest education levels				
No education	72.5	27.5		
Primary educ.	78.5	21.5	34.092	<0.001
Secondary educ.	77.6	22.4		
Higher educ.	71.4	28.6		
Place of residence				
Urban	75.9	24.1	0.012	0.902
Rural	75.7	24.3		
Region				
North-western	72.1	27.9		
South-central	76.6	23.4		
South-eastern A	72.8	27.2	36.008	<0.001
South-eastern B	74.3	25.7		
North central	80.1	19.9		
Religion				
Christian	75.5	24.5		
Muslim	77.2	22.8	10.258	0.036
Traditional religion	71.4	28.6		
No religion	85.7	14.3		
Employed				
No	82.7	17.3	118.839	<0.001
Yes	71.9	28.1		
Marital status				
Never in union	87.6	12.4		
Married	69.5 72.0	30.5 28.0		
Living with partner	59.3	40.7		
Widowed			313.367	<0.001
Divorced	61.5	38.5		
Separated	68.4	31.6		
Wealth index				
Poorest	76.1	23.9		
Poorer	75.9	24.1		
Middle	75.2	24.8	1.840	0.765
Richer	74.9	25.1		

Richest	77.0	23.0		
ANC Visits				
0-4 visits	75.2	24.8		
5-8 visits	76.5	23.5	1.450	0.487
9-20 visits	74.3	25.7		

Table 4. 5: Unadjusted and adjusted binary regression between maternal age at birth and adverse pregnancy outcomes

Variables	cOR	95% C.I.	P-value	aOR	95% C.I.	P-value
Maternal age groups 15-19 yrs = Ref.	1.00			1.00		
20-24 yrs	2.70	(2.16 - 3.37)	<0.001	2.23	(1.77 - 2.83)	<0.001
25-29 yrs	4.08	(3.28 - 5.08)	<0.001	3.13	(2.45 - 4.00)	<0.001
30-34 yrs	5.18	(4.16 - 6.46)	<0.001	3.80	(2.94 - 4.91)	<0.001
35-39 yrs	5.96	(4.80 - 7.40)	<0.001	4.53	(3.50 - 5.86)	<0.001
40-44 yrs	6.75	(5.39 - 8.45)	<0.001	5.12	(3.92 - 6.71)	<0.001
45-49 yrs	6.47	(5.12 - 8.17)	<0.001	4.94	(3.73 - 6.54)	<0.001
Education Levels						
No Education = Ref.	1.00			1.00		
Primary	0.72	(0.64 - 0.82)	<0.001	1.23	(1.07 - 1.41)	0.004
Secondary	0.76	(0.67 - 0.86)	<0.001	1.39	(1.20 - 1.60)	<0.001
Higher	1.05	(0.79 - 1.41)	0.719	1.42	(1.04 - 1.92)	0.026
Region						
North-Western = Ref.	1.00			1.00		
South Central	0.79	(0.67 - 0.93)	0.004	0.81	(0.68 - 0.97)	0.022
South-Eastern A	0.97	(0.81 - 1.16)	0.705	0.90	(0.74 - 1.10)	0.313
South-Eastern B	0.89	(0.75 - 1.06)	0.207	0.93	(0.77 - 1.13)	0.485
North Central	0.64	(0.54 - 0.76)	0.000	0.61	(0.51 - 0.74)	<0.001
Religion						
Christians = Ref.	1.00			1.00		
Muslim	0.91	(0.78 - 1.06)	0.238	0.92	(0.77 - 1.11)	0.388
Traditional Religion	1.23	(0.63 - 2.41)	0.545	1.45	(0.73 - 2.91)	0.290
No Religion	0.51	(0.29 - 0.91)	0.021	0.63	(0.35 - 1.13)	0.119
Marital Status						
Never in union = Ref.	1.00			1.00		

