Demand for reproductive health services in Benin: testing inter-relationships and parents' education association for sustainable recovery.

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ABSTRACT:

In this study, we explore the inter-relationships among the demand for reproductive health services in Benin through the analysis of the complementarity hypothesis and its association with parents' education. To that end, we investigate the link between a mother's demand for immunization against tetanus and her child's birth weight. Using the 2017's Demographics and Health Survey data set, we estimated a control function model as well as a Heckman selectivity model to deal with potential sample selection bias since birth weight for some of the infants is missing, endogeneity of tetanus immunisation to birth weight and heterogeneity of response of birth weight to vaccination. Findings of our study show that the mother's immunization against tetanus during pregnancy is key in the child's birth weight that determine his health status along his adulthood, suggesting that antenatal care services complement other reproductive health services that improve the health of the child in the womb. Moreover, demand for health care services is associated with parents' education specially the mother's education.

Keywords*: Reproductive health, Tetanus immunization, Birth weight, Control Function, Benin*
JEL code*:* I180, C14.

1. Introduction

Improving reproductive health (RH) is key in health policy agenda and sustainable development goals. Much attention is given to RH in developing countries, as indicated by the existence of policies, management strategies and guidelines that are designed and implemented by international agencies and governments to improve RH services uptake and to prevent, manage and report simple and complicated maternal cases (Woldegiorgis et al., 2020; McIntosh & Finkle, 1995; WHO, 2003).

However, sub-Saharan Africa (SSA) with the highest population growth rate in the world remains one of the developing regions with the poorest reproductive health status such as maternal and infant mortality ratio, which are the key impact indicator of health status among all public health statistics and are high (Woldegiorgis et al., 2020, Ajakaiye and Mwabu, 2007). In view of this context, the consumption of reproductive health services appears to be undoubtedly key in improving the level of reproductive health indicators as well as the expansion of the provision of reproductive health services both limited by a combination of economic, social and technological constraints (Ajakaiye and Mwabu, 2007). The key components of reproductive health care include family planning, safe delivery services, prenatal and postnatal care, treatment of placental malaria, nutrient supplements during pregnancy and behaviours that promote foetal growth. Thus, the challenges of improving the extremely poor level of reproductive health indicators need a deeply analysis of both supply and demand for reproductive health services as well as their association with key socio-economic variables like education, to help understand the types of policies that should be implemented to improve access to reproductive health care and thus improve child and maternal health. Many studies have documented that parental education, especially maternal education, has a significant positive impact on child health (Woldegiorgis et al., 2020; Apsara, 2018; Zimmerman and Woolf, 2014).

On the demand side, the utilization of reproductive health care inputs analysis is focus on market and non-market environments constraints but also on RH demand services inter-relationships among component of RH indicators (Woldegiorgis et al., 2020). The market environment includes availability of reproductive health inputs and their prices, and household income. The non-market environment comprises the household residence (a rural or an urban setting), personal characteristics of household members, such as age, education, health status, and the information they possess about the quality of reproductive health care services (Ajakaiye and Mwabu, 2007). The inter-relationships among RH indicators are captured following the approach, sometimes called model generating (Woldegiorgis et al., 2020) through path analysis while the complementary among demand for RH care services related to the complementary hypothesis of the competing risk model (Dow et al., 1999). Under this model, the general complementarity hypothesis postulates that the adoption of a specific behaviour, or the uptake of a specific input that improves health, creates incentives to engage in other health-augmenting behaviours or consumption (Ajakaiye and Mwabu, 2007).

Given that, the analysis of the demand for reproductive health care services is a significant actual area of concern in Africa, the need to focus on some investigations at this end is important, especially on child's health services proxied by birth weight. This is an important policy concern because increasing low birth weight of newborns every year could add to the disease burden on healthcare systems and individual families, depending on the setting (Soans et al., 2021; WHO, 2021; UNICEF/WHO, 2019; Blencowe et al., 2013; Rogers & Velten, 2011). According to the WHO, more than 10% of infants (i.e., ~15 million infants per year) were born preterm and 15%–20% of infants (i.e., >20 million infants per year) were born with

LBW in 2014–2015 (Soans et al., 2021; WHO, 2021; Chawanpaiboon et al., 2019; Blencowe et al., 2019). Moreover, health conditions in utero have enormous impact for later life cycles (WHO, 2021; Mwabu, 2009). There is strong correlation between low birth weight and health as well as behavioural problems in adult life. Indeed, birth weight impacts both child health and have implications for health in adulthood where productivity can be strongly affected. Thus, the analysis of the demand for reproductive health services will make it possible to formulate policies that would increase access to reproductive health services and consequently enhance child health.

In Benin, the proportion of women who have made a prenatal follow-up visit was 87% in 2001, 88% in 2006 before dropping to 83% in 2018 (EDSB, 2001, 2006, 2018). This trend is, however, not homogeneous since it results in disparities according to areas of residence. In 2006, the proportion of women who had made a prenatal follow-up visit was only 85% in rural areas against 93% in urban areas (EDSB, 2006). Compared to the standard recommended by the WHO regarding the number of prenatal visits, more than three women out of five (61%) made, for the most recent birth, at least four prenatal visits considered to be essential against a considerable proportion of 11% which did not make any visit during their pregnancy. In 2018, 90% of women in Cotonou received prenatal care prenatal care, while in rural areas this percentage was only 79% (EDSB, 2018).

