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Sociodemographic and Obstetric Predictors of Cesarean Section in Ghana

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Abstract

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

The increasing cesarean section (CS) rate in Ghana has severe public health implications as it results in significant maternal and child morbidity and mortality. An assessment of the factors contributing to the increasing CS rate in different settings is imperative to guide the development of interventions. The purpose of this study was to identify the sociodemographic and obstetric predictors of CS in a major referral health facility in Accra, Ghana. This research was grounded in the systems thinking approach and involved the use of a case-control design whereby 2,704 pairs of cases (delivered by CS) and controls (delivered by vaginal delivery) were randomly sampled from pregnant women who attended the major referral health facility between January and October 2017. Secondary data that were routinely collected at the health facility were used. Bivariate and multivariable logistic regression analyses of the data revealed higher odds of having CS with increasing maternal age, low income ($p < 0.01$, 95% CI = 1.148, 2.358), previous CS ($p < 0.001$, 95% CI = 9.230, 13.198), and low fetal weight ($p < 0.05$, 95% CI = 1.009, 1.496). Lower odds were found among women with secondary education ($p < 0.001$, CI = 0.626, 0.894) and antenatal care nonattendants ($p < 0.001$, 95% CI = 0.349, 708). No significant association was observed between mode of delivery and gestational age or parity. Tailored interventions and strategies including health education and financial incentives programs, provision of and adherence to health protocols, and improvement of data collection procedures are recommended. These may reduce the existing burden of CS and improve maternal and child health, thus contributing to the bridging of the inequity gap and bringing about positive social change.

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Dedication

I dedicate this work to my parents, Prof. Daniel Mireku-Gyimah and Prof. Mrs. Patricia Beatrice Mireku-Gyimah, and my little sister, Dr. Nana Ama Mireku-Gyimah, for their immense support.

I also dedicate this work to myself for the tears lost and the strengths found in this arduous academic journey.

Acknowledgments

My deepest gratitude to my chair, Dr. Heba Tawfik, my committee member, Dr. Aaron Mendelsohn, and all the professors whom I studied under. Also, I thank all persons and institutions who helped to make this study a success. May God richly bless them all.

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Section 1: Foundation of the Study and Literature Review

Introduction

This research assessed how sociodemographic and obstetric factors predicted cesarean section (CS) rate in a major health referral facility in Accra, Ghana. The study investigated the varying associations between sociodemographic and obstetric predictors and CS. The sociodemographic predictors studied were maternal age, educational status, and occupational status, while the obstetric predictors included obstetric history, parity, mode of delivery, gestational age, ANC attendance, referral status, and fetal weight.

Increased CS rates are a major public health problem (WHO, 2015). The rationale for conducting this research was to identify how these predictors influenced the performance of CS, to enable the development of effective and sustainable interventions, strategies, and policies that would reduce the CS rate. Reduction in the performance of CS that is not clinically indicated would invariably reduce the complications associated with it, and subsequently improve maternal and child health. This translates to significant positive social change and improved maternal and child health, and furthermore, to the general improvement in the health of families and communities, as well as health care systems (HealthyPeople2020, 2017).

In this section, I summarize research literature related to the study and describe the gap in knowledge that makes the study relevant. I also discuss the research problem and the purpose of study, and enumerate my research questions and hypotheses. Furthermore, I describe the theoretical framework which this study is grounded in, the nature of the study, as well as the review of the literature in relation to key study variables.

Background

Globally, CS) rates have risen rapidly over the past few years (Samba & Mumuni, 2016). This is the case despite the evidence that CS, when clinically not indicated, poses risks to mothers and neonates (World Health Organization [WHO], 2015). This major invasive surgery has been implicated in the increase in maternal and perinatal morbidity and mortality, a consequence of the perioperative complications that may be associated with it (Akinola et al., 2014). This is especially the situation in developing countries, where resources are inadequate to perform safe procedures or manage complications. Significant complications include iatrogenic damage to internal organs, hemorrhage, transfusions, thromboembolic disease, repeat CS, hysterectomy, febrile morbidity, and late surgical complications, as well as disabilities and fatalities (WHO, 2015). However, cognizant of the ability of CS to effectively save the lives of mothers and infants when medically required, the WHO (2015) recommends that the population CS rates remain between 5% and 10% for optimal maternal and neonatal health. CS rates that are too low or too high translate to adverse public health outcomes (Long et al., 2015).

With knowledge of the impact of sociodemographic factors including age, educational status, and occupational status, as well as obstetric factors including gestational age, antenatal care (ANC) attendance, obstetric history, parity, fetal weight, and referral status, leaders at the health facility in this study may be able to lower CS rates. Specifically, they may be able to use the information from this study to devise strategies including intensification and redirection of health education, tailoring of ANC visits, and activities to specifically target groups at risk for CS. With the information acquired from this research, facility leaders also may be able to follow up to referring communities to assess and address underlying problems that may be significant. By taking these actions, leaders may be able to improve health disparities with respect to maternal and child health. This is particularly important as the well-being of mothers and children is key to the health of families and communities, as well as health care systems (HealthyPeople2020, 2017).

Problem Statement

The proportion of CS at the population level is an indication of the extent of access and the utilization of this intervention (Betran et al., 2015). The risks associated with CS are higher for those who have limited access to comprehensive obstetric care. Pregnant women who live in deprived neighborhoods, as noted by Posthumus et al. (2013), experience more negative maternal and perinatal outcomes due to a higher prevalence of individual and environmental risk factors. Low social class as well as health and health care illiteracy leading to late initiation of ANC, undertreatment during pregnancy, or late referral for specialist care have contributed to negative maternal and perinatal outcomes. Lindquist et al. (2014) assessed the socioeconomic position of Australian women using the Index of Multiple Deprivation Quintile, which comprises deprivation dimensions including income, employment, health, and disability. This analysis showed that deprived women were more likely to receive less attention in health facilities, less likely to obtain ANC or receive care from a health professional in the first trimester of gestation, and more likely to have unplanned CS or routine postnatal assessment (Lindquist et al., 2014). In less developed countries, this phenomenon creates inequity where, despite having CS rates below those prescribed by WHO due to reduced access to the intervention, CS rates are still high with a higher risk of possible complications (Akinola et al., 2014; WHO, 2015).

Inherent challenges exist in economically deprived countries such as Ghana, including inadequate monitoring of mother and fetus during delivery and lack of standard preparedness to undertake CS when required (Prah et al., 2017). These challenges lead to poor obstetric and neonatal outcomes and are a public health concern. Cognizant of Maine’s three-delay model, which underscores the role of the three fundamental delays in maternal morbidity and mortality, Gething et al. (2012) revealed that more than a third of Ghanaian women lived too far from facilities that offer emergency obstetric and neonatal care to reach them within the clinically significant threshold time. The three delays of maternal mortality comprise (a) delay in the decision to seek care, (b) delay in reaching the appropriate facility, and (c) delay in receiving adequate care in the facility (Thaddeus & Maine, 1994). All of these delays, which have been attributed to various sociodemographic factors, are implicated in increasing CS rates and are significant causes for poor access to quality maternity care and maternal mortality (Shah et al., 2009).

These delays are prominent in low-resource settings such as Ghana. A systems thinking approach (STA) that would holistically address all these component issues may be invaluable in the resolution of the high CS rate that exists. In most countries in sub-Saharan Africa, only 1-2% of pregnant women have access to safe CSs due to lack of adequate resources at most health facilities (Chu et al., 2012). Despite this lack of access, CS remains one of the most-practiced surgical procedures, hence the continuous increase in CS rates (Chu et al., 2012). In Ghana, for example, the CS rate in 2008 was reported at 6.46%, having increased from a rate of 3.69% in 2003 (Cavallaro, 2016). More recently, the national CS rate has risen to 13%, albeit with variations within the different regions as well as different health facilities in the country (Prah et al., 2017).

To study the burden of the CS rate in Ghana, I analyzed obstetric records from a major referral hospital in Ghana. This facility treats people with all of the sociodemographic and obstetric characteristics under study. As a secondary health center, it does not have the significantly higher CS rates relative to the national average that would be expected in a tertiary health center, selection of which would not have been applicable for the purpose of this study.

In recent years, the WHO (2015) has recommended Robson’s classification, also known as the 10-group classification, as a global standard to monitor and compare the CS rates within and between health facilities or populations over time. Robson’s classification system groups pregnant women into 10 mutually exclusive categories based on five routinely collected obstetric characteristics: parity, gestational age, fetal presentation, the onset of labor, and the number of fetuses (National Perinatal Epidemiology Center, n.d.). This classification system allows for the comprehensive analysis of labor events and outcomes while taking important epidemiological variables into consideration. The classification system enables the identification and analysis of different groups of pregnant women and the extent to which they contribute to CS rates.

Following this system, facilities serving different groups of pregnant women could be compared with other facilities that may have better CS rates to inform best practices. The effectiveness of interventions that focus on the optimal application of CS, the quality of clinical practices and management, as well as the quality of collected data can all be assessed using the Robson's classification (National Perinatal Epidemiology Center, n.d.).

Table 1 shows the 10 categories of pregnant women who are included in the Robson's classification system. The relative sizes of the different groups and the CS rates within each group are assessed to compute the contribution of each group to the total CS rate in a given setting. Although the 10 Robson's criteria provide an easy method for assessing CS rates, the WHO continues to develop guidelines for its adaptation as well as the standardization of its definitions and terms (Das et al., 2017; WHO, 2016). The biggest referral center in Ghana, the Korle-Bu Teaching Hospital, which is a tertiary health facility, was estimated to have a CS rate of 46.9% based on the Robson's classification, corroborating the unusually high CS rates (Samba & Mumuni, 2016). Nevertheless, higher CS rates relative to the national average would be expected in tertiary health facilities as opposed to primary and secondary health facilities. Primary health care represents the entry channel into a health system where preventive measures are undertaken and common health conditions are seen. With the increasing intensity of disease conditions, secondary health care serves as an intermediary where conditions requiring more specialized health care are attended to. Tertiary health care represents the pinnacle of health care where rare and complex cases requiring intensive specialized subspecialty health care are managed.

Witt et al. (2014) noted that the choice of low-risk delivery methods, which are necessary for the improved health and survival of mothers and their children, rests in the ability of health professionals to identify and address the risk factors associated with high CS rates. Stivanello et al. (2014) and Sinnott et al. (2015) also acknowledged the complex nature of CS determinants with respect to not only medical indications but economic and organizational factors, maternal sociocultural predisposition, and physician's attitudes towards delivery methods. In this vein, the authors noted that most clinical indications are not absolute but are influenced by other factors which introduce significant variability as to how they affect CS rates in different populations and hospital settings.

Table 1

Robson's 10-Group Classification

Number	Group
1	Nulliparous, single cephalic, > 37 weeks in spontaneous labor
2	Nulliparous, single cephalic, > 37 weeks, induced or CS before labor
3	Multiparous (excluding previous CS), single cephalic, > 37 weeks in spontaneous labor
4	Multiparous (excluding previous CS), single cephalic, > 37 weeks, induced or CS before labor
5	Previous CS, single cephalic, > 37 weeks
6	All nulliparous breeches
7	All multiparous breeches (including previous CS)
8	All multiple pregnancies (including previous CS)
9	All abnormal lies (including previous CS)
10	All single cephalic, < 36 weeks (including previous CS)

Purpose of the Study

Although the sociodemographic factors that influence CS rates have been well documented in other parts of the world (Kambale, 2011), there is a paucity of data on how sociodemographic factors and obstetric factors affect the CS rate in the major referral health facility in Ghana, where this research was conducted (Awoonor-Williams et al., 2015). Sociodemographic factors include age, educational status, and occupational status whereas obstetric factors include gestational age, ANC attendance, obstetric history, parity, fetal weight, and referral status. No systematic research has been conducted to identify the effect of sociodemographic and obstetric factors on the CS rate in this setting.

The key reason for conducting this quantitative study was to identify the sociodemographic and obstetric factors that influence cesarean deliveries in this referral health facility in Ghana. This knowledge may help health leaders to determine which strategies and interventions would be most effective at curbing the increasing CS rates and improving maternal and child health. I also sought to inform leaders on why and how interventions could be tailored to ensure successful outcomes towards positive social change. The uniqueness of this study is evident in the fact that such a study has not yet been conducted in the selected study setting. Although Danso et al. (2009) noted that Ghanaian women generally have a preference for vaginal delivery (VD) over CS, this trend has not aligned to the CS rate, which paradoxically continues to increase.

Research Questions and Hypotheses

The research questions (RQs) and hypotheses are as follows:

RQ 1. Is there an association between maternal sociodemographic factors such as age, educational status, and occupational status and CS in the major referral health facility in Ghana?

> $H_0$1: There is no association between maternal sociodemographic factors such as age, educational status, and occupational status and CS in the major referral health facility in Ghana.
>
> $H_1$1: There is an association between maternal sociodemographic factors such as age, educational status and occupational status, and CS in the major referral health facility in Ghana.

RQ 2. Is there an association between obstetric factors such as obstetric history, parity, fetal weight, gestational age, ANC attendance, and referral status and CS in the major referral health facility in Ghana?

$H_0$2: There is no association between obstetric factors such as obstetric history, parity, fetal weight, gestational age, ANC attendance, and referral status and CS in a major referral health facility in Ghana.

$H_1$2: There is an association between obstetric factors such as obstetric history, parity, fetal weight, gestational age, ANC attendance, and referral status and CS in a major referral health facility in Ghana.