Married	3.11	(2.68 - 3.59)	<0.001	1.45	(1.20 - 1.75)	<0.001
Living with partner	2.74	(2.37 - 3.18)	<0.001	1.56	(1.31 - 1.85)	<0.001
Widowed	4.85	(3.41 - 6.89)	<0.001	2.12	(1.45 - 3.09)	<0.001
Divorced	4.42	(2.64 - 7.38)	<0.001	1.81	(1.06 - 3.08)	0.030
Separated	3.26	(2.64 - 4.02)	<0.001	1.69	(1.34 - 2.13)	<0.001
Employed						
No = Ref.	1.00			1.00		
Yes	1.87	(1.67 - 2.10)	<0.001	1.23	(1.08 - 1.39)	0.001

Source: Liberia Demographic and Health Survey Dataset, 2019/2020

Reference category is adverse pregnancy outcomes (including LBW, terminated pregnancy and stillbirth). cOR and aOR indicate crude and adjusted odds ratios, respectively. Multiple logistic regression was conducted at a statistical significance level of 0.05.

CHAPTER FIVE

DISCUSSION

5.0 Introduction

This chapter presents the discussion on the findings from the current study, organised around the study's three principal objectives. Each section interprets and contextualises the findings, employing comparative analysis with extant literature. The analysis underscores significant patterns and divergences, providing insights into the broader implications of the results. Furthermore, the chapter examines the public health policy implications of the findings, underscoring their relevance for informing interventions and strategies aimed at enhancing health outcomes.

5.1 Prevalence of pregnancy outcomes

The study found a significant correlation between advancing maternal age and an increase in adverse pregnancy outcomes. Among the age groups analysed, adolescents aged 15–19 years exhibited the lowest prevalence of adverse outcomes at 7.8% while women aged 40–44 years experienced the highest prevalence at 36.2%. Intermediate age groups, such as women aged 30–34 years (30.3%) and 35–39 years (33.4%), also demonstrated elevated rates, indicating a trend that peaks at older maternal ages. Overall, the study found a 24.3% prevalence of adverse pregnancy outcomes. These findings are consistent with similar studies in Ethiopia which reported a prevalence of adverse outcomes ranging from 24.5% to 26.9% (Abdo et al., 2016; Gedefaw et al., 2020). The increased prevalence of adverse pregnancy outcomes is exacerbated by persistent healthcare disparities, particularly in low-resource settings such as Liberia (Roberts et al., 2024). Factors such as limited access to comprehensive antenatal care, maternal health education, and socioeconomic barriers significantly contribute to adverse outcomes across age groups (Arsenault

et al., 2018; Saali et al., 2018). For older mothers, complications such as hypertension, placental insufficiency, and pre-existing health conditions are common, increasing the likelihood of adverse outcomes (McNestry et al., 2023). The prevalence of adverse pregnancy outcomes observed in this study aligns with regional estimates from a pooled DHS analysis across ten SSA countries, which reported a prevalence of 29.7% (Tamirat et al., 2021). Conversely, younger mothers face challenges related to physiological immaturity and inadequate prenatal care (Pietras et al., 2024), which heightens their vulnerability despite their overall lower prevalence rates in the current study. These results underscore the urgent need for targeted public health interventions to mitigate adverse pregnancy outcomes across age groups. Key strategies should include strengthening maternal health services, expanding antenatal care coverage, and implementing age-specific educational programmes to address the unique risks faced by both younger and older mothers. In particular, Liberia must focus on such initiatives to align with the goals outlined in the 'Every Newborn Action Plan' and to meet global targets for maternal and neonatal health by 2030 (WHO, 2024a). Investments in maternal healthcare infrastructure and education are critical for tackling the multifactorial causes of adverse outcomes and achieving sustainable improvements in maternal and child health.

5.2 Association between maternal age and pregnancy outcomes

The results of this study demonstrate that the odds of experiencing adverse pregnancy outcomes, including stillbirth, low birth weight, and miscarriage, increase progressively with advancing maternal age. Compared to women aged 15-19 years, those aged 20-24 years exhibit 2.23 times higher odds of experiencing adverse outcomes, with the risk continuing to rise across age groups. The odds peak at 5.12 times higher for women aged 40-44 years, followed by a slight reduction in the 45–49-year group. This association between maternal age and adverse pregnancy outcomes

