UNIVERSITY OF GHANA

MODELING THE RELATIONSHIP BETWEEN MATERNAL BLOOD TYPE, AND PREGNANCY COMPLICATIONS AND DELIVERY OUTCOME THROUGH MODERATED MEDIATION ANALYSIS

BY

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DECLARATION

Candidate's Declaration:

I hereby declare that this dissertation is entirely the result of our own original research and that no part of it has been presented for another degree in this university or elsewhere.

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Supervisors' Declaration:

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of the thesis laid down by the School of Graduate Studies, University of Ghana.

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ABSTRACT

Pregnancy complications and adverse delivery outcome are of global concern, yet, their causal mechanism(s) are unknown. Although, there have been studies to expound the importance of maternal blood type in pregnancy, and to associate pregnancy complications with maternal blood type, unfortunately, only direct relationships have been assessed. This study employs antepartum and intrapartum risk scores, to give a fuller picture of the complex causal relationship between maternal blood type and pregnancy complications and delivery outcomes, through a moderated mediated relationship, and a double-mediated relationship respectively. Methods: This was a retrospective study of the maternal delivery records of Battor Catholic Hospital in the Volta region of Ghana. The antepartum, intrapartum, and neonatal variables from the maternal delivery records book were extracted and together with the maternal life status, these variables were converted into antepartum and intrapartum risk scores and pregnancy delivery outcome scores, according to the degree of their adverse effect on the life of mother and child. Pregnancy complications were converted into pregnancy complications scores, according to their prevalence and case fatality rates. Mediated and moderated mediated models, were employed in R to analyze the data. The index of moderated mediation between maternal blood type and pregnancy complications outcome was significant (effect = 0.14, BootSE = 0.04 and CI = (0.07, 0.24)) and the indirect effects (when HIPRSI = 0, effect = -0.071, BootSE = 0.02 and CI = (-0.11, -0.04)) of maternal blood type through the risk of pregnancy and delivery was also significant. The double-mediated relationship between maternal blood type and pregnancy delivery outcome was significant (effect = 0.17, se = 0.05 and p-value < 0.001). In conclusion, maternal blood type is the potential cause of pregnancy complications and adverse delivery outcome.

DEDICATION

I dedicate this work firstly, to my 3 lovely children, Quinnell Nyameye, Kedrick Aseda and Kateriel Nhyirah who supported me by giving me all the time and space I needed, not only to travel to gather data and information for this study but also time to focus and complete this study as well. Secondly, to my Dear Friend and Classmate Eric Ato Abakah Amoah who has been very instrumental in my quest to further my education. Thirdly, to Mrs. Naomi Adu-Nyarko, Major Addai-Mensah and Mrs. Olivia Ofori whose support cannot be quantified.

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LIST OF ABREVIATIONS

HDFN - Hemolytic Disease of the Fetus and Newborn

NRFHR - Non-Reassuring Fetal Heart Rate

PR - Prevalence Rate

CFR - Case Fatality Rate

CFRM - Case Fatality Rate Maternal

CFRN - Case Fatality Rate Neonatal

PCCFRRM - Pregnancy Complications Case Fatality Rate Ranks Maternal

PCCFRRN - Pregnancy Complications Case Fatality Rate Ranks Neonatal

APH - Ante-Partum Hemorrhage

PPH - Post-Partum Hemorrhage

PIH - Pregnancy Induced Hypertension

WHO - World Health Organization

NICHD - National Institute of Child Health and Human Development

NIH - National Institutes of Health

DHHS - Department of Health and Human Services

ANC - Antenatal Care

APR - Antepartum Risk

APRS - Antepartum Risk Scores

APRSI - Antepartum Risk Scores Index

APRSIN - Antepartum Risk Scores Index Numeric

IPR - Intrapartum Risk

IPRS - Intrapartum Risk Scores

IPRSI - Intrapartum Risk Scores Index

MIPRSI - Moderate Intrapartum Risk Scores Index

HIPRSI - High Intrapartum Risk Scores Index

NHAS - Neonatal Health Assessment Scores

NHASI - Neonatal Health Assessment Scores Index

HASIN - Neonatal Health Risk Assessment Scores Index Numeric

PCOMPS - Pregnancy Complications Scores

PCPRR - Pregnancy Complications Prevalence Rate Rank

PCCFRR - Pregnancy Complications Case Fatality Rate Ranks

MLSS - Maternal Life Status Score

NLSS - Neonatal Life Status Score

PDOS - Pregnancy Delivery Outcome Scores

PDOSI - Pregnancy Delivery Outcome Scores Index

PDOSIN - Pregnancy Delivery Outcome Scores Index Numeric

CHAPTER ONE

INTRODUCTION

1.0 The Background of the study

A pleasant delivery outcome, where the baby is healthy and the mother is satisfied, is the dream of most pregnant women. Unfortunately, some pregnancies get miscarried, others result in stillbirths and sometimes the worst happens, the life of the child and or that of the mother is lost in the process. Even pregnancies that result in livebirths are not spared from challenges such as preterm birth, low birth weight, congenital anomalies, and other severe health challenges that adversely affect the baby's survival and long-term health. These unpleasant delivery outcomes have been attributed to the pregnancy complications encountered before, during, and after delivery such as, Eclampsia, Obstructed Labour, Uterus Rupture, Hemorrhage, Sepsis, and some medical disorders among others (Zakariah et al., 2006).

Pregnancy is a period of transition with important emotional, anatomic and physiological changes, which when not managed well, can result in pregnancy complications, maternal & neonatal morbidity and mortality. Although it is an amazing and surprising time in a mother's life, pregnancy may subject a woman's body to unprecedented levels of stress and endurance, by pushing her body to undergo some remarkable transformations to support the growth of a new life which can be very challenging for some.

The increasing needs of the growing fetus and mother's tissues throw an added burden on the mother's internal and external organs including, cardiovascular and lymphatic systems, respiratory tract, gastrointestinal tract, liver, kidneys, urinary tract, endocrine system and skin among other organs that are worth noting. Aside from the emotional, anatomic, and physiological changes that affect expectant mothers, maternal socio-demographic factors such as age, level of

educational, employment status, alcohol consumption, and others before pregnancy, may also have some effects on the pregnancy. Other factors that have a strong negative impact on the quality of life of pregnant women are, physical factors which include obstetric complications, medical history, and possible hospitalization among others, and also psychological factors such as depression, anxiety, and stress in general.

Women carry pregnancy differently, some are capable of enduring the pressure, and pain of pregnancy and childbirth better than others, the reason why some pregnancies are with little to no complications while others are plagued with complications that may threaten even the life of mother and child. Although some pregnancy complications that result in adverse delivery outcomes are a result of maternal health conditions before pregnancy, most of these life-threatening pregnancy complications occur during the period of pregnancy and delivery, due to the pressures of the current pregnancy.

Maternal and neonatal morbidity and mortality have been a major global concern, calling for various studies to identify both the direct and indirect obstetric causes. It has been found that majority of the pregnancy complications that account for at least 70% of all maternal and neonatal deaths are of direct causes, with at most 30% being a result of indirect causes of pregnancy complications (Lee et al., 2012; Zakariah et al., 2006).

Direct causes of pregnancy complications include, Obstetric Hemorrhage, usually in the form of ante-partum hemorrhage (APH), post-partum hemorrhage (PPH), or as a result of uterine rupture, among others; Hypertensive Disease, usually in the form of eclampsia, severe pre-eclampsia, pre-eclampsia and pregnancy-induced hypertension (PIH); Obstructed Labour usually as a result of pelvis inadequacies, the disproportionate size of the baby and prolonged latent phase among others; Sepsis or Genital tract infections; that occur before, during and after delivery (Zakariah et

al., 2006), while pregnancy complications that are of indirect causes, includes medical disorders, bad obstetric history and previous surgeries that occurred before the current pregnancy (WHO, 2019).

The burden of pregnancy complications is substantial across the world, many risk factors have been identified, including diabetes, infections, poor antenatal care, and other socio-economic factors, but a clear causal mechanism for these pregnancy complications is yet to be established (Padhi et al., 2015). It is vital to understand how a mother's body adapts to the pressures of pregnancy in order to anticipate and fully prepare for pregnancy complications which adversely affects some mothers compared to others.

Various attempts have been made to identify the risk factors of both direct, and indirect causes of pregnancy complications by assessing information from maternal pre-pregnancy health conditions and past obstetrical history (factors of indirect causes) as well as problems in the current pregnancy (factors of direct causes), to develop Risk Scoring Systems which can be used to identify and categorize risky pregnancies. Examples of such risk scoring systems include, Antenatal Risk Scores, Perinatal Morbidity Scores, and Antepartum Risk Scores (APRS), among others. A newer concept called Intra-Partum Risk Scoring System (IPRS), has been developed to weigh and score various checks of the vitals of mother and fetus, the signs and symptoms from observing the mother, as well as the interventions by the healthcare professionals that take place from the onset of labour to 24hrs after delivery, to identify and categorize High-Risk Deliveries. Despite the success in identifying high-risk pregnancies and deliveries, that are prone to developing into pregnancy complications, the aim is not to prevent adverse pregnancy outcomes, but rather to emphasize the importance of careful follow-up, management, and reallocation of resources for pregnant women with high risk scores (Al-Hindi et al., 2020; Duodu et al., 2022).

Prior to pregnancy, maternal blood type may have had little significance, however maternal blood group is one of the first routine tests conducted when pregnancy is confirmed. Maternal Rh blood Group test is necessary to determine the exact blood type (A or B or AB or O), the Rh factor (positive or negative) as well as maternal blood antibodies (Anti C, Anti K, etc.). Having a primary role in blood transfusion and organ transplantation, recent advances have also revealed the importance of ABO blood groups in the pathogenesis of various disorders such as diabetes mellitus, hematologic disorders among others (Sajan et al., 2021; Than et al., 2011).

A major clinical disease associated with the Rh blood group system is hemolytic disease of the fetus and newborn (HDFN), which occurs when a mother who is Rh - carries a fetus who is Rh +, and fetal red cells are released into the maternal circulation immunize the mother to make antibodies to Rh+, which traverses the placenta and damages the fetus. HDFN has remained of primary importance in obstetrics as it has claimed the lives of many fetuses and neonates, it is therefore important to know maternal blood type and Rh factor early in pregnancy, as this information may have an impact not only on the current pregnancy but also on future pregnancies (Anstee, 2010).

Ideally, neonatal blood should not get in contact with maternal blood, ABO incompatibility (Mitra et al., 2014) may happen when there is contact between;

Maternal blood type O, and fetal blood type A, B, or AB; Maternal blood type A and fetal blood type AB or B; Maternal blood type B and fetal blood type A or AB.

In the event that any of the above happens, maternal blood may develop antibodies that fight fetal blood, resulting in neonates with various congenital anomalies and at worst resulting in stillbirth.

The concept of blood type being associated with disease susceptibility and pregnancy complications is yet to be explored in Africa, where only blood transfusion and the effects of Rh factor on pregnancies, are given the necessary consideration. A proper understanding of the role of maternal blood type and its clinical significance in pregnancy, is necessary to find the appropriate solution to pregnancy complications and related issues, since most of the prior studies conducted to identify the association of the ABO blood groups with pregnancy complications, yielded consistent results (Beyazıt et al., 2017).

It is in light of this and more that, this study seeks to establish a moderated mediated relationship between maternal blood type and pregnancy complications outcome, model pregnancy delivery outcome through a double mediated relationship with maternal blood type. And also assess the effects of maternal blood type through the risk of pregnancy and delivery, pregnancy complications and delivery outcomes, using the maternal delivery records of Battor Catholic hospital in the Volta region of Ghana-West Africa.

The findings from this study will help; healthcare professionals to identify patients at risk of pregnancy and delivery challenges based on their blood type, adopt appropriate and timely measures to mitigate pregnancy complications, prevent adverse delivery outcomes; and also prepare women of various blood types on what to expect during pregnancy and delivery, and appropriately plan for childbirth in general.

1.1 The Problem Statement

Concerned with why some women enjoy a relatively smooth period in pregnancy, while others go through near death experience enduring enormous stress and complications, fueled the search

for the underlying cause(s) of pregnancy complications. Unfortunately, a clear causal mechanism for pregnancy complications is unknown (Padhi et al., 2015), and current interventions to identify high-risk pregnancies, aim not to prevent pregnancy complications and adverse delivery outcomes, but rather to emphasize the importance of antenatal care, and the careful follow-up of complications when they occur (Al-Hindi et al., 2020; Duodu et al., 2022; Goodwin et al. (1969). Again, although is a link between pregnancy-induced diseases and the ABO blood group (Mäkivuokko et al., 2012), efforts to associate maternal blood type with pregnancy complications have yielded inconsistent results across different locations (Sajan et al., 2021), which behooved further research into the exact relationships between maternal blood type, and pregnancy complications and delivery outcomes.

This study is of the view that, the differences in the distribution of maternal blood types in different geographical areas (Lu et al., 2021), as well as the moderated mediated nature of the relationship between maternal blood type and pregnancy complications, is the reason for the conflicting results recorded in previous studies. Thus, this study seeks to establish maternal blood type as a clear causal mechanism for pregnancy complications and adverse delivery outcomes, for the appropriate interventions.

1.2 The Study Objectives

The general objective of this study is to establish a moderated mediated relationship between maternal blood type and pregnancy complications, and a double mediated relationship between maternal blood type and pregnancy delivery outcome.

The specific objectives of this study are;

1. To assess the effects of the maternal blood type through the antepartum, and intrapartum risks, pregnancy complications, and pregnancy delivery outcome on the pregnant patients.
2. To establish that, the risk of pregnancy (APRSIN) mediates the relationship between maternal blood type and pregnancy complications outcome (PCOMPSIN).
3. To establish that, the risk of delivery (HIPRSI) moderates the relationship between the risk of pregnancy (APRSIN) and pregnancy Complications Outcome (PCOMPSIN), and hence establish a mediated relationship between Maternal Blood Type and Pregnancy Complications Outcome (PCOMPSIN).
4. To establish that the relationship between maternal blood type and pregnancy delivery outcome (PDOSIN), is double-mediated with the Risk of Pregnancy (APRSIN) and the Risk of Delivery (IPRSIN).

1.3 The Research Questions

This study seeks to explore the relationship between maternal blood type, pregnancy complications and pregnancy delivery outcomes, by seeking answers to the following questions;

Objective 1:

1. Is high-risk pregnancy and delivery popular among certain maternal blood types compared to others?
2. Are some pregnancy complications and complications outcomes popular among certain maternal blood types compared to others?
3. Are some pregnancy delivery outcomes popular among certain maternal blood types compared to others?

Objective 2:

4. Does risk of pregnancy (APRSIN) mediate the relationship between maternal blood type and pregnancy complications outcome (PCOMPSIN)?
5. Is the risk of pregnancy (APRSIN) alone sufficient in predicting pregnancy complications outcome (PCOMPSIN)?

Objective 3:

6. Does risk of delivery (HIPRSI) moderates the relationship between the risk of pregnancy (APRSIN) and pregnancy Complications Outcome (PCOMPSIN)?

Objective 4:

7. Is the Risk of Pregnancy (APRSIN) alone Sufficient in Mediating the Relationship Between Maternal Blood Type and Pregnancy Delivery Outcome (PDOSIN)?
8. Does both the Risk of Pregnancy (APRSIN) and the Risk of Delivery (IPRSIN) mediate the relationship between maternal blood type and pregnancy delivery outcome (PDOSIN)?

1.4 Brief Methodology

To explore and establish the role of maternal blood type as a potential cause of pregnancy complications and adverse pregnancy delivery outcomes in general, secondary data from the maternal delivery records of Battor Catholic hospital in the Volta region of Ghana-West Africa has been obtained for the purpose of this study. The various variables collected on the mother and fetus before, during and after delivery have been assessed, a weighted value of (0, 1, 2, 3, 4) has been assigned to each variable in the risk assessment tool, according to the degree of its adverse effect on the life of the mother and child as well as the survival of the child. The total sum of all the weighted values of a particular mother, with respect to the variables before delivery, gives the

Antepartum risk Scores, during and after delivery gives the Intrapartum risk scores, while that of a particular neonate, gives neonatal health assessment scores for that neonate. The higher these values are, the more challenging the life of the mother and child shall be. These scores were then standardized into risk indices to enable the generalizability of the results.

The Prevalence rate and case fatality rate of the various Pregnancy Complications were calculated and ranked to get the Pregnancy Complications Score. Pregnancy Delivery Outcome Score, was the sum of neonatal health assessment score, and maternal status score (alive - 0) or (dead - 5) which were standardized into the pregnancy delivery outcome score index. Higher values indicate the life of the mother and child may be lost during or after delivery.

Using Moderated Mediated Models, Regressions Models and bivariate analysis, a causal relationship between maternal blood type and risk of pregnancy, pregnancy complications and delivery outcomes will be assessed.

1.5 The Significance or Rational of the Study

This study seeks to;

1. Demystify that, the occurrence of pregnancy complications and adverse delivery outcomes, are not merely random events.
2. Assist healthcare professionals to identify high-risk pregnancies and high-risk deliveries based on maternal blood type at the first ANC visit.
3. Draw the attention of Statisticians to use their right tools to transform the enormous data available in the health sector into valuable information.
4. Elucidate the relevance of Blood types in general.

5. Educate women of various blood types on their risks in pregnancy and delivery.
6. Create awareness and educate the general public on the potential cause of pregnancy complications and adverse delivery outcomes.

1.6 The Limitations of the Study

The data for this study was obtained from women whose major diets consist of milk, sugar, corn, wheat, beans, tomatoes, and pepper. The study findings shall be limited to women of all blood types irrespective of their location, if they share a similar diet as indicated here.

1.7 The Organization of the study

This study consists of 5 chapters;

The first chapter focuses on introducing the study by discussing the background of the study, followed by the Problem Statement and the various objectives of this study, the research questions and a brief methodology, the significance of the study as well as the limitations of the study.

The second chapter is about the review of the literature concerning pregnancy complications and delivery outcomes, the importance of antepartum period and antenatal care, intra-partum care, antepartum and intrapartum risk scores, the ABO and Rh blood grouping system, the association between ABO blood group and diseases, the association of ABO blood group and pregnancy related complications, moderated mediation model, mediation analysis, moderation model and independent multi-categorical variable and there relevance to this study.

The third chapter, deals with the methodology through the research design, the data source and description, data processing, and moderated mediation models that were employed in this study.

The fourth chapter talks about the results and interpretation of the study, as well as discussions on the various study research questions.

The fifth and final chapter provides a summary, conclusion, and recommendations of the study.

CHAPTER TWO

REVIEW OF THE LITERATURE

2.0 Introduction

The risk of maternal morbidity and mortality as a result of pregnancy complications is of public concern worldwide and its reduction is of high priority, both locally and internationally. There have been various studies, exploring the importance of the ABO blood grouping system and the association with diseases and pregnancy complications, other studies have also aimed at developing risk scores to determine or identify high-risk pregnancies that could lead to pregnancy complications. This chapter reviews prior studies with respect to pregnancy complications and delivery outcomes, the importance of Antepartum period and Antenatal care (ANC), Intrapartum Care, Antepartum and Intrapartum Risk Scores, the ABO and Rh Blood grouping system, association between ABO blood group and diseases, the association of ABO blood group and pregnancy-related complications, moderated mediation models and how to treat independent multi-categorical independent variables.

2.1 Pregnancy complications and Delivery Outcomes

Pregnancy-related complications are a major health concern worldwide leading to significant morbidity and mortality in pregnant mothers and neonates (Beyazıt et al., 2017). With the exception of a few, most complications leading to maternal death cannot be easily prevented, as most of these complications occur during labour, delivery and or in the immediate post-partum period (Goldenberg et al., 2010). Maternal complications such as obstetric hemorrhage, hypertensive disorders, infections and obstructed labour and their effects have been extensively

studied and have been considered the direct cause of maternal deaths in Ghana and globally (Sedgh, 2010; Lee et al., 2012; Zakariah et al., 2006).

Hemorrhage, has been on the top list of complications as the leading cause of maternal mortality globally with many different etiologies, ranging from an atonic uterus to retained products of conception to lacerations of the cervix, vagina or uterus or even as a result of uterine rupture. The timing of hemorrhage is often divided between the APH and PPH periods. The most common cause of APH is placental abruption, that of PPH is uterine atony and labour obstruction, over all obstructed labour and unsafe abortions are common precursors of pregnancy-related hemorrhage (Goldenberg et al., 2010).

Having the highest case fatality rate according to a study by Lee et al., (2012), infection is considered the second most common cause of maternal death (Khan et al., 2006). The most common causes of infection-related maternal deaths are bacterial infections of the uterus, genital tract sepsis and existing maternal infections prior to pregnancy (Grimes et al., 2006).

