INEQUITIES IN THE UTILIZATION OF OBSTETRIC CARE SERVICES IN GHANA AND ITS IMPLICATIONS FOR POLICY: EVIDENCE FROM A POPULATION-BASED STUDY

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ABSTRACT

Maternal and newborn morbidity, as well as deaths, are disproportionately high in the African region, especially in sub-Saharan Africa. The majority of newborn and maternal mortality happens either during childbirth or immediately after childbearing. Although the use of obstetric services has proven to be vital in decreasing mortality arising from pregnancy complications, only antenatal care service has received significant attention across the West Africa region. Still substantial proportions of women in sub-Saharan Africa, including Ghana, miss life-saving obstetric interventions such as labor and delivery care in health facilities, caesarean section (CS) delivery, and postnatal care (PNC) services. In many low-income countries, the high rates of non-use of obstetric services are a major impediment to attaining the sustainable development goals (SDGs) on maternal and child health. Thus, evidence-informed policy interventions need to consider the determinants of under- and non-use of obstetric services among women of childbearing age. Research exploring the usage of obstetric services in developing nations, particularly in Ghana, tended to focus on limited individual-level factors of non-utilization using facility-based studies or convenience samples. Studies done thus far offer mixed empirical findings on the utilization of obstetric services, rendering policymaking in this area difficult and without clear direction. In addition to examining individual-level factors, exploring utilization of obstetric services at a more aggregate level, for example, at the level of community, are also warranted.

The objectives of this thesis are to (1) identify the social determinants of delivery in a health facility among women in Ghana; (2) examine the association between socio-economic factors and CS delivery among reproductive aged women in Ghana; (3) to assess the population attributable risk of socio-demographic characteristics on the usage of PNC services; (4) explore

spatial patterns of non-utilization of PNC services across communities and determine community-level factors linked to PNC services in Ghana. The research has yielded the following results:

1. An increased risk for delivering outside a health institution was identified among women who had lower levels of education, low-income, who live in rural locality, have experienced childbirth, and who lack knowledge about pregnancy-related complications.
2. Wealth-associated disparities in caesarean delivery was observed in Ghana. Further, affluent and well-educated women had greater likelihood to overutilize CS delivery.
3. In the study population, a substantial proportion of PNC services use were attributable to wealthier, highly educated, urban women who were Christians or Muslims.
4. From the 2-level mixed-method model, the community a woman resides in explains part of the unobserved heterogeneity in PNC services utilization. Also, spatial patterns identified hotspots of non-utilization of postnatal care services.

The central message from this dissertation is that inequalities in the use of obstetric services exist in Ghana and measures to address the disproportionate utilization of this vital services call for targeted policies that consider both individual and community-level factors.

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LIST OF ABBREVIATIONS

AIC-Akaike's Information Criterion

ANC-Antenatal Care

AOR-Adjusted Odds Ratio

AUC-Area under the curve

BIC-Bayesian Information Criterion

CHPS-Community-based Health Planning and Services

CI-Confidence Interval

CS-Caesarean section

GDHS-Ghana Demographic and Health Survey

GPS-Global Positioning System

GSS-Ghana Statistical Service

ICC-Intraclass Correlation Coefficient

OR-Odds Ratio

PAR – Population Attributable Risk

PCA-Principal Component Analysis

QIC- Quasilikelihood Information Criterion

ROC-Receiver operating characteristics

PHC-Population and housing Census

SD-Standard deviation

SDG-Sustainable Development Goal

UOR-Unadjusted Odds Ratio

VIF-Variance Inflation Factor

VPC-Variance Partition Coefficient

WHO-World Health Organization

Chapter 1. Introduction

Unfortunately, every minute a mother dies from delivery in the world [1], and over 90% of these deaths occur in low- and middle-income countries. For mothers that are fortunate to survive childbearing, roughly 10 million of them are afflicted with pregnancy and birth-related illnesses every year [2]. These maternal health figures underscore the relevance of strategic interventions in low income countries, especially in the sub-Saharan Africa region.

While an appreciable increase in the availability of obstetric care services in some sub-Saharan African countries has been observed lately, many women still do not benefit fully from essential obstetric services. To improve the utilization of obstetric care services for underserved populations, several interventions have been proposed in some jurisdictions, but their implementation in sub-Saharan Africa has not yielded the expected results due to contextual differences [3]. The Governments of most sub-Saharan African countries are still searching for cost-effective and efficient interventions to improve obstetric care service utilization in order to reduce maternal deaths. According to the Africa Progress Panel, governmental efforts ensuring timely access and usage of obstetric care services can avert nearly 75% of maternal deaths and complications arising from pregnancy and childbearing [3].

The government of Ghana and some non-governmental organizations (NGOs) have prioritized improving coverage of obstetric care services (health facility delivery, Caesarean Section (CS) delivery, and postnatal care (PNC) [4, 5] to reduce avoidable maternal deaths. Additionally, policymakers are constantly exploring innovative and cost-effective ways to reduce maternal deaths in Ghana [5]. Nevertheless, to formulate effective policies to increase and ensure equitable use of obstetric care services, it is crucial to identify locally appropriate determinants

of obstetric care service use both at the individual and contextual level. Past studies reported that several factors are linked to obstetric care usage[6]. For instance, a study in Ghana reported that health insurance coverage alone is not enough to stimulate obstetric services use, but rather a combination with other factors [6]. Therefore, it is paramount to understand the facilitators and barriers of obstetric care services use that can be modified.

This chapter introduces the background about maternal and newborn deaths as well as utilization of obstetric services in Sub-Saharan Africa and Ghana. Besides, a conceptual framework on factors associated with obstetric services usage and relevant contextual information about Ghana were described.

1.1. Pregnancy and Birth-related deaths

There are about 289,000 maternal deaths per year [7] and approximately 2.9 million annual newborn mortalities [8] worldwide. Recent data revealed a global maternal death ratio of 211 deaths per 100,000 live births in 2017 [9] and a neonatal death ratio of 18 per 1,000 live births in 2018 [10]. Nearly two-thirds of maternal mortality occurs post-delivery [11, 12]. However, the situation is different for women living in low-and middle-income countries and those in high-income countries, with the vast majority of maternal mortality occurring in low-income countries [7, 8, 11, 12]. Specifically, compared to women in high-income countries, women in low-income countries are 300 times more probable to experience maternal death resulting from pregnancy and delivery complications [1, 2]. In addition, Rahman et al. [13] estimated that in low-income countries, close to 40% of mothers encounter health issues after childbirth while 15% experience fatal complications.

Notwithstanding the global priority to reduce maternal health risks facing women of childbearing age in low-income countries, the problem is even more pressing in sub-Saharan

Africa where one out of 36 women will experience pregnancy-related deaths in their lifetime [14]. The maternal health complication rates in sub-Saharan Africa contribute to approximately 66% of global maternal morbidities [14]. In addition, 1 in 36 newborns in sub-Saharan Africa dies within one month of birth, accounting for roughly 38% of global neonatal deaths [15]. Available statistics indicated that in sub Saharan Africa the maternal mortality ratio was 533 deaths per 100.000 live births in 2017 and the neonatal mortality ratio was 27 deaths per 1,000 live births in 2017 [9, 10], which is higher than the global mortality ratio of 211 maternal deaths per 100,000 live births [14] and the worldwide newborn deaths rate of 19 deaths per 1,000 live births [15]. Together, these maternal and neonatal deaths disproportionally affect sub-Saharan Africa region.

In Ghana, a sub-Saharan African country, despite the reduction from 484 deaths per 100,000 live births in 2000 to approximately 319 deaths per 100,000 live births [14], the maternal mortality ratio is still high when compared with the 2017 global average of 211 deaths per 100,000 live births. Comparing with sub-Saharan African average of 533 deaths per 100,000 live births in 2017 [16], Ghana has a lower maternal mortality ratio. The neonatal mortality ratio of Ghana was about 24 deaths per 1,000 live births in 2017 [17] after a reduction from 43 deaths per 1,000 live births in 2003 [18]. Ghana's neonatal death ratio is lower than the sub-Saharan Africa average of 27 deaths per 1,000 live births in 2017, yet higher relative to the global average of 18 deaths per 1,000 live births in 2017 [17].

1.2. Obstetric Care Services Utilization

Most sub-Saharan Africa countries are not on track to achieving the Sustainable Development Goal (SDG) on good health and wellbeing especially on the reduction of maternal and neonatal deaths [14] largely due to the underutilization of obstetric services [19, 20]. To

ensure the SDG goals for both maternal and child health are met and to address the disparities of maternal and newborn mortality in the sub-Saharan region including Ghana, concerted efforts are required to increase the uptake of obstetric care services [21, 22]. More importantly, adequate and continued use of essential obstetric care services is critical to ensure maternal and neonatal survival [21-24]. Obstetric services encompass different levels of care, including antenatal, health facility delivery, caesarean delivery, and postnatal care (PNC). Antenatal care (ANC) refers to the monitoring of pregnant women to detect early complications; the goal is to protect both mother and baby preemptively. Health facility delivery refers to childbirth inside of an institution under the supervision of a health professional. A caesarean (CS) delivery is an abdominal surgical intervention performed to deliver a baby [25]. Lastly, PNC is preventive care meant to identify and manage complications shortly after delivery and up until six weeks post-delivery [26].

Recent estimates indicate that almost every pregnant woman (98%) uses antenatal care service in Ghana [27], a statistic that is above both the global (87%) and sub-Saharan Africa (78%) percentage of women who had at least one ANC visit in 2019 [28]. Although other obstetric services such as health facility delivery, CS delivery and PNC services have seen a rise in the uptake, the expected continuous use of obstetric care services beyond ANC services among pregnant women remains low. For instance, delivery at a facility with skilled care in Ghana has increased from 46 percent in 2003 to 73% in 2014 [29]. This prevalence of delivery care usage is less than Ghana's ANC services (98%) in 2018 utilization [27] and the global average of institutional delivery (76.4%) in 2019 [28]. Perhaps, the use of mobile community-based ANC clinics could explain the discrepancies. On the other hand, the facility-based delivery is greater than the sub-Saharan Africa prevalence of 59.5% in 2019. Likewise, CS delivery had

increased from 7% in 2008 to 12.8% in 2014 [29], however, the CS delivery in Ghana is lower than the worldwide average of 21.1% and higher than the sub-Saharan Africa prevalence of 4.1% [30]. Also, PNC services utilization within 41 days after birth has risen from 46.4% in 2003 to 84.6% in 2014 [29] which is higher than sub-Saharan prevalence of 42.8 percent [28].

1.3. Purpose of the research work

Despite the deliberate efforts of the government to increase both economic and physical access to obstetric care services via a fee exemption policy for obstetric care, together with the establishment of health posts in remote communities, discrepancies in the usage of essential obstetric care services still exist among Ghanaian women [6, 31, 32].

Even though some studies have evaluated inequities in health facility delivery [33-36], CS delivery [37-39] and postnatal care services [23] use in Ghana, there are several issues with the existing research in Ghana. Firstly, most studies were restricted to specific geographical settings [33, 35, 40] and others were hospital-based [34], which seriously affects the generalizability of the study findings. For instance, Esena and colleagues [40] studied factors related to delivery assisted by skilled attendants in the Ga East Municipality, one of 216 districts in Ghana. The small sample size used by previous studies to examine factors that were linked to health facility delivery makes it problematic to draw inferences for policy purposes. Although Gudu and Addo (2017) used 400 Ghanaian women to ascertain factors that influence the decision to choose a place for delivery [41], once geographic and demographic characteristics are considered, the subpopulations are insufficient to draw policy conclusions. Secondly, the majority of the authors used only descriptive statistics [40, 41] or a bivariate analysis [42, 43] and only a few studies used a multivariable model [33, 36]. This makes controlling for confounding variables deficient. Most studies in Ghana assessing postnatal care service

utilization were completed at the individual level [23, 44]. Thirdly, through an extensive literature review, it is clear that there is a paucity of studies considering the influence of the community where women live on postnatal care services even though there is growing evidence that community-level factors influence health care utilization [45]. In addition, assessing spatial clustering of obstetric care services is relevant to both detect hotspots of underutilization [46] and to help guide resource allocation, which is limited in Ghana. Fourthly and most importantly, previous studies' findings varied both in magnitude and direction, perhaps due to the number and type of variables that were studied, as well as the geographical context among other reasons.

Considering the identified gaps in research as well as the high maternal and neonatal deaths in Ghana, it is crucial to comprehensively examine the socioeconomic and demographic factors driving the discrepancies in the use of obstetric care services. Investigating these characteristics will shed light on the dynamics of obstetric services use, and to guide the design of policies and programs to improve accessibility to quality obstetric services and ultimately reduce preventable infant and maternal deaths.

Therefore, using the Andersen theoretical framework, this research work explored the socioeconomic and demographic factors that contributed to the underuse and lack of usage of health facility delivery, CS delivery, and PNC services in Ghana.

The chapters of the dissertation articulate four manuscripts examining different aspects of obstetric care utilization in Ghana. The second chapter will explore social determinants of delivering at a health facility in Ghana. Chapter three will examine the socio-economic inequalities in cesarean CS delivery. The fourth chapter will determine the sociodemographic disparities in the utilization of PNC services. Chapter five will explore spatial autocorrelation of non-utilization of PNC services and identify community-level characteristics influencing the use

of PNC services in Ghana. Chapter six summarizes the findings, deriving implications useful for Ghana and other developing countries.

1.4. Theoretical Framework: Andersen's Behavioral Model

Several theoretical frameworks and health behavior models including Andersen's health behavior, health belief model, young's choice-making model, and proximate determinants framework have attempted to better understand the factors influencing use or non- use of healthcare services. The Health Belief Model [47] posits that an individual's health-care utilization choice is dependent on the perceived risk of becoming ill, severity of illness, perceived balance of benefits against costs of treatment, and source of information on treatment of illness. Young's choice-making model [48] proposes that an individual's decision making around health care use is influenced by perceived severity of illness, awareness of alternative treatment such as home remedy, belief in efficacy of treatment regime, and access to the services. Moreover, Proximate Determinants framework combines both individual's indirect determinants such as socioeconomic status and proximate (intermediate) determinants [49]. Although, these models are useful in explaining individual health-care utilization decisions, Andersen's behavioral model is the only model, which explicitly includes community resources and the health care system as variables influencing health care seeking decisions.

This study used Andersen's model to guide the selection of potential variables influencing the use of obstetric care services. The model has evolved over time starting as a framework in the United States of America used to assess health care utilization at the individual-level [50] and subsequently, modified to become a behavioral health model encompassing the influence of individual-level, extrinsic and health care system characteristics

on health services usage [50, 51]. Later, this model has prominently been used to evaluate health care utilization, especially in developing countries [23, 52-54].

Starting with individual-level characteristics, Andersen's model broadly classified these characteristics into predisposing, enabling and need factors. Based on this theoretical perspective, predisposing factors represent an individual's pre-existing characteristics that can facilitate or impede health care use.

Enabling factors represent the wherewithal to seek health care services among predisposed individuals and those in need of care. Generally, enabling factors influence both economic and geographical access to care at the individual level.

Notwithstanding the powerful force that predisposing and enabling characteristics exert on the utilization of health services, need factors remain at the foundation of health care utilization. Need factors can either be evaluative or perceived. The evaluative need for health care is borne out of clinical assessment by skilled professionals while a perceived need is based on personal or self-evaluation, determined either from the perception of health status or the belief about the efficacy of health care [51].

Based on Andersen's theory, the community where an individual resides plays an important role as well because it tends to alter health perception and practices, which may eventually influence health utilization behavior.

Moreover, according to Andersen's model, health system factors also influence the decision of an individual to seek healthcare. Organizational, structural, and quality of care variables all influence the decision to seek health services, including distance to a health facility, travel time to seek care, transportation, and travel costs; all used in previous research as proxies for health system factors [50, 51].

Despite the comprehensive nature of Andersen's health behavioral model and the series of modifications it has experienced, the model does have limitations. For instance, the model fails to directly measure the effect of culture on access to health care. Yet, the model is informative and useful to guide this research.

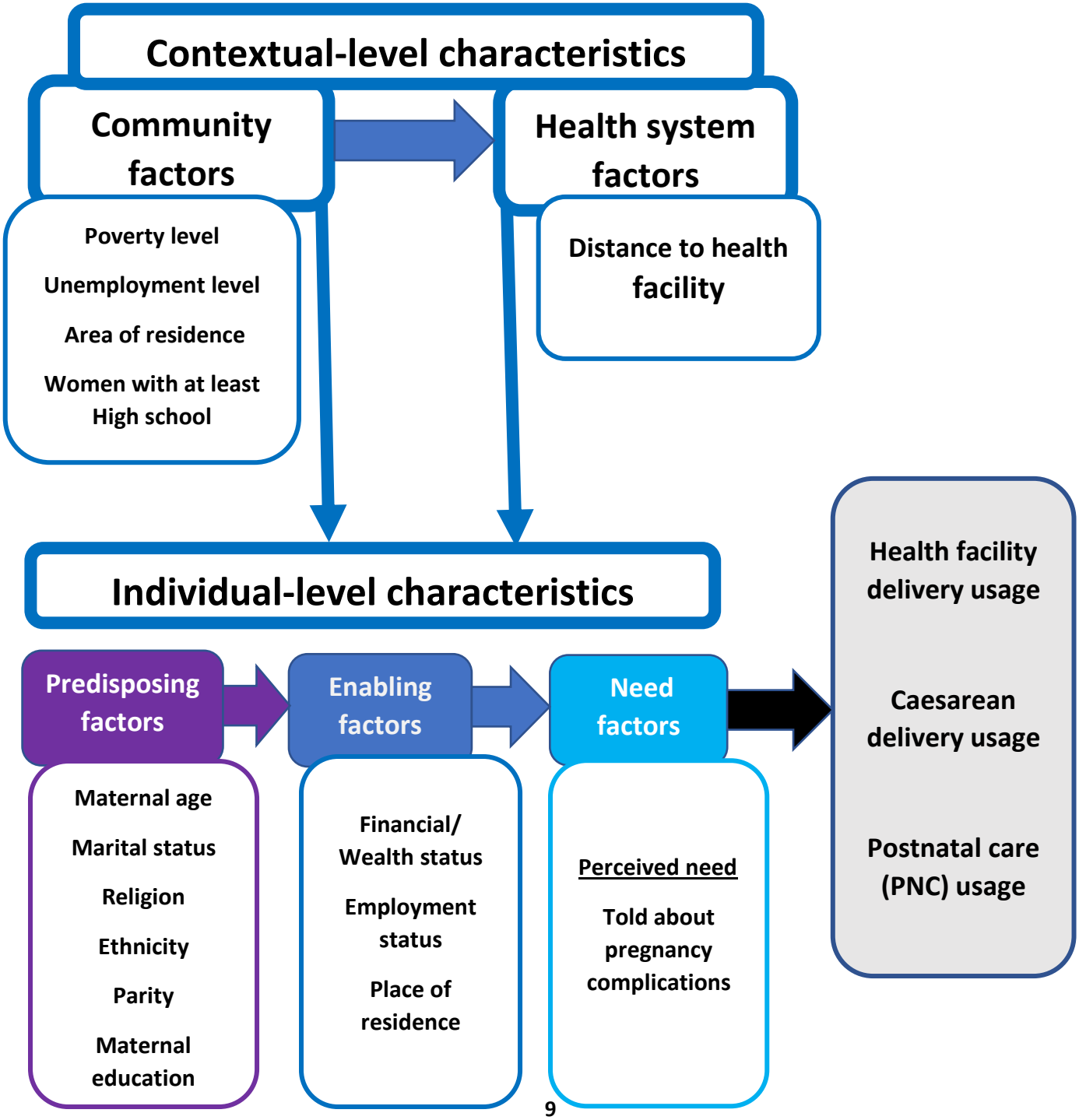

Figure 1-1. Conceptual framework for obstetric care services utilization adapted from Andersen's health behavioural model [50]

1.5. Review of determinants of Obstetric Services Utilization

This research adopts and modifies Andersen's behavioral health model as depicted in Figure 1-1. Andersen's health care utilization model was used in organizing literature review of the determinants of obstetric care services usage. Both contextual and individual-level socioeconomic and demographic factors explaining the use of obstetric services are discussed.

1.5.1. Contextual-level Factors of Obstetric Services Utilization

The community-level and health system-level factors were believed to have an effect on the use of obstetric care services. A review of the findings of previous studies have been highlighted.

1.5.1.1. *Community-level factors*

Community-level factors have been demonstrated in earlier studies to influence obstetric care services utilization. However, a study by Darega et al [55] stated that employment status has no strong relationship with health facility delivery. Other studies have found a significant association between health facility delivery and area of residence [56-58], concentration of women with higher education [56-59] and community's poverty level [21, 60].

Also, a study in Bangladesh found that health facility delivery was concentrated among communities with high wealthier households (OR=1.15, 95% CI 1.03 to 1.28), and educated women (OR=1.25, 95%CI 1.07 to 1.34) [58].

The impact of community-level characteristics on CS delivery has been established in developing countries [61]. Yaya et al [6] indicated that neighborhood socio-economic status; which was generated from education level, rural, unemployment rate, and poverty level of the neighborhood; had significant effects on CS delivery in public health care.

Moreover, some researchers have disaggregated community-level socioeconomic status to test the differential effect of factors including community poverty level, education level among others on PNC use [62, 63]. Although Mohan et al [62] and Jacobs et al [63] identified significant unobserved community-level variance of 0.47 and 0.43 respectively, the community poverty level, education level and type of residence were not significantly associated with PNC services usage.

1.5.1.2. *Health System-level factors*

Past studies have linked the utilization of obstetric services to health system-level factors especially distance to a health facility [64, 65]. Some researchers reported the strong effect of distance to a health facility in a community on health facility delivery [64]. Similarly, other investigators found the association between PNC services usage and distance to a health facility to be significant [65]. The Somefun and Ibisomi (2016) study in Nigeria identified that women who had major problems with distance to nearest health facility had 0.83 times lower likelihood of using PNC services than those without a big problem concerning distance to nearest health facility [65]. However, a review of earlier studies shows that insignificant association between the use of obstetric care services and distance to a health facility has been discerned. The Anwar et al., (2008) study revealed that the likelihood of having CS delivery was not significantly different between women with distance to hospital of 5 or more kilometers and women who

reside less than 5 kilometers from the hospital [66]. Finally, some authors reported that the effect of distance to a health facility on PNC services were not significant [62, 66-68].

1.5.2. Individual-level Factors of Obstetric Services Utilization

As depicted in Figure 1-1, maternal age, ethnicity, marital status, parity, religious affiliation, and maternal education were used as predisposing factors alongside enabling factors (wealth/financial status, place of residence and employment status) and need factor (told about pregnancy complication) in this current study as individual-level characteristics to investigate the utilization of obstetric care services.

1.5.2.1. *Health Facility Delivery*

This section summarized the results that were discerned concerning associations between health facility and some sociodemographic factors including age, marital status, religion, ethnicity, parity, number of living children, education, place of residence, employment status, wealth and perceived need characteristics.

Age

Associations between health facility delivery and age have been tested [35, 36, 42, 69-72]. For instance, a study by Speizer et al [72] found that health facility delivery among women between the ages of 25 and 34 years was not significantly different from women who were below 25 years. Likewise, no significant difference in delivery at a health facility was detected between women aged 35-49 years and those less than 25 years [72]. However, Chubike and Constance (2013) found a significant association between maternal age and health facility delivery [73].

This conflicting finding may be due to different geographical context: Speizer et al [72] focused on only Ghana's central and northern districts while Chubike and Constance [73] studied urban Abakaliki in Nigeria, but did not control for confounding variables.

Marital status

Studies have investigated the link between marital status and health facility delivery [36, 69, 70]. For example, Enuameh et al [36] reported no strong difference in health facility delivery among women who were cohabiting, divorced or separated or widowed and never married when compared with married women. On the other hand, marital status have shown a predictive effect on health facility delivery in earlier studies done in developing countries [74, 75]. In the case of a study conducted in Tanzania, married women had lower likelihood of having a supervised delivery in a health facility when compared to single women (OR=0.41, 95% C.I.: 0.25–0.66). This variation in results may be because of the larger sample size used by Enuameh et al [36] as well as the cultural diversity between Ghana and Tanzania.

Religion

Various articles examined the influence of religion on health facility delivery [35, 36, 69-72]. Some found no significant association between religion and health facility delivery [36, 71, 76] whereas others have found a strong association between health facility delivery and religion [35, 69, 70]. Boah et al [35] reported that Muslim women were more likely to have health facility deliveries than traditional believers. The study of Speizer, Story and Singh (2014) revealed that women who were traditional believers or had no religion or belong to other minority religions had a lower likelihood of delivering at a health facility than Christian women [72]. Perhaps,

these discrepancies in the findings reported by the authors could be due to the differences in sample size, study design, geographical and cultural contexts.

Ethnicity

Concerning the influence of ethnicity on health facility delivery, some of the authors reported no significant association between health facility delivery and ethnicity [35, 36, 70-72]. Among the studies that found a significant association between ethnicity and health facility delivery, Adu et al [69] revealed that women from the northern background were more likely to use health facility for delivery relative to Akans. Similarly, another study found that the odds of giving birth at a health facility were greater among Mole–Dagbani and Mande women than Akans [42]. Conversely, Gurma women had lower propensity of having health facility delivery [42]. The incoherent findings from these studies, may be due to the differences in the criteria for the selection of study participants. While many studies used nationwide data of women of childbearing age [42, 69], some researchers studied only women from just two out of the ten regions of Ghana [72].

Parity

Several earlier studies assessed the effect of parity on health facility delivery [35, 36, 42, 69, 70, 72], documenting that the parity of the women had no significant effect on health facility delivery [36, 70]. Others found a negative association between parity and health facility delivery [35, 42, 69, 72]. According to a study by Dickson et al [42], women who have four or more birthing experiences were less likely to have health facility delivery compared to those with less than 4 births. Similarly, Adu et al., (2018) found that women with 3 to 5 births and 6 or more births were less likely to have health facility delivery relative to women with births lower than 3

[69]. These varied results may be attributed to the sample size, geographical as well as cultural differences. Therefore, to minimize contextual effects, Boah et al [35] studied only 423 women in a district in northern Ghana with predominantly common cultural practices.

Maternal education

Regarding education, many studies presented the impact of education on health facility delivery [35, 36, 42, 69-72]. The researchers reported mixed findings. On one side, an insignificant association between education and health facility delivery was reported [35, 36, 70], on the other side some studies indicated a significant association between maternal education and health facility delivery [42, 69, 71, 72]. Speizer et al [72] estimated that the likelihood of delivering at a health facility were higher among women who had primary and at least secondary education than women without formal education. Similarly, Dickson, Adde and Amu (2016) found that odds of having health facility delivery among primary and secondary educated women in rural Ghana were 30% and 84% greater than uneducated women [42]. Further, some studies revealed that the effect of a partner's education on health facility delivery was significant [42, 71]. Dickson et al [42] reported that a woman with a partner who had primary, secondary and higher education were more probable to give birth at a health facility than those with no formal education. But Dickson et al [42] failed to control confounding variables such as wealth status, and employment status that has the potential to influence the association.