aligns with findings from several studies such as Khalil et al. (2013) who reported that the odds of miscarriage in women over 40 years are nearly three times higher than in younger mothers. Similarly, a national cohort study from the Netherlands indicated an elevated risk of adverse perinatal outcomes in women of advanced maternal age (Kortekaas et al., 2020). These studies support the notion that the risk of adverse outcomes significantly increases as women age. The findings of this study are consistent with those findings. The influence of maternal age on adverse pregnancy outcomes is well-documented in the literature, particularly for women classified as advanced maternal age (AMA), typically defined as those who are 35 years and older. Research consistently shows that AMA is strongly associated with an increased risk of stillbirth. For instance, Lean et al. (2017) conducted a systematic review and found that women of AMA face significantly higher risks of stillbirth compared to younger women. Frick (2021) corroborated this by reporting elevated stillbirth rates and other complications among older women. Similarly, Kortekaas et al. (2020) highlighted that those women aged 35 years and older, particularly those delivering at or beyond 41 weeks of gestation, face a considerably higher risk of stillbirth, underscoring the critical need for enhanced antenatal care in this group. The findings from this study reflect this pattern, demonstrating increased odds of stillbirth and other adverse outcomes with rising maternal age. The relationship between maternal age and low birth weight (LBW) is also complex and varies across different age groups. Studies suggest that both very young and older mothers are at elevated risk of LBW infants. Liu and Zhang (2014) reported that adolescent mothers aged 15-19 years are more likely to give birth to LBW infants than mothers aged 25-29 years, while Montori et al. (2021) found that women aged 35 and older also exhibit increased risks of LBW. This pattern is consistent with study's findings that adverse outcomes, including LBW, are more prevalent among older women. The finding that adolescents experience lower rates of adverse pregnancy outcomes contradict with evidence from Mombo-Ngoma et al. (2016), which demonstrated that adolescent

mothers, particularly those aged 16 years or younger, face significantly increased risks of preterm birth and low birth weight. Their study, conducted across four African countries, reinforces the necessity for maternal care strategies that are specifically tailored to the needs of adolescents. These findings emphasise the need for tailored prenatal interventions targeting both younger and older maternal age groups to reduce the risk of LBW and improve infant health. Miscarriage, as one of the most common early pregnancy complications, is strongly influenced by maternal age. Khalil et al. (2013) reported that women aged 40 and older have more than double the odds of miscarriage compared to younger women. The present study aligns with the findings of the study conducted by Khalil et al. (2013). Frick (2021) also observed that the risks of miscarriage, particularly during the first and second trimesters, are significantly higher in women of AMA, due to factors such as chromosomal abnormalities. Frederiksen et al. (2018) further supported this by indicating that women over 40 are at heightened risk of miscarriage and other adverse outcomes resulting from chromosomal issues. The findings of this study align with those studies, highlighting the increasing risk of miscarriage as maternal age advances and underscoring the need for close monitoring and comprehensive care for older pregnant women.

In conclusion, this study reinforces the evidence that maternal age is a critical determinant of adverse pregnancy outcomes, with both younger and older women facing distinct risks. As maternal age continues to rise globally, the need for age-specific prenatal care becomes increasingly important. Enhanced antenatal care that addresses the unique risks associated with advanced maternal age, such as stillbirth, LBW, and miscarriage, is essential for improving maternal and neonatal health outcomes. Effective planning for childbirth, alongside close monitoring during pregnancy, may prevent these risks and contribute to better outcomes for both mother and child.

5.3 Adverse pregnancy outcomes and maternal socioeconomic characteristics

The findings of the current study reveal that higher levels of education are paradoxically associated with increased odds of adverse pregnancy outcomes. This observation deviates from a substantial body of existing literature, including studies by Kebede et al. (2018) and Rogne et al. (2024), which show a protective effect of higher maternal education on outcomes such as LBW. Specifically, these studies indicate that women with higher education are more likely to engage in health promoting behaviours, access healthcare services, and mitigate complications. In contrast, this study found that women with secondary and higher education had significantly higher odds of experiencing adverse pregnancy outcomes. This may point to context-specific factors, such as differences in healthcare access or health-seeking behaviours that are not fully captured by education level alone. It is also possible that educated women may delay childbirth to pursue academic and career goals, which could increase the risk of complications associated with advanced maternal age (Khalil et al., 2013; Kortekaas et al., 2020), thereby contributing to the higher rates of adverse outcomes as observed in this study.

