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Health Status of Under-Five-Children and Tetanus Toxoid

Mbu Daniel Tambi
Department of Agricultural Economics
University of Dschang, Cameroon

Abstract

Toxoid is one of the most important and cost-effective interventions that health systems can provide to safe children's lives. Couple with others, toxoid is an effective measure of public health in helping children attain better lives without any disability. Thus, this study attempts to investigate the Child Health of Under-Five-Children and Tetanus Implications. Use is made of weighted Ordinary Least Square model. Empirical results are based on pooled data from the 2004 and 2011 Demographic and Health surveys collected by the government's statistics office. Results show that maternal immunization during pregnancy is associated positively with birth weight, overall, in rural and urban areas, and among poor and non-poor households. Other variables that are significantly associated with birth weight in rural Cameroon are: mother's education in years of schooling, mother's age, father's age, first twin birth, male child birth, non-poor, interaction of mother and father's education and urban household residence. These results have implications for addressing child health concerns in the ongoing process of growth, employment and poverty reduction in terms of improving access to antenatal care and family planning in rural Cameroon.

Keywords: Tetanus Implications, Under-five-children, Birth- weight, Ordinary Least Square, Cameroon

1. Introduction

Toxoid is one of the most important and cost-effective interventions that health systems can provide to safe children's lives. Couple with others, toxoid is the most effective measures of public health in helping children attain better lives without any disability (UNICEF, 2010). There also exists an active immunization; which involves challenging the human immune system with a vaccine composed of modified pathogens. Since the immune system has a long-lasting memory for a wide range of specific infecting agents, vaccination provides the individual with long term protection against a particular disease. Active immunization not only provides the individual with immune protection, but also reduces the circulation of the infecting agent in the population, thereby protecting unvaccinated individuals as well.

In Cameroon[1], the general health of the population has deteriorated considerably since early 1990s. The mortality rate, increased by 12% between 1991 and 1998, chronic malnutrition rate for children 12 to 23 months old also rose from 23% to 29% and the rate of delivery attended by qualified practitioners (doctors and nurses) declined by 5% during the same period. Moreover, between 1991 and 2002, the rate of HIV/AIDS infection within the sexually active population rose alarmingly from 2% to 11.8% (Government of Cameroon (GOC), 2011). As a tool to improving child and maternal healthcare, by 2008, the government of Cameroon implemented a 5-year

[1] The population of Cameroon is projected to 18 million of which 49% and 51% are men and women respectively. The population of women of reproductive age (WRA) is 23% or 4000 000 in absolute terms. The annual population growth rate is 2.83%. The mean fertility rate is 6.1 children per WRA. The crude birth rate is 42.5 per 1000 population while the crude mortality rate is 17.5 per 1000 population (Ako et al., 2008). Life expectancy is expected to increase from the current 54.5 years and 59 years to 55 and 65 for men and women respectively, infant mortality is expected to decrease from 126 per 1000 to about 100 or less (GOC, 2011).

action plan in the Extended Program for Immunization (EPI), incorporating the following: (i) mobilizing additional resources for immunization, independence and introducing new vaccines, (ii) training/retraining staff and rehabilitating/renewing equipments, (iii) developing communication materials to promote behavioural changes, (iv) outsourcing program implementation responsibilities to health districts and (v) ensuring the program monitoring and evaluation activities (GOC, 2011).

TABLE 1: IMMUNIZATION PROFILE – CAMEROON (IN %)

Vaccine	1990	2000	2012	2013	2014	2015	2016
Vaccine for Children (child aged from 0 to 5 years)							
Bacille Calmette-Guerin (BCG)	52	69	86	79	83	80	83
DTC3= DTC+ HepB-reference antigen (DTC3)	36	53	84	80	84	82	86
Measles (VAR)	-	49	77	72	79	76	68
Poliomyelitis (VPO)	34	49	82	79	83	80	89
Yellow fever (VAA)	-	-	77	72	79	75	61
Diphtheria-tetanus-pertussis (DTP1)	-	54	93	88	92	90	91
Infection due to pneuoccocus (Pneumo)	-	48	88	84	78	80	79
Avitaminosis (VIT.A)	44	62	84	81	90	87	92
Vaccine for Mothers							
Anti-tetanus for expectant mothers (VAT2+)	82	79	65	72	83	80	85
Tetanus toxoid (TT2+)	12	40	76	73	74	69	91

Source: WHO-UNICEF coverage estimates (2012) and MPH (2017)

The focus of this study is on maternal immunization by tetanus toxoid (TT2+). The evolution of this vaccine among the women population has been very irregular, beginning from 1990 (12%), 69% in 2011 with its peak in 2012 with 76% whereas vaccinating pregnant women may protect young infants from infectious causes of mortality by passive immunization and by reduced transmission to the neonate from mother (Klaugman, 2014). As noted in WHO (2006) the effectiveness of a vaccine programme largely depends on (1) the proportion of susceptible individuals who have access to immunization services, (2) the vaccine failure rate (i.e., the proportion of individuals properly vaccinated but who fail to develop a protective response, (3) the vaccine efficacy (i.e., the proportion of individuals who may be expected to develop a protective response to the vaccine under optimal field conditions never 100 %), (4) effective procedures for preserving the vaccine at optimal temperature during transit, (5) the training of vaccinators to ensure proper administration of the vaccine, (6) the attitude of the vaccination staff, (7) the knowledge and attitudes of the population, and (8) the proportion of the population willing to submit to the vaccination schedule.