Theoretical Framework

The conceptual framework for this research was the STA. This theory involves the critical consideration of all the individual aspects that make up the whole system and the promotion of the understanding of the interconnections and relationships between these individual parts (Forrester, 1994). It is the critical consideration of the individual, ecological, social, as well as political factors, that influence the system as a whole and the understanding of the relationships between these individual factors (Learning Theories, 2015). STA offers the opportunity to visualize how components are connected within the perspective of a whole entity and has been used successfully across many disciplines including mathematics, engineering, social sciences, as well as health sciences (Peter, 2014). Lich et al (2013) pointed out that, despite the increasing appreciation for the STA, the public health discipline is yet to take full advantage of this theory to solve public health problems.

I adopted the STA in this study to help holistically explain and address the high CS rate in low-resource settings. The constructs of the STA are summarized as synthesis, analysis, and inquiry (Edson, 2008). Synthesis is the assessment of the system as a whole and understanding of the system in its environment; analysis involves the understanding of the parts, activities, or behavior of the system; and inquiry is the finding of solutions through systematic investigation (Edson, 2008). Thus, I holistically assessed the burden of the CS rate in the major referral center in Ghana and enabled the identification and analysis of the component contributory factors. Concomitantly, this enabled the proposition of solutions that can effectively address this public health issue. The sociodemographic and obstetric factors that influence CS rates and that were investigated in this study traverse the individual, ecological, social, and political factors that comprise the STA. The exploration of a variety of sociodemographic and obstetric factors influencing CS rates allowed me to propose appropriate interventions to address the public health issue of high CS rates. The STA enables the holistic resolution of the increasing CS rate while offering an effective means for addressing the problem.

Nature of the Study

For the study, I adopted a quantitative approach and used a case-control design where cases and controls were randomly selected from the secondary data. Cases were participants who had a CS, and controls were participants who had VD within the same study period. The study population consisted of pregnant women who attended ANC at the major referral hospital in Accra, Ghana. I obtained routine data that had been collected and compiled by the hospital's research unit and Obstetrics and Gynaecology Department between January and December 2017. The data included postpartum and postnatal registries and patient medical folders. Only data from January to October were used, however, in the study analyses as the records for November and December had several missing variables. IBM SPSS 25 statistical software was used for statistical analysis. The variables that were assessed were maternal age, educational status, occupational status, obstetric history, parity, mode of delivery, gestational age, ANC attendance, referral status, and fetal weight. Table 2 includes definitions of the key variables in the study and Table 3, a summary of the operationalization of the variables.

I employed bivariate regression and multivariable logistic regression analyses to examine the multiple effects of the variables while controlling for confounders to determine variables that had a statistical significance and clinical importance to CS. Confounding is said to occur when a third variable explains the association between two variables while not lying in the hypothesized causal pathway (Andrade, 2007). The mixing of effects that can be caused by potential confounders results in the erroneous association between variables, hence the pertinence of their being accounted for. The confounding variables in this study were those other exposures that competed with the exposure of interest or caused a 10% or more change in an association such as maternal age and were identified and accounted for in the study analysis by employing bivariate and multivariable regression analyses (see Kelly et al., 2012). A graphical representation of the relationship between the outcome variable, exposures, and confounder is shown in the directed acyclic graph in Figure 1.

Figure 1

Directed Acyclic Graph

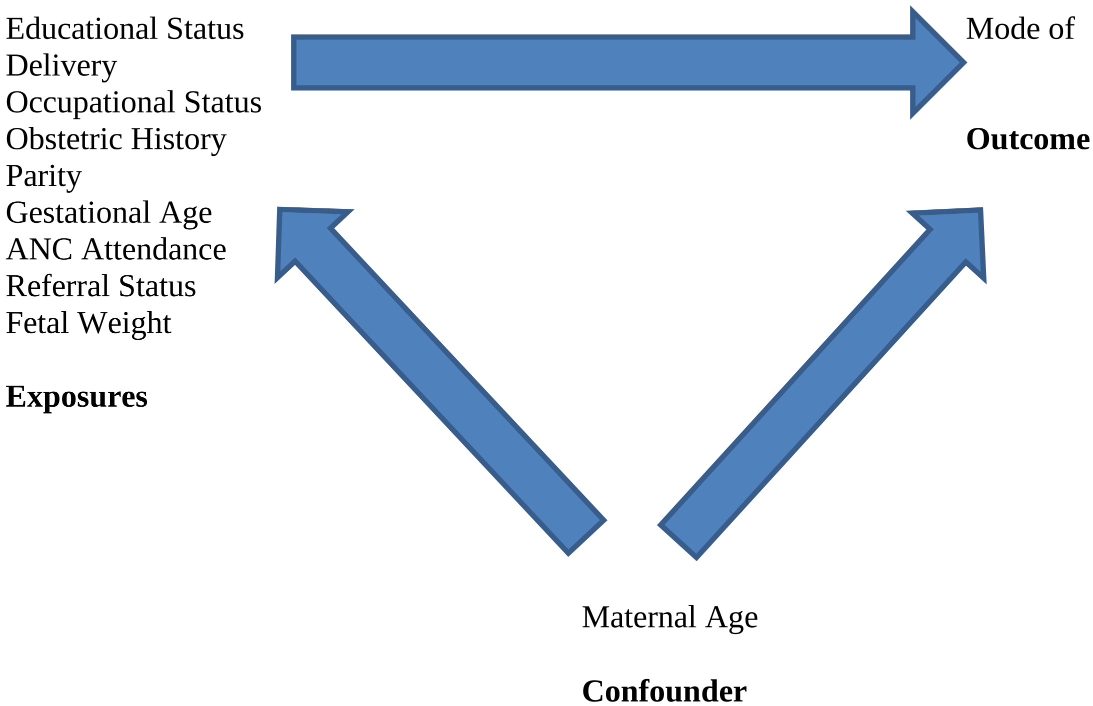

Table 2

Definitions of Key Variables

Variable	Definition
Maternal age	Number of complete years of mothers
Educational status	Level of educational attainment of mother
Occupational status	Income of mother as determined from occupational engagement of mother
Obstetric history	History of previous CS or VD prior to current pregnancy
Parity	Number of live births and stillbirths prior to current pregnancy
Mode of delivery	Mechanism of delivery by mother
Gestational age	Complete number of weeks of gestation at delivery
ANC attendance	Regularity of ANC visits
Referral status	Status of mother as per referral decision or not
Fetal weight	Weight of fetus in kg

Table 3

Operationalization of Key Variables

Variable	Operationalization
Maternal age	Measured as number of complete years: <17, 18-30, 31-40, 41-45, >45
Educational status	Primary level, secondary level, tertiary level
Occupational status	Unemployed, low income, middle income, high income
Obstetric history	Previous CS, previous VD, or none
Parity	Primipara: no prior children, multipara: between 2 to 4 children, grand multipara: >5 children
Mode of delivery	CS or VD
Gestational age	Pre-term: 28 weeks to 36 weeks, term: 37 weeks to 41 weeks, post-term: > 42weeks
ANC attendance	nonattendant: no ANC visits, infrequent attendant: 1-3 visits, frequent attendant: 4 or more visits
Referral status	Referred or not referred
Fetal weight	Very low fetal weight (VLFW): below 1.5kg, low fetal weight (LFW): 1.5kg to 2.5kg, normal weight: above 2.5kg to 3.5kg, overweight: above 3.5kg

Literature Search Strategy

I used Walden University Library databases and the Google Scholar search engine to explore peer-reviewed literature as well as seminal literature relevant to the research. This was done between January and September 2017. The databases that were assessed included Medline, PubMed, Cumulative Index for Nursing and Allied Literature (CINAHL), and PsycInfo. The databases were searched for literature from the year 2000 to 2017. Key search terms used included *cesarean section*, *rate*, *predictors*, *socioeconomic factors*, and *obstetric factors*. Using the problem-intervention-comparison-outcome (PICO) search strategy, I combined key search terms with Medline subject headings/terms (MeSH) where appropriate and adaptable to fit the databases. I explored the definitions of key search terms using a thesaurus, in addition to using different combinations of key search terms and subheadings as well as advanced search options. Search results were filtered progressively to obtain relevant publications. Relevant articles published in academic journals as well as information related to the research that was found online were all reviewed.

Literature Review Related to Key Variables

Thirty years have elapsed since the WHO first recommended an optimal CS rate of 10%-15%. Researchers have noted demographic differences across the WHO member states and have found that maternal age is the strongest predictor of the CS rate (Robson & de Costa, 2017). In a cross-sectional study that assessed the prevalence and determinants of CS in private and public facilities among 81 community-based geographical clusters in Southern Asia, researchers found that the CS rate was higher among mothers who had higher education as this group of women had a preference for CS (Neuman et al., 2014). However, the researchers did not examine why this was so. Knowledge on the reasons may be invaluable to the development of strategies to curb the increasing CS rates. I addressed this gap in the literature in this study.

Betran et al. (2016) conducted the largest research to establish a global reference for CS rates among health facilities. In this cross-sectional study, the researchers included health facilities from 43 countries for model building and testing leading to the development of the C-Model and its e-calculator, a tool for the generation of unique benchmark CS rates for individual health facilities or groups of health facilities. Four versions of the C-Model were built according to the available data. The first version is essentially based on the Robson's classification and focuses on variables such as parity, previous CS, multiple pregnancy, provider-initiated childbirth, presentation, and preterm birth; the second version includes maternal age as a demographic variable; the third version includes the presence of organ dysfunction or ICU admission; and the fourth version includes a select diagnosis of complications such as placenta praevia, abruptio placenta, chronic hypertension, preeclampsia, renal disease, and HIV. These four versions of the C-Model estimate the probability of CS depending on the significant predictors available (Betran et al., 204).

Kambale (2011) studied the social predictors of CS in Italy employing secondary data collected since 2005 from the Italian Institute of Statistics. Analysis of the nationally representative sample of 50,474 households revealed that maternal age and residence were the only significant predictors of CS in Italy. In their study, Khan et al. (2017) assessed the sociodemographic predictors and annual rates of CS in Bangladesh. The authors noted that the CS rate was on a rapid increase with a fourth of all births being CS. They further concluded that the significant predictors of CS included maternal age, place of residence, socioeconomic status, and number of children delivered, as well as number of antenatal visits (Khan et al., 2017). The authors also noted that variations in CS use existed among different geographical locations and linked this to the varying socioeconomic status among different population groups. Although they acknowledged that more comprehensive research must be conducted to justify the reasons for this variation, they also delineated that women needed to be educated on the effects of CS and service providers, better regulated to perform CS (Khan et al., 2017). Akinola et al. (2014), in their appraisal of some predictors of CS in Nigeria, employed a case-control study design where cases were selected as women who had CS and controls as women who had spontaneous VD in a university teaching hospital. Among the predictors found to influence CS rate were antepartum hemorrhage, short stature, low parity, previous history of CS, and low (1.6kg-2.5kg) or high (above 4kg) fetal weights. The authors recommended that women in these groups be counseled and prebooked at centers equipped for CS.

Other researchers have investigated the sociodemographic and obstetric factors associated with CS in Northern Ghana using a case-control study design. In this study, 150 women who had CS were selected as cases while 300 women who had spontaneous VD were selected as controls from retrospective data obtained from hospital registries (Apanga & Awoonor-Williams, 2018). Employing univariate and multivariate analysis, the researchers observed that the odds of having a CS was increased with fetal weights of 4kg or more (Adjusted OR = 1.21, 95% CI 1.064-1.657), a referral from other facilities (Adjusted OR = 1.19, 95% CI 1.108-1.337), as well as ANC visits of four times or more (Adjusted OR= 2.99, 95% CI1.762-5.065). Also, a slight increase in odds of having CS was observed among women with a gestational age of 40 weeks or more (Adjusted OR = 1.09, 95% CI 1.029-1.281). In contrast, women with gestational age less than 37 weeks (Adjusted OR = 0.20, 95% CI: 0.100-0.412), secondary or higher education (Adjusted OR = 0.55, 95% CI 0.320-0.941), and fetal weight between 1.5kg and 2.5kg (Adjusted OR = 0.17, 95% CI 0.086-0.339) had lower odds of having a CS. The quantitative methodology used here which adopted a case-control design was identified as suitable and employed for this research. In the background of all these key findings and conclusions, this study determined how particular key sociodemographic (maternal age, educational status, occupational status) and obstetric factors (obstetric history, parity, mode of delivery, gestational age, ANC attendance, referral status as well as fetal weight) affect the CS rates within the chosen study setting.

From the literature review it becomes apparent that variables selected by studies to establish their influence on CS vary from one research to another, although some variables such as maternal age, educational status, socioeconomic status, gestational age, ANC attendance, and referral status are common. The methods employed in these studies also varied, but they supported the use of a case control design. Also, the conclusions drawn from the studies varied from one health facilities or environment to the other. The implication of this is that for various health facilities and geographical settings, there is the need to investigate and establish the factors that influence CS so that specific effective interventions, strategies, and policies can be proposed and implemented to arrest the increasing CS rate and thereby reduce morbidity and mortality associated with CS among mothers and their children and also promote positive social change. In this study, I sought to determine how particular key sociodemographic (maternal age, educational status, occupational status) and obstetric factors (obstetric history, parity, mode of delivery, gestational age, ANC attendance, referral status as well as fetal weight) affect the CS rates within the chosen study setting.

Definitions

The dependent variable in this study was mode of delivery, which I defined as the mechanism of delivery i.e. whether a mother had a CS or VD (see Apanga & Awoonor-Williams, 2018).

I defined the independent sociodemographic variables as follows: maternal age as the number of complete years of mothers; educational status as the level of educational attainment of mother; and occupational status as the income of mother as determined from occupational engagement of mother (see Apanga & Awoonor-Williams, 2018).