For related care, it was given, for nearly nine women out of ten (88%) during their last live birth of the last five years, for 80% by midwives and nurses and 4% for doctors. In particular, the comparison of the data relating to the mother's immunisation against tetanus shows that the proportion of women that have received at least two injections of anti-tetanus vaccine during their last pregnancy moved from 50% in 2001 to 56% in 2006 and 52% in 2018. In other words, the last birth was protected from neonatal tetanus: in the large majority of the cases (56 %), the mother received two anti-tetanus injections or more during the current pregnancy. The proportion of women having undergone a postnatal examination after childbirth is estimated at 68%. Despite these encouraging results, the maternal and infant mortality rate remains very high and alarming. Infant mortality was estimated at 59‰ in 2018 and was more marked in rural areas and in the poorest regions. Children under one year living in rural areas (81‰) run greater risk of dying than those living in urban areas (59‰) and in Cotonou (67‰). The maternal mortality rate is estimated at 397 women for 100,000 live births in 2018.

This study explores, in the case of Benin, the inter-relationships among the demand for reproductive health care services through the analysis of the complementary hypothesis (Dow et al., 1999), exploring the link between a mother's demand for immunization against tetanus and the child's birth weight, in the way that if mothers would be strongly motivated to reduce other risks to child survival (e.g., the risk of a child dying from syndromes associated with a low-birth weight). Immunization against tetanus during pregnancy is used as a proxy for antenatal care services received by a woman and birth weight as a measure of reproductive health. Moreover, RH care services demand association with key social determinants, in particular parents' education is examined. We contribute to the empirical literature in manifolds. First, we complete the existing literature by providing an evidence of reproductive health based on a rich national data set on the households in Benin. Second, most of the previous studies investigated this relationship by using less robust estimation strategies. We therefore used in this paper both the Heckman selection model and the Control Function estimation to find consistent and robust estimates. Findings of our study show that the mother's immunization against tetanus during pregnancy is key in the child's birth weight that determine his health status along his adulthood, suggesting that antenatal care services is complementary to other

reproductive health services that improve the health of the child in the womb. Moreover, RH care services demand is associated with parents' education level especially maternal education.

The rest of the paper is organized as follows. Section 2 discusses the related literature. Section 3 presents the data and estimation strategy. This is followed by the empirical findings with robustness analysis in section 4 and 5. Section 6 provides some discussions whereas the final section briefly concludes the paper.

2. Related literature

There is an emerging literature on inter-relationship among demand for reproductive health care services. However, the literature that specifically emphasizes on the immunization against tetanus during pregnancy in the context of reproductive health care is scanty but is attracting great interest (Stjernholm et al., 2021; Blencowe et al., 2019; Choudhary et al., 2019; Thysen et al.,2019; Gandhi and Dande, 2018; Upadhyay et al., 2017; Mahmoud et al,2017). Neonatal tetanus is an important cause of the death of new-borns in most developing countries. There is therefore no doubt that, among other things, the analysis of the demand for reproductive health services on this side, especially those relating to the mother's health, and subsequently on the child's health seems a significant concern today.

According to Behrman et al. (2004), the paramount objective regarding the health policy in most developing countries is to increase children's birth weight in the zones where it appears low. The reason is that most children who have a low birth weight and who survive during childhood are, for example, likely to have reduced cognitive and neurological abilities, which limits the return to investments in human capital in them, their productivity, and their incomes in adulthood (Thysen et al., 2019; Mahmoud et al., 2017). For women, this predisposition increases the probability that they give birth to babies with low weight. Children born with a poor health condition (for example, low weight) have a higher probability of having chronic health problems during their life (Berendsen et al, 2020).

For Lopez et al. (2005), low birth weight is regarded as an important determinant of child mortality and morbidity and as an indicator of socio-economic development. It is associated with socio-economic characteristics and access to prenatal care including immunization of the mother.

As empirically observed immunization of the mother against tetanus during pregnancy is strongly associated with improvements in birth weight. There is a strong indirect link between a mother's immunization against tetanus and the child's birth weight. The anti-tetanus vaccine injection given to the mother during pregnancy makes it possible not only to protect her, but also to encourage the mother to protect the child against this and other diseases through complementary measures. Thereby, the health effect of tetanus vaccination, indirect as it may appear, makes it possible to posit the hypothesis that tetanus is complementary to inputs that determine birth weight (e.g., nutrition, counselling, and treatment against malaria (Dow et al., 1999)). According to these authors, the complementarity hypothesis predicts that a woman will increase the consumption of goods and services that enhance her child's health, when she is certain that an intervention, such as the expanded program on immunisation (EPI) of the World Health Organization (WHO), will be perpetuated in order to increase children's chances of survival.

