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Trends and predictors of home deliveries in Kassena-Nankana East and West districts in Ghana: 2003-2009.



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Research report

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Internal supervisor: Dr Eustasius **MUSENGE**

External supervisor: Dr Abraham **ODURO**

Student: Dr Tieba **MILLOGO**

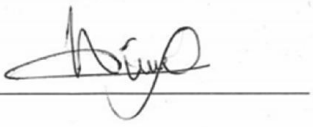
Student Number: 731876

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DEDICATION

This research is dedicated to:

- The families that have had to experience the tragedies represented by maternal and perinatal deaths
- My wife, Nicole, for your constant support and love during the different steps I have had to go through in this masters program, from the coursework to the field work. I would not have made it without you, thank you for your understanding!
- To my late father, may your soul rest in peace
- Finally, my mother and all my brothers and sisters, let us remain a wonderful family.

ABSTRACT

Introduction: About sixty million of home deliveries occur worldwide every year. The vast majority of them in Low and Middle Income Countries (LMIC) where most of all out of health facility deliveries are attended by relatives and traditional births attendants . Poor hygienic conditions, ignorance of clean birth practices and lack of skills to manage the complications when they occur, make home deliveries unsafe for the mothers and their newborns. Thus, getting pregnant women to give birth at health facility is critical in the efforts to improve reproductive health outcomes in many LMIC.

In Ghana, the out-of-pocket fees were waived for pregnant women since 2003 and the primary health care system was modified to station community health nurses in rural areas. These two strategies have a potential to reduce the proportions of home deliveries by removing financial and distance barriers to health facility utilization. The aim of this study is to document the trends and the predictors of home deliveries after the implementation of the above interventions in two districts that pioneered their implementation in the country.

Material and methods: The study was carried out in Kassena-Nankana East and West districts, of the Upper East region in Ghana, where the Navrongo Health Research Centre operates the Navrongo Health and Demographic Surveillance System (NHDSS). The study design was a series of cross sectional analytical studies using secondary data. All the deliveries that occurred between January 2003 and December 2009 in the area were included in the analysis. We used time series analysis to describe the trends of home deliveries over time and a two level logistic regression models to determine the predictors of home deliveries.

Results: In all, 25539 deliveries occurred, majority (58.11%) of them at home. The trend analysis showed a consistent and significant decline in rates of home deliveries over time

($p<0.001$). The stationary time series pattern followed by the rate of home deliveries is an Autoregressive Moving average ARMA (1, 1) model. The rates of home deliveries were halved during the study period; from 69% in 2003 to 36.54% in 2009. Although the decline was consistently observed within all the subgroups, it was more marked in the poor, the rural residents and the uneducated populations.

Non maternal education (OR: 0.28, 95% CI: 0.23-0.34; for secondary/tertiary education compared to no education), traditional religion practice by the mothers (OR: 0.59, 95% CI: 0.53-0.64; for Christians compared to traditional religion), the rural residency (OR: 0.09, 95% CI: 0.08-0.12; for the urban residents compared to rural residents) and poverty (OR: 0.16, 95% CI: 0.13-0.20; for the rich compared to the poor) were strong predictors for home deliveries. Other significant predictors include the high number of parity (OR: 1.98, 95% CI: 1.72-2.28; for multipare mothers compared with nullipare), the high number of previous home deliveries (OR: 2.96, 95% CI: 2.25-3.90; for two or more previous home deliveries compared to zero previous home delivery), the marital status (OR: 0.88, 95% CI: 0.78-0.99; for non married mothers compared to married mothers and, the pregnancy status (OR:2.21, 95% CI: 1.77-2.75; for single fetus compared to multiple fetuses).

Conclusion: The results showed that home deliveries are sharply declining since 2003 in the study area and the gaps between the rich and the poor, between the rural and the urban residents and, between educated and uneducated persons are also reducing. Even though we did not investigate the health care system related factors, the findings in our study are consistent with those broadly reported elsewhere about the predictors of home deliveries. Further studies with the before-after design are needed to show that the observed results are attributable to the two interventions.

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NOMENCLATURE

ANC: Antenatal Care

ARMA: Autoregressive Moving Averages

CHPS: Community-based Health Planning and Services

CI: Confidence Intervals

DHSs: Demographic and Health Surveys

HDSS: Health and Demographic Surveillance System

IRB: Institutional Review Board

IQR: InterQuartile Ranges

JSS: Junior Secondary School

KND: Kassena-Nankana District

MDGs: Millennium Development Goals

NHIS: National Health Insurance Scheme

NHDSS: Navrongo Health and Demographic Surveillance System

OR: Odds Ratios

PCA: Principal Component Analysis

SSA: Sub-Saharan Africa

WHREC: Wits Human Research and Ethics Committee

WHO: World Health Organization

Chapter One: Introduction

In this chapter the situation of home deliveries in developing countries was reviewed. A summary of the current state of knowledge in the literature in terms of prevalence, trends and determinants of home deliveries and the limitations of previous studies that investigated the issue of home delivery in sub-Saharan Africa and in Ghana specifically was presented. Definitions of key terms as they are used in this report were provided with an outline of the aim and the objectives of the study.

1.1. Introduction

1.1.1. Background

An estimated sixty million of out of health facility deliveries occur every year worldwide. The majority of these out of health facility deliveries (52 millions) are not attended or are attended by non medically trained birth attendants(1). The non-clinical settings delivery, also referred to as home delivery is an old and well known practice as it has long been the exclusive way of delivery in both developed and developing countries(2).

Historical evidence had revealed that, large changes have taken place during the 19th century in delivery patterns particularly in developed countries. For instance, in developed countries, home delivery is now a rare event, counting for less than 1% of all deliveries(3). The vast majority of women who deliver at home in developed countries choose to do so because of convenience and are assisted during their childbirths by a skilled trained health worker (4). In recent years studies investigated the perinatal outcomes within such planned home births comparing them to perinatal outcomes among health facility births and reported no difference in poor outcomes(5, 6). Furthermore, these home deliveries tend to provide more satisfaction to women and need less obstetric interventions (5, 7, 8). However, the safety of home as a

place of birth even in developed countries is still controversial and studies are not consistent (9, 10).

The issue of home deliveries in developing countries is different from that of developed ones. In developing countries home child birthing remains a systematic practice for an important fraction of pregnant women and is occurring in poor hygienic conditions without assistance by qualified trained birth attendants. A study conducted in 48 developing countries showed that more than 50 % of all deliveries occurred at home and only a very few (2-3% of home childbirths) were attended by a medically trained person (nurse, midwife or doctor) (11). In Sub-Saharan Africa (SSA), home deliveries are generally unassisted or assisted by relatives or untrained traditional birth attendants due to the shortage of trained human resources for reproductive health.

Findings are consistent about the association between the place of delivery, the qualification of the attendant and the outcomes for the mothers and their newborns. Delivery at health facility and attended by health professional is consistently associated with lower rates of maternal and neonatal mortalities compared with home deliveries (12-14). The perinatal mortality was found to be three times higher for home deliveries compared with health facility births (15). About 95% of worldwide maternal deaths occur in settings where significant proportions of women give birth at home (16). Thus, home delivery is a threat to the safety of motherhood in developing countries. The World Health Organization (WHO) advocated for facility delivery or skilled attendance at every birth and it is an indicator of progress towards the MDG 5 (Millennium Development Goals) aimed at reducing maternal mortality ratio by 75% by the year 2015(17). Thus, encouraging pregnant women to use antenatal care services and deliver at health facility is an important step in improving reproductive health outcomes. Numerous interventions are being implemented in several SSA countries to address the socio-

economic, geographical and distance factors and health facility barriers to health facility deliveries.

Ghana in particular has taken steps to address the economic and distance barriers to women utilizing health facility for delivery. For instance, a free delivery care policy was piloted in 2003 in four regions of Ghana and thereafter replicated in the rest of the regions in the country(18). A National Health Insurance Scheme (NHIS) was introduced in 2005 to reinforce the effects and to cater for the free delivery care policy. Finally in 2008 a free national insurance scheme for pregnant women was introduced (18, 19)to cater for all health care services for pregnant women and nursing mothers. Alongside the free delivery care policy, a Community-based Health Planning and Services (CHPS) program was established. The CHPS initiative is aimed at reducing the geographical barriers to access to health care through the training and the deployment of community health officers (CHOs) to community health compounds located within communities in rural areas (20). The Kassena-Nankana East district and the Kassena-Nankana West District formerly known as the Kassena-Nankana District are located in the Upper East region of Ghana. These districts pioneered the implementation of both free delivery care policy and CHPS program.

1.1.2. Problem statement and justification

One of the bottlenecks that hinders the progress towards the achievement of the Millennium Development Goals four and five (MDGs5&4: respectively reducing by 3/4 the maternal mortality rate and reducing by 2/3 the child and infant mortality rate between 1990 and 2015) is the high proportion of unassisted deliveries leading to poor outcomes for mothers and their newborns.

In Ghana as in many other SSA countries, the health authorities are active in implementing various interventions to accelerate the progress towards the achievement of the MDGs4&5.

Improving health facility delivery is one of the key achievements expected through the implementation of strategies targeting both economic and geographic barriers. Ghana has addressed the most important determinants of home delivery and is on track to reduce inequalities by bridging the gap between the rich and the poor and between the rural and the urban area. This is because the country has removed all "out-of-pocket" fees for pregnant women in health facilities and made basic obstetric care available and accessible to women in rural communities. Data from cross sectional studies revealed a decrease in proportions of home deliveries after these interventions have been put in place in the country. However, data from longitudinal studies are scarce; thus, there is a need for longitudinal data on trends of home delivery to further understand the achievements in bridging the gaps between rural and urban area and between rich and poor households. Also, investigation of the risk factors for home deliveries in a context of total exemption of fees for pregnant women is also needed.

1.2. Literature review

1.2.1. The prevalence and trends of home deliveries

There are fewer public health concerns about home deliveries in developed countries as compared to developing countries. A negligible proportion of deliveries take place at home in developed countries (less than 1%) and almost all such home births are planned and assisted by a trained health worker(21).

Unlike in developed countries, developing countries have a large number of women with unassisted systematic home deliveries. In most developing countries, data on the prevalence of home deliveries comes from the Demographic and Health Surveys (DHSs). A review of DHSs conducted in 48 developing countries from 2003 to 2009 showed that in 23 countries up to 50% of deliveries are taking place at home(11). In SSA specifically there are notable variations in the prevalence of home deliveries across countries. While more than 50% of all

deliveries were reported to have taken place at home in 2008 in Kenya (53.1%), Madagascar (61.7%), Nigeria (61.2%), Uganda (54.5%) and Niger (81.5%), the rates of home deliveries were much lower in the same period in Benin (19%), Namibia (17.3%) and Zimbabwe (29.5%) (22). Furthermore, within countries there are also disparities between regions and rural versus urban settings. Research has consistently showed that the prevalence is higher in rural settlements where people are mostly poor than in urban settlements.

In Ghana in 2008, 43% of all deliveries took place at home with a marked rural versus urban contrast (16.8% vs. 57.5%). The majority of the home deliveries (95%) were attended by either a traditional birth attendant, or a relative or not attended at all (23). While data on the prevalence of home delivery are available and regularly renewed through the DHSs carried out every five years, data on the trends are scarce and the only available estimations of trends are derived from comparisons of prevalence reported in successive DHSs (24).

1.2.2. The predictors of home deliveries

Factors associated with home deliveries have been broadly studied. In developed countries the choice of place to give birth is essentially motivated by convenience, the need to give birth in familiar surroundings or avoiding a medical stressful environment(5).

Studies conducted in developing countries reported a myriad of factors associated with the place of delivery. All these factors were previously grouped by researchers under the following four groups: socio-cultural factors, economic accessibility, physical accessibility and perceived need and benefit of health facility delivery(25). Socio-cultural factors and economic barriers have been widely investigated probably because most of the studies rely upon household surveys. Physical accessibility and the perceived benefit of health facility delivery are less frequently investigated. In each group various factors were investigated depending on the study design and what investigators might think relevant to their context.

While some factors are consistently reported across studies and countries, others are not, suggesting a possible context specific importance of factors (26) or lack of sufficient control for confounding in some studies.

1.2.2.1. Socio-cultural factors

Among the socio-cultural factors the most investigated are the maternal education, maternal age, the maternal parity and the maternal religion/ethnicity. Higher level of education achieved is consistently associated with lower likelihood of home delivery and most of the studies reported a dose-response relationship (27-34). Maternal age was also significant in many studies. While there is no dose-response relationship, older mothers tend to have lower rates of home delivery compared to younger ones (32-34). Higher parity was associated with higher likelihood of home delivery in some studies (33-35). This finding is not consistent across studies; some studies reported no association or an association in the opposite direction. The religion and ethnicity of the mother play a role in the choice of the place of delivery as reported in many studies. Christians and Muslims are generally less likely to deliver at home compared with those who practice the traditional religion (28, 32, 33, 36).

Other factors also reported less frequently and inconsistently are the marital status, the size of the household and the level of education achieved by the head of the households.

1.2.2.2. Factors related to economic accessibility

There is strong and consistent finding with dose-response relationship in the literature that the lower socio-economic status is a driver for home delivery. The more a household is poor the more a woman is likely to deliver at home (11, 19, 31-34). In the same vein, women with reasonable income are more likely to deliver at health facility compared to those who are homemakers or don't have substantial revenue.

1.2.2.3. Factors related to physical accessibility

It is consistently shown that women from households located in rural areas are more likely to deliver at home compared to urban residents. Alongside the maternal education and the socio-economic status, the rural versus urban gap is one of the most consistently and strong findings reported on the predictors of home deliveries (27, 28, 32, 33). The distance to health facility, whether it was estimated by the respondents (34) or measured using a geographical information system (37), consistently showed an association with the place of delivery.

The farthest a woman lives from health facility the higher the likelihood of delivering at home. However, it's important to note that distance was less frequently included in the analysis compared to other risk factors and the mean of transportation available in the households is a potential confounder that was not often measured.