I defined the independent obstetric factors as follows: obstetric history as the history of previous CS or VD prior to current pregnancy; parity as the number of live births and stillbirths prior to current pregnancy; gestational age as the complete number of weeks of gestation at delivery; ANC attendance as the regularity of ANC visits, and referral status as the status of mother as per referral decision or not (see Apanga & Awoonor-Williams, 2018).

Assumptions

The study uses a multivariable logistic regression model which has a set of implicit assumptions that must be satisfied for the model to be valid. These assumptions include linearity of independent variables and log odds, dependent variable structure, observation independence, absence of multicollinearity, and large sample size (Schreiber-Gregory & Bader, 2018).

Also the study assumed that the information provided by the study participants as obtained from the secondary electronic data was accurate although this may have not been so for all study participants.

Finally the study used occupational status of mothers as a proxy measure to estimate their levels of income due to the nature of the data obtained. This was assumed to be a good estimate although there may have been some inaccuracies.

Scope and Delimitations

The rise in CS rates is public health problem of paramount concern (WHO, 2015). This study focused on identifying how and why sociodemographic and obstetric predictors affect the conduction of avoidable CS, to facilitate the development of tailored and effective interventions and strategies that would reduce the CS rate. Expectantly this reduction in CS rate would improve maternal and child health towards a positive social change.

The study population consisted of pregnant women who attended ANC at the major referral hospital in Accra, Ghana. Mothers who did not have complete records of at least three of the variables to be studied were excluded from the study. The study population included mothers who possessed similar sociodemographic and obstetric factors across the various regions of the country, hence the generalizability of the study to rest of the populace.

Limitations

The study is prone to information bias as it cannot be ascertained that the data obtained from the secondary data as provided by study participants are all true. Also, the adoption of reported occupations as a proxy measure to estimate the level of income of mothers, albeit a good estimate, may not be completely accurate. Finally, some potential confounders (hypertension, diabetes, clinical events (e.g., dystocia, breech presentation, fetal distress, etc.), and the healthcare worker decision-making process) could not be taken into account because data on these variables were not available.

Significance

This study has the potential to provide useful empirical-based evidence that would enable make key decision-making to reduce the rate of unnecessary CS and improve maternal and child health. This decision-making would potentially involve the development of effective interventions, strategies, and policies.

The study also has the potential to identify the important at-risk groups, and the most appropriate solutions that could be implemented to limit the conduction of unnecessary CS. These solutions may involve redirection and fortification of education interventions, the need for financial assistance for deprived women, strategies to sensitize stakeholders primarily involved in the performance of CS, as well as identification of loopholes for further research.

The findings from this study have the potential to provide guidance for the development and implementation of relevant interventions tailored to target groups that are marginalized, and at risk of unjustifiable CS. Ultimately, a positive social change can be achieved as maternal and child health improve as a result of reduced CS rates.

Summary and Conclusions

This research identifies the rising performance of avoidable CS globally, as a major concern for the public health community from existing literature, and further corroborates the problem as prominent in Ghana. Cognizant of the paucity of data on the sociodemographic and obstetric predictors that influence the CS rate in the major referral health facility in Ghana, which was selected as the study setting, the research explored the sociodemographic and obstetric factors that affected CS rate in the study setting using a quantitative methodology. The essence of this exploration was to identify the effective interventions to develop pragmatic solutions to reduce CS rates, and achieve positive social change.

In Section 2, I describe the research design, rationale, and data collection methods employed to explore the sociodemographic and obstetric predictors of CS in the major referral health facility. I also describe the data analysis plan, threats to internal validity, and ethical procedures employed, pertaining to the rigorous methodology that I used to address the gap in literature.

Section 2: Research Design and Data Collection

Introduction

The research unit of the major referral facility in Accra, Ghana which was the selected study facility for this research routinely records and compiles sociodemographic and obstetric data, which are available for use by researchers as secondary data. I applied a case-control design to analyze these secondary data. I assessed particular sociodemographic and obstetric factors and analyzed variables using univariate, bivariate, and multivariable logistic regression models. The purpose of this research was to pinpoint the sociodemographic and obstetric factors that affect the CS rate in this major referral health facility in Ghana to develop interventions that would help reduce the CS rate and improve maternal and child health. In this section, I describe the research study and design in further detail. The quantitative nature of the study is emphasized, and details are provided about the variables that were assessed. The study population, sampling procedures, data analysis plan, instrumentation, and operationalization of constructs, as well as threats to the internal validity of the study, are also discussed in this section. Finally, the ethical concerns and considerations, as well as the ethical procedures that were followed in this study, are highlighted.

Research Design and Rationale

I used a case-control design whereby cases in the secondary data were mothers who had a CS and controls were mothers who had VD within the same study period. The variables that were assessed included sociodemographic factors, namely maternal age, educational status, and occupational status, and obstetric factors, namely obstetric history, parity, mode of delivery, gestational age, ANC attendance, referral status, and fetal weight. The outcome variable was the mode of delivery. The nature of this study offered the practical opportunity to quantitatively assess the association between CS and sociodemographic factors as well as obstetric factors (see Fink, 2013a; Mann, 2003).

Methodology

Population

The study population consisted of pregnant women who were delivered at the major referral hospital in Accra, Ghana, between January and October 2017. The size of the target population as obtained from the secondary data set was 5,640 mothers. A total of 5,408 mothers consisting of 2,704 pairs of cases and controls were randomly sampled from this target population.

Sampling Procedures

I obtained electronic data on variables including maternal age, educational status, occupational status, obstetric history, parity, mode of delivery, gestational age, ANC attendance, and referral status of mothers who were delivered at the major referral hospital from the routine data collected and compiled by the research unit. Permission was obtained from the administration of the major referral hospital to retrieve information from the research unit. Mothers who were delivered at the major referral facility who did not have complete records of at least three of the variables to be reviewed were excluded from the study. From the resultant data set, an equal proportion of cases and controls were randomly selected. From the electronic database, the first mother who had a CS was chosen as the first case while the next mother in succession who had a VD was chosen as the first control. The next mother in succession who had a CS was selected as the second case while the next mother who had a VD also in succession was selected as the second control. I used a Visual Basic program (see Appendix B) to select the cases and controls. From the data set, 5,408 mothers, consisting of 2,704 cases and 2,704 controls, were selected for the study.

Operationalization of Constructs

I did not use any specific instruments for data collection because the data employed were secondary data that was collected and compiled by the research unit of the major referral health facility. I operationalized the study variables for the feasibility of data analysis. The variables that I investigated in the study were maternal age, educational status, occupational status, obstetric history, parity, mode of delivery, gestational age, ANC attendance, referral status, and fetal weight. Maternal age was measured as the number of complete years and categorized into groups as < 17, 18-30, 31-40, 41-45, and > 45. Education was categorized as the primary level for mothers who had received only primary level education, secondary level for mothers who had received secondary level education, and tertiary level for mothers who had tertiary level education. The level of measurement of the education variable was categorical. Occupational status was operationalized as a categorical variable: unemployed for those who had no source of livelihood, low income for mothers who engaged in small businesses, middle income for mothers who were employed formally by private businesses or by the government, and high income for mothers who had income higher than those employed formally by private businesses or by the government. Parity was categorized as primipara with no prior children, multipara with more than two children, and grand multipara with five or more children. The mode of delivery was a dichotomous variable categorized as CS, where mothers were delivered by CS, and VD, where mothers were delivered vaginally. Gestational age was categorized as preterm, which is before 38 complete weeks; term, which is between 38 and 41 complete weeks, and postterm delivery, which is after 41 complete weeks.

ANC attendance was categorized as the frequency of ANC attendance and assessed by the number of ANC visits. These were nonattendant, with no ANC visits; infrequent attendant, with one to three ANC visits, and regular attendant, with four or more ANC visits. Referral status was a categorical variable that was assessed by whether a mother was referred from some other facility or not. The categories were referred (for mothers referred from some other health facility) and not referred (for mothers who were not referred from some other health facility). Fetal weight was a continuous variable categorized as VLFW for below 1.5kg, LFW for above 1.5kg and below 2.5kg, normal weight for above 2.5kg and less than 3.5kg, and overweight for above 3.5kg. The level of measurement for fetal weight was continuous. Table 4 shows the operationalization of the variables that were assessed in this research including the variable types and levels of measurements.

Table 4

Operationalization of Constructs

Variable	Variable label	Attribute
AGE	Age	Categorical variable (Ordinal). Measured as number of complete years; >17, 18-30, 31-40, 41-45, >46
EDUC	Educational status	Categorical variable (Ordinal). Primary level: Received some education up to the primary level. Secondary level: Received some education up to the secondary level. Tertiary level: Received education up to the tertiary level.
OCPSTA	Occupational status	Categorical variable (Nominal). Unemployed: Not engaged in any source of livelihood, Low income: Engaged in petty trade or small business, Middle income: Middle class public servant or equivalent, High income: Engaged in high profile business or earning high salary above public servant.
OBSTHX	Obstetric history	Categorical variable (Nominal). Describes prior history of CS or VD; Previous CS: Had previous CS section performed, Previous VD: Had previous VD. None: Had no previous CS or VD.
PRTY	Parity	Categorical variable (Nominal). Primipara: No prior children, Multipara: Between 2-5 children, Grand Multipara: 5 or more children.
MODDEL	Mode of delivery	Categorical Variable (Nominal). Cesarean delivery: Delivered via CS, VD: Vaginally delivered.
GESTAGE	Gestational age	Categorical Variable (Ordinal). Preterm: Before 38 complete weeks, Term: Between 38 and 41 complete weeks, Post-term delivery: After 41 complete weeks.
ANCA	Antenatal care attendance	Categorical variable (Ordinal). Frequency of ANC attendance as assessed by the number of ANC visits: Nonattendant: No ANC visits, Infrequent attendant: 1-3 ANC visits, Regular attendant: 4 or more ANC visits.
REFST	Referral status	Categorical variable (Nominal).

		As assessed by whether mother was referred from another facility. Referred: Mother referred from another health facility. Not referred: Mother was not referred from another health facility.
FTLWT	Fetal weight	Continuous variable (Interval-Ratio). As assessed by weight of fetus in kg. VLFW: below 1.5kg, LFW: above 1.5kg and below 2.5kg, Normal fetal weight: above 2.5kg and less than 3.5kg, Overweight: above 3.5kg.

Data Analysis Plan

The data analyses involved descriptive and analytic (inferential) analyses. The descriptive analysis aimed to summarize the relationship between the variables used in the study. This generates the baseline descriptive statistics of the study variables. These form an important aspect of all quantitative research as they provide a simple description of otherwise complex quantitative data. The descriptive analysis enables the presentation of data in a manner that allows for easy visualization and comprehension of the data (Larson, 2006). The mean, which represents the average of the sum of all data for a given variable; the mode, which denotes the most repeated unit within the data set; and the median, which represents the central value for which there is an equal number of lower as well as higher values, were computed to identify the characteristics of the variables. The range was used to identify the extent of dispersion of values and represents the difference between the highest and lowest scores. The standard deviation was computed to provide insight on the pattern that the data set followed (Larson, 2006). These measures were important to the analysis of the data set and described the factors that influenced the CS rate within the study setting.

Researchers use univariate descriptive statistics to summarize data as well as identify patterns in the data. Patterns are identified through methods including measures of central tendency, variability, and dispersion. I used the IBM SPSS 25 statistical software to conduct univariate descriptive analysis as it provides applications that enable the calculation of frequencies and computation of measures of central tendency, variability, and dispersion. The descriptive statistics tab in IBM SPSS 25 provides access to a sequence of options that enable the selection of the variables of interest, the tests that must be applied, the dispersion to be shown, as well as the order of display preferred. Although offering the opportunity to describe data, descriptive statistics do not provide the means for valid inferences on the association between variables to be made (Larson, 2006).

I performed analytic (inferential) analysis using multivariable logistic regression analysis. Multivariable logistic regression involves the use of techniques to simultaneously analyze the relationship between multiple variables. Multivariable regression was the technique I used in this study because it is appropriate when analyzing the relationship between an independent variable and multiple dependent variables. Hidalgo and Goodman (2013) argued that, despite the interchangeable use of the terms *multivariable* and *multivariate* by researchers, differentiating between the two terms is important for the field of public health. Equation 1 displays the form of a simple linear regression model with one outcome variable, denoted by y, and one independent variable denoted by x. By contrast, Equation 2 displays the form of a multivariable linear regression with one dependent variable denoted by y, multiple independent variables denoted by $x_1 \ldots x_k$, β_0 representing the constant term, β representing the correlation coefficients, and ε representing the residual or error. In Equation 3, a dependent variable is computed for the same independent variable but at multiple time points, or the modeling of clustered data with multiple units within clusters (Hidalgo & Goodman, 2013).

$$y = \beta_0 + x\beta + \varepsilon_y$$

(1)

$$y = \beta_0 + x_1\beta_1 + \cdots + x_k\beta_k + \varepsilon$$

(2)

$$y_{n\times p} = x_{n\times(k+1)}\beta_{(k+1)\times p} + \varepsilon$$

(3)

Multivariable regression analysis, which is based on Equation 2, was a critical aspect of the data analysis as it enabled the determination of the association between the outcome variable and the independent variables being investigated. Although the βs in a multivariable regression analysis represent the unknown correlation coefficients, which are the true population parameters, they are estimated as $\hat{\beta}$s. The matrix form of the linear regression model in Equation 2 is given in Equation 4, as follows:

$$\boldsymbol{y} + \boldsymbol{x\beta} + \boldsymbol{\varepsilon}$$

(4)

This is expanded as shown in the matrix in Equation 5:

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1p} \\ 1 & x_{21} & x_{22} & \cdots & x_{2p} \\ 1 & x_{31} & x_{32} & \cdots & x_{3p} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ 1 & x_{81} & x_{82} & \cdots & x_{8p} \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \vdots \\ \beta_8 \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \vdots \\ \varepsilon_n \end{bmatrix}$$

(5)

Threats to Validity

For the multivariable regression model to be valid, some assumptions need to be satisfied: There must be a linear relationship between the independent variables and the log of odds. Also, the outcome variable must be binary or ordinal. There must be an independent relationship between observations, in that, observations must not come from matched data or repeated observations. There must also be the absence of multicollinearity, a situation where there is near linearity among the group of independent variables within the model. Finally, a large sample size is required (Schreiber-Gregory & Bader, 2018).

