Role of Maternal Education and Prenatal Care on Child Health in Cameroon

Saleu Feumeni Josiane

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By

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Contents

List of tables

List of figures

List of abbreviations and acronyms

BMI	Body Mass Index
CHCS	Cameroon Household Consumption Survey
DHS	Demographic and Health Surveys
ICMART	International Committee for Monitoring Assisted Reproductive Technologies
IMCI	Integrated Management of Childhood Illness
NIS	National Institute of Statistics
WHO	World Health Organization

Abstract

Child health is considered a key indicator of economic development and quality of life in developing countries. In this context, this study attempts to empirically analyse the role of maternal education and prenatal care on child heath at birth in Cameroon using the databases of the Demographic and Health Surveys of Cameroon of 2004 and 2011 (EDSC) collected by the National Institute of Statistics of Cameroon. We follow a two-step estimation procedure. In the first step, a probit for participation and a multinomial probit for prenatal provider choice, and a negative binomial model of the number of prenatal visits by mothers were estimated. In the second step, a structural birth weight equation correcting for sample selection and prenatal healthcare provider choice biases was estimated. The results of the estimates show that the mother's level of education, the choice of different health professionals and the number of prenatal visits play an important role in the health of the child. In particular, the probability of consulting doctor increases with maternal education and consulting a doctor correlates positively with birth weight.

Key words: Child health, maternal education, prenatal care, inverse Mills ratio, probit model, negative binomial model, CDHS.

1. Introduction

The World Health Organization (WHO) defines health as a state of complete physical, mental and social wellbeing, and not merely the absence of disease or infirmity (OMS, 1978). As a component of human capital, health is seen as a factor of production (Becker, 1965; Grossman, 1972a, 1972b) because it is a key factor in the creation of wealth (Pritchett and Summers, 1996; Mwabu, 2001) and a consumption factor because being healthy promotes the consumption of other goods and services to improve the welfare of the individual (Grossman, 1972a). Furthermore, good health is supposed to have positive effects on economic growth (Qureshi and Mahyuddin, 2006).

The 1986 Ottawa Charter defines the health of the child as the framework within which a child or group of children are able to develop and achieve their potential, satisfy their needs and develop their ability that allows them to interact successfully with their biological, physical and social peers. Studying child health is important, not only because the child appears as the most sensitive target in household healthiness, but also it has a significant impact on his/her health in adulthood as far as several diseases that emerge in adulthood have their origins in childhood (Power and Hertzman, 2004). The health of the child can be considered as a key indicator of economic development and quality of life in developing countries.

The child's health must be preserved for this purpose insofar as it contributes to the development and wellbeing of households. While there are several indicators of child health, weight at birth is a good measure of the health of the child (Mwabu, 2009) and the outcome of the pregnancy period. A birth weight below 2,500 grams is expected to be low (Zegers-Hochshil et al, 2009) and is a major cause of mortality and morbidity in childhood. The low birth weight causes more loss-health consequences such as deterioration of cognitive development and the rise of chronic diseases later in life (Kramer, 1987; NIS[1], 2012).

In the literature, several studies identify the factors that explain the low weight of the child at birth (Darling and Atav, 2012). These factors are linked to maternal risk factors, as well as historical factors (birth intervals), anthropometric factors (low body mass index), demographic factors (maternal education, marital status) and healthcare factors (lack of prenatal care). In this study, we focus on the specific case of prenatal care because it refers to medical care provided to a pregnant mother during her pregnancy (Gajette Garrido, 2013). It is an important channel through which mothers can diagnose problems during pregnancy, allowing them to prevent complications

during childbirth. During pregnancy, prenatal services are important to ensure good health of the mother and her child (NIS, 2011).

Access to healthcare thus helps mothers to anticipate possible diseases, the possibility of multiple births (twins) and other complications (Gage, 2007). Prenatal care allows, not only to monitor the health of the mother and foetus, but also to provide the mother information for her nutrition needed during pregnancy and lactation. Prenatal care also enables the mother to have access to important services such as immunization against neonatal tetanus, treatment against malaria and HIV/AIDS test (Raghupathy, 1996; Gage, 2007). The absence of prenatal care during pregnancy proves to be insecure and risks the health of both mother and child.

To be effective, WHO recommends that all deliveries and consultations be made in an authorized health centre and under the assistance of qualified birth attendants (from level of the midwife). The information delivered by health professionals as early as possible during antenatal care has a positive impact on the course of pregnancy and the health of the unborn child. The information aims to promote the active participation of the pregnant woman and allow her to take the health professional decisions about their health. For health professionals, pregnancy is an opportunity to open a dialogue with prospective parents on monitoring pregnancy from conception to birth.

This, however, poses a problem with the choice of prenatal care professionals and service providers. They are guarantors of the health of mother and child. In developing countries, the use of modern medicine is strong competition from self-medication (modern or traditional) and lack of care (Brunet-Jailly, 1999). In addition to the lack of adequate care for some pathologies, the choices and decisions of individual patients remain the main determinants of the use of health services. Health professionals control only a very marginal part of the demand for health care and treatment of their patients routes (Dieng et al, 2013).

The use of antenatal care services could be equally enhanced by other factors, including maternal education. A number of studies (Caldwell, 1979; Fosu, 1981; Frost et al, 2004; Chakrabarti and Chaudhuri, 2007) claim that the mother's education is the most important factor that explains the differences that may exist between the behaviour of mother to care for her health and that of her child. According to the Majgaard and Mingat (2012), each additional year of education will prevent potential maternal deaths. Educated women invest more in the health of their child and contribute to the wellbeing of their offspring (Caldwell and Caldwell, 1988; Cleland, 1990).

An increase in the level of education of the girl child leads to a decrease in the prevalence of sexually transmitted diseases including HIV among women, a decrease in domestic violence and higher average age at first birth than the current average because 13.8% of Cameroonian women typically have their first child between 15 and 19 years (NIS, 2012). It is difficult for a woman with a low level of education to understand why she must not consider pregnancy as a disease (Bonono and Ongolo-Zogo, 2012). Illiteracy is a drag on the use of health facilities (Say and Raine, 2007[2]).

Statement of the problem

Maternal healthcare is essential for further improvement of the health of the mother and child. Maternal health services are expected to play a vital role in order to achieve better reproductive outcomes. Complications in pregnancy and at childbirth cause more death and disability than other reproductive health problems (EC/UNFPA, 2000). This situation is much more serious in developing countries like Cameroon, where statistics on the use of prenatal health services and children's health is low. It is essential to know the factors that reduce the use of health services and therefore the health of children in Cameroon.

Lower rates of maternal and infant mortality remains a major challenge. The success or failure of economic policy decisions depends on the ability of policy makers to develop fair policy interventions provided to the most vulnerable. For this, they must have a good understanding of the factors influencing the use of maternal health and child healthcare services in Cameroon. So far, studies have focused on the immunization of the mother (Ajakaiye and Mwabu, 2007) and the number of prenatal visits (Jayaraman et al, 2008) as a proxy of prenatal care. In Cameroon, few studies (Baye, 2010, Baye and Fambon, 2010; Tambi, 2014) have been carried out to explain child health. But none of these studies has analysed the use of healthcare providers as a determinant of child health.

The therapeutic itinerary of the pregnant woman has hardly been studied in Cameroon, yet it is of great importance. The above studies are mostly interested in the number of prenatal visits and taking the tetanus vaccine as a proxy for use of prenatal care. Yet, providers are the ones who facilitate prenatal care and are empowered to give all possible advice to pregnant women. This is the service that indicates to pregnant women the importance of prenatal visits and vaccination against tetanus. The choice of the healthcare provider can only be effective if in turn a number of other variables are also controlled.

Maternal education appears to be an important factor in the decision of the pregnant woman because she can better see the benefits to be accessed by visiting one service provider instead of another. This approach has hardly been followed in Cameroon. This work is part of the evaluation of the impact of new policies on women's use of prenatal care to improve the child's weight at birth. This study also contributes to the effort to provide decision-makers with information on the problems faced by pregnant women and the determinants of demand for healthcare in order to improve the health of the child.

The evaluation of these policies cannot be made if the analysis is not based on at least two years to see if the economic policy measures taken between these two periods have improved the effect of the use of prenatal care on the health of the child. Based on our problem, it is imperative for researchers in health economics and policy makers to focus on this area of research because child health today allows for a future population of healthy men and women who continue to participate in the labour market to improve the welfare of households.

In this context, this paper aims to answer a number of questions: (1) Which factors influence the prenatal care participation decision of mothers? (2) What are the correlates of a healthcare provider choice of pregnant women in Cameroon? (3) What are the correlates of the number of prenatal visit made by pregnant mothers? (4) What is the relative role of maternal education and prenatal care on the health of the child at birth in Cameroon between 2004 and 2011?

Overview of health policy related to the mother and child in Cameroon

In order to reduce maternal and infant mortality, Cameroon adopted, since 1970, several maternal policies and programmes implemented by the Ministry of Public Health and international organizations. These programmes include, among others, the programme of health protection of mother and child in 1974, the monitoring programme of pregnancy and childbirth of 1987, care obstetric and neonatal emergencies of 1995, and the acceleration of the reduction of maternal and infant mortality strategy. The basis of these programmes is that in Cameroon, many women die from complications related to pregnancy and childbirth (NSI, 2012). The discussions by policy makers and development partners are indicative of the fact that even if maternal health has received enough attention, efforts are still necessary to improve these results.

The under-utilization of antenatal services in Cameroon annually concerns about 970,306 expected pregnant women and their spouses and families. About 4,500 girls and women die each year during delivery. The national average is estimated at one per pregnancy for antenatal care (ANC) from 83.3% to 85% of parturient with only 60% receiving the minimum of four visits (NSI, 2012). Between 2009 and 2010, only 35% of parturient received prenatal visit in the first quarter that is to say before the end of the twelve weeks of gestation. Having missed that first visit, and also the time it is performed, may increase maternal mortality and prenatal mortgage a complete consultation process (MOH[3], 2011).

In Cameroon, the maternal mortality rate dropped from 430‰ (between 1991 and 1998) to 669‰ (in 2004) and 690‰ (in 2010) to 782‰ (2011); which is far from the global and national targets estimated at 108‰ and 350‰, respectively. The INS (2011) showed that the mortality rate of children under five dropped from 146‰ (1996-2006) to 122‰ (2006-2010). It even rose to 109‰ in 2011 but still remained far from the national target of 76 ‰ in 2015. The national MDG progress report (2012) shows that Goals 4 and 5, respectively, relating to the reduction of mortality in children under five and improving maternal health, remain quite uncertain in 2020.