1.2.2.4. The perceived need/benefit of health facility delivery

Included in this group are factors that influence the perception of how a facility-based delivery with attendance by a health worker will benefit a mother and/or her newborn. "This perception is shaped by general awareness of the dangers of childbirth and interventions available at health facilities, by individual past experiences with pregnancy, childbirth and health services, as well as by risk assessment of the index pregnancy" (25). This latter class of factors is the less frequently investigated and factors usually reported include knowledge of pregnancy risk factors, pregnancy desired, perceived quality of care at health facility, antenatal care service use, place of previous delivery etc. Among these, Antenatal Care (ANC) use and the place of previous birth are the most investigated. ANC use is usually associated with lower likelihood of home deliveries (27, 28, 33, 38). The same is true about the previous place of delivery; women who had their previous childbirths at home were more likely to give birth at home for the index delivery (33, 39). Studies that investigated ANC use

and place of delivery are consistent about this association. However, these findings are likely to be confounded by other related health service utilization factors in general (unmeasured confounders such as service availability etc.).

1.3. The limitations of previous studies

The majority of the studies that have investigated the issue of home deliveries in developing countries were cross-sectional studies using a single population survey data, mainly from DHS. Longitudinal studies in this area are rare and the few existing to our knowledge were carried out at a regional level and the findings are, therefore, not generalizable to other settings as previous studies showed an important variability of the determinants of home births across settings. Thus, there is a gap in knowledge about the trend of home deliveries. The available trends are generally derived from comparison of the levels reported in successive DHSs data. However, DHS data have important limitations with respect to home deliveries as only live births are included in the DHS data. Given the greater likelihood of home births resulting in poor outcomes for newborns (including stillbirths), it is reasonable to posit that an important fraction of home births may not be included in the DHS data leading to selection bias. In addition, as DHS are carried out once every five years, the data collected are representative of the previous five years and may not be representative of each single year during the past 5 years.

In Ghana, after the scaling up of the CHPS program and the implementation of fees' exemption interventions for pregnant women, cross sectional studies reported a decrease in home deliveries and an increase in health facility use for child births (23, 31).

Only one study investigated the trends of health facility delivery after implementation of the free delivery care policy and was carried out in settings that were covered only when the interventions were scaled up (19). Therefore, the post intervention period in this study began

in 2005 (date of scale-up) instead of 2003 and in addition the before intervention levels of home delivery in that setting were comparable to the national average. None of the studies carried out in Ghana after the implementation of these interventions (free delivery care policy and CHPS) investigated systematically the predictors of home deliveries. Although the risk factors for home delivery are well known, it is likely that changes will take place over time and specifically in communities where there are several attempts to control the key drivers for home delivery (financial and geographical barriers).

This study sought to fill the gap of knowledge in the trends of home deliveries from longitudinal data and in factors that still hold back women from delivering in health facility, by analyzing data collected in a Health and Demographic Surveillance System (HDSS) in mainly rural settings where the levels of home deliveries were high and above the national average before interventions.

1.4. Definitions of key terms

In this report the definitions to be considered for the following key terms are:

Home deliveries: All childbirths that have taken place out of a clinical setting, in a particular residence or on the road. Home deliveries include childbirths that occurred at the home of the mother, at traditional birth attendant's home or any particular setting that is not a formal clinical setting.

Health facility deliveries: All childbirths that have taken place in a health care facility, regardless of the status (private, public or confessional) and the type (Hospital, Health centre, clinics) of the facility. Childbirths that took place in community health compounds run by community health officer midwives are also included in health facility deliveries.

Skilled birth attendant: We used the definition provided by WHO i.e. a person with midwifery skills (for example, doctors, midwives, and nurses) who have been trained to proficiency in the skills necessary to manage normal deliveries and diagnose, manage, or refer obstetric complications.

1.5. Aim and objectives

This study is aimed at contributing to a better knowledge of the situation of home deliveries in the Kassena-Nankana East and West districts after implementation of the free delivery care policy and in a context of modification of the primary health care services through the scale-up of the community-based health and planning services. The two districts hosted the earlier implementation of both strategies and were home to high levels of home deliveries compared to the average national level before the onset of these interventions.

The general objective of this study is to describe the trends and identify the predictors of home deliveries in Kassena-Nankana East and West districts from 2003 to 2009.

The specific objectives are:

1) To calculate the yearly incidences of home deliveries in Kassena-Nankana East and West districts from 2003 to 2009.
2) To identify the predictors of home deliveries in Kassena-Nankana East and West districts from 2003 to 2009.
3) To describe the trends of home deliveries in Kassena-Nankana East and West districts from 2003 to 2009.

In the rest of this report we present the study methods in chapter 2, the results and a discussion respectively in chapters 3 and 4, and a fifth chapter serves as conclusion and recommendations.

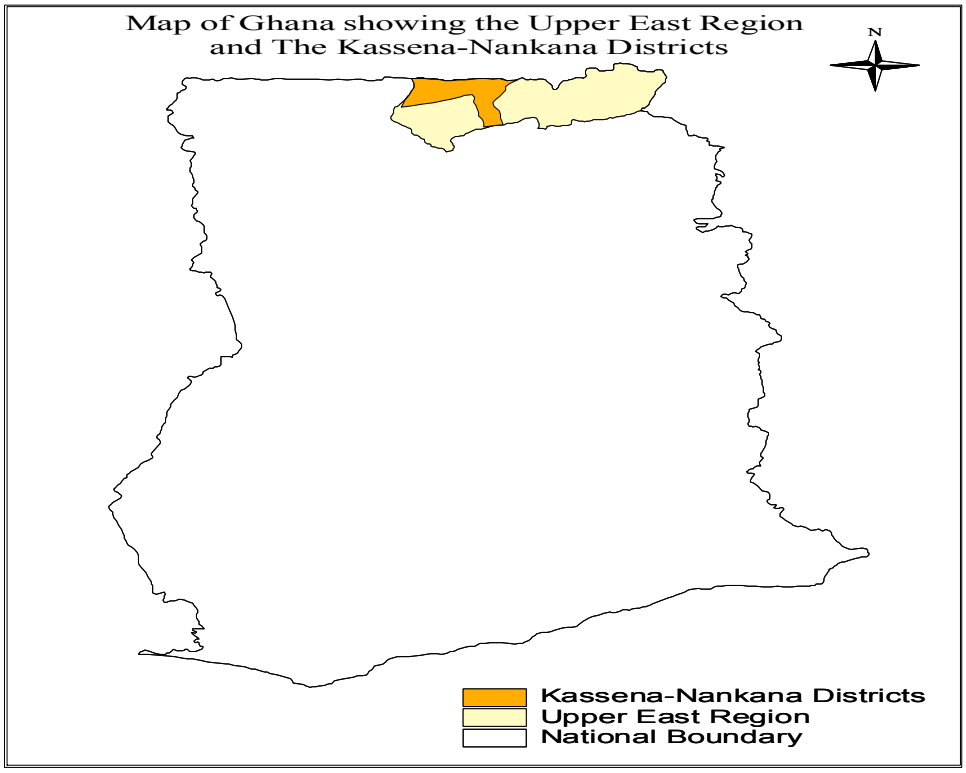
Chapter Two: Study methods

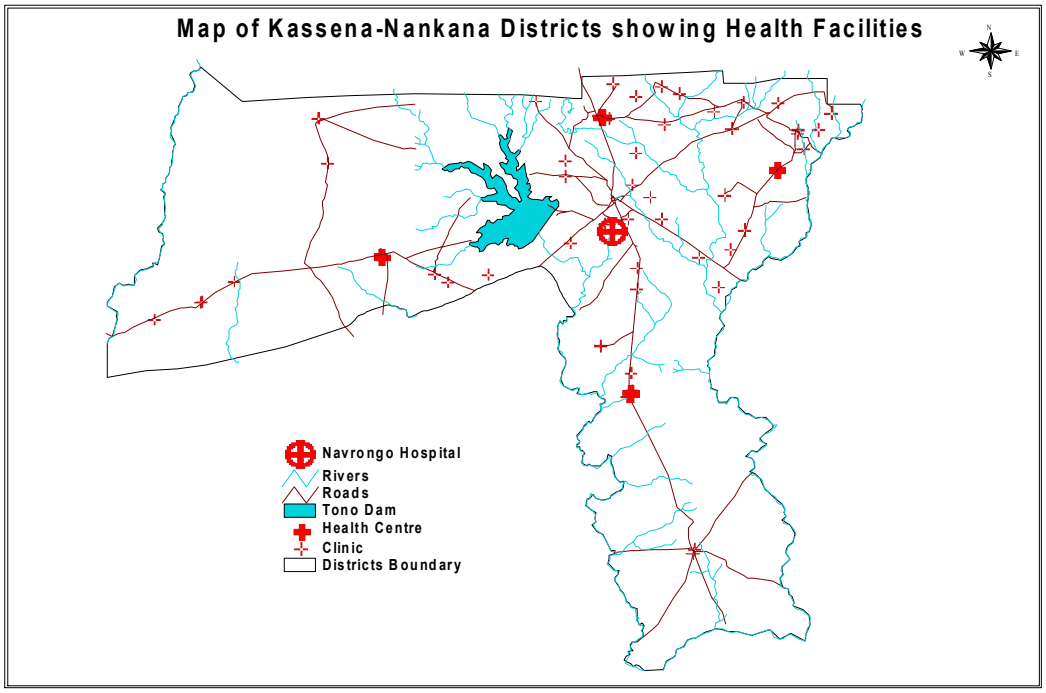
In this chapter, we describe the study design and settings. The study population and the data collection and management procedures as well as the statistical approaches are also described.

2.1 Study settings

The study is carried out in the Kassena-Nankana East and West districts. These are two contiguous districts located in the Upper East Region of Ghana. Before 2008 the two districts constituted the same and one district, the Kassena-Nankana District (KND). The two districts share borders with Burkina Faso to the north. The Navrongo Health and Demographic Surveillance System (NHDSS) operated by the Navrongo Health Research Centre (NHRC) covers the entire area of the two districts. The corresponding total land area is 1675 square kilometers and lies between latitudes 10 degrees 30′ and 11 degrees 00′ north of the equator and longitudes 1 degree 00′ and 1 degree 30′ west of the zero Meridian(40). There are two main seasons in the area, a short rainy season from May to September and a long dry season from October to April. The rainy season is the wet one and is also the period where farming takes place. It's also characterized by limited possibility of moving as most of the roads are unpaved and therefore less practicable during rainy season. The mean annual rain fall is 1300 mm and the vegetation is of Guinea Savannah type. The area is populated by two main ethnic groups, the Kasem and the Nankam, and was home in 2012 to 156,735 inhabitants residing in more than 32,000 households(41). Around 80% of the population is made of rural residents as only the Navrongo town constitutes the urban area. Subsistence agriculture is the main economic activity in the area and poverty is common place.

The health care service delivery system in the area is organized around one referral government hospital localized in Navrongo Central. There are seven health centres and several primary health care clinics fairly distributed across the area (see maps below).





Notes: the first map is Ghana with the Upper East Region and the Kassena-Nankana districts, and the second map is the two Kassena-Nankana districts with the health facilities.

The Community Health and Family Planning Services (CHPS) project that was first piloted in this area before its scaling up to the rest of the country complements the health delivery system. A total number of 27 community health compounds located in rural communities and where live Community Health Officer-midwives increased the availability of obstetric care and family planning services at community level. The community health compounds are rural-based health facilities built with active involvement of the community. The community thereafter plays an important role in the management of the health compound and the health care activities take place both at the health compound and community levels. The rationale was that the under-utilized social resources of community organization, chieftaincy, lineage and social networks could be marshaled to make volunteer services work. Community midwives were trained especially for community level service delivery and are equipped with motorbikes to allow door-to-door service delivery. The community health compounds are also used by pregnant women for delivery. The CHPS project reduces the geographical and distance barriers while putting emphasis on community participation to increase access and use of the services.

The study area is also in one of the four districts selected in 2003 by the Ghana Health Service to pilot a free delivery care policy. In 2005 a National Health Insurance Scheme (NHIS) was introduced and in 2008 the membership of the NHIS was made free to all pregnant women. Since 2008 all health care services (and not merely delivery services) are free for pregnant women.

2.2 Study design and target population

The study design was a series of cross sectional analytical studies, where secondary data was used. The primary data was gathered by NHDSS through periodic and regular household surveys. The surveys are carried out every four months and during each survey all the households in the area are visited by pre-trained fieldworkers (field workers are trained in

community entry and data collection procedures at least during three weeks prior to each round of survey) to administer a standardized questionnaire. During the baseline survey the inhabitants were enumerated. The subsequent surveys aim to update information about individuals and households. Information collected include the births, the deaths, the marriages, the in and out-migrations, the background characteristics of people (Age, gender, education, religion, relation to the head of the household etc.) and the background characteristics of the households (location, household assets). Where important, information is also collected on selected health events such as children 'immunization status, ANC services attendance by pregnant women etc. While most of the information is updated every four months, data on background characteristics such as education and household assets are updated once in two years(40).

The study population comprised all the deliveries that occurred in the area of the two districts between January 2003 and December 2009. The year 2003 corresponds to the onset of the free delivery care policy and at the end of 2009 the free NHIS for pregnant women had 18 months of implementation. The dates of childbirths were used to select all deliveries between January 1, 2003 and December 31, 2009. All the deliveries that occurred in the study period were selected regardless of the outcome for newborns (live births or stillbirths). This represented 7 years of data gathered during household's surveys.

The explicit inclusion criterion was: all deliveries that occurred in the Kassena-Nankana East and West districts between January 1, 2003 and December 31, 2009.

The exclusion criterion was: deliveries for which the exact place of delivery was missing after verification in all possible sources of data. Overall, 25539 deliveries occurred in the area during the period of study all of which were eligible and included in the analysis.

2.3 Data source, management and processing

The information necessary to this research question was collected using the birth registration form of the NHDSS (see in appendix page 24th). The data collected is entered by trained data entry agents and is thereafter stored into FoxPro. Using a list of relevant variables to our study, the data was pulled out and transferred into Stata version 12 for management and analysis. Completeness and consistency checks were carried out to find missing data and discrepancies that could be corrected by hand searching in the forms used to collect the raw data. All the data missing on the forms were considered as missing from the field and therefore cannot be corrected. Overall, four variables had definitive missing data: education status of the mothers (311; 1.2%), Wealth index of the household (654; 2.56%), religion of the mothers (2297; 9%) and twins/single births (2; 0.01%). Given the relative few numbers of missing data (less than 10%), analyses were performed based on complete cases.