Regional disparities in pregnancy outcomes represent another critical aspect of comparison. The literature review underscores that women residing in low-income areas and regions with limited healthcare access face a heightened risk of adverse pregnancy outcomes. For example, Luo et al. (2006) and Nagahawatte (2008) linked poorer pregnancy outcomes to areas with lower socioeconomic status and restricted access to healthcare. Similarly, in the current study, women from the North-Central Region demonstrated significantly lower odds of adverse outcomes compared to those from the North-Western Region. This disparity may reflect regional variations in healthcare services and infrastructure. The enhanced access to health and education in more urbanised areas, such as Gbarnga and Ganta in the North-Central Region, may have contributed to

improved maternal health outcomes in this area, corroborating findings by Shan et al. (2018) which also highlighted the impact of regional differences on adverse pregnancy outcomes. Marital status emerged as a significant socio-economic factor influencing pregnancy outcomes, with married women and those cohabiting with partners exhibiting higher odds of adverse pregnancy outcomes in comparison to never-married women. This finding contrasts with the prevailing assumption that marital status generally provides a protective effect due to enhanced social and financial support. However, research such as that conducted by Amjad et al. (2019) has underscored the potential stressors inherent in marriages or partnerships, including domestic violence or increased household responsibilities, which may heighten health risks. In accordance with this, the current study posits that increased parity among married women could contribute to these elevated odds, as greater parity is associated with heightened risks of pregnancy-related complications.

Employment status is also linked to adverse pregnancy outcomes, and the findings are consistent with existing literature. Similar to the work of Maher et al. (2023), the current study identified that employed women have higher odds of adverse pregnancy outcomes compared to unemployed women, likely due to occupational hazards or the stress associated with balancing work and pregnancy. Women engaged in physically demanding jobs or those requiring long hours may encounter increased risks of complications, corroborating findings from prior studies. Notably, while religious affiliation was not a primary focus in the initial literature review, it emerged as a significant variable in the current study. This underscores the necessity for context-specific analyses, wherein cultural and religious factors may exert a more substantial influence on health behaviours and outcomes, consistent with previous findings (Kang et al., 2020; WüthrichGrossenbacher et al., 2023).

Despite the well-established role of antenatal care (ANC) in improving pregnancy outcomes, the current study did not find statistically significant differences in adverse outcomes based on the number of ANC visits among women in Liberia. This contrasts with prior studies, such as those by Kebede et al. (2018) and Debelo et al. (2020), which emphasised the importance of regular ANC visits in reducing adverse pregnancy outcomes. Further exploration of healthcare quality and accessibility in Liberia may explain these findings.

Muslim and Traditional Religion practitioners did not show significant associations with adverse pregnancy outcomes compared to Christians, while women without religion had a lower crude odds ratio for adverse outcomes, but this was not significant after adjustment. Previous studies indicate that regular religious attendance often reduces the risk of adverse outcomes like low birth weight due to the social support, healthy behaviours, and stress relief promoted within religious communities (Burdette et al., 2012). However, there is a need to integrate religious considerations into maternal healthcare to enhance overall care quality and trust between healthcare providers and patients (Ohaja et al., 2019).

In conclusion, while the broader literature underscores the protective nature of higher education and improved socio-economic status, the current study reveals complex, at times contradictory, associations between education, marital status, and employment with adverse pregnancy outcomes. This highlights the importance of considering contextual factors such as healthcare access, cultural practices, and regional disparities when analysing pregnancy outcomes across diverse populations. Addressing these context-specific factors is essential for the development of effective public health interventions aimed at mitigating adverse pregnancy outcomes.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Main Findings