Several measures have been taken to improve maternal and child health, such as, free grant or several components of the EIC as HIV testing, antiretroviral, tetanus immunization, vitamin A supplementation and intermittent preventive treatment of malaria using insecticides treated nets, strengthening the supply of emergency

obstetric and neonatal care including caesarean kits, etc. (MOH, 2010). The purpose of motherhood programmes is to improve the health of the mother and child in general and specifically to reduce maternal mortality and morbidity. For this, MOH (2010) has set several targets such as:

- Vaccinate at least 80% of pregnant women against tetanus by 2015;
- Increase support of deliveries by skilled personnel from 54% to at least 70% by 2015;
- Reduce maternal mortality by 50% by 2010;
- Reduce the number of unwanted and early pregnancies by 2010;
- Reduce infant mortality from 77 to 50 for 10000 by 2010;
- 30% reduction in harmful practices to reproductive health by 2005;
- Increase vaccination coverage of children to 80% by 2005; and
- Implement the IMCI (Integrated Management of Childhood Illness) in at least 80% of health districts by 2005.

2. Literature review

Prenatal care is generally assumed to have a beneficial impact on the outcome of pregnancy through the detection and treatment of complications, or by contributing to the reduction of maternal risk factors. It is a means of identifying mothers at risk of delivering prematurely or those with delayed growth of the child. Prenatal visits are used to provide control of medical, nutritional and restrictive interventions that seek to reduce the risk of low birth weight and other adverse pregnancy outcomes (Magadi et al, 2000). The low weight of the child at birth is now the leading cause of neonatal mortality, since more such children are known to die during the first year of life than children with normal weight. Two main schools of thought have contributed in terms of impact on the relationship between prenatal care and the growth and development of the foetus. The authors of the first school of thought believe that prenatal care is a way to detect high-risk pregnancies and improve the growth and development of the foetus as a determinant of the child's weight at birth (Alexander and Korenbrot, 1995). The authors of the second school of thought, on the other hand, maintain that the lack of prenatal care could have a great impact on the child's weight at birth, insofar as the coping mechanism of maternal physiology and absolute parasitism of the foetus will not allow remarkable foetal development even in the presence of good nutrition (Butz et al, 1993).

Several studies have been conducted in order to find solutions to improve the child's weight at birth. Prenatal care is typically approached through several indicators: the number of prenatal visits (Rous et al, 2004; Kabubo-Mariara et al, 2009.), the quality of prenatal care (Mwabu, 2009), the time-lag of research in prenatal health services (Wehby et al, 2009), inadequate prenatal care (Magadi et al, 2000, Olowonyo et al, 2006), and taking the tetanus vaccine (Diallo et al, 2000). Several authors have also analysed other factors that may affect the health of the child as the mother's education (Frost et al, 2004), maternal age and marital status (Delpeuch et al, 2000), the birth interval (Ogunjuyigbe et al, 2008), the duration of breastfeeding (Bonnet, 2001), the standard of living of the household (Linnemayr et al, 2006), access to water (Adewara and Visser, 2011) and adequate prenatal care (Awiti, 2014).

Improving child health has benefits for the achievement of development and optimal growth. On the one hand, infant mortality and the costs related to healthcare of children are reduced. On the other, productivity gains increase and allow the mother to have more time for other household members who participate in the labour

market. According to some empirical studies, better child health allows the child to start school early and will be able to finish school on time (Grantham-McGregor et al, 1999; Filmer and Pritchett 1999; Berhman and Rosenzweig, 2004)[4].

Our study is different from the few existing studies on child health using Cameroon data. For example, the work of Baye (2010) seeks to show the contribution of children's health to the welfare of households. It uses, as a measure of child health, anthropometric indicators such as weight-for-age and the third 2001 Cameroon Household Consumption Survey (CHCS 3). The work of Baye and Fambon (2010) examine the empirical effect of parental education on child health on the one hand and child health on the welfare of households, on the other. Baye (2010) also uses the anthropometrics indicators to capture child health and the third 2001 CHCS data. In the present work, we contribute to the literature on child health by considering child weight at birth as a measure of the health of the child and the pooled 2004 and 2011 Cameroon's Demographic and Health Surveys (DHS).

3. Analytical framework and methodology of the study

Analytical framework

Since the work of Grossman (1972a) and Acton (1975), the study of the demand for healthcare has been enriched by several empirical studies in developed countries than in developing countries (Heller, 1982; Akin et al, 1995; Dor and van der Gaag, 1993; Mwabu, 1986, Gertler et al, 1988; Litvack and Bodart, 1993; Lavy and Germain, 1994).

It is clear from these studies that the health of household members is a commodity that directly increases the welfare of the household. Moreover, health indirectly increases the wellbeing of the household by increasing and enhancing the productive capacity of household members. Household members use health goods and services (modern as well as traditional) and their time in the context of disease prevention, or to cure the disease, according to the knowledge they have on health technology. On the other hand, access to goods and services is limited by the constraints imposed on the household by the market, the health market (price of consultations, medication, time of access to health centres, queuing, etc.), time and financial resources available to the household. In this context, the demand for healthcare by household members derives from the application of the basic commodity, the health of household members.

This study is part of a framework in which the household utility includes the health of the child, captured by the weight of the child at birth. Rosenzweig and Schultz (1982) propose a modified version of the utility function in which the production of child health in the womb is related to the usefulness of the mother maximizing behaviour. In this context, child health and health in general provide not only direct but also indirect utility because it is a key input in household production.

$$U = U(X, Y, H) \tag{1}$$

where, U is the utility derived from the consumption of goods, including reproductive health; X is the set of health goods that produce neutral utility to the mother but has no direct effect on the health of the mother; Y is the set of assets that produce utility

also affects the mother and the child's birth weight; and H is the health status of children, measured by weight at birth.

The reproductive health production function is given by:

$$H = H(Y, Z, \mu) \tag{2}$$

where, Z represents purchased inputs such as medical care that directly affect the health of the child and μ is the health component of children due to genetic and environmental conditions that are not influenced by the behaviour.

The mother maximizes (1) and (2) under the constraints of its budget:

$$R = XP_x + YP_y + ZP_z \tag{3}$$

where, R is the exogenous income; P_x, P_y and P_z are neutral price of health goods, consumer goods-related health (stop smoking) and the price of purchased inputs such as prenatal care), respectively.

These goods are purchased only in order to improve child health, so they enter the utility function of the mother by H. The function of the child's weight at birth is constrained by the seeking behaviour of the utility of the mother (Equations 1 and 3). The Equations 1 and 3 can be re-expressed to produce the form of health care demand functions:

$$X = D_x \left(P_x\, P_y\, P_z\, R\, \mu\right) \tag{4}$$

$$Y = D_y \left(P_x\, P_y\, P_z\, R\, \mu\right) \tag{5}$$

$$Z = D_z \left(P_x\, P_y\, P_z\, R\, \mu\right) \tag{6}$$

The effects of changes in prices of three properties on the health claim can be derived from Equations 5 and 6 because from Equation 2, a change in the child's health can be expressed as following:

$$dH = F_y dY + F_z dZ + F_\mu d\mu \tag{7}$$

F_y, F_z and F_μ are the marginal products of Y health inputs, Z and μ respectively calculated as follows:

$$F_y = \delta H/\delta Y \; ; \; F_z = \delta H/\delta Z \; ; \; F_\mu = \delta H/\delta \mu \tag{8}$$

From Equation 2, changes in health can be linked to changes in prices of health inputs:

$$\frac{dH}{dP_x} = F_y \frac{dY}{dP_x} + F_Z \frac{dZ}{dP_x} + F_\mu \frac{d\mu}{dP_x} \tag{9}$$

$$\frac{dH}{dP_y} = F_y \frac{dY}{dP_y} + F_z \frac{dZ}{dP_y} + F_\mu \frac{d\mu}{dP_y} \tag{10}$$

$$\frac{dH}{dP_z} = F_y \frac{dY}{dP_z} + F_z \frac{dZ}{dP_z} + F_\mu \frac{d\mu}{dP_z} \tag{11}$$

where, $\frac{d\mu}{dP_x} = 0$ for all i = x,y and z as well as $F_\mu(.)$ terms = 0 in Equations 9, 10 and 11 as μ is a random variable that n ' is not related to the overall price.

Methodology of study

To study the effect of maternal education and prenatal care on child weight at birth, it is useful to exploit the last two demographic and health surveys. This will enable analysis of how these effects have changed between 2004 and 2011.

The weight of the child is related to maternal education and prenatal care through the following equation:

$$H = \alpha_0 + \sum_{k=1}^{3} \alpha_k P_k + \sum_{k=4}^{6} \alpha_k E_k + \sum_{k=7}^{n} \alpha_k Z_k + \varepsilon_1 \tag{12}$$

where, H is child health measured by child weight at birth, P is a vector which includes the different prenatal healthcare providers: doctor, midwife/nurse, and nursing assistant. The other prenatal caregiver (TBA, CHW and other assistants)[5] group is considered the reference category. E is the vector of levels of maternal education notably primary, secondary and higher levels of education. Z is the vector of other explanatory variables including maternal characteristics (age, occupation, age at first

birth, etc.), characteristics of the child (sex, twin and so on) and characteristics of the father (level of education, age, occupation and so on). α is the vector of all parameters to be estimated and ε_1 is the error term which may be having a systematic, as well as a stochastic component.

The estimation of this equation raises two potential econometric problems: the presence of unregistered weights or outliers which lead to the sample selection problem and the issue of a mother choosing a health provider, which leads to the prenatal healthcare provider choice problem.

Sample selection bias

When a woman is pregnant, she has the choice between professional prenatal healthcare and self-medication. If she chooses care administered by the professional, then she has the second decision to make concerning the choice of prenatal caregiver and the number of prenatal visits to effect. The decision to participate in professional prenatal care introduces the sample selection problem in the child health production function. Mothers who participate in prenatal care sessions are more likely to get the weights of their children registered at birth than those who do not participate. Registering birth weights is therefore not a random process. In our sample, the weights of all children are not registered, implying a potential problem of sample selection. The standard econometric procedure is based on the randomness of the sample to ensure that the parameters estimated from the sample reflect the actual parameter values of the population. It is therefore necessary to address this problem.

This potential sample selection bias makes the estimated parameters in the birth weight equation biased and inconsistent. To control for sample selection bias, we use the full sample that includes both registered and unregistered birth weights. This is captured in the following indicator function:

$$S = 1\left(\beta_0 + \sum_{r=1}^{m} \beta_r Z_r + \sum_{r=m+1}^{m'} \beta_r Z_r + \varepsilon_2 > 0\right) \tag{13}$$

where, S is a sample selection indicator which takes the value 1 if child weight is recorded at birth and 0 otherwise; Z_r is the vector of exogenous variables sanctioning the selection of children in the estimation sample, which include m' − m instrumental variables or identifiers of the sample selection equation; β is a vector of parameters of the exogenous explanatory variables; and ε_2 the error term that captures the random effects, as well as unobservable characteristics of selection. Equation 13 is a probit for sample selection. After estimation, an inverse Mills ratio is generated to be included in the outcome equation as an additional variable.