Otherwise, the idea of complementarity of health inputs translates to the fact that when an unfavourable factor determining health is eliminated, other adverse factors of comparable

nature are also eliminated. For example, a reduction of the risk of child mortality through immunization against childhood diseases can encourage behaviour that reduces the risk of infant mortality due to low birth weight. That is, when one health risk is removed by public policy, mothers and households have the incentives to adopt behaviours that contribute to better development of the foetus, and which consequently reduce the risk of the baby dying of disease complications related to low birth weight. The adoption of a specific behaviour or the use of a specific means that improves health encourages the adoption of other behaviours or habits that favourably determine the child's health at birth. However, as stressed by Akakaiye and Mwabu (2007), the mother's immunization against tetanus could also lead to a moral hazard, a form of negative social externality – in the sense that when reassured that tetanus immunisation is protective, mothers may choose to deliver at home even though risks of tetanus infection are higher there than at hospitals.

Overall, many factors including the availability of routine prenatal care, the age of the mother, her education level as well as economics conditions drive the birth weight (Soans et al., 2021; Stjernholm et al., 2021; Woldegiorgis et al. 2020; Blencowe et al., 2019; Mahmoud et al, 2017; Awiti, 2012; Mwabu, 2009; Raatikainen et al., 2007; Negi et al., 2006; Joshi et al., 2005; Dickute et al., 2004).). In fact, the availability of routine prenatal care, plays a part in reducing maternal death rates and miscarriages as well as birth defects, low birth weight and other preventable infant problems. Indeed, Joshi et al. (2005) in line with Soans et al. (2021) found that in India the proportion of low birth weight was much pronounced in the range of mothers who did not receive any antenatal care, followed by those who received inadequate care. Similarly, Negi et al (2006) as well as Barros et al (1996) found that mothers who received adequate prenatal care had a significantly reduced risk of delivering a low-birth-weight infant. However, Mathule et al. (2002) found that mothers with low income had higher risk of delivery of low-birth-weight baby. Similarly, Joshi et al. (2005) found that per capita income or wealth index of the family found to be significantly associated with birth weight of the baby. About the education association, as argued by Cutler and Lleras-Muney (2006) educated parents may be more efficient in producing a child's health outcome from a given set of inputs than uneducated parents for three mains reasons. First, though they may use the same resources and time, they would use them more efficiently compared to less educated parents, for example, seeking medical services at the appropriate time, adopting preventive care and better hygiene, choosing a healthy diet, ensuring timely immunization, resorting to birth-spacing, and using pre/post-natal and neo-natal care services that promote a child's health. Second, education generally enables people to obtain better paying jobs that may come with better health insurance coverage for the family. Third, educated people may have more social networking and better communication skills, a sense of personal control and healthy behaviours, and a low discount rate for the future that enables them to invest in family health).

3. Methodology and data

3.1 Estimation strategy

There is a well-established literature on the determinants of birth weight (Rosenzweig and Schultz, 1983). We analyse here a mother's demand for tetanus immunization using a model in which child is embedded in the utility function (Rosenzweig and Schultz 1983; Ajakaiye and Mwabu, 2007).

The mother's one period utility function is written as:

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

Where X denotes goods neutral to health, i.e., items that influence the mother's utility but which exert no direct effect on her health status, eg., shoes; Y denotes goods that have an influence on the mother's health status or utility and also affect the child's birth weight, e.g., smoking by the mother; P is a child's health status, measured using a birth weight metric. The production function for birth weight can be specified as:

$$P=F(Y, Z, \mu) \quad (2)$$

Where, Z is used to capture products obtained from the market, such as pharmaceuticals, that directly affect a child's health status; and μ, represents random determinants of a child's health status.

As structured by Ajakaiye and Mwabu (2007), the reduced-form production function for birth weight is given by: $P = F(Y, Z, P_X, P_Y, P_Z, R, \mu)$. (3)

Where, R, is the exogenous income; P_Y P_X , P_Z , respectively denote the prices of goods neutral to health (X), consumer goods that have an impact on health status (Y), health investment goods such as immunisation against tetanus or childhood diseases (Z). The utility maximization behaviour of the mother given the reproductive health production function is subject to a budget constraint where health investment goods are purchased only to improve the child's health, so it enters the mother's utility function only through the health status of the child in utero.

To explore the link between the demand for tetanus immunization by the mother and the child's health, we estimate equation (2) which is the appropriate framework for measuring the effect of tetanus vaccination on birth weight. In estimating the effect of tetanus immunization on birth weight, two problems arise: (i) the selection bias due to the fact that birth weight for some of the infants is missing; (ii) endogeneity of tetanus immunisation to birth weight, because it is a choice variable and could result from the fact that women who are immunized have health endowments that predispose them to having healthier children (Grossman and Joyce, 1990). Thus, instruments for tetanus vaccination are needed in order to consistently estimate the effect of vaccination on birth weight.

The estimated model has the following structure (Ajakaiye and Mwabu, 2007).