The matrix form for the eight independent variables that were assessed in this study will be as in Equation 6:

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1p} \\ 1 & x_{21} & x_{22} & \cdots & x_{2p} \\ 1 & x_{31} & x_{32} & \cdots & x_{3p} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ 1 & x_{n\,1} & x_{n\,2} & \cdots & x_{n\,p} \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \vdots \\ \beta_p \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \vdots \\ \varepsilon_n \end{bmatrix} \tag{6}$$

This can also be expressed in equation form as follows:

$$\hat{y}_1 = \hat{\beta}_0 + x_1\hat{\beta}_1 + x_2\hat{\beta}_2 \ldots + x_k\hat{\beta}_k + \varepsilon_1$$

$$\hat{y}_2 = \hat{\beta}_0 + x_1\hat{\beta}_1 + x_2\hat{\beta}_2 \ldots + x_k\hat{\beta}_k + \varepsilon_2$$

$$\hat{y}_3 = \hat{\beta}_0 + x_1\hat{\beta}_1 + x_2\hat{\beta}_2 \ldots + x_k\hat{\beta}_k + \varepsilon_3$$

$$\vdots \;\; = \vdots + \;\; \vdots \;\; + \;\; \vdots \cdots + \;\; \vdots \;\; + \vdots$$

$$\hat{y}_{544} = \hat{\beta}_0 + x_1\hat{\beta}_1 + x_2\hat{\beta}_2 \ldots + x_k\hat{\beta}_k + \varepsilon_n$$

The estimated $\hat{\beta}$ is obtained by applying Equation 7:

$$\hat{\beta} = (\boldsymbol{x}^T\boldsymbol{x})^{-1}\boldsymbol{x}^T\boldsymbol{y} \tag{7}$$

To make the computations easy, the IBM SPSS Statistics 25 computer software which has an in-built module that runs multivariable regression analysis was utilized in this study.

Furtherance to the estimation of the βs, the reliability of the estimates is determined using the correlation coefficient. The correlation coefficient, an index that spans from -1 to +1, expresses the extent of linearity between variables. A value of 0 shows no linearity while values towards -1 and +1 express a stronger linear relationship. The coefficient of correlation as well as the adjusted coefficient of correlation is computed as follows in Equations (8) and (9):

$$R^2 = 1 - \frac{SSE}{SST}$$

(8)

where SSE is the sums of squares of the errors, and SST is the sums of squares of the total.

$$R^2 adj. = \frac{(1-R^2)(n-1)}{n-k-1}$$

(8)

where k is the number of independent variables and n is the number of data elements.

A multivariable logistic regression model enables the analysis between multiple variables while offering the opportunity to control for potential confounders. This method of analysis is particularly useful for this study as it seeks to assess the relationship between CS rate and various predictor variables while controlling for potential confounding variables. This enabled the quantification of the relationship between variables, as well as valid conclusions and inferences about how variables associated with each other to be made. Multivariable analysis has been successfully used to analyze data in the areas of quality control and assurance, marketing and consumer research, process optimization and control, research and development, and many more. Multivariable analysis however has the limitation of requiring large sample sizes for results to be meaningful due to high standard errors (The Classroom, 2019).

Data analysis involved univariate analysis, bivariate regression and multivariable logistic regression using the IBM SPSS 25 statistical software. Descriptive analysis with the crosstabs function was performed for the sociodemographic and obstetric factors of mothers. This enabled the assessment of the frequencies and percentages of cases and controls with respect to the various sociodemographic and obstetric variables. Bivariate regression models were employed to assess how each of the various independent variables including sociodemographic factors namely maternal age, educational status, occupational status, referral status; obstetric factors namely gestational age, obstetric history, parity, ANC attendance, and fetal weight was associated with the outcome variable, mode of delivery. The adjusted odds ratios (OR), 95% confidence intervals (CI), and *p*-value set at the conventional 0.05 were computed and interpreted to determine variables that had a statistical association or significance, and clinical importance to CS rate. From the bivariate analysis, variables that showed statistical significance or were confounders (i.e., caused a change in association by 10% or more) were included in the multivariable logistic regression analysis. A multivariable logistic regression model was employed to assess the concurrent effects of multiple variables while simultaneously controlling for confounding variables.

Ethical Procedures

Institutional approval from the administration of the major referral hospital from where data was collected for this research was obtained for retrieval of data from their research unit. An introductory letter from the Ghana College of Physicians and Surgeons to embark on the research was obtained, presented to the major referral hospital and approved prior to this. Institutional Review Board approval from Walden University was sought before starting the analysis for this study. The anonymity of study members was ensured during all stages of the research. Also, that the consent of study members was sought, and their right to withdraw from any potential study was communicated to them prior to data collection by the research unit of the major referral hospital which is routinely done, was verified. The approved letter giving permission to access the secondary data is included as Appendix A.

Summary

This research studied the association between the mode of delivery and sociodemographic and obstetric factors. The purpose of the study was to identify those factors that contributed to the increasing CS rate, to develop interventions towards reducing the increasing CS rate in Ghana, to improve maternal and child health. This was a quantitative study that adopted a case-control design. The study employed secondary data obtained from a major referral health facility in Ghana. The variables under investigation which were all operationalized were maternal age, educational status, occupational status, obstetric history, parity, mode of delivery, gestational age, ANC attendance, referral status, and fetal weight. The sample size was 5408 mothers consisting of 2704 cases of mothers who had delivered via CS, and 2704 controls of mothers who had been delivered vaginally. Sampling was conducted by a random successive selection of cases and controls. Data analysis was carried out using the IBM SPSS 25 statistical software. Descriptive analysis, bivariate regression, and multivariable logistic regression of data were conducted. Ethical procedures to obtain and use the secondary data as required were fulfilled. The next section in this study presents discusses and interprets the results obtained after implementation of the research methods described in this section; the conclusions drawn from the results and findings are also presented.

Section 3: Presentation of the Results and Findings

Introduction

The purpose of this research was to determine how sociodemographic factors and obstetric factors influence CS rates in the study setting under investigation. I analyzed the secondary data from the study hospital using several statistical methods to assess whether a significant association existed between the outcome variable and the independent variables. The RQs and hypotheses were as follows:

RQ 1. Is there an association between maternal sociodemographic factors such as age, educational status and occupational status, and CS in the major referral health facility in Ghana?

$H_0$1: There is no association between maternal sociodemographic factors such as age, educational status, and occupational status, and CS in the major referral health facility in Ghana.

$H_1$1: There is an association between maternal sociodemographic factors such as age, educational status and occupational status, and CS in the major referral health facility in Ghana.

RQ 2. Is there an association between obstetric factors such as obstetric history, parity, fetal weight, gestational age, ANC attendance, and referral status, and CS in the major referral health facility in Ghana?

$H_0$2: There is no association between obstetric factors such as obstetric history, parity, fetal weight, gestational age, ANC attendance and referral status, and CS in the major referral health facility in Ghana.

$H_1$2: There is an association between obstetric factors such as obstetric history, parity, fetal weight, gestational age, ANC attendance as well as referral status, and CS in the major referral health facility in Ghana.

In Section 3, I describe the data collection process and the time frame for collection of the secondary data used in this study. The section also includes a discussion of the discrepancies encountered in the use of the secondary data with respect to the data analysis plan that was detailed in Section 2, an assessment of the representativeness of the sample population and its generalization to the larger population, and the statistical findings obtained from the analyses conducted. This section also includes further discussion of key findings pertaining to the RQs and whether they support acceptance or rejection of the study's null hypotheses.

Assessing the Data Set for Secondary Analysis

I obtained data on variables that were relevant to the research from electronic data that were routinely compiled by the major referral health facility under study between January and December 2017. The months of November and December were not included for data analyses as these months did not have the full repertoire of data for the variables being investigated as per the exclusion criteria. With respect to the exclusion criteria, participants were excluded if data on more than three variables were not available in the data set. Data were collected as monthly sets from the database and subsequently combined to obtain a single data set in Microsoft Excel, which was then cleaned and imported into IBM SPSS 25 for analysis. To ensure the random selection and high internal validity, a Visual Basic program was developed and run with the data set to obtain a random control for each consecutive case. From the electronic database, the first mother who had a CS was chosen as the first case whilst the next mother in succession who had a VD was chosen as the first control. The next mother in succession who had a CS was selected as the second case whilst the next mother who had a VD also in succession was selected as the second control. This program is included in Appendix B. A total of 5,408 mothers, made up of 2,704 cases being mothers who were delivered by CS and 2,704 controls being mothers who were delivered by VD, were captured by the program. The baseline descriptive characteristics of the data set are shown in Tables 5-14. The sociodemographic and obstetric factors included in this research provided insight into how diverse and generalizable the study sample was in relation to the general population.

Results

Table 5 displays a summary of the case processing showing missing and valid values and their respective percentages.

Table 5

Baseline Descriptive Statistics: Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	%	*N*	%	*N*	%
Mode of delivery* maternal age	5,408	100.0	0	0.0	5,408	100.0
Mode of delivery * educational Status	5,408	100.0	0	0.0	5,408	100.0
Mode of delivery * occupational status	5,408	100.0	0	0.0	5,408	100.0
Mode of delivery * obstetric history	5,390	99.7	18	0.3	5,408	100.0
Mode of delivery * ANC attendance	5,403	99.9	5	0.1	5,408	100.0
Mode of delivery * referral status	5,408	100.0	0	0.0	5,408	100.0
Mode of delivery * parity	5,408	100.0	0	0.0	5,408	100.0
Mode of delivery * gestation	5,408	100.0	0	0.0	5,408	100.0
Mode of delivery * fetal weight	5,408	100.0	0	0.0	5,408	100.0
Mode of delivery * gestation	5,408	100.0	0	0.0	5,408	100.0

Tables 6 and 7 display the baseline descriptive statistics of the data set for maternal age and mode of delivery against maternal age, respectively. As shown in Table 6, the total number of participants who were selected in this study as cases and controls was 5,408. The mean maternal age was estimated as 29.89 years with a standard deviation of 5.67 while the mode for maternal age was 30 years. The mean standard error was computed as 0.77 while the minimum and maximum ages were 13 and 50 years, respectively.

As shown in Table 7, of the 2,704 mothers who underwent a CS, the highest proportion of CS was observed amongst the 18-30 years age group (51.2%), followed by the 31-40 years age group (44.7%), 41-45 years age group (2.8%), < 17 (1.0%), and > 46 (0.2%). Within the categories of age groups, the proportion of mothers who underwent CS was observed to increase generally with increasing age groups. The highest proportion of CS within age groups (62.5%) was observed among the > 46 years age group while the lowest proportion (30.8%) was observed among the < 17 years age group.

Table 6

Baseline Descriptive Statistics: Maternal Age

Statistics		
Maternal Age		
N	Valid	5,408
	Missing	0
Mean		29.85
Standard error of mean		.077
Median		30.00
Mode		30
Standard deviation		5.670
Minimum		13
Maximum		50

Table 7

Baseline Descriptive Statistics: Mode of Delivery and Maternal Age

			Age group					
			<17	18-30	31-40	41-45	>46	Total
Mode of delivery	VD	Count	63	1532	1046	60	3	2704
		% within mode of delivery	2.3	56.7	38.7	2.2	0.1	100.0
		% within age group	69.2	52.5	46.4	43.8	37.5	50.0
		% of total	1.2	28.3	19.3	1.1	0.1	50.0
	CS	Count	28	1384	1210	77	5	2704
		% within mode of delivery	1.0	51.2	44.7	2.8	0.2	100.0
		% within age group	30.8	47.5	53.6	56.2	62.5	50.0
		% of total	0.5	25.6	22.4	1.4	0.1	50.0
Total		Count	91	2916	2256	137	8	5408
		% within mode of delivery	1.7	53.9	41.7	2.5	0.1	100.0
		% within age group	100.0	100.0	100.0	100.0	100.0	100.0
		% of total	1.7	53.9	41.7	2.5	0.1	100.0

Table 8 displays the baseline descriptive statistics for mode of delivery against educational status. As shown in Table 8, amongst the total number of 2,704 mothers who had a CS, most mothers had secondary education (72.3%), followed by mothers who had tertiary education (21.1%) and mothers who had only a primary education (6.6%). Within the categories of educational status, the proportion of CS amongst mothers with tertiary education was highest (55.9%) for of a total of 1,020 mothers, followed by mothers with primary education (53.0%) for of a total of 336 mothers. Mothers with secondary education recorded the least proportion of CS (48.3%) for of a total of 4,052.