Problem of choice of healthcare provider

As indicated above, after a mother decides to participate in professional prenatal care seeking, the next issue is choosing the prenatal healthcare giver. Since we assume that the mother is rational, she chooses the caregiver that gives her maximum utility. In other words, each mother chooses a healthcare provider that allows her to maximize prenatal care utility and that choice is critical to the health of her child. In our framework, the process of choosing from the different categories of health professionals is probably not entirely random. The different health professionals faced by mothers include: the doctor, the midwife or nurse, the other caregivers: the traditional birth attendant, community health workers and others as specified in Cameroon's 2004 and 2011 DHS reports.

In our study, we follow the reasoning in Greene (2007) to illustrate our choice model through a random utility function. For the i^{th} pregnant woman facing the problem of choosing a prenatal healthcare provider from a set of j providers, the utility function of choice j takes the following form:

$$U_{ij} = x_{ij}\beta_j + \varepsilon_{ij} \tag{14}$$

where, U_{ij} is the utility derived by the mother ifrom a health professional j, $x_{ij}\beta_j$ is the deterministic component of the utility function and ε_{ij} the stochastic component of the function. In terms of probability, this problem can be presented as follows:

$$P_{ij} = max\left(\left(x_{i1}\beta_{1,}x_{i2}\beta_{2,}\ldots..,x_{iJ}\beta_j'\right) = x_{ij}\beta_j\right) \tag{15}$$

It is clear from the literature that the multinomial probit model is preferable to model the choice between interdependent terms, although in practice the estimation of these parameters by the maximum likelihood method could be time consuming even with high powered computers (Bolduc et al, 1996).

Equation 15 can explicitly be rewritten as follows:

$$P_{ij} = (P_i = j/j = 4, X) = F\left(\gamma_0 + \sum_{r=1}^{m}\gamma_r Z_r + \sum_{r=m+1}^{v'}\gamma_r Z_r\right) \tag{16}$$

where, P is a multiple prenatal care provider choice indicator, j = 1,2,3,4 representing the doctor, midwife/nurse, nursing assistant and other caregivers, respectively. Other caregivers for j = 4 is considered our reference category. X is the vector of explanatory variables.

The explanatory variables are: Z_r is a vector of exogenous variables including m variables which also belong to the structural child health equation (Equation 12) and $\nu' - m$ a vector of instrumental variables or identifiers that affect the choice of health providers but have no direct influence on child health except through prenatal healthcare utilization. γ_r is a vector of ν' parameters of exogenous explanatory variables in the prenatal healthcare professionals choice model to be estimated. After estimating Equation 16 using a multinomial probit model, we predict probit indices, probit probability density functions and probit cumulative density functions. By dividing the corresponding probability density functions by the cumulative density functions, we derive Inverse Mills Ratios (IMRs) à la Heckman (1979).

An alternative way to proxy maternal prenatal healthcare consumption is to use number of visits instead of health professionals consulted (see Appendix B).

Augmented structural equation

To resolve the sample selection and the provider-selectivity biases, two sets of inverse Mills ratios are generated after estimating Equations 13 and 16, respectively. The identification strategy proposed does not only solve the problem of sample selection with Heckman (1979), but also solves the problem of endogeneity of choice of prenatal healthcare provider. This represents the first stage of our econometric model.

In the second stage, the computed IMRs in the first stage are included in the structural child health Equation 1 to augment it to Equation 17. These additional variables are represented by λ, which is a vector of four inverse Mills ratios: one for the sample selection and three for the provider choices: doctor, midwife/nurse, and nursing assistant. These IMRs are used in the second stage estimating equation to correct for sample selection and prenatal healthcare provider choice biases.

$$H = \psi_0 + \sum_{k=2}^{4} \psi_k P_k + \sum_{k=5}^{7} \psi_k E_k + \sum_{k=8}^{n} \psi_k Z_k + \sum_{k=n+1}^{n'} \psi_k \lambda_k + \mu \qquad (17)$$

where, the variables are defined as above, and ψ the vector of parameters to be estimated. It is perhaps important to mention here that in some instances, the vector Z includes a year dummy and interaction terms, and interactions in these cases capture the incremental effect of levels of education between 2004 and 2011, $(n' - n)$ are the four lambdas and μ the error term.

Identification strategy

To interpret the estimated parameters of our model, it is important that the effects of endogenous variables and selection problem are identified (Mwabu, 2009). In this study, we use three instruments: the time to get to water source, the average distance

to health facility, and the number of nurses per 100,000 residents. Time to water source and distance to health facilities are captured as cluster means to minimize their possibility of being choice driven. These instruments are used to identify the factors that influence maternal decision to participate in prenatal care and the choice of prenatal healthcare provider.

The time spent to fetch water can influence the decision of the mother to go to the health centre to seek prenatal care. Distance as an instrument relies on the assumption that it is correlated with prenatal care and is justified by the intuition that mothers generally allocate the time available to them on several activities. Studies like those of Qian et al (2009) show that distance significantly influences prenatal care. However, a household that is very health conscious may choose to settle near a health facility. Even if this is a possibility for some mothers, it is unlikely to be so for all mothers. Distance and time prices typically act as opportunity cost for health seeking activities that require travels to health facilities. The average regional number of nurses is also used as an instrument.

4. Data source

In Cameroon, the National Institute of Statistics (NIS) was responsible for collecting data for the Demographic and Health 2004 and 2011 and this under the high patronage of the Ministry of Economy, Planning and Regional Planning. The last survey was conducted in 2011 after those of 1991, 1998 and 2004. The 2011 survey targeted a representative national sample of about 11,732 children aged 0-59 months; while in 2004, there were approximately 8,125 children with women in reproductive age (15-49). The results of these surveys were presented for the 10 regions of Cameroon and Yaounde and Douala which are the largest cities in the country and for urban and rural areas.

Our observation unit being children aged 0-59 months, we have more information related to children like the weight, sex, age, size at birth, place of birth, children from a same couple, etc. In both surveys, a two-stage sampling frame was used. The 2011 DHS was designed to provide data for monitoring and evaluation of progress in the field of population and health since last conducted in 2004.

Demographic and Health Surveys (DHS) conducted in Cameroon have information on the number of prenatal visits, the person consulted during pregnancy, duration of pregnancy at the first visit, the number of prenatal visits, tetanus vaccine during pregnancy, and the weight of the child at birth. They allow you to search the social determinants of utilization of healthcare services during pregnancy and birth weight, since it contains information on social, economic and demographic characteristics of respondents and those households in which they live.

5. Empirical results

This section presents the results of our estimates. We will present the determinants of the decision of mothers to participate in prenatal care, of choice of professional health, of prenatal visit and of weight of child at birth. But before this, we will present the descriptive statistics of variables used in our estimates for the two years of study considered.

Descriptive statistics

We proceed by presenting descriptive statistics for each year of study to better assess the evolution of the variables considered in the study. Table 1 and Table 2 show the descriptive statistics from the database of demographic health surveys (DHS) of 2004 and 2011, respectively.

Table 1: Descriptive statistics from the 2004 DHS

Variables	Observations	Mean	Standard errors	Codification
Characteristics of the mother and the child				
Primary education level	8125	0.448	0.497	1 if yes, 0 otherwise
Secondary education level	8125	0.281	0.449	1 if yes, 0 otherwise
Higher education level	8125	0.009	0.096	1 if yes, 0 otherwise
Primary education level by MPSU	8125	0.448	0.263	
Secondary education level by MPSU	8125	0.281	0.269	
Higher education level by MPSU	8125	0.009	0.043	
Age of the mother	8125	27.714	6.90	In years
Number of children	8125	3.43	2.18	Number of children alive
Agricultural activity	8125	0.450	0.497	1 if agriculture, 0 otherwise
Thin	8125	0.028	0.165	1 if yes, 0 otherwise

continued next page

Table 1 Continued

Variables	Observations	Mean	Standard errors	Codification
Characteristics of the mother and the child				
Normal	8125	0.339	0.4735	1 if yes, 0 otherwise
Overweight	8125	0.089	0.285	1 if yes, 0 otherwise
Anaemic	8125	0.225	0.417	1 if yes, 0 otherwise
Child girl	8125	0.500	0.500	1 if yes, 0 otherwise
Characteristics of the father				
Primary education level	8125	0.308	0.462	1 if yes, 0 otherwise
Secondary education level	8125	0.334	0.471	1 if yes, 0 otherwise
Higher education level	8125	0.040	0.197	1 if yes, 0 otherwise
Characteristics of the household				
Sex of head of household: male	8125	0.826	0.378	1 if yes, 0 otherwise
Zone of residence: rural	8125	0.611	0.487	1 if yes, 0 otherwise
Christian religion	8125	0.673	0.469	1 if yes, 0 otherwise
Muslim religion	8125	0 .20	0.403	1 if yes, 0 otherwise
Poor	8125	0.444	0.496	1 if yes, 0 otherwise
Rich	8125	0.322	0.467	
Bantous	8125	0.293	0.455	1 if yes, 0 otherwise
Semi-Bantous	8125	0.329	0.470	1 if yes, 0 otherwise
Instruments				
Time to fetch water by MPSU	8125	18.72	14.867	in minutes
Distance to a health centre by MPSU	8125	0.42	0.317	in kilometres
Number of nurse per 100000 patients by region	8125	871.64	606.05	
Dependent variables				
Doctor	8125	0.0631	0.243	
Midwife	8125	0.424	0.4943	
Nursing assistants	8125	0.065	0.247	
Reported birth weight	8125	0.559	0.496	1 if yes, 0 otherwise
birthweight	4543	3353.9	768.1	in grams
Number of prenatal visits	8125	1.374	1.311	

Source: Computed by the author using the 2004 Cameroon demographics health surveys.
Notes: IMR is inverse Mills ratio. MPSU is mean at primary sampling unit. Std. Dev. is the standard deviation.