The third major cause of maternal mortality is Hypertensive disorders (Khan et al., 2006; Rogerson et al., 2018). Some maternal deaths occur following the onset of eclampsia which is a multisystem disorder unique to pregnancy. Usually occurring in late pregnancy or during the post-partum period (Goldenberg et al., 2010), Eclampsia is associated with a variety of short-term and long-term complications in mothers and infants, including placental abruption and disseminated intravascular coagulation. The effects of Eclampsia usually lead to hemorrhage, strokes, cardiovascular disease, metabolic disorders including liver and kidney failure in the mother, asphyxia, aspiration pneumonia, fetal growth restriction (FGR) in the fetus, which can even result in preterm birth (Al-Nasiry et al., 2015; Hendrix et al., 2019; Veerbeek et al., 2015). All these are part of the major causes of neonatal and maternal mortality and morbidity (Backes et al., 2011).

2.2 The Importance of Antepartum Period and Antenatal Care (ANC)

Prenatal care was pioneered by Ballantyne in 1901, it systematizes a set of conducts and guidelines directed at pregnant women (Drife, 2002). ANC refers to the routine care based on these prenatal guidelines delivered to pregnant women, right from conception to the onset of labour, considered one of the three most essential cares given to pregnant women by qualified health professionals such as doctors, midwives, or nurses (Say et al., 2014). These professionals have been trained and educated with expertise to identify, provide and manage normal pregnancies and deliveries and to refer all complicated pregnancies and delivery cases including neonates with special needs, to facilities that are well-equipped to manage and cater for them (Dickson et al., 2017).

The aim of antenatal care is to prepare women for birth and motherhood, as well as to check, identify, manage and alleviate the three types of health problems that occur during pregnancy which affect not only the mother, but the babies as well. These health problems are a result of; complications and challenges of the current pregnancy, pre-existing conditions of the mother that gets worsen as a result of the current pregnancy and the effects of unhealthy lifestyles of the mother (WHO, 2002).

The timing of the first ANC visit is of utmost importance, various physical examinations and blood tests are conducted to provide adequate information on the pregnancy which helps to plan subsequent visits (Tikmani et al., 2019). A standard of four antenatal visits with a qualified health care provider is recommended for a healthy pregnant woman (Sarker et al., 2020), however, an updated framework by WHO in 2016 highlighted a minimum of eight ANC visits with a qualified health care provider to adequately prepare for the delivery process and to avoid pregnancy complications (Sarker et al., 2020).

Overall, ANC seeks to protect the health of the expectant mother and the unborn baby, improve delivery outcomes and assist in transitioning to the post-natal period with minimum challenges (Duodu et al., 2022).

2.3 The Intrapartum Care

Maternal complications in previous pregnancies, previous gynecological history and major fetal abnormalities obtained through scans are very helpful information that assists midwives and gynecologists in anticipating health challenges and possible complications in the current pregnancy. Aside from these, the various checks of vitals of mother and fetus, the signs and symptoms from observing the mother, as well as the interventions by the healthcare professionals that take place from the onset of labour help midwives and gynecologists to anticipate and manage maternal complications that may arise.

The period of delivery is critical to the survival of the mothers and their babies, the risk of morbidity and mortality usually increases considerably because the majority of maternal complications occur during and within 24hrs after this period. Due to the limited time setting of this period, healthcare professionals come under pressure, pulling in all resources and applying all forms of techniques to save and manage complications should there they arise. Griffin et al., (2017), concluded that about three-quarters of the maternal deaths, about half of stillbirths and about one-quarter of the neonatal deaths of their study occurred around delivery period.

2.4 The Antepartum and Intrapartum Risk Scores

Prenatal care has been the best way to monitor the health of expectant mothers and that of their babies, through various routine checks conducted during the ANC visits by healthcare professionals. Getting early and regular antenatal visits can help health care professionals to diagnose, treat and manage conditions based on Pre-pregnancy health conditions, previous obstetric history as well as Problems in current pregnancy, which could lead to maternal and neonatal morbidity and mortality. The vital information gathered by these healthcare professionals are the variables used in developing the antepartum and intrapartum risk scoring tools, which can be used to identify high-risk pregnancies and high-risk deliveries that usually result in complications and adverse delivery outcomes.

The first Antenatal Risk Score was developed by Goodwin et al. (1969), the tool weight different adverse pregnancy related events before delivery according to their relative severity to the health and survival of mother and child, to produce a numeric outcome score. The system was validated and the scores were categorized into low (0-2), moderate (3-6), and high (≥7) risk pregnancies by (Burstyn, 2010). Jain et al. (2014), in their prospective study, went further by integrating Intrapartum and Neonatal parameters into the Antepartum parameters into developing Maternal and Fetal risk scoring systems to identify perinatal deaths which as a success. In their study Maternal risk scores were categorized into No Risk (0 – 3), Low-Risk (4 – 9) and High-Risk (≥10)

There have been others like (Hutcheon et al. (2017), who have developed Antepartum Scoring tools that proved difficult to implement.

The Antepartum and Intra-Partum risk score index from Alberta perinatal health program has been adopted and validated to identify women with high-risk pregnancies and high-risk deliveries respectively. This method was adopted Al-Hindi et al. (2020), in their retrospective study of the

Association of Antenatal Risk Score with Maternal and Neonatal Mortality and Morbidity even though they only used the antepartum risk score index excluding part D.

2.5 The ABO And Rh Blood Grouping System

Our blood type is more than a letter and a sign, it is a priceless gift for us especially when we are in need of life-saving transfusions and also holds the key that helps us to better understand our health. In 1901, the ABO blood group system was first discovered and defined by Karl Landsteiner in Austria. It categorizes the human blood groups into A, B, O, and AB, based on the presence of naturally occurring antigens on red blood cells and serum antibodies (Tan & Graham, 2013).

Due to the inherited antigenic substance characteristics of these blood groups, people from different ethnic groups or geographical regions have different characteristics or distinctions in the distribution of ABO blood types (Lu et al., 2021). There are dozens of known blood classifications, which are based on whether there are genetic antigens on the surface of the red blood cells, however, only two, namely the ABO blood group classification system and the Rh blood group classification system, are widely used in medical practice (Lu et al., 2021).

The Rhesus (Rh) blood group is one of the most complex blood groups known in humans, it has remained of primary importance in obstetrics, being the main cause of hemolytic disease of the newborn (HDN) with Anti-D and Anti-C causing the most severe form of HDN (Sheeladevi et al., 2013).

Currently, the knowledge on blood groups has been explored beyond the usual tests of agglutination and transfusion, a proper understanding of this knowledge is essential to modulate

blood group-linked diseases processes as well as to better understand pregnancy complications causes which are still at the stage of research (Mitra et al., 2014).

2.6 The Association Between ABO Blood Group and Diseases

Associations between blood type and diseases have been studied since the early 1900s when researchers determined that antibodies and antigens are inherited (Lutfullah et al., 2010). The differences in the characteristics of the distribution of ABO blood types, as a result of inherited antigenic substance characteristics of blood groups, especially with respect to people from different ethnic groups or geographical regions (Lu et al., 2021), help explain the differences in the susceptibility and the distribution of diseases among people of different ethnic groups and geographical regions (Abegaz, 2021). Differences in blood pressure results in Caucasians and Blacks were observed in the study by (Ewald & Sumner, 2016) and another study by Anstee (2010) people from African and Melanesians of South East Asia had survival genes that protected them from the effects of the plasmodium parasite of malaria compared to the rest of the world.

In the years between 1960 and 1970, large epidemiological studies were carried out around the world, connecting the human ABO blood group to the vulnerability to develop a number of diseases (Mäkivuokko et al., 2012). The broadly postulated connections with the ABO blood group, included infectious and non-infectious diseases, cognitive disorders, cardiovascular and circulatory diseases, hematologic disorders, cancers, metabolic diseases, COVID-19 and malaria (Mäkivuokko et al., 2012).

Recent research studies assessing the association between blood type and diseases, have featured people of different geographical regions who have different educational backgrounds with varied

interests. Some of these studies have been steered by natives from countries such as India (Rana et al., 2021), Korea and China (Lu et al., 2021), Canada (Wang et al., 2018), Ethiopia (Abegaz, 2021), United Kingdom (Anstee, 2010b) Nigeria (Ikeagwulonu et al., 2021), United States of America (Than et al., 2011b), Germany (Gassner & Wagner, 2022) among others. Supervised by notable institutions and departments such as, the Institute of Translational Medicine, Department of Neuroanaesthesiology, Department of Biology, Department of Etiology, Department of Epidemiology, Department of Research and Department of Blood Transfusion Medicine. And were approved by reputable institutional review boards including, Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), National Institutes of Health (NIH), Department of Health and Human Services (DHHS, Bethesda, MD, USA), the Maccabi Institutional Review Board (Israel), the Health Science Board of Hungary (Budapest, Hungary) and the Human Investigation Committee of Wayne State University (Detroit, MI, USA) (Than et al., 2011) among others.

By employing varied mechanisms (Abegaz, 2021) in exploring their data**,** some of the results from these studies indicated; Blood type A patients along with other non-O blood types were at a higher risk of liver cancer (Lu et al., 2021)**;** a positive correlation was found between blood group A patients with chronic hepatitis-B infection and pancreatic cancer (Mitra et al., 2014b); a positive correlation was also found between blood group B patients and ovarian cancer (Mitra et al., 2014); it was also confirmed that blood group O patients had some protection against falciparum malaria but had increased severity of Vibrio cholerae when infected by it (Anstee, 2010b)**;** it was observed that patients with blood groups A and B were more inclined to COVID-19 infections, compared to patients of blood groups O and AB who were significantly of lower risk of COVID-19 infection (Rana et al., 2021).

In general, most of these studies observed that non-O blood types are more susceptible to diseases than O blood types and concluded that, ABO blood types are not the exact causes of diseases, but rather people of certain blood types are susceptible and easily surrender to certain diseases and health problems, calling for further investigations particularly on the molecular level of ABO blood groups and their association with various diseases (Abegaz, 2021).

A proper understanding of the blood group system and their clinical significance to approach blood group-linked diseases (Mitra et al., 2014) has necessitated the knowledge of blood groups to be explored beyond the usual tests of agglutination and transfusion, to better understand the role blood groups play with respect to their association with multiple diseases so that disease processes can successfully be modulated (Mitra et al., 2014).

2.7 The Association of ABO Blood Group and Pregnancy-Related Complications

Pregnancy-related complications have been a major health concern globally and similar to understanding the associations between blood type and diseases, various studies by different people of different backgrounds with different perspectives, have been conducted to identify the association of blood type with pregnancy-related complications (Sajan et al., 2021). Some of these studies have been done to expound the impact of ABO blood group on pregnancy and pregnancy-related complications and its effects on the mother and newborn infant as blood type has been considered as an independent risk factor in the occurrence of pregnancy-related complications in pregnant patients and neonates (Beyazıt et al., 2017).

However, there have been wide variations and inconsistencies in the results from most of the studies concerning the association of blood type with pregnancy-related complications, with some

studies reporting an increased incidence of some pregnancy complications among certain blood types, while other studies showed no association between those pregnancy complications and the said blood types. Some of these inconsistencies were confirmed by Sajan et al. (2021) in their study to determine the maternal ABO blood group and its correlation with pregnancy-related complications, where their results were in discordance with the results of previous studies.

Assessing and evaluating the vital link between blood type and pregnancy complications by people with different backgrounds and with varied interests, is a step in the right direction, however, unless the results from the various risk scoring tools are standardized, and the right models and analysis are done, subsequent studies will continue to yield inconsistent results.

Indeed, our blood carries more information than we give credit for, exploring its importance and association with our very foundation through pregnancy and childbirth is a worthy course, which truly deserves our attention and efforts. Successfully modeling pregnancy complications and delivery outcomes will not only take a load off the shoulders of healthcare professionals who will have ample time and resources to cater to patients that truly need them, but this information will surely prepare women of different blood types on what to expect should they decide to go through the glorious journey of childbirth.

2.8 Statistical Methods Employed in Previous Studies

Although there have been several studies assessing the effect of maternal blood type in pregnancy, the aim of most of these studies were to associate maternal blood type to pregnancy complications, by employing descriptive statistics such as central tendency (mean), measures of dispersion (standard deviation) and frequency distribution (percentages) to summarize their data (Sajan et al.,

2021; Oseni & Akomolafe, 2011; Beyazıt et al., 2017). Some of these studies employed measures of disease frequency such as Rates (Sajan et al., 2021) and measures of association and impact, such the Odds Ratio (OR) (Than et al., 2011; Li et al., 2021). Few studies have employed inferential statistics to assess the linear relationship between maternal blood type and pregnancy complications as seen in Figure 2.1 below. The frequently used methods are univariate and multiple regression analysis, meant to reveal the correlation between maternal blood type and pregnancy complications (Than et al., 2011; Jin et al., 2020).

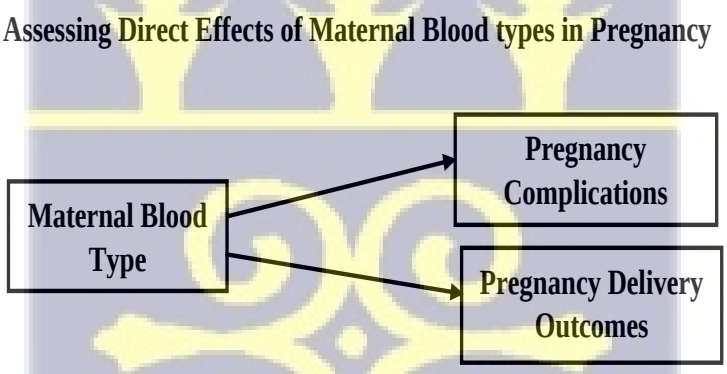

Figure 2.1: Direct Relationships with Maternal Blood Type in Pregnancy

Currently, no study has been conducted to give a comprehensive view of the relationship between maternal blood type, pregnancy complications and delivery outcome, through antepartum or intrapartum risks or both.

Exploring the associations of pregnancy complications and maternal blood type through non-linear models, will help identify the actual relationship between pregnancy complications and blood type in order to properly interpret and compare the results across studies irrespective of place and time.

2.9 Mediation and Moderated Mediation Models

Figure 2.2 illustrates a moderated mediation process. Moderated mediation which is also called conditional indirect effects (Preacher et al., 2007) is when the effect of the independent variable *X* on the mediator (Path a) and/or the partial effect *M* of the moderator on the dependent variable *Y* (Path b), depends on the levels of another variable, *W* –moderator(s) (Muller et al., 2005).

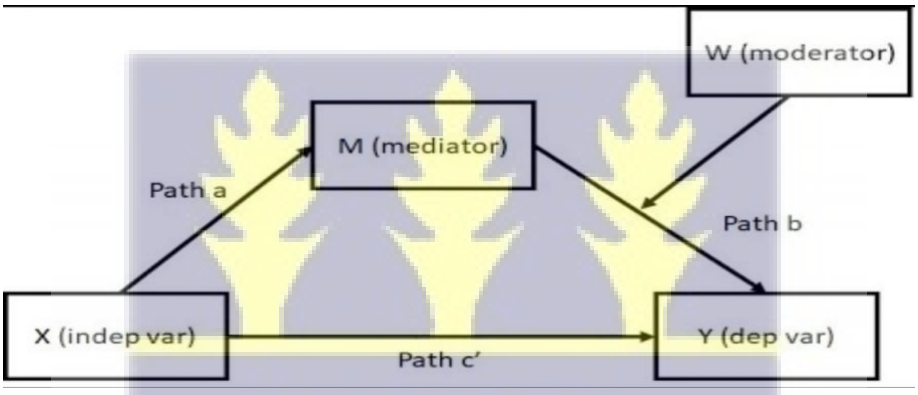

Figure 2.2: Schematic diagram of a moderated Mediation Analysis

The mediator is part of the causal pathway and explains the process through which the independent and dependent variables are related. The moderating variable(s) affect the strength and direction of the relationship between independent and dependent variables through the mediator.

Langfred, (2004) was the first to provide a comprehensive treatment of the question of how to conceptualize moderated mediation, classify different types of moderated mediation models, and develop the logic and methodology for the statistical analysis of such models using multiple regression, although there were existing perspectives on moderated mediation (James & Brett, 1984). Krosgaard et al., (2002), demonstrated an acceptable statistical approach for Type 1 moderated mediation, while Muller et al., (2005) provided additional clarity and definition of moderated mediation, and Preacher et al., (2007) proposed other types of moderated mediation that are widely used.

Statistical mediation and moderation analysis are commonplace in psychological science (Hayes & Preacher, 2014a), but the principles of mediation and moderated mediation have successfully been applied in Education(Kelly & Konold, 2020), Business (Feng & Wang, 2016), Human Resource Management (Einarsen et al., 2018), and in the Health Sector (Aroke et al., 2020; Guo et al., 2019; Hou et al., 2020) where, race did not significantly moderate the relationship between objective measures of SES and pain severity, self-efficacy mediated the relationship between perceived stress and diabetes self-management, and resilience partially mediated the effect of social support on mental health among health care workers respectively according to these studies.

This study employs mediator and moderator to give a fuller picture of the complex causal relationship between maternal blood type and pregnancy complications and delivery outcomes. This will help to describe and quantify the mechanism responsible for life-threatening complications which is considered a lofty scientific accomplishment (Hayes & Preacher, 2014a).

CHAPTER THREE

METHODOLOGY

3.0 Introduction

With the desire to demystify pregnancy complications and to confirm or not if its occurrence is a merely random event, a retrospective study of the maternal delivery register of Battor Catholic hospital in the Volta region of Ghana (West Africa) has been carried out, employing both qualitative and quantitative methods to explore inductively, the importance role maternal blood types play in the occurrence of pregnancy complications and delivery outcomes as a whole. In the event of significant results, it will be easy to strategize and identify high-risk pregnancies and deliveries based on maternal blood type on the first ANC visit, to be given the needed care.

This chapter will focus on the research design including the theoretical framework, data source and description, data pre-processing and the models (Double mediation and moderated mediation) that are employed in this study.

3.1 Research Design

This was a retrospective study, with the focus to assess and analyze the various health variables collected on the mother and child before, during and after delivery to determine the Antepartum Risk Score, Intrapartum Risk Score, Neonatal Health Assessment Score, Pregnancy Complications Score and Pregnancy Delivery Outcome Score, which were then standardized into risk indices to enable the generalizability of the results.

Figures (3.1 and 3.2) below, give comprehensive theoretical frameworks for modeling the relationship between pregnancy complications and delivery outcomes using maternal delivery

records, and although it has been utilized partially (Al-Hindi et al., 2020), this is the first study to fully implement it.