$P = w_I\delta_p + \beta I + \varepsilon_1$: Birth weight production function (4)

$I = w\delta_t + \varepsilon_2$: Mother's tetanus immunisation status (5)

$S = 1(w\delta_s + \varepsilon_3 > 0)$: Selection of a child into the estimation sample (6)

where P, I and, S respectively, denote the child's birth weight, immunization status, and the selection of observations into the estimation sample. Given that children whose birth weight is missing are excluded from the sample, equation (4) makes it possible to control for sample selection bias when estimating the parameter vector, (δ, β) . The w_I and w are, respectively, two vectors of exogenous variables in the outcome equation (4) and the selection equation (6). Vector w is a grouping of the variables w_1 and the identification variables that affect the mother's immunisation against tetanus status (I), but have no direct influence on the child's birth weight.

Moreover, the heterogeneity of birth weight due to non-linear interaction of tetanus vaccination with unobservables and omitted variables is also a source of bias for the estimated structural coefficients. To accommodate any non-linear interactions of unobservable variables with the birth weight regressors, and to account for sample selection bias, equation (6) is rewritten as:

$$P = \alpha_0 + w_1 \bullet \delta + \beta \bullet I + \alpha_1 \bullet V + \gamma \bullet (V \bullet I) + \lambda \bullet Mills + \theta \bullet (I \bullet Q) + \mu \quad (7)$$

Where, V denotes the predicted residual for I, derived from a probit model. V serves as a control variable for the unobservable variables which are correlated with I.

$(V \bullet I)$ represents the interaction between the predicted residual and the mother's immunisation status and controls for the effects of any neglected non-linear interaction of an unobservable variable with the immunization status of the mother. According to Card (2001), the inclusion of this term purges the estimated coefficients of the effects of the unobservable variables. The interaction of V with I captures the idea that the size of a specific unobservable varies non-linearly with I. Thus, its unobserved and neglected effect (V×I) changes in a non-linear way as I changes (Ajakaiye and Mwabu, 2007).

Q is the exogenous supply of the factors determining health status. Mills is the inverse of Mills ratio. The Mills ratio holds constant the effects of the non-random sample on structural parameters and μ represents a composite term of error made up of and the predicted part of ε_2, under the hypothesis that E (ε_1) =0.

The terms $V,(V \bullet I)$ and Mills's ratio in equation (7) are the control function variables because they control for the effects of the unobservable factors that would affect the estimated of structural parameters.

Empirically, the Heckman procedure is used to deal with the sample selection bias (Wooldridge, 2002). The endogeneity of tetanus immunisation to birth as well the heterogeneity of birth weight due to non-linear interaction of tetanus vaccination with unobservable and omitted variables are addressed by the control function approach (Garen, 1984; Wooldridge, 1997; Card, 2001) through $V,(V \bullet I)$. The control function approach is an econometric method used to correct for biases that arise because of selection and/or endogeneity (Wooldridge 1997, 2003).

3.2 Data and variables

We used the 2017's Demographic and Health Surveys (DHS) whose objective is to collect, analyse and disseminate demographic and health data relating to fertility, family planning, health and nutrition of the mother and the child. Nearly 15928 women were interviewed. All women aged between 15 and 49 years in the sampled households were interviewed. In assessing mother's immunization against tetanus, we adopted the definition of the Macro International which considers anti-tetanus cover to be complete if the mother received two injections during the pregnancy or, at least, two injections (the last having been carried out during the three years preceding a birth); or, at least, three injections (the last having been carried out during the five years preceding a birth); or, at least, four injections (the last having been carried out during the ten years preceding a birth); or, at least, five injections before a birth.

As empirically observed, the main determinants of birth weight in this paper include the sex of the child, the residence, the mother's age and vaccination status against neonatal tetanus. In addition to these variables, the determinants of demand for tetanus immunization include the wealth, the number of years of education of the mother, the number of years of education of the head of the household and the amount of time spend to fetch water. As was mentioned above, the determinants of demand for births at health facilities are the same as those of demand for tetanus immunization. The number of years of instruction received by the mother is used as educational variable in this study. Therefore, the coefficients indicate the effect of an additional year of education on the demand for vaccination of children for each educational level.

4. Empirical findings

Table A1 in appendices presents the descriptive statistics of the variables used in the study. The child's birth weight is known only for 90.19 % of births. The average birth weight is 3054 g with a high variability around the means of 593.4 and a minimum weight of 500 g and a maximum weight of 6000 (Table 1). In terms of residence area, those who live in urban area appear to have higher birth weight than their counterpart from rural area. This is consistence with some findings including those of Munthali (2007) and Elo (1992) who observed that percentage of children who were fully vaccinated in urban areas was higher than in rural areas.

Regarding immunization against tetanus, the DHS data show that 70.68% of women were fully vaccinated against tetanus during their last pregnancy that is have at least 2 injections or more during their last pregnancy (Table A1). The average age of women is 28.63 years, and the average year of education is 3.12. Husband is slightly more educated than his spouse with 3.60 years of education on average. Moreover, only 44.2 % of household live in urban against 55.8 % for rural inhabitants. As far as the wealth class is concerned, about 36.61% of households are poor, 18.74 are in the middle class and 44.64 are rich.