Table 2: Descriptive statistics from the 2011 DHS

Variables	Observations	Means	Standard errors	Modalities
Characteristics of the mother and the child				
Primary education level	11 732	0.418	0.493	1 if yes, 0 otherwise
Secondary education level	11 732	0.305	0.460	1 if yes, 0 otherwise
Higher education level	11 732	0.028	0.165	1 if yes, 0 otherwise
Primary level by MPSU	11 732	0.418	0.241	
Secondary education level by MPSU	11 732	0.305	0.276	
Higher education level by MPSU	11 732	0.028	0.080	
Age of the mother	11 732	27.93	6.76	In years
Number of child	11 732	3.42	2.07	Number of children alive
Agricultural activity	11 732	0 .352	0.477	1 if agriculture, 0 otherwise
Thin	11 732	0.037	0.190	1 if yes, 0 otherwise
Normal	11 732	0.323	0.467	1 if yes, 0 otherwise
Overweight	11 732	0.099	0.299	1 if yes, 0 otherwise
Anaemic	11 732	0.1991	0.399	1 if yes, 0 otherwise
Child girl	11 732	0.504	0.500	1 if yes, 0 otherwise
Characteristics of the father				
Primary education level	11 732	0.311	0.463	1 if yes, 0 otherwise
Secondary education level	11 732	0.3232	0.467	1 if yes, 0 otherwise
Higher education level	11 732	0.061	0.239	1 if yes, 0 otherwise
Characteristics of the household				
Sex of head of household: male	11 732	0 .8183	0.385	1 if yes, 0 otherwise
Zone of residence Rural	11 732	0.600	0.489	1 if yes, 0 otherwise
Christian Religion	11 732	0.696	0.459	1 if yes, 0 otherwise
Muslim Religion	11 732	0.238	0.426	1 if yes, 0 otherwise
Poor	11 732	0.448	0.497	1 if yes, 0 otherwise
Rich	11 732	0.336	0.472	
Bantous	11 732	0.261	0.439	1 if yes, 0 otherwise
Semi-Bantous	11 732	0.315	0.464	1 if yes, 0 otherwise
Instruments				
Time to fetch water by MPSU	11 732	20.45	15.977	In minute
Distance to a health centre by MPSU	11 732	0.722	0.165	In kilometre
Number of nurse per 100000 patients by region	11 732	863.73	614.67	

continued next page

Table 2 Continued

Variables	Observations	Means	Standard errors	Modalities
Doctor	11 732	0.099	0.299	
Midwife	11 732	0.384	0.486	
Nursing assistants	11 732	0.079	0.270	
Reported birthweight	11 732	0.602	0.489	1 if yes, 0 otherwise
Birthweight	7 074	3443.68	775.03	In grams
Number of prenatal visits	11 732	1.410	1.307	

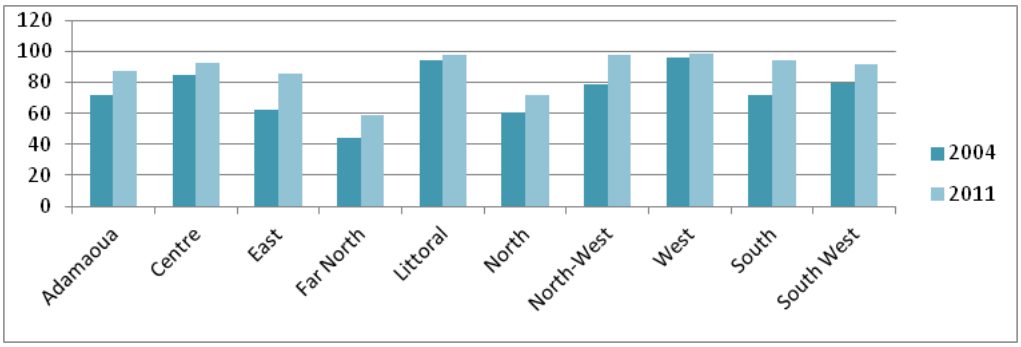
Source: Computed by the author using 2011 Cameroon demographics health surveys.
Notes: IMR is inverse Mills ratio. MPSU is mean at primary sampling unit. Std. Dev. is the standard deviation.

In Africa, 13% of children have a low birth weight compared with 5% in the Pacific, 7% in Europe and 8% in America. Nevertheless, Southeast Asia and the Mediterranean region have even higher percentages compared with Africa. According to WHO (2011), most sub-Saharan African countries have weak health outcomes of children. For example, 11% of children in Cameroon and 14% of children in Gabon had low birth weight. This rate increased to 10% in 2011 in Cameroon (INS, 2012). In view of these statistics in tables 1 and 2, we can see that the average weight of children is 3353.9 grams in 2004 against 3443.68 grams in 2011 and only 55.9% of children have a weight recorded in 2004 against 60% in 2011.

On average, 44% of mothers had completed primary education in 2004; 28.1% of mothers with a secondary education; 0.9% of mothers have a higher level of education. In contrast, in 2011, on average 41.8% of mothers had completed primary education; 30.5% of mothers with a secondary education and 2.8% of mothers have a higher level of education. It is thus noted that the proportion of women in secondary and higher education has increased significantly. More women seek a high level of education. According to Unesco (2010), 68% of women can read and write properly. About 80% to 90% of girls are enrolled in primary school, 38% continue in secondary education and only 10% reach a level of higher education. In rural areas, female literacy rate is much lower than in large cities like Yaounde and cannot exceed 30%. These gaps in the education of women and girls points at a lack of information, among these, of missed appointments for prenatal visits, problems in taking drugs, non-exclusive breastfeeding and booking of vaccination for the child (Unicef, 2010; Unesco, 2010).

Statistics from the UN report of 2010 show that the use by pregnant women of antenatal care is only 63% in Africa, against 97% in Europe, 95% in North America, 73% in Latin America and the Caribbean, and 65 % in Asia. The proportion of women who gave birth in a health centre is 42% in Africa against 98% in Europe, 99% in North America, 75% in Latin America and the Caribbean, and 53% in Asia. In 2011, 85% of women consulted a health professional during pregnancy of their most recent birth, and this proportion has changed little since 2004 (83%).

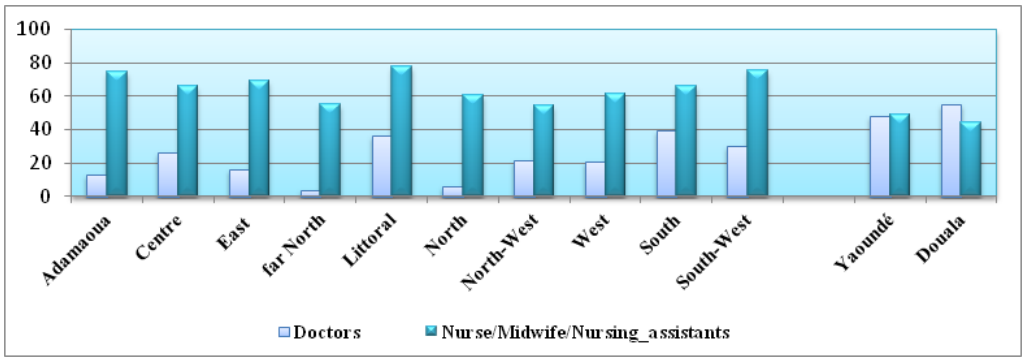
Figure 1: Proportion of mothers who consulted qualified persons



Source: Constructed by the author using EDSC-MICS (2011).

These differences are due to the fact that efforts to make geographically accessible health centres within an hour of walking are not acted upon because of the poor distribution of human resources and inadequate existing technical health facilities.

Figure 2: Proportion of health providers in each region in Cameroon in 2011



Source: Constructed by the author using EDSC-MICS (2011).

Figure 2 shows the distribution of health professionals in various regions of Cameroon. These proportions have certainly changed but have changed very little between 2004 and 2011. This may be due to the observed regional disparities. In the whole country, consultations of qualified staff have increased but remain very low in the Far North regions (44% to 59%), North (61% to 71.7%), and East (62% to 85.4%). It is close to 100% in areas of the Centre (85% to 92.8%), Western (96% to 98.9%) and Littoral (94% to 97.4%).

In Cameroon, prenatal care was provided in most cases by nurses, midwives or auxiliary nurses (62%) and in 22% of cases by doctors. Traditional birth attendants and community health workers hardly involved (INS, 2011). Figure 2 shows the distribution of different providers in different regions of Cameroon. This figure allows us to observe that there are more nurses, midwives and auxiliary nurses than doctors overall. We also observe that the regions Littoral and Southwest have more nurses, midwives and nursing assistants. North and Far North regions have fewer doctors than other regions. Doctors are more concentrated in the major cities of Cameroon.

To be more specific, referring to the tables 1 and 2, about 6% of mothers make use of a doctor while 42% have used a midwife or a nurse, and 6.5% make use of assistants caregivers. In 2011, about 9% of mothers make use of a doctor, while 38.4% have used a midwife or a nurse, and 7.9% make use of nursing aides. This shows that midwives and nurses are the most requested by mothers in 2011 and less than in 2004. This can be justified by the lack of funds to meet a doctor or by the lack of doctors in regions where they are located.

Tables 1 and 2 indicate 8.9% of mothers are overweight while only 2.8% of mothers are poor, while in 2011, 9.9% of mothers were overweight and 3.7% of mothers are only lean. Diouf (2011) shows that a Body Mass Index (BMI) at the time of conception is associated with an increased risk of pregnancy complications. Considered a proxy of maternal nutritional status, is associated with foetal growth and birth weight (Vahratian et al, 2005; Frederick et al, 2008; Heude et al, 2011)[6]. These tables also show that 22.5% of mothers are anaemic during pregnancy while in 2011, 19.91% of mothers are anaemic. According Owais et al (2011), anaemia of the mother can affect the child's weight at birth. Anaemia during pregnancy is a common problem and 50% of pregnant women in developing countries suffer from anaemia; 20% of maternal deaths are directly or indirectly related to anaemia.[7]

Determinants of the decision of mothers to participate in prenatal care

Table 3 shows the marginal effects obtained from a simple probit depicting the factors that influence the decision of the mother to participate in prenatal care. From Table 3, we can see that the time for collecting water, the distance to the health centre and the average numbers of nurses were used as instruments.

Table 3: Determinants of participation in prenatal healthcare (probit model)

Variables	Marginal effects of participation in prenatal healthcare
Characteristics of the mother	
Primary Education	0.100*** (0.0174)
Secondary Education	0.195*** (0.0208)
Higher Education	0.366*** (0.0259)
Primary Education by MPSU	0.316*** (0.0329)
Secondary Education by MPSU	0.440*** (0.0418)
Higher Education by MPSU	0.163 (0.128)
Age of mother	0.00653*** (0.00129)
Thin	-0.0729** (0.0285)
Normal	-0.0247*(0.0136)
Overweight	0.0244 (0.0201)
Anaemia	-0.0202 (0.0158)

continued next page

Table 3 Continued

Variables	Marginal effects of participation in prenatal healthcare
Number of children	-0.0168*** (0.00412)
Agricultural activity	-0.0955*** (0.0131)
Characteristics of the father and the household	
Primary Education	0.0714*** (0.0141)
Secondary Education	0.129*** (0.0148)
Higher Education	0.205*** (0.0325)
Male	-0.0543*** (0.0143)
Rural area	-0.127*** (0.0159)
Christian religion	0.0893*** (0.0190)
Muslim religion	0.0463** (0.0212)
Poor	-0.133*** (0.0146)
Rich	0.0466*** (0.0180)
Bantou ethnic group	-0.0493** (0.0208)
Semi Bantou ethnic group	0.270*** (0.0162)
Year dummy	0.0391*** (0.0116)
Instruments	
Time to fetch water by MPSU	-0.00142*** (0.000442)
Distance to a health centre by MPSU	-0.203*** (0.0316)
Density of nurse by MPSU	2.48e-05** (1.04e-05)
Constant	
R^2 / Pseudo R^2	0.4064
LR chi 2 (P value)	4207.08 (0.0000)
Log pseudo likelihood	-6.404 e+10
Predicted probability	0.5953
Observations	19,857

Source: Computed by the author using the pooled 2004 and 2011 Cameroon demographics health surveys and Stata 12.
Notes: MPSU is mean at primary sampling unit. Standard errors in parentheses. *** p<0.01. ** p<0.05. * p<0.1.