Theoretical Framework - Concepts and Variables for Modeling the Relationship Between Maternal Blood Type, Pregnancy Complications and Delivery Outcome

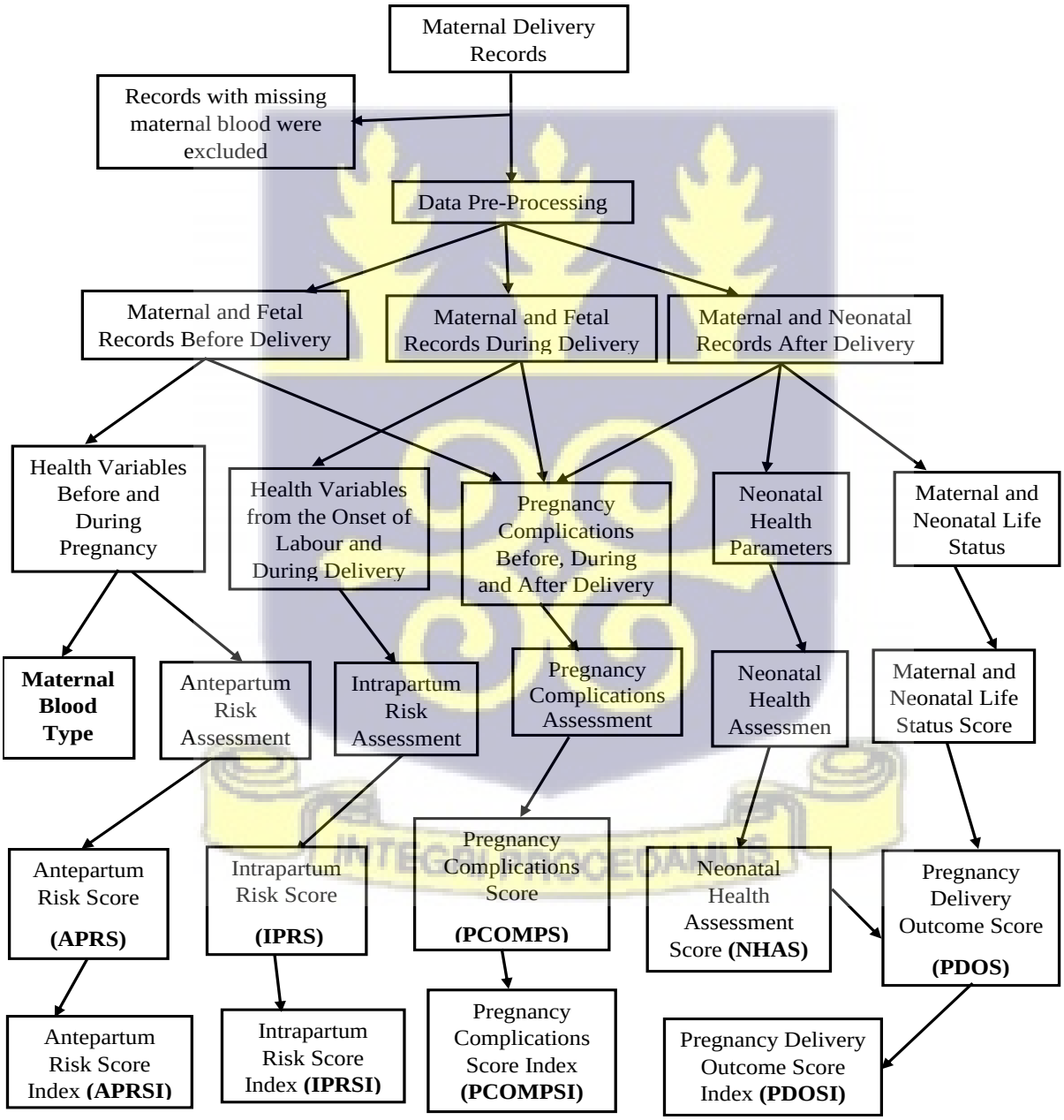

Figure 3.1: Theoretical Framework- Concepts and Variables in Pregnancy

Theoretical Framework – Relationships Between Maternal Blood Type, Antepartum Risk, Intrapartum Risk, Pregnancy Complications and Pregnancy Delivery Outcome

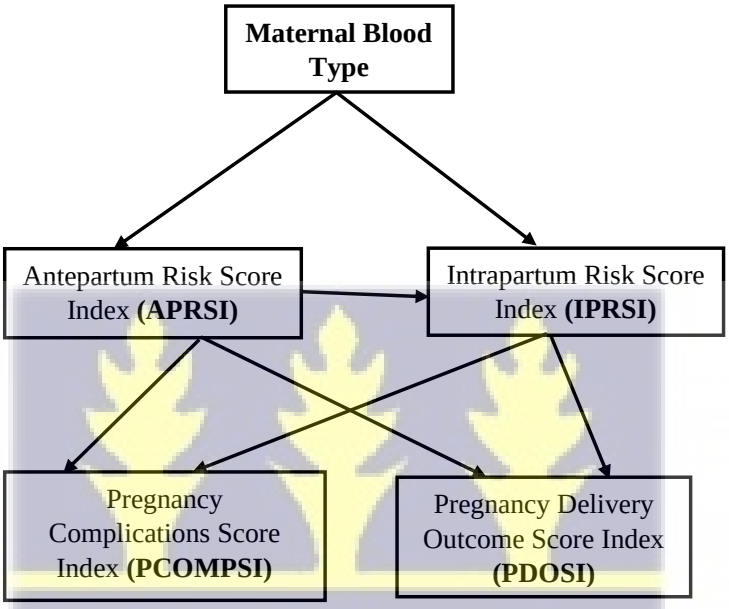

Figure 3.2: Theoretical Framework- The Relationships with Maternal Blood Type in Pregnancy

It is worth noting that, this study is the first to develop Pregnancy Complications Scores and Pregnancy Delivery Outcome Scores as well as the first to implement Intrapartum Risk Scores and Index, to model Pregnancy Complications and Delivery Outcomes.

3.2 Data Source and Description

Secondary data of the maternal delivery book with records from (Jan. 1st to Dec. 31st) 2020 was obtained from Battor Catholic Hospital, in the Volta Region, Ghana, and entered into excel with due diligence and repeated checks, records with maternal blood type missing were excluded. This study included Multiple complications and Other complications, as they resulted in different

delivery outcomes compared to their respective complications outcomes and to account for all other complications which were not explicitly stated respectively.

3.3 Data Pre-Processing

Maternal and embryonic records before and during delivery, extracted from the maternal delivery records gave rise to the health variables before and during pregnancy, and health variables from the onset of labour and during delivery which were then assessed using the Antepartum and Intrapartum risk scoring tools into Antepartum and Intrapartum risks scores respectively.

Maternal and neonatal records during and after delivery extracted from the maternal delivery records gave rise to the neonatal health parameters, and maternal and neonatal life status. The neonatal health parameters were then assessed using the Neonatal Health Assessment tool into Neonatal Health Assessment scores.

Pregnancy complications indicated in the maternal delivery records extracted and scored according to their prevalence rates and case fatality rates, while the delivery outcome was a combination of the Neonatal Health Assessment scores and maternal and neonatal life status.

All the scores obtained from the data pre-processing were converted to indices to enable proper analysis, interpretation as well as appropriate inferencing of the results.

3.3.1 Antepartum Risk, Intrapartum Risk and Neonatal Health, Assessment Tools

Antepartum and Intrapartum risk assessment tools available at the Alberta Perinatal Health Program have been adopted for this study. The various items and their corresponding scores for

all four parts of Antepartum and Intrapartum tools have been validated and updated, and in addition to them, were variables on the maternal socioeconomic status, maternal parity and maternal Antenatal visits. This study has also included the neonatal health assessment tool inspired by Jain S et al. (2014), together with maternal and neonatal life status (dead or alive), to provide comprehensive pregnancy delivery outcomes. A primary source of information, from an Obstetrician & Gynecologist at Hope Christian Hospital and a Principal Midwife of Ghana Health Service, has served as the basis for validating the above risk assessment scoring tool, and recommended the need for the additional variables to reflect our setting.

Antepartum Risk Assessment Tool

The Antepartum risk assessment scores has been proven to be feasible tool in identifying low, moderate, and high-risk pregnancies. The antenatal risk assessment tool is based on 84 variables collected on mother and fetus from the first ANC visit to the onset of labour consisting of four parts A, B, C and D. A weighted relative risk (a, b, c or d), that takes values (0, 1, 2, 3, 4) is assigned to each variable according to the degree of its adverse effect on the life of mother and child, as seen below in Figure 3.3;

ANTENATAL RISK ASSESSMENT TOOL

Part A	PRE-PREGNANCY CONDITION	Weighted Relative Risk (a)
	Maternal Anthropometric Characteristics	
1	Age <17 at delivery	1
2	Age >35 at delivery	2
3	Weight >91 kg	1
4	Weight <45 kg	1
5	Height <152 cm	2
	Socioeconomic Characteristics	
6	Education- None	2
7	Education- Primary	1
8	Education- Junior High School and above	0
9	Occupation - Self Employed	0
10	Occupation - Public Sector Employed	1
11	Occupation - Private Sector Employed	1
12	Occupation - Unemployed	2
13	Occupation - Student-below tertiary	2
14	Occupation - Dependent	2
15	Occupation - Housewife	1
16	Occupation - Nil	2
	Maternal Pre-pregnancy Health Conditions	
17	Diabetes - Controlled by diet only	1
18	Diabetes - Insulin used	3
19	Diabetes - Retinopathy documented	3
20	Heart Disease - Asymptomatic (no effect on daily living)	1
21	Heart Disease - Symptomatic (affects daily living)	3
22	Infection - Syphilis	1
23	Infection - HepB	2
24	Infection - PMTCT	2
25	Hypertension - 140/90 mmHg or greater < 20 weeks CHPT	2
26	Hypertension - Antihypertensive drugs	3
27	Hypertension - Chronic renal disease documented	2
28	Other medical disorders - Epilepsy, severe asthma, lupus	1

Part B	PAST OBSTETRICAL HISTORY	Weighted Relative Risk (b)
	Condition	
1	Neonatal death(s)	3
2	Stillbirth(s)	3
3	Abortion between 12 and 20 weeks and under 500g of birth weight	1
4	Delivery at 20 - 37 weeks	1
5	Cesarean section	2
6	Multiple Cesarean sections	3
7	Infertility Treatment	1
8	Bad Obsteric History (BOH)	2
9	Small for dates - 5th percentile	1
10	Large for dates - 95th percentile	1
11	RH Iso-immunization - unaffected infant	1
12	RH Iso-immunization - affected infant	3
13	Significant congenital anomaly, e.g., Chromosomal, Heart,	1

Part C	PROBLEMS IN THE CURRENT PREGNANCY	Weighted Relative Risk (c)
	Condition	
1	Diagnosis of large for dates	2
2	Diagnosis of small for dates	3
3	Polyhydramnios or oligohydramnios	2
4	Severe (Polyhydramnios or oligohydramnios)	3
5	Anhydramnios	3
6	Multiple pregnancies	3
7	Malpresentation (breech or transverse lie)/ Malposition	3
8	CPD/ Inadequate Pelvis	3
9	Tilted/Unfavourable Cervix	3
10	Placenta Previa	3
11	Short Inter Pregnancy Interval	1
12	Membranes ruptured before 37 weeks	2
13	Bleeding < 20 weeks Abortion	1
14	Bleeding >20 weeks APH	3
15	Gestational hypertension PIH	2
16	Proteinuria ≥1+	1
17	Pre-eclampsia	2
18	Severe Pre-eclampsia	3
19	Gestational diabetes documented, PME	1
20	Blood antibodies (Rh, Anti C, Anti K, etc.)	3
21	Anemia	1
22	Severe Anemia	2
23	Edema	1
24	Big Abdomen	1
25	Grand Mullip	1
26	BTL	1
27	Elderly Primip	1
28	Pregnancy > 42 weeks- Post Term	2
29	Pregnancy > 41 but ≤ 42 weeks- Post Date	1
30	Poor weight gain (26 - 36 weeks < 0.5 kg/week or weight loss)	1
31	Smoker - anytime during pregnancy	1

Part D	OTHER RISK FACTORS	Weighted Relative Risk (d)
	Condition	
1	Major Fetal Anomaly	3
2	Minor Fetal Anomaly	2
3	Cervical Surgery, Prior Hysterotomy, Myomectomy	3
4	Intra Uterine Growth- Fibroids, Ovarian Cancer	3
5	Perineal Repair	2
	Acute Medical Disorder and Substance Abuse	
6	Sickle Cell Disease	3
7	Acute Asthma	3
8	UTI	3
9	Thyrotoxicosis	3
10	Alcohol ≥3 drinks on any one occasion during pregnancy	2
11	Alcohol ≥1 drinks per day throughout pregnancy	2
12	Drug dependent	2

Antenatal Risk Assessment Tool - Adapted from the Alberta Perinatal Health Program and Updated
Low risk (0 - 2), moderate risk (3 - 6), and high risk (≥7) Pregnancy

Figure 3.3: The Antepartum Risk Assessment Tool

Part A – Maternal Characteristics and Pre-pregnancy Condition

Maternal characteristics included, maternal Anthropometric Characteristics such as Age, Weight and Height, Socioeconomic Characteristics such as Education and Occupation. Maternal Pre-pregnancy Health Condition included factors such as Chronic Diseases, Heart Diseases, Sexually Transmitted Infections, Diabetes and Hypertension. Maternal Age was categorized as, below 18 Years, between (18 -34) Years and Beyond 34 Years, Maternal Level of Education was categorized into Illiterate, Primary, JHS, SHS and Tertiary, Occupation was categorized as None, Unemployed, House wife, Dependent, Student, Self Employed, Private Sector Employed and Public Sector Employed, as given below in Table 3.1;

Table 3.1: Antenatal Risk Assessment Tool – Part A

Part A	Pre-Pregnancy Condition	Weighted Relative Risk (a)
	Maternal Anthropometric Characteristics	
1	Age <17 at delivery	1
2	Age >35 at delivery	2
3	Weight >91 kg	1
4	Weight <45 kg	1
5	Height <152 cm	2
	Socioeconomic Characteristics	
6	Education- None	2
7	Education- Primary	1
8	Education- Junior High School and above	0
9	Occupation - Self Employed	0
10	Occupation - Public Sector Employed	1
11	Occupation - Private Sector Employed	1
12	Occupation - Unemployed	2
13	Occupation - Student-below tertiary	2
14	Occupation - Dependent	2
15	Occupation - Housewife	1
16	Occupation - Nil	2
	Maternal Pre-pregnancy Health Conditions	
17	Diabetes - Controlled by diet only	1
18	Diabetes - Insulin used	3
19	Diabetes - Retinopathy documented	3
20	Heart Disease - Asymptomatic (no effect on daily living)	1
21	Heart Disease - Symptomatic (affects daily living)	3
22	Infection - Syphilis	1
23	Infection - HepB	2
24	Infection - PMTCT	2
25	Hypertension - 140/90 mmHg or greater < 20 weeks CHPT	2
26	Hypertension - Antihypertensive drugs	3
27	Hypertension - Chronic renal disease documented	2
28	Other medical disorders - Epilepsy, severe asthma, lupus	1

Antenatal Risk Assessment Tool Part A- Adapted from the Alberta Perinatal Health Program and Updated

Part B - Maternal Past Obstetric History

Maternal past obstetric history included Neonatal death(s), Stillbirth(s), Abortion, Preterm birth, Cesarean section (s), Data on Fertility, Bad obstetric history, Data on whether babies were small or large for gestational dates, Rh isoimmunization, and Significant congenital anomalies, as given below in Table 3.2;

Table 3.2: Antenatal Risk Assessment Tool – Part B

Part B	Past Obstetrical History	Weighted Relative Risk (b)
	Condition	
1	Neonatal death(s)	3
2	Stillbirth(s)	3
3	Abortion between 12 and 20 weeks and under 500g of birth weight	1
4	Delivery at 20 - 37 weeks	1
5	Cesarean section	2
6	Multiple Cesarean sections	3
7	Infertility Treatment	1
8	Bad Obstetric History (BOH)	2
9	Small for dates - 5th percentile	1
10	Large for dates - 95th percentile	1
11	RH Iso-immunization - unaffected infant	1
12	RH Iso-immunization - affected infant	3
13	Significant congenital anomaly, e.g., Chromosomal, Heart,	1

Antenatal Risk Assessment Tool Part B - Adapted from the Alberta Perinatal Health Program and Updated

Part C – Maternal Health Problems in the Current Pregnancy

Maternal health problems in the current pregnancy included Data on whether fetuses are small or large for gestational age, Short Inter Pregnancy Interval, Data on Amniotic fluid volume, Multiple pregnancies, Malpresentation, Müllerian anomalies, Inadequate pelvis, Unfavorable cervix, Premature rupture of membranes, Placenta Previa, Bleeding, Gestational hypertension and diabetes, Edema, Proteinuria, Pre-eclampsia, Severe Pre-eclampsia, Eclampsia, Blood antibodies, Anemia, Post-term pregnancy, Poor weight gain and Smoking, as given below in Table 3.3;

Table 3.3*:* Antenatal Risk Assessment Tool – Part C

Part C	Problems In The Current Pregnancy	Weighted Relative Risk (c)
	Condition	
1	Diagnosis of large for dates	2
2	Diagnosis of small for dates	3
3	Polyhydramnios or oligohydramnios	2
4	Severe (Polyhydramnios or oligohydramnios)	3
5	Anhydramnios	3
6	Multiple pregnancies	3
7	Malpresentation (breech or transverse lie)/ Malposition	3
8	CPD/ Inadequate Pelvis	3
9	Tilted/Unfavorable Cervix	3
10	Placenta Previa	3
11	Short Inter Pregnancy Interval	1
12	Membranes ruptured before 37 weeks	2
13	Bleeding < 20 weeks Abortion	1
14	Bleeding >20 weeks APH	3
15	Gestational hypertension PIH	2
16	Proteinuria ≥1+	1
17	Pre-eclampsia	2
18	Severe Pre-eclampsia	3
19	Gestational diabetes documented, PME	1
20	Blood antibodies (Rh, Anti C, Anti K, etc.)	3
21	Anemia	1
22	Severe Anemia	2
23	Edema	1
24	Big Abdomen	1
25	Grand Mullip	1
26	BTL	1
27	Elderly Primip	1
28	Pregnancy > 42 weeks- Post Term	2
29	Pregnancy > 41 but ≤ 42 weeks- Post Date	1
30	Poor weight gain (26 - 36 weeks < 0.5 kg/week or weight loss)	1
31	Smoker - anytime during pregnancy	1

Antenatal Risk Assessment Tool Part C - Adapted from the Alberta Perinatal Health Program and Updated

Part D - Other Risk Factors

Other risk factors included Fetal Anomalies, Cervical Surgery, Prior Hysterotomy, Myomectomy, Intra Uterine Growth, Perineal Repair, Acute Medical Disorders and Substance Abuse, as given below in Table 3.4;

Table 3.4: Antenatal Risk Assessment Tool – Part D

Part D	OTHER RISK FACTORS	Weighted Relative Risk (d)
	Condition	
1	Major Fetal Anomaly	3
2	Minor Fetal Anomaly	2
3	Cervical Surgery, Prior Hysterotomy, Myomectomy	3
4	Intra Uterine Growth- Fibroids, Ovarian Cancer	3
5	Perineal Repair	2
	Acute Medical Disorder	
6	Sickle Cell Disease	3
7	Acute Asthma	3
8	UTI	3
9	Thyrotoxicosis	3
	Substance Abuse	
10	Alcohol ≥3 drinks on any one occasion during pregnancy	2
11	Alcohol ≥1 drinks per day throughout pregnancy	2
12	Drug dependent	2

Antenatal Risk Assessment Tool Part D - Adapted from the Alberta Perinatal Health Program and Updated

Intrapartum Risk Assessment Tool

This study is the first to validate and include Intrapartum Risk Assessment tool to identify low, moderate, and high-risk deliveries to model pregnancy complications and delivery outcome.