Further, the first time this vaccine was introduced, it induced many allergic reactions on the mothers/foetus that created fear on the part of the women and so some of them became skeptical while others due to the vaccination campaign were still encourage to take the vaccine. Generally, vaccines can occasionally induce allergic reactions, ranging from mild to severe anaphylactic responses. Adverse responses may be due to components of the vaccine, e.g., residuals of materials used in the preparation of the vaccines, preservatives, etc. Specific recommendations with regard to allergic reactions are provided by the producers of each vaccine and should be consulted. Excessive interpretation of contraindications (e.g., non-febrile mild acute illnesses, or mild illnesses with temperature elevations of 101o F or less) results in reduced uptake of vaccine. While severe illness should be viewed as contra-indicative of immunization, mild acute illness with or without low grade fever, current microbial therapy and the convalescent phase of an illness are not reasons to avoid or delay vaccination (WHO, 2006).

Following the GOC (2011) and the respective demographic health surveys, the trend and coverage of tetanus immunization have not also been uniform, varying as follows: 71% in 1991, 82% in 1998, 79% in 2004 and 51% in 2011. There is need to emphasize that the role of tetanus vaccination is to reduce the risk of the fetus contracting tetanus during birth, an outcome which motivates the mother to invest in better nutrition and behaviours that enhance fetal growth and therefore reduce the risk of her infant dying due to low birth weight.

The central argument is not that tetanus vaccination directly increases birth weight, but that it's strongly correlated with healthcare consumption and behaviours that increases birth weight (Bategeka et al., 2009).

Despite these efforts, child health care literature in the case of Cameroon is severely lacking (Ako et al., 2008). Training in reproductive health overall has not been a priority in the health sector. Current deliberations over approaches to reproductive health provide a window of opportunity to improve access to care to enable women to attain good health, maintain good health during their reproductive years. The cost of health services rose nearly three times as fast as the average inflation rate over the last five years, by some 70% and it is apparent that financial capacity has a considerable impact on demand for health services. Annual average health spending per capital is three times higher in urban than in rural areas and four times as high among the non-poor as among the poor. Moreover, health problems are concentrated among disadvantaged groups and these rates have stagnated or worsen over the past three decades (GOC, 2011). All these factors are likely to result in low birth weight and high maternal mortality in most rural communities where medical services are inadequate in supply or entirely lacking in Cameroon.

As established in the preceding paragraphs, child health deficiencies can lead to disability and illness with long term consequences on physical growth and development of children that manifest in adult life and can also lead to death. Based on this, child health literature has gained some grounds in Sub Saharan Africa (Kenya, Nigeria, Ghana and Ethiopia to name a few) but to the best of our knowledge very limited effort has been made in Cameroon. Thus, as intimated above, the only studies that have attempted to shed some light in this domain are Baye and Fambon (2010) using the 2001 Cameroon household consumption survey data. Our study is therefore, bridging this gap by attempting to relate mother tetanus immunization to child health at birth using the 2011 Cameroon's demographic health survey data. Considering these issues, it has become imperative for health researchers, governments and organizations to focus their attention in this domain of research which is pressing as the job market needs both men and women and most importantly healthy population to increase productivity and reduce poverty. To fill this literature gap in Cameroon therefore, this paper proposes to address the following objectives: to examine the determinants of mother's immunization in Cameroon, to assess the impact of mother tetanus immunization on child health production, to decompose birth weight effects by area of residence and household income and to propose policy implications on the basis of the findings.

2. Literature Review

Child health is captured in this study as birth-weight, as already established, birth weight is the first weight of the foetus or newborn obtained after birth. For live births, birth weight should preferably be measured within the first hour of life, before significant postnatal weight loss has occurred. UNICEF/WHO (2004) reveals that prior to 1990; most estimates of low birth weight for developing countries were based on data compiled from health facilities. However, such estimates are biased for most developing countries because the majority of newborns are not delivered in facilities and those that are delivered in health facilities are a selected sample of all births. As an alternative to facility-based data, information on birth weight has been collected systematically since about 1990 from mothers participating in nationally representative household surveys, mostly the USAID supported Demographic and Health Surveys (DHS) while the UNICEF-supported Multiple Indicator Cluster Surveys (MICS) (UNICEF/WHO, 2004).

In Cameroon, the phenomenon of birth weight missing is still relatively high using the USAID supported DHS especially among the rural population. According to the World Bank, rural population refers to people living in rural areas as defined by national statistical offices; in Cameroon, about 59.3 percent of its population lives in rural communities in 1990; 50.1 percent in 2000; 41.6 percent in 2010 and 41.3 percent in 2012. The rural community in this part of the world is characterized by; inadequate supply of medical centers and services, poor road infrastructure and communication network, inadequate water supply…

Pregnant mothers in Cameroon, due to the mass campaign for immunization awareness and the benefits of prenatal services since 2008, commit themselves to immunization programs which in most cases are fixed days in the medical centers. However, it has been noted that most of the mother's takes advantage of the tetanus toxoid (TT2+) to delivered their babies at home and so do not register the weight of their children. The idea of traditional birth attendants as revealed by Ako et al (2008) has equally increase the act of home delivery of rural Cameroon, not-with-standing, Ako et al also revealed that from the 5-year action plan in the EPI, the government of Cameroon took the initiative to train about a 1000 traditional birth attendants, unfortunately this have not been

quite effective. This explained why birth weight of home delivery children is missing in the Cameroon DHS; meaning the mothers who did not deliver at the clinics generally did not report birth weights for their children.