Moreover, we can see that the chi 2 statistic is sufficiently high, indicating that the instruments strongly identify the sample selection equation. Diagnostics test indicate that the inputs into this model are endogenous while P-value=0.000. This indicates that the model is globally significant. The problems that the mothers meet to have access to health centre reduce the likelihood of participation in prenatal care by 20.3%.

The density of nurses increases the probability of participation in prenatal care. Similarly, the mother's level of education at the individual or at the community level and father's education increase the likelihood to participate in prenatal care. This

probability increases as the level of education increases. For the specific case of maternal education, this probability increases from 10% at the primary level, 19.5% at secondary level, and 36.6% at the higher level.

Being poor and rural residency reduce the probability of participation in prenatal care by 13.3% and 12.7%, respectively. While being rich increases the probability of participation in prenatal care by 4.6%. Between 2004 and 2011, the likelihood of mothers attending antenatal care increased by 3.9 %.

Multinomial probit estimates of determinants of choice of prenatal care professional

Table 4 contains the marginal effects from the multinomial probit for analysing the determinants of the choice of prenatal healthcare professionals. From Table 4, we can see that the chi 2 statistic is sufficiently high indicating that the instrument strongly identify the choice model equation. Diagnostics test indicate that the inputs into this model are endogenous while P-value=0.000. This indicates that the model is globally significant.

Time to fetch water marginally but significantly reduces the probability of consulting a nursing assistant during prenatal visits. While distance imputes an opportunity cost for visiting midwives, it enhances the probability of consulting with nursing assistants. The density of nurses increases the probability of consulting with nursing assistants, while reducing that of consulting with midwives.

Table 4 also shows that the level of maternal education is very important in the choice of providers. Levels of education are highly correlated with the probability of selecting health professionals. Secondary education increases the likelihood of mothers choosing a doctor by 2.5%, a midwife by 4.8% and a nursing aider by 1.85%. The primary level education increases the likelihood of choosing a nursing aider by 1.82%. It is thus noted that mothers who have completed just primary education tend to choose nursing aiders, while those with a higher level of education have a high probability of about 6.7% of choosing a doctor. Higher education, in particular, reduces the likelihood of choosing a midwife by 6.86%.

Table 4: Determinants of choice of prenatal healthcare giver (multinomial probit model)

Variables	(1) Marginal effects doctor	(2) Marginal effects midwife	(3) Marginal effects nursing assistants
Characteristics of the mother			
Primary Education	0.00646 (0.00811)	0.0159 (0.0135)	0.0182** (0.00707)
Secondary Education	0.0250** (0.00978)	0.0482*** (0.0164)	0.0185** (0.00930)
Higher Education	0.0670*** (0.0221)	-0.0686** (0.0327)	-0.00621 (0.0188)

continued next page

Table 4 Continued

Variables	(1) Marginal effects doctor	(2) Marginal effects midwife	(3) Marginal effects nursing assistants
Primary Education by MPSU	0.0420*** (0.0137)	0.159*** (0.0243)	0.0307** (0.0126)
Secondary Education by MPSU	0.0906*** (0.0142)	0.165*** (0.0289)	-0.0911*** (0.0159)
Higher Education by MPSU	0.0490*(0.0255)	0.0953 (0.0699)	0.0910** (0.0366)
Age of mother	0.00327*** (0.000369)	0.0103*** (0.000832)	0.00173*** 0.000451)
Thin	-0.0261*** (0.00866)	-0.00397 (0.0214)	0.00997 (0.0123)
Normal	-0.00638 (0.00402)	-0.00616 (0.00890)	0.0111** (0.00494)
Overweight	-0.00677 (0.00516)	-0.000377 (0.0131)	0.00926 (0.00767)
Anaemia	0.00674 (0.00468)	0.00499 (0.00998)	-0.0117** (0.00513)
Number of the children	-0.0125*** (0.00133)	-0.0448*** (0.00276)	-0.00913*** (0.00150)
Agricultural activity	-0.00825* (0.00440)	-0.0173* (0.00912)	0.00124 (0.00484)
Characteristics of the father and the household			
Primary Education	-0.00749 (0.00500)	-0.00814 (0.0102)	-0.00184 (0.00527)
Secondary Education	0.00284 (0.00486)	-0.0101 (0.0107)	-0.0158*** (0.00550)
Higher Education	0.0201** (0.00872)	-0.0436** (0.0191)	-0.0211** (0.00950)
Male	-0.00588 (0.00422)	-0.0377*** (0.00978)	-0.0106* (0.00563)
Rural area	-0.0153*** (0.00509)	-0.0293*** (0.0108)	0.0191*** (0.00569)
Christian religion	0.00615 (0.00670)	0.0424*** (0.0135)	0.0197*** (0.00696)
Muslim religion	0.00379 (0.00864)	0.0572*** (0.0158)	-0.00349 (0.00831)
Poor	-0.00669 (0.00517)	-0.0299*** (0.0107)	-0.0118** (0.00561)
Rich	0.0137*** (0.00520)	0.00321 (0.0114)	0.000320 (0.00640)
Bantou ethnic group	0.0332*** (0.00816)	0.0208 (0.0146)	-0.0400*** (0.00665)
Semi Bantou ethnic group	0.0219*** (0.00711)	0.0122 (0.0133)	-0.00958 (0.00677)

continued next page

Table 4 Continued

Variables	(1) Marginal effects doctor	(2) Marginal effects midwife	(3) Marginal effects nursing assistants
Instruments			
Time to fetch water by MPSU	-8.23e-05 (0.000136)	0.000117 (0.000283)	-0.000441*** (0.000155)
Distance to a health centre by MPSU	0.0117 (0.00932)	-0.101*** (0.0204)	0.0232** (0.0112)
Density of nurses by MPSU	4.64e-06* (2.72e-06)	-3.21e-05*** (6.92e-06)	1.08e-05*** (4.03e-06)
Year dummy	0.0261*** (0.00338)	-0.0347*** (0.00769)	0.0110*** (0.00415)
Constant			
LR chi 2 (P value)	3284.97 (0.0000)		
Log pseudo likelihood	-20 670.138		
Predicted probability	0.0584	0.418	0.782
Observations	19,857	19,857	19,857

Source: Computed by the author using the pooled 2004 and 2011 Cameroon demographics health surveys and Stata 12.
Notes: MPSU is mean at primary sampling unit. Standard errors in parentheses. *** p<0.01. ** p<0.05. * p<0.1.

At the community level, the primary education level increases the likelihood of choosing a doctor, a midwife and nursing assistant by 4.2%, 15.9%, and 3.07%, respectively. The secondary education also records a higher probability for midwives at 16.5% relative to doctors at 9.06%. This level of education reduces the probability of choosing a nursing assistant by 9.11%. Higher education increases the likelihood of consulting a doctor, a midwife and a nursing assistant by 4.9%, 9.53%, and 9.10%, respectively. A general observation at the community level is that all levels of education appear to correlate with the use of midwives. The main transmission channel of the effect of average level of education at the community level to individual mothers is likely to be through participation in associations (traditional, economic and/or religious).

The mother's health is also important for the choice of the healthcare provider. Being a thin mother reduces the likelihood of consulting a doctor and midwife by 2.61% and 0.3%, respectively. The anaemic mothers have more propensities to meet the doctors and the midwives.

Being a highly educated father increases the likelihood of mother consulting a doctor by 2.01%. An additional child to a mother reduces the probability of choosing a different healthcare provider. Thus, a mother who has many children may feel less concerned

with prenatal care because of her perceived experience. To this could be added the likelihood that the time and monetary resources may be too thinly distributed among the children that participation in prenatal care may be recording high opportunity costs.

Rural residency increases the probability of using a nursing assistant, while reducing the likelihood of consulting a doctor or a midwife. In addition, rural areas are generally deprived of experienced doctors and midwives. This can discourage some mothers who will then prefer not to consult anyone, especially given that access to care can be expensive. Agricultural employment and poverty status unambiguously reduce the probability of using a doctor or a midwife for prenatal healthcare consultation.

Determinants of number of prenatal visits

Table 5 shows the results of the estimation of factors that influence the frequency of prenatal visits. This was done using the negative binomial model which is an extension of the Poisson model. We can see that the chi 2 statistic is sufficiently high indicating that the instruments strongly identify the sample selection equation. Diagnostics test indicate that the inputs into this model are endogenous while P-value=0.000. This indicates that the model is globally significant.

Table 5: Determinants of prenatal visits with the binomial negative model

Variables	Marginal effects prenatal visits
Characteristics of the mother	
Primary Education	0.153*** (0.0353)
Secondary Education	0.291*** (0.0435)
Higher Education	0.123 (0.0769)
Primary Education by MPSU	0.554*** (0.0607)
Secondary Education by MPSU	0.419*** (0.0689)
Higher Education by MPSU	0.482*** (0.141)
Age of mother	0.0363*** (0.00186)
Thin	-0.0713 (0.0524)
Normal	-0.00531 (0.0210)
Overweight	0.0141 (0.0298)
Anaemia	-0.000809 (0.0232)
Number of children	-0.157*** (0.00648)
Agricultural activity	-0.0575*** (0.0219)
Characteristics of the father and the household	
Primary Education	-0.0102 (0.0248)
Secondary Education	-0.000271 (0.0247)
Higher Education	0.0316 (0.0414)
Male	-0.0991*** (0.0226)

continued next page

Table 5 Continued

Variables	Marginal effects prenatal visits
Rural area	-0.0702*** (0.0252)
Christian religion	0.172*** (0.0325)
Muslim religion	0.142*** (0.0417)
Poor	-0.131*** (0.0255)
Rich	0.0877*** (0.0264)
Bantou ethnic group	0.00996 (0.0343)
Semi Bantou ethnic group	0.0917*** (0.0321)
Year dummy	0.0170 (0.0180)
Instruments	
Time to fetch water by MPSU	-0.00141** (0.000693)
Distance to a health centre by MPSU	-0.209*** (0.0478)
Density of nurses by MPSU	-1.86e-05 (1.54e-05)
Constant	
R^2 / Pseudo R^2	0.0420
LR chi 2 (P value)	2681.15 (0.0000)
Log likelihood	-30570.63
Predicted probability	1.3041
Observations	19 857

Source: Computed by the author using the pooled 2004 and 2011 Cameroon demographics health Surveys.
Notes: IMR is inverse Mills ratio. MPSU is mean at primary sampling unit. BW is the birth weight which measures child health in vitro and at birth. Standard errors in parentheses. *** p<0.01. ** p<0.05.* p<0.1.