Table 8

Baseline Descriptive Statistics: Mode of Delivery and Educational Status

			Educational status			
			Primary level	Secondary level	Tertiary level	Total
Mode of delivery	VD	Count	158	2096	450	2704
		% within mode of delivery	5.8	77.5	16.6	100.0
		% within educational status	47.0	51.7	44.1	50.0
		% of total	2.9	38.8	8.3	50.0
	CS	Count	178	1956	570	2704
		% within mode of delivery	6.6	72.3	21.1	100.0
		% within educational status	53.0	48.3	55.9	50.0
		% of total	3.3	36.2	10.5	50.0
Total		Count	336	4052	1020	5408
		% within mode of delivery	6.2	74.9	18.9	100.0
		% within educational status	100.0	100.0	100.0	100.0
		% of total	6.2	74.9	18.9	100.0

Table 9 displays the baseline descriptive statistics for the mode of delivery against occupational status. From Table 9, amongst the total number of 2,704 mothers who had a CS, the highest proportion had a low income (67.5%), followed by mothers with middle income (19.2%) and unemployed mothers (10.6%). The lowest proportion of mothers who had a CS had a high income (2.7%). Within the categories of occupational status, the proportion of CS generally decreased with decreasing income; however, this trend changed noticeably with mothers with high income as they were observed to have the lowest proportion of CS (43.5%). The highest proportion of CS was observed among mothers with middle income (52.5%), followed by mothers with low income (50.2%) and, finally, unemployed mothers (46.7%).

Table 9

Baseline Descriptive Statistics: Mode of Delivery and Occupational Status

			Occupational status				
			Unemployed	Low income	Middle income	High income	Total
Mode of delivery	VD	Count	327	1811	471	95	2704
		% within mode of delivery	12.1	67.0	17.4	3.5	100.0
		% within Occupational status	53.3	49.8	47.5	56.5	50.0
		% of total	6.0	33.5	8.7	1.8	50.0
	CS	Count	287	1824	520	73	2704
		% within mode of delivery	10.6	67.5	19.2	2.7	100.0
		% within Occupational status	46.7	50.2	52.5	43.5	50.0
		% of total	5.3	33.7	9.6	1.3	50.0
Total		Count	614	3635	991	168	5408
		% within Mode of delivery	11.4	67.2	18.3	3.1	100.0
		% within Occupational status	100.0	100.0	100.0	100.0	100.0
		% of Total	11.4	67.2	18.3	3.1	100.0

Table 10 displays the baseline descriptive statistics for the mode of delivery against gestation. As shown in Table 10, out of 2,704 mothers who had a CS, only 3.7% were postterm, followed by preterm gestation (24.2%) and term gestation (72.0%). Within the categories of gestation, mothers who had preterm deliveries recorded the highest proportion of CS (59.1%), followed by mothers who had term deliveries (49.7%) and mothers who had postterm deliveries (44.7%).

Table 10

Baseline Descriptive Statistics: Mode of Delivery and Gestation

			Gestation			
			Pre-term	Term	Post-term	Total
Mode of Delivery	VD	Count	608	1971	125	2704
		% within mode of delivery	22.5	72.9	4.6	100.0
		% within gestation	48.1	50.3	55.3	50.0
		% of total	11.2	36.4	2.3	50.0
	CS	Count	655	1948	101	2704
		% within mode of delivery	24.2	72.0	3.7	100.0
		% within gestation	51.9	49.7	44.7	50.0
		% of total	12.1	36.0	1.9	50.0
Total		Count	1263	3919	226	5408
		% within mode of delivery	23.4	72.5	4.2	100.0
		% within gestation	100.0	100.0	100.0	100.0
		% of total	23.4	72.5	4.2	100.0

Table 11 displays the baseline descriptive statistics for the mode of delivery against parity. As shown in Table 11, out of the total of 2,704 mothers who underwent CS, most were primipara (61.9%), while grand multiparous mothers were observed to have the lowest proportion of CS (2.5%). Multiparous mothers recorded a proportion of 35.7%. Within the categories of parity, mothers who were having their first babies were observed to have the highest proportion of CS (51.4%). This was followed by multiparous mothers (48.3%), while mothers who had had five or more previous pregnancies recorded the least proportion of CS (41.6%).

Table 11

Baseline Descriptive Statistics: Mode of Delivery and Parity

			Parity			
			Primipara	Multipara	Grand Multipara	Total
Mode of Delivery	VD	Count	1579	1031	94	2704
		% within mode of delivery	58.4	38.1	3.5	100.0
		% within parity	48.6	51.7	58.4	50.0
		% of total	29.2	19.1	1.7	50.0
	CS	Count	1673	964	67	2704
		% within mode of delivery	61.9	35.7	2.5	100.0
		% within parity	51.4	48.3	41.6	50.0
		% of total	30.9	17.8	1.2	50.0
Total		Count	3252	1995	161	5408
		% within mode of delivery	60.1	36.9	3.0	100.0
		% within parity	100.0	100.0	100.0	100.0
		% of total	60.1	36.9	3.0	100.0

Table 12 displays the baseline descriptive statistics for the mode of delivery against ANC attendance. As shown in Table 12, a noticeable proportion of 95% of the total of 2,704 mothers who had had a CS were regular attendants of ANC. The proportion of these mothers who were infrequent attendants and nonattendants were 2.9% and 2.1%, respectively. Within the categories of ANC attendance, there was an observed general increase in the proportion of CS across the increasing frequency of ANC attendance. Nonattendants had the lowest proportion of CS (30.8%), followed by infrequent attendants (45.1%) and regular attendants (50.9%).

Table 12

Baseline Descriptive Statistics: Mode of Delivery and ANC Attendance

			ANC Attendance			
			Nonattendant	Infrequent attendant	Regular attendant	Total
Mode of Delivery	VD	Count	126	95	2480	2701
		% within mode of delivery	4.7	3.5	91.8	100.0
		% within ANC attendance	69.2	54.9	49.1	50.0
		% of total	2.3	1.8	45.9	50.0
	CS	Count	56	78	2568	2702
		% within mode of delivery	2.1	2.9	95.0	100.0
		% within ANC attendance	30.8	45.1	50.9	50.0
		% of total	1.0	1.4	47.5	50.0
Total		Count	182	173	5048	5403
		% within mode of delivery	3.4	3.2	93.4	100.0
		% within ANC attendance	100.0	100.0	100.0	100.0
		% of total	3.4	3.2	93.4	100.0

Table 13 displays the baseline descriptive statistics for the mode of delivery against obstetric history. From Table 13, out of the total 0f 2704 mothers who had a CS, the highest proportion had had a previous CS (36.9%), while mothers who had had a previous VD were observed to have the least proportion of CS (29.6%). Mothers with no previous obstetric history were observed to fall in between with a proportion of 33.4%.

Within the categories of obstetric history, the proportion of CS observed generally increased with increasing frequency of ANC attendance. Mothers who had had previous

CS recorded a remarkably higher proportion of CS (83.5%), while those who had had previous VD recorded the lowest (32.6%). Falling in between were mothers who had no previous obstetric history (51.7%).

Table 13

Baseline Descriptive Statistics: Mode of Delivery and Obstetric History

			Obstetric History			
			None	Previous CS	Previous VD	Total
Mode of Delivery	VD	Count	841	197	1652	2690
		% within mode of delivery	31.3	7.3	61.4	100.0
		% within obstetric history	48.2	16.5	67.4	49.9
		% of total	15.6	3.7	30.6	49.9
	CS	Count	903	997	800	2700
		% within mode of delivery	33.4	36.9	29.6	100.0
		% within obstetric history	51.8	83.5	32.6	50.1
		% of total	16.8	18.5	14.8	50.1
Total		Count	1744	1194	2452	5390
		% within mode of delivery	32.4	22.2	45.5	100.0
		% within obstetric history	100.0	100.0	100.0	100.0
		% of total	32.4	22.2	45.5	100.0

Table 14 and 15 displays the baseline descriptive statistics mode for fetal weight, and mode of delivery against fetal weight respectively. From Table 14, the mean fetal weight was estimated as 3.023kg at a standard deviation of .7214, and a mean standard error of 0.0098. The minimum and maximum fetal weights were 0.5 and 6.1 respectively.

From Table 15, of the total of 2704 mothers who underwent CS, the highest proportion were those who normal babies (57.0%), followed by mothers who had overweight babies (20.7%), mothers who had LFW (16.7%), and mothers who had VLFW (5.6%).

Within categories of fetal weight, mothers who had babies with VLFW recorded the highest proportion of CS (56.7%), followed by those who had babies with LFW (53.6%), and those who had overweight babies (49.7%). Mothers who had babies with normal fetal weight recorded the lowest proportion of CS (48.5%).

Table 14

Baseline Descriptive Statistics: Fetal Weight

Statistics		
Weight		
N	Valid	5408
	Missing	0
Mean		3.023
Standard error of mean		.0098
Median		3.100
Mode		3.0
Standard deviation		.7214
Range		5.6
Minimum		.5
Maximum		6.1

Table 15

Baseline Descriptive Statistics: Mode of Delivery and Fetal Weight

			Fetal weight				
			VLFW	LFW	Normal fetal weight	Overweight	Total
Mode of Delivery	VD	Count	116	390	1633	565	2704
		% within mode of delivery	4.3	14.4	60.4	20.9	100.0
		% within fetal weight	43.3	46.4	51.4	50.3	50.0
		% of total	2.1	7.2	30.2	10.4	50.0
	CS	Count	152	451	1542	559	2704
		% within mode of delivery	5.6	16.7	57.0	20.7	100.0
		% within fetal weight	56.7	53.6	48.6	49.7	50.0
		% of total	2.8	8.3	28.5	10.3	50.0
Total		Count	268	841	3175	1124	5408
		% within Mode of Delivery	5.0	15.6	58.7	20.8	100.0
		% within Fetal Weight	100.0	100.0	100.0	100.0	100.0
		% of Total	5.0	15.6	58.7	20.8	100.0

Table 16 displays the baseline descriptive statistics for mode of delivery against referral status. From Table 16, the total 2704 mothers who had a CS, 56. 3% were referred while 43.8% were not.

Within the categories of referral status, mothers who were referred recorded a slightly lower proportion of CS (49.2%) as compared to mothers who were not referred (51.1%).

Table 16

Baseline Descriptive Statistics: Mode of Delivery and Referral Status

			Referral status		
			Not referred	Referred	Total
Mode of delivery	VD	Count	1132	1572	2704
		% within mode of delivery	41.9	58.1	100.0
		% within referral status	48.9	50.8	50.0
		% of total	20.9	29.1	50.0
	CS	Count	1183	1521	2704
		% within mode of delivery	43.8	56.3	100.0
		% within referral status	51.1	49.2	50.0
		% of total	21.9	28.1	50.0
Total		Count	2315	3093	5408
		% within mode of delivery	42.8	57.2	100.0
		% within referral status	100.0	100.0	100.0
		% of total	42.8	57.2	100.0

The research analysis focused on addressing the research questions as follows:

RQ 1. Is there an association between maternal sociodemographic factors such as age, educational status and occupational status and CS in the major referral health facility in Ghana?

RQ 2. Is there an association between obstetric factors such as obstetric history, parity, fetal weight, gestational age, ANC attendance, and referral status, and CS in the major referral health facility in Ghana?

Bivariate analysis of the mode of delivery against the sociodemographic factors and obstetric factors are as displayed in Tables 17 and 18 respectively. From Table 17, the bivariate analysis showed that with increasing maternal age, there were increasing odds of undergoing CS. This was however not statistically significant across all categories of maternal age.

Compared to mothers who had tertiary education, mothers who had primary level education (OR = 0.889, $p = 0.353$, CI = 0.695, 1.139) and secondary level education (OR = 0.737, $p < 0.001$, CI = 0.642, 0.846) were less likely to have CS and this was strongly statistically significant for mothers with secondary level education.

There were increasing odds of undergoing CS with increasing income of mothers, but this was statistically significant only for middle-income mothers (OR = 0.031, $p < 0.05$, CI = 1.033, 1.998).

From Table 18, an increasing odds of having CS was observed with increasing gestational age. Mothers who had preterm deliveries had a higher odds of having a CS by a factor of 1.33 and this result was statistically significant (OR = 1.333, $p < 0.05$, CI = 1.003, 1.772).

Primiparous mothers (OR = 1.487, $p = < 0.05$, CI = 1.079, 2.049) were observed to have the highest odds of having a CS, followed by multiparous mothers (OR = 1.312, $p = 0.102$, CI = 0.947, 1.816); these findings were however not statistically significant.

Mothers who were nonattendants of ANC (OR = 0.429, $p < 0.001$, CI = 0.312, 0.591) had the lowest odds of having a CS, followed by mothers who were infrequent ANC attendants (OR = 0.793, $p = 0.135$, CI = 0.585, 1.075), and there was strong statistical significance amongst mothers who were ANC nonattendants.

Mothers who had had neither a previous VD or previous CS were observed to have more than double the likelihood to have a CS (OR = 2.217, $p < 0.001$, CI = 1.954, 2.516), while mothers who had had a previous CS were observed to have a remarkable more than 10 fold the odds of having a CS as compared to mothers who had had a previous VD (OR = 10.451, $p < 0.001$, CI = 8.777, 12.444). These results showed a strong statistical significance.

Mothers who had babies with VLFW (OR = 1.324, $p < 0.05$, CI = 1.013, 1.732) and LFW (OR = 1.169, $p = 0.088$, CI = 0.977, 1.398) were observed to have higher odds of having a CS by a factor of 1.324 (32.4%) and 1.169 (16.9%) respectively, while mothers who had babies with normal fetal weight (OR = 0.501, $p = 0.954$, CI = 0.833, 1.094) were observed to have a lower odds of having a CS by a factor of 0.954 (4.6%). These results were statistically significant amongst mothers who had babies with VLFW.

Mothers who were not referred (OR = 1.080, $p = 0.161$, CI = 0.970, 1.203) were observed to be slightly more likely (8%) to have a CS as compared to their referred counterparts however, this result showed no statistical significance.