2.3.1 The outcome variable

The outcome variable is "place of delivery". On the birth registration form the field workers fill the information about the place of each delivery by choosing one out of many options. The diagram below summarizes the question for the place of delivery:

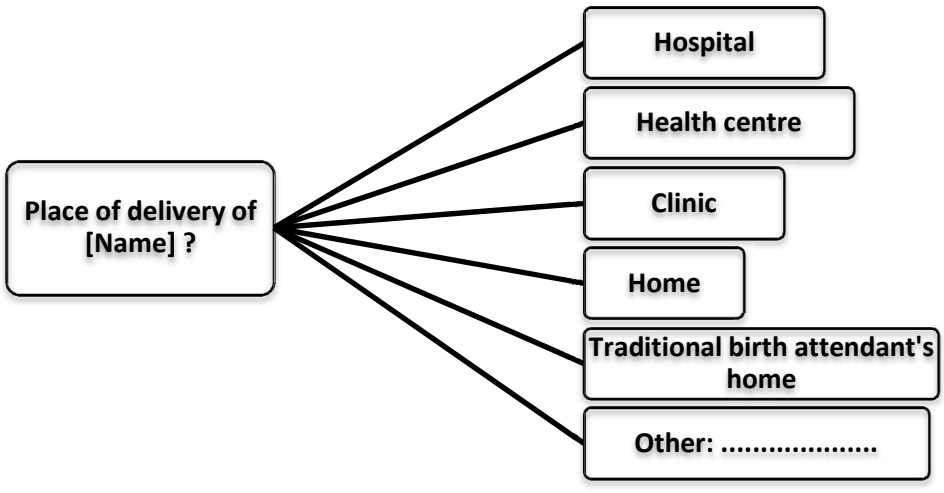


Figure 1: Summary of the question for the outcome variable

The different options were grouped into two categories to construct a binary outcome: Health facility deliveries and home deliveries. Fall under the category of health facility deliveries all deliveries that occurred in hospital, health centres or clinics and community health compounds. Deliveries that occurred in any other place (Home, traditional birth attendant's home, home of a relative etc.) were grouped into home deliveries. The latest birth registration form is in the appendix of the report (see in appendix page 24th).

2.3.2 Time variable and household's assets

The dates of childbirth were used to compute daily dates, monthly dates, quarterly dates and yearly dates. The monthly dates comprised 84 reading dates from January 2003 to December 2009 (7*12) and the quarterly dates comprised 28 reading dates from the first quarter of 2003 to the last quarter of 2009 (7*4). The "day of the week" function of Stata was used to extract from "dates of birth" the day in a week (Sunday to Saturday) where each delivery occurred. Information on days of delivery was later used to create a binary variable with the following two responses: week days for all deliveries that occurred from Monday to Friday and weekends for all deliveries on Saturday and Sunday. The same was done using the monthly dates where all deliveries that occurred from October to April were grouped into dry season deliveries and the rest were grouped into rainy season deliveries. Using the information on the assets of the households a wealth score was computed as an indicator of the socio-economic status using Principal Component Analysis (PCA) method. The assets included in the PCA analysis ranged from large household assets such as land and car ownership to smaller household items such as radio, fan etc.

2.4 Statistical methods

Descriptive statistics for the study sample were computed using means and standard deviations or medians and interquartile ranges (IQR) for continuous covariates, and proportions were used to describe categorical exposures.

For the objective 1: The yearly incidence rates of home deliveries were calculated as the proportions of all home deliveries occurring during each calendar year over the total number of deliveries in that calendar year.

For the objective 2: The predictors of home deliveries were investigated by fitting two levels logistic regression model to the data using the characteristics of mothers updated at each childbirth and characteristics of the households as regressors. Univariate multilevel logistic regressions were firstly carried out with each explanatory variable. The unadjusted Odds Ratios (OR; and their confidence intervals and p-values) from the univariate analyses were then used to select the covariates for the multivariable analysis. A multivariable two levels random intercept logistic regression model was secondly fitted using all the covariates that showed some evidence of association in univariate analysis ($p<0.1$). The level of significance was set at 5% and thus 95% Confidence Intervals (CI) are computed for the OR.

For the objective 3: Descriptive time series were used to graphically describe both the overall trends and the trends in home deliveries within subgroups defined by the socio-economic status, the education status and the area of residence. Different time scales were used for the graphical representation: monthly dates and quarterly dates. To filter for noise in monthly data, symmetric simple 3 months moving-averages were used (smoothing technique). A condition for applying time series analysis is that the series must be stationary, that is the mean, the variance and the autocorrelation structure of the time series are constant over time. The stationarity of the data was tested using the Dickey-Fuller test for unit root(42). The null hypothesis for the Dickey-Fuller test is that the series is not stationary i.e. it has a unit root.

Trends description combined both the observed values and the fitted values based on a linear regression model. A test for significant temporal trend was first carried out using linear regression of the number of home deliveries over the time variable in monthly dates. Finally, to account for the autocorrelations of the errors terms in time series, we improved the linear regression model by fitting Autoregressive Moving Averages models (ARMA). The autocorrelation and partial autocorrelation functions were used to identify the suitable ARMA model to fit the data(43). An ARMA model was fitted to the data without covariates and another ARMA was fitted controlling for education, richness and age of the mothers.

2.5 Ethical considerations

The data used in this study are part of data regularly collected by the NHDSS since 1992. Community consent was obtained prior to the set up of NHDSS and during each round of survey a verbal consent is taken from the heads of the households or any elder found available during the visit of the household by the field workers. This technique was found to be ethically acceptable for the Health and Demographic Surveillance System (HDSS).

The study proposal was reviewed and approved by both the Wits Human Research and Ethics Committee (WHREC; clearance number 130963) and the Institutional Review Board (IRB) of the Navrongo Health Research Centre (NHRCIRB175). The ethics certificates are in the appendix of this report. We were given anonymous data selected to answer the research question where mothers, their newborns and households are identified using unique identification numbers. The data was stored in a computer protected by a pass word. The analyses we preformed did not identify any woman or household.

Chapter Three: Results

In this chapter the background characteristics of the study population and the trends in home deliveries using various time scales and within different subgroups are described. The results of the univariate analysis and the multivariable analysis for predictors of home deliveries are also presented.

3.1 Background characteristics of the study sample

During the study period (January 2003 to December 2009) a total number of 25,539 deliveries occurred in the households of the two districts of which 52.37% (13,376 deliveries) were from the East district and 47.63% (12,163 deliveries) were from the West district. The majority of all deliveries (58.11%, 95% CI: 57.51-58.72) occurred at home. The total number of deliveries (25,539) occurred in 16,429 households giving the average number of 1.6 childbirths per household during the period.

The mean age of mothers at childbirth was 28.33 years (SD: 7.62 years). The mean age was greater for mothers delivering at home compared to those delivering in health facilities (29.09 vs. 27.28; $p<0.001$). The overall median age was 27 years (IQR: 22-34). The median age was greater for mothers who delivered at home (29 years; IQR: 23-35) compared to mothers who delivered in health facilities (26 years; IQR: 22-32). Overall, teenage mothers (13 to19 years) represented 11.6% (2,978/25,539) of all the mothers and were 2.5% more represented among facility deliveries (13.12%) compared with home deliveries (10.61%). Majority of the deliveries (40.02%) occurred in mothers aged between 25 and 34 years. Mothers in the oldest age group (35-49 years) accounted for 22.93% of all deliveries and were 10% more represented among home deliveries (27.2%) compared to facility deliveries (17.01%).

More than one third (39.12%) of the mothers had no education level. Figure *2* below shows the distribution of the sampled mother according to their level of education at childbirth.

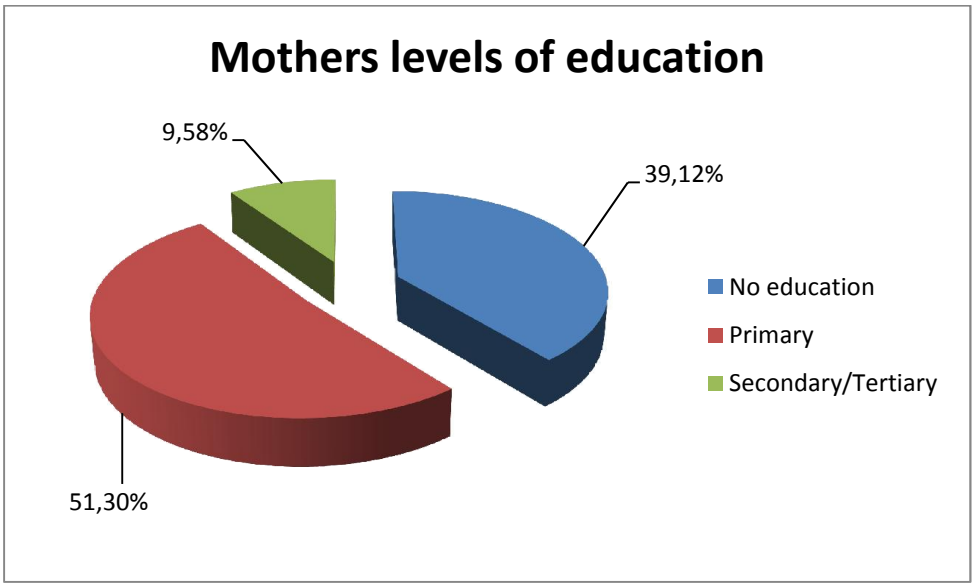


Figure 2: Mothers educational levels (n=25539)

Overall, the proportion of home deliveries occurring in non educated mothers (47.67%) was higher compared to the proportion of health facility deliveries (27.15%). In the opposite proportions of health facility deliveries occurring to mothers who had some levels of education (either primary, secondary or tertiary) were consistently higher to the proportions of home deliveries occurring to mothers with the same levels of education. These patterns are also observed in yearly data as shown in Figure 3.

Only 15.18% of the mothers were not married at the time of their childbirths. While the proportion of home deliveries occurring in non married mothers (12.97%) was lower compared to that of health facility deliveries (18.25%), a higher proportion of home deliveries (87.03%) occurred among married mothers compared to health facility deliveries (81.75%). More married mothers delivered at home than in health facilities.

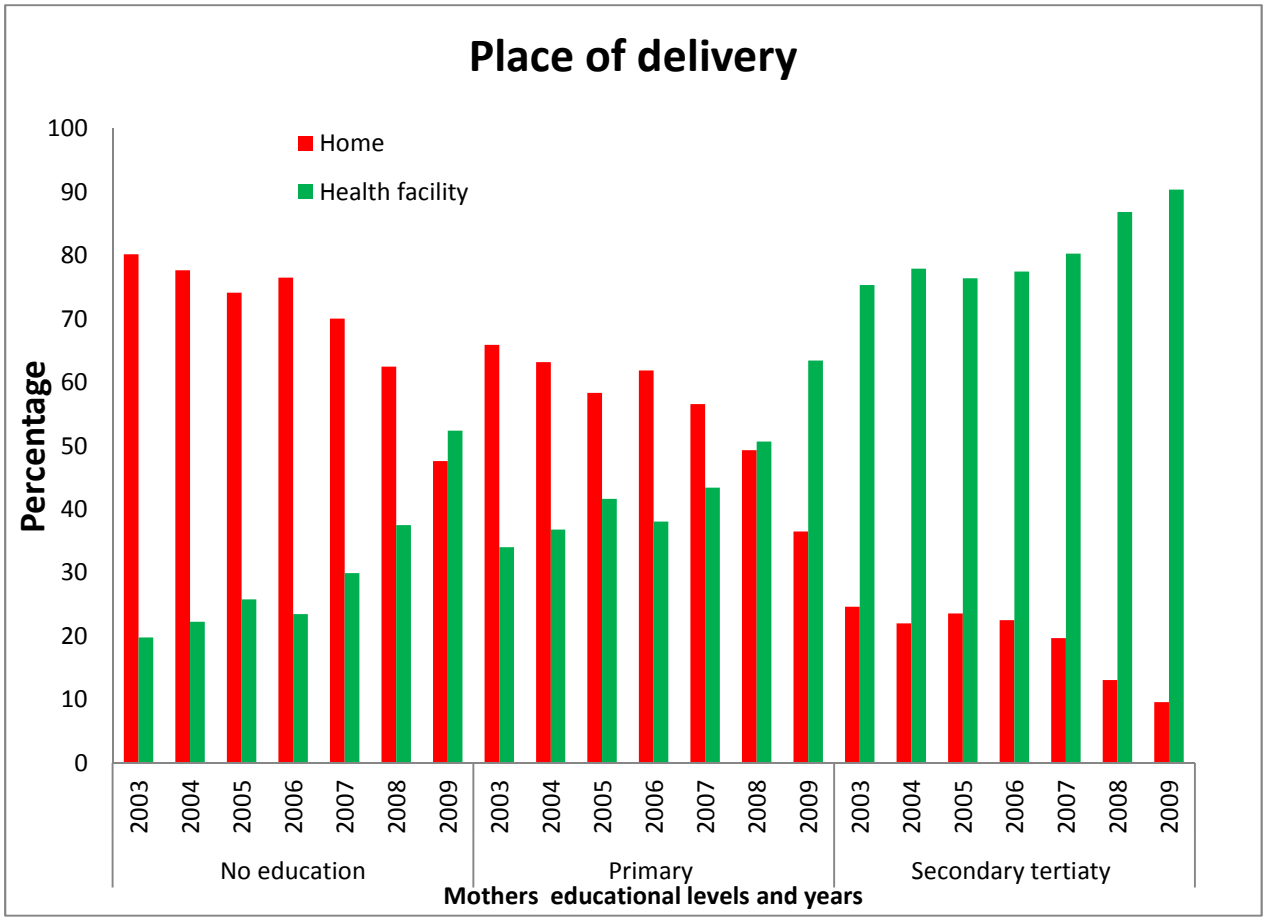


Figure 3: Place of delivery by mother's educational levels and years

About half of all deliveries (49.44%) occurred among mothers with Christian background, traditional religion practitioners representing 44.06% and Islam was minority with 6.49%. The proportion of home deliveries in women of traditional background (53.92%) is higher compared with health facility deliveries. However, 14% more women of Christian background delivered in health facilities (57.87%) compared with home (43.51%) and 10% more women of the Islam background delivered in health facilities (12.06%) compared with home (2.57%). Table 1 below summarizes some background characteristics of the study sample.