It is clear that the level of maternal education both at the individual and at the community level is positively and significantly correlated with the number of antenatal visits. In other words, education helps a lot in the use of antenatal care services. These results corroborate those by Boateng and Constant (2008) and Jewell (2009). If the level of education of pregnant mothers is high, then they will become more aware of the need to go for health services such as contraceptives to space births, reduce fertility, especially prenatal care and therefore the child health. Mothers with secondary education are 29.1% more likely to do more prenatal visits than those with a primary education level.

Place of residence and level of life are negatively and significantly correlated with the number of antenatal visits. Specifically, women who live in rural areas have fewer prenatal visits of up to 7.02%. While being poor discourages a mother from prenatal visits by about 13.1%. In Cameroon, rural areas are characterized by problems of non-existence or non-rehabilitation of health infrastructure. Pregnant women are often forced to travel many kilometres to reach a health facility. This hampers access to prenatal care. Renaudin et al (2008) in their study of financial barriers to access to obstetric care, found similar results for Mauritania. Their results show that women in rural areas have less access to obstetric care than those in urban areas.

The access time to water and the distance to the health centre negatively influence participation in prenatal care. Having many children already play a negative and significant effect on access to care. This could be understood to imply that the mother may find that she already mastered all procedures in prenatal health care and therefore decides not to visit ignoring that every pregnancy is likely to be different.

Determinants of birth weight of the child

Case 1: Choice of health providers as a measure of prenatal care

Table 6 presents ordinary least squares (OLS) estimates of the structural equation (column 1) and estimates corrected for sample selection and prenatal provider choice biases (columns 2 and 3). Whatever the level, maternal education is positively and significantly correlated with the weight of the child at birth. The effectiveness of different education levels increase gradually from primary to higher levels. Similarly, the weight of the child increases with the level of education. In particular, the returns to higher education are 6.7% compared to 4.23% and 4.15% for the primary and secondary education levels, respectively. This is an indication which identifies a delay in terms of child health in vitro and at birth.

At the community level, it is only the primary education that is significantly and positively correlated with birth weight. This is an indication that there's a certain synergy between the graduates of primary school in the community to improve the health of the child at birth. It could also be an indication that women with primary education benefit more from participation in associations composed of women with all levels of education on issues related to child health at birth.

Table 6: Determinants of birth weight

Variables	OLS	Corrected for sample selection and prenatal provider choice biases	
	Log BW	(2) Log BW	(3) BW
Providers of health			
Doctor	0.0392*** (0.00776)	0.0406*** (0.00776)	123.0*** (25.01)
Midwife	0.0329*** (0.00510)	0.0328*** (0.00510)	94.79*** (16.43)
Nursing assistants	0.0125 (0.00894)	0.0126 (0.00893)	29.33 (28.78)
Characteristics of the mother and the child			
Primary Education	0.0334*** (0.00997)	0.0423*** (0.0106)	173.2*** (33.99)
Secondary Education	0.0176 (0.0110)	0.0415*** (0.0125)	156.8*** (40.35)
Higher Education	0.0241 (0.0182)	0.0677*** (0.0211)	221.0*** (68.08)
Primary Education by MPSU	0.0260 (0.0180)	0.0550** (0.0239)	177.6** (77.00)

continued next page

Table 6 Continued

Variables	OLS	Corrected for sample selection and prenatal provider choice biases	
	Log BW	(2) Log BW	(3) BW
Secondary Education by MPSU	-0.0232 (0.0190)	0.00178 (0.0225)	-14.07 (72.53)
Higher Education by MPSU	-0.0352 (0.0366)	0.00854 (0.0391)	32.56 (125.9)
Age of the mother	0.000342 (0.000516)	0.00450*** (0.00116)	15.34*** (3.741)
Thin	-0.0498*** (0.0175)	-0.0562*** (0.0176)	-198.3*** (56.63)
Normal	-0.00319 (0.00557)	-0.00381 (0.00575)	-1.363 (18.53)
Overweight	0.0166** (0.00722)	0.0174** (0.00733)	62.06*** (23.63)
Anaemia	-0.0129** (0.00603)	-0.0131** (0.00622)	-42.21* (20.03)*
Girl	-0.0393*** (0.00441)	-0.0393*** (0.00441)	-140.2*** (14.19)
Number of the children	0.00927*** (0.00171)	-0.00805* (0.00485)	-29.03* (15.62)
Agricultural activity	0.0194*** (0.00600)	0.0150** (0.00618)	54.05*** (19.91)
Characteristics of the father and the household			
Primary Education	0.0222*** (0.00669)	0.0187*** (0.00678)	55.40** (21.85)
Secondary Education	0.0356*** (0.00639)	0.0299*** (0.00695)	83.99*** (22.37)
Higher Education	0.0300*** (0.0101)	0.0355*** (0.0118)	114.1*** (38.10)
Male	0.00794 (0.00578)	-0.00727 (0.00710)	-35.41 (22.89)
Rural area	0.00476 (0.00632)	-0.00339 (0.00713)	-16.25 (22.97)
Christian religion	0.0170* (0.00896)	0.0368*** (0.0103)	128.9*** (33.34)
Muslim religion	0.0365*** (0.0103)	0.0495*** (0.0113)	191.4*** (36.36)
Poor	-0.0281*** (0.00678)	-0.0382*** (0.00751)	-134.8*** (24.19)
Rich	-0.0169*** (0.00631)	-0.00992 (0.00646)	-40.84** (20.81)
Bantou ethnic group	0.0182** (0.00909)	0.0194* (0.0103)	83.91** (33.09)
Semi Bantou ethnic group	-0.0113 (0.00831)	0.00115 (0.00986)	-3.536 (31.76)
Year dummy	0.0318*** (0.00467)	0.0341*** (0.00608)	112.9*** (19.58)
Mills Inverses Ratios			
IMR for selection bias		0.0355 (0.0249)	148.5* (80.37)
IMR for the doctor		4.406*** (0.908)	14,159*** (2,926)
IMR for midwife		1.351*** (0.498)	4,722*** (1,603)
IMR for nursing assistants		8.464*** (3.057)	31,136*** (9,849)
Constant	7.980*** (0.0191)	-0.700 (2.222)	-27,527*** (7,160)
Observations	11,617	11,617	11,617
R^2	0.040	0.043	0.050

Source: Computed by the author using the pooled 2004 and 2011 Cameroon demographics health surveys.
Notes: IMR is inverse Mills ratio. MPSU is mean at primary sampling unit. BW is the birth weight which measures child health in vitro and at birth. Standard errors in parentheses. *** p<0.01. ** p<0.05. * p<0.1.

The fact that the mother is skinny affects the weight of her child. The child loses up to 198 grams. The female child reduces birth weight by 140.2 grams. Birth weight reduces by 41.21 grams if mother is anaemic.

It is also clear from these results that the use of a doctor and midwife for prenatal care is highly significantly and positively correlated with birth weight. The doctor seems more effective than the midwife recording gains in birth weight (4.06 % against 3.28% or 123 grams against 94.79 grams, respectively). This implies that the mother who consults a doctor can see the weight of the child improve more than if she had consulted a midwife or nursing assistant.

We visited a hospital in the capital city Yaoundé and talked with both prenatal care givers and some pregnant women to better understand the mechanism by which consulting a doctor may give rise to improvements in birth weight. Our conversation with health professionals indicated that doctors are expected to be more inclined to give quality prenatal advice than other prenatal caregivers. In particular, doctors are expected to give better advice about nutrition and food to consume during pregnancy. Through a series of ultrasounds and examination, the doctor is more able to observe how the child is growing in vitro. An experienced midwife may sometimes be able to make accurate diagnoses, but the doctors are expected to give better diagnosis most of the time.

Moreover, there is some psychological premium that mothers perceive when they consult doctors in addition to the quality of advice they may get. These may culminate to reflect the observed contribution of a doctor in registering positive marginal gains in child health at birth. In this context, it is possible that consulting a doctor may encourage an expectant mother to adopt other health seeking behaviours like avoiding alcohol and cigarettes, and adopting nutritious foods that may accelerate child growth in the womb and at birth.

The age of the mother, her commitment to agriculture, education of the father and religion are strongly and positively correlated with birth weight. They represent 0.45% (age); 1.5% (occupation of the mother); 3.5% (upper education level of the father); 3.68% (Christian); 4.95% (Muslim). The number of children living in the household and living standards are negatively correlated with the weight of the child at birth.

The inverse Mills ratios are positive and significant. The significance of the inverse Mills ratio confirms the presence of selection bias and a problem of choice of health professionals. These positive coefficients imply that the weight of a child with the average characteristics of the population is higher than for those who would be chosen at random from the sample or visit a specific prenatal provider.

To study how levels of education affected birth weight between 2004 and 2011, we interacted levels of education with the year dummy and the results are hosted in Table C1 in Appendix C. In essence, the results show that none of the three levels of education registered any significant effect on birth weight between 2004 and 2011. This is an indication that there has been no incremental effect of levels of education on child health in the period of study.

Case 2: Prenatal visits as a measure of prenatal care

Following the analysis of the reduced form of prenatal visits by a negative binomial model, we re-estimate the structural Equation 9 replacing prenatal healthcare providers by the predicted number of visits from the reduced form equation to examine its effect on the weight of the child at birth. Table 7 presents ordinary least squares (OLS) estimates of the structural equation (column 1) and estimates corrected for sample selection and estimates corrected for selection bias only (column 2 and 3).

In light of results, it is possible to say that prenatal visits are positively and significantly correlated to child weight at birth. They contribute about 177 grams to the weight of the child. Corman and Grossman (1985) in their study on the production of child health in the womb in the USA found similar results. They found that the effect of prenatal care on the child's health is zero if the risk factors associated with pregnancy remain constant.