In this line of argument, Tambi (2014) in linking child health, maternal labour force participation and household asset endowments: what the people say, reveals that pregnant women in Cameroon are more conscious of vaccination immunization as compare to other possible interventions, such as mother and child feeding programs, well baby clinics, micro-nutrients supplementation, and even health and nutrition educational outreach. This might be cause partly by the lack of knowledge in prenatal care issues and partly because the ministry of public health in Cameroon following the 2008 Action Plan has laid more emphasis on vaccination both during and after pregnancy.

Considering the tetanus disease, WebMD (2015) noted that tetanus is a bacterial infection that causes painful muscle spasms and can lead to death. Generally, tetanus bacteria are commonly present in soil, dust and manure and it can infect a person even through a tiny scratch. However, children and even grown-ups are more likely to get tetanus through deep punctures from wounds created by nails, blades, scissors, niddles and knives especially during delivery. The bacteria travel through the blood or nerves of the infected person to the central nervous system. The tetanus disease is often called lockjaw and it has as symptoms: headache, muscle stiffness, starting in the jaw then the neck, arms, legs or abdomen. Other symptoms includes: swallowing problems, irritability and restlessness, tetanus symptoms result from a toxin produced by tetanus bacteria. Symptoms often begin around a week after infection. But this may range from three days to three weeks or even longer. The most common symptom is a stiff jaw, which can become *locked*. This is how the disease came to be called lockjaw. Fever and sweating, high blood pressure and palpitation, muscle spasms in the face, causing a strange-looking steady smile or grin and if not treated, tetanus can cause death from suffocation (UNICEF, 2010).

Brennam (2015) noted that tetanus as a disease is a dangerous nerve ailment caused by the toxin of a common bacterium (clostridium tetani), it may occur when bacterial spores enter the body by way of animal or insect bites, surgical wounds, needle injection, burns, splinters, ulcers and infected umbilical cords and by proverbial rusty nails, scissors and knives. Brennam also revealed that an estimated one million infants die of tetanus in developing countries each year because of poor hygiene. He added that since childhood immunization laws were passed in the US in the 1970s only about 50 cases a year are reported in this country; about three-quarters are elderly people or people who have never been immunized. In Cameroon, childhood immunization laws are still to be a reality, meaning the tetanus disease is still an issue of great concern, especially among rural inhabitance and poor households in general. Particular to this study, the immunization variable capture is simply a proxy for the broader issue of accessing prenatal health care services, hence our tetanus immunization variable is not only capturing the impact of getting the tetanus vaccine but also the range of services associated with receiving the tetanus immunization vaccine.

As a remedy for the tetanus disease, tetanus toxoid is the type of vaccine considered in our study as the appropriate cure for the tetanus disease. The variable tetanus immunization (coded as M1 in the DHS) simply refers to the number of tetanus toxoid injections given to a mother during pregnancy to avoid convulsions after birth. This variable indicated whether the respondent received a tetanus toxoid injection during the pregnancy for DHS-I countries. Tetanus toxoid is a passive immunization; that is a passive immunization involves the transfer of antibodies generated by one individual to another individual in an attempt to prevent or attenuate an anticipated infection. This method is less effective and short lived than active immunization but it has the advantage of being more immediately effective. This is an important strategy in the use of antibody preparations for prophylaxis against/or treatment of tetanus, rabies, varicella and hepatitis A and B.

Maternal immunization is important in the sense that, cutting an infant's umbilical cord and dressing the wound, creates opportunities for tetanus infection if high standards of cleanliness are not maintained. Maternal vaccination against tetanus, however, creates antibodies that are passed on to the child in utero, giving protection to the disease in newborns. The effects of maternal vaccination (toxoid) on infant mortality have already been examined (see, Koenig, 1998). There is a substantial reduction in mortality in the first month of life (neonatal mortality) among children of women who received the tetanus toxoid, with a decline in the neonatal mortality rate from around 70 per 1000 to around 40 per 1000 (see, Canning et al, 2010). Further Gupta and Keyl (1998) also revealed that complete prenatal immunization with tetanus toxoid during pregnancy (two doses 1 month apart) is associated with an 88 percent reduction in the risk of neonatal tetanus among the newborn children.

They also noted that in multivariable analysis only complete immunization and the use of clean instruments for cutting the umbilical cord are independently associated with a reduction in risk of neonatal tetanus.