Table 1: Background characteristics of the study population by place of delivery

	Home delivery n (%)	Facility delivery n (%)
Total	14841 (58.11)	10698 (41.89)
Age of mothers at child birth		
13-19	1574 (10.61)	1404 (13.12)
20-24	3555 (23.95)	2930 (27.39)
25-34	5678 (38.26)	4543 (42.47)
35-49	4034 (27.18)	1821 (17.02)
Marital satus of the mothers		
Not married	1925 (12.97)	1952 (18.25)
Married	12916 (87.03)	8746 (81.75)
Religion of the mothers (n=23242)		
Traditional	7352 (53.92)	2889 (30.07)
Christian	5932 (43.51)	5560 (57.87)
Islam	350 (2.57)	1159 (12.06)
Previous parity of the mothers		
Zero	3187 (21.47)	3893 (36.39)
One	2924 (19.70)	2318 (21.67)
Two and more	8730 (58.82)	4487 (41.94)
Place of birth of the previous child n=6201		
Home	3293 (87.53)	1058 (43.38)
Health facility	469 (12.47)	1381 (56.62)
Number of previous home deliveries		
Zero	11226 (75.64)	9559 (89.35)
One	3186 (21.47)	1010 (9.44)
Two or 3	429 (2.89)	129 (1.21)
Twins or single birth (n=25537)		
Multiple	521 (3.51)	505 (4.72)
Single	14319 (96.49)	10192 (95.28)
Area of residence		
Rural	14477 (97.55)	7516 (70.26)
Urban	364 (2.45)	3182 (29.74)
Size of the household		
1-4	2505 (16.88)	2775 (25.94)
5-6	3696 (24.90)	2862 (26.75)
7-9	4436 (29.89)	2826 (26.42)
10 and more	4204 (28.33)	2235 (20.89)
Season of delivery		
Dry season	7014 (47.26)	4924 (46.03)
Rainy season	7827 (52.74)	5774 (53.97)
Days of delivery		
Week days	10530 (70.95)	7696 (71.94)
Weekends	4311 (29.05)	3002 (28.06)

More than fifty percent of all deliveries occurred in mothers that were multi-para at the time of the childbirth (parity two or more), 27.72% occurred in nulliparous mothers and the rest were deliveries to para one mothers. Higher proportions of health facility deliveries were noted in women who were nulliparous and para one (respectively 36.39% and 21.67%) compared to home deliveries in the same groups of mothers (respectively 21.47% and 19.70%). However, the proportion of home deliveries in multipare mothers (58.82%) was 17% higher than that of health facility deliveries in the same group (41.94%).

Aside the parity, we investigated the place of birth of the previous child born to the same mother during the study period. Overall, 6,201 women delivered at least twice in the study period and could have a previous delivery place to compare with an index delivery. The majority of these previous deliveries occurred at home. The proportion of home deliveries was 2 times higher in women whose previous child was born at home compared to the proportion of health facility deliveries (87.53% vs. 43.38%). Contrary, the proportion of health facility deliveries was much higher in mothers whose last child was born in a health facility (56.62% vs. 12.47%). The same pattern was shown in the data investigating the number of previous home deliveries of a woman. While the majority of all deliveries were not preceded by any home delivery (81.39%), in 16.43% of the cases the mother had already delivered at home one time and in 2.18% she had two or three antecedents of home childbirths. The proportion of health facility deliveries was higher (89.35%) in mothers who had no antecedent of home deliveries compared to the proportion of home deliveries (75.64%) in the same group. In the opposite, the proportion of home deliveries were higher in mothers who delivered one time or more at home compared to health facility deliveries.

A few proportion of all deliveries (4%) consisted of multiple births. The proportion of singleton deliveries occurring in health facility was lower than that of singleton deliveries occurring at home (95.28% vs. 96.49%). But in multiple ‘childbirths the figure was the

opposite with a higher proportion of health facility deliveries among twins 'births compared to home deliveries (4.72% vs. 3.51%).

As for the general population of the study area, the majority of the mothers were rural residents (86.12%). A proportion of 97.55% of all home deliveries occurred in rural residents while the proportion of all facility deliveries that occurred to rural residents was 70.26%. Only 2.45% of all home deliveries occurred to urban residents while 29.74% of all facility deliveries were in urban residents.

More than one household out of two (54.11%) had between 5 and 9 members and one quarter (25.21%) of the households had more than 10 household members. Also, as the household size increases, the proportions of home deliveries compared to health facility deliveries increase. While the proportion of home deliveries was lower than that of health facility deliveries in household with 1 to 4 members (16.88% vs. 25.94%), it was almost 8% higher (28.33% vs. 20.89%) in households with a size greater than 10 members compared to the proportion of health facility deliveries in the same group.

According to the wealth index, 24.59% of the deliveries occurred in households that were poor and 14.22% occurred in household considered as rich. Higher proportions of home deliveries were observed in households ranked as poor, next poor or average compared to health facility deliveries. As one moves from poor to rich categories, the proportions of home deliveries decline sharply while that of health facility deliveries are increasing with the same trend (see Figure 4).

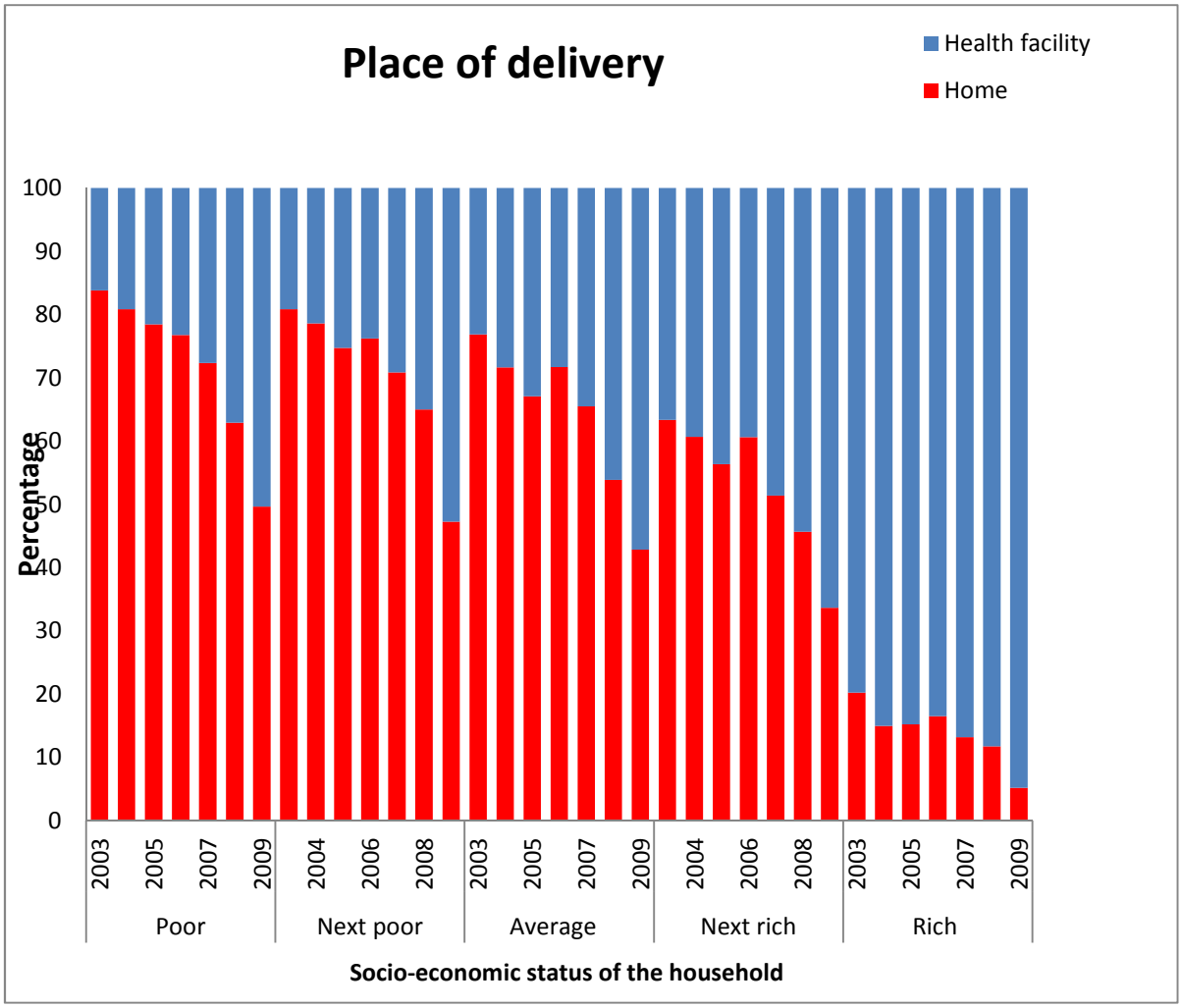


Figure 4: Place of delivery by socio-economic status and by years

With respect to the day of delivery, 71.37% occurred during a weekday. Proportions of home deliveries were lower in weekday's deliveries (70.95% vs. 71.94%) and higher in weekend's deliveries (29.05% vs. 28.06%) compared with health facility deliveries. The dry season defined as from November to April was the time of delivery of 46.74% of all childbirths. The proportions of home deliveries were higher during the dry season (47.26% vs. 46.03%) and lower during the rainy season (52.74% vs. 53.97%) compared with health facility deliveries.

3.2 The yearly proportions of home deliveries

The proportions of home deliveries during each year of the study period are presented in the Figure 5. Home deliveries have been gradually declining during the period of study moving from 69% of all deliveries in 2003 to 36.54% in 2009. The proportions showed two distinct periods in the decline of home deliveries: between 2003 and 2006 where the average decline in the proportions of home childbirth was 2 percent points per year and between 2006 and 2009 where the decline was more important, attaining 10 percent points per year.

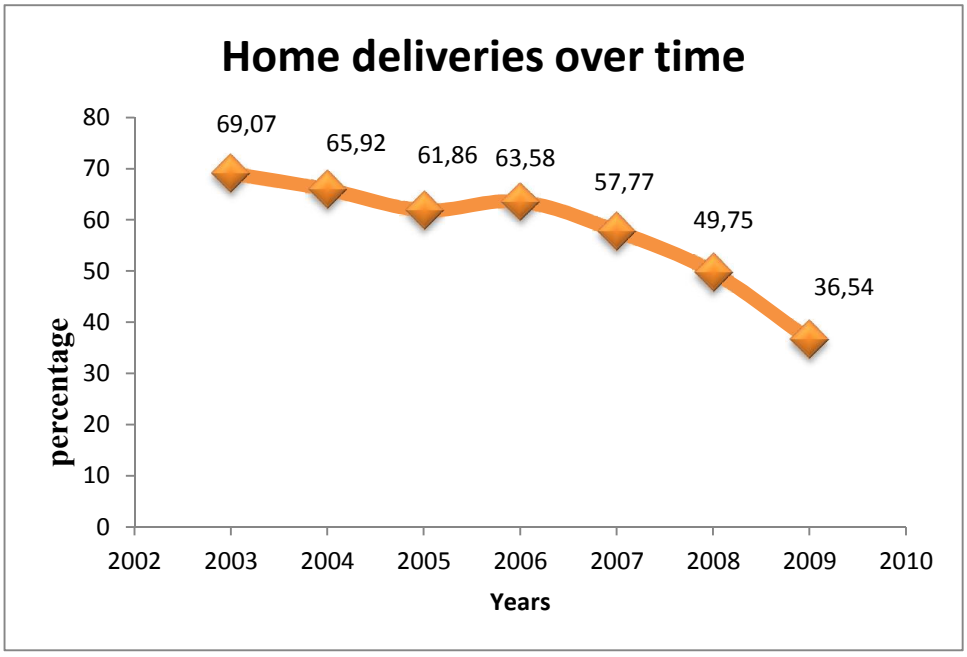


Figure 5: Yearly incidences of home deliveries

3.3 Predictors of home deliveries

3.3.1 Results from the univariate analysis

Unadjusted Odds Ratios were computed using a multilevel logistic regression. The effect of each covariate on the outcome was modeled independently. The two levels in the analysis were childbirths (level 1) which included individual characteristics and households (level 2)

which included the characteristics of the households. The different predictors investigated are grouped into three categories: maternal factors, households related factors and factors related to the timing of delivery.

3.3.1.1Maternal factors

In the univariate analysis the maternal age was significantly associated with the odds of home delivery. As age increases, the odds of a woman delivering at home also increase. The oldest mothers (35-49 years) had almost threefold odds increase of home delivery (OR: 2.88; 95% CI: 2.48-3.35) compared with teenage mothers (13-19 years).

There is a strong and negative association between the level of education and home delivery. The more a mother is educated the less likely she will deliver at home. Mothers who had achieved the primary educational level were 64% less likely (OR: 0.36; 95% CI: 0.33-0.40) to deliver at home and those with secondary or tertiary levels were almost 100% less likely to deliver at home (OR: 0.03; 95% CI: 0.02-0.03) compared with mothers who had no education level.

Non-married women were more likely to deliver at home compared with married ones. Single mothers were 82% more likely to have their child birth at home (OR: 1.82; 95% CI: 1.62-2.05) compared with married mothers. When compared to nulliparous mothers, para one mothers and multi-para mothers were respectively two times (OR: 1.92; 95% CI: 1.72-2.14) and 3.4 times (OR: 3.36; 95% CI: 3.05-3.70) more likely to deliver at home. Women of Christian and Islam backgrounds were respectively 76% (OR: 0.24; 95% CI: 0.21-0.27) and 97% (OR: 0.03; 95% CI: 0.02-0.04) less likely to have their childbirth happening at home compared to those of traditional religion background. More singleton childbirths occurred at home compared to twins' births. The odds of home deliveries among singleton deliveries were 71% higher (OR: 1.71; 95% CI: 1.37-2.16) compared with twins 'births.