Financial/Wealth status

Most studies conducted in other developing countries [77-79] reported that wealth status is a key determinant driving the choice of the place to deliver a baby. Most studies explained the effect of wealth or financial status on health facility delivery in terms of the indirect costs

associated with birthing at a health facility especially in the context where facility delivery is a public good [80-82]. Some authors indicated that transportation cost can cause a delay in seeking a health facility for delivery [83] and even birthing outside a health facility [81, 84]. Perhaps, the extra cost associated with the purchase of delivery products such as detergents, diapers, sanitary pads, bed sheets, and many others at the health facility further pushes poorer mothers away from having facility-based delivery as expressed in a similar study [85]. Also, studies in India reported that the main factor in women's decision to have health facility delivery is affordability [86]; wealthier women tend to have the autonomy to freely make an informed choice about the place to give birth [87].

Employment status

Previous researchers have investigated the influence of employment status on health facility delivery [35, 69, 71, 72]. However, the authors reported varied results. The disparities in findings could be attributed to smaller size [35], and limited geographical coverage [72]. No strong associations between employment status and health facility delivery were reported [69, 71]. Conversely, some studies stated a strong association between employment status and health facility delivery [35, 72]. Speizer et al, (2014) revealed that the probability of delivering at a health facility was greater among women who were farmers and self-employed than unemployed women (OR=0.73, 95%CI: 0.56-0.96), after adjusting for confounding variables [72].

Place of residence

Prior studies assessed the effect of residing place of women on health facility delivery [69-71]. The Adu et al. (2018) study detected a significant association between place of residence and health facility delivery revealing that the odds of having health facility delivery

among rural dwellers were lower than urban women (OR=0.51, 95%CI: 0.17-0.85) [69]. However, other studies reported no strong association between health facility delivery and place of residence [70, 71].

Knowledge of pregnancy complications

According to the Mpembeni et al., (2008) study conducted in Tanzania, a significant association was established between knowledge of pregnancy complications and delivering in a health facility under the supervision of skilled health professional [74]. This study reported that after adjusting for confounding variables, the odds of delivering in a facility with skilled attendants was about 3 (OR=2.95, 95% Confidence interval (CI): 1.65-5.25) times higher among women with moderate knowledge of pregnancy risk factors than those with no knowledge on pregnancy risk factors [74]. The review of the studies conducted in Ghana found that none examined the effect of knowledge of pregnancy complications on the use of health facility delivery.

1.5.2.2. *Caesarean Section Delivery*

There are many studies that have investigated the effect of women's socio-economic characteristics on CS delivery [38, 66, 88, 89]. Evidence from past studies have been summarized based on the factors such as age, marital status, religion, ethnicity, parity, number of living children, maternal education, wealth status, employment status and place of residence.

Age

Previous studies have examined the role of maternal age on uptake of CS delivery [38, 88, 89]. Some studies reported that age influences CS delivery [38, 89]. Khawaja et al [89]

intimidated that older women aged 20-29 years, 30-39 years and > 40 years were 1.50 times, 1.83 times and 3.75 times respectively more likely to have CS delivery than younger women (below 20 years). However, studies in Ghana [88] and India [90] found no significant association between age and CS delivery. The incoherence in results could partially be ascribed to the fact that some of the studies were hospital-based and sample size were smaller [88, 90].

Marital status

Despite the importance of marital status of women on CS delivery reported in other countries [91, 92], an insignificant association was reported by Manyeh (2018) in Ghana [38]. The conflicting findings could be attributed to the fact that Fairley et al [91] conducted their study in Scotland, a developed country which has a different demographic and cultural setting. On the other side, the Manyeh et al [38] carried out their investigation in only Greater Accra region of Ghana.

Religion

The effect of religion on CS delivery have been published in some developing countries [66, 93, 94]. A study in India found that Christian women had lower likelihoods of having CS delivery than Hindu women [93] whereas another study discovered that Bangladeshi women who belong to other religious group relative to Muslims were more likely to have CS delivery (OR=2.05, 95%CI: 1.22–3.43) [66]. There is no clear direction and magnitude of the effect of religion on CS delivery. On top of that, no study has been done in Ghana to ascertain the influence of women's religious affiliation on CS delivery.

Ethnicity

Regarding the association between ethnicity and CS delivery, some studies have been carried out [95, 96]. A study conducted in the United States reported a significant association between ethnicity and CS delivery [96]. A similar study that was conducted in India revealed that Turks were less likely to have delivery by CS than Persians (OR=0.77, 95%CI: 0.60- 0.99) [95]. Nonetheless, extensive literature search finds that no study in Ghana has investigated the association between ethnicity and CS delivery.

Parity

The influence of parity on caesarean delivery been reported in earlier studies [38, 88, 89, 95]. Many of the studies indicated that parity of women was significantly associated with CS delivery [38, 95, 97, 98]. For instance, Yassin and Saida (2012) ~~a study~~ revealed that women who have given birth thrice or more were more likely to have CS delivery relative to women with two or less birthing experience (OR=2.0, 95%CI: 1.6-2.4) [98]. However, other studies found no significant association between parity and caesarean delivery [88, 89]. The demographic distribution and geographical difference of the study locations as well as the use of smaller sample size, and the hospital-based nature of some of the studies could explain the discrepancies in the findings.

Education

The association between education and caesarean delivery has been examined [38, 88, 93]. Apanga and Awoonor-Williams (2018) reported that women who attained secondary or higher were less likely to have a caesarean delivery than those with primary or no education [88]. On the other hand, Manyeh et al., (2018) found that women who had primary, junior high and at

least senior high education were more likely to have caesarean delivery than uneducated women [38]. Also, no strong association between CS delivery and women's education was found by other studies [89, 90]. The contrasting findings could be attributed to differences in the study design. As an example, Apanga and Awoonor-Williams [88]employed case-control study design while Manyeh et al [38] used cross-sectional study design. Some of the studies were hospital-based [90] whilst others used smaller sample sizes [88, 90].

Wealth status

Though the negative association between wealth status and CS delivery has been reported elsewhere [99], others have indicated a positive effect of wealth status on CS delivery [93, 100-102]. The Manyeh et al., (2018) study found that women who were poorer, middle-class, richer and richest had higher likelihood of having CS delivery than poorest women [38]. Perhaps this may be attributed to the ancillary costs linked to seeking CS delivery as stated in similar studies [103, 104]. These studies indicated that indirect costs such as unapproved fees, income loss from inability to work, travel and transportation costs, prevent vulnerable groups from accessing this surgical procedure [103, 104]. The concentrated CS delivery among women with lower financial restrictions could be explained by the perception of CS delivery being a safer choice for delivery [105, 106] and therefore increasing maternal requests [107].

Employment status

Though some studies have been done to decipher the association between employment status and CS delivery [93-95, 98, 99], the findings were incoherence. Some studies reported significant effect of women's employment status on CS delivery [90-92]. Conversely, insignificant associations between employment status and CS delivery were reported in similar

studies [38, 93-95, 98]. Variation in study design and smaller sample sizes may have influence the disparities in the study findings.

Place of residence

Research into the impact of place of residence on the utilization of CS delivery has been well-documented in other low- and lower-middle-income countries [90, 93, 97-99] but no study in Ghana has examined this association. The existing studies in other countries reported conflicting results. Some researchers identified association between place of residence and CS delivery [97-99]. The Long et al., (2015) study in Mozambique indicated that urban women were 4.45 times more likely to have CS birth than rural women [97]. Other studies found the association between CS delivery and place of residence not significant [90, 93]. The varied results could be as a result of the hospital-based nature of the studies, smaller sample sizes, and the limitation of the data analysis to only univariate as shown in a study in India [90].

1.5.2.3. *Postnatal Care Utilization*

The effect of socio-economic and demographic determinants on PNC services use have been previously been investigated [62, 63, 65]. Some of the findings from the earlier studies are presented according to the study factors.

Age

Studies on the influence of maternal age on PNC use have been published [108, 109] but they reported mixed findings. While a study reported a significant influence of maternal age on PNC usage [109], other studies indicated that there was no significant effect of maternal age on PNC use [12, 62, 63, 108]. These varied findings can be attributed to the study type, sample size,

and geographical differences. For instance, Jacobs et al [63] studied 551 mothers in 4 rural districts of Zambia whereas the study by Dhaher et al [12] was conducted in three Palestinian clinics and 264 postpartum mothers were used.

Marital Status

Most previous studies that investigated the effect of marital status on PNC services utilization [108-110], indicated that no strong association exists. The Jacobs (2017) study in Zambia reported no strong difference in the utilization of PNC services between married and unmarried women [63].

Religion

Researchers have attempted to link religion affiliation of women to the use of PNC services especially in low- and lower-middle-income countries [65, 66, 108, 109]. The Anwar et al., (2008) study conducted in Bangladesh found no strong association in the use of PNC services between other religious group and Muslim women (OR=0.87, 95%CI:0.57- 1.33) [66]. Although this finding is consistent with similar studies in Ghana, those studies utilized smaller sample sizes with smaller geographical range [69, 108, 109]. On the other hand, a study that was carried out in Nigeria found that Christians as well as traditional and other believers were more likely to use PNC services than Muslim women [111]. Due to the mixed findings, population-based studies that employ large sample sizes are warranted in Ghana in the near future.

Ethnicity

Considering the impact of ethnicity on PNC services usage, investigations have been conducted [69, 111]. Adu et al., (2018) reported that Ghanaian women who belong to the

northern tribe were 1.93 (95%CI:1.6- 2.25) times more likely to use PNC than Akans [69]. Likewise, Ononokpono et al., (2014) established the association between ethnicity and the use of PNC services in Nigeria [111]. These findings contrast the report by Dhakal et al [112] that ethnicity is not significantly associated with PNC services use in Nepal. The discrepancies could be as result of the cultural and geographical contexts of the studies. Also, the smaller sample size of 150 women that was used in the Nepalese study because of the 41% non-response rate may have affected the results [112].

Parity

Parity of women have been noted in prior studies to have an impact on the use of PNC services [65]. Research conducted in Nigeria by Somefun and Ibisomi (2016) revealed that mothers with 3 or more births were more likely to use PNC services when compared with their counterparts with less than 3 births [65]. Conversely, other studies indicated that the effect of parity on PNC services usage were not significant [62, 69]. The inconsistent findings could be due to sample selection since Mohan et al [62] studied only women from rural Tanzania.

Place of residence

The place of residence of women was found by Agho et al.,(2016) to have significant impact on the use of PNC services; specifically, rural dwellers were 69% more likely to avoid PNC services relative to urban women (OR=1.69, 95%CI: 1.40-2.06) [113]. Conversely, several researchers also indicated that place of residence were not significantly associated with PNC services usage [62, 65, 69]. The variations in the findings may be due to the differences in health care systems, geographical settings and sample size.

Employment status

The influence of employment status on PNC services utilization has been assessed by some studies [108, 110, 113]. Agho et al.,(2016) estimated that women in Nigeria who were working had lower likelihood of not using PNC services than women who were not working (OR=0.84, 95%CI: 0.76-0.92) [113] whereas other studies reported that employment status and use of PNC services were not significantly associated [108, 110]. For instance, the study by Nuamah et al [108]used a smaller sample size concentrated in only one district of Ghana, which may have contributed to the varied findings.

Education

Earlier researchers analyzed the association between PNC use and education [69, 108, 109]. Their findings were inconsistent, some studies revealed no strong effect of education on PNC services use [108, 109] whilst Adu et al., (2018) reported a significant association [69]. To illustrate, Mohan et al., (2015) [62] found that primary or higher educated women had higher likelihoods of using PNC services when compared with lower educated women (OR=1.37, 95%CI: 1.04-1.81); Dhakal et al., (2007) however, found no significant association was identified between use of PNC services and women's education [112]. Unfortunately, the Mohan et al., (2015) study was prone to selection bias due to the high non-response rate (41%) and used smaller sample size of 150 women [62].

Wealth status

Regarding women's wealth status, the association between PNC utilization and wealth status has been examined in earlier studies [62, 69, 108, 109]. The analyses from some of the

studies showed that the wealth status of women and PNC usage were not strongly associated [69, 109]. Conversely, studies by Mohan et al., (2015) [62, 108] and Nuamah et al., (2019) [62, 108] found that women with the highest wealth status had a greater likelihood of using postnatal care than their counterparts with the lowest wealth status. The difference in the study findings could partly be attributed to the variation in geographical coverage and sample size of the studies.

1.6. Context of the Research

This research was carried out in Ghana, a British colony that gained independence on March 6, 1957, and subsequently became a republic on July 1, 1960. The Republic of Ghana is situated on the coast of the Gulf of Guinea at the center of West Africa with three neighboring countries: Togo, Côte d'Ivoire, Burkina Faso (Figure 1-2). The overall land cover of Ghana is 238,537 square kilometers which can be demarcated into 3 ecological zones, namely: coastal, middle and savannah [29]. Accra is the administrative capital, which is in Greater Accra, one of the 10 administrative regions of the country: Western, Central, Volta, Eastern, Ashanti, Brong Ahafo, Northern, Upper East and Upper West (Figure 1-2). Based on decentralization, the regions are sub-divided into 216 metropolitan/municipal/ districts [114].

The country has a population of 30.42 million from a projected 2010 census figure [115], and a population density of 103 persons per square kilometer in 2010 [114]. Ghana is a multi-ethnic country with Akans constituting nearly half (48%) of the population [114]. Concerning geographical location, 50% of the populace inhabit three regions (Greater Accra, Ashanti, Eastern), while the Upper East region has the least number of residents [114]. Also, about 51% of Ghanaian residents are living in urban areas.

Figure 1-2 Map showing Administrative Regions of Ghana [29]

The Ghanaian economy is diversified, with a mix of agriculture, service and industrial sectors, and recently commercialized oil production [116]. Surprisingly, the agriculture sector, contributes least to the gross domestic product [117], employs about 45% of the workforce [118]. Typical of lower-middle-income countries, there is inequality in wealth status in Ghana with the coexistence of people in extreme poverty with those who are very rich. To reduce Ghana's poverty levels , in 2007 the government introduced the Livelihood Empowerment Against Poverty (LEAP) program [29].

Also, the educational system of the country has received enormous investment; notable ones include the introduction of free education for public basic schools (primary and junior high school) [119] and more recently the removal of school fees for senior high school education in

2017 [120]. For tertiary education, there are public and private universities, colleges of education, colleges of nursing, and many others. Moreover, the literacy rate among youth (15-24 years) in Ghana is about 85% [114].

According to the 2010 Ghana population and housing census (GSS 2012), no substantial population differences exist between males and females (95.2 males per 100 females). Like most countries, the life expectancy rate for males (60 years) is lower than females (63 years), with a national goal to increase overall life expectancy to 70 years no later than 2020 [121]. Ghana has a low contraceptive usage rate of 26.7% and a high adolescent birth rate of 76.3 births per 1,000 girls, contributing to a fertility rate of 4. The national goal is to reduce the fertility rate to 3 by the year 2020; the government intends to achieve this target by increasing contraceptive usage rates to 50% [121]. Roughly 40% of the Ghanaian population is under 15 years of age.

1.7. Obstetric Care Interventions in Ghana

To ensure quality maternal health care is equitable, accessible and available, the government of Ghana initiated several interventions spanning from disease control programs, sanitation projects to reproductive health policies. For instance, the water, sanitation, and hygiene (WASH) project in Ghana was initiated to increase access to improved sanitation and drinking water sources [118]. But the two prominent policy interventions implemented are the Community-Based Health Planning and Services (CHPS) and the maternal care fee exemption policy. Studies have linked these policy changes to an increase in the uptake of obstetric care services since their implementation [29, 122].

The CHPS program was implemented country-wide in 1999 after a successful pilot project in 1994 [123]. The program aims to help deliver universal primary health care through

the provision of services at the community-level especially at rural, remote and hard -to-reach areas [124]. The strategy of the CHPS is to promote task shifting by training community health officers and the selection of volunteers from the communities to run health posts. These personnel are tasked with delivering basic essential medical care to the community and refer complicated conditions for further medical attention. In 2016, the government of Ghana showed continuous commitment to ensuring universal primary health care coverage by the revision of the national CHPS policy to facilitate its implementation [125].

The National Health Insurance Scheme (NHIS) and the fee exemption policy for maternal care were operationalized to ensure financial accessibility [2]. Ghana abolished the out-of-pocket payment popularly referred to as "cash and carry system" literally meaning pay before you receive healthcare services [126] with the introduction of NHIS in September 2003. The full-scale implementation of the policy was carried out in April 2005 [127]. The NHIS is funded from taxes, social security contributions and international partners [122]. The free maternal health care policy was initiated in 2008 with the aim of exempting pregnant women from paying fees when accessing maternity. The free maternal care policy covers antenatal care and pregnancy-related care, delivery care including caesarean section, postnatal care for both mother and baby and even support care for babies with special needs such as preterm, low birth weight, birthed by HIV infected mothers, and many more [128]. In addition to specialized care, newborns receive umbilical cord care, assessment for growth restriction, screening, and management of anemia [129]. The postnatal benefit package for mothers includes provisions for iron and folic acid supplement, screening, and management of medical conditions, counseling on healthy feeding practice, early detection of danger signs for babies such as feeding problems, as

well as reproductive options such as contraception usage, and spacing of births among others [128].

1.8. Ethical considerations

This thesis used the 2014 Ghana Demographic and Health Survey (GDHS) dataset. Ethical approval was granted for the 2014 GDHS by both the Ethics Boards of the ICF International and Ghana Health Service. For this research, permission to use the anonymized publicly available secondary data was obtained from Measure DHS. Survey participants were anonymous in the study and so additional ethics approval was not required. Exemption from ethics review was granted by the Ethics Review Board of the University of Saskatchewan.

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Chapter 2 explores the socioeconomic and demographic factors contributing to the inequalities in the usage of health facility delivery. **Chapter 2** addresses the research gaps identified in **chapter 1** by employing conditional regression model to adjust for the impacts of confounding and interactions, an attempt to address some methodological limitations of earlier studies in Ghana.

Chapter 2 has been published in BMC Reproductive Health **"Dankwah, E.**, Zeng, W., Feng, C., Kirychuk, S., & Farag, M. (2019). The social determinants of health facility delivery in Ghana. Reproductive health, 16(1), 101. doi: 10.1186/s12978-019-0753-2" (Journal Impact Factor: 2.29). In **chapter 2**, I conceptualized, reviewed the literature, cleaned and analyzed the data, interpreted the findings and wrote the chapter.

Chapter 2. The Social Determinants of Health Facility Delivery Among Reproductive Aged Women in Ghana

2.1. INTRODUCTION

Every year, there are over 200 million conceptions [1]. However, about forty-percent of these conceptions result in pregnancy-related problems among women around the world [1]. Childbirths in health facilities have been recognized as one of the best strategies to avoid maternal mortalities and morbidities and to improve the health of newborns [2-4]. Despite this recognition, a significant percentage of childbirths occur outside health facilities in low-income countries [3, 5]. One of the tragic consequences of this underutilization is the 830 maternal deaths that occur each day because of pregnancy and labour-related complications [6]. If this consequence is not tragic enough, delivery outside a health facility also has ramifications for infants. Delivery outside of health facilities contributed to annual neonatal mortalities of 3 million [7] and 2.65 million stillbirths globally in 2008 [8]. Further, home delivery is linked with increased risk of third stage delivery issues including retained placenta, postpartum haemorrhage [9].

Ghana has a population of about 28 million and a population density of 124. Females account for about fifty-one percent of the population with an estimated total fertility rate of 4 [6]. According to the Ghana Demographic and Health Survey report [10], inhabitants reside almost equally in urban and rural areas. In Ghana, health facilities administer health care through maternity homes, Community-based Health Planning and Services (CHPS) health post, public, private and mission hospitals. The distribution of health care facilities is skewed in favour of urban areas.

Maternal deaths continue to be unjustifiably high, though the number of deaths has almost been halved from 634 per 100,000 live births in 1990 to 319 per 100,000 live births in 2015 [6]. This reduction is thought to be the result of the introduction of free maternal care policy, antenatal care (ANC) services and increased institutional deliveries [11-13]. However, even though most pregnant Ghanaian women seem to use ANC services, a large percentage of deliveries still take place outside a health facility. This trend is supported by data collected in the 2008 Ghana Demographic and Health Survey (GDHS): 95 percent of pregnant women reported utilizing ANC services from skilled personnel, including medical doctors, midwives, and nurses. Nonetheless, only 59% delivered at a health facility in the presence of a health professional in 2008 [14]. The Government of Ghana has introduced initiatives such as free maternal health care services, Community-based Health Planning and Services (CHPS), and improved antenatal care and education in an effort to improve access to health facility delivery; these initiatives have been successful in increasing the use of health facility delivery but it remains inequitably distributed [15, 16]. According to a 2011 survey, 37 percent of childbirths occurred at health facility in Northern Ghana, and 52.7 percent of deliveries occurred at health facility in rural Ghana [17]. Both of these percentages were well below the national health facility delivery rate of 67.4 percent in 2011 [17]. Thus, more efforts are needed to ensure equitable access to this potentially life-saving service.

Understanding the determinants of health facility delivery is important for targeting policies and interventions. A body of literature has found that socioeconomic and demographic dynamics affect women's choice of birthplace [18-27], however, inconsistency about how these factors influence women's decisions remains a major concern. In Ghana, some studies have investigated the effect of sociodemographic characteristics on health facility delivery [18, 23, 28,

29]. Notwithstanding, these studies were not exhaustive, and highlight the need for further research. For example, none of the studies considered the effect of 'need' on the use of health facilities as a place for delivery. Also, previous studies did not use nationwide data making it inaccurate to generalize findings to the entire population. The present study aims to examine socio-demographic determinants influencing the use of health facility delivery among Ghanaian women of reproductive age.

2.2. METHODS

2.2.1. *Study Data*

The 2014 Ghana Demographic and Health Survey (GDHS) dataset was used in this study after permission from the MEASURE DHS. The 2014 GDHS was carried out by the Ghana Statistical Service (GSS) in collaboration with Inner City Fund (ICF) International and Ghana Health Service (GHS). The survey used two-stage systematic sampling to select participants from households nested in clusters (enumeration areas) across all the 10 regions of Ghana. The survey interviewed 9,396 women aged 15-49 years with a response rate of 97% [10]. Women's information including socio-demographic characteristics and reproductive health records were collected. Detailed information on the sampling techniques and the questionnaires have been reported elsewhere [10].

2.2.2. *A conceptual framework for health facility delivery*

This research adopted and modified the Andersen's healthcare utilization model to study obstetric services use (place of delivery). Andersen's model considers three types of factors as

drivers of health services use: predisposing, enabling and need factors [30-32]. First, predisposing factors refer to characteristics that exert influence prior to the occurrence of the given health behavior, by encouraging or inhibiting the uptake of health facility delivery in this case. Predisposing characteristics include all characteristics that might condition an individual's perceptions of need and use of health facility delivery. These predisposing factors can take the form of demographic factors (age, ethnicity), reproductive history (parity), cultural beliefs (religion), civil status (marital status), and social structure/factors (education) among other factors [31, 32]. Second, enabling factors are related to the resources that facilitate or impede the utilization of health services which include financial status, employment status, resources in the community and other factors[31, 32]. Third, Andersen's model proposes that "Need" for care is important for influencing behavior [31]. Andersen's model was used as a framework to guide selection of potential factors associated with health facility delivery. The explanatory predictors considered in the study were grouped into predisposing factors (age, marital status, religion, ethnicity, parity, maternal education), enabling factors (financial status, employment status and place of residence) and perceived need as shown in Figure 2-1. Ethnic groups are representative of the regions in Ghana. To prevent multicollinearity issues in the analysis of the data, ethnicity was studied in lieu of region of residence. Since this dataset does not include a variable representing actual medical need for health facility delivery, the variable 'told about pregnancy complications' was used as a proxy for perceived need for health facility delivery; the choice of this variable as a proxy for need is based on another study that used a similar variable [33].

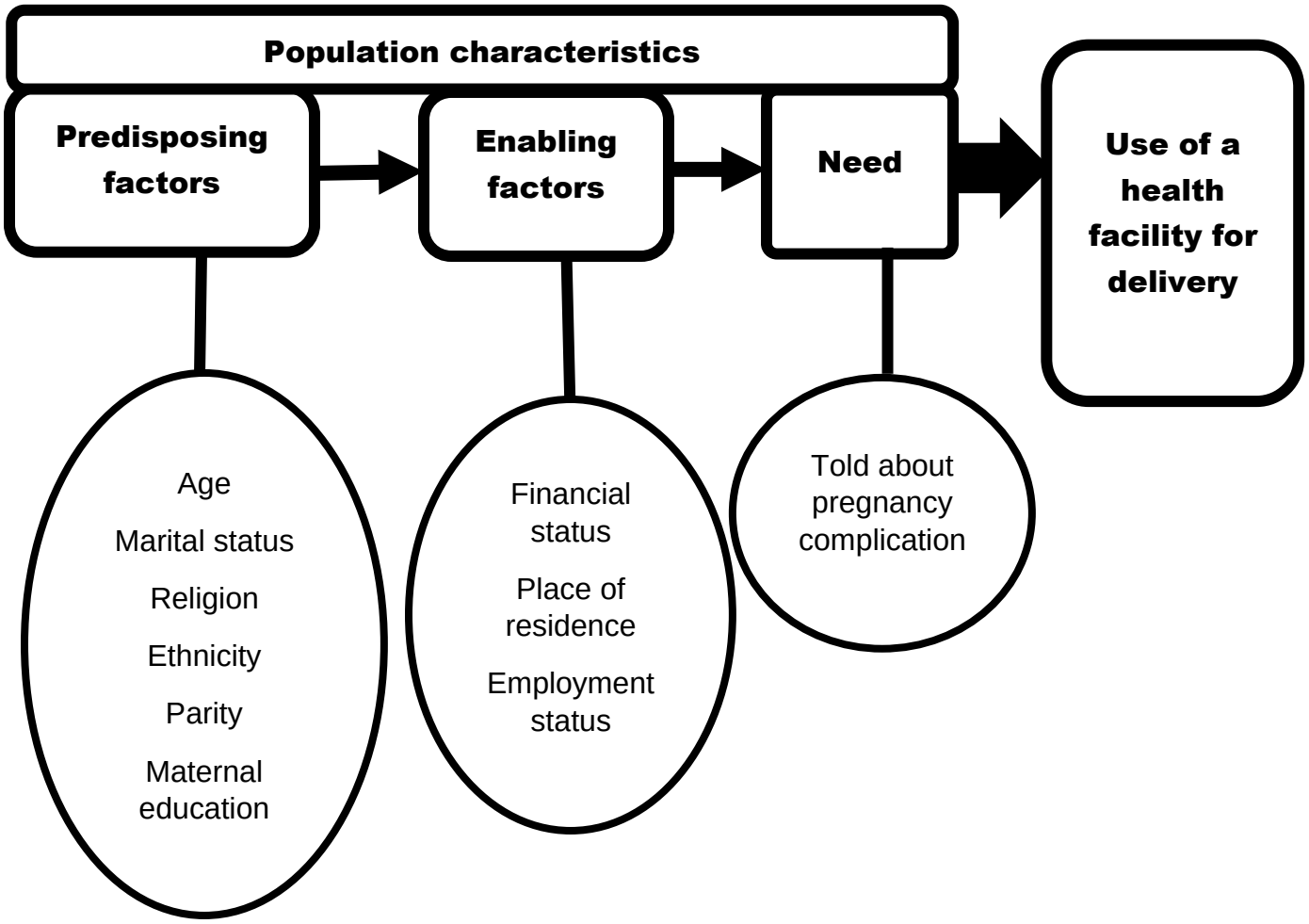

Figure 2-1: Theoretical framework adapted from Andersen's health utilization model for health facility delivery

2.2.3. *Study variables*

The study sample included 4,293 women of reproductive age (15 to 49 years) who responded to the question asking about place of delivery. Birth outside a health facility hereinafter was referred to as home delivery. The outcome variables were coded as follows: health facility delivery = '1' and, home delivery = '0'. Ten explanatory variables were used: (1) maternal age, (2) marital status, (3) religion, (4) ethnicity(5) parity, (6) place of residence, (7)

education, (8) financial status, (9) employment status and (10) having been told about pregnancy complications.