3. Methodology

Following the WHO (2006), tetanus immunization may be determine by factors such as: wealth index, mother's age at last birth, education, husband's occupation, ever using contraception, fertility preference, wanted last child, having permission to go to hospital/health center, pregnancy complications and mass media exposure for receiving tetanus vaccination. As stated above, birth weight itself is determine by other factors such as nutritional status, age of the mother, areas of residence..., which are proxies of availability of health care also nutrients affect the health of the child in the uterus. Based on these, the birth weight production function may take the structural form:

$$B = w + \varphi_1\chi_1 + \varphi_2\chi_2 + \varphi_3\chi_3 + \varphi_4\chi_4 \qquad 1$$

Where B is birth weight and the outcome variable, predicted by multiple explanatory variables; w indicates the value of B when all values of the explanatory variables are zero. The χ of 1 to 4 simply refers to continuous explanatory variable (such as the mother (education, age), father (education, age), child (sex, twin birth) and household (social status, place of residence) characteristics) and may be represented using a line of best-fit, where the B is predicted, at least to some extent, by χ. Each φ parameter indicates the average change in B that is associated with a unit change in χ, whilst controlling for the other explanatory variables in the model. Equation 1 is the structural equation of interest that is the birth weight production technology whose parameters are to be estimated. The Ordinary Least Square (OLS) model based on equations *1* will be estimated for the determinants of birth weight using the econometric software STATA 11.0. Holding to the ideas of O'Donnell et al (2008), it is also relevant to establish if the factors that affect child growth have a different impact depending on whether the mother received incomplete immunization while pregnant. The OLS regression is particularly powerful as it relatively easy to check the model assumption such as linearity, constant variance and the effect of outliers using simple graphical methods (Hutcheson and Sofroniou, 1999).

In addition to the model parameters and confidence intervals for φ, it is useful to also have an indication of how well the model fits our DHS data. Following Hutcheson (2011), our Model-fit can be accessed through comparing deviance measures of nested models. For example, the effect of variable χ_4 on B in the model above can be calculated by comparing the nested models thus,

$$B = w + \varphi_1\chi_1 + \varphi_2\chi_2 + \varphi_3\chi_3 + \varphi_4\chi_4$$
$$B = w + \varphi_1\chi_1 + \varphi_1\chi_2 + \varphi_3\chi_3 \qquad 2$$

The change in deviance between these models indicates the effect that χ_4 has on the prediction of B when the effects of χ_1, χ_2 and χ_3 have been accounted for (it is, therefore, the unique effect that χ_4 has on B after taking into account χ_1, χ_2 and χ_3). The overall effect of all the four explanatory variables on B can be assessed by comparing the models;

$$B = w + \varphi_1\chi_1 + \varphi_2\chi_2 + \varphi_3\chi_3 + \varphi_4\chi_4$$
$$B = w \qquad 3$$

From this determination of our model fit, the significance of the change in the deviance scores can be accessed through the calculation of the F-statistic and this is made possible through the STATA 11.0 soft ware. Further from the software we are able to estimate the parameter for w which indicates the predicted consumption when all explanatory variables are equal to zero; the φ parameters which indicate the average change in birth weight that is associated with each unit increase in the explanatory variable (Hutcheson, 2011). While the significance

of the relationship between each explanatory variable and birth weight can be estimated by comparing the deviance statistics for nested models.

Data Presentation

In Cameroon, the Ministry of Economic Affairs, Programming and Regional Development is the executing agency of the DHS and it is the National Institute of Statistics that collects the data. We used the DHS 2011 and 2004 in our study, principally, the 2004/2011 DHS was aimed at a national representative sample of about 11732 children (0 – 59 months) while in 2004 there were 8,125 children (0 - 59 months.

The key variables derived from external data include food prices, housing prices and transportation/communication prices. Using the combined data set of 2004 and 2011 DHS (see the Descriptive Statistic Table 2 below), an important feature of our sample is that birth weight information is missing for 8247 children, comprising 42 percent of the total sample. The remainder 11610 children or 58 percent of the sample had birth weight information. Birth weight is missing mainly for children born at home. In 2004, nearly 42 percent of the Cameroonian children were born at home while in 2011 it was 60 percent. The report of a birth weight in the household sample is assumed to be strongly associated with a mother's contact with a clinic or with the health personnel during or after birth. So we assume that any child who was born at the clinic and had a missing birth weight had also a missing growth monitoring card at the time of the survey. The specific variables to be used in this study include: outcome variable (Birth weight of children in kilograms); potentially endogenous determinants of birth weight (tetanus vaccination and age of mother at first birth); exogenous demographics (residence, mother's education in single years, father's education in complete years, sex of the child, mother's age, father's age, sex of household head i.e. male or female head…).

4. Empirical Results

4.1 Weighted Sample Descriptive Statistics

Considering the mean birth weight for all children with birth weight in the year 2004/2011, we observed that it's 3.6 Kg, with a low-birth-weight incidence of 0.6 kg (600g) following the minimum and maximum values of the descriptive statistics. The same data set reveals only slight differences in incidences of low-birth weights based on reported and measured weights. In response to birth weight questions, mothers said 15 percent of their newborns were smaller than an average child (perceived to be less than 3.6 kg but greater than 2.5kg) while the highest birth weight registered in the clinics is about 6.6 kg.