The previous number of home deliveries of the same mother during the study period also showed some evidence of association. Mothers who previously delivered one time at home were 55% (OR: 1.55; 95% CI: 1.38-1.73) more likely to have another home delivery compared to those who did not deliver previously at home. Women who had previously delivered twice or more at home also showed greater odds of home delivery. However, the difference was not significant (OR: 1.10; 95% CI: 0.85-1.45).

3.3.1.2 Household related factors

The size of the household is positively associated with home deliveries. As the size increases, the odds of home delivery increase. For each three members increase in household size, the odds of home delivery increase significantly by 32% (OR: 1.32; 95% CI: 1.27-1.37).

While there is no significant difference in odds of home deliveries between next poor (wealth quintile 2) and poor (wealth quintile 1) households (OR: 0.89; 95% CI: 0.78-1.02), being in an average household (wealth quintile 3), a next rich household (wealth quintile 4) or a rich household (wealth quintile 5) reduces significantly the odds of home deliveries compared to being in a poor household. Home deliveries were 42% less likely to occur in average households (OR: 0.58; 95% CI: 0.51-0.66) and 99% less likely to occur in rich households (OR: 0.01; 95% CI: 0.01-0.02) compared to poor ones. Deliveries to women living in urban area are significantly less likely to occur at home when compared to those occurring in rural resident mothers (OR: 0.02; 95% CI: 0.01-0.02).

3.3.1.3 Time of delivery

Deliveries occurring during week days (Monday to Friday) were less likely to take place at home compared to weekends 'deliveries (OR: 0.91; 95% CI: 0.83-0.99). There was no significant difference in place of birth between the childbirths occurring during dry season and rainy season. The odds of home deliveries sharply decline from 2003 to 2009. The odds

of home delivery were 20% lower in 2004 (OR: 0.81; 95% CI: 0.69-0.95) and 99% lower in 2009 (OR: 0.1; 95% CI: 0.09-0.12) compared to 2003.

3.3.2 Results from the multivariable analysis

We fitted a two level logistic regression model to our data using all the covariates that showed some evidence of association with home deliveries in univariate analysis ($p<0.1$). The inter-household variance in home deliveries in the empty model was 4.74 (95% CI: 4.27-5.27). After inclusion of the covariates in the model the inter-household variance in home deliveries reduced to 1.83 (95% CI: 1.54-2.17) meaning that more than half of the variation observed between households in the empty model was explained by individual and household characteristics. The remaining half was still significant and was not explained by the covariates in our model. The chi2 of the likelihood ratio test comparing the multilevel logistic regression to the simple logistic regression was 355.75 ($p<0.001$). The results from the multivariable model are presented along with the results from univariate analysis in Table 2 below. We controlled for the temporal trend in the multivariable analysis.

Table 2: unadjusted and adjusted odds ratios for predictors of home deliveries.

Variables	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Age of the mother n (%)		
13-19 (r)	1	1
20-24	1.19 (1.03-1.36) **	1.04 (0.90-1.21)
25-34	1.23 (1.07-1.40) **	0.84 (0.71-0.99) **
35-49	2.88 (2.48-3.35) ***	1.01 (0.83-1.22)
Education status of mothers n (%)		
No education (r)	1	1
Primary/JSS	0.36 (0.33-0.40) ***	0.69 (0.63-0.75) ***
Secondary/tertiary	0.03 (0.02-0.03 ***	0.28 (0.23-0.34) ***
Marital satus of mothers n (%)		
Married (r)	1	1
Not married	1.82 (1.62-2.05) ***	0.88 (0.78-0.99) **
Religion of the mothers		
Traditional (r)	1	1
Christian	0.24 (0.21-0.27) ***	0.59 (0.53-0.64) ***
Islam	0.03 (0.02-0.04) ***	0.27 (0.21-0.33) ***
Parity of the mothers at child birth		
Zero (r)	1	1
One	1.92 (1.72-2.14) ***	1.71 (1.51-1.95) ***
Two or more	3.36 (3.05-3.70) ***	1.98 (1.72-2.28) ***
Number of previous home births		
0 (r)	1	1
1	1.55 (1.38-1.73) ***	2.22 (1.97-2.51) ***
2-3	1.10 (0.84-1.45)	2.96 (2.25-3.90) ***
Pregnancy status		
Multiple (r)	1	1
Single	1.71 (1.37-2.16) ***	2.21 (1.77-2.75) ***
Size of the household (3 members increase)	1.32 (1.27-1.37) ***	1.11 (1.07-1.15) ***
Wealth index of the household		
Poor (r)	1	1
Next poor	0.89 (0.78-1.02)	1.02 (0.89-1.15)
Average	0.58 (0.51-0.66) ***	0.75 (0.66-0.85) ***
Next rich	0.27 (0.24-0.31) ***	0.55 (0.48-0.63) ***
Rich	0.01 (0.01-0.02) ***	0.16 (0.13-0.20) ***
Area of residence		
Rural (r)	1	1
Urban	0.02 (0.01-0.02) ***	0.1 (0.08-0.12) ***
Days of delivery		
Weekends (r)	1	1
Week days	0.91 (0.83-0.99) **	0.88 (0.80-0.96) **
Season of delivery		
Dry season (r)	1	1
Rainy season	0.94 (0.87-1.02)	0.99 (0.92-1.08)

Notes: *p<0.05; **p<0.01;***p<0.001; "r": reference category JSS: Junior Secondary School

3.3.2.1 Maternal level predictors

After controlling for the other factors in the model, maternal age between 25-34 years was associated with lower odds (OR: 0.84; 95% CI: 0.71-0.99) of home deliveries compared to teenage mothers. There was no difference between teenage mothers and the mothers aged between 20-24 years and between 35-49 years.

Maternal education was significantly associated with the place of childbirth. Women who had Primary or junior secondary education (OR: 0.69; 95% CI: 0.63-0.75) and those who attained senior secondary or tertiary education (OR: 0.28; 95% CI: 0.23-0.34) were less likely to give birth at home compared to their uneducated counterparts. After controlling for the other factors Non-married women were now less likely to deliver at home compared to married ones (OR: 0.88; 95% CI: 0.78-0.99). Being Muslim or Christian reduced the odds of delivering at home respectively by 73% (OR: 0.27; 95% CI: 0.21-0.33) and 41% (OR: 0.59; 95% CI: 0.53-0.64) compared to being traditional religion practitioner. Parity showed the same positive association with dose-response relationship with home deliveries as in univariate analysis. The odds of home deliveries were 1.7 times (OR: 1.80; 95% CI: 1.26-2.59) higher in women who had parity one at the recorded child birth and two times higher in multipare mothers (OR: 1.98; 95% CI: 1.72-2.28) compared with those who were nulliparous the recorded delivery.

The history of home delivery was an important predictor of home birth. Women who delivered one time at home are 2 times (OR: 2.22; 95% CI: 1.97-2.51) more likely to repeat and those who delivered at home two or three times are 3 times (OR: 2.96; 95% CI: 2.25-3.90) more likely to repeat compared with women who did not have a history of previous home delivery . Singleton childbirths were 2 times more likely to occur at home compared with the birth of twins (OR: 2.21; 95% CI: 1.77-2.75).

3.3.2.2 Household level predictors

As the household size increases the odds of women delivering at home also increase. For each 3 members increase in the size of the household the odds of a woman delivering at home increase by 11% (OR: 1.11; 95% CI: 1.07-1.15).

The socio-economic class was an important predictor of home deliveries. The negative association between wealth index and home delivery observed in univariate analysis was confirmed by the multivariable model. There is no difference between childbirths occurring in households ranked as next poor (OR: 1.01; 95% CI: 0.89-1.15) and those considered as poor. Contrariwise, childbirths that occurred in households ranked as average, next rich and rich were respectively 25% (OR: 0.75; 95% CI: 0.66-0.85), 45% (OR: 0.55; 95% CI: 0.48-0.63) and 84% (OR: 0.16; 95% CI: 0.13-0.20) less likely to occur at home compared to households ranked as poor. There was overwhelming evidence that child births occurring to urban resident mothers were less likely to take place at home compared with those occurring to rural residents mothers (OR: 0.09; 95% CI: 0.08-0.12).

3.3.2.3Time of the childbirth

Childbirths occurring on weekdays were significantly 12% (OR: 0.88; 95% CI: 0.69-0.93) less likely to take place at home compared to the childbirths that occurred on weekends, and as shown in the trend analysis, the odds of home delivery were gradually declining over time with odds of home childbirth 90% lower in 2009 compared to 2003.

3.4 Trends in home deliveries

We used data aggregated by months and quarters to explore the trends in home deliveries and the effects of selected covariates on the trends in home deliveries over time.

3.4.1 Overall trends in home deliveries

The numbers of total deliveries and home deliveries were in a first time graphically displayed using different time scales: time in quarters of years and time in monthly dates.

The Figure ***6*** shows the quarterly numbers of total deliveries and home deliveries over time.

Total numbers of deliveries were fluctuating around 950 births per quarter from 2003 to the fourth quarter of 2007. Between the first quarter of 2008 and the last quarter of 2009, the total numbers of deliveries per quarter were less than 950, oscillating between 800 and 950 giving an overall trend of slight decline in the numbers of total deliveries during the study period. The numbers of home deliveries per quarter showed a clear and more marked trend of decline from 2003 to 2009, moving from around 650 home deliveries per quarter in 2003 to less than 350 home deliveries per quarter in 2009. The fluctuations observed in both total numbers of deliveries and numbers of home deliveries per quarter do not describe a clear pattern of seasonality per year as peaks were observed at any quarterly date from the first to the fourth quarter.

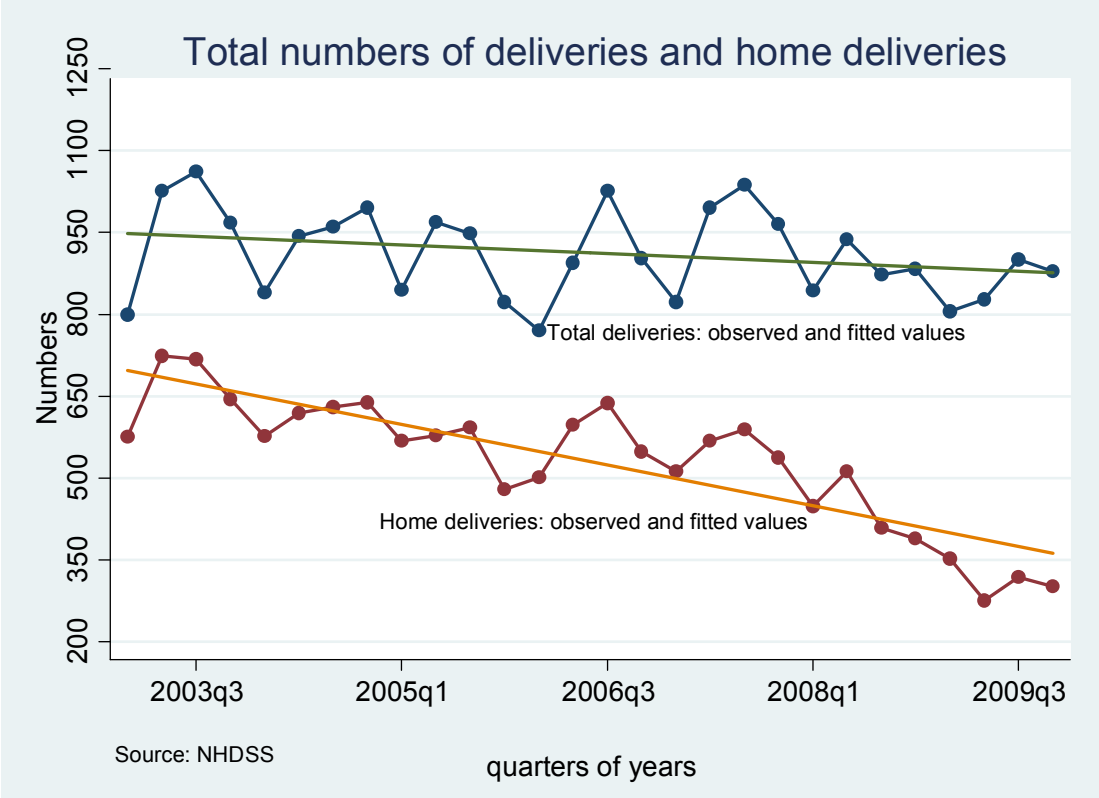


Figure 6: Trends in total deliveries and home deliveries: observed values and fitted line

The same patterns are shown with monthly data in Figure 7. In order to reduce the noise, the monthly data were smoothed using symmetric 3 months moving-averages. The figure 7 showed that consistently for each year, the maximum monthly numbers of total births and home deliveries occur in August, September or October. Both total deliveries and home deliveries describe the same and repetitive yearly cycle over time. Generally the numbers start increasing from January and reach the peak in September before dropping from September to December. If the cycle is the same over time, the numbers that constitute the cycle are however decreasing. Again this decline was more important for home deliveries for which a particular marked decline is observed after 2008.