From the bivariate analysis, variables that showed statistical significance within any of its categories or were confounders i.e. caused a change in association by 10% or more were included in the multivariable logistic regression analysis. In this regard education, occupation, gestation, parity, obstetric history, ANC attendance, and fetal weight were observed to be significant, while maternal age was identified as a confounder. These variables were thus included in the multivariable logistic regression analysis.

Table 17

Bivariate Analysis: Sociodemographic Factors

	Unadjusted OR	95% C.I. Lower	95% C.I. Upper	Sig.
Maternal Age				
<17	.267	.060	1.194	.084
18-30	.542	.129	2.272	.402
31-40	.694	.165	2.911	.618
40-45	.770	.177	3.351	.728
>46*	1	-	-	-
Educational Status				
Primary Level	.889	.695	1.139	.353
Secondary Level	**.737**	**.642**	**.846**	**.000**
Tertiary Level*	1	-	-	-
Occupational status				
Unemployed	1.142	.810	1.611	.449
Low Income	1.311	.960	1.790	.089
Middle Income	**1.437**	**1.033**	**1.998**	**.031**
High Income*	1	-	-	-

*= Reference Category
Sig= *p*-value

Table 18

Bivariate Analysis: Obstetric Factors

		95% C. I.		
	Unadjusted OR	Lower	Upper	Sig.
Gestation				
Pre-Term	**1.333**	**1.003**	**1.772**	**.048**
Term	1.223	.934	1.602	.143
Post-Term*	1			-
Parity				
Primipara	**1.487**	**1.079**	**2.049**	**.015**
Multipara	1.312	.947	1.816	.102
Grand Multipara	1			-
ANC Attendance				
Nonattendant	**.429**	**.312**	**.591**	**.000**
Infrequent Attendant	.793	.585	1.075	.135
Regular Attendant*	1			-
Obstetric History				
None	2.217	1.954	2.516	.000
Previous CS	**10.451**	**8.777**	**12.444**	**.000**
Previous VD*	1			-
Fetal Weight				
VLFW	**1.324**	**1.013**	**1.732**	**.040**
LFW	1.169	.977	1.398	.088
Normal Fetal Weight	.954	.833	1.094	.501
Overweight*	1			-
Referral				
Not Referred	1.080	.970	1.203	.161
Referred*	1			-

*= Reference Category
Sig= *p*-value

Table 19 and 20 display the results of the multivariable logistic regression analysis of sociodemographic factors and obstetric factors respectively. It can be inferred from Table 19 that with increasing maternal age, there was an increase in the odds of mothers having a CS. This confirms that older mothers were more likely to undergo CS. While this was statistically significant among the <17 years age group ($p < 0.05$, 95% CI = 0.031, 0.807), none of the other categories of age showed a significant association and all confidence intervals included the value 1. The odds of having a CS as compared to VD were generally lower across all age groups.

Compared to mothers with tertiary level education, mothers with only primary level education (OR = 1.070), were 7.0% more likely to have a CS while mothers with secondary education (OR = 0.748), were 25.2% less likely to have a CS. While the association between CS and secondary education was significant ($p < 0.001$, 95% CI = 0.626, 0.894), that for primary education was not ($p = 0.659$, 95% CI = 0.796, 1.434).

Compared to their high-income counterparts, mothers with low income (OR = 1.645, $p < 0.001$, 95% CI = 1.148, 2.358) had the highest odds of having a CS by a proportion of 64.5% and this was statistically significant. Also, mothers with middle income had a higher odds of having a CS by a proportion of 46.9% and this was also statistically significant (OR = 1.469, $p < 0.05$, 95% CI = 1.016, 2.122). Although unemployed mothers also showed a higher odds of having a CS as compared to those with high incomes, this association was not statistically significant (OR = 1.463, $p = 0.55$, 95% CI = 0.991, 2.159).

From Table 20, compared to mothers who had post-term gestation, mothers who carried their pregnancies to term (OR = 0.919, $p = 0.564$, 95% CI = 0.687, 1.224) had a slightly lower odds of having a CS, while mothers who had preterm gestation (OR =

1.334, $p = 0.65$, 95% CI=0.983, 1.811) had a higher odds of having a CS; there was however no statistically significant association for these results.

Compared to their grand multiparous counterparts, multiparous mothers (OR = 1.058, $p = 0.760$, 95% CI = 0.735, 1.525) and primiparous mothers (OR = 1.368, $p = 0.103$, 95% CI = 0.939, 1.994) were more likely to have a CS however these results were not statistically significant.

Compared to mothers who had previously had VD, those who had had previous CS were remarkably more than 11 times more likely to have a CS (OR = 11.0, $p < 0.001$, 95% CI = 9.230, 13.198). Also, mothers who had neither had a previous CS nor VD were more than twice as likely to have a CS (OR = 2.375, $p < 0.001$, 95% CI = 2.021, 2.791). There was a very strong statistical association for these results.

There was a lower odds by a factor of 0.498 of nonattendants of ANC (OR = 0.497, $p < 0.001$, 95%CI = 0.349, 708) having a CS as compared to regular attendants and this association was strongly significant. While a lower odds of having a CS was also observed for infrequent attendants of ANC, no significant association was found (OR = 0.891, $p = 0.557$, 95% CI=0.635, 1.247).

Compared to mothers who had macrosomic babies, those who had babies with LFW had higher odds by a factor of 1.228 (22.8%) of having a CS and this was statistically significant (OR = 1.228, $p < 0.05$, 95% CI = 1.009, 1.496). Also mothers who had babies with VLFW had higher odds of having a CS (OR = 1.239 $p = 0.157$, 95% CI = 0.921, 1.668) while mothers who had babies with normal fetal weight had lower odds of having a CS (OR = 0.957, *p* = 0.565, 95% CI = 0.822, 1.113). This finding was however not statistically significant.

Table 19

Multivariable Logistic Regression Analysis: Sociodemographic Factors

		95% C. I.				95% C. I.		
	Unadjusted OR	Lower	Upper	Sig.	Adjusted OR	Lower	Upper	Sig.
Maternal Age								
<17	**.267**	**.060**	**1.194**	**.084**	**.158**	**.031**	**.807**	**.027**
18-30	.542	.129	2.272	.402	.340	.071	1.624	.176
31-40	.694	.165	2.911	.618	.523	.110	2.492	.416
40-45	.770	.177	3.351	.728	.804	.163	3.967	.789
>46*	1	-	-	-	1	-	-	-
Educational Status								
Primary Level	.889	.695	1.139	.353	1.070	.797	1.436	.652
Secondary Level	**.737**	**.642**	**.846**	**.000**	**.748**	**.626**	**.894**	**.001**
Tertiary Level*	1	-	-	-	1	-	-	-
Occupational status								
Unemployed	1.142	.810	1.611	.449	1.463	.991	2.159	.055
Low Income	**1.311**	**.960**	**1.790**	**.089**	**1.645**	**1.148**	**2.358**	**.007**
Middle Income	1.437	1.033	1.998	.031	1.469	1.016	2.122	.041
High Income*	1	-	-	-	1	-	-	-

*= Reference Category
Sig= *p*-value

Table 20

Multivariable Logistic Regression Analysis: Obstetric Factors

	Unadjusted OR	95% C. I. Lower	95% C. I. Upper	Sig.	Adjusted OR	95% C. I. Lower	95% C. I. Upper	Sig.
Gestation								
Pre-Term	**1.333**	**1.003**	**1.772**	**.048**	1.334	.983	1.811	.065
Term	1.223	.934	1.602	.143	.919	.688	1.226	.564
Post-Term*	1			-	1	-	-	-
Parity								
Primipara	**1.487**	**1.079**	**2.049**	**.015**	1.368	.939	1.994	.103
Multipara	1.312	.947	1.816	.102	1.058	.735	1.525	.760
Grand Multipara	1			-	1	-	-	-
ANC Attendance								
Nonattendant	**.429**	**.312**	**.591**	**.000**	**.497**	**.349**	**.708**	**.000**
Infrequent Attendant	.793	.585	1.075	.135	.890	.635	1.247	.497
Regular Attendant*	1			-	1	-	-	-
Obstetric History								
None	**2.217**	**1.954**	**2.516**	**.000**	**2.375**	**2.021**	**2.791**	**.000**
Previous CS	**10.451**	**8.777**	**12.444**	**.000**	**11.037**	**9.230**	**13.198**	**.000**
Previous VD*	1			-	1	-	-	-
Fetal Weight								
VLFW	**1.324**	**1.013**	**1.732**	**.040**	1.239	.921	1.668	.157
LFW	1.169	.977	1.398	.088	**1.228**	**1.009**	**1.496**	**.041**
Normal Fetal Weight	.954	.833	1.094	.501	.957	.822	1.113	.565
Overweight*	1			-	1	-	-	-

*= Reference Category
Sig= *p*-value

Summary

In summary, there were higher odds of having a CS with increasing maternal age and among teenagers below 17 years ($p < 0.05$, 95% CI, 0.031, 0.807), mothers with low income ($p < 0.001$, 95% CI = 1.148, 2.358), mothers who had had previous CS ($p < 0.001$, 95% CI = 9.230, 13.198), and mothers who had babies with LFW ($p < 0.05$, 95% CI = 1.009, 1.496). A lower odds of having a CS was observed among women with secondary education ($p < 0.001$, CI = 0.626, 0.894) and ANC nonattendants ($p < 0.001$, 95% CI = 0.349, 708). No significant association was found between mode of delivery and gestational age or parity.

Section 4: Application to Professional Practice and Implications for Social Change

Introduction

The purpose of this research was to delineate the sociodemographic and obstetric factors that are associated with CS in the major referral health facility in Ghana and propose strategies and interventions that would effectively and efficiently reduce CS rates towards enhancing maternal and child health. Ultimately, in conducting the study I aimed to inform why and how interventions could be formulated to achieve optimal CS rates for positive social change. I adopted a case-control design for the quantitative investigation. The study was grounded in the STA theory; the goal was to explain how a holistic resolution to the increasing CS rates could be developed while taking into account the understanding of how integral components of the system influence the system as a whole. The RQs and hypotheses centered on whether there was any significant association between CS and sociodemographic as well as obstetric factors. In Section 3, I reported statistical findings. In Section 4, key findings are reviewed and interpreted cognizant to the study limitations. I also address the implications of the findings for positive social change and offer tailored recommendations to reduce CS rates.

The study analysis was able to describe the relationship between various sociodemographic and obstetric factors and mode of delivery. Because the likelihood of mothers to have a CS generally increased with maternal age in the referral health facility, older mothers were at greater risk of undergoing the procedure; however, mothers below 17 years were particularly more likely to have CS. With increasing maternal age, mothers were more likely to have a CS, but this was so also for very young mothers.

With respect to educational status, a U-shaped association was revealed whereby, compared to mothers with tertiary education, mothers with primary education were more likely to have a CS while mothers with secondary education were less likely to have CS; this was specifically significant for mothers who had secondary education. With respect to occupational status, the odds of having CS increased with increasing income of mothers. Compared to mothers with high income, mothers with low income were the most likely to have a CS followed by mothers with middle income. There was a statistically significant association between CS and low income as well as middle income.

Having a CS was also significantly associated with having an obstetric history. There was a palpable 11 times increase in the likelihood of a mother having a CS if she had had a previous CS, as compared to those who had had a previous VD. Mothers who had neither a previous VD nor CS had double the odds of having a CS. The regularity of attendance of ANC was associated with higher odds of having a CS. Mothers who had not attended any ANC were half as likely to have a CS as compared to those who had attended ANC four or more times, and this association had very strong statistical significance. Mothers who had babies above 3.5kg were found to be more likely to have a CS as compared to those who had babies with weight between 1.5kg and 2.5kg. No significant association was found between CS and fetal weight that was below 1.5kg or between 2.5kg and 3.5kg. Also, there was no statistically significant association found between CS and gestational age, parity, or referral.

Interpretation of the Findings

Consistent with the findings of Robson and de Costa (2017), maternal age was found to be a strong predictor of CS. Very young women and older women were most at risk of undergoing a CS in this study. Suboptimal physiological function of the genital tract and uterine musculature, as well as hormonal system, occurs with increasing maternal age. This leads to a higher likelihood of obstructed labor among older women and hence the higher risk of undergoing CS. Maternal comorbidities that result from advancing maternal age has also been noted to increase the risk of CS among older women (Rydahl et al., 2019).

Also consistent with research conducted by Neuman et al. (2014), which highlighted that CS rate was higher among mothers who had higher education, this study showed that women with secondary education were less likely to have a CS as compared to those with tertiary education. Neuman et al. noted that this group of women had a preference for CS, although why this is so was not examined. This finding was however not consistent with the results of research conducted by Apanga and Awoonor-Williams (2018), who found that women with lower educational status were rather more likely to undergo CS. This may be attributable to the likelihood of women with higher education being more informed on the complications of CS. According to Dankwah et al. (2019), women with higher education were more likely to have CS as they were in a position to better access obstetric care. This was attributed to their autonomy and capacity to take decisions about their own health and their comprehension of the importance of CS where clinically indicated. In contrast, lack of knowledge and misconceptions on CS by less educated women limit the uptake of CS. Gilbert et al. (2010) noted that higher education was associated with repeat elective CS. Among Ghanaian women, traditional beliefs, such as the necessity for women to experience labor pains to be a real mother (Aziato, 2017), and financial deprivation among women with lower education may limit their option for elective CS. Further research is necessary to corroborate this hypothesis. The disparities in the findings by the researchers may be attributed largely to sociocultural disparities (Konlan, 2019), in that, whereas socioeconomic status may not seriously affect access to facilities for CS in one geographical setting, it may be a strong influencer in another setting.