The birth weight of many children is missing and on the whole there are about 58.46 percent with 58.41 and 58.52 percent respectively for the female and male children is use in our analysis. This missing birth weight may either be because of missing record card at the time of data collection or home delivery. From the statistical table above, about 5724 of children never had birth weight recorded. This means that the will be a kind of potential bias as we are going to face a selection problem. Not-with-standing, since we intend to use a weighted ordinary least square, it's obvious that our result is going to suffer from this bias which cannot be handled by the WOLS rather by instrumental variable approach in terms of measurement and the Heckman model in terms of selectivity. Generally, the principal disadvantages of this birth weight missing value is that: it reduces statistical power, it doesn't use all information, estimates will be biased, room for error when specifying model, reduces variability, weakens covariance and correlation estimates in the data (because ignores relationship between variables) and finally results in biased estimates.

The 2004 DHS shows that most mothers had their first child at age 18; this age remained relatively constant throughout the 2004/2011. However, the youngest mother had her first child at 12 years old while the oldest had her first child at the age of 40. As noted in literature the age of the woman at first birth has much implications on the antenatal services demanded before/after delivery. Considering the community effect, as seen in Table 2 below, over 63.6 percent of pregnant women received at least twice vaccination against tetanus during their last pregnancy in the case of Birth Weight children and 63 percent in the case of children without birth weight. This result from Cameroon DHS is lower as compared to rates obtained by previous studies in most of the developing countries, for instance, Gupta and Keyl (1998) reported tetanus vaccination rates of higher orders of magnitude for Malawi, Tanzania, Zambia and Zimbabwe over the period 1986-1994 while Mwabu (2009) in Kenya realized that about 73 percent of the Kenya pregnant women obtained tetanus vaccination for their previous pregnancy.

Concerning other exogenous demographics, about 49.3 percent of the new born were male children for birth weight and 83.5 percent for children without birth weight this is equal to the percentage of female children in terms of birth weight proportions, while about 64.3/85.3 percent of men in the sample population in 2004/2011 where family head. About 40.1/38.2 percent of the households in the statistical table live in urban centers with an average mean age of 39 and 28 years for the male and female parents respectively, having at-least 4 years of education. Taking in to consideration that education of the mother is expected to increase both the intake of antenatal care and independently affect the birth weight of the new born, while age effects are difficult to predict a priori. Still within the statistical variables we observed that about 4.3/4.2 percent of birth was first twin birth. The time dummy variable reveals that the coefficient of change between 2004 and 2011 is positive (58.8 percent for children with birth weight and 44 percent without birth weight).

Table 2: Weighted Sample Statistics of Birth Weight (BW) and No Birth Weight Children

Variable	BW Children		No BW Children	
	Mean	**SD**	**Mean**	**SD**
Birth weight_mpu in grammes	3404.727	769.724	3415.007	368.194
Immunization status_mpu (= 1 if mother atleast immunized, 0 otherwise)	0.636	0.097	0.630	0.091
Mother's age at first birth_mpu	18.368	1.572	18.216	1.467
Mother's education in years of schooling_mpu	4.528	3.211	4.105	3.031
Mother's Education Squared_mpu	36.112	3.842	31.078	29.989
Mother's Age_mpu	27.913	2.096	27.850	2.100
Mother's Age Squared_mpu	826.236	124.786	823.544	125.228
Father's education in years of schooling (_mpu)	38.712	4.057	4.817	2.908
Father's Education Squared_mpu	5.123	3.027	45.118	36.131
Father's Age_mpu	49.444	39.011	38.824	4.129
Father's Age Square_mpu	1613.557	403.037	1628.657	419.781
Mother's education * Father's education (_mpu)	36.047	24.916	33.767	23.631
First Twin Birth_mpu	0.043	0.067	0.042	0.066
Male Child Gender_mpu	0.493	0.115	0.853	0.150
Socioeconomic ndex_mpu	2.737	1.232	2.469	1.137
Male HH head_mpu	0.643	0.067	0.853	0.150
2011 dummy	0.588	0.492	0.440	0.496
HH place of Residence				
Rural HH residence_mpu	0.602	0.388	0.617	0.377
Urban HH residence_mpu	0.401	0.490	0.382	0.486
HH Socioeconomic Status				
Poor HH_mpu	0.472	0.412	0.504	0.402
Middle HH_mpu	0.210	0.225	0.218	0.227
Rich HH_mpu	0.317	0.465	0.276	0.447
Sample size	11610		5724	

Source: Computed by the author from the pooled data of 2004/2011 Cameroon DHS.

The rural residence reveals that 60.2/61.7 percent of households live in rural community in 2004/2011 as oppose to 40.1/38.2 percent in urban centers. This may be due to the fact that many more households in Cameroon lives in the rural communities, in fact, the 2011 government of Cameroon statistics reveals that the rural population in 2011 is far greater than that of other years due to mass campaign of the problems associated with rural exodus. The summary statistics table also shows that about 73.7/46.9 percent of households has a higher socioeconomic index. Mean while 47.2/50.4 percent of household are poor, 21/21.8 are averagely rich while 31.7/27.6 are rich households.

4.2 Determinants of mother's tetanus immunization status

Table 4 presents the results of a linear probability model of mother demand for tetanus vaccination. There is a strong correlation of mother's age at first birth, Mother's education in complete years of schooling, father's age, first twin birth and non-poor households, interaction of mother's and father's education and urban residence with demand for tetanus vaccination. The positive coefficient on these variables depends on the extent of the relationship with tetanus vaccinations in terms of maternal demand for health services.