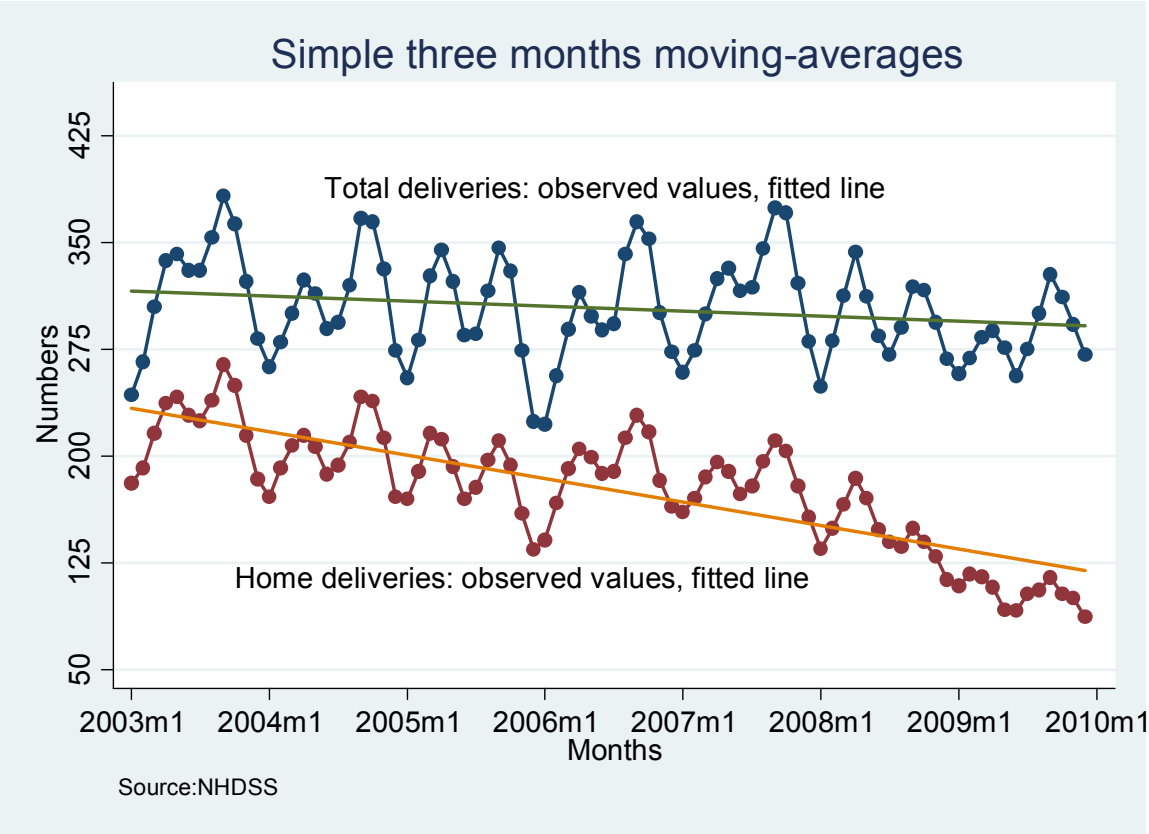


Figure 7: Trends in total deliveries and home deliveries observed values and fitted line

The previous figures showed an overall pattern of decline in both total deliveries and home deliveries over time. While the decline in the number of total deliveries is slight and taking place very slowly, the number of home deliveries is declining markedly and more quickly.

Besides the raw numbers of home deliveries, the monthly rates of home deliveries were calculated and graphically displayed to show the trends in home deliveries.

The monthly rates of home deliveries presented in Figure 8 showed a consistent and continuous decline in the proportions of home deliveries at any point in time. The exception was a slight increase in 2006 that was immediately followed by a sustainable decrease.

The pattern seen towards the end of the period with the actual numbers was also confirmed by the proportions with a marked and accelerated decrease in rates of home deliveries after January 2008.

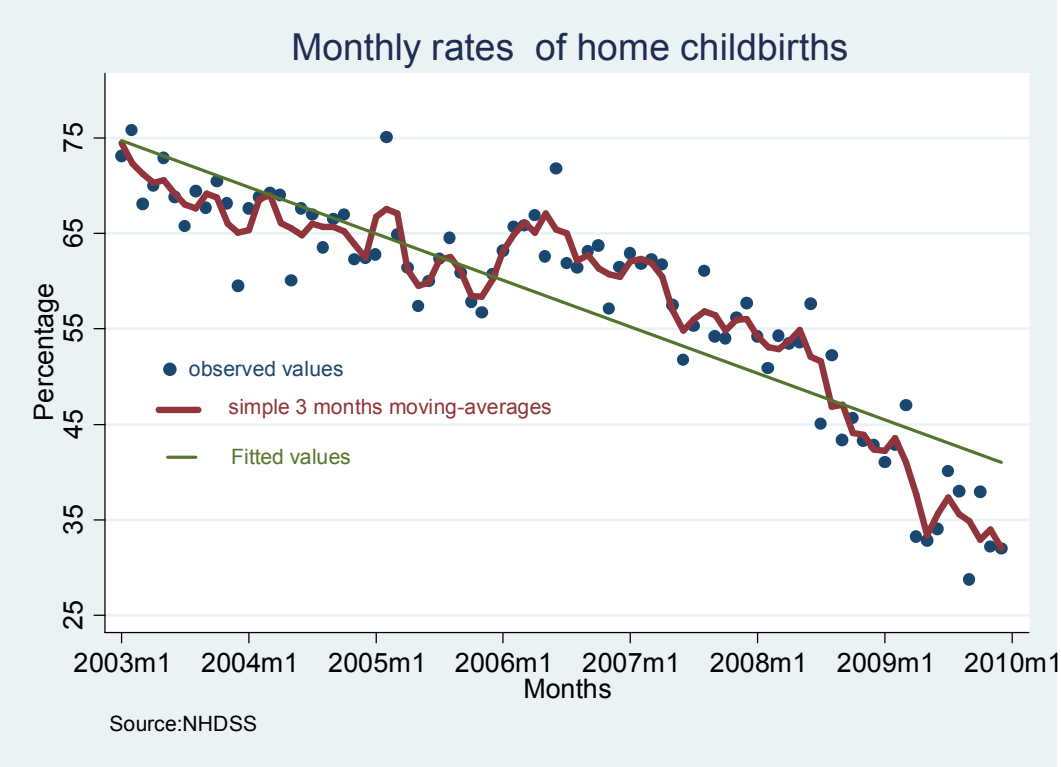


Figure 8: Trend in rate of home deliveries using monthly scale

Symmetric 3 months moving-averages and observed values of the rates of home deliveries are used in the Figure 8. Unlike the raw numbers of home deliveries, the proportions of home deliveries do not describe a clear seasonal pattern. Higher proportions of home deliveries were observed in both dry season (2003, 2004, and 2007) and rainy season (2006, 2008, and 2009) and peaks were observed at least one time in January, February, March, April, June and July.

3.4.2 Trends in home deliveries per socio-economic status and area of residence

We displayed graphically the trends of home delivery using the monthly rates per area of residence (rural vs. urban) and across the different socio-economic groups defined by the wealth index. The Figure 9 shows the trend according to the residency and socio-economic statuses.

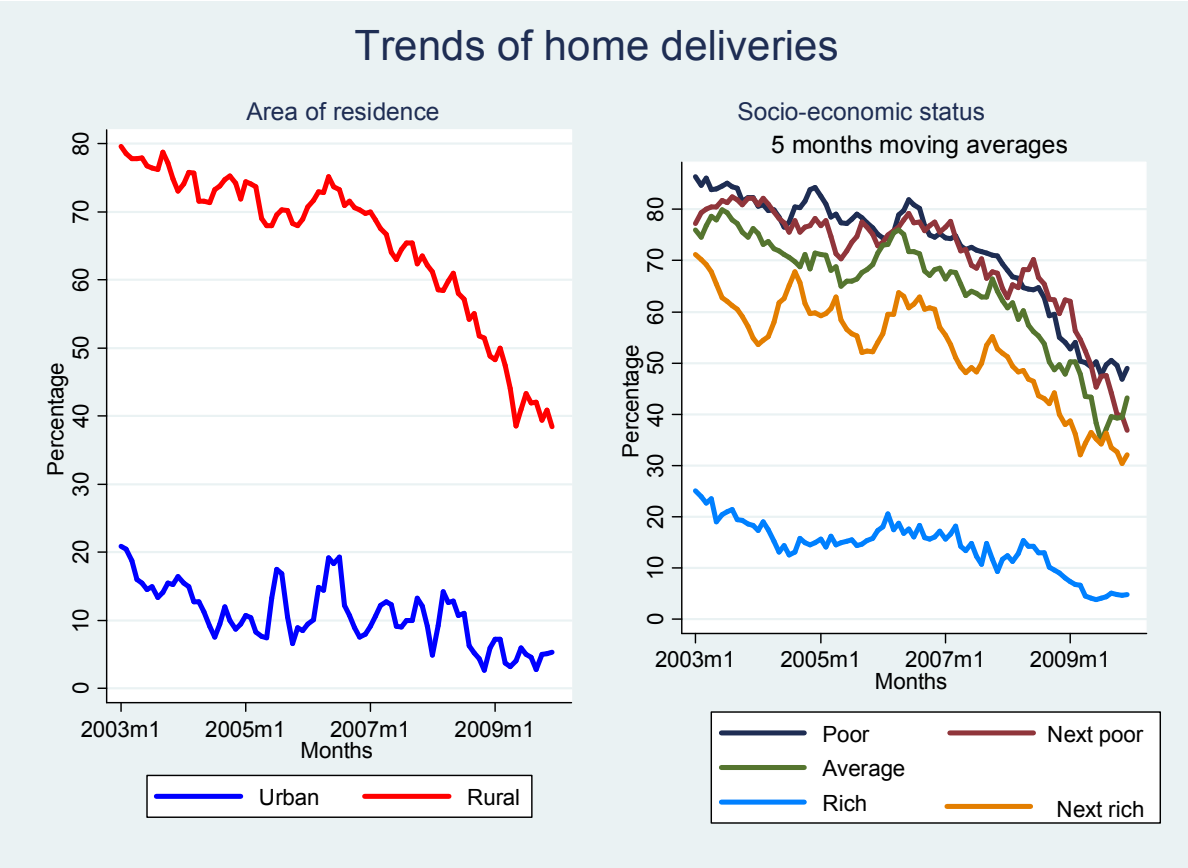


Figure 9: Monthly rates of home deliveries per residence area and socio-economic groups

There is a wide disparity between the rural and the urban areas. While 80% of all deliveries in rural area took place at home in 2003, only 20% of all deliveries in urban area in 2003 occurred at home giving a gap of around 60%. The rates are declining in both areas over time; the drop in rural area was more important reducing the gap between the two zones by the end of 2009.

Home delivery is a minor issue in rich households compared with poor and next poor households. Households ranked as average and next rich had also lower rates of home deliveries compared with these two groups. The trends showed a decline over time in all socio-economic groups. However, there was a marked decline in the first four groups compared to the rich resulting in a reduction of the inequalities observed at the open period of the study.

3.4.3 Trends in home deliveries by mothers educational levels

The trends of home deliveries in the groups defined by the educational levels of the mothers were also investigated by graphically displaying the monthly rates of home deliveries across the different levels of education (see Figure 10).

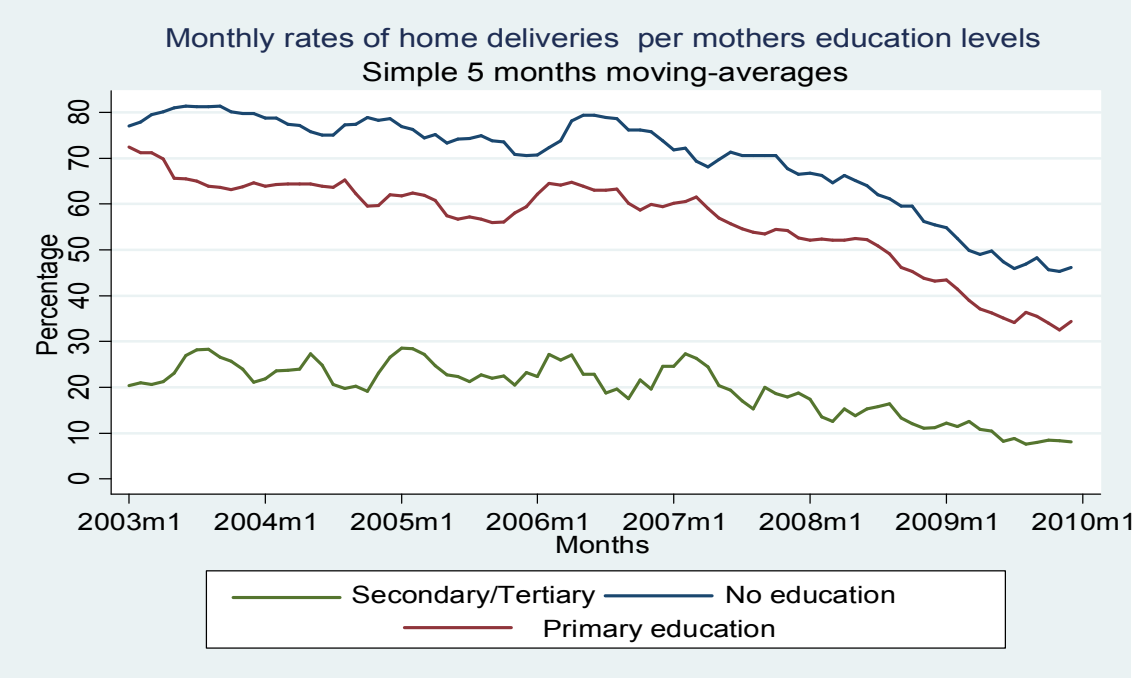


Figure 10: Trends in home deliveries per mothers' educational status

As shown in Figure 10, the educational level of the mothers was critical in the choice of the place of delivery throughout the study period. Mothers with secondary and tertiary levels of education have much lower rates of home deliveries. The overall trend showed a decrease in rates of home deliveries in all groups. However, the decline was again most important in no educated mothers (more than 30% decline) and mothers with primary education level (around 40% decline) compared with mothers, who received secondary and tertiary education (around 20%). At the end of the study period the gap between more educated and less educated tend to decrease.

3.4.4 Trends in home deliveries using ARMA models

The stationarity of the time series was checked in the monthly rates of home deliveries using the Dickey Fuller test. The results of the Dickey Fuller test including a trend parameter presented in Table 3 showed that we can reject the non stationarity as the test statistic fall under the rejection area (Z(t)= -4.38; p=0.002). We therefore conclude that the data are stationary.

Table 3: Dickey-Fuller test for unit root including the linear regression and trend components

	Test statistic	Interpolated Dickey-Fuller		
		1% critical value	5% critical value	10% critical value
Z(t)	-4.38	-4.08	-3.47	-3.16
MacKinnon approximate p-value for Z(t) = **0.002**				
Regression for ΔY_t over Lag1 of Y				
ΔY_t	Coefficient	P-value	95% confidence interval	
Lag1 of Y	-0.40	<0.001	(-0.59)- (-0.22)	
Trend	-0.0017	<0.001	(-0.0025)-(-0.0009)	
Constant	0.30	<0.001	0.16-0.44	

ΔY_t: $Yt-Yt_{-1}$: rate of home deliveries at time t minus rate of home deliveries at time t-1.