INTRAPARTUM RISK ASSESSMENT TOOL

No.	Condition	Weighted Relative Risk (p)
1	≤ 34 weeks- Severe Pre-term	3
2	35-36 weeks- Pre-term	1
3	(0-1) Antenatal Visits	3
4	(2-3) Antenatal Visits	2
5	Chorioamnionitis	2
6	Meconium in labour	1
7	Prolonged Labour, Poor/Slow Labour progress, Failed Induction, Maternal Exhaustion	3
8	Fetal Heart Rate Abnormalities-NRFHT, Fetal Distress	2
9	Bleeding (200-499) ml in Normal delivery or (500-999) ml in C/S deliveries	1
10	PPH- Bleeding (500-999) ml in Normal delivery or (1000-1499) ml in C/S deliveries	3
11	APH preceding Labour	3
12	Severe PPH (≥1000) ml in Normal delivery or (≥1500) ml in C/S deliveries	4
13	Ruptured Membranes > 24hrs	2
14	PROM	1
15	Seizures	1
16	Seizures & High BP	2
17	Cord Prolapse	1
18	Placenta Abruption	3
19	Retained Placenta	2
20	Fever	1
21	Elective c/s - Maternal Request / BTL	1
22	Coagulopathy	1

Intra-Partum Risk Assessment Tool - Adapted from the Alberta Perinatal Health Program and Updated
Low risk (0 - 2), moderate risk (3 - 6), and high risk (≥7) Delivery

Figure 3.4: The Antepartum Risk Assessment Tool

The intrapartum risk assessment tool was based on 24 variables that were collected on the mother and child at the onset of delivery, during and 24hours after the delivery process. The variables included, Term Cyesis, ANC visits, Mode of delivery, Meconium in labour, Membrane ruptures, Labour Obstructions or Delays, Placental complications, Bleedings, Fetal heart beats Coagulopathy among others. The ANC Visits were categorized into Below 2 Visits, (2-3) Visits, (4-7) Visits, (8-10) Visits and Beyond 10 Visits. A weighted relative risk p, that takes values (0, 1, 2, 3, 4) is assigned to each variable according to the degree of its adverse effect on the life of mother and child, seen in Figure 3.4 and Table 3.5;

Table 3.5: Intrapartum Risk Assessment Tool

No.	Condition	Weighted Relative Risk (p)
1	≤ 34 weeks- Severe Pre-term	3
2	35-36 weeks- Pre-term	1
3	(0-1) Antenatal Visits	3
4	(2-3) Antenatal Visits	2
5	Chorioamnionitis	2
6	Meconium in labour	1
7	Prolonged Labour, Poor/Slow Labour progress, Failed Induction, Maternal Exhaustion	3
8	Fetal Heart Rate Abnormalities-NRFHT, Fetal Distress	2
9	Bleeding (200-499) ml in Normal delivery or (500-999) ml in C/S deliveries	1
10	PPH- Bleeding (500-999) ml in Normal delivery or (1000-1499) ml in C/S deliveries	3
11	APH preceding Labour	3
12	Severe PPH (≥1000) ml in Normal delivery or (≥1500) ml in C/S deliveries	4
13	Ruptured Membranes > 24hrs	2
14	PROM	1
15	Seizures	1
16	Seizures & High BP	2
17	Cord Prolapse	1
18	Placenta Abruption	3
19	Retained Placenta	2
20	Fever	1
21	Elective c/s - Maternal Request / BTL	1
22	Coagulopathy	1

Intra-Partum Risk Assessment Tool - Adapted from the Alberta Perinatal Health Program and Updated
Low risk (0 - 2), moderate risk (3 - 6), and high risk (≥7) Delivery

Neonatal Health Assessment Tool

The neonatal health risk assessment score is based on 37 variables collected on the newborn, that is used to assess the health and survival of the baby, consisting of two parts E and F. A weighted

relative risk p, that takes values (0, 1, 2, 3, 4) is assigned to each variable according to the degree of its adverse effect on the health and survival of the baby, as seen below in Figure 3.4;

NEONATAL HEALTH ASSESSMENT TOOL

Part E	NEONATAL CONGENITAL ANOMALY ASSESSMENT	Weighted Relative Risk (e)	Part F	OTHER FETAL HEALTH CONDITIONS	Weighted Relative Risk (f)
	Condition			**Fetal Growth Complications**	
1	Undescended Testicles	3	1	Intra Uterine Growth Retardation	3
2	Webbed feet and fingers	3	2	Fetal Macrosomia	1
3	Extra digits on both hands or foot	2	3	Normal Growth	0
4	Extra Digits on one hand or foot	1	4	Hypoglycemia	1
5	Fetal microcyte	3	5	Low Birth Weight	1
6	Talipes	3	6	Premature	2
7	Hydrocephalus	3		**Fetal Infections**	
8	Unperforated anus	3	7	Exposed to Maternal Pre-Pregnancy infections (STIs)	2
9	Deformed Arm	3	8	Offensive liquor-Infected	2
10	Chest In-drawing	3	9	Sepsis	4
11	Limb Contractures	3	10	Meconium Aspirations	3
12	Dilated calyces of the kidney	3		**Fetal Trauma**	
13	False tooth	0	11	Mild Birth Asphyxia	1
14	Abnormal Penis	3	12	Birth Asphyxia	2
15	Duodenal Atresia	3	13	Severe Birth Asphyxia	3
16	Near Fetal Blindness	3	14	Grunting respiration	2
17	Facial Palsy	3	15	Neonatal Jaundice	1
18	Not sucking	2	16	Hematoma	1
19	Siamese Twins, 2 heads one body	4	*Neonatal Health Assessment Tool - Inspirations from Jain S et al. (2014)*		
20	Fetal Heart rate/beat abnormalities, Persistent Fetal Tachycardia/ Tachypnoea/ NRFHR	3	*Baby with Low-health challenge (1 - 2), Moderate-health challenge (3 - 6), and Severe-health Challenge (≥7)*		
21	Hydrops Fetalis	3			

Figure 3.5: The Neonatal Health Assessment Tool

Part E - Fetal Congenital Anomalies

Fetal Congenital Anomalies included, Undescended Testicles, Webbed feet and fingers, Extra digits on both hands or foot, Extra Digits on one hand or foot, Deformed Arm, Fetal microcyte, Talipes, Hydrocephalic, Unperforated anus, Chest In-drawing, Limb Contractures, False tooth, Abnormal Penis, Duodenal Atresia, Near Fetal Blindness, Facial Palsy, lack of suckling reflexes, Siamese Twins, Fetal Heart rate/beat abnormalities, Persistent Fetal Tachycardia/ Tachypnoea/ NRFHR, as given below in Table 3.6;

Table 3.6: Neonatal Health Assessment Tool - Part E

Part E	NEONATAL CONGENITAL ANOMALY ASSESSMENT	Weighted Relative Risk (e)
	Condition	
1	Undescended Testicles	3
2	Webbed feet and fingers	3
3	Extra digits on both hands or foot	2
4	Extra Digits on one hand or foot	1
5	Fetal microcyte	3
6	Talipes	3
7	Hydrocephalus	3
8	Unperforated anus	3
9	Deformed Arm	3
10	Chest In-drawing	3
11	Limb Contractures	3
12	Dilated calyces of the kidney	3
13	False tooth	0
14	Abnormal Penis	3
15	Duodenal Atresia	3
16	Near Fetal Blindness	3
17	Facial Palsy	3
18	Not sucking	2
19	Siamese Twins, 2 heads one body	4
20	Fetal Heart rate/beat abnormalities, Persistent Fetal Tachycardia/ Tachypnoea/ NRFHR	3
21	Hydrops Fetalis	3

Neonatal Health Assessment Tool Part E- Inspirations from Jain S et al. (2014)

Part F - Other Fetal health conditions

Other Fetal health conditions included, Fetal Growth Complications including, Intra Uterine Growth Retardation, Fetal Macrosomia, Hypoglycemia, Low Birth Weight and Fetal Prematurity, Fetal Infections which includes, Exposure to from maternal ST-Infections, Offensive liquor (infected), Sepsis and infections due to meconium aspirations and Fetal Trauma experienced during the delivery process including, Birth Asphyxia, Grunting respiration, Neonatal Jaundice and Cephal Hematoma as given below in Table 3.7;

Table 3.7: Neonatal Health Assessment Tool – Part F

Part F	OTHER FETAL HEALTH CONDITIONS	Weighted Relative Risk (f)
	Fetal Growth Complications	
1	Intra Uterine Growth Retardation	3
2	Fetal Macrosomia	1
3	Normal Growth	0
4	Hypoglycemia	1
5	Low Birth Weight	1
6	Premature	2
	Fetal Infections	
7	Exposed to Maternal Pre-Pregnancy infections (STIs)	2
8	Offensive liquor-Infected	2
9	Sepsis	4
10	Meconium Aspirations	3
	Fetal Trauma	
11	Mild Birth Asphyxia	1
12	Birth Asphyxia	2
13	Severe Birth Asphyxia	3
14	Grunting respiration	2
15	Neonatal Jaundice	1
16	Hematoma	1

Neonatal Health Assessment Tool Part F- Inspirations from Jain S et al. (2014)

3.3.2 Antepartum, Intrapartum and Neonatal Health Assessment Scores

Pregnant patients' health variables before, during and after delivery that were extracted from the maternal delivery records, were assessed using the assessment tools indicated above.

The Antepartum Risk Scores (APRS)

Depending on the number of the variables in the Antepartum risk assessment tool that pertains to a pregnant patient, a sum of their respective weighted relative risks indicates the risk of carrying that pregnancy. The risks are summed according to the four parts of the assessment tool as indicated below;

$$\textbf{APRS} - \textbf{Part A} = \sum_{1}^{28} a_i \,, \qquad \textbf{APRS} - \textbf{Part B} = \sum_{1}^{13} b_i \,, \qquad \textbf{APRS} - \textbf{Part C} = \sum_{1}^{31} c_i \qquad \text{and}$$

$$\textbf{APRS} - \textbf{Part D} = \sum_{1}^{12} d_i \,.$$

The total sum of the risks from all the four parts if any, gives the APRS for carrying that

$$\mathbf{APRS} = APRS - Part\ A + APRS - Part\ B + APRS - Part\ C + APRS - Part\ D$$

$$\mathbf{APRS} = \sum_{1}^{28} a_i + \sum_{1}^{13} b_i + \sum_{1}^{31} c_i + \sum_{1}^{12} d_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The higher the APRS, the riskier the pregnancy is considered.

The Intrapartum Risk Scores (IPRS)

Depending on the number of the variables in the Intrapartum risk assessment tool that pertains to a pregnant patient in labour, a total sum of their respective weighted relative risks gives the risk (IPRS) of delivering that child, as seen below;

$$\mathbf{IPRS} = \sum_{1}^{24} p_i$$

The higher the IPRS, the riskier the delivery process is considered.

The Neonatal Health Assessment Scores (NHAS)

Depending on the number of the variables in the Neonatal Health Assessment tool that pertains to a newborn, a sum of their respective weighted relative risks indicates the health and survival challenges of that baby. The risks are summed according to the two parts of the assessment tool as indicated below;

$$\mathbf{NHAS - Part\ E} = \sum_{1}^{21} e_i \text{ and } \mathbf{NHAS - Part\ F} = \sum_{1}^{16} f_i$$

The total sum of the scores from the two parts if any, gives the NHAS concerning the health and survival of the child as seen below;

$$\mathbf{NHAS} = NHAS - Part\ E + NHAS - Part\ F$$

$$= \sum_{1}^{21} e_i + \sum_{1}^{16} f_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The higher the NHAS, the more challenging the health and survival of the baby is considered.

3.3.3 Pregnancy Complications Scores (PCOMPS)

All the maternal complications namely; Sepsis, Uterine rupture, Obstructed labour, Eclampsia and PPH that occurred during and after delivery, including cases where the pregnancies and deliveries were plagued with Multiple complications were recorded. Even though APH is a complication that occurs during the antepartum stage, it was included, due to its devastating effect on both mother and child during and after delivery.

Most of the maternal and neonatal deaths as well as neonatal health challenges could easily be traced to one complication or another, the remaining cases that could not, were recorded under Other complications. This study treated Multiple and Other complications the same way as the widely recognized pregnancy complications as seen in Table 4.1.

In order to give each complication a fair representation in the pregnancy complications score (PCOMPS), the ranks of the Prevalence Rate and the Case fatality rate of each pregnancy complication were factored into the PCOMPS as seen in Table 4.2.

Prevalence Rate (PR) gives the burden of a particular complication among the pregnant patients that delivered during the period of this study. PR was calculated for each of the pregnancy complications considered in this study, as given below;

$$\mathbf{PR} = \frac{\textbf{The Number of cases of a particular complication recorded among the patients}}{\textbf{The total number of the patients}} \quad \text{.....(3)}$$

These values were ranked to derive the Pregnancy Complications Prevalence Rate Rank (PCPRR) for the various complications.

Case Fatality Rate (CFR) evaluates the risk of a mother or baby dying as a result of the effect of a particular complication. CFR was calculated for each of the pregnancy complications considered under this study, as given below;

$$\mathbf{CFR} = \frac{\textbf{Number of deaths associated with a particular complication}}{\textbf{Number of individuals who actually developed that particular complication in this study}} \quad \text{.....(4)}$$

These values were calculated with respect to the life of the mother (CFRM) and neonate (CFRN), and were ranked to derive the Pregnancy Complications Case Fatality Rate Ranks Maternal (PCCFRRM) and Pregnancy Complications Case Fatality Rate Ranks Neonatal (PCCFRRN) for the various complications.

$$\textbf{PCOMPS}) = \textbf{The Rank of} \left\{ \frac{\textbf{PCPRR} + \textbf{PCCFRRM} + \textbf{PCCFRRN}}{3} \right\} \quad \text{.....(5)}$$

for each of the Pregnancy Complications. Pregnancies that did not record any complication during and after delivery, and did not result in any adverse delivery outcome, were assigned a PCOMPS value of (0) as seen in Table 4.2.

3.3.4 Pregnancy Delivery Outcome Score (PDOS)

The total sum of Maternal Life Status Score (MLSS), Neonatal Life Status Score (NLSS), and NHAS give rise to the PDOS. Maternal and Neonatal life statuses take values of 0 when the mother is alive and 5 when the mother died during or after delivery. Neonatal health assessment scores values as earlier indicated.

$$\mathbf{PDOS} = \mathbf{NHAS} + \mathbf{MLSS} + \mathbf{NLSS} \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

3.3.5 Converting Risk Scores to Risk Indices

To make these Risk Scores more comparable, they needed to be standardized. Standardization enables these scores to be compared across; Different pregnancies of the same woman; Different pregnancies of different women of the same blood type; Different pregnancies of different women of different blood type; Different pregnancies of different women of the same blood type within the same geographical regions; Different pregnancies of different women of different blood types and of different geographical regions.

Indexing has been one of the best ways to standardize numeric scores, therefore, the Risk Scores, were converted to Risk Scores Indices according to the following criteria;

1. APRSI- APRS from (0 – 2) indicated low-risk pregnancy, APRS from (3 - 6) indicated moderate-risk pregnancy, and APRS (≥ 7) indicated high-risk pregnancy.
2. IPRSI - IPRS from (0 – 2) indicated low-risk delivery, IPRS from (3 - 6) indicated moderate-risk delivery, and IPRS (≥ 7) indicated high-risk delivery (HIPRSI).

3. NHASI - NHAS of (0) indicated Healthy Baby, NHAS from (1 – 2) indicated Low-health challenged Baby, NHAS from (3 - 6) indicated Moderate-health challenged Baby, NHAS (≥ 7) indicated Severe-health Challenged Baby.
4. PCOMPSI – PCOMPS of (0) indicated the pregnancy was not complicated, PCOMPS between (1-2) indicated the pregnancy was complicated, PCOMPS (≥ 3) the pregnancy was highly complicated.
5. PDOSI – PDOS of (0-1) indicated Both mother and child were Alive and Baby was very healthy (Pleasant Delivery Outcome), PDOS between (2-3) indicated the Both mother and child were Alive, Baby was with some health challenge (Both Alive, Unhealthy Baby), Pregnancy delivery Scores (≥ 4) indicated either mother, child, or both are Dead (Adverse Delivery Outcome).

In order to predict PDO the ordinal values of PDOSI, Pleasant Delivery Outcome, Both Alive, with Unhealthy Baby, and Adverse Delivery Outcome, had to be converted to numeric values of 0, 1 and 2 respectively giving rise to PDOSIN.

Due to the mediated nature of APR and IPR, their ordinal values; low, moderate and high-risk had to be converted to numeric values of 0, 1, and 2 respectively giving rise to APRSIN and IPRSIN.

The ordinal values of NHASI; Healthy Baby, Low-health challenged Baby, Moderate-health challenged Baby, Severe-health challenged Baby were also converted to numeric values of 0, 1, 2 and 3 respectively.

3.4 Moderated Mediation and Double Mediated Models

1. To address the second and third objectives, we considered a moderated mediation model that involves the moderator, moderating the relationship between the mediator and the dependent variable. From Figure 3.5, APRSIN mediates the relationship between maternal blood type and pregnancy complications while HIPRSI is moderating the relationship between APRSIN and pregnancy complications.

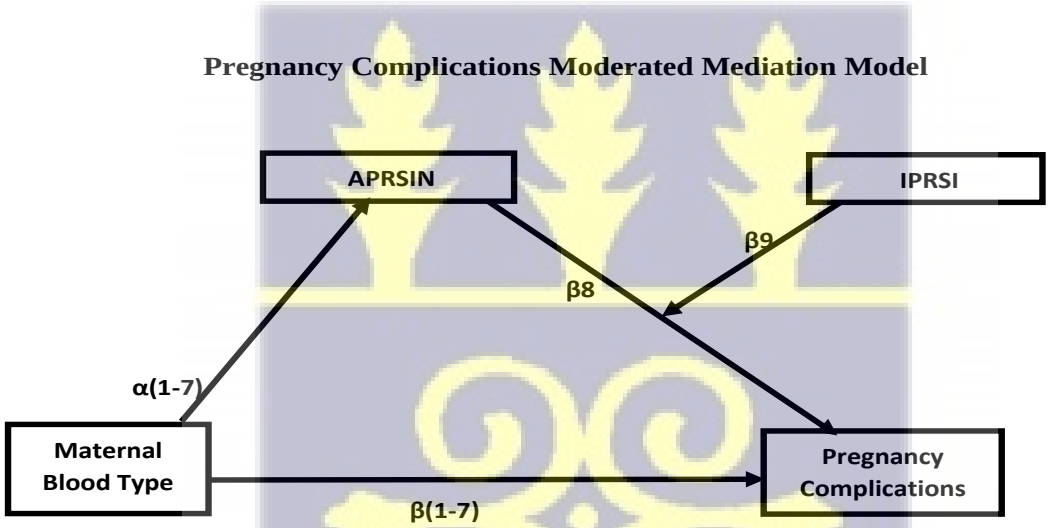

Figure 3.6*:* Moderated Mediation Model for Pregnancy Complications Outcome

1. **Multi-categorical exposure variable** - Maternal Blood type (A- (reference), A+, B-, B+, O-, O+, AB- and AB+)
2. **Dependent variable** –Pregnancy Complications Outcome (PCOMPSIN)
3. **Mediator** –Antepartum Risk (APRSIN)
4. **Moderator** –Intrapartum Risk (Low and Moderate-Risk (reference), High-Risk)
5. **Path α (1-7)** – Direct relationships between Maternal Blood types and APRSIN
6. **Path β8** – Direct relationship between APRSIN and PCOMPSIN
7. **Path β (1-7)** – Direct relationships between Maternal Blood types and PCOMPSIN

Figure 3.6, leads to the following set of equations.

$$\mathbf{PCOMPSIN} = \beta_0 + \beta_1 Ap + \beta_2 Bn + \beta_3 Bp + \beta_4 On + \beta_5 Op + \beta_6 ABn + \beta_7 ABp + \beta_8 APRSIN + \beta_9 HIPRSI + \beta_{10} APRSIN * HIPRSI + \varepsilon_4 .....(7)$$

$$\mathbf{APRSIN(M)} = \alpha_0 + \alpha_1 Ap + \alpha_2 Bn + \alpha_3 Bp + \alpha_4 On + \alpha_5 Op + \alpha_6 ABn + \alpha_7 ABp + \varepsilon_4 .....(8)$$

2. To address the fourth objective, we considered a double mediation model that involves 2 mediators mediating the relationship between the independent variable and the dependent variable. From Figure 3.6, APRSIN and IPRSIN mediate the relationship between maternal blood type and pregnancy delivery outcome.

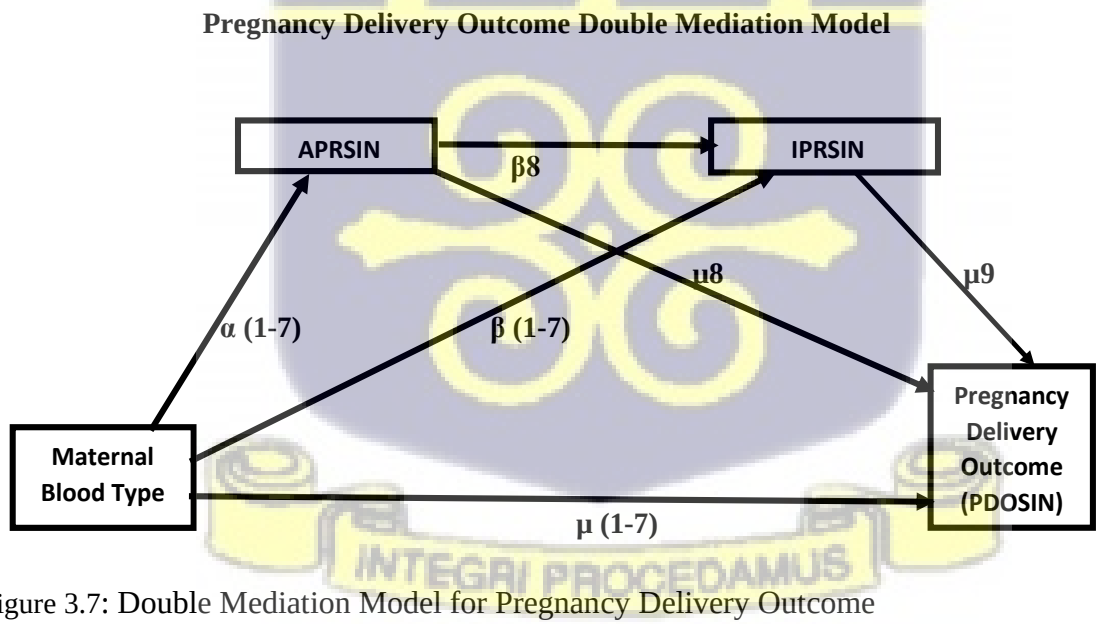

Figure 3.7: Double Mediation Model for Pregnancy Delivery Outcome

1. **Multi-categorical exposure variable** - Maternal Blood type (A- (reference), A+, B-, B+, O-, O+, AB- and AB+)
2. **Dependent Variable** –Pregnancy Delivery Outcome (PDOSIN)
3. **Mediator-1** –Antepartum Risk (APRSIN)

4. **Mediator-2**–Intrapartum Risk (IPRSIN)
5. **Path α (1-7)** – Direct relationships between Maternal Blood types and APRSIN
6. **Path β (1-7)** – Direct relationships between Maternal Bloods type and IPRSIN
7. **Path β8** – Direct relationship between APRSIN and IPRSIN
8. **Path μ (1-7)** – Direct relationships between Maternal Blood types and PDOSIN
9. **Path μ8** – Direct relationship between APRSIN and PDOSIN
10. **Path μ9** – Direct relationship between IPRSIN and PDOSIN

The schematic diagram in Figure 3.7, leads to the following set of equations.

$$\mathbf{PDOSIN} = \mu_0 + \mu_1 Ap + \mu_2 Bn + \mu_3 Bp + \mu_4 On + \mu_5 Op + \mu_6 ABn + \mu_7 ABp + \mu_8 APRSIN + \mu_9 IPRSIN + \varepsilon_4 \ldots\ldots\ldots\ldots (9)$$

$$\mathbf{APRSIN}(\mathbf{M}_1) = \alpha_0 + \alpha_1 Ap + \alpha_2 Bn + \alpha_3 Bp + \alpha_4 On + \alpha_5 Op + \alpha_6 ABn + \alpha_7 ABp + \varepsilon_4 \ldots\ldots\ldots\ldots (8)$$

$$\mathbf{IPRSIN}(\mathbf{M}_2) = \beta_0 + \beta_1 Ap + \beta_2 Bn + \beta_3 Bp + \beta_4 On + \beta_5 Op + \beta_6 ABn + \beta_7 ABp + \beta_8 APRSIN + \varepsilon_4 \ldots\ldots\ldots\ldots (10)$$

3.5 Model Parameters Estimation

This study employs the maximum likelihood estimation method (Usher, 2016; Zivot, 2012) to determine the values for the parameters of the models. The nlminb optimization method (Nash, 2010, 2014; Rashid, 2017; Rosseel, 2012), and bootstrap estimation methods (Hayes & Preacher, 2014b; Hayes A. F. & Preacher K. J., 2014; Preacher & Hayes, 2004, 2008) are performed using process macros. R packages; *lavaan*, *QuantPsyc*, *psych*, *arsenal*, *Hmisc*, *car*, *nortest* and *leaps* were used to conduct data management, processing and statistical analysis of the moderated mediated model.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

To establish that maternal blood type is the potential cause of pregnancy complications and adverse delivery outcomes, maternal delivery records from 1st January to 31st December were obtained and pre-processed to test the moderated mediated and double mediated models for pregnancy complications and delivery outcomes. This section is of three parts, part one consists of data processing results, part two consists of results from preliminary analysis and model fits and part three is a discussion of the results.