Generally, in Cameroon the first child of a mother irrespective of her age at first birth and mother's pregnant with first twin is always look upon as a mystery. First pregnancy has been noted to be troublesome, some of the women in course of coping to adopt the child in their womb ends up vomiting, others suffer from all sort of illnesses. As revealed in the medical literature all this malice are normal because the mother's system must be culture to accept the new foetus introduce in her system while the baby in the womb tries to create its own conducive environment in the mother's womb. The harassment in the woman system can really be very traumatizing and so urging the mother to take every precaution possible to protect her unborn child by participating in tetanus vaccination programs. The experience is also very common to mothers with first twin babies and theirs is even more serious as culturally twins are belief to be super normal children with extra ordinary power.

Table 3: Reduced-form parameter estimates for tetanus immunization (= 1 if immunized, 0 otherwise)

Variables	Coefficient	Standard Error	Robust T-Statistics
Mother's age at first birth_mpu	0.0078***	0.0007	10.50
Mother's education in years of schooling_mpu	0.0076***	0.0013	5.90
Mother's Education Squared_mpu	0.0001	0.0001	1.67
Mother's Age_mpu	-0.0717***	0.0027	-26.51
Mother's Age Squared_mpu	0.0012***	0.0000	27.04
Father's education in years of schooling (_mpu)	-0.0061***	0.0013	-4.59
Father's Education Squared_mpu	0.0002***	0.0000	2.67
Father's Age_mpu	0.0038***	0.0008	4.32
Father's Age Square_mpu	-0.0000***	8.21e-06	-5.32
Mother's education * Father's education (_mpu)	0.0001***	0.0001	3.04
First Twin Birth_mpu	0.3501***	0. 0111	31.64
Male Child Gender_mpu	-0.0190***	0.0061	-3.10
Socioeconomic ndex_mpu	0.0215***	0.0015	13.85
Male HH head_mpu	-0.1054***	0.0051	-20.67
Urban HH residence_mpu	0.0123***	0.0027	2.65
Constant	1.4564***	0.0401	36.31
R^2/Pseudo-R^2	0.4334	n/a	n/a
F-Stat [df; p-val]	597.37 [15, 11716); 0.0000]	n/a	n/a
Observations	11732		

Source: author. Notes: ***, ** and * indicate 1%, 5% and 10% levels of significance respectively.

Mother's education plays a major role in vaccination intake. The more knowledge one has the more health conscious one become. Information is power, so well informed mother's through the media, health training programs, circular education and newspaper can act as a catalyst to attend or take vaccination. On the other hand, mother's age is negatively correlating with tetanus vaccination. It's said that age is experience, what an age person can sit and see most often the young cannot see, however, this depends on the context, notwithstanding the older mothers know the dangers of delivery, hence they will always encourage pregnant mothers to take all

measures to ensure the safety of their children. However, the younger mothers full of excitement and anxiety may even abort the child especially in the case of unmarried mothers.

Another strong determinant of maternal immunization is wealth status. Non-poor parents are more conscious of their health conditions, this may be explained by the accessibility to money that enables them to visit any medical center or command any medical service they desire. This factor explains why urban residence is negatively correlating with vaccination intake because it's not all sufficient to live in a city but one should have the available means to access the hospital. Most often hospitals in cities are more expensive as compared to those in the suburbs. Tetanus vaccination is also negatively correlating with father's education in complete years of schooling, male household head and male child; this may be due to the above mention reasons. We also observed that many mothers in urban households took vaccination in 2004/2001 during their last pregnancy. This probably might have been due to the massive participation of pregnant women in vaccination and other health programs as the government of Cameroon following the Action Plan as define by Ministry of Health in collaboration with WHO to promote vaccination campaign in Cameroon.

4.3 Estimates of Child Health Production Function

The WOLS estimates are based on the assumptions that: the unobservable variables are linearly correlated with the outcome variable and the estimation sample is randomly selected among children of age 0 to 59 months. The results of WOLS approach is presented in Table 5.

Considering WOLS estimates, we observed that the tetanus vaccination is positively associated with birth weight. As seen in the literature, Gupta and Keyl (1998) observed that tetanus vaccination is assumed to be complementary to prenatal care in the production of birth weight. Thus, the estimate of mother's immunization of table 5 clearly confirms this relationship. The results as seen in ordinary least square approach simply indicate that babies born to immunized mothers were heavier than babies of mothers who had not received tetanus vaccination. However, the estimated gain in birth weight in this case cannot be attributed to tetanus immunization alone since the complementarity hypothesis states that the gain comes from mothers' actions in areas of prenatal and general healthcare induced by vaccination during pregnancy. The estimated coefficients on mother's age at first birth is negative and significant, implying that mother's age at first birth does not correlate with birth weight, this result shows that delaying the age at which the first birth occurs is associated with a decrease in birth weight. This result is consistent with the observation of Tambi (2014) that mother's age at first birth is negatively correlating with birth weight, further; evidences by age group suggest that rates of adverse perinatal outcome such as low birth weight and stillbirth are linked to maternal age 35–39 years old.