Lag1 of Y: First lag of the rate of home deliveries. t=time in months

The results of the linear regression showed a significant temporal trend with ß= -0.0017 (p<0.001). The overall equation of the difference in rate of home deliveries at any time t can be written as: $Yt-Yt_{-1}= 0.30-0.40Yt_{-1}-0.0017t$. Or $Yt =0.30+ (1-0.40) Yt_{-1} -0.0017t$.

The rate of home deliveries at a particular time t depends on its previous value and is also function of the time t plus a significant drift walk (0.30).

Although the data on rate of home deliveries is stationary and seasonality absent from the proportions of home deliveries over time, the autocorrelation of the errors may lead to bias in the estimates calculated by fitting an Ordinary Least Square regression. The correlogram of the residuals (autocorrelation functions and partial autocorrelation functions) showed significant correlations between residuals and the correlations between the errors terms were confirmed by the White noise test (Portmanteau (Q) statistic = 376.91; $p<0.001$). Autoregressive Moving Averages (ARMA) models of order 1 were therefore fitted to the data to account for the autocorrelations of the errors terms. A first model was fitted without covariates and the results are shown in Table 4.

Table 4: ARMA model estimates of the percentage of home deliveries.

Proportions of home deliveries	**Coefficient**	**P-value**	**95% confidence interval**
Constant	0.54	**0.001**	0.10-1.13
Autoregressive Lag1	0.99	**<0.001**	0.96-1.03
Moving averages Lag1	-0.58	**<0.001**	(-0.81)-(-0.35)
Sigma	0.04	**<0.001**	0.03-0.05

The series is highly correlated at a level of 0.99 with a negative impact in the ensuing month (-0.58). The plot of the predicted values based on the ARMA (1, 1) model is shown in *Figure 11* (left hand). The patterns displayed by this graph confirmed that the time series of the rates of home deliveries follows fairly an ARMA (1, 1) model.

The ARMA (1, 1) model was re-fitted controlling for education rate, richness rate and the age of the mothers to investigate the effects of these covariates on the rates of home deliveries at population level. The results of the model with covariates are presented in Table 5 and the right hand graph in *Figure 11* showed the trends in home deliveries, education rate and richness rate in the population.

Table 5: ARMA model estimates of home deliveries controlling for covariates

Proportions of home deliveries	Coefficient	P-value	95% confidence interval
Constant	0.61	**0.02**	0.10-1.13
Rate of educated mothers	-0.18	0.24	(-0.14)-(0.12)
Rate of rich	-0.34	**0.01****	(-0.61)-(-0.08)
Age of the mothers	0.01	0.45	(-0.01)-(0.19)
Autoregressive Lag1	0.99	**<0.001**	0.96-1.03
Moving averages Lag1	-0.62	**<0.001**	(-0.82)-(-0.42)
Sigma	0.04	**<0.001**	0.03-0.05

There is a negative correlation between the education rate of the mothers, the richness rate and the rate of home deliveries. As the rate of mothers with some levels of education rises the rate of home deliveries decreases, however, the association is not significant (p=0.24). Unlike education rate, the negative association between rate of richness and rate of home deliveries was significant (p=0.01).

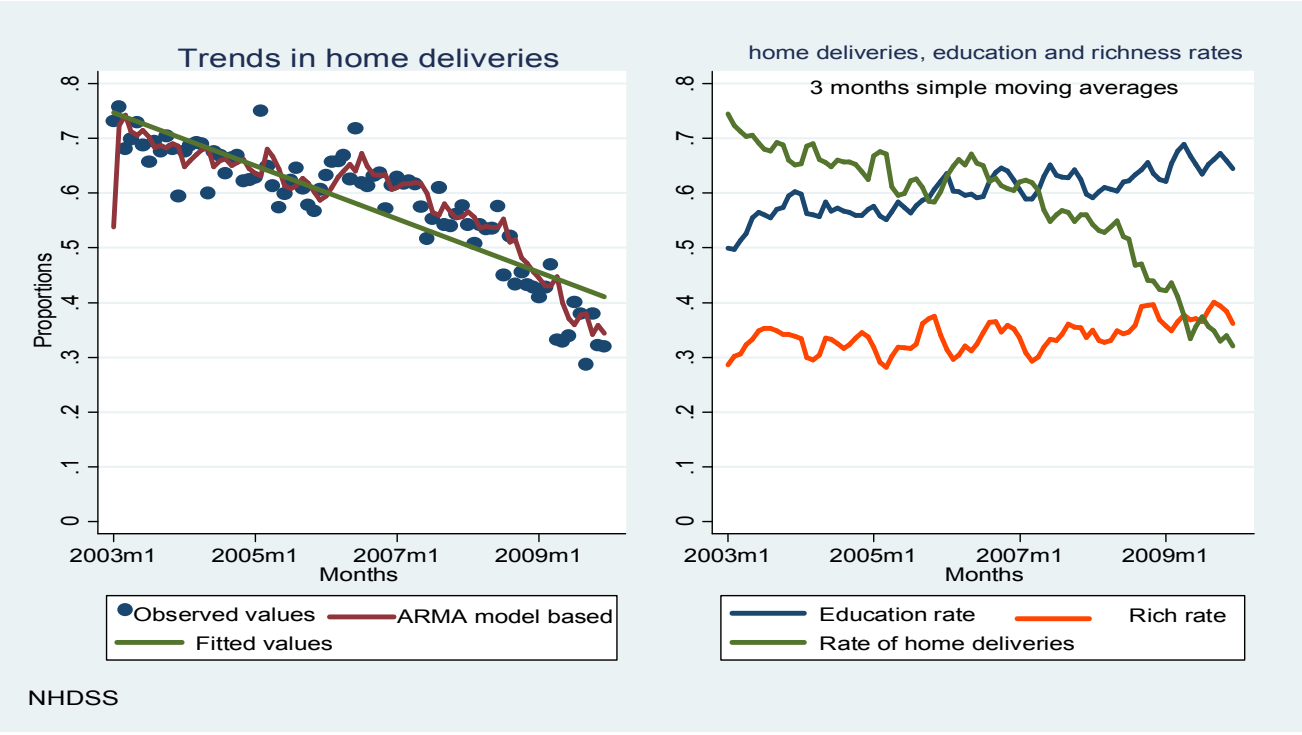


Figure 11: Trends in home deliveries, education and richness rates.

Globally, as for the individuals' data, the aggregated data also showed that poverty and lack of education are important drivers of home deliveries. As the rates of educated mothers and rich households increase in the population, the rate of home deliveries is decreasing.

Chapter Four: Discussion

In this section our main findings are discussed in the light of recent literature on home deliveries in both the broad sub-Saharan African region and in Ghana specifically. We also proposed context-based explanations for some findings.

The aim of this study was to describe the trends of home deliveries over time and to identify the predictors for home delivery in the Kassena-Nankana East and West districts in a context of complete free health care services for pregnant women.

The study showed that home deliveries have been gradually declining between 2003 and 2009. Even though the gaps between the rich and poor, rural and urban residents and between non educated and educated mothers were notably reduced over time, home deliveries remain a more important issue in poor people, rural residents and non educated mothers. The analysis revealed that maternal factors (age, education, parity, marital status, and the history of home delivery) and households' related factors (size of household, the wealth index, area of location) were significant predictors of home deliveries. A negative correlation was found between rate of home deliveries and rates of education and richness in the population.

4.1 Incidence and trends in home deliveries

The yearly incidence proportions of home deliveries showed a gradual and consistent decline moving from 69% in 2003 to 36% in 2009. The incidence of 69% found in 2003 is consistent with the proportions of home deliveries reported by Ghana Demographic and Health Survey conducted in 2003 and which reported a proportion of 73.3% of home deliveries in the Upper East Region where the two districts of study are located. The levels of home deliveries in the Ghana DHS 2003 also confirmed that home deliveries were much frequent in the Upper East Region compared to the average national level: 73.3% vs. 53% (44). While the figures for

2003 were consistent with the Ghana DHS, the findings for 2009 showed a completely different figure from that reported by Ghana 2008 DHS. Indeed, in 2008 the Ghana DHS reported a national average proportion of 43% and a proportion of home deliveries in the Upper East Region of 52.6% (23). These figures are much higher than those found in our study. But the comparability of DHS data with our data is hampered by important differences in the methodologies: DHS data report aggregated figures for the past five years preceding the study instead of yearly figures and in addition DHS data are limited to live births. The differences in proportions of deliveries could be due to different methodological approaches. For example in a more comparable study carried out in 2006 in the Volta and Central regions, where data was collected on place of delivery using a single cross sectional study, the figures were much lower than those found in our study for the equivalent period and were thus more consistent with the general figures that placed the Upper East region behind the national level. Indeed, in data collected on 2004 and 2005 deliveries, the home deliveries represented 44.2% and 53.3% of all deliveries in respectively the Central region and the Volta region(31). The figures in our study can also reflect true differences between national, regional and local data in home deliveries as the national and regional levels data sometimes hide important local disparities in service utilization. It's also reasonable to think that the Kassena-Nankana East and West districts where the community midwives project was first implemented and where many concurrent research projects in community are being implemented may be achieving important and more accelerated results compared to other districts of the Upper East region.

Though the extent is different, the overall declining trend described in our data is consistent with the national level data. According to Ghana DHS the proportions of home deliveries declined from 54% in 2003 to 43% in 2008. During the same period of time home deliveries in the Upper East region declined from 73.3% to 52.6%. Further analyses carried out in our study showed a declining trend in all subgroups defined by socio-economic status, residence

status and education levels. However, the decline was more important in groups with higher levels of home deliveries at the starting period of the study (2003) leading to a gap-bridging situation between the poor and the rich, between rural and urban residents and between educated and non educated women. A similar study carried out using data from another HDSS in Ghana and focused on Health facility delivery reported similar findings for the trend of facility-based deliveries between 2004 and 2009(19). In that study the health facility deliveries increased by 21% between January 2004 and December 2009 and the increase was more important in the less rich compared to the rich. Although a study reported that the NHIS may be benefiting more of the rich than the poor(45), our results on health service utilization for delivery show that all socio-economic groups are improving and that the more vulnerable groups benefited more than the rest suggesting some progress in achieving equity in access to health services.

4.2 Predictors of home deliveries

Maternal age was significantly associated with home deliveries, as mothers aged 25-34 years were less likely to deliver at home compared with teenage mothers (13-19 years). Maternal age was reported in many studies (29, 33, 34). In general, older mothers tend to have more home deliveries compared to younger mothers, but the order is not consistent across studies and some studies did not find an association between maternal age and place of delivery (27). The inconsistency between findings may reflect different levels of control for confounding.

The results also revealed that, maternal education and socio-economic status were highly correlated with home deliveries: the more a woman is educated the less likely she is to give birth at home and women from rich households are less likely to deliver at home too. The same finding was revealed by the analysis of aggregated data where the increase in both educational rate and richness rate in the population was negatively correlated with the rate of

home deliveries. These findings are consistent with those broadly reported by studies on predictors of home deliveries as Education and wealth index are among the most consistent predictors of home deliveries reported in the literature. Almost all the many studies that investigated the issue of home deliveries in SSA and in Ghana found an association in the same direction between mothers educational level, households wealth index and place of birth (11, 27-31, 33-36, 46). Education improves the mothers' awareness of public health issues while empowering them with respect to the decision making process within the household. As there are always costs attached to health service delivery even in settings implementing free delivery care policies (residual costs linked to transportation etc.), the rich are expected to utilize services more than poor.

Mothers of traditional religious background were more likely to have their deliveries occurring at home compared with their counterpart of Christianity or Islam backgrounds. These findings are consistent with those reported in Ghana by different other studies (28, 47). The importance of cultural beliefs was also reported in a study conducted in Zambia (30). However, a study reporting results based on DHS data from many countries found an inconsistent association between religion and home deliveries suggesting a context specific relevance of this factor (33).

Married mothers compared to non-married mothers and multiparous ones compared to primiparous were more likely to deliver at home. This is also broadly reported in the literature (28, 33-35) and may be due to multiparous mothers feeling more confident about childbirth compared with primiparous. In addition married women are more likely to live in households where a relative willing to assist for home delivery is available (mothers in law). The plausibility of this speculation is supported by the finding on the size of the households, whereby greater household' size was associated with increase odds of home delivery.

The greater the number of previous home deliveries, the more a woman was likely to deliver at home. Thus, this factor is not widely investigated in the literature; findings are consistent in the few studies which looked at the previous place of birth as a determinant of a current place of birth (33, 39). One should, however, keep in mind that this is susceptible of being confounded by many factors (unmeasured confounders such service availability). In addition in our data the previous place of delivery did not capture the entire history of deliveries but instead was limited to the window of observation. Rural residents were more likely to give birth at home compared with those living in urban area. This finding is broadly reported across studies and settings and is probably a result of the conjunction between multiple factors (type of occupations, community level of awareness, service availability etc.) that make the urban area a more enabling environment for health facility utilization.

Finally, we observed that the place of delivery was dependent on whether it was a weekday or weekend, as an indirect measure of the women' anticipation of the quality of the service at health facility level. Deliveries occurring on weekends were more likely to take place at home. Given that the full staff in the health facility is not on duty during weekends particularly in rural areas we think that some women may anticipate long waiting time to get assistance by delivering at home.

Globally, the findings of this study support the vulnerability of poor and uneducated people with respect to health facility utilization for delivery while showing the likely benefic effects of interventions that target financial and geographical barriers in reducing the burden of home deliveries in the whole population.

Chapter Five: conclusion and recommendations

Findings from Demographic and Health Surveys (DHSs) are all consistent that in the SSA region progress is slow despite the various efforts to get women delivering in health facilities and thus being attended by medically trained health worker. In this study carried out at a local level we found that although more than one third of the pregnant women are still having their deliveries at home, the incidence of home deliveries is sharply declining over time. The gaps in home deliveries rates between the rich and the poor and, between rural versus urban residents are also quickly and notably reducing over time even though the inequities are persistent. Poverty, non education, rural residency remain important drivers of home deliveries even after the implementation of the free delivery care policy.