Table 7: Determinants of child weight at birth by the 2SLS and correction for selection bias (including number of prenatal visits)

Variables	OLS	Correction of selection bias	
	logBW	(2) logBW	(3) BW
Prenatal care	0.0127*** (0.00178)	0.0843 (0.0694)	197.2 (221.7)
Characteristics of the mother			
Primary Education	0.0130 (0.0109)	0.00347 (0.0138)	46.69 (44.00)
Secondary Education	-0.00291 (0.0117)	-0.0174 (0.0188)	-29.78 (59.96)
Higher Education	0.0112 (0.0182)	0.00918 (0.0194)	36.22 (62.08)
Primary Education by MPSU	0.0230 (0.0188)	-0.0123 (0.0360)	-10.99 (115.1)
Secondary Education by MPSU	0.00712 (0.0193)	-0.0158 (0.0295)	-25.50 (94.26)
Higher Education by MPSU	-0.0402 (0.0356)	-0.0723 (0.0459)	-206.7 (146.7)
Age of the mother	-0.000431 (0.000518)	-0.00232 (0.00199)	-5.727 (6.359)
Thin	-0.0423** (0.0172)	-0.0386** (0.0178)	-138.0** (56.73)
Normal	-0.00416 (0.00557)	-0.00433 (0.00559)	-15.44 (17.87)
Overweight	0.00900 (0.00732)	0.00881 (0.00734)	24.17 (23.44)
Anaemia	-0.00936 (0.00607)	-0.00944 (0.00608)	-25.29 (19.42)
Girl	-0.0377*** (0.00442)	-0.0377*** (0.00442)	-129.7*** (14.11)
Number of the children	0.00984*** (0.00178)	0.0182** (0.00854)	50.35* (27.28)
Agricultural activity	0.0107* (0.00601)	0.0123* (0.00674)	40.95* (21.53)
Characteristics of the father and household			
Primary Education	0.0215*** (0.00695)	0.0229*** (0.00702)	72.08*** (22.44)
Secondary Education	0.0280*** (0.00655)	0.0301*** (0.00675)	90.88*** (21.57)

continued next page

Table 7 Continued

Variables	OLS	Correction of selection bias	
	logBW	(2) logBW	(3) BW
Higher Education	0.0270*** (0.0101)	0.0291*** (0.0106)	103.6*** (33.80)
Male	0,00550 (0,00544)	0.0103 (0.00747)	22.11 (23.86)
Rural area	0.0216*** (0.00633)	0.0235*** (0.00753)	69.53*** (24.07)
Christian religion	0.0166* (0.00912)	0.00812 (0.0131)	44.80 (41.81)
Muslim religion	0.0398*** (0.0111)	0.0317** (0.0135)	138.1*** (42.96)
Poor	-0.0170** (0.00674)	-0.0109 (0.00972)	-44.70 (31.04)
Rich	-0.00673 (0.00636)	-0.0106 (0.00807)	-35.60 (25.79)
Bantou ethnic group	0.0252*** (0.00889)	0.0249*** (0.00890)	104.8*** (28.44)
Semi Bantou ethnic group	-0.00673 (0.00823)	-0.00558 (0.0103)	-19.72 (33.00)
Year dummy	0.0298*** (0.00467)	0.0300*** (0.00467)	99.90*** (14.93)
Reduced form residual		0.0717 (0.0694)	163.0 (221.7)
IMR for selection bias		0.0306 (0.0266)	126.1 (85.11)
Constant	7.998*** (0.0199)	8.019*** (0.0397)	3,077*** (126.7)
Observations	11 617	11 617	11 617
R-squared	0.032	0.032	0.037

Source: Computed by the author using the pooled 2004 and 2011 Cameroon demographics health surveys.
Notes: IMR is inverse Mills ratio. MPSU is mean at primary sampling unit. BW is the birth weight which measures child health in vitro and at birth. Standard errors in parentheses. ***p<0.01. ** p<0.05. * p<0.1.

Unlike the previous case, none of the levels of education either at individual or community level are significantly correlated to child weight. The thinness of the mother has a significant negative effect on the child weight of about 138 grams. Maternal anaemia negatively influences the birth weight by about 25.29 grams. As before, being female babies depresses the birth weight by up to 3.7% (129.7 grams).

The father's level of education also plays a positive role in improving birth weight and the effect increases steadily as the level of education increases from 72.08 grams, 90.88 grams to 103.6 grams for primary, secondary and university level education, respectively. Poverty status also has a negative and significant effect on birth weight of the child. The inverse Mills ratio related to selection bias is positive and significant, confirming the presence of a bias in sample selection.

We also interact levels of education with the dummy variable that captures the years and the results are summarized in Table C2 in Appendix C. We also find that the results show that none of the three levels of education has a significant effect on the birth weight between 2004 and 2011. As in the previous case, there is no additional effect of the levels of education on children's health in the period study.

6. Conclusion

This study attempted to empirically analyse the role of maternal education and prenatal care on child health in Cameroon using the 2004 and 2011 databases of Cameroon demographic and health surveys (CDHS) collected by the government's statistics office. In particular, the study investigated the determinants of prenatal care participation decision, factors that influence prenatal healthcare professional choices, factors that influence the number of prenatal visit, and factors that influence birth weight. Equally, this study gets down to verifying if the improvement of level of education of the mother has ameliorated the child health between 2004 and 2011. We have followed a procedure of econometric estimate in two steps. Globally, the models are significant while the p-values are nulls.

The first step was to estimate a probit model of the decision to participate and a multinomial choice model of health care professionals, respectively. The probit estimates showed that mother's level of education, whether at the individual or community level, and father's education increased the probability of participation in prenatal care. This probability increased with the level of education. Multinomial probit estimates showed that the education level of the mother is very important in the choice of health providers. Education levels are strongly correlated with the probability of choosing a health care professional at the expense of another. The mothers with a higher level of education had a high probability to choose the doctor and falling for the midwife during the pregnancy, while those who have a primary education level are likely to choose the nursing assistants.

In the second step, a structural birth weight equation correcting for prenatal care selectivity and caregiver choice biases were estimated in adding the inverses of Mills ratios like a further variable in the structural model of birth weight. From this step, the results showed that birth weight was explained positively by the level of maternal education and the type of professionals solicited, as well as by the number of prenatal visits. Therefore, the effectiveness of different education levels increased progressively from primary to upper levels. It is also clear from these results that the use of the doctor and midwife is highly significantly and positively correlated with birth weight. This implies that the mother who consulted a doctor was likely to see the health of her child improve more than if she had consulted a midwife. None of the level of education registers a differential significant effect on the birth weight between 2004 and 2011.[8]

We also did the same analysis by measuring prenatal care by the number of prenatal visits in order to evaluate the robustness of our results. The use of negative binomial model estimates of this model showed that the level of maternal education, both at the individual and at the community level, is positively and significantly correlated with the number of antenatal visits. Place of residence and poverty status have a negative and significant influence on the number of antenatal visits. The women who live in rural areas undertook fewer prenatal visits than their urban counterparts. At the level of structural equation, we observe that the prenatal visits are positively and significantly correlated to weight of child. The levels of education, either at individual level or at community level, is no significant in the explanation of weight of child. The health of mother and the sex of child have negative effect on weight of child.

Policy implications

It appears from our results that the higher the level of education of mothers, the more they are likely to attend prenatal care and consult skilled health providers and thus improve the weight of the child at birth. Mothers who have a higher level of education are more likely to exploit sources of information such as newspapers, brochures, and the internet. They are more likely to do search for information and to express themselves. It is still them who make use of doctors and midwives during pregnancy. Those with low levels of education may not possess all these capacities and are more likely to use auxiliary nurses and traditional doctors. It is, therefore, necessary to focus on the information that must be conveyed to mothers. It could strengthen information campaigns on the importance of prenatal care through awareness on the health of the mother and the need to have a healthy child. It could also involve the use of mobile agencies to convey messages through mobile phones to clients emphasizing the importance of prenatal visits for pregnant women. This idea has already been used in the case of diseases such as polio and malaria.

Low standards of living and rural dwelling continue to be an obstacle to proper monitoring of pregnancies. In such situations, women are less likely to attend prenatal care or if they do are more likely to consult less qualified providers. This has an impact on birth weight. The lack of health professionals in rural areas also explains the paucity of prenatal care and therefore the low probability that the child will weigh much at birth. It would be useful to focus on training and allocation of qualified health professionals. These will be more effective if sent specifically to rural areas and encouraged by special allowances or free accommodation. Their presence in rural areas further reassures mothers and will certainly contribute to the reduction of maternal and infant mortality. It would also be necessary to encourage health providers to move to rural areas and conduct exchanges through health campaigns. This is because the caregiver typically communicates very little with pregnant women because of the long queues, the limited time set for antenatal consultation and the poor financial status of caregivers. Yet such campaigns allow them to interact with

pregnant women on how to behave during and after pregnancy, on maternal nutrition, and on medication to consume such as iron, vitamin B complex and calcium.

Women's access to the nearest health centres and the time they take to fetch water remains a major problem. At an advanced stage of pregnancy, expectant mothers have difficulty walking long distances to get medical care. That is probably why some resort to traditional doctors, or ignore professional prenatal care. Increasing the densities of health centres, health personnel and water points would increase prenatal healthcare demand, thereby improving mother and child health.

Notes

1. National Institute of Statistics.

2. See Bonono and Ongolo-Zogo (2012).

3. Ministry of Health.

4. Cited by Baye (2010).

5. The TBA variable is grouped in other types of providers because it is poorly represented in relation to the data in our database DHS.

6. See Diouf (2011).

7. Anaemia is a disease characterized by a reduction in the number of red blood cells and a weakening of the concentration of haemoglobin in the blood. It is mainly due to iron deficiency, which is essential for the formation of red blood cells. Anaemia can lead to decreased resistance, fatigue, particularly in pregnant women.

8. See Appendix C (tables C1 and C2).

9. The care received during prenatal visits include: taking the weight and size; checking the blood pressure; urine and blood tests; the actual care like injections against tetanus; prescribing iron tablets and antimalarial drugs; and the advice given to pregnant women during consultations.

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Appendixes

Appendix A: The qualified professionals of prenatal health care in Cameroon

In Cameroon, doctors, midwives, nurses and nursing aides are considered to be qualified health professionals. Each professional has maternal health skills but at different levels through the duration of their training. Doctors have between 7 and 10 years of training while midwives and nurses have between 2 and 3 years of training and the aides-carers have at most one year of training.

The obstetrician's gynaecologists have greater knowledge of the female anatomy and are in high demand for surgeries. They perform caesarean sections, and provide advice on nutrition, lifestyle and monitoring of the pregnancy. They are also able to follow-up the mother in case of diseases (malaria, anaemia, HIV) during pregnancy.

The midwife or nurse specializes typically in monitoring pregnant women from conception to birth. She certainly gives nutrition advice but may not normally be entrusted with decisions in case of complications.

The nursing assistant is specifically trained to assist other healthcare providers. In particular, the nursing assistant is responsible for caring for the patients by measuring weight, temperature, and blood pressure.

Appendix B: Modelling number of prenatal visits using a Negative Binomial Estimator

To assess the robustness of our results, it is interesting to use another measure of prenatal care. The number of prenatal visits can also proxy for prenatal care. This is justified by the observation that prenatal care was given to pregnant women during prenatal visits. Moreover, some studies have captured access to health care by the number of prenatal visits[9] (Andres, 2000; Pradhan et al, 2004; Conway and Deb, 2005; Winkelmann, 2006; Salvado, 2007; Sander, 2008).