Table 4: Parameter Estimate of Child Health Outcomes

Variable	Method Used: Weighted OLS		
	Coefficient	**Standard Error**	**Robust T-Statistics**
Immunization status_mpu	385.3338***	44.3725	8.68
Mother's age at first birth_mpu	-39.7874 ***	3.6663	-10.85
Mother's education in years of schooling_mpu	52.6652***	6.2380	8.44
Mother's Education Squared_mpu	-4.2669 ***	0.4868	-8.76
Mother's Age_mpu	75.9429***	13.6018	5.58
Mother's Age Squared_mpu	-1.1092***	0.2241	-4.95
Father's education in years of schooling (_mpu)	36.2327***	6.6691	5.43
Father's Education Squared_mpu	2.0962***	0.4568	4.59
Father's Age_mpu	26.9651***	4.3096	6.26
Father's Age Square_mpu	-0.442***	0.0393	-11.22
Mother's education * Father's education _mpu	0.637***	0.2415	2.62
First Twin Birth_mpu	108.381***	54.9856	1.97

Male Child Gender_mpu	213.693***	29.6687	7.20
Socioeconomic ndex_mpu	43.445***	7.5409	5.76
Male HH head_mpu	281.723***	24.8153	11.35
Urban HH residence_mpu	26.545**	12.9495	2.05
Constant	4585.391***	204.9231	22.38
R -Squared	0.1208	n/a	n/a
F-Stat [df; p-val]	95.49 [16, 11123; 0.0000]	n/a	n/a
Uncensored Observations	11140		

Source: author. Notes: ***, ** and * indicate 1%, 5% and 10% levels of significance, respectively.

Other variables positively correlating with birth weight include: mothers education in years of schooling, mothers age, father's age, first twin birth, male child birth, non-poor, interaction of mother and father's education and urban household residence. These variables positively correlate with birth weight of the baby, especially the education and age of parent creates serious awareness on the value of life and the need of prenatal care during pregnancy. This finding is consistent with a joint report by the United Nations Children's Fund (UNICEF) and WHO which states: "for the same gestation age, girls weigh less than boys, first born infants are lighter than subsequent infants, and twins weigh less than singletons" (UNICEF/WHO, 2004). The report further states that a baby's low birth weight is a result of preterm birth (before 37 weeks of gestation) or of restricted fetal (intrauterine) growth, the mother's own fetal growth and her diet from birth to pregnancy.

The effect of complementarity hypothesis is clearly observed here in the sense that male child, father's age and mother's age that were negatively correlating with tetanus immunization are now correlating with birth weight proving that there are other prenatal factors complementing to increase the birth weight of the child rather than tetanus immunization. Estimates shows that the presence of male headed household does not influence the birth weight of the child ceteris paribus, there is a possibility that the father takes care of some of the household chores as well as family affairs and so allowing the mother to pursue the antenatal care services that directly correlate with birth weight. However, following our results, this will depends on the educational level of the father in the house. This also explains why father's education strongly correlates with birth weights. We also observed that birth weight of babies in urban areas is high than otherwise and that male infants are heavier than female infants.

4.4 Child health outcome by Residence and Household Income

Correlates of rural and urban households

The tetanus immunization status for rural and urban households positively correlates with birth weight at one percent level of significance. In terms of magnitude, the result shows that urban residence had a higher number of children vaccinated in the 2004/2011 DHS year as compare to rural household residence that also correlate with birth weight. This result reflects the problem of opportunity cost, substitution effect and standard of living. Generally, in rural community social infrastructures such as hospitals, communication and road network are inadequate and poorly constructed, hence making it difficult for pregnant women to attend prenatal care. At times, pregnant rural women may not take their tetanus vaccine due to the long distance to the medical centre or a complete lack of well equipped hospitals in the rural milieu, none the less they use other alternatives and do extra sacrifice to get the maternal immunization. In another sense, long distances to the medical centre means most mothers will prefer to work in the farms or take the opportunity to do other things that will yield them revenue, than to take the risk of attending vaccination programs, given their low standard of living.

Other women will substitute medical care for traditional practices. On the other hand, due to the awareness of the importance of tetanus immunization gotten from radio, television or news paper as well as the availability of medical centers and qualified personnel in the urban community, most pregnant women will take this opportunity to take the tetanus vaccination and so giving birth to children with better birth weights. Other variables significantly associated to birth weight for urban residence includes; mother's age, father's age, first twin birth, interaction of mother and father's education, birth of male child, wealth index and presence of male household head.