In considering the results of this study, some limitations and strengths should be kept in mind.

5.1 Limitations of the study

5.1.1 Study design

In this study we performed secondary data analysis, thus the scope of the predictors that could be investigated was limited. We did not take the opinions of the women who gave birth at home. Previous studies on reasons of deliveries where women were interviewed reported a number of reasons related to the health care system and cultural practices and beliefs. Such factors are not directly investigated in our study.

We planned to investigate some predictors, which were not fully collected during the study period or were yet to be collected leading to their exclusion from the current study: the antenatal care service utilization during the pregnancy, the distance between the household and the health facility and the educational level of the head of the household are examples of such predictors.

Even though the results showed a significant decline in home deliveries during the study period, our ability to attribute this pattern to the free delivery care policy and the CHPS program is low as our results are limited to the post intervention period.

5.1.2 Measurement of exposure variables

The number of previous home deliveries used in this analysis is an incomplete data in the way that it does not capture the entire information about the reproductive life of a woman, but is only limited to the window of observation: 2003, January to 2009, December. Only the deliveries that occurred in that period had information on place of delivery in the dataset and could be used to compute previous place of delivery. A woman who did not give birth at home at least one time during that period is classified as having zero previous home deliveries while she might have delivered at home one time or more before January 2003 leading to a potential misclassification bias on this exposure.

5.2 Strengths of the study

5.2.1 Measurement of the outcome variable

The information on the place of each delivery in this study is likely to be more precise compared to DHSs because the household's surveys are carried out every four months. Recall bias is less likely to occur as information is sought on a delivery that occurred in a period less than or equal to four months. The Health and Demographic surveillance Systems are more effective in capturing the information on all deliveries that occurred in each household because the pregnancy status of women in the household is recorded during previous surveys and the ending event of the pregnancy is then monitored. Thus, aside the self reporting by interviewed persons; the field workers have previous records on pregnancies and can easily identify omitted information to be asked during each household survey. Finally, the place of

delivery in this study was recorded independently of the outcome for the newborns. This rules out the potential selection bias encounters in DHSs data with respect to home deliveries. In collecting information only on live births, DHSs data probably misses an important fraction of home deliveries given the greater likelihood of home deliveries to give stillbirths.

5.2.2 The study design

The data in this study is from repeated cross sectional studies allowing us to carry out trends analysis that would not have been possible in a single cross sectional study. We have very précised dates of births even for deliveries that occurred at home allowing the computation of précised monthly and yearly rates of delivery. By following the same households over time, we gathered data on home deliveries for which the comparability from one year to another was not hampered by sample variability.

5.2.3 Statistical analyses

We performed analyses on both individuals' data and aggregated data. The effects of selected covariates found in analysis of individuals' data were confirmed at population level using aggregated data. It is noteworthy that our predictors' analysis was carried out controlling for temporal trend; this is very rare in the literature as most of the studies rely on single cross sectional study.

The study showed that local level studies are valuable particularly when community level interventions are being implemented, as global figures may hide important achievements at local levels and aggregated data may fail to reflect the actual state when changes are taking place quickly.

5.3 Recommendations

In the light of the findings and the strengths and limitations stated above we recommend that:

- Interventions targeting only the poor and uneducated people are implemented to reinforce the effects of the existing interventions in order to accelerate the achievement of equity in health facility utilization for deliveries;
- Multi-sectorial approaches are developed, involving health and education sectors. Education of young girls should be regarded as key in the attempts to improve health facility utilization for deliveries;
- During the ANC visits health workers should target multiparous pregnant women and those with history of previous home delivery as groups at risk of delivering at home for further sensitization on the issues of home deliveries.
- Other SSA countries where the burden of home deliveries is high should consider replicating the CHPS program along with a removal of users 'fees for obstetric care.
- Further studies are carried out in Kassena-Nankana East and West districts where the CHPS program and the free delivery care were piloted to properly evaluate their impacts on health service utilization for delivery using a before-after design. The geographical information system on the households of the NHDSS was yet to be finished; upon the completion of that, a study on home deliveries involving spatial analysis should be consider in order to map the population at greater risk. A study making the link between the home deliveries and the outcomes for newborns is also worthwhile and could be used to plead at both community and decision makers' levels for more commitments in the fight against home deliveries.

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APPENDICES

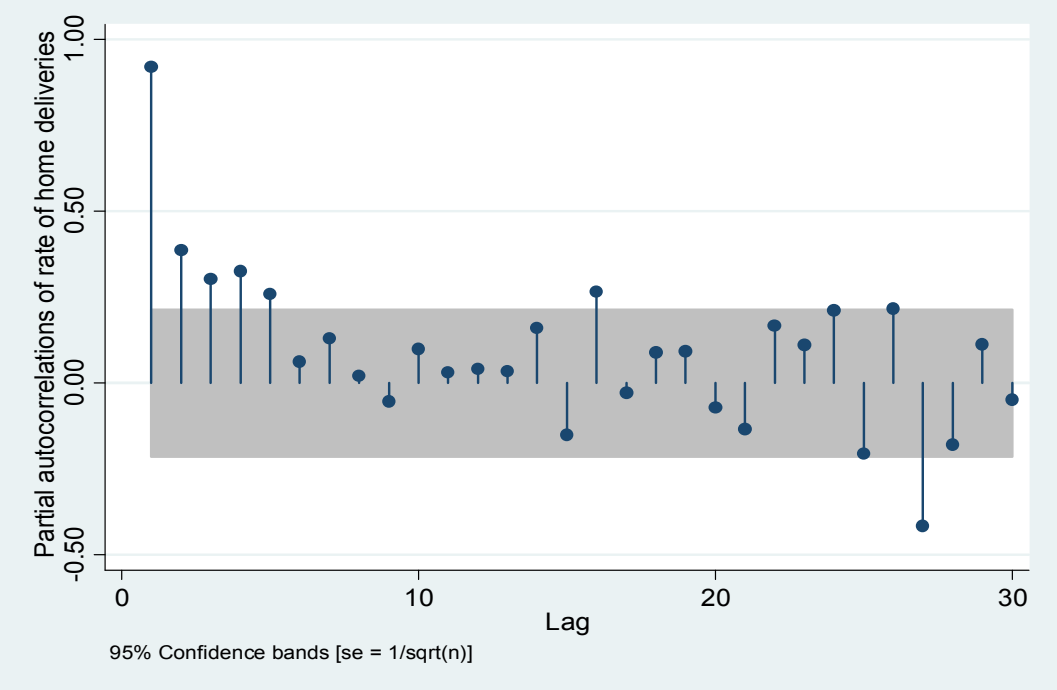


Figure 12: The partial autocorrelations function with 95% confidence band

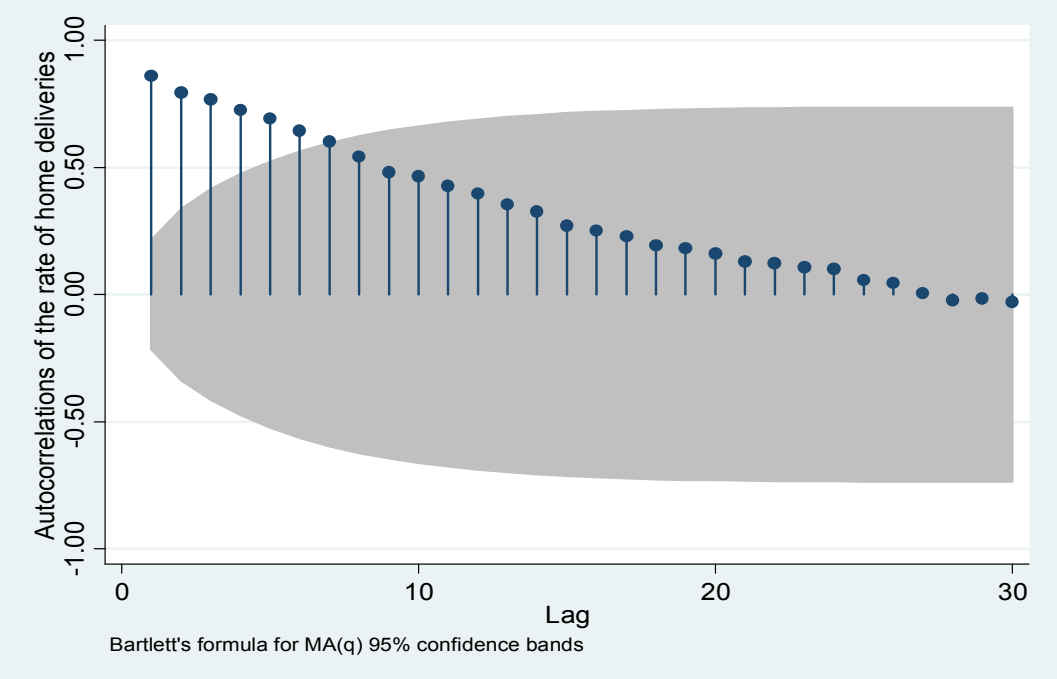


Figure 13: The autocorrelations function with 95% confidence band

R14/49 Dr Tieba Millogo

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M130963

NAME: (Principal Investigator) Dr Tieba Millogo

DEPARTMENT: Public Health
Epidemiology and Biostatistics
Kassena-Nankana East and West District, Ghana
Navrongo Health Research Center

PROJECT TITLE: Trends and Predictors of Home Deliveries in Kassena-Nankana East and Kassena-Nankana West Districts in Ghana: 2003-2009

DATE CONSIDERED: 27/09/2013

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Dr Eustasius Musenge

APPROVED BY: Professor PE Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 30/09/2013

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.**

Principal Investigator Signature

Date 02/11/2013

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

In case of reply the
number and date of this
letter should be quoted.

My Ref. App/HomeDel/01/2014
Your Ref:



Navrongo Health Research Centre
Institutional Review Board
Ghana Health Service
P. O. Box 114
Navrongo, Ghana
Tel/Fax: +233-3821-22348
Email: irb@navrongo-hrc.org

31st January, 2014

Dr. Tieba Millogo
Institut de Recherche en Sciences de la Santé
03, B.P. 7192 Ouagadougou 01
Burkina Faso

ETHICS APPROVAL ID: NHRCIRB175

Dear Dr. Millogo,
Approval of protocol titled: *"Trends and predictors of home deliveries in Kassena-Nankana East and Kassena-Nankana West districts in Ghana: 2003-2009*

Following your satisfactory address of the concerns raised by the NHRCIRB expedited review of the above-mentioned protocol, the Board is pleased to grant you approval.

The documents that were reviewed and approved include the following:

- Protocol submission form
- Study protocol version 1.0 dated 27/09/2013

Please note that any amendment to this approved protocol must receive ethical clearance from the NHRCIRB before its implementation.

The Board should be notified about the actual start date of the project and would expect a report on your study, annually or at the close of the project, which ever comes first. Should you require a renewal of your approval, the report should be submitted two (2) months before the expiration date.

You are also to note that this approval expires on 30th January, 2015.

The Board wishes you the best in this study.

Sincerely,

Dr. (Mrs.) Nana Akosua Ansah
(Vice Chair, NHRCIRB)

Cc: The Director,
NHRC, Navrongo

NHRCBIRTHFORM_Oct_2012

NAVRONGO HEALTH RESEARCH CENTRE
BIRTH REGISTRATION FORM

1. BASIC INFORMATION

1.1 Field worker..... | | | FW

1.2. Date of Interview .... | | | | | | | | | DINT

2. SOURCE OF INFORMATION

2.1. Reported by..... | 1. FW | 2. FS | 3 CKI | REPORT BY

2.2. CKI Compound ID..... | | | | | | CKI CODE

3. INFORMATION ON PARENTS

3.1. Compound ID..... | | | | | | COMP_ID

3.2. Household Name and ID---------- | | HH_ID

3.3. Mother's Line Number..... | | | TEMP_ID

3.4. Permanent ID of Mother..... | | | | | | | | | MOTHER_ID

3.5. Name of Mother_____

3.6. Date of Birth of child..... | | | | | | | | | BIRTHDATE

3.7. Permanent ID of Father..... | | | | | | | | | FATHER_ID

3.8. Name of Father_____

3.9. Place of Birth

1. Hospital	2.Health Centre or Clinic	3. Home	4.Traditional Birth Attendant's home
5. Other (Specify):----------			

P_BIRTH

3.10. Who was the main person who assisted in the delivery?

1. Doctor	2. Midwife	3. Nurse	4. CHO
5. TBA	6. Family member	7. Other (Specify)	9.NK

ASSIST_DEL

3.11. What was used in cutting the umbilical cord?

1. New razor blade	2. Old razor blade	3. Knife	
4. Sharp stone	5. Scissors	6. Other (Specify)	99. NK

CUTCOD

3.12 What was applied to the umbilical after it was cut?

1. Shea butter	2. Black powder and shea butter	3. Western medicine	CORDRESS
4. Nothing	5. Other (specify)	9. NK	

3.13How was the baby delivered?

Normal vaginal delivery	2. 1. Cesarean Section	3. Vacuum Extraction	DELIVERY
4. Forceps	5. Vaginal cutting	7. Other	

3.14.Did you seek antenatal care during your pregnancy?..... 1. Yes | 2. No — ANCATT

3.15.How many months was the pregnancy when you first sought antenatal care? ..... PRGMONTH

3.16.How many times did you seek antenatal care during your pregnancy? ..... NUMANC

4. MOTHER'S BIRTH RECORD:

4.0. Is this your first live birth?.....
Please enter "88" for 4.1 if answer to 4.0 is 1.Yes. — 1. Yes | 2. No — FIRST_NB

4.1. How many live births have you had, including this child? — CEB

4.2. Total number of children born from recent pregnancy: — TBIRTH

4.3. Number of live births from recent pregnancy: ..... — LBIRTH

5. INFORMATION ON CHILD/CHILDREN:

5.1a. Permanent ID of child ..... PERM_ID

5.2a Name of child _____

5.3a Sex:..... M=MALE | F=FEMALE — SEX

5.1b Permanent ID of second child(if any) PERM_ID

5.2b Name of second child: _____

5.3b Sex:..... M=MALE | F=FEMALE — SEX

Note: Remember to fill vaccination information for this child using blank vaccination form.