Maternal age violated the linearity assumption when a quadratic term was imposed (p-value = 0.001) and hence was categorized. As shown in Table 2-1, explanatory variables were categorized based on an extensive review of empirical literature [18, 23, 25, 26], and were grouped as follows: (1) Maternal age was classified as 15-24 years, 25-34 years, and 35-49 years; (2) marital status (married, unmarried); (3) religion (Christian, Islam, Traditional and Others); ethnicity (Akan, Northern tribes, Ewe, Ga and other); (5) parity (1 birth, 2 births, 3 births or more); (6) place of residence (urban, rural); (7) Education was classified into no education, primary (grade 1-6), at least secondary (above grade 6); (8) The Financial status variable was created from the Wealth index variable that was available in GDHS dataset. The GDHS generated the Wealth index based on information on household assets using principal component analysis (PCA). The Wealth index variable was comprised of 5 categories namely poorest, poorer, middle, richer and richest. The Financial status variable used in this study is comprised of 3 categories: poor (poorer, poorest), middle, and rich (richer, richest) as reported in similar studies[25, 34]; (9) employment status (not working and working); and (10) told about pregnancy complications (yes, no).

Table 2-1. Study Variable description

Variable name	Description	Level of measurement
Place of delivery	Respondents place of delivery	Categorized, 0= Home delivery, 1= Health facility
Age	Maternal age (years)	Categorized, 1= 15 to 24, 2= 25 to 34, 3 = 35 to 49
Marital status	Current marital status	Categorized, 0 = Unmarried, 1 = Married
Religion	Religious affiliation of the women	Categorized, 1 =Christians, 2= Islam, 3 = Traditional/other
Ethnicity	Women ethnic group	Categorized, 1= Akan, 2= Northern tribes, 3= Ewe, 4 =Ga, 5 = other
Parity	Birth history	Categorized, 1= 1 birth, 2 = 2 births, 3 = 3 or more births
Residence	Place of residence	Categorized, 1 = Urban, 2 = Rural
Education	Highest educational level	Categorized, 1 = No Education, 2 = Primary, 3 = at least Secondary
Financial status	Financial status of the household	Categorized, 1 = Poor, 2 = Middle, 3 = Rich
Employment status	Whether working or not	Categorized, 1= Not working, 2= Working
Pregnancy complications	Told about pregnancy complications	Categorized, No = 0, Yes = 1

2.2.4. *Statistical Analyses*

The present study used sampling weights provided by GDHS. The weighting factor from the survey was used to address sampling error and non-response to ensure the validity of the findings. All analyses were conducted in SAS version 9.4 (SAS Institute, Cary, NC, USA). Proportions and frequencies were tabulated for each of the categorical independent variables. The effect of the risk factors on health facility delivery was fitted using a logit mode.

Equation 2-1: Logistic Regression Model for Health facility delivery

$$p\,(Yi = 1) = pi$$

$$\text{logit}\,(pi) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots + \beta_k X_{ki}$$

where pi is the probability of health facility delivery among i th women; β_0 is the intercept; β_k is the regression parameters; Xi is the independent variable; Yi is the outcome of interest.

This study employed the Taylor series linearization method, which is a variance estimation procedure used by PROC SURVEYLOGISTIC in SAS, to adjust for the clustering effect. Univariable logistic regression models were used to screen independent variables for further analysis. In the unadjusted model, risk factors with a liberal of p-value ≤ 0.25 were selected for inclusion in the multivariable logistic regression model based on the Hosmer and Lemeshow publication [35]. This lenient p-value cut-off was used to prevent missing important factors whose effect could be suppressed or concealed by confounding effects. Multicollinearity among select explanatory variables for the adjusted model was checked to ensure independent contribution of the study factors can be separate out, so that unstable regression coefficients estimates are avoided [36]. A variance inflation factor (VIF) > 2.5 and tolerance < 0.4 were used as a cut-off in this study as proposed by Johnston et al [36] to be able take of collinearity in a

model with difficulty of drawing causal inference such as logistic regression from cross-sectional studies. A multivariate logistic regression model was fitted to examine the link between health facility delivery and explanatory factors. The manual backward elimination technique was employed for model building in this research [37]. First, all factors that were selected for the adjusted model were included. Factors with the highest p-values and widest 95% confidence intervals were selected for elimination from the model one at a time until all the predictors in the model were significant at p-value ≤0.05. The odds ratios and corresponding 95% confidence intervals were computed for all the significant variables in the adjusted model. Confounding was assessed and greater than 20% change in the parameter estimate (beta coefficient) was the upper limit [37]. Two-way interactions among significant factors in the adjusted model were tested [37]. Also, the model with the smallest Akaike's Information Criterion (AIC) was selected as a parsimonious model. Further, the area under the Receiver Operating Characteristic (ROC) was used for model diagnostics to assess the discriminatory power of the model on the study outcome. Finally, regression model specification link test was done to detect model specification errors and Hosmer-Lemeshow goodness of fit test was conducted [35, 38, 39].

2.3. RESULTS

Descriptive Results

In this research, 4,293 women within the ages of 15 and 49 years birthed within five years prior to the 2014 GDHS and responded to the place of delivery question (Table 2-2). The study population average age was 29.7 years (SD=9.71). About 72% of women reported health facility delivery, while 28% used home delivery.

Age. Almost half (47.6%) of the women fell between the ages of 25-34 years. About one-third (31%) of the women's ages ranged between 35-49 years, while roughly 1 in 5 (21%) were between 15-24 years. Across these age groups, similar trends were observed. About three-quarters (73.9%) of the women aged 15-24 years delivered at a health facility. Likewise, 73 percent and 70.3 percent reported having health facility delivery among 25-34 and 35-49-year-olds, respectively (Table 2-2).

Marital Status. The majority (61.7%) of the women were married. Out of married women, health facility deliveries accounted for 72.7%. Similarly, 71.8% of unmarried women reported having health facility delivery (Table 2-2).

Religion. Most of the women (71.0%) were Christians. The second largest religious group was Muslim (21.4%), followed by traditional and other beliefs (7.6%). Health facility delivery trends were alike among Christian and Muslim women, but there was a marked difference among women with traditional and other beliefs. The study found that about three-quarters of Christians (76.2%) and Muslims (72.8%) reported having had health facility delivery. Also, a much smaller percentage (35.5%) of women with traditional and other beliefs had a delivery at a health facility (Table 2-2).

Ethnicity. Akan and northern tribes constituted close to 80% of the women. Ewes were 11.1% while Ga women and women from other minority ethnic groups accounted for 4.6% and 4.2% respectively. Apart from women who declared the northern tribe, all the ethnic groups had health facility delivery more than 70 percent.

Parity. More than half (56.9%) of the women had given birth at least 3 times whilst 22.8% of the women had given birth once, and 20.3% had given birth twice. Among first time mothers, 84.6% delivered at a health facility. Also, 78.3% of women who had given birth twice

used health facility for deliveries. Lastly, among mothers with three or more children, 65.9% of deliveries took place at a health facility (Table 2-2).

Residence. More than half (53.8%) of the women lived in rural areas. Among these rural dwellers, about two-thirds (60%) used health facility for delivery whereas approximately 9 in 10 (89.8%) urban dwellers delivered at a health facility (Table 2-2).

Education. Over a half (54.3%) of the women had attained at least secondary education. About a quarter (26.1%) of the women had no formal education, and nearly one-fifth (19.6%) had attained primary education. Regarding health facility delivery, more than half (54%) of the women with no education reported having had a delivery at a health facility. For women with primary and at least secondary education, health facility delivery was 69.3% and 86.7% respectively (Table 2-2).

Financial Status. The **"**poor" category included about 41.3% of the population while the "middle" income group included about 20%, and more than one-third (38.7%) of the women were in the "rich" group. Concerning the use of health facility delivery, roughly three-fifths (57.4%) of the poor women reported having had health facility delivery. Among middle-class and rich women, 78% and 95.6% births respectively occurred at a health facility (Table 2-2).

Employment status. Approximately 4 out of 5 (79.4%) women were working. For health facility delivery, 75% of women who did not work and 71% of those that were working birthed at a health facility (Table 2-2).

Perceived need. Women who were informed about pregnancy complications had health facility delivery higher than their counterparts who were not aware of pregnancy complications (75.3% vs. 68.5%).

Table 2-2. Distribution of health facility delivery across sociodemographic predictors (N=4293)

Study predictors	**N (%)**	**Health facility delivery N= 3107(%)**
Age		
15-24	922 (21.4)	681 (73.9)
25-34	2026 (47.6)	1480 (73.0)
35-49	1345 (31.0)	946 (70.3)
Marital Status		
Married	2801 (61.7)	2035 (72.7)
Unmarried	1492 (38.3)	1072 (71.8)
Religion		
Christian	3047 (71.0)	2321 (76.2)
Muslim	922 (21.4)	671 (72.8)
Traditional/other	324 (7.6)	115 (35.5)
Ethnicity		
Akan	1,642 (38.3)	1,305 (79.5)
Northern tribes	1,796 (41.8)	1,156 (64.3)
Ewe	476 (11.1)	359 (75.4)
Ga	198 (4.6)	158 (79.8)
Other	180 (4.2)	128 (71.1)
Parity of the women		
1 birth	934 (22.8)	790 (84.6)

2 births	839 (20.3)	657 (78.3)
3 or more births	2520 (56.9)	1660 (65.9)
Place of Residence		
Urban	1777 (46.2)	1595 (89.8)
Rural	2516 (53.8)	1512 (60.0)
Education		
No Education	1419 (26.1)	766 (54.0)
Primary	869 (19.6)	602 (69.3)
Secondary and above	2005 (54.3)	1739 (86.7)
Financial status		
Poor	2241 (41.3)	1287 (57.4)
Middle	812 (20.0)	634 (78.0)
Rich	1240 (38.7)	1186 (95.6)
Employment status^		
Not working	885 (20.6)	668 (75.5)
Working	3,405 (79.4)	2,436 (71.5)
Perceived need (Told about pregnancy complications) ϕ		
Yes	3,423 (82.5)	2,579 (75.3)
No	724 (17.5)	496 (68.5)

N, number of observations; %, percent; SD, standard deviation; ϕ N=4,147, ^N= 4290, due to missing observations; 2014 GDHS data

Univariable Analysis Results

The associations between select social determinants and health facility delivery were tested (Table 2-3). Unadjusted analyses revealed the following associations:

Age. The study found a weak association between the age of a woman and health facility delivery. The univariable analysis produced point estimates a little over one for women aged 25-34 years (Unadjusted OR (UOR)=1.09; 95%CI= 0.91-1.30) and those aged 35-49 years (UOR=1.03; 95%CI= 0.81-1.31) relative to women aged 15-24 years. Additionally, the overall p-value (0.6) was greater than 0.25 and hence was not selected for the multivariable logistic regression model (Table 2-3).

Marital Status. The relationship between marital status and health facility delivery in this study was not significant (UOR= 1.05; 95%CI=0.85-1.28). Further, p-value (0.7) higher than 0.25 was identified. In view of that, marital status was not considered for further analysis in the adjusted model (Table 2-3).

Religion. Muslims and Christians were 4.20 (95%CI = 2.43–7.26) times and 5.85 (95%CI = 3.79–9.0) times respectively, more likely to deliver at health facility as compared to traditional and other believers (Table 2-3).

Ethnicity. Except for women from other minority ethnic groups that had no significant difference in health facility delivery when compared to women of northern descents (UOR=1.67; 95%CI: 0.98-2.83). Akans (UOR=2.61; 95%CI:1.85-3.71), Ewes (UOR=2.14; 95%CI:1.29-3.51) and Ga women (UOR=2.80; 95%CI:1.59-4.94) had a greater likelihood of birthing at a health facility than northern women (Table 2-3).

Parity. The higher the number of times a woman give birth, the less likely to resort to health facility delivery in subsequent births. The results revealed that women who had given

birth twice were 1.73 (95%CI = 1.35-2.21) times more likely to deliver at health facility than mothers with three or more births. First-time mothers were 2.77 (95%CI = 2.19-3.50) times more likely to have health facility delivery than women who had given birth three or more times (Table 2-3).

Residence. Women living in urban areas were 6.71 (95%CI = 4.76-9.44) times more likely to deliver at health facility than rural residents (Table 2-3).

Education. Compared to women with no education, secondary or higher educated women 5.92 (95%CI = 4.43-7.90) times more likely to deliver at health facility. Women with primary education were 1.89 (95%CI = 1.40-2.55) times more likely to report having health facility delivery than women with no education (Table 2-3).

Financial Status. The odds of having health facility delivery among rich women were about 18.55 (95%CI=12.54-27.44) times when compared to the poor. Moreover, middle class women were 2.69 (95%CI = 2.03-3.59) times more likely to deliver at health facility than poor women (Table 2-3).

Employment status. As demonstrated in Table 2-3, no significant difference was detected between women who were working and those who were not working (UOR= 0.88; 95%CI=0.69-1.13).

Perceived need. From Table 2-3, women who were aware of pregnancy complications had a higher likelihood of using health facility for delivery relative to women who were not informed about pregnancy complications (UOR =1.65; 95%CI=1.29-2.11).

Table 2-3. Unadjusted Odds ratio and 95% Confidence interval of having health facility delivery by sociodemographic risk factors in the bivariate logistic regression analyses

Predictors	UOR (95% Confidence Interval)	P-value
Age (Ref: 15-24)		
25-34	1.09 (0.91, 1.30)	0.6
35-49	1.03 (0.81, 1.31)	
Marital status (Ref: Unmarried)		
Married	1.05 (0.85, 1.28)	0.7
Religion (Ref: Traditional/other)		
Muslim	4.20 (2.43, 7.26)	<0.0001
Christian	5.85 (3.79, 9.0)	
Ethnicity (Ref: Northern tribes)		
Akan	2.61 (1.85,3.71)	<0.0001
Ewe	2.14 (1.29, 3.51)	
Ga	2.80 (1.59, 4.94)	
Other	1.67(0.98, 2.83)	
Parity of the women (Ref: 3 or more births)		
1 birth	2.77 (2.19, 3.50)	<0.0001
2 births	1.73 (1.35, 2.21)	
Residence (Ref: Rural)		
Urban	6.71 (4.76, 9.44)	<0.0001
Highest Education Level (Ref: No education)		
Primary	1.89 (1.40, 2.55)	<0.0001
Secondary and above	5.92 (4.43, 7.90)	
Financial status (Ref: Poor)		

Middle	2.69 (2.03, 3.59)	<0.0001
Rich	18.55 (12.54, 27.44)	
Employment status (Ref: Not working)		
Working	0.88 (0.69, 1.13)	0.33
Told about pregnancy complications (Ref: No)		
Yes	1.65 (1.29, 2.11)	<0.0001

Ref, reference; %, percent; UOR, Unadjusted odds ratio; 2014 GDHS data

Multivariable Analysis Results

Women's age, marital status, and employment status were study variables with a p-value above 2.5 in the unadjusted model were not considered as a candidate in the multivariable model and so they were not assessed for multicollinearity.

As shown in Table 2-4, mean VIF of 1.38 suggests a global stability among the study variables and hence collinearity was dispelled. Also, all the study predictors had VIF less than 2.5 and tolerance more than 0.4.

Table 2-4. Results of the multicollinearity test

Study Predictors	**VIF**	**Tolerance**
Religion	1.16	0.86
Ethnicity	1.03	0.97
Parity	1.11	0.90
Place of residence	1.75	0.57
Education	1.50	0.67
Financial status	2.07	0.48
Told about pregnancy complication	1.01	0.98
Mean VIF	1.38	

VIF, variance inflation factor

Moreover, the influence of ethnicity in the unconditional model was diminished in the adjusted model. Women's ethnicity did not have significant association with health facility delivery as shown in Table 2-5.

The final model with only significant predictors was selected as a parsimonious model because of lower AIC (3877.8) when compared to the empty model (AIC=5062.5). The receiver operating characteristic (ROC) curve displayed in Figure 2-2 and the area under ROC curve of 0.78 (95%CI=0.76, 0.79) from the final model shows a better model fit. Furthermore, the results from the link test infer that the model have greater explanatory power and is specified correctly (p-value=0.44). Also, the insignificant p-value of 0.3978 from the Hosmer-Lemeshow goodness of fit test indicates the model is appropriate for the data.

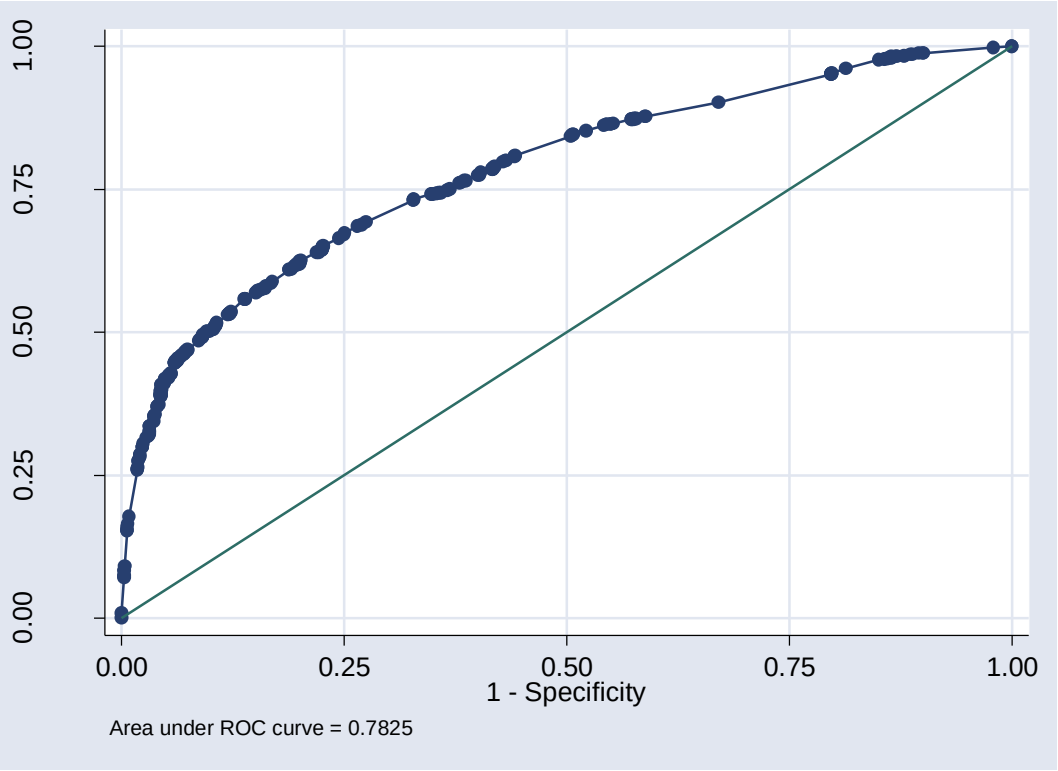

Figure 2-2. The receiver operating characteristic (ROC) curve of the final model

In this study, no confounding and significant interaction term was identified. Table 2-5 present the significant factors associated with health facility delivery in the multivariable logistic regression analysis.

Religion. The likelihood of health facility delivery among Christians was 2.53 (95%CI=1.67-3.84) times higher than traditional and other believers. Likewise, Muslims were 2.75 (95%CI=1.61- 4.69) times more likely to deliver at a health facility than traditional and other believers (Table 2-5).

Parity. Odds of having health facility delivery among women who had given birth once were 1.58 (95%CI = 1.18-2.12) times higher than mothers with 3 or more births. Conversely, no significant difference was detected between women who had given birth twice and those with three or more childbirth experience (Adjusted Odds ratio (AOR) =1.07; 95%CI=0.82-1.39) (Table 2-5).

Residence. Women living in urban areas were 2.21 (95%CI = 1.53-3.19) times more likely to use health facilities for delivery than their rural counterparts (Table 2-5).

Education. Women who attained at least secondary education were 2.04 (95%CI = 1.57-2.64) times more likely to deliver at a health facility than uneducated women. Likewise, women who had a primary education were 1.39 (95% CI = 1.02-1.92) times more likely to have health facility delivery relative to those without education (Table 2-5).

Financial Status. The odds of having health facility delivery were 6.91 (95%CI= 4.12-11.59) times higher among the rich than poor women. Compared to poor women, middle-level women were 1.57 (95%CI= 1.18-2.08) times more likely to deliver at a health facility (Table 2-5).

Perceived need. The analysis revealed that women who were aware of pregnancy complications were 1.32 (95%CI: 1.02-1.70) times more likely to deliver at a health facility when compared with women who were not informed about pregnancy-related issues (Table 2-5).

Table 2-5. Adjusted Odds ratio and 95% Confidence interval of having health facility delivery by sociodemographic risk factors in the multivariable logistic regression analyses

Predictors	AOR (95% Confidence Interval)	P-value
Religion (Ref: Traditional/Other religion)		
Muslim	2.75 (1.61, 4.69)	<0.0001*
Christian	2.53 (1.67, 3.84)	<0.0001*
Ethnicity (Ref: Northern tribes)		
Akan	0.96 (0.68, 1.35)	0.82
Ewe	1.01 (0.59, 1.74)	0.96
Ga	1.00 (0.63, 1.61)	0.96
Other	0.82 (0.47, 1.40)	0.46
Parity of the women (Ref: 3 or more births)		
1 birth	1.58 (1.18, 2.12)	0.002 *
2 births	1.07 (0.82, 1.39)	0.6
Residence (Ref: Rural)		
Urban	2.21 (1.53, 3.19)	<0.0001*
Highest Education Level (Ref: No education)		
Primary	1.39 (1.02, 1.92)	0.04*
Secondary and above	2.04 (1.57, 2.64)	<0.0001*
Financial status (Ref: Poor)		
Middle	1.57 (1.18, 2.08)	0.002*
Rich	6.91 (4.12, 11.59)	<0.0001*

Told about pregnancy complications (Ref: No)		
Yes	1.32 (1.02, 1.70)	0.03*

Ref, reference; %, percent; AOR, Adjusted odds ratio; *significant at p-value of 0.05; 2014 GDHS data

2.4. DISCUSSION

Home delivery, especially without skilled supervision, is a major concern not only in Ghana but also in other developing countries including Kenya [27] and India [26]. Even after the introduction of CHPS and the implementation of a health policy that granted free access to maternal health care, a significant proportion of Ghanaian women still deliver at home. Our study revealed that about 72% of childbirths in Ghana occur at health facilities. Though, this percentage is an improvement from the 61.9% health facility delivery rate reported by Boah et al [28], yet it is unacceptably low if the goal is to achieve universal coverage in terms of health facility delivery.

In Ghana, there are several factors that ultimately influence women's decisions about the place of their birth. However, the findings of the data analyses revealed that women's age was not strongly associated with health facility delivery. This study finding agrees with a similar study in Ghana [40]. With respect to marital status, a Ghanaian study supported this research that insignificant association exist between marital status and health facility delivery [41]. Furthermore, Dickson et al [42] contradicted this research finding that the effect of ethnicity on health facility delivery was not significant. But the study focussed on only rural Ghana.

Based on the results of our study, factors that may be important for women's decision-making about the place of their delivery include place of residence, education, financial status, religion, parity, and perceived need. Recognition of a host of factors that have the potential to be

predictive of women's decision-making reflects the need to take a public health approach that emphasizes the social determinants of health when examining health facility deliveries. A social determinants approach recognizes that health extends far beyond the medical model. Using a social determinants' lens to improve health facility deliveries has the potential to transform Ghanaian women's birthing experiences, health outcomes, and their children's wellbeing. However, the relevance of each of our study's factors must be assessed in light of the literature.

Residence. Place of residence tends to influence the choice women make about place of delivery [43]. In our study, only about half of births among women living in rural areas occurred at a health facility, and this is consistent with statistics reported by Ghana Health Service [44]. Women living in urban areas were more likely to deliver at a health facility than rural dwellers in the multivariate regression model controlling for other important factors. These findings are consistent with the results reported in other African countries, including Ethiopia [45], Nigeria [46], and Kenya [24]. The disparity between rural and urban women may be a consequence of the physical location of health facilities. That is, more maternal health facilities are located in urban areas, meaning that those facilities are more accessible to the women that live there. Urban women do not face the same barriers to physical access that rural women do; poor roads and the remoteness of some communities mean that health facility delivery may not be a viable option for some rural women. Further, the proximity of health facilities in urban areas means there is a more concrete network between various health services, and urban women may be able to receive referrals and make use of multidisciplinary teams to a greater extent than rural women. Given the strong association between place of residence and home delivery, efforts directed at improving rural health services in Ghana may be warranted.

Education. A woman's choice regarding where she delivers her child and her education level are closely linked [27]. Upon holding everything else constant, as the level of education increased, the likelihood of health facility delivery increased. This finding is consistent with other studies [19, 23, 34, 47, 48]. This trend is thought to be a function of improved health literacy among educated women. That is, educated women are better able to understand and become informed about health care issues. As a result, their health care decisions reflect this awareness [49]. This finding indicates that creating public health programming that targets women with lower levels of education may be an effective way to increase the number of health facility deliveries.

Financial Status. In our study, the poorer the woman, the less likely it is that she delivers at a health facility. This trend is mirrored in studies conducted in Kenya [27, 49], Ghana [25], and Nigeria [48]. Given that Ghana's maternal health care is free, our results suggest that, aside from the cost of health services, other economic factors influence women's decision-making when it comes to the choice of delivery place. This nuanced interpretation draws a crucial distinction between the Ghanaian context and other jurisdictions and must be explored. This interpretation is affirmed in some literature, where a women's inability to purchase maternal health services was not the sole reason for opting to deliver outside of a health facility [24]. Other contributing factors may include: the cost of transportation, time spent traveling, and miscellaneous fees associated with receiving care in health facilities [50, 51]. This broad interpretation of the costs associated with health facility deliveries is crucial for gaining a deeper understanding of how financial status influences women's decisions to resort to home delivery.

Religion. Women who were Christians or Muslims were more likely to deliver at a health facility than those who had traditional and other beliefs. This result is supported by other

research conducted in Ghana [18], but contrary to the results from a research study conducted in Uganda [19]. Given the differences in socio-demographics between Uganda and Ghana, the discrepancy may be a function of the different religious make-ups. The reason why women with traditional and other beliefs are less likely to deliver at health facilities may be because of their opposition to modern health services. These women may perceive pregnancy and labour as natural occurrences that should be free of medical intervention, except in the case of an emergency [5, 52]. Considering that religion is highly personal, public health interventions aimed at connecting these women with maternal health services must be developed with the utmost cultural competence to help discourage home deliveries and its associated consequences.