4.1 Data Processing results

Tables 4.1 and 4.2 consists of the data processing details of pregnancy complications outcome.

Table 4.1: Data Pre-processing- Pregnancy Complications Details

Complications	Dead - Mother	Dead - Baby	Health Challenged Baby	Total
Sepsis	2	9	1	11
PPH	0	6	29	183
APH	1	2	3	18
Eclampsia	0	1	3	10
Obstructed Labour	1	8	21	109
Other	0	22	138	160
Multiple Comp	0	7	10	44
No Complications	0	0	1	1559
Total	**4**	**55**	**206**	**2094**

Table 4.2: Data Pre-processing - Computing Pregnancy Complications Score - PCOMPS

Complication	Complication Prevalence		Case fatality-Mother		Case fatality-Baby		Average Rank	PCOMPS	PCOMPSIN
	Rate	Rank	Rate	Rank	Rate	Rank			
Sepsis	0.5	2.0	18.2	7.0	81.8	7.0	5.3	7.0	2
PPH	8.7	7.0	0.0	2.5	3.3	1.0	3.5	2.0	1
APH	0.9	3.0	5.6	6.0	11.1	4.0	4.3	5.0	2
Eclampsia	0.5	1.0	0.0	2.5	10.0	3.0	2.2	1.0	1
Obstructed Labour	5.2	5.0	0.9	5.0	7.3	2.0	4.0	3.0	2
Other	7.6	6.0	0.0	2.5	13.8	5.0	4.5	6.0	2
Multiple Comp	2.1	4.0	0.0	2.5	15.9	6.0	4.2	4.0	2
No Complications									0

4.2 Preliminary Analysis

Preliminary analysis consists of univariate and bivariate analysis of antepartum and intrapartum risks, pregnancy complications and pregnancy delivery outcome variables aimed at achieving the objectives of this study which are as follows;

4.2.1 Univariate Analysis

The following are the univariate analysis of maternal blood type, antepartum risk, intrapartum risk, type of pregnancy complications, level of pregnancy complications, neonatal health, pregnancy delivery outcome, neonatal life and maternal life.

From Table 4.3, Out of the 2094 pregnant patients included in this study;

The maternal blood types were distributed as follow; pregnant patients of blood type A- were 30 (1.4%), type A+ were 420 (20.1%), type B- were 33 (1.6%), type B+ were 577 (27.6%), type O-

were 80 (3.8%), type O+ were 851 (40.6%), type AB- were 4 (0.2%), and type AB+ were 99 (4.7%).

The antepartum risks were distributed as follow; low-risk pregnancy cases were 520 (24.8%), moderate-risk pregnancy cases were 934 (44.6%), and high-pregnancy cases 640 (30.6%).

The intrapartum risks were distributed as follow; low-risk delivery cases were 1154 (55.1%), moderate-risk delivery cases were 797 (38.1%), and high-risk delivery cases were 143 (6.8%).

Table 4.3: Univariate Analysis

Variable	Number (%)
Blood Type	
A-	30 (1.4%)
A+	420 (20.1%)
B-	33 (1.6%)
B+	577 (27.6%)
O-	80 (3.8%)
O+	851 (40.6%)
AB-	4 (0.2%)
AB+	99 (4.7%)
Antepartum Risk	
High-Risk Pregnancy	640 (30.6%)
Low-Risk Pregnancy	520 (24.8%)
Moderate-Risk Pregnancy	934 (44.6%)
Intrapartum Risk	
High-Risk Delivery	143 (6.8%)
Low-Risk Delivery	1154 (55.1%)
Moderate-Risk Delivery	797 (38.1%)

The level of pregnancy complications outcomes was distributed as follow; Complicated cases were 193 (9.2%), Highly Complicated pregnancy cases were 342 (16.3%), and Uncomplicated pregnancy cases were 1559 (74.5%).

The types of the pregnancy complications were distributed as follow; Obstructed Labour cases were 109 (5.2%), APH cases were18 (0.9%), Eclampsia cases were 10 (0.5%), Multiple

Complications cases were 44 (2.1%), Other Complication cases were 160 (7.6%), PPH cases were 183 (8.7%), Sepsis cases were 11 (0.5%), and Uncomplicated cases were 1559 (74.5%).

The maternal life outcomes were distributed as follow; alive 2090 (99.8%), and maternal death cases were 4 (0.2%).

Table 4.3: Univariate Analysis cont...

Variable	Number (%)
Level of Complication	
Complicated	193 (9.2%)
Highly Complicated	342 (16.3%)
No Comp	1559 (74.5%)
Type of Complication	
Obstructed Labour	109 (5.2%)
APH	18 (0.9%)
Eclampsia	10 (0.5%)
Multiple Complications	44 (2.1%)
Other	160 (7.6%)
PPH	183 (8.7%)
Sepsis	11 (0.5%)
No Comp	1559 (74.5%)
Maternal Life Status	
Alive	2090 (99.8%)
Dead	4 (0.2%)

The neonatal health outcomes were distributed as follow; healthy baby cases were 1602 (76.5%), low-health challenged baby cases were 236 (11.3%), moderate-health challenged baby cases were 197 (9.4%), severe-health challenged baby cases were 4 (0.2%), and neonatal death cases were 55 (2.6%).

Pregnancy delivery outcomes were distributed as follow; adverse delivery outcome cases were 55 (2.6%), both alive, unhealthy baby 201 (9.6%), and pleasant delivery outcome cases were 1838 (87.8%).

The neonatal life outcomes were distributed as follow; livebirth cases were 2039 (97.4%), early neonatal deaths (ENND-Fresh SB) cases were 10 (0.5%), IUFD (still birth) cases were 40 (1.9%), and macerated IUFD cases were 5 (0.2%).

Table 4.3: Univariate Analysis cont...

Variable	Number (%)
Neonatal Health	
Healthy Baby	1602 (76.5%)
Moderate-health challenged Baby	197 (9.4%)
Severe-health challenged Baby	4 (0.2%)
Low-health challenged Baby	236 (11.3%)
Dead Baby	55 (2.6%)
Pregnancy Delivery outcome	
Pleasant Delivery Outcome	1838 (87.8%)
Both Alive, Unhealthy Baby	201 (9.6%)
Adverse Delivery Outcome	55 (2.6%)
Neonatal Life Status	
Alive	2039 (97.4%)
ENND-Fresh SB	10 (0.5%)
IUFD (still birth)	40 (1.9%)
Macerated IUFD	5 (0.2%)

4.2.2 Bivariate Analysis

Below are bivariate results aimed at addressing the specific study objectives through the research questions, as outlined in chapter one;

The Effect of Maternal Blood Type in Pregnant

The aim of the specific objective 1, was to assess the effects of the maternal blood type through the antepartum, and intrapartum risks, pregnancy complications, and pregnancy delivery outcome on the pregnant patients. Below are bivariate answers to the three research questions that address the specific objective 1;

Research question 1: Are the high-risk pregnancy and delivery, popular among certain maternal blood types compared to others?

Relationship Between Maternal Blood Type and Antepartum Risk

The relationship between maternal blood type and risk of pregnancy is significant (p-value < 0.001). With respect to the effects of maternal blood type through the risk of pregnancy, 17 (56.7%) and 13 (43.3%) of A- pregnant patients were High-Risk, and Moderate-Risk pregnancy cases respectively, with no cases of Low-Risk pregnancy. For blood type A+ pregnant patients, 106 (25.2%), 205 (48.8%), and 109 (26.0%) were High-Risk, Moderate-Risk, and Low-Risk pregnancy cases respectively. For blood type B- pregnant patients, 18 (54.5%) and 15 (45.5%) were High-Risk, and Moderate-Risk pregnancy cases respectively, with no cases of Low-Risk pregnancy. For blood type B+ pregnant patients, 165 (28.6%), 269 (46.6%), and 143 (24.8%) were High-Risk, Moderate-Risk, and Low-Risk pregnancy cases respectively. For blood type O- pregnant patients, 46 (57.5%), and 34 (42.5%) were High-Risk, and Moderate-Risk Pregnancy cases respectively, with no cases of Low-Risk pregnancy. For blood type O+ pregnant patients, 253 (29.7%), 360 (42.3%), and 238 (28.0%) were High-Risk, Moderate-Risk, and Low-Risk pregnancy cases respectively. For blood type AB- pregnant patients, 3 (75.0%), and 1 (25.0%) were High-Risk, and Moderate-Risk pregnancy cases respectively, with no cases of Low-Risk pregnancy. For blood type AB+ pregnant patients, 34 (34.3%), 35 (35.4%), and 30 (30.3%) were High-Risk, Moderate-Risk, and Low-Risk pregnancies respectively, as seen below in Table 4.4;

Table 4.4: Bivariate Analysis of the Antepartum Risk and Maternal Blood Type

Pregnancy Risk	A-	A+	B-	B+	O-	O+	AB-	AB+	Total	p value
High-Risk Pregnancy	17 (56.7%)	106 (25.2%)	18 (54.5%)	165 (28.6%)	46 (57.5%)	253 (29.7%)	3 (75.0%)	34 (34.3%)	642 (30.7%)	
Moderate - Risk Pregnancy	13 (43.3%)	205 (48.8%)	15 (45.5%)	269 (46.6%)	34 (42.5%)	360 (42.3%)	1 (25.0%)	35 (35.4%)	932 (44.5%)	
Low-Risk Pregnancy	0 (0.0%)	109 (26.0%)	0 (0.0%)	143 (24.8%)	0 (0.0%)	238 (28.0%)	0 (0.0%)	30 (30.3%)	520 (24.8%)	
TOTAL	**(N=30)**	**(N=420)**	**(N=33)**	**(N=577)**	**(N=80)**	**(N=851)**	**(N=4)**	**(N=99)**	**(N=2094)**	**< 0.001**

Relationship Between Maternal Blood Type and Intrapartum Risk

The relationship between maternal blood type and the risk of delivery is not statistically significant (p-value = 0.366), although the effect of the risk of delivery were not same. For blood type A- pregnant patients,13 (43.3%), 16 (53.3%), and 1(3.3%) were Low-Risk, Moderate-Risk and High-Risk Delivery cases respectively. For blood type A+ pregnant patients, 245 (58.3%), 12 (36.4%), and 2 (6.1%) were Low-Risk, Moderate-Risk and High-Risk Delivery cases respectively. For blood type B- pregnant patients, 19 (57.6%), 12 (36.4%), and 2 (6.1%) were Low-Risk, Moderate-Risk and High-Risk Delivery cases respectively. For blood type B+ pregnant patients, 303 (52.5%), 233 (40.4%), and 41(7.1%) were Low-Risk, Moderate-Risk and High-Risk Delivery cases respectively. For blood type O- pregnant patients, 39 (48.8%),32 (40.0%), and 9 (11.2%) were Low-Risk, Moderate-Risk and High-Risk Delivery cases respectively. For blood type O+ pregnant patients, 485 (57.0%), 304 (35.7%), and 62 (7.3%) were Low-Risk, Moderate-Risk and High-Risk Delivery cases respectively. For blood type AB- pregnant patients, 2 (50.0%), and 2 (50.0%) were Low-Risk and Moderate-Risk with no High-Risk Delivery. For blood type AB+ pregnant patients, 48 (48.5%), 45 (45.5%), and 6(6.1%) of were Low-Risk, moderate-risk and High-Risk Delivery cases respectively, as displayed in Table 4.5.

Table 4.5: Bivariate Analysis of the Intrapartum Risk and Maternal Blood Type

Delivery Risk	A-	A+	B-	B+	O-	O+	AB-	AB+	Total	p value
High-Risk Delivery	1 (3.3%)	22 (5.2%)	2 (6.1%)	41 (7.1%)	9 (11.2%)	62 (7.3%)	0 (0.0%)	6 (6.1%)	143 (6.8%)	
Moderate-Risk Delivery	16 (53.3%)	153 (36.4%)	12 (36.4%)	233 (40.4%)	32 (40.0%)	304 (35.7%)	2 (50.0%)	45 (45.5%)	797 (38.1%)	
Low-Risk Delivery	13 (43.3%)	245 (58.3%)	19 (57.6%)	303 (52.5%)	39 (48.8%)	485 (57.0%)	2 (50.0%)	48 (48.5%)	1154 (55.1%)	
TOTAL	**(N=30)**	**(N=420)**	**(N=33)**	**(N=577)**	**(N=80)**	**(N=851)**	**(N=4)**	**(N=99)**	**(N=2094)**	**0.366**

Research question 2: Are some pregnancy complications and complications outcomes popular among certain maternal blood types compared to others?

Relationship Between Maternal Blood Type and Complications Outcome

The relationship between maternal blood type and pregnancy complications outcome is not significant with (p-values = 0.696), however, the effect of maternal blood type through the pregnancy complications outcome were not same. For blood type A- pregnant patients, 2 (6.7%), 6 (20.0%) and 22 (73.3%) Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively. For blood type A+ pregnant patients, 67 (16.0%), 34 (8.1%), and 319 (76.0%) were Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively. For blood type B- pregnant patients, 4 (12.1%), 1 (3.0%), and 28 (84.8%) were Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively. For blood type B+ pregnant patients, 100 (17.3%), 57 (9.9%), and 420 (72.8%) were Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively. For blood type O- pregnant patients, 15 (18.8%), 9 (11.2%), and 56 (70.0%) were Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively. For blood type O+ pregnant patients, 136 (16.0%), 77 (9.0%), and 638 (75.0%) were Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively. For

blood type AB- pregnant patients, 1 (25.0%) and 3 (75.0%) were Highly Complicated, and Uncomplicated pregnancy cases respectively, with no Complicated pregnancy cases. For blood type AB+ pregnant patients, 17 (17.2%), 9 (9.1%), and 73 (73.7%) were Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively, as seen below in Table 4.6.

Table 4.6: Bivariate Analysis of Pregnancy Complications and Maternal Blood Type

Level of Complication	A-	A+	B-	B+	O-	O+	AB-	AB+	Total	P value
Complicated	6 (20.0%)	34 (8.1%)	1 (3.0%)	57 (9.9%)	9 (11.2%)	77 (9.0%)	0 (0.0%)	9 (9.1%)	193 (9.2%)	
Highly Complicated	2 (6.7%)	67 (16.0%)	4 (12.1%)	100 (17.3%)	15 (18.8%)	136 (16.0%)	1 (25.0%)	17 (17.2%)	342 (16.3%)	
Uncomplicated	22 (73.3%)	319 (76.0%)	28 (84.8%)	420 (72.8%)	56 (70.0%)	638 (75.0%)	3 (75.0%)	73 (73.7%)	1559 (74.5%)	
TOTAL	**(N=30)**	**(N=420)**	**(N=33)**	**(N=577)**	**(N=80)**	**(N=851)**	**(N=4)**	**(N=99)**	**(N=2094)**	**0.696**

Again, the relationship between maternal blood type and the type of pregnancy complications is not significant with (p-values = 0.917), however, the effect of maternal blood type through the different types of pregnancy complications were not same. For blood type A- pregnant patients, 2 (6.7%), 6 (20.0%), and 22 (73.3%) had Obstructed Labour, PPH, and Uncomplicated cases respectively. For blood type A+ pregnant patients, 19 (4.5%), 3 (0.7%), 1 (0.2%), 10 (2.4%), 31 (7.4%), 33 (7.9%), 4 (1.0%), and 319 (76.0%) had Obstructed Labour, APH, Eclampsia, Multiple Complications, Other Complications, PPH, Sepsis, and Uncomplicated cases respectively. For blood type B- pregnant patients,1 (3.0%), 1 (3.0%), 2 (6.1%), 1 (3.0%), and 28 (84.8%) had Obstructed Labour, APH, Other Complications, PPH, and Uncomplicated cases respectively. For blood type B+ pregnant patients, 32 (5.5%), 4 (0.7%), 3 (0.5%), 14 (2.4%), 48 (8.3%), 54 (9.4%), 2 (0.3%), and 420 (72.8%) had Obstructed Labour, APH, Eclampsia, Multiple Complications, Other Complications, PPH, Sepsis, and Uncomplicated cases respectively. For blood type O-, 5 (6.2%), 1 (1.2%), 2 (2.5%), 5 (6.2%), 9 (11.2%), 2 (2.5%), and 56 (70.0%) had Obstructed Labour,

APH, Multiple Complications, Other Complications, PPH, Sepsis, and Uncomplicated cases respectively. For blood type O+ pregnant patients, 45 (5.3%), 9 (1.1%), 5 (0.6%), 18 (2.1%), 61 (7.2%), 61 (7.2%), 72 (8.5%), 72 (8.5%), and 638 (75.0%) had Obstructed Labour, APH, Eclampsia, Multiple Complications, Other Complications, PPH, Sepsis, and Uncomplicated cases respectively. For blood type AB- pregnant patients, 1 (25.0%), and 3 (75.0%) had Other Complications, and Uncomplicated cases respectively. For blood type AB+ pregnant patients, 5 (5.1%),1 (1.0%), 12 (12.1%), 8 (8.1%), and 73 (73.7%) had Obstructed Labour, Eclampsia, Other Complications, PPH, and Uncomplicated cases respectively, as seen below in Tables 4.7;

Table 4.7: Bivariate Analysis of Pregnancy Complications and Maternal Blood Type

Complication	**A-**	**A+**	**B-**	**B+**	**O-**	**O+**	**AB-**	**AB+**	**Total**	**p value**
Obs. Labour	2 (6.7%)	19 (4.5%)	1 (3.0%)	32 (5.5%)	5 (6.2%)	45 (5.3%)	0 (0.0%)	5 (5.1%)	109 (5.2%)	
APH	0 (0.0%)	3 (0.7%)	1 (3.0%)	4 (0.7%)	1 (1.2%)	9 (1.1%)	0 (0.0%)	0 (0.0%)	18 (0.9%)	
Eclampsia	0 (0.0%)	1 (0.2%)	0 (0.0%)	3 (0.5%)	0 (0.0%)	5 (0.6%)	0 (0.0%)	1 (1.0%)	10 (0.5%)	
Multiple Comp.	0 (0.0%)	10 (2.4%)	0 (0.0%)	14 (2.4%)	2 (2.5%)	18 (2.1%)	0 (0.0%)	0 (0.0%)	44 (2.1%)	
Other	0 (0.0%)	31 (7.4%)	2 (6.1%)	48 (8.3%)	5 (6.2%)	61 (7.2%)	1 (25.0%)	12 (12.1%)	160 (7.6%)	
PPH	6 (20.0%)	33 (7.9%)	1 (3.0%)	54 (9.4%)	9 (11.2%)	72 (8.5%)	0 (0.0%)	8 (8.1%)	183 (8.7%)	
Sepsis	0 (0.0%)	4 (1.0%)	0 (0.0%)	2 (0.3%)	2 (2.5%)	72 (8.5%)	0 (0.0%)	0 (0.0%)	11 (0.5%)	
Uncomplicated	22 (73.3%)	319 (76.0%)	28 (84.8%)	420 (72.8%)	56 (70.0%)	638 (75.0%)	3 (75.0%)	73 (73.7%)	1559 (74.5%)	
TOTAL	**(N=30)**	**(N=420)**	**(N=33)**	**(N=577)**	**(N=80)**	**(N=851)**	**(N=4)**	**(N=99)**	**(N=2094)**	**0.917**

Research question 3: Are some pregnancy delivery outcomes popular among certain maternal blood types compared to others?