The number of prenatal visits can be modelled using the Poisson distribution. This model is well-adapted for count data (Wiseman et al, 2007). Let y_i be the number of prenatal visits randomly by a pregnant woman. Poisson model specified from the number of prenatal visits (y_i) is described by a Poisson distribution with parameter λ_i (average number of visits) that is a function of a set of variables. Given a discrete random variable Y and the observed frequencies y_i for i = 0,1,2,...,n with $y_i \geq 0$, then:

$$Prob\left(Y = y_i / X_i\right) = \frac{e^{-\lambda_i} \lambda_i^{y_i}}{y_i!} \qquad (B_1)$$

Poisson distribution implies equality of the conditional variance and conditional mean (equi-dispersion). However, the characteristic of equi-dispersion implies a clear restriction in the estimate. This is because with economic data (for example, the use of health services), usually the variance exceeds the average. This is due to the heterogeneity of unobservable factors (heterogeneity of maternal conditions) through the sample and is known as the over-dispersion (Wedel et al, 1993). Indeed, some women knowing that they have often been having problematic pregnancies tend to have more prenatal visits than those with no complications, which inflate the variance of prenatal visits (Jones, 2007). This over-dispersion is due to the presence of a large proportion of zero observations in the data registered by women who make no visits during pregnancy. In this case, the average is smaller than the variance and the Poisson regression is not desirable.

An alternative solution to this problem is to apply the maximum likelihood negative binomial regression model, which allows for over-dispersion (Mwisha, 2011). The negative binomial model allows the variance to differ from the average. This can be specified as follows:

$$\ln \lambda_i = \beta' X_i + \varphi \qquad (B_2)$$

where, gamma distribution with mean equal to variance. The resulting probability distribution is:

$$Prob\left(Y = y_i / \varphi\right) = \frac{e^{-\lambda_i \exp(\varphi)} \lambda_i^{y_i}}{y_i!} \quad y = 0,1,2,... \qquad (B_3)$$

Appendix C: Additional estimations including interactions between level of education and dummy variable

Table C1: Determinants of the child's weight at birth by the ordinary least squares method with interactions between level of education and dummy variable of year (including number of health professionals)

Variables	MCO	Correction of the selection bias problem and the choice of prenatal health providers	
	(1) logBW	(2) logBW	(3) BW
Providers of health			
Doctor	0.0389*** (0.00776)	0.0405*** (0.00777)	122.7*** (25.03)
Midwife	0.0329*** (0.00510)	0.0328*** (0.00510)	94.82*** (16.43)
Nursing assistants	0.0125 (0.00894)	0.0126 (0.00894)	29.04 (28.79)
Characteristics of the mother			
Primary Education	0.0333** (0.0139)	0.0400*** (0.0144)	155.3*** (46.28)
Secondary Education	0.0207 (0.0148)	0.0382** (0.0164)	140.0*** (52.91)
High Education	0.0648** (0.0326)	0.0787** (0.0332)	239.2** (107.0)
Primary Education *year dummy	0.000602 (0.0156)	0.00334 (0.0157)	28.45 (50.54)
Secondary Education*year dummy	-0.00462 (0.0159)	0.00452 (0.0164)	25.13 (52.83)
High Education*year dummy	-0.0508 (0.0345)	-0.0129 (0.0357)	-17.39 (114.9)
Primary Education by MPSU	0.0255 (0.0181)	0.0540** (0.0240)	175.9** (77.43)
Secondary Education by MPSU	-0.0240 (0.0190)	0.000788 (0.0226)	-17.25 (72.96)
High Education by MPSU	-0.0334 (0.0366)	0.00771 (0.0392)	31.42 (126.4)
Age of the mother	0.000335 (0.000516)	0.00441*** (0.00117)	15.09*** (3.777)
Thin	-0.0497*** (0.0175)	-0.0561***0.0176)	-198.0*** (56.67)
Normal	-0.00312 (0.00558)	-0.00374 (0.00576)	-1.298 (18.55)
Overweight	0.0166** (0.00722)	0.0174** (0.00734)	62.19*** (23.66)
Anaemia	-0.0129** (0.00603)	-0.0131** (0.00623)	-42.36** (20.06)

continued next page

Table C1 Continued

Variables	MCO	Correction of the selection bias problem and the choice of prenatal health providers	
	(1) logBW	(2) logBW	(3) BW
Number of the children	0.00925*** (0.00171)	-0.00767 (0.00490)	-27.96* (15.77)
Agricultural activity	0.0196*** (0.00601)	0.0151** (0.00619)	54.26*** (19.93)
Characteristics of the father and the household			
Primary education	0.0221*** (0.00669)	0.0187*** (0.00679)	55.42** (21.86)
Secondary education	0.0353*** (0.00640)	0.0301*** (0.00697)	84.30*** (22.46)
High education	0.0289*** (0.0101)	0.0353*** (0.0120)	113.6*** (38.73)
Sex of head of household	0.00796 (0.00579)	-0.00699 (0.00712)	-34.66 (22.95)
Rural area	0.00461 (0.00633)	-0.00318 (0.00715)	-15.52 (23.03)
Christian religion	0.0168* (0.00896)	0.0364*** (0.0104)	128.2*** (33.43)
Muslim religion	0.0362*** (0.0103)	0.0491*** (0.0113)	190.3*** (36.44)
Poor	-0.0282*** (0.00678)	-0.0380*** (0.00754)	-134.0*** (24.29)
Rich	-0.0168*** (0.00631)	-0.00991 (0.00647)	-40.68* (20.85)
Bantou ethnic group	0.0186** (0.00910)	0.0194* (0.0103)	83.36** (33.31)
Semi Bantou ethnic group	-0.0110 (0.00832)	0.00112 (0.00986)	-3.789 (31.77)
Year dummy	0.0345** (0.0142)	0.0312** (0.0144)	90.36* (46.47)
Mills Inverses Ratio			
IMR for selection bias		0.0360 (0.0250)	150.7* (80.49)
IMR for doctor		4.333*** (0.950)	13,934*** (3,061)
IMR for midwife		1.309*** (0.504)	4,594*** (1,622)
IMR for nursing assistants		8.381*** (3.086)	31,116*** (9,941)
Constant	7.980*** (0.0204)	-0.578 (2.237)	-27,288*** (7,206)
Observations	11 617	11 617	11 617
R-squared	0.041	0.043	0.050

Source: Computed by the author using the pooled 2004 and 2011 Cameroon demographics health surveys.
Notes: IMR is inverse Mills ratio. MPSU is mean at primary sampling unit. BW is the birth weight which measures child health in vitro and at birth. Standard errors in parentheses. *** p<0.01. ** p<0.05. * p<0.1.

Table C2: Determinants of the child's weight at birth by the ordinary least squares method with interactions between level of education and dummy variable of year (including number of prenatal visit)

Variables	OLS	Correction of selection bias	
	(1) logBW	(2) logBW	(3) BW
Prenatal visit	0.0127*** (0.00178)	0.0859 (0.0694)	201.2 (221.8)
Characteristics of the mother			
Primary Education	0.0240 (0.0156)	0.0142 (0.0176)	71.00 (56.14)
Secondary Education	0.0114 (0.0162)	-0.00383 (0.0217)	-1.995 (69.27)
High Education	0.0371 (0.0323)	0.0342 (0.0329)	90.10 (104.9)
Primary Education *year dummy	-0.0174 (0.0177)	-0.0171 (0.0177)	-39.02 (56.53)
Secondary Education*year dummy	-0.0227 (0.0178)	-0.0222 (0.0178)	-45.61 (56.82)
High Education*year dummy	-0.0366 (0.0345)	-0.0359 (0.0346)	-77.15 (110.4)
Primary Education by MPSU	0.0220 (0.0188)	-0.0137 (0.0361)	-14.30 (115.2)
Secondary Education by MPSU	0.00627 (0.0193)	-0.0172 (0.0295)	-28.52 (94.34)
High Education by MPSU	-0.0385 (0.0356)	-0.0711 (0.0460)	-205.1 (146.9)
Age of the mother	-0.000446 (0.000518)	-0.00239 (0.00199)	-5.884 (6.364)
Thin	-0.0426** (0.0172)	-0.0387** (0.0178)	-138.1** (56.75)
Normal	-0.00401 (0.00557)	-0.00413 (0.00560)	-14.99 (17.88)
Overweight	0.00907 (0.00732)	0.00884 (0.00734)	24.23 (23.44)
Anaemia	-0.00946 (0.00608)	-0.00951 (0.00608)	-25.49 (19.42)
Girl	-0.0379*** (0.00442)	-0.0378*** (0.00442)	-130.0*** (14.11)
Number of the children	0.00986*** (0.00178)	0.0184** (0.00855)	50.92* (27.30)
Agricultural activity	0.0110* (0.00601)	0.0127* (0.00675)	41.89* (21.56)
Characteristics of the father and the household			
Primary Education	0.0214*** (0.00695)	0.0228*** (0.00703)	71.83*** (22.44)
Secondary Education	0.0277*** (0.00656)	0.0297*** (0.00676)	90.23*** (21.59)
High Education	0.0267*** (0.0101)	0.0285*** (0.0106)	102.3*** (33.86)
Sex of head of household	0.00558 (0.00545)	0.0105 (0.00747)	22.64 (23.87)
Rural area	0.0214*** (0.00634)	0.0236*** (0.00754)	69.67*** (24.08)
Christian religion	0.0162* (0.00912)	0.00750 (0.0131)	43.47 (41.85)
Muslim religion	0.0393*** (0.0111)	0.0310** (0.0135)	136.7*** (42.99)
Poor	-0.0171** (0.00674)	-0.0107 (0.00972)	-44.24 (31.06)
Rich	-0.00689 (0.00637)	-0.0110 (0.00808)	-36.36 (25.81)

continued next page

Table C2 Continued

Variables	OLS	Correction of selection bias	
	(1) logBW	(2) logBW	(3) BW
Semi Bantou ethnic	-0.00651 (0.00823)	-0.00586 (0.0103)	-20.43 (33.03)
Year dummy	0.0486*** (0.0164)	0.0484*** (0.0164)	139.6*** (52.35)
Reduce form residual		0.0733 (0.0695)	167.0 (221.9)
IMR for selection bias		0.0286 (0.0267)	122.0 (85.24)
Constant	7.988*** (0.0218)	8.011*** (0.0404)	3,059*** (128.9)
Observations	11 617	11 617	11 617
R-squared	0.032	0.032	0.037

Source: Computed by the author using the pooled 2004 and 2011 Cameroon demographics health surveys.
Notes: IMR is inverse Mills ratio. MPSU is mean at primary sampling unit. BW is the birth weight which measures child health in vitro and at birth. Standard errors in parentheses. *** p<0.01. ** p<0.05. * p<0.1

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