Parity. The number of times a woman had given birth was strongly associated with health facility delivery. As birthing times decreased, the likelihood of health facility delivery increased. In a similar study conducted in rural south Ghana, first-time mothers were more likely to have health facility delivery than women who had previously given birth more than twice [23]. This direct association is consistent with findings from the literature [24, 27, 47]. One possible explanation for this finding could be that if a woman received poor health services during her previous deliveries, she may be less likely to access those services again [24, 53, 54]. Apart from these negative experiences, self-confidence from previous labours [19], lower complications from a previous pregnancy, and the notion that home delivery is a sign of bravery [5] tend to aggravate the likelihood of delivering at home. Unpacking this trend is important because if the quality of maternal health services is detracting women from using them, then improvements must be made. Further investigation is needed to examine the association between the quality of maternal health care and health facility delivery among multiparous. Given the data source, this was not possible in the current study. However, such an investigation would provide important

insights about the quality of maternal health care services, and their ability to adequately meet expectant mothers' needs. Eventually, it would assist in improving health facility deliveries among multiparous women.

Perceived need. The study identified that health facility delivery was significantly associated with the perceived need of the mothers, but the association was not strong. Perceived need i.e. knowledge about pregnancy complications was associated with health facility delivery in this study. The study result is consistent with some earlier studies in the African sub-region [28, 33, 55] that found greater use of health facility delivery among mothers who were informed about pregnancy and delivery issues. This result exposes the quality of health information mothers received during antenatal care (ANC) since the rate of ANC uptake has been reported to be very high in Ghana by other studies [10, 28]. This finding points to the need to give increased attention to health education about potential delivery associated complications as part of ANC in Ghana.

Study strength and limitations

This study used a large nationally representative Demographic and Health Survey data to examine the social determinants of health facility delivery use. The results from the present study contribute to the body literature on the social determinants of health and highlight the need for targeted maternal health programming especially in developing economies. However, this research was characterized by some limitations which should be recognized in the interpretation of the findings. Information on recent delivery within five years prior to the survey were collected to minimise recall bias since the survey relied on self-report. Also, as a result of a lack of data on actual medical needs, the variable "told about pregnancy complications" was used as a

proxy for perceived need and hence conclusions based on this variable should be drawn with caution.

2.5. CONCLUSION

This study adds to the body of international literature on the social determinants of health as it finds that there is a host of factors that influences Ghanaian women's decision about health facility delivery. This study found that women who were at a higher risk of delivering outside health facilities were less educated, rural dwellers, and have previously given birth. Also, in spite of Ghana's free maternal health care policy, poorer women were much less likely to have a health facility delivery, which raises the issue of other indirect financial barriers to access and the importance of tackling these barriers. Many of these factors are demand-side factors and so targeted policies and effective maternal health programmes should be developed to increase health facility delivery among Ghanaian women and improve equitable access to it. Finally, this research further recommends examining how community-level characteristics such as levels of unemployment, education and poverty exert influence on health facility delivery.

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The disproportionate use of Caesarean Section (CS) delivery highlighted in **chapter 1** and the disparities in health facility delivery discussed in **chapter 2,** necessitated **chapter 3** to elucidate socioeconomic discrepancies in the caesarean delivery beyond just place of delivery.

Chapter 3 is published in the International Journal for Equity in Health "**Dankwah, E.**, Kirychuk, S., Zeng, W., Feng, C., & Farag, M. (2019). Socioeconomic inequalities in the use of caesarean section delivery in Ghana: a cross-sectional study using nationally representative data. International journal for equity in health, 18(1), 162. doi:10.1186/s12978-019-0753-2" (2-year Impact Factor -2.473). In **chapter 3**, I conceptualized, reviewed the literature, cleaned and analyzed the data, interpreted the findings and wrote the chapter.

Chapter 3. Socioeconomic inequalities in the use of Caesarean Section Delivery in Ghana: a cross-sectional study using nationally representative data

3.1. INTRODUCTION

Caesarean Section (CS) is a life-saving obstetric surgical intervention for mothers and babies [1, 2]. This vital clinical procedure is often needed as a result of several medical conditions including macrosomia, pregnancy-induced hypertension, maternal weight, among others [3-5]. Yearly, about 18.5 million CS births are recorded worldwide,[6] this CS rate constitutes an average 19.1 percent of total births with great variations across geographic regions [7-9].

This CS disparity represents underuse or possibly medically unjustified overuse [7, 10-13]. Studies have posited that unlike higher-income countries that have adequate or even overuse, C-Sections in lower-income regions of the world are persistently underutilized [11, 14, 15] though developing countries represent 60% of global births,[6]. Irani and Deering[16] reported a 3.6% CS rate in sub-Saharan Africa.

Globally, inequities in the use of CS for delivery have seriously affected maternal and newborn health outcomes [11, 14]. However, most studies have linked inadequate access to CS delivery to maternal and newborn deaths and morbidities especially in resource limited settings [11, 14, 15]. Further, Ahmed and Tuncalp [17] related poor maternal and perinatal health outcomes to delay or lack of timely caesarean intervention; which has consequences such as stillbirth, ruptured uterine, obstetric fistula and many other obstetric conditions.

Recent studies have found that out of the 3.2 million extra CS that would be required every year in low-income settings to avoid maternal and neonatal deaths, approximately 68.5% would be needed in Africa [6].

Like many developing countries, Ghana's maternal mortality rate is high; by the end of 2015, the estimated rate was 319 maternal deaths per 100,000 live births [18]. According to the 2014 mortality report, 9% of all female deaths in Ghana were pregnancy-related, [19]. Available data declared a CS rate of 6.9 in 2008 [20] with an unmet C-sections of about 23,467 per year in Ghana [6]. Though the association between CS birth and socio-economic predictors have been well-established in the literature, [21-27] the inconsistent findings underpin the need for this study. Specifically, a small number of studies have been conducted in Ghana to examine CS delivery use [28-30]. However, the magnitude and direction of the socioeconomic effects on CS birth remain unclear. For example, while no significant association between CS delivery and parity was reported by Pra et al [29]. Manye et al [30] found that parity of the women was a strong predictor of CS delivery use. Likewise, older women (>34 years) were more likely to use CS delivery than younger women according to Manye et al [30] and yet the reverse is the case in the study by Prah et al [29].

Moreover, most of the existing Ghanaian studies on CS births are hospital-based and some failed to sample participants randomly which has the potential to bias the study estimates. For instance, Danso et al [28] used a convenience sampling technique to select 154 women who used CS delivery from two teaching hospitals in Ghana. Similarly, Prah et al [29] reviewed medical records from a health facility and reported a CS delivery rate of 26.9%. Further, the only existing population-based study on CS delivery focused on small geographical area of the country [30], that was in just two rural districts out of the 216 districts in Ghana and therefore restricts making inference about the entire population [30]. Also, none of the studies quantified the extent of inequality using concentration index and curve. This study aims to contribute to a growing international policy-relevant body of literature examining the effect of socioeconomic

factors on CS delivery [31-33]. The goal of this study is to investigate the association between CS delivery and socio-economic factors using nationally representative data from Ghana.

3.2. METHODS

3.2.1. *Study data and variables*

The data for this study were drawn from the 2014 Ghana Demographic and Health Survey (GDHS), a nationwide population-based survey. The subset of data used for this study includes only females between 15 and 49 years old residing in Ghana. Participants were selected into the survey in two stages as described by the Ghana Statistical Service (GSS) and its collaborators: Inner city fund (ICF) International and Ghana Health Service (GHS) [34]. Firstly, 427 clusters were selected and subsequently, 30 households from each cluster were randomly selected. In total, 12,831 households were selected for the survey; actual interviews were conducted in 11,835 households out of the 12,010 households that were occupied representing a response rate of 98.5%. Trained interviewers used a structured questionnaire that was pretested to collect data from 9,396 women on the socio-demographic background, reproductive, family planning history and other aspects of women's health. Among eligible women, the interviewed women in GDHS recorded a 3% non-response rate. Weighted cluster sampling was applied in the survey [34].

The 2014 GDHS gathered data on recent births in the five years preceding the survey. The study outcome was whether the delivery was a CS or not. Women who reported having used CS delivery were classified as "1 = CS delivery" otherwise, they were classified as "0 = not CS delivery". Based on the Andersen health behavioral model, the following self-reported variables from the survey were selected and studied to assess the inequities in use of CS delivery: maternal

age, marital status, religion, ethnicity, parity, place of residence, education, financial status, and working status. To prevent redundancy of the region of residence variable and be able disaggregate the extent of inequality in CS delivery at a lower level, ethnicity was included in this study instead region of residence because a region is composed of ethnic groups.

For the analysis conducted in this study, categorization of the variables was guided by prior studies [24, 25, 30, 35]. As demonstrated in Table 3-1, maternal age was categorized into three groups (15-24, 25-34, 35-49) due to the violation of the assumption of linearity (p-value <0.0001). Regarding marital status, it was grouped into single, married, cohabitating and widowed or separated or divorced. For the religious affiliation of the women, it was classified into three groups (Christians, Islam and Traditional/other). The categories used for the variable Ethnic group of the woman were Northern tribes, Akan, Ewe, Ga, and others. The parity of the women which is the birth order was categorized into three cohorts (One birth, 2 births, and ≥3 births). With respect to education, women were categorized into four groups: no education, primary, secondary, and higher. Women's place of residence was grouped into rural and urban. The wealth quintile of the women was ascertained using principal component analysis of assets and household factors and hence classified into the poorest, poorer, middle, richer, and richest as present in other studies [36]. Finally, the working status of the women was classified into employed and unemployed.

Table 3-1. Description of study variables

Variable name	Description	Level of measurement
CS delivery	Whether CS delivery or not	Categorized, 0= Not CS delivery, 1= CS delivery
Age	Maternal age (years)	Categorized, 1= 15 to 24, 2= 25 to 34, 3 = 35 to 49
Marital status	Current marital status	Categorized, 0 = Single,1 = Married, 3=Cohabitating, 4= widowed/Separated/ Divorced
Religion	Religious affiliation of the women	Categorized, 1 =Christians, 2= Islam, 3 = Traditional/other
Ethnicity	Women ethnic group	Categorized, 1= Akan, 2= Northern tribes, 3= Ewe, 4 =Ga, 5 = other
Parity	Birth history	Categorized, 1= 1 birth, 2 = 2 births, 3 = 3 or more births
Residence	Place of residence	Categorized, 1 = Urban, 2 = Rural
Education	Highest educational level	Categorized, 1 = No Education, 2 = Primary, 3 = Secondary, 4= Higher
Wealth quintile	Wealth quintile of the women	Categorized, 1 = Poorest, 2 = Poorer, 3=Middle, 4 = Richer, 5=Richest
Working status	Whether working or not	Categorized, 1= Unemployed, 2= Employed

3.2.2. *Statistical Analyses*

Frequencies and percentages were calculated for categorical variables included in this study using the Pearson Chi-square test. To examine the determinants of CS delivery, a regression model with a logit link function was fitted. The logistic regression model used in this study was premised on this equation:

Equation 3-1: Logistic Regression model for CS delivery

$$P(Yi = 1) = pi$$

$$\text{Logit}(pi) = \beta_0 + \beta_1 xi_1 + \beta_2 xi_2 + \cdots + \beta_k xi_k$$

where pi is the probability of CS delivery among i th respondents, β_0 was the intercept, β_k represented regression coefficients of the predictors, xi_k was the study predictors

Univariable and multivariable analyses were conducted to estimate the odds ratio (OR) and 95% confidence interval. A lenient p-value of 0.25 was adopted to select potential predictors into the adjusted model, mainly to avoid missing important factors in the multivariable analysis whose effect could be masked, suppressed or inflated by other controlling variables [37, 38]. Multicollinearity was tested for risk factors selected for the multivariable model. Variance inflation factor (VIF) greater than 2.5 or tolerance of less than 0.4 was set as the limit because beyond this cut-off, it may cause correlations among study factors in the logistic regression model as suggested by Johnston et al [39]. A manual backward elimination selection method was used to estimate the adjusted odds ratio (AOR) for CS births. In the adjusted model, explanatory variables were considered significant at p-value ≤0.05. Confounding and interaction effects of predictors in the adjusted model were checked. In this study, explanatory variables were included

in the multivariate regression analysis if the percentage change in the regression coefficient between the crude and the adjusted model was greater than 20%. Also, two-way interactions were examined between significant explanatory variables in the adjusted model. Sample weighting adjustment was applied for the unequal proportion of samples from the population and differential nonresponse rate. Moreover, the model incorporated a robust variance estimation method to ensure accurate points and intervals were computed after adjusting for design characteristics. In addition, the area under the curve (AUC) of the receiver operating characteristics (ROC) was computed, and a parsimonious model was selected using Akaike's Information Criterion (AIC). Smaller AIC was chosen as a better model [40]. Lastly, to ascertain the model was specified correctly, link test was performed to check specification errors and a post estimation Hosmer-Lemeshow goodness-of-fit test was done [38, 41, 42].

To estimate the inequality in CS birth based on wealth quintile, the following health equity metrics were used: rate-ratios, concentration curves and concentration indices [43-46]. To compute rate-ratio, the percentage of CS delivery among the richest group was divided by the proportion of CS delivery among the poorest group. Furthermore, the degree of inequality was displayed graphically using the concentration curve; this was done by plotting the cumulative proportion of the population ranked by the wealth quintile of the women on the x-axis against the cumulative proportion of CS delivery on the y-axis. The diagonal line on the graph is the equality line of caesarean delivery based on wealth quintile. A concentration curve that is above the equality line indicates that CS births are concentrated among economically disadvantaged groups whereas a curve below the equality line suggests more CS delivery among the wealthier groups. The Concentration index was used to quantify the level of inequities in the use of CS delivery. The scale of concentration index ranges from -1 to +1, zero signifies equality in CS

delivery whereas negative and positive values represent a greater concentration of CS births among the lower-class and affluent groups respectively [43-45]. For clarity in the interpretation of concentration of index, Koolman and Doorslaer redistribution scheme [47] was adopted in this study to estimate the percentage redistribution of CS delivery use required to achieve a concentration index equal to zero. All the data analyses were conducted in STATA version 14.0 (Stata Corp., College Station, Texas: StataCorp LP, USA) and Microsoft Excel version 16. The equation for the concentration index was adopted from some studies [44, 45]:

Equation 3-2: Concentration index

$$\text{Concentration index} = (p_1L_2 - p_2L_1) + (p_2L_3 - p_3L_2) + \ldots + (p_{T-1}L_T - p_TL_{T-1})$$

p_T: the cumulative percent of the sample ranked by the socioeconomic groups

L_T: the corresponding concentration curve ordinate; and

T: the number of wealth groups

3.3. RESULTS

3.3.1. Descriptive results

Out of the 4294 women that were asked whether the delivery was by CS or not in the GDHS, 11.4% reported using CS for delivery. The distribution of women across predictors and the mode of delivery is detailed in Table 3-2.

Age. The ages of the mothers were between 15-49 years with an average age of 29.7 years. Most (47.2%) of the mothers were aged 25-34 years. CS births among women aged 25-34 years were nearly double of those aged 15-24 years (11.5% versus 6.6%). CS delivery rate was 14.3% in older women (35-49 years), compared with 6.6% among younger women (15-24 years) (Table 3-2).

Marital status. A majority (65.2%) of the women were married. Women cohabitating had the lowest proportion (8.9%) of CS births whereas women who were either widowed or divorced or separated had a CS rate little above 12% (Table 3-2).

Religion. Nearly three-quarters of women (71.8%) were Christians. CS births for Christians were about twice that of the traditional and other believers (12.4% versus 5.6%). On the other hand, the proportion of Muslim women who reported having had a CS was 9.9% (Table 3-2).

Ethnicity. With respect to ethnic orientation, Northern women were 41.8% while Akans were 38.3%. Minority groups constituted about 20% of the women; they were Ewe (11.1%), Ga (4.6%) and other ethnic groups. CS delivery ranged from a lowest rate of 7.5% among northern tribes to 16.2% in Ga women (Table 3-2).

Parity. Around 58.7% of the mothers had at least 3 births. Parity of the women had an inverse relationship with CS delivery. CS rate decreases as birth order increases: CS delivery among mothers with one birth reduced from 16.6% to 12.2% (2 births) and 9.2% (3 or more births).

Education. One-third (33.0%) of the women had no formal education whilst only 4.0% attained post-secondary education. For women with no education, the proportion of women who had a CS delivery was 6.1% whereas the CS prevalence among women with primary education was 8.5%, 14% among women with secondary education, and 33.1% among women with higher education (Table 3-2).

Place of residence. More than half (58.6%) of the women resided in the rural settings of Ghana. The results show that the CS delivery rate was more than two-fold higher in urban dwellers than women living in rural communities (17.1% versus 7.3%).

Wealth quintile. The analysis revealed that an increase in the wealth status of women had a corresponding increase in the CS rate. Just over one-quarter (27.5%) of the richest group had CS birth whilst the percentage was 5% for the poorest group (Table 3-2).

Working status. Out of 5 mothers, about four were employed (79.4%). There was no substantial difference in the proportion of CS births among employed and unemployed women (11.4% versus 11.0%).

3.3.2. Univariable model results

The crude association between mode of delivery and predictors are displayed in Table 3-2. The results revealed that except for women's working status that was excluded, all the explanatory variables were selected for further analysis in the multivariable model at a liberal p-value of 0.25.

Table 3-2: Distribution of women by predictors and caesarean section (CS) delivery, and crude odds ratio and 95% confidence interval of having CS delivery in univariable model

Predictors	**N (%)** **4294 (100%)**	**CS delivery (%)**	**Crude OR (95% CI)**	**P-value (Chisq)**
Maternal age				
15-24 years 25-34 years 35-49 years	923 (21.5) 2026 (47.2) 1345 (31.3)	6.6 11.5 14.3	ref. 2.42 (1.65, 3.55) 3.31 (2.39, 4.59)	<0.0001
Marital status				
Single Married Cohabitating Widow/Separated/Divorced	363 (8.5) 2801 (65.2) 830 (19.3) 300 (7.0)	2.1 11.9 8.9 12.3	ref. 1.52 (1.01, 2.28) 0.99 (0.62,1.60) 1.74 (0.84, 3.63)	0.01
Religion				
Traditional/other Islam	324 (7.6) 885 (20.6)	5.6 9.9	ref. 1.56 (0.69, 3.49)	0.06

Christian	3085 (71.8)	12.4	1.97 (0.98, 3.96)	
Ethnicity*				
Northern tribes Akan Ewe Ga Other	1,796 (41.8) 1,643 (38.3) 476 (11.1) 198 (4.6) 180 (4.2)	7.5 15.2 11.3 16.2 10.0	ref. 2.19 (1.62, 2.96) 1.50 (0.99, 2.27) 2.93 (1.68, 5.14) 1.65 (0.85, 3.21)	<0.0001
Parity				
1birth 2 births ≥3 births	935 (21.8) 839 (19.5) 2520 (58.7)	16.6 12.2 9.2	ref. 0.68 (0.51, 0.91) 0.54 (0.41, 0.71)	<0.0001
Education				
No education Primary Secondary Higher	1419 (33.0) 869 (20.2) 1837 (42.8) 169 (4.0)	6.1 8.5 14.8 33.1	ref. 1.88 (1.15, 3.07) 3.10 (2.25, 4.27) 8.28 (5.11, 13.41)	<0.0001
Place of residence				
Rural Urban	2516 (58.6) 1778 (41.4)	7.3 17.1	ref. 2.55 (1.89, 3.43)	<0.0001
Wealth quintile				
Poorest Poorer Middle Richer Richest	1318 (30.6) 923 (21.5) 812 (18.9) 685 (16.0) 556 (13.0)	5.0 7.2 11.1 16.5 27.5	ref. 1.56 (1.01, 2.41) 2.67 (1.82, 3.92) 4.21 (2.81, 6.30) 8.12 (5.52, 11.94)	<0.0001
Working status				
Unemployed Employed	886 (20.6) 3408 (79.4)	11.0 11.4	ref. 1.03 (0.75, 1.43)	0.8

Abbreviations: N, number of observations; %, percent; *N=4293, due to missing values; CI, confidence interval; OR, odds ratio; ref., reference; SD, standard deviation.

3.3.3. Multivariable model results

As demonstrated in Table 3-3, none of the study predictors had higher VIF and lower tolerance than the threshold of 2.5 and 0.4 respectively.

Table 3-3. Results of the multicollinearity test

Predictors	**VIF**	**Tolerance**
Age	1.93	0.52
Marital status	1.19	0.84
Religion	1.17	0.85
Ethnicity	1.03	0.97
Parity	2.48	0.40
Place of residence	1.76	0.57
Education	1.68	0.60
Wealth quintile	2.36	0.42

*****VIF > 2.5 or tolerance <0.40

The final model had lower AIC than the empty model (without study predictors) (2.90e+09 vs 3.29e+09) and was chosen. The model specification link test shows that the final model was correctly specified (p-value=0.28), and the p-value of 0.64 generated from the Hosmer-Lemeshow postestimation test suggests the model properly fit the data. Besides, the area under the ROC curve of 0.72 (95%CI: 0.70, 0.75) as well as the ROC curve (Figure 3-1) indicates the model have sufficient discriminatory power on the dichotomous outcome of interest.

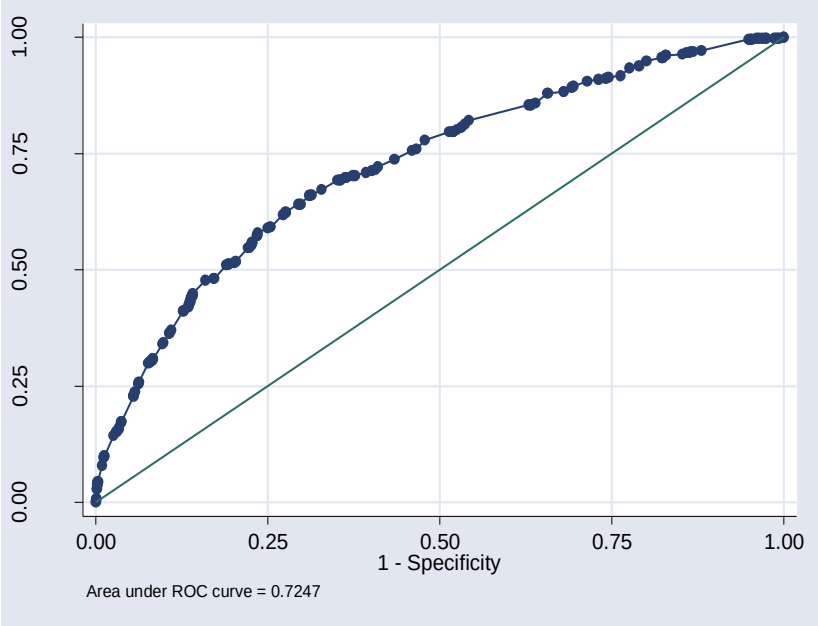

Figure 3-1. Receiver Operator Characteristics curve of the final model

The multivariable associations between mode of delivery and associated factors are presented in Table 3-4. In the adjusted model, women's religion, ethnicity, place of residence and marital status were not statistically significant at a p-value of 0.05 when all factors were controlled (Table 3-4). Predictors that had significant effect on CS delivery were maternal age, parity, education level, and wealth quintile. The analysis did not find confounders and significant interaction among the predictors in the multivariable model.

Age. This study detected a positive association between CS birth and maternal age. Mothers aged 25-34 years were 3.15 (95% CI= 2.11- 4.71) times more likely to have had a CS delivery relative to women with ages 15 to 24 years. Similarly, older women aged 35-49 years were 7.53 (95% CI = 5.11-11.08) times more likely to have had a CS birth than younger women (15-24 years).

Parity. The analysis revealed that parity had a direct relationship with CS delivery. Women who had two births and at least 3 births were 0.53 (95%CI= 0.38-0.73) and 0.31 (95%CI=0.22-0.43) times, respectively less likely to have a CS delivery than women with one birth.

Education. Regarding education, secondary educated and higher educated mothers were about 1.65 (95%CI=1.15-2.36) and 2.17 (95%CI=1.26- 3.74) times, respectively, more likely to have a CS birth relative to uneducated women. CS delivery among women with primary education was not significantly different from uneducated women (AOR=1.59, 95% CI=0.98-2.59).

Wealth quintile. Concerning the wealth quintile of women, the odds of having a CS delivery was 2.76 (95%CI=1.77- 4.28) times and 4.38 (95%CI=2.83- 6.77) times higher among richer and richest women respectively, than the poorest women. Likewise, middle-class mothers were 2.13 (95%CI=1.43- 3.18) times more likely to have CS delivery relative to the poorest mothers. No statistically significant difference in the likelihood of CS delivery was found between poorer and poorest women (AOR=1.36, 95%CI=0.89- 2.06).

Table 3-4. AORs and corresponding 95% CIs of having a caesarean delivery by predictors in the multivariable logistic regression model

Predictors	**AOR (95% CI)**	**P-value**
Maternal age (ref. 15-24 years)		
25-34 years	3.15 (2.11, 4.71)*	<0.0001
35-49 years	7.53 (5.11,11.08)*	<0.0001
Marital status (ref. Single)		
Married	1.34 (0.85, 2.09)	0.20
Cohabitating	1.14 (0.69, 1.91)	0.60
Widow/Separated/Divorced	1.74 (0.82, 3.67)	0.15
Religion (ref. Traditional/other)		
Islam	1.12 (0.57, 2.21)	0.73
Christian	0.85 (0.48, 1.48)	0.57
Ethnicity (ref. Northern tribes)		
Akan	1.11 (0.80, 1.52)	0.50
Ewe	0.86 (0.57, 1.29)	0.46
Ga	1.36 (0.77, 2.42)	0.29
Other	1.01 (0.50, 2.04)	0.97
Parity (ref. one birth)		
2 births	0.52 (0.38, 0.73)*	<0.0001
≥3 births	0.31 (0.22, 0.43)*	<0.0001
Education (ref.no education)		
Primary	1.59 (0.98, 2.59)	0.06
Secondary	1.65 (1.15, 2.36)*	0.006
Higher	2.17 (1.26, 3.74)*	0.005
Place of residence (ref. rural)		
Urban	0.99 (0.73,1.35)	0.95
Wealth quintile (ref. poorest)		
Poorer	1.36 (0.89, 2.06)	0.2
Middle	2.13 (1.43, 3.18)*	<0.0001
Richer	2.76 (1.77, 4.28)*	<0.0001
Richest	4.38 (2.83, 6.77)*	<0.0001

Abbreviations: CI, confidence interval; AOR, adjusted odds ratio; %, percent; ref., reference, * Significant at p-value =0.05.

The study findings point to wealth-related inequity in CS birth. The analysis revealed higher CS birth among rich mothers when compared to the poor (rich: poor ratio=5.5). As shown in figure 1, richer and richest women had a higher CS rate than average national CS rate. A positive concentration index value of 0.172 was calculated, which indicates more concentration of CS delivery among wealthier women (Figure 3-2).