Table 1 displays the mean comparison test. Mean comparison test shows that there is significant difference in the child's birth weight with and without immunization among households in general and urban households. Since these differences could also be caused by other factors, a multivariate analysis is carried out further to understand the impact of immunization on child's birth weight in Benin. As mentioned above, the main determinants of birth weight in this paper include the age and education of the mother, the education of the head of the household, the sex of the child, and the mother's vaccination against neonatal tetanus. Other factors such as residence and wealth also affect the health of the child in the womb according to the different estimators.

Table 1: Mean differences of birth weight in respect to immunization

	Full sample	Immunization status		t-test
Birth weigh		Immunized	Non-immunized	
Full sample	227.8544	235.110	193.154	-1.7616**
	(1080.38)	(17.645)	(15.743)	
Urban	260.4947	284.130	199.999	-1.9823 **
	(1212.439)	(30.812)	(26.840)	
Rural	206.0082	196.6024	189.241	-0.2632
	(981.604)	(20.140)	(19.415)	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2 shows how tetanus immunization affects birth weight. This table summarizes the results of different estimates including OLS (Column 1), Heckman selection model (Column 2 and 3) and Control Function (Column 4 and 5). Each of these estimators indicates a positive and significant effect of the mother's immunization against tetanus on the child's weight. However, the magnitude of the coefficients varies according to the estimators. For the ordinary least squares, the effect was 2.4%, and for the Heckman model it was 2.3%, indicating that the parameters change very little with the removal of the selection bias. In this regard, Heckman's selectivity method reveals that there may not be a selectivity bias regarding birth weight effect of a mother's immunization status. Indeed, the results in table 2 show that the coefficient of the inverse of the Mills ratio is insignificant, suggesting that birth weight is not associated with the demand for clinic birth. Accounting for the endogeneity of vaccination, and the heterogeneity of response of birth weight to vaccination with linear and nonlinear interaction, the effects become 6.1% and 9.2%, more that than twice and triple respectively. The coefficient of the fitted residual in table 2 (column 4) is statistically significant indicating that the vaccination

status is endogenous to birth weight. In addition, the coefficient of the control function variable (V*I) is also statistically significant, revealing the heterogeneity of the response of birth weight to vaccination due to non-linear interaction of vaccination with unobserved determinants of birth weight. These results show that the control function is the appropriate estimation strategy because it considers both the endogeneity of vaccination, and the heterogeneity of response of birth weight to vaccination. Also, the CF estimates reveal that immunization substantially increases birth weight. Moreover, the results in table 2 show that males are heavier at birth than females for all specifications.

Table 2: Mother's immunization status and child's birth weight

Variable	Estimation strategy				
	OLS	Heckman		Control Function Approach	
Sample Selection Variable (= 1 if birth weight is not missing)	Birth weight	Sample Selection Variable (1=if birth weight >0)	Birth weight equation	Linear Interaction of vaccination with unobservables	Non-linear interaction of tetanus protection with unobservables
Mother's tetanus protection (1=Protected)	0.024**		0.024***	0.061***	0.092***
	(0.010)		(0.009)	(0.016)	(0.033)
Mother's age	0.012***	0.125***	-0.001	0.603	0.592
	(0.004)	(0.018)	(0.004)	(0.393)	(0.394)
Mother's age square	-0.000**	-0.003***	0.000	-0.078	-0.076
	(0.000)	(0.000)	(0.000)	(0.059)	(0.059)
Sex of the Child	-0.043***	-0.018	-0.040***	-0.034***	-0.034***
	(0.007)	(0.036)	(0.008)	(0.008)	(0.008)
Residence	0.013*	0.068*	-0.007	0.010	0.011
	(0.007)	(0.041)	(0.008)	(0.008)	(0.008)
Identification variables (affect sample selection but not birth weight)					
Mother's education (No education)		0.027***			
		(0.006)			
Husband's education (No education)		0.019***			
		(0.005)			
Poverty status (Poorer as base category)					
Middle		0.250***			
		(0.047)			
Richer		0.343***			
		(0.047)			
Time to fetch water		-0.000			
		(0.000)			
Control function Variables (account for birthweight effects of unobservables in the error term)					
Reduced form Tetanus protection residual				-0.037***	-0.102***
				(0.013)	(0.039)
Tetanus protection status x Tetanus protection residual					0.084**
					(0.034)
Inverse of the Mills Ratio			0.824		-0.004
			(0.218)		(0.040)
Constant	7.828***	-1.393***	8.055***	8.012***	7.977***
	(0.057)	(0.294)	(0.070)	(0.017)	(0.050)
R squares	0.030			0.017	0.020
Wald test		20.27 [0.001]			
Sample sizes	3,077	5,187	5,187	2,264	2,264

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Regarding the determinants of demand for reproductive health care services, table 2 in column 2 and table A1 shows factors associated with the demand for births at health facilities and vaccination against tetanus. As mentioned above, births at health facilities are put forward because in the data set, reporting of birth weight by mothers is strongly associated with clinic birth. In both cases, the results show that factors are similar and include the age of the mother, her number of years of education, the number of years of education of the husband, the area of residence and the wealth class. They reveal that rural mothers are less likely to deliver at the clinics or to get vaccinated against tetanus compared with urban mothers. In addition, they show

that household wealth and education increase the probability of reporting a birth weight as well as getting immunized against tetanus. In this regard, parent's education appears to be a key mechanism in order to improve the demand for births at health facilities and vaccination against tetanus. However, compared with the father's, the mother's education seems furthermore associated with the demand for births at health facilities than getting vaccination against tetanus, suggesting that father's education is important key of mother's demand for vaccination.