Table 5: Parameter Estimate of child health by Residence and Economic Status of Households

Variable	Weighted Ordinary Least Square				
	HH Geographic Residence		HH Socio-Economic Status		
	Rural	Urban	Poor	Middle	Rich
Immunization status_mpu	123.8767*** (4.74)	423.2937*** (5.33)	211.838*** (6.03)	318.001*** (7.51)	462.872*** (9.87)
Mother's age at first birth_mpu	-61.1122*** (-10.45)	7.2906*** (2.00)	-74.5131*** (-10.23)	-3.431*** (-0.97)	-13.742*** (-3.54)
Mother's education in years of schooling_mpu	164.952*** (15.32)	-30.669 (-4.87)	197.871*** (11.94)	42.786 (6.91)	37.616 (5.72)
Mother's Education Squared_mpu	-15.7467*** (-14.11)	1.4419*** (3.30)	-18.472*** (-9.53)	-5.3602*** (-10.70)	-3.534*** (-7.14)
Mother's Age_mpu	79.53375*** (3.81)	-230.830*** (-16.32)	113.253*** (4.37)	-98.545*** (-7.45)	-142.21*** (-9.61)
Mother's Age Squared_mpu	-1.3753*** (-4.02)	3.4083*** (14.65)	-1.9203*** (-4.51)	1.361*** (6.27)	2.032*** (8.38)
Father's education in years of schooling (_mpu)	-151.509** (-13.30)	73.1987** (10.63)	-175.745*** (-12.07)	35.693*** (5.26)	10.672** (1.53)
Father's Education Squared_mpu	8.547867 (9.04)	-3.222079 (-7.42)	8.7758*** (6.61)	-1.538*** (-3.18)	.691 (1.49)
Father's Age_mpu	21.69529 (3.32)	36.9142*** (7.99)	-34.877*** (-4.20)	22.102** (4.99)	40.304*** (8.86)
Father's Age Square_mpu	-.1037712 (-1.77)	-.287736*** (-6.49)	-.0145 (-0.20)	-.252*** (-5.86)	-0.518* (-12.68)
Mother's education * Father's education (_mpu)	3.1901*** (6.59)	-1.2207 *** (-5.95)	3.305*** (4.95)	-.502*** (-2.12)	0.2311*** (21.53)
First Twin Birth_mpu	448.7775*** (5.13)	311.937*** (5.74)	944.915*** (7.64)	143.923*** (-2.91)	14.254*** (0.26)
Male Child Gender_mpu	363.4824 (6.74)	167.802* (6.43)	553.058*** (8.29)	219.116*** (7.61)	268.859*** (9.04)
Socioeconomic ndex_mpu	-2.9827 (-0.26)	54.244*** (6.09)	(-4.893) (-0.27)	33.350*** (4.74)	71.828*** (9.28)
Male HH head_mpu	294.4596 (7.32)	143.599*** (5.82)	338.409*** (6.30)	206.784*** (8.81)	316.349*** (12.10)
Urban HH residence_mpu	n/a	n/a	101.174*** (2.81)	28.742*** (2.72)	50.095*** (3.93)
Constant	3947.146*** (12.97)	5754.625*** (25.70)	3826.665*** (9.92)	4223.969*** (21.51)	4740.248*** (20.98)
R -Squared	0.1912	0.1834	0.2181	0.1094	0.1288
F-Stat [df; p-val]	101.39 [5, 6433; 0.0000]	70.00 [15, 4675; 0.0000]	81.62 [16, 4683; 0.0000]	61.03 [16, 7952; 0.0000]	83.48 [16, 9030; 0.0000]
Uncensored Observations	6449	4691	6956	7969	9047

Source: Author. Notes: ***, ** and * indicate 1%, 5% and 10% levels of significance, respectively. N/B: Dependent variable is child health; absolute value of robust t-statistics in parentheses beneath estimates.

Correlates of Poor, Middle and Rich households

Mother tetanus immunization is strongly correlated with birth weight among non-poor (middle and rich class) households is significant at one percent and poor households at one percent significance level also. This simply

reveals the fact that both the poor and non-poor households have become conscious of their health especially during pregnancy. Covariates positively associated with birth weights in non-poor households include mother's education, father's education, father's age, first twin birth, male child, mother's age, , urban residence and male household head and wealth index of households.

Tetanus strongly correlates with birth weight in non-poor households because of the easy accessibility to good and well equipped medical center coupled with other prenatal care services. Ceteris paribus, the non-poor are more conscious of their health situation as well as the poor especially when they are educated. The non-poor households equally have the necessary means to hire the services of qualified medical nurses/doctors as well as other prenatal services mean while the poor simply make good use of the opportunity offered to them by the government.

5. Conclusion

This study is entitled "effects of mother's tetanus immunization on child health at birth" the objectives are: to examine the determinants of mother's immunization in Cameroon; (to assess the impact of mother tetanus immunization on child health production; examine how birth weight production function can be estimated by area of residence and household income. The structural model of birth weight for Cameroon has been estimated using the 2004/2011 DHS in STATA 11.0. The data is from the pooled data from 2004 and 2011 DHS respectively.

From the ordinary least estimates, the results show that tetanus vaccination during pregnancy is associated with increase in birth weight. This finding strengthens the tetanus complementarity hypothesis reported in the literature on birth weight production functions. For instance, zinc supplementation of diet during pregnancy has been found to increase birth weight in randomized trials (Castillo-Duran and Weisstaub, 2003).

From economic perspective, policy makers could reduce low birth weight through obligatory and low cost maternal immunisation. This can result to reduced: infant mortality, neonatal care, costs of infant illness as well as increase productivity gain from reduced stunting, productivity gain from increased ability and intergenerational benefits. Hence, investing in child health at birth, given the right conditions, can engender income growth, reduce poverty and initiate the process of accumulation of human capabilities.

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