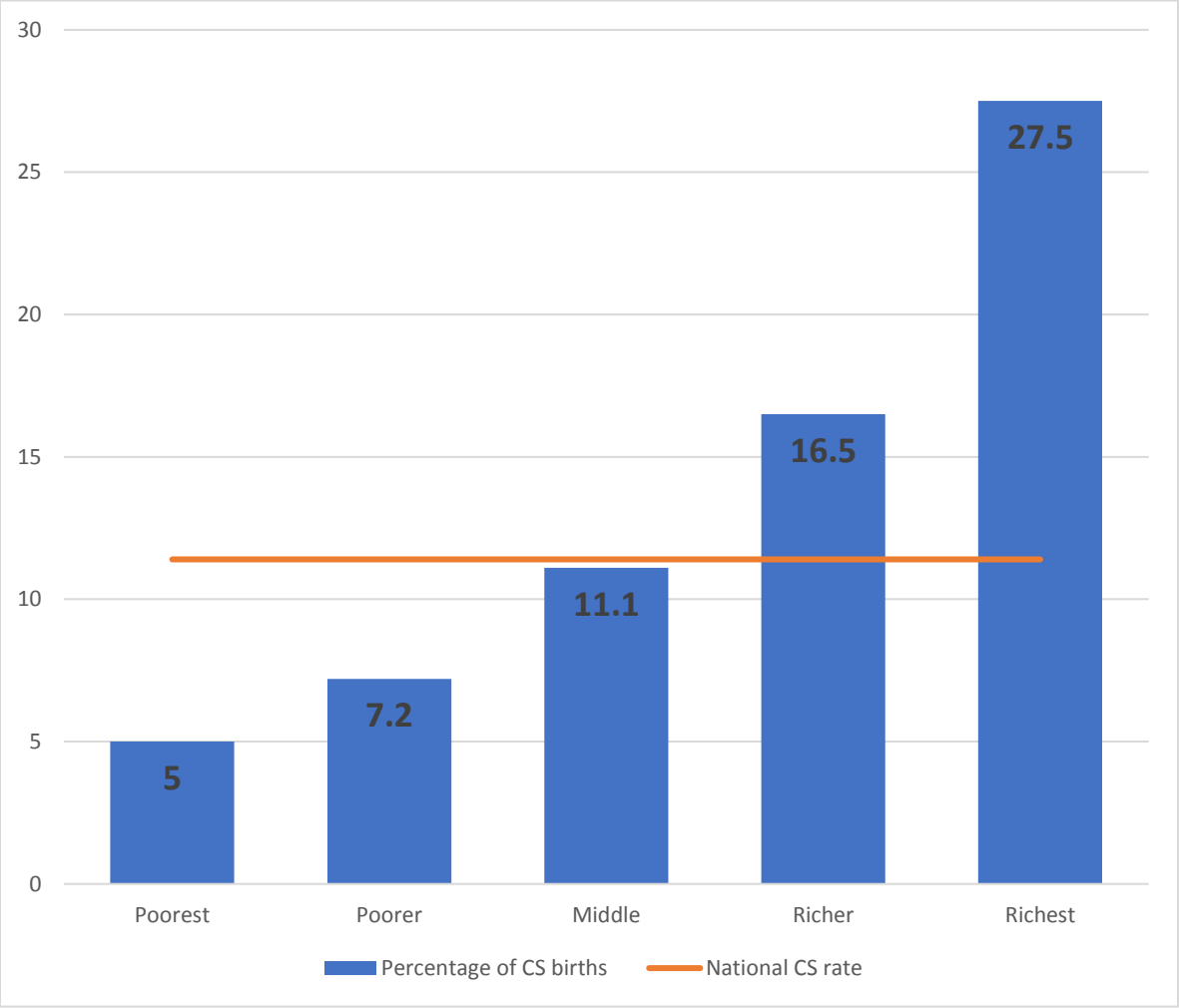

Figure 3-2. Distribution of caesarean delivery by wealth quintile, GDHS data 2014

Likewise, the concentration curve displays a curve below the equality line representing greater frequency of CS births among the affluent group (Figure 3-3). Finally, based on Koolman

and Van Doorslaer's methodology, 12.9% of CS deliveries should be shifted away from the richer group to address the unmet CS delivery needs among less privileged women to achieve a concentration index of zero. The use of the concentration curve and index is only to illustrate the extent of income-based inequalities in utilization. However, more research is needed to determine how inequitable this utilization pattern is. The goal is not necessarily to reach a concentration index of zero. If CS acted as a luxury good in an economic sense, then it would be expected that richer women would use more of it. More affluent women having higher rates of CS is not necessarily a problem in terms of equity if these CS surgeries are not paid for using public money and if poorer women have access to needed CS deliveries.

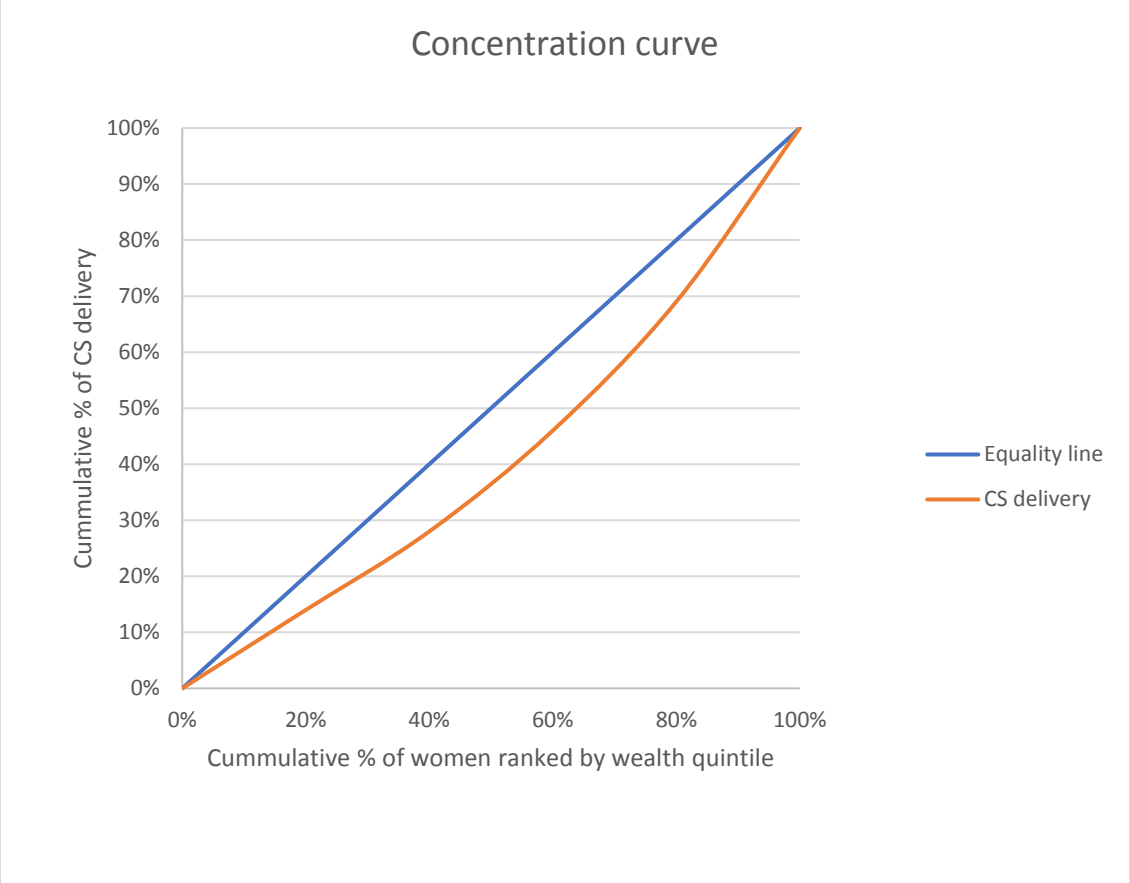

Figure 3-3. Concentration curve for caesarean delivery, GDHS data 2014

3.4. DISCUSSION

In this study, the total CS delivery level of 11. 4% was higher than 6.59% reported in a similar study in Ghana [30] but falls within the WHO recommended levels of 5-15% [6, 15]. In addition, the CS delivery prevalence from this study was higher relative to the 7.3% and 3% CS rate estimated for Africa and West Africa respectively [14].

The study shows strong associations between CS birth and some predictors including mother's age, parity, education level, and wealth quintile. In this current study, marital status of the women was not significantly associated with CS birth, this result is consistent with a similar study in Ghana [30]. Also, religion was not a significant predictor for CS delivery in this study; this is in contrast with the results of similar studies in Bangladesh [48] and India [49] that found a strong association, perhaps due to limited covariables, different cultural and geographical context. For instance, in the Indian study [49] most of the women were Hindus but in Ghana they are in the minority religious group. Similar to the findings of this research, a study in Ethiopia reported that ethnicity of women was not significantly related to CS delivery [22]. Furthermore, this research found a strong relationship between place of residence and CS birth at univariable stage, but the effect was not significant in the adjusted model. This finding is consistent with similar studies elsewhere [49, 50].

Age: The relationship between CS birth and age has been studied extensively in the literature with considerable mixed findings. A study conducted in Egypt found that younger (30 years and below) women were more likely to have a CS birth [25] whilst other authors observed higher likelihood for CS delivery among older women [24, 26, 51-53]. The latter finding is consistent with the results of this study. This result could be explained by natural physiological and anatomical changes accompanying aging which expose older mothers to an elevated risk of

pregnancy and delivery related complications [54-56]. These physical changes coupled with a higher rate of request for CS delivery by these mothers [54] could be the main reasons for the higher rate. Also, the older women may perceive caesarean section as a safe delivery option to protect their fetus after a long period of conception difficulty, and the fear of delivery pains and losing of baby [57]. Alternatively, perhaps uneasiness and fear associated with CS delivery could deter particularly younger mothers as reported in similar studies in Nigeria [58] and Tanzania [59]. Also, young mothers may refuse CS delivery because of the risk of repeated CS births and the complications associated with more than 3 repeated CS as reported in a study [60]. Moreover, young women probably might prefer vaginal delivery because of perceived immediate recovery after childbirth as indicated in a study related study [57].

Parity: The association between woman's parity and the likelihood to have a CS delivery has been long-established in body literature. Conventionally, mothers with higher birth order are less likely to have a CS [24, 25, 33]. The results of the current study are consistent with previous research in this area. First time mothers have a higher likelihood of having a CS delivery [26] probably due to fear of labor pain [28]. On the other hand, mothers who had given birth before have a lower likelihood of having a CS delivery until the fifth birth [61]. This lower CS delivery among multiparous women could be explained by their previous delivery type as well as level of satisfaction of the obstetric care received. Supporting this possible explanation, a study in Burkina Faso [62] reported that mothers with a normal delivery experience might reject CS delivery even when it is medically recommended because of the guilt of not delivering naturally and the risk of possible future caesarean sections. Also, other studies have found that women with previous caesarean delivery have a higher likelihood of repeated CS [32, 63].

Education: Earlier studies which examined the association between maternal education level and CS delivery have had mixed findings. Though a study found no statistically significant association between the likelihood of CS delivery and education level of the mother [25] other studies have also revealed that education level of mothers was strongly linked to the likelihood of CS delivery. Moreover, a study conducted with a smaller sample size at northern Ghana reported lower risk of CS delivery among women with secondary or higher education [64]. Conversely, this study's findings are consistent with previous studies in Bangladesh[24], Brazil [53], Thailand [27], Pakistan [26] and China [65] which found that highly educated (secondary and postsecondary) women were more likely to have a CS delivery than women with no formal education. This finding could be explained by the enhanced ability of women with secondary and postsecondary to better access obstetric care due to their autonomy and ability to take decisions about their health [66] and knowledge about risks and benefits of CS interventions [67]. On the other hand, women with no or limited education may have limited knowledge [68] and/or misconceptions about CS which could discourage use [69], and even may not report to health facilities amidst delivery complication for the CS procedure [70].

Wealth quintile: Research into the relationship between wealth quintile and CS delivery has been well established in literature. Some studies have reported that the likelihood of CS delivery increases with better wealth quintile [11, 26, 49, 65, 71-73], the results of this study is consistent with the overall literature in general and with similar studies such as the study from Mozambique that reported underuse of CS delivery in less affluent mothers [74] and another study from Bangladesh that revealed about 2.5 times likelihood of CS delivery among wealthier women relative to the poorest [24]. This study's finding of higher likelihood of CS delivery among richest, richer and middle-class women could be the result of the costs associated with CS

birth. Though CS delivery is covered in Ghana's free maternal health services policy [75, 76] Ghanaian women may still incur indirect costs including transportation [77], and unapproved fees from health professionals as well as service expenses outside the policy [78]; These CS related costs could play an important role in preventing poor women from accessing CS care at health facilities. Type of health facility accessed for obstetric care has been reported to be associated with use of CS for delivery in international studies, showing a higher likelihood of CS in private facilities [32, 79], and a higher likelihood of CS deliveries to be medically justified in public hospitals [80]. However, this study did not include place of delivery as a explanatory variable. Further, affluent women may tend to have a higher likelihood of requesting CS delivery [4] because of perceived lower risk [81]. Contrary to the findings of a study by Hou et al [65], this research found no significant difference in the likelihood of CS delivery between women in the two lowest wealth quintiles.

Finally, on wealth-related inequities in CS delivery, the rich versus poor ratio of 5.5 computed in this study demonstrates a pro-rich CS intervention uptake, though lower than the ratio of 7.52 and 7.73 reported in Bangladesh [48] and Namibia [45] respectively. Further, the concentration curve and the concentration index reported in this study testify to the degree of inequality in the use of CS services for the wealthy as found in similar studies [45, 48].

Strengths and limitations of the study: This study used a large nationally representative population-based data to investigate the factors associated with inequalities in the utilization of CS delivery among women in Ghana. However, a few limitations of the study data were identified. First, recall bias could arise because the survey relied on self-reporting. However, the question regarding CS birth was restricted to recent birth within five years preceding the survey, limit recall bias. Also, the GDHS did not include data on medical need for CS and hence further

population-based studies are required to investigate association between CS delivery and medical need factors. Finally, as a result of lack of data on type of CS and place of birth, the study could not distinguish between elective and emergency CS and whether CS delivery occurred at a public or private facility.

3.5. CONCLUSION

Even though Ghana has achieved a CS prevalence of 11.4%, which is consistent with WHO recommendations, this study's finding of large inequalities in the use of CS based on wealth and education helps provide evidence for policy intervention. The importance of generating evidence for the presence of socioeconomic inequalities in the use of CS in Ghana is that it directs public policy to go beyond aggregate level indicators and critically examine caesarean delivery distribution. Moreover, despite Ghana's free maternal healthcare interventions, poorer women had much lower use of CS holding everything else constant which indicates that removing fees alone may not be sufficient to adequately improve access to CS for poor women. This policy implication is similar to that proposed by other researchers who have proposed paying utmost attention to socially disadvantaged women to minimize inequalities in the use of CS delivery. On the other hand, while, the underuse of CS among poorer and lower educated women raises serious concerns about access to CS delivery services, the possible medically unjustified overuse of CS delivery as income and education increases raises a different set of concerns, which require targeted health policy interventions to ensure medically appropriate use of CS delivery among richer and more educated women.

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Chapter 4 builds on **chapter 2** and **chapter 3** by quantifying the proportion of obstetric care services utilization in the study population attributable to certain socio-demographic factors. Unlike past studies that used the classical methodological techniques, **chapter 4** fitted a Generalised estimating equation (GEE) on the 2014 GDHS data to generate parameters for the computation of population attributable risk of women's sociodemographic factors on PNC services use.

Chapter 4 has been submitted to the Journal of Biosocial Science "**Dankwah, E.**, Feng, C., Lepnurm, R., Kirychuk, S., Zeng, W., & Farag, M. (2020). Sociodemographic correlates of postnatal care services utilization among Ghanaian mothers: a population attributable risk approach. Journal of Biosocial Science, JBS-5102" (Impact Factor (2019) – 1.207). In this chapter, I conceptualized, reviewed the literature, cleaned and analysed the data, and also did the interpretation of the findings and the write up of **chapter 4**.

Chapter 4. Sociodemographic correlates of postnatal care services utilization among Ghanaian mothers: a population attributable risk approach

4.1. INTRODUCTION

Pregnancy related medical complications that result in morbidities and loss of life of mothers and babies have received global attention [1, 2]. Yet, these complications still occur during antepartum (prenatal), intrapartum (childbirth) and postpartum (postnatal) periods, especially in developing countries [1, 2]. Of the three phases of reproductive life, it appears that the majority of the life-threatening conditions and deaths occur post-delivery [3-5]. It has been reported that approximately 40% of newborn mortality and half of maternal deaths happen within a day after birthing [6]. There vast discrepancies in maternal and child health across continents and even within countries. On newborn mortalities, every year approximately 3 million deaths occur in low-income nations [7]. The African region persistently suffers the highest maternal mortality ratios contributing 57 percent of all pregnancy-related deaths globally translating into a maternal death of 1 in 39 [8]. These deaths occur as a result of short as well as prolonged sickness and disability including postpartum conditions [9].

Globally, there is a concerted effort to promote the use of obstetric services because they are associated with dramatic reductions in maternal and newborn deaths [10, 11]. Improving obstetric services utilization rates in developing countries [12-14] is critical towards achieving the world health organization's (WHO) sustainable development goals (SDGs) on maternal and child morbidity as well as mortality [15]. Therefore, it is important to understand the disparities in the usage of obstetric care services including postnatal care (PNC) services to provide more targeted policy approaches. Observational studies can generate relevant evidence to tackle this

underutilization of PNC services, but findings from previous studies [12, 13, 16-19] about the association between sociodemographic factors and the use of PNC services remains uncertain.

According to Ganle et al [20], Ghana has PNC services utilization coverage of 76%. In Ghana discrepancies in the use of PNC services have been observed [21], but past studies that examined the association between PNC services use and sociodemographic factors in Ghana have documented conflicting conclusions [22, 23]. However, these studies may differ in their findings due to methodological issues including: the use of different definitions for PNC services utilization; hospital-based designs limiting the drawing of inference to the entire population; limited geographical scope; small sample sizes; and deficient control of confounding. Most importantly, none of the studies in Ghana computed the population attributable risk (PAR) of sociodemographic characteristics associated with the usage of PNC services. Using a PAR quantifies the proportion of PNC services utilization attributable to sociodemographic risk factors in the study population and will be important to guide policymaking.

This study aims to estimate the PAR of sociodemographic factors to determine their attributable impact on the uptake of PNC services.

4.2. METHODS

4.2.1. Study data

De-identified secondary data from the 2014 Ghana Demographic and Health Survey (GDHS) was used in this study. Ghana Statistical Service, Inner City Fund (ICF) International and Ghana Health Services conducted the 2014 GDHS [21]. The GDHS enrolled respondents based on two-levels: (1) 427 clusters (hereinafter communities) (2) 12,831 households. Overall,

9396 women aged between 15 to 49 years with episode of childbirths in the past five years were selected from the households and interviewed using a pretested questionnaire. The response rate for the survey was 97 percent. The respondents answered questions on socio-demographic and reproductive health issues, [21].

4.2.2. Study variables

Outcome variables: The outcome of interest in this study was the use of PNC services. From the 2014 GDHS, women that were checked by skilled professionals after delivery within 41 days postdelivery were classified as using PNC services whilst those who did not receive post-delivery checkup within 41 days after live birth were considered non-users of PNC services in this study. The dependent variable used for analyses in this study was measured as a binary variable.

Independent variables: Sociodemographic factors that were considered in this study were chosen based on Andersen's behavioral model [24, 25]. The study sociodemographic characteristics were predisposing characteristics (women's age, marital status, religion, ethnicity, educational level) and enabling factors (wealth status, employment status, place of residence) . Region of residence which is represented by the ethnic groups in Ghana was not examined in this research.

The predisposing variable, age was examined as a continuous predictor because the linearity assumption was met when a quadratic term was tested (p-value=0.41). The rest of the independent variables were analyzed as categorical variables as reported in similar studies [26, 27].

4.2.3. Statistical Analyses

Descriptive statistics: In this study, mean and standard deviation (SD) of continuous variable was computed. The frequency and percentages of categorical predictors from the chi-square analyses are presented in Table 4-1.

Inferential statistics: The 2014 GDHS generated clustered data. Studies have shown that clustering effects in survey data may bias findings [28] and hence the need for an appropriate statistical technique such as Generalized Estimating Equation (GEE) is needed to generate valid inferences [29, 30]. Unlike, conventional logistic regression model that may provide biased estimates of the regression parameters when analyzing clustered data [30], GEE provides unbiased population-averaged parameters [31].

In this study, GEE with a sandwich estimate of the variance and a logit link function was fitted to determine the association between sociodemographic factors and the utilization of PNC services. An exchangeable correlation structure that considers participants from the same cluster to have equal correlations was applied as recommended in a previous study [32] for complex cluster designs. The sandwich-based estimator was chosen to manage correlation structure misspecifications in this study because the 2014 GDHS data has more than 40 clusters [32]. Three models were fitted namely null, unadjusted and adjusted. To begin, a null model with no study predictors was fitted. Thereafter, a series of unadjusted models were fitted for each of the risk factors, univariate associations with p-values of less than 0.25 were selected for analysis in the final adjusted model [33, 34].

Although there is no conventional threshold for VIF and tolerance, earlier studies have indicated that VIF > 2.5 and <0.4 can disturb the regression estimates especially in logistic regression models [35]. Multicollinearity was checked for all the variables selected for

multivariable analyses at the stated cut-off. Further, all the selected variables were entered in the multivariable model at once and then backward elimination was used to remove redundant predictors until the final model only has study predictors that are strongly associated with the utilization of PNC services. Odds ratios were deemed statistically significant at a 95% confidence interval (CI). Additionally, this study tested all possible two-way interactions. Confounding effects in the adjusted model were checked using a 20-percentage change in regression coefficient as a cut-off [34]. The predicting power of the final model was examined using a receiver operating characteristic (ROC) curve. Further, the Quasilikelihood information criterion (QIC) was used to select a preferred and parsimonious model based on the smallest value [36, 37]. Sampling weight was considered in the study and STATA 14 (StataCorp LP, College Station, TX, USA) was used for the data analyses.

Finally, population attributable risk (PAR) was estimated for all significant sociodemographic factors in the final model similar to a Nigerian study [16] to find out the magnitude of their influence on the use of PNC services. PAR was calculated based on the assumption that significant unbiased association exist between exposure and outcome [38]. PAR and its 95% CI was computed using the equation from a previous study [39, 40]:

Equation 4-1. The Population Attributable Risk equation for PNC services usage:

$$\boldsymbol{PAR = \frac{Pi(AOR - 1)}{AOR}}$$

where Pi is the proportion of women who used PNC services according to sociodemographic factors, and AOR is adjusted Odds ratio for utilization of PNC services.

4.3. RESULTS

4.3.1. Descriptive statistics

A total of 4292 women were studied in this research. The study found that about 8 in 10 (84 percent) women used PNC services.

As shown in Table 4-1, the average age of women in this present study was 30.9 (SD=7.33) years. Close to half (46.7%) of the women had at least secondary education. Women without formal education used PNC services (74.1%) less than women with secondary or higher education (91.2%). The majority (52.2%) of the women were considered poor and of these, 76% used PNC services while rich women had the highest utilization rate of PNC services, at 95.2%. With respect to place of residence, 58.6% of the women resided in rural areas. Among urban dwellers, 92.0% used PNC services whereas 78.4% of rural residents utilized PNC services. Single women had the highest (87.3%) use of PNC services, though most (65.2%) of the women in the study were married. Among women who were not working, 85.8% received PNC services. Concerning religion, traditional or other believers represented the smallest group (7.5%) and they had lower PNC services utilization rate when compared to Muslims and Christians (Table 4-1). Women who had more than two birthing experiences were the majority (58.7%) and 81.1% of them used PNC services. Akan and northern tribe women constituted about 80 percent of the study respondents (Table 4-1).

4.3.2. Inferential statistics

Univariate model: Table 4-1 presents the study analyses results of the unadjusted associations between sociodemographic factors and the utilization of PNC services. Women's

age, education, wealth status, place of residence, religion, parity, and ethnicity all had p-values of less than 0.25 in the univariable model and were subsequently retained in the multivariable analyses.

Table 4-1. Distribution of PNC services utilization across sociodemographic factors (N=4,292), and Unadjusted odds ratio (UOR) and 95% confidence interval (CI) for socio-demographic factors of utilization of PNC services in the unadjusted GEE model, Ghana, 2014.

Study Predictors	**Overall N (%)**	**Used postnatal care N (%)**	**UOR (95% CI)**	**P-value**
Age (Mean ± SD)	30.9 ± 7.33	30.6 ± 7.03	0.98 (0.96, 1.00)	0.1*
Educational attainment				
No education	1,418 (33.0)	1,051(74.1)	Reference	<0.0002*
Primary	869 (20.3)	725 (83.4)	1.11 (0.84, 1.48)	
Secondary/Higher	2,005 (46.7)	1,829 (91.2)	2.12 (1.40, 3.20)	
Wealth status				
Poor	2,241 (52.2)	1,703 (76.0)	Reference	<0.0001*
Middle	811 (18.9)	751 (89.0)	2.01 (1.54, 2.61)	
Rich	1,240 (28.9)	1,180 (95.2)	4.74 (2.87, 7.86)	
Place of residence				
Urban	1777 (41.4)	1,634 (92.0)	3.06 (2.15, 4.35)	<0.0001*
Rural	2515 (58.6)	1,971(78.4)	Reference	
Marital status				
Cohabitating	830 (19.3)	672 (81.0)	1.00 (0.65, 1.51)	0.5
Widow/divorced/separated	300 (7.0)	254 (84.7)	1.07 (0.67, 1.71)	
Married	2,799 (65.2)	2,362 (84.4)	1.19 (0.85, 1.67)	
Single	363 (8.5)	317 (87.3)	Reference	
Employment status$^{\phi}$				
Working	3,403 (79.3)	2,842 (83.5)	0.93 (0.72, 1.20)	0.6
Not working	886 (20.7)	760 (85.8)	Reference	
Religion				

Muslim	922 (21.5)	801(86.9)	2.09 (1.35, 3.22)	0.0008*
Christians	3,046 (71.0)	2,621(86.0)	2.51 (1.54, 4.08)	
Traditional/other	324 (7.5)	183 (56.5)	Reference	
Parity				
One birth	935 (21.8)	826 (88.3)	1.36 (1.07, 1.73)	0.02*
Two births	838 (19.5)	737 (88.0)	1.22 (0.94, 1.58)	
Three or more births	2,519 (58.7)	2,042 (81.1)	Reference	
Ethnicity^				
Akan	1,642 (38.3)	1,473 (89.7)	1.96 (1.20, 3.21)	0.002*
Northern tribes	1,795 (41.8)	1,411 (78.6)	1.31 (0.82, 2.09)	
Ga	198 (4.6)	179 (90.4)	3.29 (1.67, 6.47)	
Other	180 (4.2)	150 (83.3)	1.18 (0.66, 2.10)	
Ewe	476 (11.1)	391 (82.1)	Reference	

N, number of observations; SD, standard deviation; %, percent; ΦN= 4289 and ^N=4291 , due to missing values; CI, confidence interval; UOR, Unadjusted odds ratio; *, p-value <0.25.

Multivariable model: Multicollinearity tests were conducted on all the independent variables that were selected for the adjusted model. The mean VIF value of 1.49 suggests low collinearity. All the study predictors had VIF less than 2.5. and tolerances above 0.40, a cut-off for models that are weak, and so adjustments for collinearity was not necessary.

Also, the area under the ROC of 0.73 (95%CI: 0.71-0.75) for the final model was moderately high indicating the model was a good binary classifier for the use of PNC services.

In the multivariable GEE model, no significant two-way interaction terms or confounding effects were identified. The final adjusted model had the smallest QIC (3451.3) relative to the null model (QIC=3797.9) and hence was selected as the best and most parsimonious model. From the multivariable model, strong associations were found between the use of PNC services and the study variables: wealth status, education, place of residence, religion, and ethnicity.