Moreover, the demand for births at health facilities and for tetanus vaccination first increases with age of the mother and then falls, suggesting that younger mothers are more likely than older women to deliver in clinic as well as getting immunized against tetanus.

5. Robustness analysis

To check the sensitivity of our results, we ran the same regression on the sample of rural and urban dwellers. Tables A1 displays estimation results for tetanus vaccination demand of the mother location. Tables A2 and A3 present estimation of birth weight production functions by location.

Tables A2 and A3 show all specifications parameter estimates of the birth weight production function by residence area. Across sub-sample, the effects of tetanus vaccination on birth weight are positive, confirming the results found at the national level. However, the estimate is more robust in rural area because it has been confirmed for all specifications. The positive association between weight birth and mother's immunization against tetanus in urban area appears only in Heckman selection model which reveals that there may not be a selectivity bias regarding birth weight effect of a mother's immunization status. In addition, the coefficients of the fitted residual and interaction terms are statistically insignificant for the urban sub-sample, suggesting that endogeneity and heterogeneity are not a problem, what is not the case in rural areas. Thus, the unobservables influence birth weight in rural area in contrast to urban. However, the variability of this effect is even greater between the rural area (0.107) and the urban area (0.030), more than three times as much. Moreover, the results show that male newborns are heavier than females in all specifications in both areas, which is an indication that this estimate is quite robust.

The determinants of demand for births at health are similar at all levels apart from urban side, where the father's education is not significant, revealing that mother's education is more associated with demand for births at health in urban area. About, those related to vaccination against tetanus, they are similar at national and rural level. At urban level, only age of the mother and wealth status, affects positively demand for tetanus vaccination. Compared to rural area, the relationship of demand for tetanus with education is missing. It suggests that in rural area, parent's education favours the adoption of behaviours that contribute positively to the growth of the foetus.

6. Discussion

This study analysed the inter-relationships among the demand for reproductive health care services in Benin and their association with parent's education. To that end, the link between a mother's demand for immunization against tetanus and her child's birth weight based on the complementary hypothesis of the competing risk model (Dow et al., 1999) is investigated. Several methodological approaches were implemented to address biases due to sample selectivity, endogeneity and heterogeneity when investigating the indirect role played by mother's tetanus immunization in the growth of the foetus. The results show that the control function is the appropriate estimation strategy to account for endogeneity of tetanus

immunisation to birth and the heterogeneity of birth weight due to non-linear interaction of tetanus vaccination with unobservable and omitted variables. Indeed, it has increased the robustness and magnitude of tetanus vaccination on birth weight. With the introduction of control variables, the results show that immunization substantially increases birth weight, thus highlighting the strong and robust association between tetanus vaccination and birth weight (Afaya et al., 2021, Tambi and Atemnkeng, 2018, Ajakaiye and Mwabu, 2007). So, the econometric results indicate evidence of a positive association between immunization and birth weight and then its consistency with the complementary hypothesis (Dow et al. (1999)). The results confirm those of several authors, including Kaba et al., (2021), Choudhary et al., (2019); Thysen et al. (2019); Gandhi and Dande, (2018); Tambi and Atemnkeng (2018); Upadhyay et al. (2017); Ajakaiye and Mwabu (2007), Dow et al. (1999). In addition, as mentioned by Ajakaiye and Mwabu (2007), the control function estimates of the birth weight production function suggest that the information that mothers possess about health-improving technologies plays a critical role in motivating them to invest in behaviors and consumption that complement tetanus immunization in increasing birth weight. Consequently, we can assume that the mother's immunization against tetanus improves her child's health through the use of complementary health inputs or adoption of health reinforcing behaviours and then admit that in Benin, pregnant women who received neonatal tetanus vaccination were more likely to engage in behaviors to increase their newborn's weight than women who were not immunized.

They also show the heterogeneity of the trends revealed by the previous studies according to the residence area. Indeed, in the case of Benin, although the results are confirmed both in rural and urban areas, the estimates are more robust and greater in rural area than in urban, due to the consideration of the implicit influence of the unobservable on birth weight which characterizes the rural area. So, with reliable information, the rural women are more prepare to invest in behaviors and consumption that complement tetanus immunization in increasing birth weight. In general, the health awareness, expressed both as knowledge and pro-health behaviors, is lower in the populations of pregnant women living rural areas than in urban areas (Szubert et al., 2020).