Relationship Between Maternal Blood Type and Delivery Outcome

The relationship between maternal blood type and pregnancy delivery outcome is not significant with (p-value = 0.878), however, the effects of maternal blood type through the delivery outcomes

were not same. For blood type A- pregnant patients, 29 (96.7%), and 1 (3.3%) were Pleasant Delivery Outcome and Both Alive, Unhealthy Baby cases respectively, with no case of Adverse Delivery Outcome.

For blood type A+ pregnant patients, 371 (88.3%), 37 (8.8%), and 12 (2.9%) were Pleasant Delivery Outcome, Both Alive, Unhealthy Baby and Adverse Delivery Outcome cases respectively. For blood type B- pregnant patients, 29 (87.9%), 3 (9.1%), and 1 (3.0%) were Pleasant Delivery Outcome, Both Alive, Unhealthy Baby and Adverse Delivery Outcome cases respectively. For blood type O- pregnant patients, 67 (83.8%), 9 (11.2%), and 4 (5.0%) were Pleasant Delivery Outcome, Both Alive, Unhealthy Baby and Adverse Delivery Outcome cases respectively. For blood type O+ pregnant patients, 750 (88.1%), 83 (9.8%), and 18 (2.1%) were Pleasant Delivery Outcome, Both Alive, Unhealthy Baby and Adverse Delivery Outcome cases respectively. For blood type AB- pregnant patients, 3 (75.0%), and 1 (25.0%) were Pleasant Delivery Outcome and Both Alive, Unhealthy Baby cases respectively, with no case of Adverse Delivery Outcome.

For blood type AB+ pregnant patients, 85 (85.9%), 12 (12.1%), and 2 (2.0%) were Pleasant Delivery Outcome, Both Alive, Unhealthy Baby and Adverse Delivery Outcome cases respectively, as seen below in Table 4.8;

Table 4.8: Bivariate Analysis of Pregnancy Delivery Outcome and Maternal Blood Type

Delivery Outcome	A-	A+	B-	B+	O-	O+	AB-	AB+	Total	p value
Pleasant Delivery	29 (96.7%)	371 (88.3%)	29 (87.9%)	504 (87.3%)	67 (83.8%)	750 (88.1%)	3 (75.0%)	85 (85.9%)	1838 (87.8%)	
Both Alive, Unhealthy Baby	1 (3.3%)	37 (8.8%)	3 (9.1%)	55 (9.5%)	9 (11.2%)	83 (9.8%)	1 (25.0%)	12 (12.1%)	201 (9.6%)	
Adverse Delivery	0 (0.0%)	12 (2.9%)	1 (3.0%)	18 (3.1%)	4 (5.0%)	18 (2.1%)	0 (0.0%)	2 (2.0%)	55 (2.6%)	
TOTAL	**(N=30)**	**(N=420)**	**(N=33)**	**(N=577)**	**(N=80)**	**(N=851)**	**(N=4)**	**(N=99)**	**(N=2094)**	**0.878**

Mediated Relationship Between Maternal Blood Type and Complications Outcome

The aim of the specific objective 2, was to establish that, the risk of pregnancy (APRSIN) mediates the relationship between maternal blood type and pregnancy complications outcome (PCOMPSIN). Below are bivariate answers to the two research questions that address the specific objective 2;

Research question 4: Does risk of pregnancy (APRSIN) mediate the relationship between maternal blood type and pregnancy complications outcome (PCOMPSIN)?

Although bivariate results are not enough to establish that, a mediated relationship may exist between maternal blood type and pregnancy complications outcome by the risk of pregnancy, assessing the relationships between; maternal blood type and the risk of pregnancy; maternal blood type and pregnancy complications; the risk of pregnancy and pregnancy complication, gives an idea of such a relationship.

From the bivariate results of specific objective 1, the relationship between maternal blood type and the risk of pregnancy was significant (p-value < 0.001), and the relationship between maternal blood type, and pregnancy complications outcome was not significant with (p-values = 0.696). This section has established that, the relationship between risk of pregnancy and pregnancy complications is significant with a p-value (< 0.001) below are the details;

Relationship Between Antepartum Risk and Complications Outcome

The relationship between risk of pregnancy and pregnancy complications outcome is significant (p-value < 0.001). Below are the effects of antepartum risk on pregnancy complications; For High-Risk Pregnancy cases 136 (21.2%), 82 (12.8%), and 422 (65.9%) ended in Highly Complicated,

Complicated, and Uncomplicated pregnancy cases respectively. For Moderate-Risk Pregnancy cases 139 (14.9%), 84 (9.0%), and 711 (76.1%) ended in Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively. For Low-Risk Pregnancy cases, 67 (12.9%), 27 (5.2%), and 426 (81.9%) ended in Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively, as seen below in Table 4.9;

Table 4.9: Bivariate Analysis of Complications and Antepartum Risk

Level of Complications	High-Risk Pregnancy	Low-Risk Pregnancy	Moderate-Risk Pregnancy	Total	p value
Complicated	82 (12.8%)	27 (5.2%)	84 (9.0%)	193 (9.2%)	
Highly Complicated	136 (21.2%)	67 (12.9%)	139 (14.9%)	342 (16.3%)	
Uncomplicated	422 (65.9%)	426 (81.9%)	711 (76.1%)	1559 (74.5%)	
Total	**(N=642)**	**(N=520)**	**(N=932)**	**(N=2094)**	**< 0.001**

Research question 5: Is the risk of pregnancy (APRSIN) alone sufficient in predicting pregnancy complications outcome (PCOMPSIN)?

Bivariate results are not enough to determine if the risk of pregnancy alone sufficient in predicting pregnancy complications outcome.

Moderated Relationship Between Antepartum Risk and Complications Outcome

The aim of the specific objective 3, was to establish that, the risk of delivery (HIPRSI) moderates the relationship between the risk of pregnancy (APRSIN) and pregnancy Complications Outcome (PCOMPSIN), and hence establish a mediated relationship between Maternal Blood Type and

Pregnancy Complications Outcome (PCOMPSIN). Below is bivariate answer to the research question that address the specific objective 3;

Research question 6: Does risk of delivery (HIPRSI) moderates the relationship between the risk of pregnancy (APRSIN) and pregnancy Complications Outcome (PCOMPSIN)?

Although bivariate results are not enough to establish that, a moderated relationship may exist the between risk of pregnancy, and pregnancy complications outcome by the risk of delivery, assessing the relationships between; the risk of pregnancy and pregnancy complications outcome; risk of pregnancy and the risk of delivery; the risk of delivery and pregnancy complications outcome, gives an idea of such relationship.

From the objective 2, the relationship between risk of pregnancy and pregnancy complications was significant (p-value < 0.001). This study has also established that, the relationship between Risk of Pregnancy and Risk of Delivery is significant with a p-value (< 0.001) and the relationship between Risk of Delivery and Pregnancy Complications Outcome is also significant with a (p-value < 0.001). Below are the details;

Relationships Between Intrapartum Risk and Complications Outcome

The relationship between the risk of delivery and pregnancy complications is significant (p-value < 0.001). For High-Risk Delivery cases, 117 (81.8%), 15 (10.5%), and 11 (7.7%) ended in Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively. For Moderate-Risk Delivery cases, 187 (23.5%), 176 (22.1%), and 434 (54.5%) %) ended in Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively. For Low-Risk Delivery cases, 38 (3.3%), 2 (0.2%), and 1114 (96.5%) ended in Highly Complicated, Complicated, and Uncomplicated pregnancy cases respectively, as seen below in Table 4.10;

Table 4.10: Bivariate Analysis of Pregnancy Complications and Intrapartum Risk

Level of Complications	High-Risk Delivery	Low-Risk Delivery	Moderate-Risk Delivery	Total	p value
Complicated	15 (10.5%)	2 (0.2%)	176 (22.1%)	193 (9.2%)	
Highly Complicated	117 (81.8%)	38 (3.3%)	187 (23.5%)	342 (16.3%)	
Uncomplicated	11 (7.7%)	1114 (96.5%)	434 (54.5%)	1559 (74.5%)	
Total	**(N=143)**	**(N=1154)**	**(N=797)**	**(N=2094)**	**< 0.001**

Relationships Between Antepartum Risk and Intrapartum Risk

The relationship between the risk of pregnancy and the risk of delivery is significant (p-value < 0.001). For High-risk pregnancy cases, 65 (10.1%), 266 (41.4%), and 311 (48.4%), ended in High-risk, Moderate-risk and Low-risk delivery cases respectively. For Moderate-risk pregnancy cases, 43 (4.6%), 359 (38.5%), and 530 (56.9%), ended in High-risk, Moderate-risk and Low-risk delivery cases respectively. For Low-risk pregnancy cases, 35 (6.7%), 172 (33.1%), and 313 (60.2%), ended in High-risk, Moderate-risk and Low-risk delivery cases respectively as seen below in Table 4.11;

Table 4.11: Bivariate Analysis of Complications and Antepartum Risk

Delivery Risk	High-Risk Pregnancy	Low-Risk Pregnancy	Moderate-Risk Pregnancy	Total	p value
High-Risk Delivery	65 (10.1%)	35 (6.7%)	43 (4.6%)	143 (6.8%)	
Low-Risk Delivery	311 (48.4%)	313 (60.2%)	530 (56.9%)	1154 (55.1%)	
Moderate-Risk Delivery	266 (41.4%)	172 (33.1%)	359 (38.5%)	797 (38.1%)	
Total	**(N=642)**	**(N=520)**	**(N=932)**	**(N=2094)**	**< 0.001**

Double Mediated Relationship Between Maternal Blood Type and Delivery Outcome

The aim of objective 4, was to establish that the relationship between maternal blood type and pregnancy delivery outcome (PDOSIN), is double-mediated with the Risk of Pregnancy (APRSIN)

and the Risk of Delivery (IPRSIN). Below are the bivariate answers to the two research questions that address the specific objective 4;

Research question 7: Is the Risk of Pregnancy (APRSIN) alone Sufficient in Mediating the Relationship Between Maternal Blood Type and Pregnancy Delivery Outcome (PDOSIN)?

Although bivariate results are not enough to establish that, a mediated relationship may exist the between maternal blood type and pregnancy delivery outcome by the risk of pregnancy, assessing the relationships between; maternal blood type and pregnancy delivery outcome; maternal blood type and the risk of pregnancy; the risk of pregnancy and pregnancy delivery outcome, gives an idea of such relationship.

From the bivariate results of specific objective 1, the relationship between maternal blood type and pregnancy delivery outcome was not significant with (p-value = 0.878), and the relationship between maternal blood type and the risk of pregnancy was significant (p-value < 0.001). This study has also established that, the relationship between risk of pregnancy and pregnancy delivery outcome is statistically significant with (p-value < 0.001) Below are the details;

Relationship Between Antepartum Risk and Delivery Outcome

The relationship between the Risk of Pregnancy and Pregnancy Delivery Outcome is significant (p-value < 0.001).

For High-risk pregnancy cases, 531 (82.7%), 90 (14.0%), and 21 (3.3%), ended in Pleasant Delivery Outcome, Both Alive, Unhealthy Baby, and Adverse Delivery Outcome cases respectively. For Moderate-risk pregnancy cases, 828 (88.8%), 78 (8.4%) and 26 (2.8%), ended in Pleasant Delivery Outcome, Both Alive, Unhealthy Baby, and Adverse Delivery Outcome cases respectively. For Low-risk pregnancy cases, 479 (92.1%), 33 (6.3%), and 8 (1.5%), ended in

Pleasant Delivery Outcome, Both Alive, Unhealthy Baby, and Adverse Delivery Outcome cases respectively, as seen below in Table 4.12;

Table 4.12: **Bivariate Analysis of Pregnancy Delivery Outcome and Antepartum Risk**

Delivery Outcome	High-Risk Pregnancy	Low-Risk Pregnancy	Moderate-Risk Pregnancy	Total	p value
Pleasant Delivery Outcome	531 (82.7%)	479 (92.1%)	828 (88.8%)	1838 (87.8%)	
Both Alive, Unhealthy Baby	90 (14.0%)	33 (6.3%)	78 (8.4%)	201 (9.6%)	
Adverse Delivery Outcome	21 (3.3%)	8 (1.5%)	26 (2.8%)	55 (2.6%)	
Total	**(N=642)**	**(N=520)**	**(N=932)**	**(N=2094)**	**< 0.001**

Research question 8: Does both the Risk of Pregnancy (APRSIN) and the Risk of Delivery (IPRSIN) mediate the relationship between maternal blood type and pregnancy delivery outcome (PDOSIN)?

Although bivariate results are not enough to establish that, a double mediated relationship may exist the between maternal blood type and pregnancy delivery outcome by the risk of pregnancy and delivery, assessing the relationships between; maternal blood type and pregnancy delivery outcome; maternal blood type and the risk of pregnancy; the risk of pregnancy and pregnancy delivery outcome; maternal blood type and the risk of delivery; the risk of pregnancy and the risk of delivery; the risk of delivery and pregnancy delivery outcome, gives an idea of such relationship.

From the bivariate results of specific objective 1, the relationship between maternal blood type and pregnancy delivery outcome was not significant with (p-value = 0.878), and the relationship between maternal blood type and the risk of pregnancy was significant (p-value < 0.001), and the relationship between maternal blood type and the risk of delivery was not statistically significant with (p-value = 0.366). From the bivariate results of specific objective 3 the relationship between

risk of pregnancy and risk of delivery is statistically significant with (p-value < 0.001), again the relationship between risk of pregnancy and pregnancy delivery outcome has been found to be statistically significant with (p-value < 0.001). This study has also established that, and the relationship between risk of delivery and pregnancy delivery outcome is also statistically significant (p-value < 0.001). Below are the details;

Relationships Between Intrapartum Risk and Delivery Outcome

The relationship between the risk of delivery and pregnancy delivery outcome is significant (p-value < 0.001). For High-Risk delivery cases, 79 (55.2%), 36 (25.2%), and 28 (19.6%) ended in Pleasant Delivery Outcome, Both Alive, Unhealthy Baby and Adverse Delivery Outcome cases respectively. For Moderate-Risk delivery cases, 644 (80.8%), 126 (15.8%), and 27 (3.4%) ended in Pleasant Delivery Outcome, Both Alive, Unhealthy Baby and Adverse Delivery Outcome cases respectively. For Low-Risk delivery cases, 1115 (96.6%), and 39 (3.4%) ended in Pleasant Delivery Outcome and Both Alive, Unhealthy Baby cases respectively with no Adverse Delivery Outcomes as seen below in Table 4.13;

Table 4.13: Bivariate Analysis of Pregnancy Delivery Outcome And Intrapartum Risk

Delivery Outcome	High-Risk Delivery	Low-Risk Delivery	Moderate-Risk Delivery	Total	p value
Pleasant Delivery	79 (55.2%)	1115 (96.6%)	644 (80.8%)	1838 (87.8%)	
Both Alive, Unhealthy Baby	36 (25.2%)	39 (3.4%)	126 (15.8%)	201 (9.6%)	
Adverse Delivery	28 (19.6%)	0 (0.0%)	27 (3.4%)	55 (2.6%)	
Total	**(N=143)**	**(N=1154)**	**(N=797)**	**(N=2094)**	**< 0.001**

4.3 Model Fits Analysis

In order to achieve the broader aim of this study, which was to establish a Moderated Mediated relationship between Maternal Blood Type and Pregnancy Complications, and a Double Mediated Model for Pregnancy Delivery Outcome, the specific objectives of the study as presented in chapter one, were analyzed using regression, mediation and moderated mediation statistical tools through process macro and lavaan. Due to the similarity in the results, only the process macro results are presented, as below;

4.3.1 Mediated Relationship - Maternal Blood Type and Pregnancy Complications

The aim of the specific objective 2, was to establish that the antepartum risk mediates the relationship between maternal blood type and pregnancy complications outcome, this study established that, the mediated relationship between maternal blood type and pregnancy complications outcome using the risk of pregnancy as the mediator is significant with a ($R = 0.13$, $R\text{-sq} = 0.02$, $MSE = 0.56$, and Overall $p < 0.001$). Details are below in Tables 4.14 and 4.15, and also included the model fit result for the relationship maternal blood type and the risk of pregnancy in Table 4.16;

Table 4.14: Modeling Pregnancy Complications Outcome

A Mediated Relationship Between Maternal Blood Type and Pregnancy Complications Outcome (Process Macro)

Model Summary

R	R-sq	MSE	p
0.13	0.02	0.56	**< 0.001*** **

Total effect of Maternal Blood Type on Pregnancy Complications Outcome

effect	Se (HC4)	p
0.0667	0.12	0.59

Direct effect of Maternal Blood Type on Pregnancy Complications Outcome

effect	Se (HC4)	p
0.1408	0.1201	0.2411

Indirect effect (Maternal Blood Type -> APRSIN -> PCOMPSIN)

Mediator	Effect	BootSE	Boot (LL, UL) CI
APRSIN	-0.07	0.02	**(-0.11, -0.04)**

Normal theory test for indirect effect (Maternal Blood Type -> APRSIN -> PCOMPSIN)

Mediator	Effect	Se (HC4)	Z	p
APRSIN	-0.07	0.02	-3.95	**< 0.001*** **

Table 4.15: Model Details - Mediation Relationship of Maternal Blood type and Pregnancy Complications Outcome (Process Macro)

Parameters	Coeff	Se (HC4)	t	p	Boot Coeff	Boot Mean	Boot (LL, UL) CI
Constant	0.13	0.12	1.12	0.265	0.13	0.14	(-0.09, 0.37)
A+	0.14	0.12	1.17	0.241	0.14	0.14	(-0.11, 0.35)
B-	-0.06	0.17	-0.35	0.729	-0.06	-0.06	(-0.37, 0.26)
B+	0.18	0.12	1.52	0.13	0.18	0.18	(-0.06, 0.39)
O-	0.15	0.14	1.06	0.29	0.15	0.15	(-0.14, 0.42)
O+	0.15	0.12	1.26	0.208	0.15	0.14	(-0.10, 0.36)
AB-	0.14	0.76	0.19	0.851	0.14	0.13	(-0.53 1.51)
AB+	0.17	0.14	1.22	0.221	0.17	0.17	(-0.11, 0.42)
APRSIN	0.13	0.02	5.66	< **0.001*** **	0.13	0.13	(0.09, 0.17)

Table 4.16: Model Details - Relationship Between Maternal Blood Type and the Antepartum Risk (Process Macro)

Parameters	Coeff	Se (HC4)	t	p	Boot Coeff	Boot Mean	Boot (LL, UL) CI
Constant	1.57	0.1	16.18	< **0.001*** **	1.5667	1.5665	**(1.38, 1.74)**
A+	-0.58	0.1	-5.6	< **0.001*** **	-0.5762	-0.5766	**(-0.77, -0.38)**
B-	-0.02	0.13	-0.16	0.87	-0.0212	-0.0216	(-0.27, 0.23)
B+	-0.53	0.1	-5.21	< **0.001*** **	-0.5285	-0.5287	**(-0.71, -0.34)**
O-	0.01	0.11	0.07	0.94	0.0083	0.0079	(-0.20, 0.22)
O+	-0.55	0.1	-5.49	< **0.001*** **	-0.5502	-0.55	**(-0.73, -0.36)**
AB-	0.18	0.4	0.46	0.64	0.1833	0.1826	(-0.48, 0.57)
AB+	-0.53	0.13	-4.15	< **0.001*** **	-0.5263	-0.5249	**(-0.76, -0.28)**
R = 0.19	**R-sq = 0.04**		**MSE = 0.53**		**Overall p < 0.001*** **		

4.3.2 Moderated Relationship - Antepartum Risk and Pregnancy Complications

The aim of the specific objective 3, was to establish that the risk of delivery moderates the relationship between the risk of pregnancy and pregnancy complications outcome in the moderated mediated model for pregnancy complications outcome.