However, women's age and marital status were not significantly associated with the use of PNC services. The analysis revealed that middle-class and rich women were 1.65 (95%CI: 1.23-2.20) and 3.22 (95%CI: 1.99-5.20) times respectively more likely to receive PNC services when compared to poor women. Although no significant difference in the use of PNC services was found between primary educated women and those without formal education (p-value= 0.3), odds of receiving PNC services among women who had secondary or higher education were1.52 (95%CI:1.09-2.11) times more than women with no education. Also, urban dwellers had a higher propensity of using PNC services relative to rural dwellers (AOR=1.48, 95%CI: 1.02-2.15). Concerning religion, the likelihood of using PNC services was greater among Muslims (AOR= 2.26, 95%CI:1.53-3.34) and Christians (AOR=2.21, 95%CI:1.52-3.22) when compared to traditional or other believers. Lastly, Akan (AOR=1.79, 95%CI: 1.13-2.83) and Ga women (AOR=2.80, 95%CI: 1.31- 5.97) had a higher likelihood of using PNC services than Ewe women while PNC services usage among northern tribes (p-value= 0.1) and other ethnic groups (p-value=0.8) were not significantly different from the Ewes.

Population Attributable Risk: As displayed in Table 4-2, the PAR calculated for significant study predictors showed that 17% (95%CI:16.0-19.0) of the PNC services utilization in the study population was attributable to secondary or higher education. Regarding wealth, 8% (95%CI: 6.0-10.0) and 23% (95%CI: 22.0-24.0) of the utilization of PNC services in the study population were attributable to middle and rich wealth status respectively. Moreover, in the study population, 15% (95%CI: 14.0-16.0) of PNC services uptake was attributed to dwelling in urban areas whereas 40% (95%CI: 39.0-41.0) and 12% (95%CI: 11.0-13.0) of the PNC services utilization in the study population was attributable to being a Christian and a Muslim respectively. Finally, an estimated 18% (95%CI: 17.0-19.0) and 14% (95%CI: 13.0-15.0) of

PNC service utilization in the study population was attributed to being an Akan and a member of the northern tribes respectively.

Table 4-2. Adjusted odds ratio (AOR) and PAR with 95% confidence interval (CI) and p-value for sociodemographic factors of utilization of PNC services in the multivariable GEE model, Ghana, 2014

Predictors	**AOR (95%CI)**	**P-value**	**PAR (95%CI)**	**% PAR (95%CI)**
Age (years)	0.99 (0.97, 1.02)	0.6	–	-
Educational attainment				
No education	Reference		–	-
Primary	1.03 (0.79, 1.33)	0.9	-	-
Secondary/Higher	1.52 (1.09, 2.11)**	0.01	0.17 (0.16, 0.19)	17.0 (16.0, 19.0)
Wealth status				
Poor	Reference		–	-
Middle	1.65 (1.23, 2.20)**	0.001	0.08 (0.06, 0.10)	8.0 (6.0, 10.0)
Rich	3.22 (1.99, 5.20)**	<0.0001	0.23 (0.22, 0.24)	23.0 (22.0, 24.0)
Place of residence				
Urban	1.48 (1.02, 2.15)**	0.04	0.15 (0.14, 0.16)	15.0 (14.0, 16.0)
Rural	Reference		–	-
Religion				
Muslim	2.26 (1.53, 3.34)**	<0.0001	0.12 (0.11, 0.13)	12.0 (11.0, 13.0)
Christians	2.21 (1.52, 3.22)**	<0.0001	0.40 (0.39, 0.41)	40.0 (39.0, 41.0)
Traditional/other	Reference		–	-
Parity				
One birth	1.10 (0.86, 1.40)	0.4	–	-
Two births	1.04 (0.79, 1.36)	0.8	–	-
Three or more births	Reference		–	-
Ethnicity				
Akan	1.79 (1.13, 2.83)**	0.01	0.18 (0.17, 0.19)	18.0 (17.0,19.0)
Northern tribes	1.58 (0.84, 2.97)	0.2	-	-
Ga	2.80 (1.31, 5.97)**	0.008	0.03 (0.02, 0.04)	3.0 (2.0, 4.0)

Other	1.26 (0.63, 2.53)	0.5	-	-
Ewe	Reference		–	-

CI, confidence interval; AOR, Adjusted odds ratio; PAR, Population Attributable Risk; Ref, Reference; %, percent; ** Significant at p-value = 0.05; GDHS data 2014

4.4. DISCUSSION

This study reported higher (84%) uptake of PNC services compared to past studies in Ghana that reported uptake of 76% [20] and 43.8 percent [41]. These studies did not use recent GDHS data leading to disparities in the prevalence of PNC services usage [20, 41]. For example, a study [41] utilized 2003 GDHS data for their investigation.

Previous studies have found an insignificant association between use of PNC services and maternal age [16, 23], marital status [16, 18], employment status [23, 42] and parity [12] similar to this study. Besides, using a GEE model with a sandwich-based estimator of variance, this study estimated independently the significant impact of education, wealth status, place of residence, religion, and parity on the use of PNC services.

Furthermore, the link between maternal education and utilization of PNC services has been extensively studied [12, 16, 17]. The significant effect of women's education identified in this study is consistent with results reported by earlier research [12, 16, 17]. This finding can be explained by the observation that early health education intervention given after delivery tends to improve the use of PNC services [43, 44] but more educated women may benefit more from health education than uneducated women [18]. Also, women with advanced education may be knowledgeably informed about the availability of obstetric services as well as birth-related complications which could stimulate uptake of PNC services when necessary [5, 12, 45, 46]. Finally, well-educated women are likely to be familiar enough with technology [47], to navigate

through electronic media for maternal health messages [16] and the health information gained could make women confident and autonomous in seeking PNC services [12, 17, 48].

Additionally, the results from this research revealed that a substantial proportion of utilization of PNC services in the study population was attributed to women's wealth status which concurs with earlier studies [5, 16, 19]. Compared to the poor women, rich and middle-class women had increased likelihood of receiving PNC services and this may be because wealthier women can afford the expenses associated with seeking PNC services in spite of the free maternal health policy in Ghana as stated in an analogous study [49]. Other studies have supported the assertion that affluent women have abundant resources to enable them to allocate a substantial amount towards healthcare charges including PNC services [19, 50]. Also, financial hardship among poor women could restrict their access to information on obstetric services benefits and availability through the different media channels due to the inability to procure electronics such as radio, television, and computers [5, 51, 52]. Moreover, extra costs such as travel costs for PNC visit [51], informal tariffs at health institutions [53] may deter less privileged women from receiving PNC services.

The influence of place of residence on the utilization of PNC services has been well documented in other developing countries [43, 54, 55]. The PAR of residence derived in this research is comparable to a similar study[16], and the usage of PNC services was greater in urban relative to rural women, as observed in similar studies [54-57] This urban privilege could possibly be explained by the disproportionate distribution of health facilities being concentrated in urban settings and hence easier access to obstetric services in urban communities [58]. Due to the skewed distribution of health facilities, women in rural areas may have problems with distance to a health facility and longer travel time that could affect maternal health-seeking behavior [59,

60]. Reliable transport has also been found to improve the utilization of PNC services [19, 51]. This finding may be relevant to this present study because most rural areas in Ghana have poor transportation systems that make it difficult for mothers to travel long distances to a health facility to receive PNC services [61]. Also, health facilities in rural areas are generally limited by poor infrastructure and a shortage of qualified staff to provide quality obstetric services. The inadequacies of health facilities in rural areas may be a consequence of poor living conditions in rural communities which can serve as barriers to recruit trained health professionals [62, 63]. Perhaps, concerns about the quality of obstetric care services in rural areas may also deter women from seeking maternal care there [51, 64-66]. Moreover, unlike rural communities, urban communities tend to be more diverse with people from different cultural and socioeconomic backgrounds which promotes sharing of ideas and practices that can influence the uptake of obstetric care services including postnatal care services [17]. Lastly, women living in an urban area may be knowledgeable about obstetric services relative to those in rural areas because of their connectivity to social media, the influx of radio and television in urban areas that serve as a powerful tool to broadcast information on mother and baby's health and hence facilitates the uptake of these essential obstetric services as reported elsewhere [16].

In this study, religion played a significant role in the usage of PNC services similar to some previous studies However, findings from this research are not consistent with some studies that used smaller samples size to investigate PNC services use in some parts of Ghana [22, 23]. Previous studies indicated that religion and cultural customs are intertwined and affect maternal health services utilization [17, 51, 67]. Moreover, the underutilization of PNC services among traditional and other believers could be linked to the cultural practice of keeping babies in the house away from the public longer than the post-delivery period stated in similar studies [67,

68]. This finding highlights the need to engage religious leaders in establishing community and home-based PNC programs to enhance the use of PNC services as recommended in a Nepalese study [69].

Finally, this current study was consistent with earlier studies [17, 41, 70] that revealed a significant association between ethnicity and the use of PNC services. This study results established that Akan and Ga women had greater propensity of using PNC services. Also, the PAR of ethnicity generated in this study could be explained by the fact that ethnic groups have disparate cultural beliefs and practices during a postnatal period that tend to modify perceived need and utilization of PNC services as reported in comparable studies [71, 72].

Study strengths and limitations

This study used data from a population-based national survey with a large sample size and a non-response rate of just 3%. Moreover, GEE with a sandwich-based estimator, a robust model, was fitted on the clustered data that was used in this study to identify sociodemographic factors that have a significant association with PNC services usage for the computation of PAR. The study findings have contributed meaningfully to knowledge on obstetric service utilization and serve as a reference point for policy formulation and implementation in Ghana as well as other low-income countries. However, the study also suffers from some limitations. First, the data relied on self-reporting, which means that there may be a risk of information bias. Second, this study relied on the 2014 GDHS dataset that utilized a cross-sectional study design and so causality cannot be estimated.

4.5. CONCLUSION

This research confirmed that significant proportion of PNC services use was attributable to religion and ethnicity of the mothers . In addition, urban women who were affluent and well educated contributed significantly in the variation of PNC services utilization in the study population. Moreover, to ensure equitable use of PNC services, policies and programs need to be directed to the rural poorly educated women. Also, policies that are developed with religious leaders may assist in PNC uptake in certain religious populations. Lastly, subsequent studies should examine cultural factors and investigate community-level factors influencing PNC services utilization. .

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The socioeconomic and demographic determinants identified from **chapter 2** to **chapter 4** as well as the recognition that a substantial part of the disparities in obstetric care services use could be linked to women's community, has warranted this follow up chapter. **Chapter 5** build on the earlier chapters to identify high-risk communities and community-level predictors of postnatal care (PNC) services utilization independent of individual-level factors using a multilevel mixed logistic regression model.

Preprint of **chapter 5** is available online DOI: https://doi.org/10.21203/rs.3.rs-31656/v1

"(PDF) Assessing the Contextual Effect of Community in the Utilization of Postnatal Care Services in Ghana". Available from: https://www.researchgate.net/publication/342023764_Assessing_the_Contextual_Effect_of_Community_in_the_Utilization_of_Postnatal_Care_Services_in_Ghana [accessed Jul 21 2020].

Also, **chapter 5** has been submitted to the BMC Health Services Research "Dankwah, E., Zeng, W., Feng, C., Kirychuck, S., Lepnrum, R. & Farag, M. (2020). Assessing the Contextual Effect of Community in the Utilization of Postnatal Care Services in Ghana, BHSR-D-20-01224" (1.932 - 2-year Impact Factor). I conceptualized, reviewed the literature, cleaned and analyzed the dataset, and also did the interpretation of the findings and wrote the **chapter 5**.

Chapter 5. Assessing the Contextual Effect of Community in the Utilization of Postnatal Care Services in Ghana

5.1. INTRODUCTION

The post-natal period is a critical stage in the obstetric cycle, especially, the first 24 hours and early days following childbirth [1, 2]. Women and babies need special attention during this period because most deaths occur in that time [3]. Moreover, studies have found that adequate care during the post-partum period is vital for maternal and child survival, especially in poorer regions of the world with high maternal and neonatal mortalities [4, 5]. Researchers contend that achieving a post-natal care (PNC) services utilization rate of 90% in Africa could save between 10 to 27 percent of neonatal deaths [2].

Despite the benefits derived from PNC services, a large proportion of sub-Saharan Africa mothers and babies especially those that delivered outside health facility do not use post-natal services [6]. Ghana is a western African country that spans a land area of 238,535 km² [7] and shares boundary with Burkina Faso to the north, Cote d'Ivoire to the west, Togo to the east and the Gulf of Guinea on the south (Figure 5-1). Ghana had 10 administrative regions during the 2014 Ghana Demographic and Health Survey (GDHS) namely Western, Central, Greater-Accra, Volta, Eastern, Ashanti, Brong Ahafo, Northern, Upper East and Upper West (Figure 5-1). The situation is not different in Ghana, a nation with a fertility rate of 4 and approximately 76% livebirths from all pregnancies [7]. A critical mass of mothers and newborns lack needed PNC services [7, 8]. A previous study conducted in one administrative region of Ghana reported that PNC services covered 43.8% of mothers [8] whereas another study revealed that 56% of neonates immediately received PNC services within 48 hours after their birth [9] in Ghana. Such underutilization and discrepancies in the usage of postdelivery services exposes mother and

newborn to higher risk of morbidity and mortality [10], as well as undermining healthy behaviors and practices such as exclusive breastfeeding and uptake of family planning [1].

It is manifestly clear that identifying determinants of PNC service utilization are necessary to guide public health interventions. Most studies on the usage of PNC services are concentrated on identifying individual-level factors [11-15]. Although evidence exists at the individual-level that PNC services utilization is associated with socioeconomic predictors [13, 16-19], there is a general concern that PNC interventions focused solely on influencing individual-level risk factors do not achieve the desired results. For this reason, recent studies considered community-level effects [20, 21], but the results were mixed. For instance, Worku et al [22] found no significant area-level effects on the use of PNC services. Some multilevel studies in Tanzania [23], Nigeria [24], Zambia [25], Kenya [26] and India [27, 28] reported that a community-level effect strongly predicted PNC services use, after controlling for individual-level predictors. In addition, these previous studies estimated different community-level effects of communities on the utilization of PNC services; for example Mohan et al [23] and Solanke et al [29] reported that 12% and 37.2% unexplained community variance respectively accounted for the variability in PNC services use. Many methodological limitations accompanied these contradictory findings including the use of a limited number of independent variables and inadequate adjustment for confounding.

Likewise, inequalities in the use of PNC services across communities have been observed in Ghana [7]. However, research about the utilization of PNC services in Ghana is scanty [8, 30]. In addition, most of the studies were restricted to a specific geographical area of the country which seriously affects the potential for extrapolation of findings to the entire population [8, 30]. A thorough literature review indicated that community-level effects on variation in the use of

PNC services in Ghana remain uncertain. The review showed that the majority of studies conducted in Ghana used only individual-level data [12]. Hence, there is a dearth of evidence measuring the association between community-level risk factors and the utilization of PNC services specific to Ghana. This study intends to assess (1) the community-level effect on the utilization of PNC services in Ghana using a multilevel regression model with a logit link function and (2) explore the spatial pattern of non-use of PNC services across Ghanaian communities. The findings from this study could be used to inform equity-based interventions to improve the use of PNC services across communities in Ghana and other low-income countries.

Figure 5-1: Map of Ghana and its location in Africa. Source: http://www.mapsopensource.com.

5.2. METHODS

5.2.1. Study sampling and data source

This research used the 2014 Ghana Demographic and Health Survey (GDHS) dataset. As described by Ghana Statistical Service (GSS) [7], the participants of this survey were sampled nationwide from 427 clusters (hereinafter community) using a two-stage sampling technique. Overall, 9,396 women aged 15-49 years were chosen and interviewed after consenting to participate [7]. The 2014 GDHS response rate was 97 percent. This nationwide survey captured information including women's reproductive health, health-seeking behavior, socioeconomic, and demographic background as well as geo-reference data. The Global Positioning System (GPS) data were collected for all the 427 communities in Ghana. Out of the interviewed women, 4292 gave birth in the previous 5 years before the survey and responded to the interview question about whether they received skilled care after delivery (Figure 5-2), which constituted the study sample for this study. Detailed information on the sampling procedure and data is published in the Ghana Demographic and Health Survey of 2014 [7].

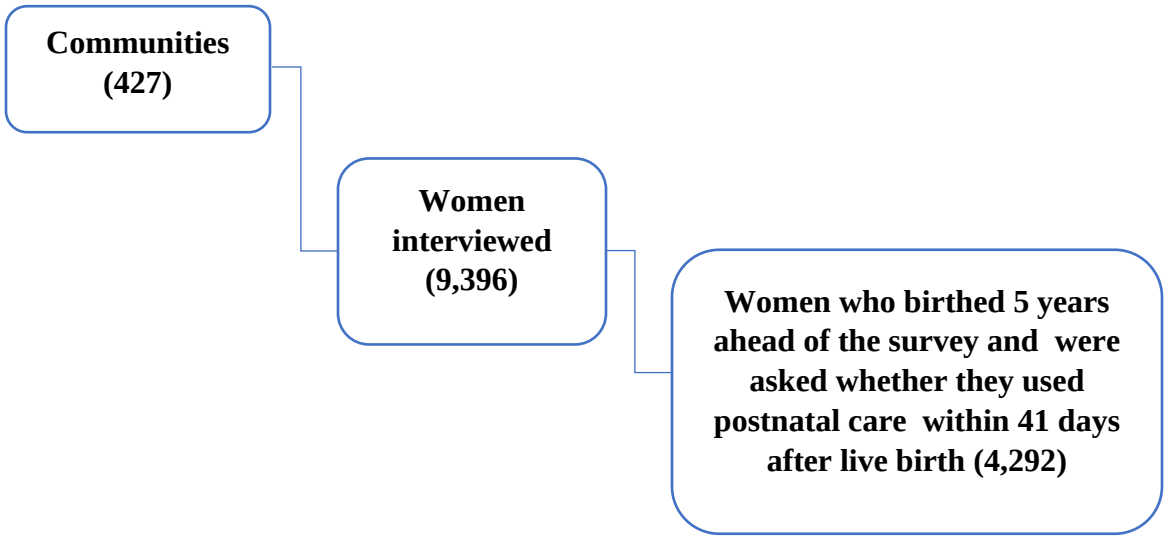

Figure 5-2. Hierarchical structure of the 2014 GDHS data.

5.2.2. Study factors

The dependent variable was whether the mother received PNC services from a health care provider after delivery within 41 days or not. The outcome measure was coded 'yes or no' depending on the response to the questionnaire. The questions in the survey regarding PNC services were restricted to last delivery in the past five years hitherto the 2014 GDHS to limit recall bias. The coding structure for the outcome variable has been detailed in Table 1.

The community-level and individual-level factors employed in this study were chosen using the Andersen health utilization model as displayed in Figure 5-3. Community-level factors describe the characteristics of the community while the individual-level factors focus on women's attributes. Andersen's behavioral model highlights the health system and community characteristics as well as predisposing and enabling factors as facilitating and inhibitory factors for health care utilization [31, 32].

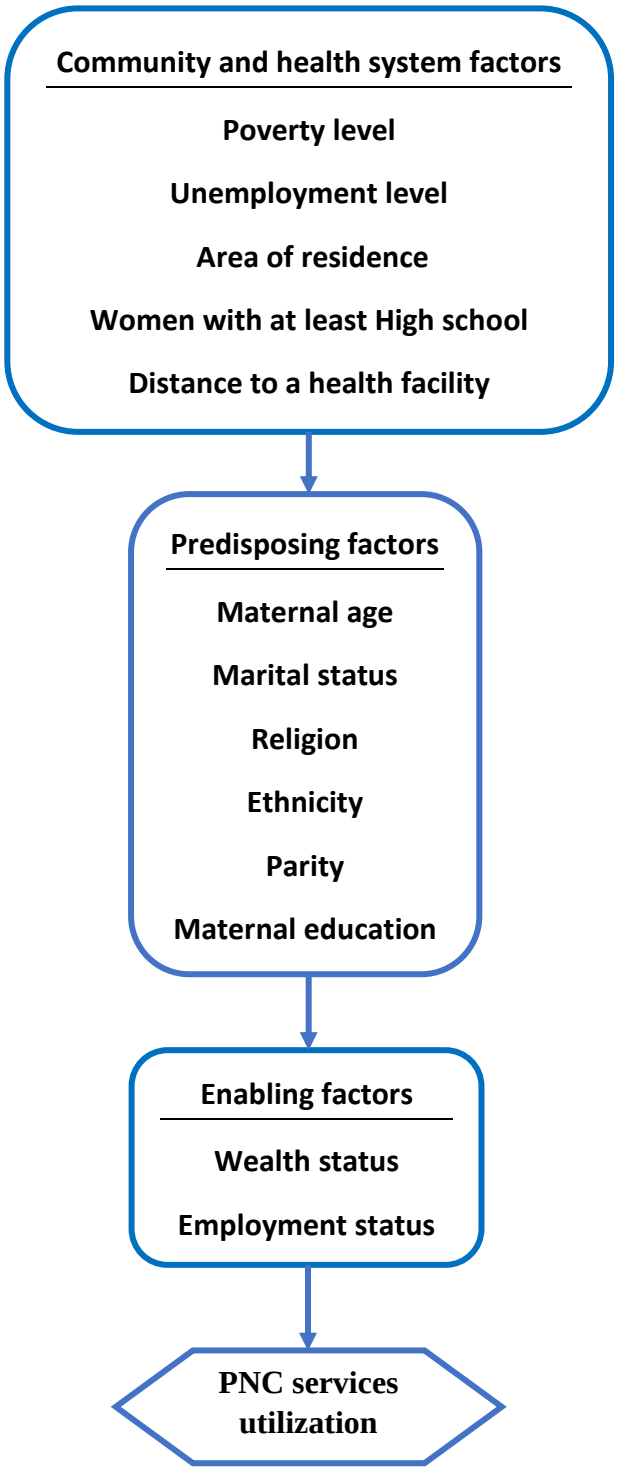

Figure 5-3. Adapted Andersen's health utilization model for PNC services utilization

According to the 2014 GDHS, information about the usual community the women lived in, whether rural or urban was captured and was termed as area of residence in this study. Also, the 2014 GDHS collected information about whether women had an issue with distance to a health facility when seeking medical attention. This survey question captured self-reported information on women's perceived distance to a health facility in their community and was referred hereinafter in this study as community-level problem with distance to a health facility. The 2014 GDHS created two dummy variables for distance to a health facility: a big problem (indicating longer distance) and not a big problem (suggesting shorter distance). This variable was used as a proxy to measure the effect of community-level problem with distance to a health facility on the dependent variable as done in an analogous study in Nigeria [46].

On the other hand, the community poverty level was categorized into two groups as reported in a similar study [33]. The community poverty level variable was created from the wealth index in the survey data. The GDHS wealth index was made from information on possession of household assets and dwelling factors including means of transport, refrigerator, toilet facilities among others [24]. The survey employed Principal component analysis to create wealth index [24] that was categorized into quintiles: poorest, poorer, middle, richer and richest. In this study, the poorest and poorer groups were merged to represent the poor category. The percentage of women who were poor per community was estimated. Community's level of poverty was coded as high '1' when above 50% otherwise was coded low '0' (Table 5-1).

The community level of education was generated from women's responses to the question "highest education attended" in the survey. The survey data categorized the highest education attended into 4 groups namely no education, primary (1-6 years), Secondary (7-12 years) and higher. For this study, the higher education attended variable was created by

combining secondary and higher education. The percentage of women with at least secondary education was computed for each community. Also, the community unemployment level was generated from the responses of women on either they were working or not. The survey data created two dummy variables of employment: working '1' and not working '0'. The percentage of unemployment per community was calculated. The study variables such as community level of education (p-value=0.67) and community unemployment level (p-value= 0.29) did not fail the linearity test and were examined as a continuous variable. The community-level factors that were analyzed to explain the discrepancies in the utilization of PNC services include the area of residence, community-level problem with distance to a health facility, community poverty level, community education level, and community unemployment level.

Individual-level variables that were studied in this research were maternal age, marital status, religion, ethnicity, parity, education, wealth status, and employment status. As exhibited in Table 5-1 of this study, maternal age was examined as a continuous variable. Marital status was grouped as single, cohabitating, widow/divorced/separated and married. In terms of religion, this study classified women into traditionalist or other, Muslim, and Christian. Also, this study considered ethnicity instead of region of residence to prevent multicollinearity issues and to comprehensively understand the level of inequalities in the use of PNC services especially among minority ethnic groups which will not be possible at the regional level (aggregate level). In this study, ethnicity was classified as Akan, Northern tribes, Ewe, Ga, and other groupings. For this research, the parity of the women was grouped into 1 birth, 2 births, and ≤ 3 births. Women's highest education level was classified into no education, primary, secondary or higher. This study grouped women's wealth status into poor, middle, and rich classifications. Finally,

women's employment status was grouped into not working and working. The categorizations of the study predictors were adopted from the literature [34, 35].

Table 5-1: Summary of study factors

Variable name	Variable Description	Coding structure
Dependent variable		
Postnatal care	Whether postnatal care was received or not within 41 days after live birth	Categorized, 0= No, 1= Yes
Individual-level variables		
Maternal age	Maternal age in years	Continuous, ranged from 15 to 49 years
Marital status	Current marital status	Categorized, 1 = Single, 2 = Cohabitating, 3 = Widow/divorced/separated, 4 = Married
Religion	Women's religious affiliation	Categorized, 1 = Traditional/other, 2= Muslim, 3 = Christian
Ethnicity	Ethnic group of the women	Categorized, 1 = Akan, 2= Northern tribes, 3 = Ewe, 4 = Ga, 5 = Other
Parity	History of births	Categorized, 1 = One birth, 2 = Two births, 3 = Three or more births
Educational attainment	Highest educational level	Categorized, 0 = No Education, 1= Primary, 2 = Secondary/ Higher
Wealth status	Wealth status of household	Categorized, 1 = Poor, 2 = Middle, 3 = Rich
Employment status	Working status of the women	Categorized, 1= Not Working, 2 = Working

Community-level variables	Variable Description	Coding structure
Distance to health facility	Community problem with distance to health facility	Categorized, 0 = not a big problem, 1= big problem
Area of residence	Whether community is rural or urban	Categorized, 0 = Rural, 1 = Urban
Community poverty level	Percentage poverty level per community	Categorized, 0 =Low (≤ 50%), 1= High (>50%)
Community educational level	Percentage of women with at least secondary education per community	Continuous, ranged from 0 to 100
Community unemployment level	Percentage of women without work per community	Continuous, ranged from 0 to 81.3

5.2.3. Statistical analyses

Descriptive statistics

This research employed Chi-square tests to ascertain the differences in the distribution of women across all the categories of the explanatory variables. In this study, proportions and frequencies of postnatal care services use were tabulated according to the hypothesized socio-demographic and economic predictors for women of child-bearing age. Mean and standard deviation and median and interquartile range were used for normally and non-normally distributed continuous variables respectively.

Spatial Clustering

This study hypothesized that spatial autocorrelations exist in the use of PNC services across communities. Kulldorff's spatial scan statistics is a powerful tool to detect spatial

autocorrelations based on geographic positioning [36]. This technique was employed in this study to identify local clusters of PNC services across the communities. For analyses, this study used the GDHS spatial data that only allows a set of coordinates per community. A purely spatial analysis was conducted using a discrete binomial model to scan for communities with high rates of non-utilization of PNC services in Ghana. SaTScan technique used in this study hypothesized that the risk of non-use of PNC services was likely different between the inner and outer parts of a circular window. The circular- shape spatial window scan communities to identify areas with a maximum spatial cluster size of 50 percent of the population at risk. The probability model relied on Monte Carlo simulation with replication of 999 and 50 percent of the population at risk was considered the maximum size of a spatial cluster [37]. The analyses were conducted using SaTScan software, version 9.6.0. The outputs generated from SaTScan analyses were displayed on Google Maps to highlight the spatial patterns of non-use of PNC services.