About the determinants of demand for reproductive health care services, the findings are consistent with the empirical literature on reproductive health in Africa (Kaba et al., 2021, Soans et al., 2021; Stjernholm et al., 2021, Woldegiorgis et al., 2020, Blencowe et al., 2019, Choudhary et al; 2019; Thysen et al., 2019; Gandhi and Dande, 2018; Tambi and Atemnkeng, 2018; Upadhyay et al., 2017; Mahmoud et al., 2017; Awiti, 2012; Bisai et al., 2006; Leal et al.; 2006; Negi et al., 2006; Joshi et al., 2005; Dickute et al., 2004; Ainsworth et al., 1996). They include the age of the mother, her number of years of education, the number of years of education of her husband, the area of residence and the wealth class. In particular, the parents' education, especially the maternal education remains as key mechanism to improve the demand for reproductive health services care in line with the previous studies (Woldegiorgis et al., 2020; Apsara, 2018; Zimmerman and Woolf, 2014; Glewwe, 1999). In this regard, as suggested by Woldegiorgis et al., 2020, the fact that parent's education, especially mother's education came out as a strong predictor of demand for reproductive health service care, suggests that responsibilities for improving RH outcomes, in particular child heath is not limited to the healthcare system, but extends to the educational sectors as well.

Specifically, our finding reveals that parents' education, especially mother education is positively associated with births at health. Regarding demand for vaccination, our finding suggests that father's education is most associated with immunisation decisions than mother's, suggesting its key of mother's demand for vaccination in line with Apsara (2018). As noted by Chen and Li (2009), the father's education may be important because fathers are often more

educated than mothers in developing countries. They supposed that it may be that fathers play a more active role in certain kinds of health decisions such as immunization decisions or participation decisions particularly if they require travel to a health clinic. Apsara, (2018) reinforces the association between father's health knowledge with immunisation decisions while highlight that mother's health knowledge and her empowerment within the home are the channels through which her education impacts her child's height and weight respectively. However, in urban areas, education is not associated with demand for immunisation. This can be explained by lower educational inequalities in missed opportunities for vaccination in urban area (Sambala et al., 2018).

In line with the previous studies that focus on the linkage between parents' education and child heath in general and specifically on demand for reproductive health services, our finding confirms that parents' education, especially the mother's education is a key determinant. These findings on one side, substantiate the need for integrated RH care services to boost the use of complementary health inputs and on the other side, the need for integrated approaches to RH services and education to improve deeply child health.

7. Concluding remarks

This study explores the inter-relationships among the demand for reproductive health services in Benin through analysis of the complementarity hypothesis (the competing risk model, Dow et al.1999) and its association with parents' education. Using the 2017's Demographics and Health Survey data set, we estimated a control function model as well as a Heckman selectivity model to deal with potential sample selection bias and endogeneity issues. Based on the findings of the control function estimates, the hypothesis that tetanus is complementary to inputs that determine birth weight is confirmed. Otherwise, the mother's immunization against tetanus improves child health using complementary health inputs or adoption of health reinforcing behaviours. In addition, besides the age of the mother, the area of residence and the wealth class, parents' education specially mother's education are key determinant of child health.

These findings suggest a need for appropriate measures to expand and improve medical infrastructure in Benin, especially the facilities for the provision for integrated reproductive health services. In this regard, the option of integrated packages of high-impact interventions and quality care already implemented need to be strengthened. There is also a need for categorical subsidy to make reproductive health services to a large proportion of population (eg. poor and pregnant women). The results also show the need to give priority to child education, especially girls' education as a long-term strategy for improving child health in utero. For women and men at reproductive age, it is important to implement large-scale health education campaigns targeted. As mentioned by Ajakaiye and Mwabu (2007), the unified demand framework used in these studies helps the policy makers evaluate how participation in immunization plus interventions empowers women by improving their health, equipping them with useful skills, and connecting them to productive livelihoods.

All in all, findings of this studies support investment in integrated reproductive health services extend to others interventions such as parent's and child education. In particular, child education specially girls' education can improve the health status of the children of these girls in the future. However, this study is limited in some extent. We have not taken into account the resources that are controlled by various household members. It could be possible through intra-household models' implementation but this is limited by data availability.

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APPENDIX

Table A1: Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Birth weight	5,789	3054	593.4	500	6000
Mother's age	8,216	28.63	9.567	15	49
Mother's year of education	15,928	3.128	4.189	0	17
Husband's year of education	10,604	3.604	4.942	0	17
Time to fetch water	15,928	400.0	471.9	0	998
Time to reach to a public health center	7,197	36.95	41.36	1	996
Tetanos protection	9,030	70.68		0	1
Sex of the infant	11,756	50.56		0	1
Residence	15,928	0.442		0	1
Wealth class	15,928				
Poor		36.61			
Middle		18.74		0	1
Rich		44.64		0	1

Table A2: Demand for Tetanus Vaccination: Dependent Variable Equals One if Mother was Vaccinated During Pregnancy and Equals Zero Otherwise (t-statistics in Parentheses)