Thirty years have elapsed since the WHO first recommended an optimal CS rate of 10-15% (WHO, 2015). Researchers have noted demographic differences across the WHO member states and have attributed the strongest predictor of CS rate to maternal age (Robson & de Costa, 2017). Khan et al. (2017) set out to determine the sociodemographic predictors and annual rates of CS in Bangladesh between 2004 and 2014. Adopting a four-wave, nationally representative cross-sectional survey design, the authors highlighted formal education as a significant contributor to the increased CS rates amongst Bangladeshis and residents of other developing nations. An important reason cited in this regard was the fact that higher education had a direct bearing on the decision-making modalities and autonomy of mothers. Also, the notion of safety and less interference with career led to higher CS rates amongst mothers with higher educational status (Khan et al., 2017). Further research may be required to investigate how career influences CS rates in Ghana.

This study revealed that the higher the income of a mother, the lower the possibility of undergoing CS. This may be attributable to the ability of high-earning mothers to afford preventive and curative healthcare while pregnant, thus avoiding the preventable complications of pregnancy that may necessitate CS during delivery. This finding is consistent with research conducted by Posthumus et al. (2013), who noted that low social class and health and health care illiteracy result in an increased CS rate, along with a nonoptimal ANC attendance, inadequate treatment of pregnant women, and delayed referral to referral facilities. Lindquist et al. (2014) also asserted that poorer women potentially receive less attention in health facilities, have inadequate ANC attendance particularly in the first trimester, and have unplanned CS. The result of this study is at variance with Khan et al. (2017), who noted that the prevalence of CS rates was significantly higher among rich mothers as compared to poorer mothers. The reasons given for this included the inability for mothers with low income to afford the costs associated with undergoing an operation and the extra costs that may be associated with having a CS, which may lead to a relatively lower accessibility to the procedure.

He et al. (2016) and Moradi et al. (2019) showed that the costs and length of facility stay associated with having CS was significantly higher as compared to that associated with VD. Also, the higher tendency for mothers with higher income to be aware of their existing ailments may stimulate them and their doctors to opt for CS. Furthermore, profit-gaining intentions by health care providers and proprietors may contribute to the choice of CS by rich clients (Khan et al., 2017). Singh et al. (2017) further assented to the findings of this study in their research on the prevalence and determinants of voluntary cesarean deliveries and socioeconomic inequalities in India. They concluded that increasing maternal age, higher educated mothers, and mothers with higher socioeconomic status were among the significant determinants of high CS rates. This study also corroborated findings by Akinola et al. (2014) that mothers who had had previous CS were more likely to deliver via CS. This finding was very strong and significant. This is explained by Kietpeerakool et al. (2019), who established that mothers with previous CS were seven times more likely to have a uterine rupture during VD as compared to their counterparts without previous CS. Uterine rupture is one of the most devastating obstetric complications as it often presents fatal maternal and fetal situations. Also, mothers with previous CS were more likely to have morbidly adherent placenta, placenta praevia, near-maternal-misses, and severe maternal outcomes (Kietpeerakool et al., 2019). The authors recommended that women in these groups be counselled and prebooked at centers equipped for CS.

Akinola et al. (2014), in their study, noted that among the predictors found to influence CS rate were antepartum hemorrhage, short stature, low parity, previous history of CS, and low (1.6kg-2.5kg) or high (above 4kg) fetal weights. Akinola et al., in their appraisal of some predictors of CS in Nigeria, employed a case-control study design where cases were selected as women who had CS and controls as women who had spontaneous VD in a university teaching hospital. Their result was consistent with the finding from this study, which revealed that mothers who had babies with LFW (1.5kg-2.5kg) were more likely to have had CS. This is plausible as mothers who require CS may not have reached term gestation or may have had an underlying comorbidity that resulted in intrauterine growth restriction; it further corroborates the poor outcomes associated with a high CS rate. Apanga and Awoonor-Williams (2018) also investigated the sociodemographic and obstetric factors associated with CS in Northern Ghana using a case-control study design. In this study, 150 women who had CS were selected as cases while 300 women who had spontaneous VD were selected as controls from retrospective data obtained from hospital registries (Apanga & Awoonor-Williams, 2018). Employing bivariate and multivariate analysis, the researchers observed that the odds of having a CS was increased with fetal weights of 4kg or more (Adjusted OR = 1.21, 95% CI 1.064-1.657), referral from other facilities (Adjusted OR = 1.19, 95% CI 1.108-1.337), as well as ANC visits of four times or more (Adjusted OR= 2.99, 95% CI1.762-5.065). Also, a slight increase in odds of having CS was observed among women with gestational age of more than 40 weeks (Adjusted OR = 1.09, 95% CI 1.029-1.281). In contrast, women with gestational age less than 37 weeks (Adjusted OR = 0.20, 95% CI: 0.100-0.412), secondary or higher education (Adjusted OR = 0.55, 95% CI 0.320-0.941), and fetal weight between 1.5kg and 2.5kg (Adjusted OR = 0.17, 95% CI 0.086-0.339) had lower odds of having a CS. These results aligned with the findings of this study with regard to ANC visits, educational status, and LFW. As this discussion indicates, a case-control design was suitable and consistent with related research and my objective. This was to determine how particular key sociodemographic (maternal age, educational status, occupational status) and obstetric factors (obstetric history, parity, mode of delivery, gestational age, ANC attendance, referral status as well as fetal weight) affect the CS rates within the chosen setting.

Limitations of the Study

The study is prone to information bias because the secondary data as provided by study participants may not have necessarily been accurate. Due to the nature of the data obtained, I used reported occupations as a proxy measure to estimate the level of income of mothers. This is assumedly a good estimate of the income of mothers although there may be some inaccuracy. Also, a number of potential confounders could not be accounted for due to the unavailability of data on such variables. Such potential confounders may include underlying disease conditions such as hypertension, diabetes, clinical events (e.g., dystocia, breech presentation, fetal distress, etc.), and the healthcare worker decision-making process.

Recommendations

This study provides useful evidence that health leaders can act on to potentially reduce the rate of unnecessary CS and improve maternal and child health. It is essential to intensify education on the consequences of the choices of mothers with respect to mode of delivery. Although this is done at ANC, it may be inadequate as not all mothers frequently partake in ANC. Opiyo et al. (2019) noted that while health education is an integral part of ANC, there is the need for nonclinical educational interventions to reduce CS. Components of this health education suggested by WHO include childbirth training workshops, nurse-led applied relaxation programs, psychosocial couple-based prevention programs, as well as psychoeducation for the phobia associated with childbirth (Opiyo et al., 2019). Education should be targeted at mothers and potential mothers who are more likely to miss ANC and should be tailored and communicated such that the desired impact of messages are maximized. This will enable mothers and potential mothers to make informed choices that will be beneficial to both themselves and their children.

It is pivotal that education is also targeted at teenagers especially, so as to prevent teenage pregnancies. In recognition of this, key factors such as maternal age, educational status, and occupation, as well as geographical position, would need to be taken into critical consideration. Women must be counselled to plan their pregnancies taking note of the optimal reproductive age range so as to avoid preventable CS and reduce CS rates. Shahraki-Sanavi et al. (2014) showed that education improved model construct scores for awareness, attitude, subjective norms, behavioral intentions, and perceived behavioral control. Education and group discussions also reduced elective CS and skewed choice towards natural birth (Shahraki-Sanavi et al., 2014). Such education could be incorporated into the curricula of academic institutions and also disseminated within less privileged communities via mobile educational teams that would seek to reach geographical areas which otherwise would not have the privilege of such education. Cognizant to the STA theory in which this study was grounded, formulation and implementation of policy towards this educational approach would be invaluable in the quest to holistically reduce CS rates in Ghana and other developing countries alike.

A financial incentives program to be provided to deprived expectant mothers would also be most beneficial towards reducing unnecessary CS (Opiyo et al., 2019). Poor mothers who are identified and incentivized would then be in a position where they would be capable of affording preventive and curative healthcare thus preventing the possible complications that may necessitate CS. This would also enable optimum nutrition, acquisition of prenatal medications, access to health care, as well as health education and educational resources, all of which are essential for a healthy pregnancy and reduction of avoidable CS (Opiyo et al., 2019). Also, a waiver of medical bills for deprived expectant mothers could be instituted in health facilities so as to empower such women to take optimal care of themselves during their pregnancies and be able to have safer deliveries.

The most prominent finding in this study was the fact that having a previous CS was associated with the possibility of having another CS. In this vein, the procedure itself is a predictor of CS rate hence its reduction invariably would result in a reduction of the CS rate. To achieve this, strategies to sensitize both expectant mothers and health care providers to opt for CS only when absolutely necessary are essential. Provision of protocols in health care institutions for undertaking the surgical procedure and, mandatory healthcare provider refresher courses and workshops would be helpful in this regard (Opiyo et al., 2019; Khan et al., 2017). This would ensure the consistent stimulation of the need to avoid unnecessary CS in healthcare facilities and ultimately decrease the CS rate.

There is the need to urgently improve the data collection protocols and procedures in health facilities so that all relevant information can be easily obtained. This should enable the conduct of research that would elucidate all predictors of CS rates and inform the formulation and implementation of strategies, policies, and interventions to reduce CS rates and improve maternal and child health, and concomitantly the health of the general populace. Improving data collection procedures is of paramount significance as it offers the unique opportunity to adapt or modify interventions which target key predictors of CS rate while seeking to appropriately consider health system capacities, available resources, as well as existing national policies (Opiyo et al., 2019). Furtherance to this, research to assess the effectiveness of strategies, interventions, and policies to reduce CS rates would be invaluable to pinpointing best practises towards reducing inappropriate CS.

Implications for Professional Practice and Social Change

That the rise in CS rates is a public health menace has been categorically reiterated in this study. Public health practitioners hold the professional and ethical mandate to identify the barriers to improving health indicators and find redress to them. Identification of the sociodemographic and obstetric factors that contribute to high CS rate is an important lever in the search for effective and efficient interventions to reduce CS rate as well as improve maternal and child health, and national health indicators.

The empirical evidence harnessed by this study provides the guidance required for the development and implementation of relevant interventions that are tailored to suit the target communities. This would in turn help to successfully realize the decrease in CS rates that the public health community seek to achieve. The study also provides the basis for further research in unexplored areas that would build on existing knowledge base for continual and sustainable improvement in maternal and child health, and in the health of the general populace as a whole.

The findings and recommendations made in this study would create a positive social change when successfully implemented. In the background of the knowledge on how sociodemographic and obstetric factors relate with CS rate in the major referral facility in Ghana, which the study explored, the interventions, strategies, and policies proposed have been tailored to ensure they are effective and efficient. When successfully implemented a decrease in CS rates would be realized as the performance of unnecessary CS would decrease. A reduction in CS rates would translate to safer births with a less proportion of mothers developing the complications associated with having CS. Healthy mothers and babies across both deprived and rich communities mean the elimination of health inequalities and inequities, and the bridging of the health disparities gap that exist amongst Ghanaian communities. Ultimately, a positive social change would be realized as an improvement in maternal and child health and elimination of the inequality gap would result in a healthier population as a whole, both nationally and internationally.

Conclusion

The increasing CS rate that exists in Ghana is a public health problem and is influenced by sociodemographic and obstetric factors. Knowledge on how this influence is exerted on the option of CS as the choice of delivery, which this study explores, provides insight into how interventions can be developed and implemented to reduce CS rate. The study hypothesized that CS rate was influenced by sociodemographic as well as obstetric factors and this was explored.

This study has established that there is a higher odds of having a CS with increasing maternal age, mothers who were earning low incomes, mothers who had had previous CS, and mothers who had babies with LFW.

The study also established that there was also a lower odds of having a CS amongst mothers who had obtained secondary education and mothers who were nonattendants of ANC. There was however no significant association observed between mode of delivery and gestational age, parity or referral status.

This study has delineated the effect of sociodemographic and obstetric factors on the option of CS as a mode of delivery and has pinpointed tailored recommendations that can reduce the CS rate. Maternal and child health would improve with these recommendations implemented, and general population health would subsequently also improve. The disparities that give rise to health inequities and inequalities would be bridged in the process towards positive social change as interventions seek to provide quality, affordable and accessible maternal health care to all cognizant of the social determinants of health. Intensified and redirected health education, financial incentives program, revamping of data collection procedures, as well as strategies to sensitize mothers and healthcare providers are interventions that this study proposed to be able to curb the performance of avoidable CS and reduce CS rate. In alignment with the STA, the simultaneous incorporation of all these interventions and strategies will address the individual component issues that lead to the increasing CS rates and thus provide a holistic and sustainable solution to this public health problem. Maternal and child welfare being implicit in the health of future generations when improved will in turn improve resolution of public health issues amongst families, communities, and health care systems.