Multilevel regression model

Given the sampling technique and the hierarchical nature of the weighted 2014 GDHS data, a 2-level mixed logistic regression model was specified for the dichotomous outcome [20, 38] using mean-variance adaptive Gauss–Hermite quadrature at an integration point of 12. The components of the model were level one (individuals) nested in level two (communities). This study considers the error in the second level as a random effect to check for disparities in the likelihood of PNC services usage across the communities. The two-level mixed model used is stated below.

Equation 5-1: Multilevel logistic regression model

$$p\,(Yi = 1) = pi$$

$$\text{Logit}(pi) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots + \beta_k X_{ki} + \mu_{group(i)}$$

where $\mu j \sim N(0, \sigma^2_{group})$; β_0, intercept; β_k, regression coefficient of the variables; X_{ki}, study predictors; σ^2_{group}, community-level variance

Three models were estimated in this study. A null model was first fitted with no covariates. Second, unconditional mixed logistic regression analyses were conducted between the use of PNC services and each individual-level as well as community-level predictors. Unadjusted odds ratios were generated and correlations with liberal p-values of 0.25 or less were selected as candidates for the multivariate 2-level mixed modeling [39]. This unconventional cut-off was used to avoid the elimination of important predictors that could be masked or suppressed by other control variables [39, 40]. Lastly, as proposed by Hosmer and Lemeshow [40], a selection method that manually eliminates insignificant factors was utilized in the final model. This backward technique sequentially removes less relevant characteristics, beginning with the highest p-value and eventually retaining just significant predictors with a p-value less than or equal to 0.05.

A complete case analysis was used in this study to remove subjects with missing values. A polynomial model was used to test the assumption of linearity for age by introducing a quadratic term. Multicollinearity test for selected individual-level predictors was done to ensure inflated standard errors due to many predictors measuring the same characteristics are controlled. In this research, the parameters for variance inflation factor (VIF) ≤ 2.5 and tolerance ≥ 0.4 were set as recommended by Johnston et al [41]for the logistic regression model to identify potentially redundant variables due to collinearity.

Type-3 likelihood ratio test was used to examine categorical explanatory variables that have classifications greater than two. Predictors were considered confounders if the difference in the regression coefficient in the unconditional and conditional model was > 20% [39]. This study tested interactions among predictors that were significant in the multivariable model.

The final model had both fixed and random effects, which were reported as odds ratios and intraclass correlation coefficients (ICC) respectively. To compare the effect on individuals across the communities, this study manually calculated population-averaged odds ratios (ORs) and 95% confidence intervals from the subject-specific coefficients from the final model using the following equation:

Equation 5-2: Population-averaged Odds Ratios

$$\beta_{PA} = \beta/(\sqrt{(1 + 0.346\sigma^2 group)})$$

where σ^2_{group} is community-level variance, β is the subject-specific regression coefficient.

Based on the latent response variable approach [42], the variance partition coefficient (VPC) which is also referred to as Intraclass Correlation Coefficient (ICC) was calculated for the community in both the null and final model, which measures the variability in the dependent variable attributable to the contextual level [43]. The VPC was computed from this formula below.

Equation 5-3: Variance Partition Coefficient (VPC)

$VPC = \sigma^2 group/((\sigma^2 group + \pi^2/3)$ where σ^2_{group} is community-level variance.

This study computed "design effect (deff)", the quotient of the variance in a clustered data structure relative to that in an independent structure. Due to the fact that the variation within or between clusters for discrete data is not always constant, deff is an approximation [44].

Equation 5-4: Design effect

$$deff \approx 1 + (C - 1) \times ICC,$$

where C is average cluster size and ICC represents intraclass correlation coefficient.

The final model in this study was compared with the null model, and a smaller value of Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC) was regarded as a parsimonious model [45]. Also, model diagnostics was done using the area under the curve (AUC) of the receiver-operating characteristic (ROC). Alpha level of 0.05 was used to gauge the association that was statistically significant in this current research. STATA 14 (Stata Corp. Inc., TX, USA) was employed in this study.

5.3. RESULTS

5.3.1. Descriptive statistics

In this study, a total of 427 communities were examined and within all these communities 84% of the mothers utilized PNC services whilst 16% did not use with significant inequities in the utilization of this essential service (Figure 5-4).

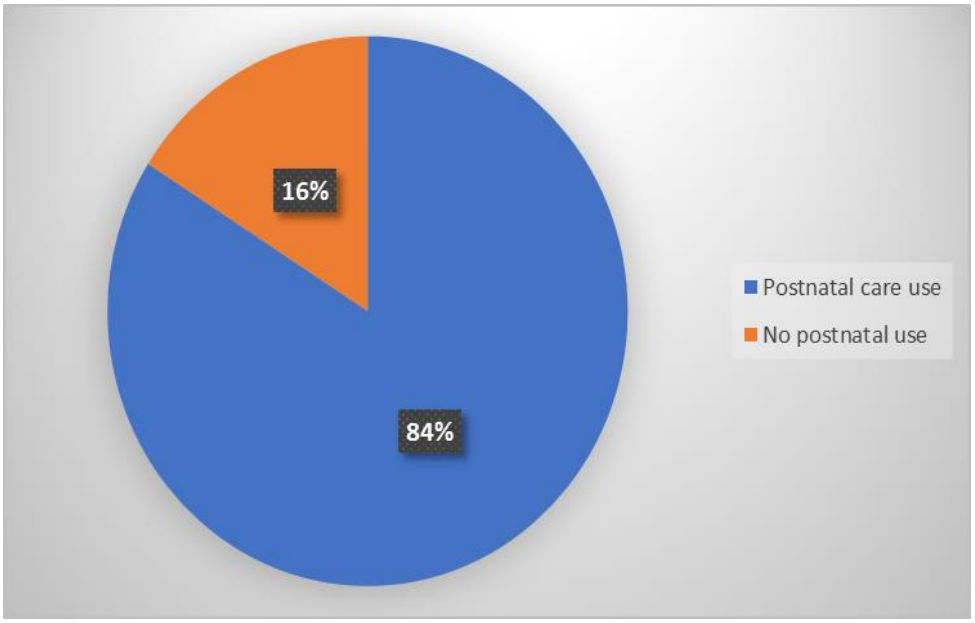

Figure 5-4. Distribution of postnatal care service utilization among reproductive aged Ghanaian women, 2014 GDHS data.

Spatial Autocorrelation

The median number of women per community that reported non-use of PNC services was 1 (Interquartile range (IQR): 0-2). Regarding clusters with high rates of non-utilization of PNC services, this study found significant spatial autocorrelations of non-use of PNC services in Ghana (Figure 5-5). The spatial scan statistic output identified 4 significant clusters with disproportionately higher non-usage of PNC services than their neighboring communities. The biggest cluster composed of 13 communities in the northern region and three communities in the Volta region, covering a diameter of 123.9 kilometers. This cluster had a relative risk of 3.97 (p-value <0.00001) which indicates that women who dwell in the area were 3.97 times more likely to miss PNC services than surrounding communities. Also, a second cluster was detected among ten northern communities covering a diameter of 80.1 kilometers. The risk of not receiving PNC services among women who resided in this cluster area was 3.93 times more when compared to those outside that locality. Furthermore, this study detected another significant cluster that

comprised of 15 communities: Volta region (8 communities), Brong Ahafo (2 communities) and Northern region (5 communities). The cluster diameter was 78.8 kilometers and the relative risk of not using PNC services in the clustered area was 2.36 (p-value < 0.000003). This revealed that women who live in this locality were 2.36 times more likely not to utilize PNC services relative to bordering communities (Figure 5-5). Lastly, a cluster was identified in the Eastern region of Ghana which was made up of five communities covering a diameter of 40.78 kilometers; women living in this clustered locality had a likelihood of not using PNC services which was 3.51 times higher than dwellers in the surrounding communities (Figure 5-5).

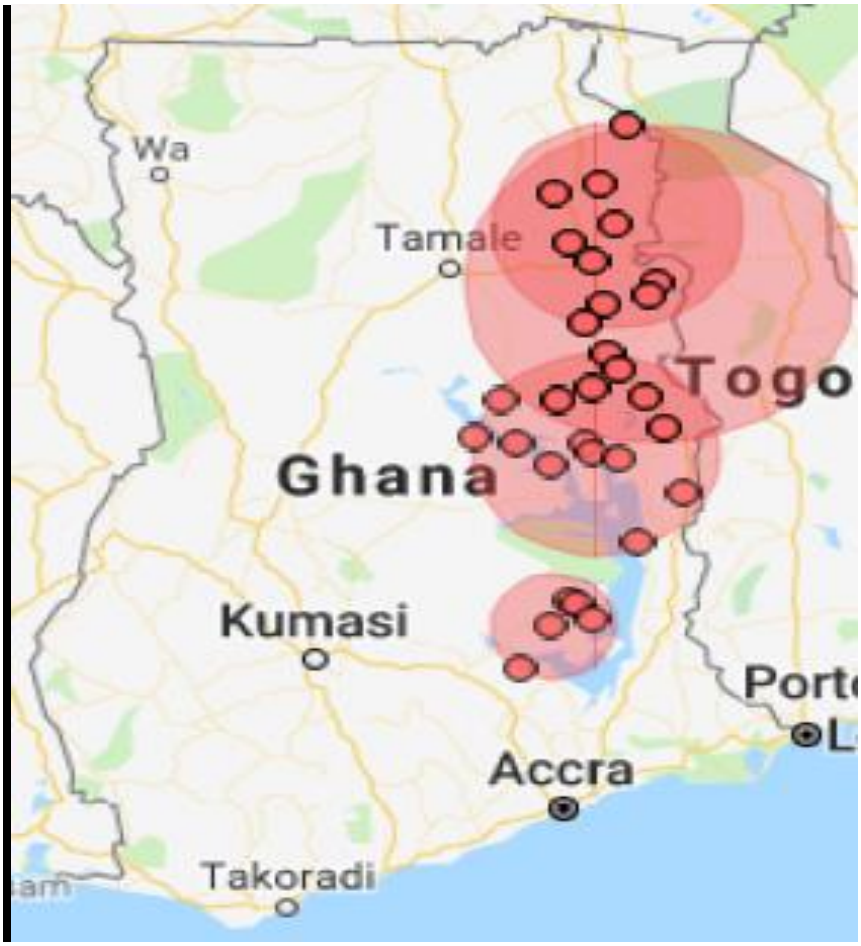

Figure 5-5: Map of Ghana showing significant clusters of non-utilization of PNC services

Community-level characteristics

The distribution of study predictors by the community has been outlined in Table 5-2. Concerning the community-level problem with distance to a health facility, 69.3% of the communities did not have a big problem with distance to a health facility while 30.7 percent had a big problem with distance to a health facility. In terms of PNC services utilization, 87.5% and 76.0% utilization rates were found in communities that did not have a big problem with distance to a health facility and communities with a big problem with distance to a health facility respectively.

Regarding area of residence, about 58.6 percent of the communities were in rural areas whereas about two-fifth (41.6%) of the communities were situated in the urban areas. The utilization rate of PNC services in urban communities was 98.0% whilst 78.4% occurred in rural communities (Table 5-2).

With respect to poverty levels of communities, PNC services utilization rate was 71 percent in communities with a high poverty level whereas it was 89.3 percent in communities with a low poverty level (Table 5-2). This implies that women residing in poorer communities have lower utilization of PNC services. The average community-level percentage of women with at least secondary education was 45.1±26.02. Community unemployment level variable met the linearity assumption (p-value=0.29). The average percentage of communities' unemployment was 26.4±13.01 (Table 5-2).

Individual-level characteristics

Table 2 displays the distribution of individual-level socioeconomic control variables by PNC services use. Regarding age, the linearity assumption was not violated (p-value= 0.148) and

hence was analyzed as a continuous variable. Overall, 4292 women were included in the study, their ages were from 15 to 49 years with a mean age of 30.9±7.3 years. Among women who received PNC services, the average age was 30.6±7.0 year (Table 5-2).

Regarding marital status, 65.2% of the women were married, 19.3% were cohabitating, 8.5% were single while 7.0% were divorced or widowed or separated. Comparison in the use of PNC services by marital status showed that 87.3% of single women received PNC services, 84.7% of divorced or widowed or separated, 84.4% of married and 81.0% of cohabitating women used PNC services (Table 5-2).

Concerning religion, Christians represented 71 percent of the study respondents. Muslims accounted for 21.5% of women whilst 7.5% were traditional or other believers. In connection with PNC services, 56.5% of women who were traditional or other believers used PNC services. Most Christians (86.0%) and Muslims (86.9%) received PNC services (Table 5-2).

Northern tribes constituted 41.8% of the study population followed by Akans (38.3%) while other ethnic groupings were the least represented (4.2%) among the study participants corresponding with their percentage in the population. The highest utilization of PNC services was found among Ga women (90.4%) whereas northern tribe women had the highest non-utilization of PNC services (21.4%)(Table 5-2).

Considering parity, 58.7% of women had at least 3 births whereas 21.8% and 19.5% of the women had given birth once and twice respectively. Further, 81.1% of women who had given birth thrice or more used PNC services. Among women who had one birth and two births, 88.3% and 88.0% respectively received PNC services (Table 5-2).

Concerning education, 33.0% of women had no education and 46.7% had at least secondary education. In terms of the use of PNC services, 83.4% of women who attained primary education and 91.2% of women who had secondary or higher education received PNC services. Among women with no education, 74.1% used PNC services (Table 5-2).

As for wealth status, more than half (52.2%) of the women were considered poor, 28.9% were rich, and the remaining18.9% were middle-class. Regarding uptake of PNC services, 76% of poor women received PNC service whereas 81.4% and 95.2% of middle-class and rich women used PNC services respectively (Table 5-2). Referring to women's employment status, 79.3% were working and 83.5% of those working received PNC services compared to 85.8% of women who were not working (Table 5-2).

Table 5-2: Distribution of women by predictors and PNC services utilization, and unadjusted odds ratios (UOR), 95%CI, and p-values for predictors of using PNC services among Ghanaian women from the univariable 2-level logistic regression model.

Predictors	**Overall (N=4,292)%**	**Used postnatal care (N =3,605)%**	**No postnatal care (N = 687)%**
Individual-level characteristics	**N (%)**	**N (%)**	**N (%)**
Age (Mean ± SD)	30.9 ± 7.33	30.6 ± 7.03	31.3 ± 7.62
Marital status			
Single	363 (8.5)	317 (87.3)	46 (12.7)
Cohabitating	830 (19.3)	672 (81.0)	158 (19.0)
Widow/divorced/separated	300 (7.0)	254 (84.7)	46 (15.3)
Married	2,799 (65.2)	2,362 (84.4)	437 (15.6)
Religion			
Traditional/other	324 (7.5)	183 (56.5)	141(43.5)
Islam	922 (21.5)	801(86.9)	121(13.1)
Christians	3,046 (71.0)	2,621(86.0)	425(14.0)

Ethnicity^	**Overall (N=4,292)%**	**Used postnatal care (N =3,605)%**	**No postnatal care (N = 687)%**
Akan	1,642 (38.3)	1,473 (89.7)	169 (10.3)
Northern tribes	1,795 (41.8)	1,411 (78.6)	384 (21.4)
Ewe	476 (11.1)	391 (82.1)	85 (17.9)
Ga	198 (4.6)	179 (90.4)	19 (9.6)
Other	180 (4.2)	150 (83.3)	30 (16.7)
Parity			
One birth	935 (21.8)	826 (88.3)	109 (11.7)
Two births	838 (19.5)	737 (88.0)	101 (12.1)
Three or more births	2,519 (58.7)	2,042 (81.1)	477 (18.9)
Educational attainment			
No education	1,418 (33.0)	1,051(74.1)	367 (25.9)
Primary	869 (20.3)	725 (83.4)	144 (16.6)
Secondary/Higher	2,005 (46.7)	1,829 (91.2)	176 (8.8)
Wealth status			
Poor	2,241 (52.2)	1,703 (76.0)	538 (24.0)
Middle	811 (18.9)	751 (89.0)	89 (11.0)
Rich	1,240 (28.9)	1,180 (95.2)	60 (4.8)
Employment status$^{\phi}$			
Not working	886 (20.7)	760 (85.8)	126 (14.2)
Working	3,403 (79.3)	2,842 (83.5)	561(16.5)
Community-level characteristics			
Community Problem with distance to health facility			
Not a big problem	2,973 (69.3)	2,603 (87.5)	370 (12.5)
Big problem	1,319 (30.7)	1,002 (76.0)	317 (24,0)
Area of residence			
Urban	1777 (41.4)	1,634 (92.0)	143 (8.0)

Rural	2515 (58.6)	1,971(78.4)	544 (21.6)
Community Poverty level			
Low High	3,046 (71.0) 1,246 (29.0)	2,720 (89.3) 885 (71.0)	326 (10.7) 361 (29.0)
Community Education level			
Percentage of women with at least secondary education per community (Mean ± SD)	45.1 ± 26.02	54.6 ± 26.11	35.6 ± 26.20
Community unemployment level			
Percentage of women without work per community (Mean ± SD)	26.4 ± 13.01	27.6 ± 12.95	25.2 ± 13.06

N, number of observations; SD, standard deviation; %, percent; ϕN= 4289 and ^N=4291 , due to missing values; CI, confidence in; GDHS data 2014

Inferential statistics

Univariable analysis results: Two-level mixed models were fitted to account for community-level variance. Most communities had more than one woman who participated in the 2014 GDHS, and this has the tendency to cause clustering in the dataset. The number of women in the community ranged from 1 to 33 with an average of about 10 women per community. The design effect of 4.3 computed in this study suggested a clustered data structure and hence justified the use of multilevel analysis as proposed by Maas and Hox [44]. In the univariate model, only women's marital (p-value=0.4) and employment (p-value=0.8) status had p-values greater than 0.25 and were excluded from the study (Table 5-3).

Table 5-3: Distribution of women by predictors and PNC services utilization, and unadjusted odds ratios (UOR), 95%CI, and p-values for predictors of using PNC services among Ghanaian women from the univariable 2-level mixed logistic regression model.

Predictors	**UOR (95% CI)**	**P-value**
Individual-level characteristics		
Age (years)	0.98 (0.97, 0.99)	0.02
Marital status		
Cohabitating	0.84 (0.55, 1.27)	0.4
Widow/divorced/separated	0.94 (0.56, 1.57)	
Married	1.05 (0.72, 1.53)	
Single	Reference	
Religion		
Islam	3.03 (1.98, 4.65)	<0.0001
Christians	3.04 (2.18, 4.22)	
Traditional/other	Reference	
Ethnicity		
Akan	1.88 (1.26, 2.81)	0.0001
Northern tribes	1.07 (0.71, 1.62)	
Ga	2.69 (1.35, 5.33)	
Other	0.85 (0.49, 1.66)	
Ewe	Reference	
Parity		
Three or more births	0.65 (0.50, 0.85)	0.0005
Two births	0.96 (0.69, 1.33)	
One birth	Reference	
Educational attainment		
No education	0.41 (0.31, 0.52)	<0.0001
Primary	0.52 (0.40, 0.69)	

Secondary/Higher	Reference	
Wealth status		
Poor	0.18 (0.13, 0.26)	<0.0001
Middle	0.39 (0.27, 0.58)	
Rich	Reference	
Employment status		
Working	0.97 (0.76, 1.24)	0.8
Not working	Reference	
Community-level characteristics		
Community Problem with distance to health facility		
Not a big problem	1.39 (1.11, 1.73)	0.004
Big problem	Reference	
Area of residence		
Urban	3.32 (2.35, 4.68)	<0.0001
Rural	Reference	
Community Poverty level		
High	0.28 (0.20, 0.41)	<0.0001
Low	Reference	
Community Education level		
Percentage of women with at least secondary education per community	1.03 (1.02, 1.04)	<0.0001
Community unemployment level		
Percentage of women without employment per community	1.01 (0.99, 1.02)	0.22

CI, confidence interval; UOR, unadjusted odds ratio; GDHS data 2014

Multivariable analysis results: Apart from marital status and employment status variables that were not considered in the adjusted model, the rest of the study variables were tested for multicollinearity. All risk factors that were selected for the adjusted model had VIF ≤ 2.5 and tolerance ≥ 0.4. In addition, the overall mean VIF of 1.58 indicated that multicollinearity was not considered problematic (Table 5-4).

Table 5-4: Results of multicollinearity test for selected predictors for the multivariable model

Predictors	**VIF**	**Tolerance**
Individual-level characteristics		
Age	1.66	0.60
Religion	1.21	0.83
Ethnicity	1.03	0.97
Parity	1.73	0.58
Education	1.86	0.54
Wealth status	2.42	0.41
Community-level characteristics		
Community Problem with distance to health facility	1.33	0.75
Area of residence	1.82	0.55
Community Education level	2.50	0.40
Community Poverty level	1.52	0.66
Community unemployment level	1.05	0.95
Mean VIF	**1.58**	

As shown in Table 5-5, the final model had smaller AIC and BIC; therefore, was selected as a more parsimonious model (AIC= 3146.7 ; BIC=3235.8) than the model without risk factors

(AIC=3304.9, BIC=3317.6). The AUC of 0.86 (95%CI: 0.85-0.87) from the ROC curve demonstrates the model is a good binary classifier of PNC service use or not (Figure 5-6).

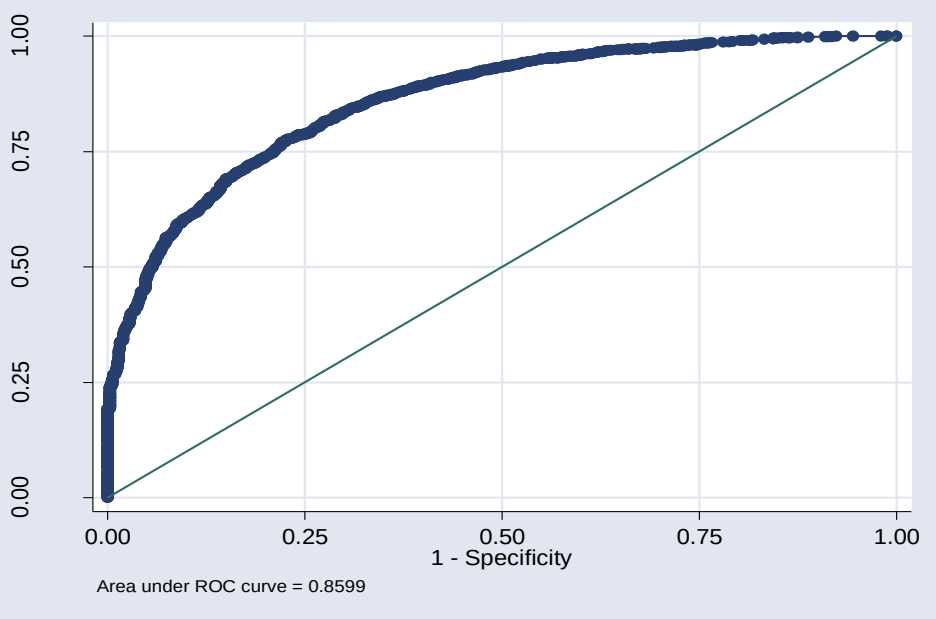

Figure 5-6. Receiver Operating Characteristics curve of the final model

The results from the multivariable 2-level mixed model with logit link function are shown in Table 5-5. In this study, potential confounders were maintained in the model. No interaction term was found beyond the significant main effects of the predictors in the multivariable model.

Community-level effect (Random effects)

In this study, intraclass correlation coefficients (ICC) computed from the 2-level mixed logistic regression models were used to measure the degree of heterogeneity in PNC services use accounted for by the differences between communities. The ICCs showed significant proportions of variability in PNC utilization in this study. The intercept only model (without study variables)

examined in this study reported significant variation in PNC services utilization across the communities (ICC =0.36 (95% CI: 0.30-0.42). The variation in the use of PNC services across the community continued to be significant after including individual-level study predictors. The result from the final model showed that 24% (95% CI: 0.18-0.30) of the unobserved variation in PNC services utilization could be explained by community heterogeneity (Table 5-5).

Moreover, the results of the association between community-level predictors and receiving PNC services are shown in Table 5. This analysis indicate that the likelihood of using PNC services by a woman, who resided in a community with a higher poverty level was 0.60 (95%CI:0.44-0.81) times less likely than a woman who lived in a community with a lower poverty level. Also, a moderate association between community-level secondary or higher education and the use of PNC services was identified. For a one percentage change in the level of community secondary or higher education, the odds of using PNC services increases by 1.01 (95%CI:1.01-1.02) times. However, the analyses indicate that the effect of a community-level problem with distance to a health facility, area of residence and community-level unemployment on the utilization of PNC services in the crude model were diminished in the multivariable model after controlling for other explanatory factors. The use of PNC services did not have an independently significant association with community problem with distance to a health facility (AOR=1.08, 95%CI: 0.89, 1.32), area of residence (AOR=1.05, 95%CI: 0.75-1.46) and community-level unemployment (AOR=0.99, 95%CI: 0.98-1.00).

Individual-level effect

Based on Table 5-5, the findings of this study show that religion, ethnicity, education, and wealth status emerged as significantly associated with services uptake. The study results

showed that Muslims (AOR= 2.42, 95%CI: 1.68-3.49) and Christians (AOR= 1.99, 95%CI: 1.50-2.63) were more likely to receive PNC services compared to women who were traditional and other believers from any community. Similarly, odds of receiving PNC services by women who were Akan (AOR=1.46, 95% CI: 1.05-2.05), Northern tribes (AOR=1.74, 95%CI: 1.19-2.54), and Ga (AOR=1.87, 95%CI:1.05-3.33) were higher than Ewe women from any community. Also, the findings from this research highlighted that the likelihood of receiving PNC services among women with no education (AOR= 0.72, 95%CI: 0.56-0.92) and primary educated women (AOR= 0.60, 95%CI: 0.61-0.99) were lower when compared to women who attained secondary or higher education from any community. On wealth status, the odds of receiving PNC services among poor and middle-class women were 0.44 (95%CI: 0.31-0.63) and 0.60 (95% CI: 0.43–0.85) times respectively lower than rich women who reside in any community. Conversely, individual-level factors such as age, and parity were not significantly associated with the use of PNC services (Table 5-5).

Table 5-5: Population-averaged Odds ratios (OR) and 95%CI for socioeconomic predictors of using PNC services among Ghanaian women from the final 2-level mixed logistic regression model.