VARIABLES	(1)	(2)	(3)
	Full Sample	Urban	Rural
Age of Mother, years	0.060***	0.068*	0.060**
	(0.023)	(0.041)	(0.027)
Age of Mother squares, years	-0.001**	-0.001	-0.001*
	(0.000)	(0.001)	(0.000)
Sex of the Child (1 = Male)	-0.043	0.030	-0.081
	(0.042)	(0.072)	(0.052)
Area of Residence	0.114**	-	-
	(0.048)		
Identification Variables (affect demand for immunizations but not birth weight)			
Mother's Education, years	0.017**	0.014	0.025**
	(0.008)	(0.011)	(0.012)
Husband's education, years	0.019***	0.004	0.029***
	(0.006)	(0.009)	(0.008)
Wealth quintile (0 = Poor)			
Middle	0.309***	0.283**	0.303***
	(0.056)	(0.118)	(0.064)
Rich	0.475***	0.528***	0.430***
	(0.058)	(0.097)	(0.073)
Time spent to fetch water	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Constant	-0.826**	-0.875	-0.810*
	(0.351)	(0.632)	(0.424)
Sample sizes	4,120	1,598	2,522

Table A3: Mother's immunization status and child birth weight rural

Variable	Estimation strategy				
	OLS	Heckman		Control Function Approach	
Sample Selection Variable (= 1 if birth weight is not missing)	Birth weight	Sample Selection Variable (1=if birth weight >0)	Birth weight equation	Linear Interaction of vaccination with unobservables	Non-linear interaction of tetanus protection with unobservables
Mother's tetanus protection (1=Protected)	0.025*		0.021*	0.088***	0.107***
	(0.013)		(0.012)	(0.022)	(0.041)
Mother's age	0.016***	0.105***	0.006	0.503	0.692
	(0.005)	(0.023)	(0.006)	(0.293)	(0.194)
Mother's age square	-0.000**	-0.002***	-0.000	-0.048	-0.066
	(0.000)	(0.000)	(0.000)	(0.049)	(0.049)
Sex of the Child	-0.042***	0.038	-0.042***	-0.034***	-0.034***
	(0.009)	(0.047)	(0.010)	(0.011)	(0.008)
Identification variables (affect sample selection but not birth weight)					
Mother's education (No education)		0.044***			
		(0.010)			
Husband's education (No education)		0.030***			
		(0.007)			
Poverty status (Poorer as base category)					
Middle		0.236***			
		(0.056)			
Richer		0.354***			
		(0.061)			
Time to fetch water		0.000			
		(0.000)			
Control function Variables (account for birthweight effects of unobservables in the error term)					
Reduced form Tetanus protection residual				-0.048***	-0.108**
				(0.019)	(0.054)
Tetanus protection status x Tetanus protection residual					0.083*
					(0.049)
Inverse of the Mills Ratio			0.824		-0.011
			(0.218)		(0.050)
Constant	7.766***	-1.379***	7.951***	7.993***	7.973***
	(0.075)	(0.365)	(0.091)	(0.022)	(0.063)
R squares	0.034			0.021	0.023
Wald test		16.80 [0.0002]			
Sample sizes	1,659	3,099	3,099	1,274	1,274

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A4: Mother's immunization status and child birth weight for Urban

Variable	Estimation strategy				
	OLS	Heckman		Control Function Approach	
Sample Selection Variable (= 1 if birth weight is not missing)	Birth weight	Sample Selection Variable (1=if birth weight >0)	Birth weight equation	Linear Interaction of vaccination with unobservables	Non-linear interaction of tetanus protection with unobservables
Mother's tetanus protection (1=Protected)	0.023		0.030**	0.022	0.014
	(0.015)		(0.015)	(0.024)	(0.048)
Mother's age	0.006	0.153***	-0.011	0.203	0.512
	(0.006)	(0.031)	(0.007)	(0.293)	(0.194)
Mother's age square	-0.000	-0.003***	0.000***	-0.068	-0.046
	(0.000)	(0.000)	(0.000)	(0.049)	(0.029)
Sex of the Child	-0.045***	-0.103*	-0.034***	-0.035***	-0.034***
	(0.010)	(0.058)	(0.012)	(0.012)	(0.008)
Identification variables (affect sample selection but not birth weight)					
Mother's education (No education)		0.020**			
		(0.008)			
Husband's education (No education)		0.009			
		(0.006)			
Poverty status (Poorer as base category)					
Middle		0.293***			
		(0.092)			
Richer		0.332***			
		(0.076)			
Time to fetch water		0.000			
		(0.000)			
Control function Variables (account for birthweight effects of unobservables in the error term)					
Reduced form Tetanus protection residual				-0.024	-0.029
				(0.020)	(0.055)
Tetanus protection status x Tetanus protection residual					0.050
					(0.049)
Inverse of the Mills Ratio			0.824		-0.059
			(0.218)		(0.062)
Constant	7.931***	-1.341***	8.173***	8.055***	8.092***
	(0.089)	(0.507)	(0.111)	(0.025)	(0.078)
R squares	0.023			0.011	0.013
Wald test		8.12 [0.017]			
Sample sizes	1,418	2,088	2,088	990	990

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1