This study established that, risk of delivery (HIPRSI) moderates the relationship between the risk of pregnancy (APRSI) and pregnancy complications outcome (PCOMPSIN) with index of moderated mediation (Index = 0.14, BootSE = 0.04, and CI = (0.07, 0.24)). The moderated mediated relationship between maternal blood type and pregnancy complications outcome with a statistically significant (R = 0.49, R-sq = 0.24, MSE = 0.44, and Overall p < 0.001). Details are below in Tables 4.17 and 4.18;

Table 4.17: Model Details - Moderated Mediation Relationship Between Maternal Blood type and Pregnancy Complications (Process Macro)

Parameters	Coeff	Se (HC4)	t	p	Boot Coeff	Boot Mean	Boot (LL, UL) CI
constant	0.10	0.10	0.97	0.330	0.10	0.10	(-0.09, 0.31)
A+	0.10	0.11	0.99	0.323	0.10	0.10	(-0.11, 0.30)
B-	-0.09	0.14	-0.65	0.514	-0.09	-0.09	(-0.35, 0.18)
B+	0.12	0.10	1.15	0.251	0.12	0.12	(-0.09, 0.31)
O-	0.05	0.12	0.39	0.696	0.05	0.05	(-0.20, 0.28)
O+	0.08	0.10	0.77	0.439	0.08	0.08	(-0.14, 0.26)
AB-	0.18	0.76	0.24	0.809	0.18	0.17	(-0.47 1.57)
AB+	0.13	0.12	1.04	0.300	0.13	0.12	(-0.11, 0.35)
APRSIN	0.12	0.02	5.99	**0.000*** **	0.12	0.12	**(0.08, 0.16)**
HIPRSI	1.70	0.07	23.02	**0.000*** **	1.70	1.71	**(1.56, 1.84)**
Int_1	-0.25	0.06	-4.18	**0.000*** **	-0.25	-0.25	**(-0.37, -0.14)**

Table 4.18: Modeling Pregnancy Complications Outcome

A Moderated Mediated Relationship of Maternal Blood type and Pregnancy Complications Outcome (Process Macro)

Model Summary

R	R-sq	MSE	p
0.49	0.24	0.44	**< 0.001*** **

Direct effect (Maternal Blood Type -> PCOMPSIN)

effect	se (HC4)	p
0.1	0.11	0.323

Indirect effect (Maternal Blood Type -> APRSIN -> PCOMPSIN)

Effect	se (HC4)	p	BootSE	Boot (LL, UL) CI
-0.07	0.02	**0.000*** **	0.02	**(-0.11, -0.04)**

Index of moderated mediation

	Index	BootSE	Boot (LL, UL) CI
HIPRSI	0.14	0.04	**(0.07, 0.24)**

Test of highest order unconditional interaction

	R2-chng	p
M*W	0.0045	**< 0.001 *** **

Indirect and Conditional indirect effects

HIPRSI	Effect	BootSE	Boot (LL, UL) CI
0	-0.071	0.02	**(-0.11, -0.04)**
1	0.074	0.03	**(0.01, 0.15)**

4.3.3 Double Mediation Model for Pregnancy Delivery Outcome

The aim of objective 4, was to establish that the relationship between maternal blood type and pregnancy delivery outcome (PDOSIN), is double-mediated with the Risk of Pregnancy (APRSIN) and the Risk of Delivery (IPRSIN). This study first established that, a mediated relationship between maternal blood type and pregnancy delivery outcome using only the risk of pregnancy is significant with (R = 0.11, R-sq = 0.01, MSE = 0.18, and Overall p < 0.001) as seen in Tables 4.19 and 4.20. And then established that, the double mediated relationship between maternal blood type and pregnancy delivery outcome using both the risk of pregnancy and delivery as mediators is also significant with (R = 0.38, R-sq = 0.14, MSE = 0.15, and Overall p < 0.001). Details below in Tables 4.21 and 4.22, and also included a model fit of the relationship between maternal blood type and pregnancy delivery outcome, as seen in Table 4.23;

Table 4.19: Model Details - Mediation Relationship of Maternal Blood type and Pregnancy Delivery Outcome (Process Macro)

Parameters	Coeff	Se (HC4)	t	p	Boot (LL, UL) CI
Constant	-0.06	0.04	-1.41	0.16	(-0.12, 0.03)
A+	0.14	0.04	3.48	< **0.001*****	(0.06, 0.21)
B-	0.12	0.09	1.37	0.17	(-0.03, 0.30)
B+	0.15	0.04	3.88	< **0.001*****	(0.07, 0.22)
O-	0.18	0.07	2.62	**0.009****	(0.05, 0.31)
O+	0.14	0.04	3.63	< **0.001*****	(0.050, 0.19)
AB-	0.21	0.38	0.54	0.587	(-0.10, 0.91)
AB+	0.16	0.06	2.86	**0.004****	(0.05, 0.27)
APRSIN	0.06	0.01	4.52	< **0.001*****	(0.03, 0.08)

Table 4.20: Modeling Pregnancy Delivery Outcome

A Mediated Relationship Between Maternal Blood Type and Pregnancy Delivery Outcome (Process Macro)

Model Summary

R	R-sq	MSE	P
0.11	0.01	0.18	**< 0.001*** **

Total effect of Maternal Blood Type on Pregnancy Delivery Outcome

effect	Se (HC4)	P
0.1119	0.0408	**0.0061** **

Direct effect of Maternal Blood Type on Pregnancy Delivery Outcome

effect	Se (HC4)	P
0.1444	0.0415	**< 0.001*** **

Indirect effect (Maternal Blood Type -> APRSIN -> PDOSIN)

Mediator	Effect	BootSE	Boot (LL, UL) CI
APRSIN	-0.0325	0.0092	**(-0.053, -0.017)**

Normal theory test for indirect effect (Maternal Blood Type -> APRSIN -> PDOSIN)

Mediator	Effect	Se (HC4)	Z	p
APRSIN	-0.0325	0.0093	-3.4825	**< 0.001*** **

Table 4.21: Modeling Pregnancy Delivery Outcome

A Double Mediated Relationship Between Maternal Blood Type and Pregnancy Delivery Outcome (Process Macro)			
Model Summary			
R	**R-sq**	**MSE**	**p**
0.38	0.14	0.15	**< 0.001*** **
Total effect of Maternal Blood Type on Pregnancy Delivery Outcome			
	effect	**Se (HC4)**	**p**
	0.11	0.04	**0.006****
Direct effect of Maternal Blood Type on Pregnancy Delivery Outcome			
effect		**Se (HC4)**	**p**
0.17		0.05	**< 0.001*** **
Indirect effect (Maternal Blood Type -> APRSIN -> PDOSIN)			
Effect		**BootSE**	**Boot (LL, UL) CI**
-0.02		0.008	**(-0.04, -0.01)**
Indirect effect (Maternal Blood Type -> APRSIN -> IPRSIN -> PDOSIN)			
Effect		**BootSE**	**Boot (LL, UL) CI**
-0.01		0.003	**(-0.02, -0.01)**

Table 4.22: Model Details - A Double Mediated Relationship Between Maternal Blood Type and Pregnancy Delivery Outcome (Process Macro)

Parameters	Coeff	Se (HC4)	t	p	Boot Coeff	Boot Mean	Boot (LL, UL) CI
Constant	-0.17	0.05	-3.81	**< 0.001*** **	-0.17	-0.17	**(-0.19, -0.002)**
A+	0.17	0.05	3.55	**< 0.001*** **	0.17	0.17	**(0.08, 0.25)**
B-	0.15	0.08	1.88	**0.060***	0.15	0.15	**(0.01, 0.30)**
B+	0.16	0.05	3.47	**0.001****	0.16	0.16	**(0.07, 0.24)**
O-	0.17	0.07	2.52	**0.012***	0.17	0.17	**(0.04, 0.31)**
O+	0.15	0.04	3.44	**0.001****	0.15	0.15	**(0.07, 0.23)**
AB-	0.23	0.46	0.51	0.608	0.23	0.23	(-0.18, 1.06)
AB+	0.15	0.06	2.68	**0.007****	0.15	0.16	**(0.05, 0.27)**
APRSIN	0.04	0.01	3.26	**0.001****	0.04	0.04	**(0.02, 0.06)**
IPRSIN	0.25	0.02	12.41	**< 0.001*** **	0.25	0.25	**(0.21, 0.29)**

Table 4.23: Model Details - Relationship Between Maternal Blood Type and Pregnancy Delivery Outcome (Process Macro)

Parameters	Coeff	Se (HC4)	t	p	Boot Coeff	Boot Mean	Boot (LL, UL) CI
Constant	0.03	0.04	0.95	0.342	0.03	0.03	(-0.00, 0.11)
A+	0.11	0.04	2.74	**0.006****	0.11	0.11	**(0.23, 0.18)**
B-	0.12	0.09	1.35	0.179	0.12	0.12	(-0.03, 0.30)
B+	0.12	0.04	3.14	**0.002****	0.12	0.12	**(0.04, 0.19)**
O-	0.18	0.07	2.61	**0.009****	0.18	0.18	**(0.05, 0.31)**
O+	0.11	0.04	2.83	**0.005****	0.11	0.11	**(0.02, 0.16)**
AB-	0.22	0.39	0.56	0.575	0.22	0.21	(-0.09, 0.93)
AB+	0.13	0.06	2.32	**0.020***	0.13	0.13	**(0.02, 0.24)**
R = 0.05	**R-sq = 0**		**MSE = 0.18**			**Overall p = 0.098**	

4.4 Discussions

This study explored the relationship of Maternal Blood Type with Pregnancy Complications and Delivery Outcomes, focusing on to the nature of the relationships, unlike previous studies that focused on establishing only direct relationships between Maternal Blood Types and Pregnancy Complications Outcome (Sajan et al., 2021).

Similar to what has been seen in previous studies (Sajan et al., 2021; Oseni & Akomolafe, 2011; Beyazıt et al., 2017; Than et al., 2011; Li et al., 2021; Jin et al., 2020), this study found no significant direct relationships between maternal blood type and pregnancy complications, and delivery outcome. Nonetheless, this study has established a significant Moderated Mediated relationship between Maternal Blood Type and Pregnancy Complications Outcome, and a Double Mediated relationship between Maternal Blood Type and Pregnancy Delivery Outcome, which confirms the importance of the nature of the relationship that exists between maternal blood type and pregnancy complications and delivery outcome.

The effects of maternal blood type in pregnancy are indirect, but are displayed through the maternal symptoms exhibited during pregnancy and delivery, captured as the antepartum and intrapartum risks respectively. While the symptoms during pregnancy can be managed by healthcare professionals through the ANC interventions, depending on how the delivery process goes, the pregnancy may develop into Complications. Again, not all the effects of maternal blood type on the fetus can be managed through the ANC interventions during pregnancy, as a result, irrespective of how the delivery process goes, a pregnancy may result in adverse delivery outcome.

This section will focus on assessing the specific study objectives and the research questions as presented in chapter one, by discussing the research findings from the results of the study.

4.4.1 Assessing the Moderated Mediation Model for Complications Outcome

The aims of the specific objects (two and three), were to establish a Moderated Mediated relationship between Maternal Blood Type and Pregnancy Complications using the Risk of Pregnancy as a mediator and the Risk of Delivery as a moderator as seen below;

From the Tables (4.14 to 4.18), there was a significant relationship between Maternal Blood Type and The Risk of Pregnancy and although there was no direct relationship Between Maternal Blood Type and Pregnancy Complications Outcome, the Antepartum Risk fully mediated the relationship between Maternal Blood Type and Pregnancy Complications Outcome (R =0.13, R-sq =0.02 with p-value < 0.001).

The mediated relationship between Maternal Blood Type and Pregnancy Complications was greatly improved by the moderating effect of Risk of Delivery (R =0.49, R-sq =0.24 with p-value < 0.001), thereby establishing that Maternal Blood Type is the potential cause of Pregnancy Complications Outcome through a Moderated Mediated relationship with Index of Moderated Mediation (Index = 0.14, BootSE = 0.04, and CI = (0.07, 0.24)). The indirect effect of maternal blood type on pregnancy complications outcome was significant (when HIPRSI = 0, effect = -0.071, BootSE = 0.02 and CI = (-0.11, -0.04)). The conditional indirect effect of maternal blood type on pregnancy complications outcome was significant (when HIPRSI = 1, effect = 0.74, BootSE = 0.03 and CI = (0.01, 0.15)). The interaction effect of the risk of pregnancy and delivery on pregnancy complications outcome was significant (R2-chng = 0.0045 and p-value < 0.001).

The estimates of the coefficients of the model parameters were all not statistically significant with the exception of the Antepartum Risk, Intrapartum Risk and the Interaction effect of the two, indicating the full mediation of the Antepartum Risk Between Maternal Blood Type and Pregnancy Complications Outcome. The implications of these findings are that, the effect of Maternal Blood

Type on the pregnant patient get displayed through the symptoms and changes in health the pregnant patient go through, which are captured as the Antepartum Risk using the Antepartum Risk-Scoring Tool. During the pregnancy period, the changes in pregnant patient's health, will determine whether the pregnancy will be categorized as Low, Moderate and High-Risk Pregnancy case. Although having a High-Risk Pregnancy case can lead to Pregnancy Complications Outcome, the happenings during labor and delivery which are captured as the Intrapartum Risks, using the Intrapartum Risk-Scoring Tool, will finally determine the Pregnancy Complications Outcome. According to the moderated mediation model, a mother with High-Risk Pregnancy case and a Low-Risk Delivery case stands a better chance at having Uncomplicated Pregnancy Outcome, than a mother with Low-Risk Pregnancy case but High-Risk Delivery case. From Table (4.6) Maternal Blood Type AB+ has the highest chance of having Complications in pregnancy, followed by Maternal Blood Types A-, O-, B-, AB+, B+, O+ and A+.

4.4.2 Assessing the Double Mediation Model for Delivery Outcome

The aim of objective 4 was to establish that the relationship between maternal blood type and pregnancy delivery outcome (PDOSIN), is double-mediated with the Risk of Pregnancy (APRSIN) and the Risk of Delivery (IPRSIN). From Table 4.23, the model fit results for the direct relationship between maternal blood type and pregnancy delivery outcome, although not statistically significant (R =0.05, R-sq =0.0024 with p-value = 0.0981), however, most of the estimates of the coefficients of the model parameters were statistically significant with p-values, A+(0.006), B+(0.002), O-(0.009), O+(0.005), and AB+(0.02), while the following were not, with p-values, Constant (0.342), B-(0.179), AB-(0.57).

This study established a mediated relationship between maternal blood type and pregnancy delivery outcome using only the risk of pregnancy was significant with (R = 0.11, R-sq = 0.01, MSE = 0.18, and Overall p < 0.001). The direct effect of maternal blood type on pregnancy delivery outcome was significant (effect = 0.14, se = 0.042, and p-value < 0.001). The total effect of maternal blood type on pregnancy delivery outcome was significant (effect = 0.11, se = 0.04, and p-value = 0.0061). The indirect effects of maternal blood type on pregnancy delivery outcome, through the antepartum risk alone was significant (effect = -0.033, BootSE = 0.01 and CI = (-0.053, -0.017)), as seen from Tables (4.19 and 4.20). The challenge was that, R-sq = 0.01 is too small, the risk of pregnancy could only account for 1% of the total variability in the relationship between maternal blood type and pregnancy delivery outcome.

The double-mediated relationship between Maternal Blood Type and Pregnancy Delivery Outcome was significant (R =0.38, R-sq =0.14 with p-value < 0.000). The direct effect of maternal blood type on pregnancy delivery outcome was significant (effect = 0.17, se = 0.05, and p-value < 0.001). The total effect of maternal blood type on pregnancy delivery outcome was significant (effect = 0.11, se = 0.04, and p-value = 0.006). The indirect effects of maternal blood type on pregnancy delivery outcome, through the antepartum risk alone was significant (effect = -0.02, BootSE = 0.01 and CI = (-0.4, -0.1)). The indirect effects of maternal blood type on pregnancy delivery outcome, through both the antepartum and intrapartum risks was significant (effect = -0.01, BootSE = 0.003 and CI = (-0.02, -0.01)), as seen in Tables 4.21 and 4.22.

The estimates of the coefficients of the model parameters were all statistically significant (Boot (LL, UL) CI = Contant (-0.19, -0.002), A+(0.08, 0.25), B-(0.01, 0.30), B+(0.07, 0.24), O-(0.04, 0.31), O+(0.07, 0.23), AB+(0.05, 0.27) and APRSIN (0.02, 0.06) and IPRSIN (0.21, 0.29)) except Blood Type AB- (Boot (LL, UL) CI = (-0.18, 1.06), indicating the partial mediation of both

mediators. The non-significant result for Blood Type AB- might be due to their small number, only 4 pregnant patients of Blood Type AB- gave birth during that period.

Aside from the significant indirect effects of Maternal Blood Type on Pregnancy Delivery Outcome, both the direct and total effects of Maternal Blood Type on Pregnancy Delivery Outcome were also significant with p-values, (0.0004 and 0.006) respectively. This implies that, with just the knowledge of the Maternal Blood Type, one can have an idea about how their Pregnancy Delivery Outcome is likely to be. From Table (4.22) Maternal Blood Type A- has the best chance of Pleasant Delivery Outcome, followed by Maternal Blood Types AB+, O+, B-, B+, A+. On the contrary, Maternal Blood Types O- and AB- have a higher risk of Adverse Delivery Outcome.

4.4.3 Assessing the Effect of Maternal Blood Type in Pregnancy

The aim of the first specific objective was to assess the effect of maternal blood type on pregnant patients, through the antepartum and Intrapartum Risks, the type and pregnancy complications, and Delivery Outcomes.

1. **Is High-Risk Pregnancy Popular Among Certain Maternal Blood Types Compared to Others?**

High-Risk Pregnancy cases were popular among some Maternal Blood Types. According to Tables (4.4), while the general effect through the High-risk Pregnancy cases among the pregnant patients was (30.7%), pregnant patients with Blood Types AB- (75%), O- (57.5%), A- (56.7%), B- (54.5%) and AB+ (34.3%) were more affected compared with Blood Types A+, B+ and O+ whose effects were less than (30.7%). All the negative (-) Blood Types were high-risk pregnancy cases because of their risk of Hemolytic Disease of the New born.

2. **Is High-Risk Delivery Popular Among Certain Maternal Blood Types Compared to Others?**

High-risk delivery cases were popular among some Maternal Blood Types. According to Tables (4.5), while the general effect through the High-Risk Delivery cases among the pregnant patients was (6.8%), pregnant patients with Blood Types O- (11.2%), O+ (7.3%) and B+ (7.1%) were more affected compared with Blood Types AB+, B-, A+ and A- whose effects were less than (6.8%). Pregnant patients of Blood Type AB- had no High-Risk Delivery cases.

3. **Are Some Pregnancy Complications Popular Among Certain Maternal Blood Types Compared to Others?**

According to Table (4.7), the general effect through the Obstructed Labour cases among the pregnant patients was (5.2%), however, pregnant patients with Blood Types A- (6.7%), O- (6.2%), B+ (5.5%) and O+ (5.3%) were more affected compared with Blood Types AB+, A+ and B- whose effects were less than (5.2%). No pregnant patient of Blood Type AB- had Obstructed Labour cases.

While the general effect through the APH cases among the pregnant patients was (0.9%) pregnant patients with Blood Types, O+ (5.3%), B- (3%) and O- (1.2%) were more affected compared with Blood Types B+ and A+, whose effects were less than (0.9%). Pregnant patient of Blood Types AB+, AB- or A- had no APH cases.

The general effect through the Eclampsia cases among the pregnant patients was (0.5%), however, pregnant patients with Blood Types AB+ (3%) and O+ (1.2%) were more affected compared with Blood Types B+ and A+, whose effects were less than (0.5%). Pregnant patient of Blood Types

AB-, O-, B- or A- had no Eclampsia cases. None of the negative blood types (-) recorded any case of Eclampsia.

While the general effect through the Multiple Complications cases among the pregnant patients was (2.1%), pregnant patients with Blood Types O- (2.5%), B+ (2.4%) and A+ (2.4%) were more affected compared with Blood Types O+ that had equal effect as the general (2.1%). Pregnant patient of Blood Types A-, B- AB- or AB+ had no Multiple complications cases.