Predictors	**Null model OR (95% CI)**	**Final model AOR (95% CI)**	**P-value**
Fixed effect			
Individual-level characteristics			
Age (years)		1.00 (0.98, 1.01)	0.9
Religion			
Muslim Christians		2.42 (1.68, 3.49)* 1.99 (1.50, 2.63)*	<0.0001 <0.0001

Traditional/other		Reference	
Ethnicity			
Akan		1.46 (1.05, 2.05)*	0.03
Northern tribes		1.74 (1.19, 2.54)*	0.004
Ga		1.87 (1.05, 3.33)*	0.03
Other		1.05 (0.62, 1.77)	0.9
Ewe		Reference	
Educational attainment			
No education		0.72 (0.56, 0.92)*	0.009
Primary		0.60 (0.61, 0.99)*	0.04
Secondary/Higher		Reference	
Parity			
Three or more births		0.87 (0.69, 1.11)	0.3
Two births		1.01 (0.76, 1.35)	0.9
One birth		Reference	
Wealth status			
Poor		0.44 (0.31, 0.63)*	<0.0001
Middle		0.60 (0.43, 0.85)*	0.004
Rich		Reference	
Community-level characteristics			
Community Problem with distance to health facility			
Not a big problem		1.08 (0.89, 1.32)	0.4
Big problem		Reference	
Area of residence			
Urban		1.05 (0.75, 1.46)	0.8
Rural		Reference	
Community Poverty level			
High		0.60 (0.44, 0.81)*	0.001

Low		Reference	
Community Education level			
Percentage of women with at least secondary education per community		1.01 (1.01, 1.02)*	0.001
Community unemployment level			
Percentage of women without employment per community		0.99 (0.98, 1.00)	0.5
Random effects	**Null model**	**Final model**	
Community level variance (95% CI))	1.84** (1.40, 2.42)	1.02 (0.73, 1.42)*	
ICC (95% CI)	0.36 (0.30, 0.42)	0.24 (0.18, 0.30)*	
Model fit statistics			
AIC	3304.9	3146.7	
BIC	3317.7	3235.8	

CI, confidence interval; OR, Odds ratio; SE, Standard error; ICC, Intraclass Correlation Coefficient; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; *significant at $p<0.05$; GDHS data 2014

5.4. DISCUSSION

This study reported a higher utilization rate of PNC services across communities than findings of the Sakeah study team in Ghana; this discrepancy may have arisen because they studied only two rural districts with a smaller sample size [12].

Also, this research found that the community-level variables: problems with distance to a health facility; area of residence; and community-level unemployment level were not significantly associated with the use of PNC services. In agreement with this research, Mohan et al [23] reported no significant association between community-level distance to a health facility and PNC services utilization. Also similar to this study, some researchers reported that the

association between use of PNC services and area of residence was not significant [25, 46]. In addition, a study by Darega et al [47] found no significant association between employment status and the use of PNC services. However, the results of this study are not consistent with other studies conducted in other developing countries which found a significant association between the use of PNC services and employment status [13]. This might be explained by the fact that contrary to these previous studies, which were carried out at the individual level, this study assessed community-level unemployment independent of individual level characteristics so there is a difference in the level of analysis.

Most importantly, this study found significant variability in use of PNC services utilization at the community level independent of individual-level characteristics. The association between community-level poverty and use of obstetric care services has long been established in the literature [33, 47-49]. Nonetheless, the evidence is somewhat mixed as the results from a previous study that was conducted in the rural part of Tanzania found no substantial association between community-level poverty and utilization of PNC services [23]. This current study adds to the body of evidence indicating that poverty at the community level matters over and above poverty at the individual level; this finding may be explained by women in poorer communities inability to afford indirect costs such as transportation, illegal fees being demanded at health facilities among other costs that are often required for accessing obstetric services [50], even though postdelivery care itself is free. Also, women from poorer communities might suffer discrimination from health workers [51, 52], which could make them avoid further contact with the health system including PNC services. Lastly, as expected evidence confirms that women from richer communities face lower barriers to receiving needed maternal healthcare [53].

Contrary to a study that found no significant effect of community-level education on the utilization of PNC services [23, 49], this research identified a significant association between the use of postnatal services and community-level education. The limited number of explanatory variables that were used in the previous studies could explain the discrepancies in the findings because confounding variables can potentially alter the results when they are insufficiently controlled. The findings of this study highlight the importance of community-level education, in that higher education means better access to health information and hence better understanding of the benefits of maternity services, and often more autonomy to choose evidence-based obstetric services rather than potentially harmful cultural practices [54].

Additionally, this study identified that most of the significant clusters of non-utilization of PNC services were found in the Northern region. This result affirms the long-held notion of spatial disparities in the utilization of obstetric care services between northern and southern regions of Ghana [48, 55]. Similar trends have been observed by other studies on maternal health services utilization [51, 52]. Also, this study revealed that a significant portion of the variation in PNC services use was attributed to unobserved community-level variance like other studies elsewhere [23, 49]. Specifically, this study found that about 24% of variability in the usage of PNC services could be explained by unmeasured community-level characteristics.

Apart from women's community poverty and educational level that may partially explain the inequalities in the use of PNC services as identified in this study, this spatial and unexplained variation in the utilization of PNC could be as a result of some potentially relevant community-level factors for which data are not available. The geographical variation in the non-utilization PNC services may be attributed to inadequate number of health facilities and health professionals in the northern region as suggested the earlier Addai study [55]. Also, media

exposure tends to influence the community's uptake of maternal health services including PNC services based on previous studies [24, 33]. The differential usage of PNC services perhaps may be due to the influential role of cultural values and practices as reported in other studies [56]. However, the GDHS data lacks variables which could be used as proxies for cultural variables that influence maternal health-seeking behavior, and so further studies are required to unravel the influence of community's cultural underpinnings on the use of PNC services. Future research is warranted to identify further community-level characteristics that could explain the unmeasured community heterogeneity in PNC services uptake in Ghana. Notwithstanding, the link between the community where women reside, and the use of PNC services established in this study is of importance since it provides insight into the community-level influence to help address the inequalities in PNC services use.

Concerning individual-level predictors, some past studies did not find significant association between PNC services utilization and women's age [23, 49], marital status [25], employment status [14, 15], and parity [23] similar to the findings of this present study. In this current research, wealth status of women was found to be significantly associated with the use of PNC services. The odds of receiving PNC services were lower among the poor and middle-class women than rich women. This result is consistent with findings of studies conducted in Nigeria [20], India [28] and Bangladesh [57]. The literature seems to unequivocally suggest that wealthier women have better access to maternal health services in general since they can afford the ancillary costs that are related to accessing PNC services [58].

Also, some comparable studies in other developing countries reported that maternal education significantly influences PNC service utilization [20, 23, 59]. Consistent with these studies, this research found that lower education was negatively associated with uptake of PNC

services. Specifically, this study identified a lower likelihood of PNC service use among women with no education and women with primary education relative to women with at least secondary education. This is an expected finding and can be explained by an educated women's higher likelihood to be more informed about health risks and benefits which is then translated into demand for PNC services [11]. On the other hand, less educated women may not be knowledgeable about availability and accessibility of PNC services as well as how the health system operates [49]. Also, these lower educated women could have less influence in decision making about their health and this eventually affects PNC services uptake [59].

Moreover, this research revealed that religion is significantly associated with the use of PNC services with traditional and other believers having significantly lower levels of PNC utilization, which is consistent with the findings of a study by Ononokpono et al [20]. This study finding may be explained by previous research's findings that reported on the traditional cultural practice of keeping newborns from the public due to fear of harm in the first month after their birth [56]. To increase the uptake of PNC services among this group, the involvement of religious leaders and home visits have been proposed by earlier studies [56, 60]. This study suggests that the effect of religion on postnatal care use should be further investigated to better understand the underpinnings.

Finally, some sub Saharan African studies are consistent with this research that ethnicity is a significant predictor of PNC services utilization [20, 61]. Ethnic groups are predominantly made up of people who share similar characteristics, and this has the potential to influence their perception about health and ultimately women's health seeking behavior [20, 62].

Study strengths and limitations

This study contributes to the growing literature on the effect of community-level factors on the uptake of PNC services. Multilevel mixed modeling was used to ascertain the impact of community-level factors on the use of PNC services, which is a more advanced approach to estimating the relationships than much of the available literature. Also, this study highlighted communities with a higher risk of not receiving PNC services for targeted interventions. Another significant strength of this research is the use of a large nationwide population-based dataset with a very high (97%) response rate. Despite these strengths, there are limitations in interpreting the results. First, self-reported data can lead to information bias, which could affect accurate classification. Recall bias could be a concern; however, information on the women's PNC services use was restricted to 5 years preceding the survey and hence recall bias is probably not a major concern in this study. Also, medical need and information on quality of service received as well as cultural variables were not available in the secondary dataset of the 2014 GDHS. This study considered enumeration areas as communities, which may not necessary be representative of the actual communities because they have arbitrary boundaries. The 2014 GDHS lacked variables to examine the effect of travel time, quality of care, transportation system and cost of travel on the use of obstetric care services [24]. For this reason, only distance to a health facility was used in this research; relying on the response to the question of whether the distance to a health facility was either a "big problem or not a big problem" in the survey. Also, the GPS points taken in the 2014 GDHS were deliberately displaced randomly at a maximum of 2 kilometers and 5 kilometers in urban and rural communities respectively and seldom repositioning at random one GPS point by 12 kilometers to ensure confidentiality and to conceal the identity of the respondents; so it is not probable that the findings from this study would be

affected. Lastly, causality of the association cannot be inferred because a cross-sectional study design was used.

5.5. CONCLUSIONS

This study generated important findings that could be used to inform policies and programs targeted at improving uptake of PNC services and reducing inequities in utilization. First and foremost, this research demonstrated the spatial pattern of PNC services utilization across communities. Hotspots of non-use of PNC services were identified in this research to guide planning and resource allocation to reduce health inequities. Though non-use of PNC services in Ghana occurred across communities, this study revealed that this problem is more serious in communities in the Northern region, which is an issue that requires more research to understand and address better. The issue of geographical disparities is common in many countries around the world and this is why the approach to understanding geographical inequities used in this paper is relevant beyond Ghana.

Secondly, the results of this study identified community-level factors that potentially influence women's health-seeking behaviors. Principally, this study revealed that women who dwell in a community with a high level of poverty have lower odds of using PNC services, controlling for the effect of poverty at the individual level. The study findings imply that reducing the inequality gaps in the use of PNC services require strategies beyond focusing on individual women because there are community level effects that need to be tackled with community-specific strategies.

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Chapter 6. Conclusions

Unraveling the socioeconomic and demographic characteristics influencing normal delivery or by caesarean at a health facility followed by postnatal care (PNC) utilization for reproductive-aged women [1, 2] is critical in identifying inequities in the use of obstetric services and forming policies and interventions to improve the utilization of quality maternal healthcare to help reduce poor maternal health outcomes. The main aim of this thesis is to examine the inequities in the usage of obstetric care services in Ghana. **Chapter 2** focused on understanding the role of socioeconomic and demographic factors in health facility delivery. **Chapter 3** examined the socioeconomic inequalities in caesarean delivery. **Chapter 4** assessed the population attributable risk (PAR) of sociodemographic factors on PNC services utilization. Finally, in **chapter 5** clusters of non-use of PNC services were identified and the impact of community-level characteristics on the usage of PNC services was explored. This chapter retraces the flow of thesis research, summarizes the key findings, the relevance of the findings, limitations of the research and identifies issues for future research.

6.1. The Flow of the Research work

This research pursued four objectives that yielded four manuscript-based chapters. **Chapter 2** employed a model with a logit link function to identify individual-level characteristics associated with delivery at a health facility. **Chapter 3** used a logistic regression model to examine the socio-economic factors that were linked to CS delivery and computed a concentration index as a measure of the degree of inequality of CS delivery. **Chapter 4** utilized a Generalized estimating equation (GEE) with a logit link function to identify sociodemographics that had an effect on PNC services use and estimated PAR. **Chapter 5** employed spatial scan statistics to ascertain spatial autocorrelation in the non-use of PNC services across communities

and explored the community effect on the heterogeneity of PNC services utilization using multilevel mixed logistic regression analysis, after controlling for individual-level factors.

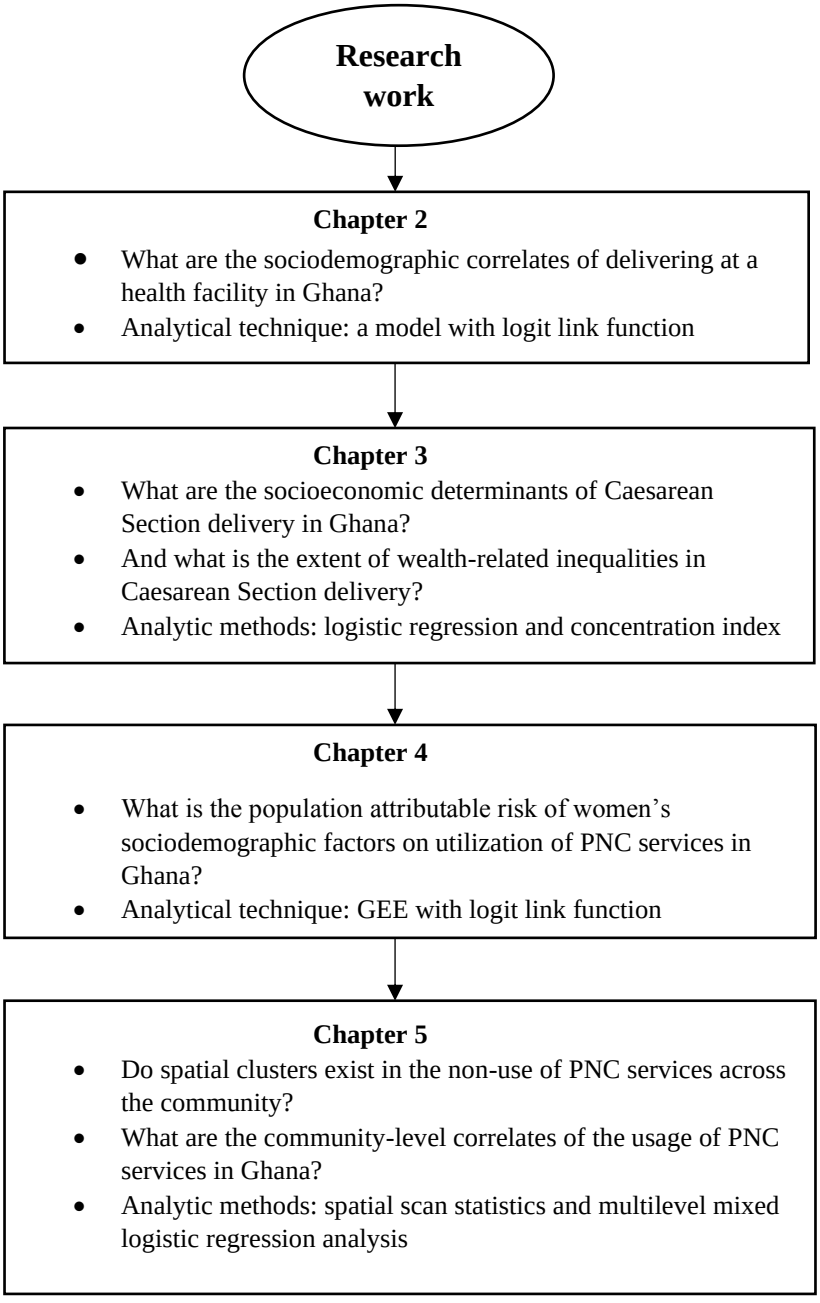

Figure 6-1: Research work flowchart

6.2. Methodological Considerations

The 2014 Ghana Demographic and Health Survey dataset was analyzed and presented in all four manuscripts comprising this dissertation. The data was obtained from the internationally renowned Demographic and Health Survey program. The data were collected by the Ghana Statistical Service, Ghana Health Service and the National Public Health Reference laboratory with technical assistance from ICF international. The 2014 GDHS was funded by USAID, donor partners and government of Ghana [3]. The 2014 GDHS had a 97% response rate and is a large nationally representative population-based dataset. Notwithstanding, the data lacked variables on quality of care and culture [3].

Andersen's health behavioral model was used in this dissertation instead of other theoretical frameworks because of the consideration of community resources and health system characteristics in the model, in addition to the individual-level characteristics [4]. This dissertation studied numerous socioeconomic and demographic factors. The individual-level characteristics considered were maternal age, education level, wealth status, marital status, religion, parity, place of residence, employment status and ethnicity. Region mostly reflects the ethnic composition of Ghana, where different ethnic groups inhabit different regions. Hence, to avoid collinearity issues and to ensure policy interventions are relevant; this research focuses on the community level. Community poverty level, community high school level, community problem with distance to a health facility, area of residence and community unemployment level were examined.

With the permission and release of the 2014 GDHS dataset by the MEASURE DHS, this dissertation utilized several methods: (1) multivariable logistic regression model, (2) computation of concentration index, (3) generalised estimating equation (GEE) model, (4)

estimation of population attributable risk, (5) spatial scan statistics, and (6) multilevel mixed effect regression model. To ascertain the accuracy of the parameter estimates, model diagnostics were done including Link test, Hosmer-Lemeshow goodness of fit test, quasilikelihood (QIC) among many others. Finally, sampling weight was applied and adjustment for clustering effect was considered.

6.3. Summary of Findings

This thesis discusses the socioeconomic and demographic inequalities in the utilization of obstetric services in Ghana.

Chapter 2 investigated the social determinants of birthing at a health facility [2]. The study reports that 72% of birthing happened at a health facility in Ghana which is lower than 73.1% reported in the 2014 GDHS report [3] because this manuscript used complete case analysis for missing data which excludes respondents with missing observations from the analysis. The results show that place of residence, wealth status, education, religion, parity and knowledge about pregnancy complications had significant effect on delivering at a health facility. First, the probability of having health facility delivery was higher among urban dwellers when compared with rural women. Second, delivery at a health facility was greater among middle-class and rich women than the poor. Third, women who were educated were more probable to give birth at a health facility relative to women with no education. Also, the likelihood of first-time mothers delivering at a health facility was higher than mothers with at least three birth experiences. Finally, the research showed that odds of delivering at a health facility was greater among women who had knowledge of pregnancy complications than those who were not.

In **chapter 3**, the socioeconomic characteristics of women associated with CS delivery were examined using a large nationwide population-based dataset with enough confounding and covariables [1]. This study has been an effort to address the methodological flaws such as smaller sample size, small geographical focus and inadequate adjustment for confounders identified in earlier studies in Ghana [5, 6]. The study found that the prevalence of CS delivery was 11.4%, a figure less than the 12.8% reported in 2014 GDHS due to the utilization of complete case analysis for missing data. However, CS delivery was higher among women in the wealthiest quintile (27.5%) than their counterparts in the poorest quintile (5%). Besides, some socioeconomic factors were identified to have significant association with CS delivery. This research revealed that older women, those with secondary or higher education as well as wealthier had a greater likelihood of having CS birth. Also, mothers with more than one birth had a greater risk of needing CS delivery. This study found that inequalities in the utilization of CS delivery persist in Ghana.

Contrary to the conventional methodological approach that was used in past studies conducted in Ghana [7] to ascertain the effect of sociodemographic attributes of women on the uptake of PNC services within 41 days after live delivery, the study in **Chapter 4** recognized the possibility of clustering in the study outcome because of the likeness of the survey answers within a community, and so generalized estimating equation (GEE) procedure was employed. The 2014 GDHS report [3] stated 81.1% of respondents utilized PNC services within two days after live birth which is lower than the 84% prevalence of PNC service usage within 41 days prior to live delivery documented in this thesis. In this study, it was observed that significant proportion of PNC services use was attributable to sociodemographic factors including religion, ethnicity, place of residence, wealth status, and education attainment of women. This chapter

reported that a significant proportion of uptake of PNC services by the study population was independently attributable to sociodemographic factors that included Christian or Muslim faith, wealth, residing in an urban setting, and being well educated.

Chapter 5 considered the contextual impact of women's community on the use of PNC services which is an extension of chapter 4. This research utilized structured methodologies: (1) spatial scan statistics identified communities with higher risk of non-utilization of PNC services and stated that communities with elevated levels of non-use of PNC services were predominantly spotted in the Northern region of Ghana; and (2) two-level hierarchical model was specified to ascertain the community-level characteristics that influence PNC services utilization. The study findings reported a strong effect of community levels of poverty and secondary education on the use of PNC services. Specifically, this study found that living in a community with a substantial proportion of mothers who are poor increases the chance of not using PNC services. Twenty-four percent of the differences in the use of PNC services due to unexplained community variability.

Finally, two attributes among women remained significant in all 4 studies on obstetric care utilization. Wealth status and education level were consistent predictors of inequities in the usage of obstetric services in Ghana.

6.4. Implications of the Findings

The studies in the earlier chapters sufficiently controlled for confounders and interactions using multivariable regression models, an important step that was lacking in previous Ghanaian research. The new evidence from the four studies shows that the socio-economic and demographic characteristics associated with obstetric care service use in Ghana will help tackle the maternal and newborn health inequities at local as well as national levels [8-10]. The research

findings are expected to support targeted interventions to improve obstetric services utilization and thus contribute to decreasing maternal and newborn deaths and morbidity. The results of this study could help institute deliberate programs to promote health-seeking behavior and community demand for obstetric care services. Moreover, the study findings could be vital for effective monitoring and evaluation of current obstetric service interventions. Also, the study could guide the allocation of limited resources for equitable distribution and access to maternal health services for marginalized groups as well as underserved communities. The implications for the studies in this thesis were articulated in chapters two through five.

In **chapter 2**, poorer women had lower likelihoods of having a health facility delivery, which calls for measures to deal with the ancillary costs discouraging women from delivering at a health facility. Second, many of the study predictors drive demand for health facility delivery and thus projecting the importance of sociodemographic determinants of obstetric services usage alongside improving physical accessibility.

Chapter 3 reports the discriminate use of CS delivery among both privileged and socially disadvantaged women. The underuse of CS delivery among less privileged and the overuse of CS delivery among women of high socioeconomic status suggest the need for equity-oriented policies and programs, to encourage the use of this essential surgical intervention among the vulnerable group and concurrently discouraging overuse among the advantaged group.

The significant individual-level characteristics associated with PNC services uptake found in **chapter 4** make immense contributions to the body of literature, with important implications for policy and programs in Ghana and other developing countries. Specifically, the findings from this research provide evidence for initiatives that focus on rural dwellers,

incorporate religious leaders and support poorly educated women as means to improve the uptake of PNC services.

Chapter 5 found community-level factors that influence use of PNC services among women of childbearing age. These community characteristics can direct allocation of resources to minimize the inequalities in PNC usage. Furthermore, the insignificant association between community perceived distance to a health facility and the usage of PNC services, perhaps suggests the CHPS initiative has improved access but the spatial disparities of non-use of PNC services particularly between communities in northern and Southern Ghana point to other modifiable factors that could guide community-targeted interventions that can lead to all-inclusive use of PNC services..

Ghana has achieved a marked increase in the use obstetric care services according to findings from this dissertation when compared with previous national surveys. In addition, modifiable factors were identified that can serve as a basis to policy formulation. This dissertation found that maternal age had a significant effect on only CS delivery and not on place of delivery or use of PNC. The findings are consistent with the evidence in the academic literature indicating that age is significantly positively associated with CS delivery. Place of residence had a strong influence on health facility delivery and PNC services use but not CS delivery; this may be attributed to the fact that CS is at least partly driven by medical need. Religion was also significantly associated with obstetric services use except CS delivery, which is likely to also be driven by the fact that CS is a life saving medical intervention in many cases, compared to receiving obstetric care services. Disparities in the use of PNC services based on ethnicity were significant but ethnicity was not a significant factor for health facility delivery and CS delivery; this could be attributed to some cultural practices and norms, particularly among

Akan and Ga people. Overall, wealth status and education of mothers were the major determinants of obstetric care services usage (health facility delivery, CS, and PNC). Large gradients of inequality in use of the three maternal health services based on a women's wealth and education levels were identified. The free universal basic education and free senior high school policies, which were recently introduced in Ghana, should especially target girls to help improve uptake of obstetric care services. The free maternal health services policy has been successful in achieving huge progress and hence should be continued; however, special attention should be given to unapproved fees that are being demanded by heath care providers, which could be one of the reasons behind the persistent association of wealth with use of all maternal health care services, in spite of the free health services policy. Finally, since wealth matters for women's health, the livelihood empowerment program that is mandated to support the poor should be strengthen by improving its benefit package and expanding coverage.

6.5. Strengths and Limitations

This dissertation applied several robust statistical and spatial analyses methods on large nationwide de-identified secondary dataset (2014 GDHS) to uncover the inequities in the usage of obstetric care services in Ghana. But the study factors were captured during the survey period, and not at the time of utilization of the obstetric care services which could lead to misclassification bias. However, the 2014 GDHS used international standard protocols to collect data using well-trained interviewers and hence interviewer bias was limited. As well selection bias was not a concern in the voluntary survey because random sampling was utilized. Self-reporting used in the survey could lead to recall bias. However, the study participants were restricted to women with current birth within five years prior to the 2014 GDHS to limit recall

bias. Information bias arising from social desirability of sensitive survey questions may be a source of worry, but privacy and confidentiality were assured for the survey participants.

Moreover, the 2014 GDHS lack data on actual medical needs, the research work in chapter 3 used a proxy for perceived need (told about pregnancy complications) and therefore inferences should be drawn with caution. Furthermore, whether the CS delivery was elective or emergency and whether the caesarean section was performed at a public or private facility was not specified in the 2014 GDHS data. Also, because of GDHS data limitations, some cultural and quality of care factors were not studied. Only live births were considered in this dissertation due to lack of data on stillbirths in the 2014 GDHS. This research used cluster as a community in chapter 5 for the spatial autocorrelation identification and the multilevel mixed modeling, but this community may not necessarily depict the actual communities in Ghana. Errors resulting from the displacement of some of the 2014 GDHS GPS coordinates could not be excluded. This dissertation could not assess district of residence to support targeted policies and programs because district data were not available. Finally, causal inferences cannot be claimed because cross-sectional data was used for this research.

6.6. Direction for future research

Further research could expand the findings on the utilization of obstetric care services in Ghana discussed in this thesis. Future research should employ qualitative studies to investigate cultural characteristics influencing the use of obstetric care services. In addition, culturally sensitive studies that focus on specific groups identified in this thesis should be done to find possible modifiable factors that are peculiar to the cohorts. Also, further studies should consider the quality of health care variables to explain the inequalities in obstetric care services.

Moreover, future studies should use actual distance to provide further insight on their effect on the use of obstetric care services because most studies including this thesis used perceived distance to a health facility. Further research is needed to test whether delivery at public or private health facility influence CS delivery when data becomes available. Research involving whether the CS delivery was elective or emergency is warranted to support policy interventions on unmet CS delivery and medically unjustified CS use. Finally, future studies could employ longitudinal studies to elucidate the study characteristics associated with the utilization of obstetric care services to strengthen the findings from this thesis and limit misclassification due to self-reporting.

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Appendix

Letter of exemption from ethical review

To:	Marwa Farag, MSc., Ph.D. Associate Professor, School of Public Health University of Saskatchewan
Student:	Emmanuel Dankwah Ph.D. candidate, Epidemiology School of Public Health
Date:	September 13, 2019
RE:	Letter of Exemption

Thank you for submitting your project to investigate the inequities in the use of obstetric care services in Ghana. This project meets the requirements for exemption status as per **Article 2.2 of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2 (2018)**, which states "Research does not require REB review when it relies exclusively on information that is:

a. publicly available through a mechanism set out by legislation or regulation and that is protected by law; or
b. in the public domain and the individuals to whom the information refers have no reasonable expectation of privacy."

It should be noted that though your project is exempt of ethics review, your project should be conducted in an ethical manner (i.e. in accordance with the information that you submitted). It should also be noted that any deviation from the original methodology and/or research question should be brought to the attention of the Behavioural Research Ethics Board for further review.

Digitally Approved by Diane Martz, Chair
Behavioural Research Ethics Board
University of Saskatchewan