References

Akinola, O. I., Fabamwo, A. O., Tayo, A. O., Rabiu, K. A., Oshodi, Y. A., & Alokha, M. E. (2014). Cesarean section- an appraisal of some predictive factors in Lagos Nigeria. *BMC Pregnancy and Childbirth, 14*, Article 214. http://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/1471-2393-14-217

Andrade, C. (2007). Confounding. *Indian Journal of Psychology, 49*(2), 129-131. https://doi.org/10.4103/0019-5545.33263

Awoonor-Williams, J. K., Bailey, P. E., Yeji, F., Adongo, A. E., Baffoe, P., Williams, A., & Mercer, S. (2015). Conducting an audit to improve the facilitation of emergency maternal and newborn referral in Northern Ghana. *Global Public Health*, *10*(9), 1118-1133. https://doi.org/10.1080/17441692.2015.1027247

Aziato, L., Acheampong, A. K., & Umoar, K. L. (2017). Labor pain experinces and perceptions: A qualitative study among post-partum women in Ghana. *BMC Pregnancy and Birth*, *17*, Article 73. https://doi.org/10.1186/s12884-017-1248-1

Betran, A. P., Torloni, M. R., Zhang, J., Ye, J., Mikolajcyzk, R., Deneux-Thareux, C., Oladapo, O. T., Souza, J. P., Tunçalp, Ö., Vogel, J. P., & Gülmezoglu, A. M. (2015). What is the optimal rate of cesarean section at the population level? A systematic review of ecologic studies. *Journal of Reproductive Health*, *12*, Article 57. https://doi.org/10.1186/s12978-015-0043-6

Cavallaro, F. L., Cresswell, J. A., Franca, G. V. A., Victora, C. G., Barros, A. J. D., & Ronsmans, C. (2013). Trends in cesarean delivery by country and wealth quintile:

Cross-sectional surveys in southern Asia and sub-Saharan Africa. *Bulletin of World Health Organization*, 91, 914-922D. http://www.who.int/bulletin/volumes/91/12/13-117598/en/

Chu, K., Cortier, H., Maldonado, F., Mashant, T., Ford, N., & Trelles, M. (2012). Cesarean section rates and indications in sub-Saharan Africa: A multi-country study from Medicins sans Frontieres. *PLoS One*, *7*(9), Article e44484. https://doi.org/10.1371/journal.pone.0044484

Danso, K. Schwandt, H. M., Turpin, C. A., Seffah, J. D., Samba, A., & Hindin, M. J. (2009). Preference of Ghanaian women for vaginal or cesarean delivery postpartum. *Ghana Medical Journal*, *43*(1), 29-33. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2709173/

Dankwah, E., Kirychuk, S., Zeng, W., Feng, C., & Farag, M. (2019). Socioeconomic inequalities in the use of cesarean section delivery in Ghana: A cross-sectional study using nationally representative data. *International Journal for Equity in Health*, *18*, Article 162. https://doi.org/10.1186/s12939-019-1063-6

Das, V., Kumar, N., Kumari, V., |Agarwal, A., Pandey, A., & Agarwal, S. (2017). Increasing rates of cesarean section, an upcoming public health problem: An audit of cesarean section in a tertiary care center on North India based on Robson classification. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*, *6*(11), 4998-5002. http://doi.org/10.18203/2320-1770.ijrcog20175015

Edson, R. (2008). Systems thinking. Applied. A primer.

http://www.anser.org/docs/systems_thinking_applied.pdf

Fink, A. (2013). *Evidence-based public health practice*. Sage Publications.

Forrester, J. W. (1994). Systems dynamics, systems thinking, and soft OR. *System Dynamics Review 10*(2). https://onlinelibrary.wiley.com/doi/epdf/10.1002/sdr.4260100211

Frankfort-Nachmias, C., & Leon-Guerrero, A. (2015). *Social statistics for a diverse society* (7th ed.). Sage Publications.

Gething, W. P., Johnson, F. A., Frimpong-Ainguah, F., Nyarko, P., Baschieri, A., Aboagye, & Atkinson, M. P. (2012). Geographical access to care at birth in Ghana: A barrier to safe motherhood. *BMC Public Health, 12*(991). http://doi.org/10.1186/1471-2458-12-991

Gilbert, A., Benjamin, A., & Abenhaim, H. A. (2010). Does education level influence the decision to undergo elective repeat cesarean section among women with a previous cesarean section. *Journal of Obstetrics and Gynaecology Canada, 32*(10), 942-7. http://doi.org/10.1016/s1701-2163(16)34681-3.

He, Z., Cheng, Z., Wu, T., Zhou, Y., Chen, J., Fu, Q., & Feng Z. (2016). The costs and their determinants of cesarean section and vaginal delivery: An exploratory study in Chongquin municipality, China. *Biomed Research International.* http://doi.org/10.1155/2016/5685261

HealthyPeople2020. (2017). Maternal, infant, and child health. https://www.healthypeople.gov/2020/topics-objectives/topic/maternal-infant-and-child-health

Hidalgo, B., & Goodman, M. (2013). *American Journal of Public Health, 101*(3), 39-40. http://doi.org/10.2105/AJPH.2012.300897

Kambale, J. M. (2011). Social predictors of cesarean section births in Italy. *African Health Sciences*, *11*(4), 560-565. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3362978/

Kelly, A. C., Detorri, J. R, & Brodt, E. D. (2012). Assessing bias: the importance of considering confounding. *Evidence Based Spinal Care*, *3*(1), 9-12. http://doi.org/10.1055/s-0031-1298595

Khan, N., Islam, M., Sharif, A. A., Alam, M., & Rahman, M. (2017). Socio-demographic predictors and average annual rates of cesarean section in Bangladesh between 2004 to 2014. *PLOS Medicine*. https://doi.org/10.1371/journal.pone.0177579

Kietpeeracool, c., Lumbiganon, P., Laopaiboon, M., Rattanakanokchai, S., Vogel, J. P., & Gulmezoglu, M. A. (2019). Pregnancy outcomes of women with previous cesarean sections: Secondary analysis of World Health Organization of multicountry survey on maternal and newborn health. *Scientific Reports*, *9* Article 9748. https://www.nature.com/articles/s41598-019-46153-4

Larson, M. G. (2006). Descriptive statistics and graphical displays. *Circulation 4*(114), 76-81. https://doi.org/10.1161/CIRCULATIONAHA.105.584474

Lindquist, A., Kurinczuk, J. J., Redshaw, M., & Knight, M. (2014). Experiences, utilization, and outcomes of maternity care in England among women from different socioeconomic groups: Findings from the 2010 national maternity survey. *British Journal of Obstetrics and Gynecology*, *122*(12), 1610-7.

https://doi.org/ 10.1111/1471-0528.13059

Long, Q., Kempas, T., Madade, T., Klemetti, R., & Hemminki, E. (2015). Cesarean section rates in Mozambique. *BMC Pregnancy and childbirth, 15*(253). https://doi.org/10.1186/s12884-015-0686-x

Mann, J.C. (2009). Observational research methods. Research design II: Cohort, cross-sectional, and case-control studies. *Emergency Medicine*, *20*(1). http://doi.org/10.1136/emj.20.1.54

Moradi, F., Aryankhesal, A., Heidari, M., Soroush, A., & Sadr, S. R. (2019). Interventions in reducing cesarean sections in the world: A systematic review. *Malaysian Journal of Medical Sciences*, *26*(5), 21-37. http://doi.org/10.21315/mjms2019.26.5.3.

National Perinatal Epidemiology Center. (n.d.). Robson’s 10-group classification system. http://robson10gcs.ucc.ie/

Neuman, M., Glyn, A., Azad, K., Kuddus, A., Osrin, D., More, N. S., Nair, N., Tripathy, P., Sokorski, C., Saville, S., Sen, A., Colbourn, T., Houweling, T. A. J., Seward, N., Manandhar, D. S., Shrestha, B. P., Costello, A. & Prost, A. (2014). Prevalence and determinants of cesarean section in private and public health facilities in underserved South Asian communities: Cross-sectional analysis of data from Bangladesh, India, and Nepal. *BMJ Open*, *4*(12). http://dx.doi.org/10.1136/bmjopen-2014-005982

Opiyo, N., Kingdon, C., Oladapo, T. O., Souza, P., J., Vogel, P., J., Bonet, M., Bucagu, M., Portela, A., McConville, F., Downe, S., Gulmezoglu, M., A., & Betran, P., A.

(2019). Non-clinical interventions to reduce unnecessary cesarean sections: WHO recommendations. *Bulletin of the World Health Organization.* http://doi.org/10.2471/BLT.19.236729

Osei-Assibey, E. (2014). Nature and dynamics of inequalities in Ghana. *Development, 57*(3-4), 521-530. http://africainequalities.org/wp-content/uploads/2016/10/Ghana-Country-Study.pdf

Posthumus, G. A., Steegers, P. A. E, Denktas, S., & Bonsel, J. G. (2013). Women living in deprived neighborhoods receive perinatal care compared to women from population-matched non-deprived areas in The Netherlands: Anke posthumus. *European Journal of Public Health*, *23*(1). https://academic.oup.com/eurpub/article/23/suppl_1/ckt123.159/2837678

Prah, J., Kudom, A., Afrifa, A., Abdulai, M., Sirikyi, I., & Abu, E. (2017). Cesarean section in a primary health facility in Ghana: Clinical indications and feto-maternal outcomes. *Journal of Public Health in Africa*, *8*(2). https://doi.org/10.4081/jphia.2017.704

Rydahl E., Declercq, E., Mettle J., & Maimburg R. D. (2019). Cesarean section on a rise-Does advanced maternal age explain the increase? A population based register study. *PLOS One*, *14*(1). https://doi.org/10.1371/journal.pone.0210655

Samba A., & Mumuni, K. (2016). A review of cesarean sections Using the ten-group classification system (Robson classification) in the Korle-Bu teaching hospital, Accra, Ghana. *Gynaecology and Obstetrics,* 6(385). https://doi.org/10.4172/2161-0932.1000385

Schreiber-Gregaaory, D. N., & Bader, K. (2018). Logistic and linear regression assumptions: Violation recognition and control. https://www.researchgate.net/publication/341354759_Logistic_and_Linear_Regression_Assumptions_Violation_Recognition_and_Control

Shahraki-Sanavi, F., Ansari-Mogaddam, A., Faraji, S.M., & Rakhshani, F. (2014). Effective education to decrease elective cesarean section. *Journal of Pakistan Medical Association*, 64(5), 500-5. https://www.researchgate.net/publication/266571235_Effective_education_to_decrease_elective_cesarean_section

Singh S. K., Vishwakarma D., & Sharma S. K. (2019). The prevalence and determinants of voluntary cesarean deliveries and socioeconomic deliveries in India: Evidence from national family health survey (2015-2016). *Clinical Epidemiology and Global Health.* https://doi.org/10.1016/j.cegh.2019.08.018

Sinnott, S-J., Brick, A., Laytev R., Cunningham, N, & Turner, T. J. (2016). National variation in cesarean section rates: A cross-sectional study in Ireland. *PLOS ONE, 11*(6). https://doi.org/10.1371/journal.pone.0156172

Stavinello, E., Rucci, P., Lenzi, J., & Fantini, M. P. (2014). Determinants of cesarean section: a classification tree analysis. *BMC Pregnancy and childbirth, 14* Article 215. https://doi.org/10.1186/1471-2393-14-215

Thaddeus S., & Maine D. (1994). Too far to walk: maternal mortality in context. *Social Science Medical*, *38* (8). https://doi.org/10.1016/0277-9536(94)90226-7

The Classroom. (2019). Multivariate Techniques: Advantages and Disadvantages.

https://www.theclassroom.com/multivariate-techniques-advantages-disadvantages-8247893.html

Witt, W. P., Wisk, L.E, Cheng E. R., Mandell, K., Chatterjee, D., Wakeel, F., Godecker, A. L. & Zarak. D. (2014). Determinants of cesarean delivery in the US: A lifecourse approach. *Maternal and Child Health Journal*, 19, 84-93. https://doi.org/10.1007/s10995-014-1498-8

World Health Organization. (2015). Cesarean sections should only be performed when medically necessary. http://www.who.int/mediacentre/news/releases/2015/cesarean-sections/en/

Appendix A: Permission to Access Data

G-132 file

GHANA COLLEGE OF PHYSICIANS AND SURGEONS
FACULTY OF PUBLIC HEALTH

OUR REF:
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Email:

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22 NOV 2017
RIDGE – ACCRA

9th October, 2017

The Medical Director
Ridge Hospital
Ridge, Accra

Dear Sir,

INTRODUCTORY LETTER

Dr. Nana Mireku-Gyimah is a former resident of the Ghana College of Physicians and Surgeons, Public Health department, embarking on a research study entitled "Sociodemographic and Obstetric Predictors of Caesarean Section (CS) in the Ridge Hospital in Ghana". As part of this research, he is obliged to assess data from the Obstetric and Gynaecology department of the Ridge Hospital.

We would be grateful if all the necessary assistance is given him so he can successfully conduct the research.

Counting on your usual warm consideration.

Thank you,

Yours faithfully,

Dr K. O. Antwi-Agyei
Training Coordinator
Faculty of Public Health

Head of Public Health Dpt for your attention

Appendix B: Visual Basic Program to Select Cases and Controls

```
Private Sub CommandButton1 Click()

"//Get total data to be analysed
totRow = Worksheets("Sheet1").Cells(Rows.Count, 1).End(xlUp).Row

Dim nextType As String

"//Set the first Delivery method to "C/S"
nextType = "C/S"
Dim start As Integer
"//Set the starting row for C/S method of delivery
start = 1

"//Loop through all data in "Sheet 1"
For i = 1 To totRow
"//Check if method of delivery in Row I, Column 10 is "C/S"
  If Worksheets("Sheet1").Cells(i, 10).Value = nextType Then
"//Copy data in row i
Worksheets("Sheet1").Rows(i).Copy
"//Activate "Sheet 2"
Worksheets("Sheet2").Activate
"//Select Cell at position "Start, 1"
  Worksheets("Sheet2").Cells(start, 1).Select
"//Paste data copied from row i on "Sheet 1"
ActiveSheetPaste
"//Activate "Sheet 1"
  Worksheets("Sheet1").Activate
‘’//Increase Row by one
  start = start + 1
"//Check if next delivery method is "C/S'
   If nextType = "C/S" Then
"//Set Next Delivery method to "VD"
  nextType = "VD"
     Else
"//Set Next Delivery method to "C/S"
 nextType = "C/S"
     End If
     End If
"//Increase start row by 2
Next    "// End of loop

End Sub
```