The study aimed to determine the prevalence of pregnancy outcomes—including stillbirth, low birth weight, and terminated pregnancies—among women of reproductive age in Liberia, while also examining the influence of maternal age at birth on these outcomes. Using data from 8,065 women in the Liberia Demographic and Health Survey 2019/2020, the findings revealed a steady increase in adverse pregnancy outcomes with advancing maternal age. The highest prevalence was observed among women aged 40–44 years (36.2%), while the lowest prevalence was recorded among adolescents aged 15–19 years (7.8%). Overall, 24.2% of women experienced adverse pregnancy outcomes, emphasizing the significant impact of maternal age. The study demonstrates a strong correlation between maternal age and adverse pregnancy outcomes, with elevated risks particularly evident for younger mothers (15–19 years) and older mothers (45–49 years). Women in the mid-reproductive age range (30–34 years) were found to be at relatively lower risk. These findings suggest that the likelihood of adverse pregnancy outcomes increases significantly with age, particularly for women aged 30 years and older.

Unexpectedly, women with secondary or higher education demonstrated higher odds of adverse outcomes compared to those with no education, implying that other factors, such as socioeconomic conditions or health issues, may contribute to these risks. Furthermore, regional disparities indicated that women in urbanised areas of the North-Central region faced lower odds of adverse outcomes, likely attributable to improved access to healthcare and education. Employment, marriage, and cohabitation also appeared to elevate the odds of adverse pregnancy outcomes, potentially due to factors such as higher parity, increased stress, or economic challenges.

6.3 Conclusion

In conclusion, the study identified significant associations between maternal age and adverse pregnancy outcomes in Liberia. Women classified as of advanced maternal age (35 years and above) demonstrated a higher likelihood of experiencing stillbirth, miscarriage, or low birth weight compared to their adolescent counterparts. Notably, the 15-19 years age group exhibited a lower proportion of adverse outcomes, which contradicts prevalent assumptions. These findings indicate that advanced maternal age poses a greater risk within the Liberian context and should be prioritised for targeted maternal health interventions. Unexpectedly, women with secondary education or higher exhibited greater odds of adverse outcomes, implying that socioeconomic factors or underlying health conditions may influence these findings. Furthermore, regional disparities underscore the necessity for equitable access to healthcare, particularly in rural areas, to enhance pregnancy outcomes across all demographic groups in Liberia.

6.4 Recommendations

Based on the findings from the study, it is recommended that:

1. The Ministry of Health should implement age-specific maternal health programmes that focus on adolescents (15-19 years) and older women (45-49 years), who are at a higher risk for adverse pregnancy outcomes, such as stillbirth and low birth weight. These programmes should prioritise early screening, prenatal counselling, and specialised care to mitigate risks for these vulnerable age groups.
2. The ministries of Education, Health, and Social Welfare should collaborate to address the socioeconomic factors contributing to adverse pregnancy outcomes, even among women with higher education levels. Programmes should combine education with tailored

healthcare interventions, stress management, and economic support to improve pregnancy outcomes across all socioeconomic sub-groups.

3. Liberia's Health Ministry should prioritise public health campaigns to increase awareness of the risks associated with both early and advanced maternal age, particularly within educational institutions and via mass media platforms.
4. The health authority in Liberia should enhance access to comprehensive antenatal care services in rural and underserved regions. Regional disparities in pregnancy outcomes suggest a need for the equitable distribution of healthcare resources, particularly in areas with limited infrastructure, to ensure that women across all regions receive adequate maternal care. This means that mobile clinics and community health worker-led outreach should be expanded to improve ANC access in remote and underserved regions where maternal age-related risks are most pronounced.

6.5 Original contribution to knowledge

This study represents a significant and original contribution to maternal health research in Liberia by being the first to examine the relationship between maternal age and adverse pregnancy outcomes, utilising data from the 2019/2020 Liberia Demographic and Health Survey (LDHS). Although previous studies have explored maternal age as a risk factor in various African and global contexts, there has been a paucity of country-specific analyses focused on Liberia. The study addresses this gap by identifying the age groups most at risk, specifically adolescents and women aged 35 years and above, and analysing how socio-demographic and economic factors influence adverse outcomes such as stillbirth, miscarriage, and low birth weight. These findings provide evidence-based insights that can support the formulation of age-sensitive policies, resource allocation, and maternal health interventions tailored to Liberia's population healthcare system.

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