The general effect through the Other Complications cases among the pregnant patients was (7.6%), however, pregnant patients with Blood Types AB- (25%), AB+ (12.1%) and B+ (8.3%) were more affected compared with Blood Types A+, O+, O- and B- whose effects were less than (7.6%). Pregnant patient of Blood Type A- had no Other complication cases.

While the general effect through the PPH cases among the pregnant patients was (8.7%), pregnant patients with Blood Types A- (20%), O- (11.2%) and B+ (9.4%) were more affected compared with Blood Types A+, B-, O+ and AB+ whose effects were less than (8.7%). Pregnant patient of Blood Type AB- had no PPH cases.

The general effect through the Sepsis cases among the pregnant patients was (0.5%), however, pregnant patients with Blood Types O- (2.5%) and A+ (1.0%) were more affected compared with Blood Types B+ and O+ whose effects were less than (0.5%). Pregnant patient of Blood Types AB-, AB+, B- or A- had no Sepsis cases.

4. **Are Some Pregnancy Delivery Outcomes Popular Among Certain Maternal Blood Types Compared to Others?**

According to Table (4.8), the effect through the Pleasant Delivery Outcome cases among the pregnant patients was (87.8%) and pregnant patients with Blood Types B- (87.9%), O+ (88.1) and

A- (96.7%) enjoyed more Pleasant Delivery Outcome cases compared with Blood Types AB-, AB+, O-, B+ and A+ whose Pleasant Delivery Outcome cases were below (87.8%).

The effect through the Unhealthy Baby cases among the pregnant patients was (9.6%), unfortunately pregnant patients with Blood Types O- (11.2%), O+ (9.8), AB- (25%) and AB+ (12.1%) were more affected compared with Blood Types A-, A+, B- and B+ Blood Types whose effects were less than (9.6%).

The effect through the Adverse Delivery Outcome cases among the pregnant patients was (2.6%), unfortunately pregnant patients with Blood Types O- (5%), B+ (3.1%), B- (3%) and A+ (2.9%) were more affected compared with O+ and AB+ Blood Types whose effects were less than (2.6%). Pregnant patient of Blood Types A- and AB- had no Adverse Delivery Outcome cases.

5. **Do Pregnancy Complications Have Same Effects on the Different Maternal Blood Types?**

According to Table (4.6), Pregnant patients with Maternal Blood Types B+ and O-, were more affected by the effects through the Complicated and Highly Complicated Pregnancy cases compared to the pregnant patients with the other Blood Types. Maternal Blood Type A- pregnant patients were more affected by the effects through the Complicated Pregnancy cases only while, Maternal Blood Types AB- and AB+- pregnant patients were more affected by the effects through the Highly Complicated Pregnancy cases only. The effects through the Pregnancy Complications cases in general, were not much felt by pregnant patients with Blood Types A+, B- and O+.

While the general effect through the Complicated Pregnancy cases among the pregnant patients was (9.2%), pregnant patients with Blood Types, A- (20.0%), O- (11.2%) and B+ (9.9%) were

more affected compared to pregnant patients with Blood Types A+, B-, O+, AB- and AB+ whose effects were less than (9.2%).

The general effect through the Highly Complicated Pregnancy cases among the pregnant patients was (16.3%), unfortunately, pregnant patients with Blood Types AB- (25.0%), O- (18.8%), B+ (17.3%) and AB+ (17.2%) were more affected compared to Blood Types, A-, A+, B-, or O+, whose effects were less than (16.3%).

6. Is Risk of Pregnancy Sufficient in Predicting Pregnancy Complications?

According to Table (4.14), Although the Antepartum Risk fully mediated the relationship between Maternal Blood Type and Pregnancy Complications Outcome (R =0.13, R-sq =0.02 with p-value < 0.00), the Risk of Pregnancy could only explain 13% of the total variability in the Pregnancy Complications Outcome, therefore, the Risk of Pregnancy alone mediating Maternal Blood Type and Pregnancy Complications Outcome was statistically significant but not sufficient.

7. What Is the Relevance of Risk of Delivery in Predicting Pregnancy Complications?

According to Table (4.17), Moderating the relationship between the Risk of Pregnancy and Pregnancy Complications by the Risk of Delivery, greatly improved the mediated relationship between Maternal Blood Type and Pregnancy Complications Outcome from (R =0.13, R-sq =0.02 with p-value < 0.00) to (R =0.49, R-sq =0.24 with p-value < 0.00). By moderating the mediated effect of the Risk of Pregnancy with the Risk of Delivery, between Maternal Blood Type and Pregnancy Complications Outcome, Maternal Blood Type could explain almost 50% of the total variability in Pregnancy Complications Outcome, thereby elucidating the relevance and importance of the Risk of Delivery.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary and conclusions derived in establishing a Moderated Mediated relationship between Maternal Blood Type and Pregnancy Complications Outcome, and a Double-Mediated relationship between Maternal Blood Type and Pregnancy Delivery Outcome. It also provides recommendations that can be pursued by health professionals and the general public.

This study was conducted to establish the role of Maternal Blood Type as the potential cause of Pregnancy Complications and Adverse Delivery Outcome in general, in partial fulfillment of the requirement for the award of MPhil in Statistics degree at the University of Ghana, Legon.

This study obtained a secondary data from the maternal delivery records of Battor Catholic hospital in the Volta region of Ghana-West Africa and utilized statistical tools such us, moderated mediated models, regressions models and bivariate analysis, to establish a relationship between Maternal Blood Type and Pregnancy Complications Outcome, as well as Pregnancy Delivery Outcome.

5.1 Summary of Findings

The broader aim of this study has been achieved, Maternal Blood Type is the potential cause of Pregnancy Complications Outcome and Adverse Pregnancy Delivery Outcome. This study established A Moderated Mediated relationship between Maternal Blood Type and Pregnancy Complication Outcome and modeled Pregnancy Delivery Outcome through the Double Mediation of the Antepartum and Intrapartum Risks, between Maternal Blood Type and Pregnancy Delivery

Outcome. Anchored on the problem statement and research questions, the findings of the study were summarized as presented chapter one;

Summary of Findings on the Problem Statement:

This study is of the view that, the differences in the distribution of maternal blood types in different geographical areas, as well as the moderated mediated nature of the relationship between maternal blood type and pregnancy complications is the reason for the conflicting results recorded in previous studies. And that, Maternal Blood Type Is the potential cause of Pregnancy Complications and adverse Delivery Outcomes.

From Tables (4.14 to 4.18), this study established a significant relationship between Maternal Blood Type and Pregnancy Complications Outcome, through the full mediation of the Antepartum Risk and a significant moderating effect of the Intrapartum Risk between the Antepartum Risk and Pregnancy Complications Outcome (R =0.49, R-sq =0.24 with p-value < 0.00), thereby establishing that Maternal Blood Type is the potential cause of Pregnancy Complications Outcome through a Moderated Mediated relationship with Index of moderated mediation (CI = (0.07, 0.24)). The conditional effects of the Antepartum Risk at the different levels of the Intrapartum Risks were statistically significant (p-value <0.000), the indirect effect through the Antepartum Risk alone was statistically significant (CI = (-0.11, -0.04)), through both the Antepartum and the Intrapartum Risks were also statistically significant (CI = (0.01, 0.15) together with their interaction (M*W, p-value < 0.000). According to the moderated mediation concepts, the effect of Maternal Blood Type on the pregnancy gets displayed through the symptoms and changes the mother goes through which are captured through the Antepartum Risk-Scoring tool, as the

Antepartum Risk. And although having a High-Risk Pregnancy can lead to Pregnancy Complications, the happenings at and during labor and delivery captured as the Intrapartum Risk, will finally determine the Complications Outcome. In summary, a pregnant patient with high-risk pregnancy but a low-risk delivery, stands a better chance at having Uncomplicated Pregnancy, than a pregnant patient with Low-Risk Pregnancy but a High-Risk Delivery case. Our studies revealed that, the indirect effects of Maternal Blood Type on Pregnancy Complications through the Antepartum Risk alone, the occurrence of Pregnancy Complications increases according to the order of the Blood Types; A+, O+, AB+ and B+, B-, A-, O-, and AB-. And the indirect effects of Maternal Blood Type on Pregnancy Complications through the Antepartum Risk and High Intrapartum Risk, the occurrence of Pregnancy Complications increases according to the order of the Blood Types; A+, O+, B+, AB+, B-, A-, O-, and AB-.

This study first established a mediated relationship between maternal blood type and pregnancy delivery outcome using only the risk of pregnancy was significant with (R = 0.11, R-sq = 0.01, MSE = 0.18, and Overall p < 0.001). The direct effect of maternal blood type on pregnancy delivery outcome was significant (effect = 0.14, se = 0.042, and p-value < 0.001). The total effect of maternal blood type on pregnancy delivery outcome was significant (effect = 0.11, se = 0.04, and p-value = 0.0061). The indirect effects of maternal blood type on pregnancy delivery outcome, through the antepartum risk alone was significant (effect = -0.033, BootSE = 0.01 and CI = (-0.053, -0.017)), as seen from Tables 4.19 and 4.20. The challenge was that, R-sq = 0.01 is too small, the risk of pregnancy could only account for 1% of the total variability in the relationship between maternal blood type and pregnancy delivery outcome, introducing the second mediator (the risk of delivery) significantly improves the model.

The Double Mediation model established for Pregnancy Delivery Outcome, with the Risk of Pregnancy and Delivery mediating the relationship between Maternal Blood Type and Pregnancy Delivery Outcome, was significant (R =0.38, R-sq =0.14 with p-value < 0.000), elucidating the important role that Maternal Blood Type play as the potential cause of Adverse Delivery Outcome. The indirect effect of Maternal Blood Type on Pregnancy Delivery Outcome through the Antepartum Risk alone was statistically significant (CI = (-0.04, -0.01)), the indirect effect through the Risk of Delivery alone was not statistically significant (CI = (-0.07, 0.03)) while, the indirect effects through both mediators the Antepartum And Intrapartum Risks were significant (CI = (-0.02, -0.005)). In addition, both the direct and total effects of Maternal Blood Type on Pregnancy Delivery Outcome were also statistically significant (p-values =0.0004 and 0.006) respectively which implies that, with just the knowledge of the Maternal Blood Type, one can have an idea about how their Pregnancy Delivery Outcome will likely be. Our study revealed that, Maternal Blood Type A- had the highest Pleasant Delivery Outcome cases, followed by AB+, O+, B-, B+, O- and A+ with Maternal Blood Type AB- recording the highest adverse delivery outcome cases.

Effects of Maternal Blood type in Pregnancy:

Below is summary of findings on the research questions, aimed at addressing the effects of Maternal Blood Type in pregnancy, through the Risk of Pregnancy and Delivery, Pregnancy Complications and Delivery Outcomes.

High-Risk Pregnancy cases were popular among some Maternal Blood Types. According to Table (4.4), Pregnant patients with Blood Types AB- (75%), O- (57.5%), A- (56.7%), B- (54.5%) and AB+ (34.3%) were more affected by High-risk Pregnancy cases, compared with Blood Types A+,

B+ and O+. All the negative (-) Blood Types were high-risk pregnancy cases because of their risk of Hemolytic Disease of the New born.

High-risk delivery cases were popular among some Maternal Blood Types. According to Table (4.5), Pregnant patients with Blood Types O- (11.2%), O+ (7.3%) and B+ (7.1%) were more affected by High-Risk Delivery cases, compared with Blood Types AB+, B-, A+ and A-. Pregnant patients of Blood Type AB- had no High-Risk Delivery cases.

According to Table (4.7), Pregnant patients with Blood Types A- (6.7%), O- (6.2%), B+ (5.5%) and O+ (5.3%) were more affected by Obstructed Labour cases, compared with Blood Types AB+, A+ and B-. No pregnant patient of Blood Type AB- had Obstructed Labour cases.

Pregnant patients with Blood Types, O+ (5.3%), B- (3%) and O- (1.2%) were more affected by APH cases, compared with Blood Types B+ and A+. Pregnant patient of Blood Types AB+, AB- or A- had no APH cases.

Pregnant patients with Blood Types AB+ (3%) and O+ (1.2%) were more affected by Eclampsia cases, compared with Blood Types B+ and A+. Pregnant patient of Blood Types AB-, O-, B- or A- had no Eclampsia cases. None of the negative blood types (-) recorded any case of Eclampsia.

Pregnant patients with Blood Types O- (2.5%), B+ (2.4%) and A+ (2.4%) were more affected by Multiple Complications cases, compared with Blood Types O+. Pregnant patient of Blood Types A-, B- AB- or AB+ had no Multiple complications cases.

Pregnant patients with Blood Types AB- (25%), AB+ (12.1%) and B+ (8.3%) were more affected by Other Complications cases, compared with Blood Types A+, O+, O- and B-. Pregnant patients of Blood Type A- had no Other complication cases.

Pregnant patients with Blood Types A- (20%), O- (11.2%) and B+ (9.4%) were more affected by PPH cases, compared with Blood Types A+, B-, O+ and AB+. Pregnant patient of Blood Type AB- had no PPH cases.

Pregnant patients with Blood Types O- (2.5%) and A+ (1.0%) were more affected by Sepsis cases, compared with Blood Types B+ and O+. Pregnant patient of Blood Types AB-, AB+, B- or A- had no Sepsis cases.

According to Table (4.8), pregnant patients with Blood Types B- (87.9%), O+ (88.1) and A- (96.7%) enjoyed more Pleasant Delivery Outcome cases compared with Blood Types AB-, AB+, O-, B+ and A+. Pregnant patients with Blood Types O- (11.2%), O+ (9.8), AB- (25%) and AB+ (12.1%) were more affected by Unhealthy Baby cases, compared with Blood Types A-, A+, B- and B+. Pregnant patients with Blood Types O- (5%), B+ (3.1%), B- (3%) and A+ (2.9%) were more affected by Adverse Delivery Outcome cases, compared with O+ and AB+. Pregnant patient of Blood Types A- and AB- had no Adverse Delivery Outcome cases.

According to Table (4.6), Maternal Blood Types B+ and O-, were more affected by Complicated and Highly Complicated Pregnancy cases compared to the remaining Blood Types, Maternal Blood Type A- was more affected by Complicated Pregnancy cases while, Maternal Blood Types AB- and AB+ were more affected by Highly Complicated Pregnancy cases. The effects of Pregnancy Complications were not much on Maternal Blood Types A+, B- and O+.

According to Table (4.14), Antepartum Risk fully mediated the relationship between Maternal Blood Type and Pregnancy Complications Outcome (R =0.13, R-sq =0.02 with p-value < 0.00), however, the Risk of Pregnancy could only explain 13% of the total variation in Pregnancy

Complications Outcome, therefore, the Risk of Pregnancy alone was not sufficient in predicting Pregnancy Complications Outcome.

According to Table (4.17), by moderating the mediated effect of the Risk of Pregnancy, between Maternal Blood Type and Pregnancy Complications Outcome with the Risk of Delivery, Maternal Blood Type could explain almost 50% of the variability in Pregnancy Complication Outcome, thereby elucidating the relevance and importance of the Risk of Delivery.

5.2 Conclusion

This study aimed to confirm maternal blood type as the potential cause of Pregnancy Complications and Adverse Delivery Outcome, by establishing a Moderated Mediated relationship between Maternal Blood Type and Pregnancy Complications Outcome, and model Pregnancy Delivery Outcome.

The research findings indicate that, Maternal Blood Type is in a statistically significant Moderated Mediated relationship with Pregnancy Complications Outcome, and also in a statistically significant Double Mediated relationship with Pregnancy Delivery Outcome, thereby establishing and confirming Maternal Blood Type as the potential cause of Pregnancy Complications and Adverse Delivery Outcome.

The study also assessed the effect of Maternal Blood Type in pregnancy, through the Risk of Pregnancy and Delivery, Pregnancy Complications and Pregnancy Delivery outcome, and the results are as follows;

All the negative blood types in decreasing order, AB-, O-, A- and B- were prone to High-Risk Pregnancies, while blood types A+ and B+ were prone to Moderate-Risk Pregnancies. Blood types O+ and AB+ were likely to enjoy relatively Low-Risk Pregnancies.

The blood types in decreasing order, O-, O+ and B+ were prone to High-Risk Deliveries, while the following blood types in decreasing order, A-, AB+ and AB+ were prone to Moderate-Risk Deliveries. Blood types A+ and B- were likely to enjoy relatively Low-Risk Deliveries.

The blood types in decreasing order, AB-, O-, B+, AB+ and A- were much affected by Complications in Pregnancy, while blood type, A+, B- and O+ were likely to have little to no effects of Complications in Pregnancy.

Blood types in decreasing order, A-, O-, B+ and O+ were prone to and highly affected by Obstructed Labour in pregnancy and during delivery, while blood type AB- recorded no case of Obstructed Labour.

Blood types in decreasing order, B-, O- and O+ were prone to and highly affected by APH in pregnancy, while blood types AB+, AB- and A- recorded no case of APH.

Blood types in decreasing order, AB+ and O+ were prone to and highly affected by Eclampsia in pregnancy and during delivery, while blood types AB-, O-, B- or A- recorded no case of Eclampsia.

Blood types in decreasing order, O-, B+ and A+ were prone to and highly affected by Multiple Complications in pregnancy and during delivery, while blood types A-, B- AB- or AB+ recorded no case of Multiple complications.

Blood types in decreasing order, AB-, AB+ and B+ were prone to and highly affected by Other Complications in pregnancy, while blood type A- recorded no case of Other complications.

Blood types in decreasing order, A-, O- and B+ were prone to and highly affected by PPH during and after delivery, while blood type AB- recorded no case of PPH.

Blood types in decreasing order, O- and A+ were prone to and highly affected by Sepsis in pregnancy and after delivery, while blood types AB-, AB+, B- or A- recorded no case of Sepsis.

Only blood type A- was prone to and enjoyed a relatively high Pleasant Delivery Outcome, while the following blood types in decreasing order O-, B+, B- and A+ were prone to and highly affected by Adverse Delivery Outcome.

The following blood types A-, B- and AB-, were prone and had Babies with low health challenges, while blood types AB+ and O+ were prone and had Babies with Moderate and Severe health Challenges respectively.

The following blood types A+, B+ and O- were prone to and highly affected by Maternal and Neonatal Deaths, while blood types A- and AB-, recorded no case of Neonatal Death.

Based on the indicated findings, the following conclusions are drawn;

Pregnancy Complications and Adverse Delivery Outcome do not occur at random, but pregnant patients are susceptible to their occurrence according to their blood type. The antepartum and intrapartum risks, also known as the Risk of Pregnancy and Delivery respectively, are not same across blood types. While some pregnant patients of certain blood types endure near death experiences in pregnancy, some others enjoy relatively smooth journey during pregnancy and or delivery.

The effect of pregnancy complications cases is not same across blood types, while some pregnant patients of certain blood types are almost immune to the occurrence of certain complications in pregnancy, some others are prone to these complications irrespective of the available interventions.

Since the delivery process in pregnancy is also affected by the effects of maternal blood type, the Risk of Pregnancy alone is not enough to predict Pregnancy Complications and Delivery Outcome.

Therefore, assessing and including the Risk of Delivery is vital to predict Pregnancy Complications and Delivery Outcome in pregnancy.

The effects of maternal blood type in pregnancy, in the form of Pregnancy Complications and Adverse Delivery Outcomes, can be assessed through the Risk of Pregnancy and Delivery, in a moderated mediated analysis and a double mediated analysis respectively.

Thus, Maternal Blood Type is the potential cause of Pregnancy Complications and Adverse Delivery Outcome with indirect effects, that cannot be detected through assessing their direct relationships.

5.3 Recommendations

The following are recommended to midwives and health professional, fellow statisticians and the general public;

1. Health professionals should anticipate certain pregnancy complications from certain pregnant patients according to their blood types on the first ANC, to offer quality care.
2. Public health interventions to prevent and manage pregnancy complications and adverse delivery outcomes, should be blood group based, to achieve success.
3. Statisticians with the right tools should attend to the vast data available at the health sector, to model for future health complications and diseases.
4. Health professionals should liaise with statisticians to explore the risk of delivery (Intrapartum Risk), to identify more causal factors.
5. Mothers with Moderate-Risk Pregnancy and Delivery cases, should be given the similar attention as High-Risk Pregnancy and Delivery cases, as Moderate-Risk Pregnancy and

Delivery cases, had equal and even more devastating effects on the life and health of the babies than the much focused High-Risk Pregnancies.

6. Women should familiarize themselves with their blood types and adequately prepare for their blood type prone complications, before getting pregnant.
7. Pregnant patients should honor all their food cravings during pregnancy, as the nutrients in the foods they crave, are vital to their health and development of the baby.

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