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The Impact of Prenatal Care on Child Malnutrition: Evidence from Guinea-Bissau

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Abstract

We analyse the impact of prenatal care on child malnutrition, using data from a baseline household survey conducted in rural Guinea-Bissau. We employ children's anthropometric measures to estimate malnutrition indicators, and then apply a Logistic Regression approach to determine the impacts of hospital delivery and the number of prenatal appointments on these indicators. Bearing in mind the potential endogeneity issues in our approach, we make use of an Instrumental Variable. Our results show that children who are born in a hospital are less likely to be malnourished years later. These results bear important policy implications for the context of rural Guinea-Bissau, advocating for policies which incentivize deliveries in health facilities.

Keywords: Development Economics, Malnutrition, Childbirth, Prenatal Care, Guinea-Bissau

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1. Introduction

Malnutrition is associated with nearly half of children's deaths around the world[1]. Globally, about 155 million children under 5 years old suffer from stunting, which means they are too short for their age, while 41 million suffer from wasting, which means they are too thin for their height[2]. Through lack of adequate nutrition, children are more exposed to multiple diseases, more likely to die from those diseases, and less likely to be healthy even if they survive, due to growth deficits and hindered cognitive development associated to malnutrition. Anthropometric indicators, particularly the height for age indicator, reflect parents' accumulated investments in nourishment and health care over childhood (see Duflo, 2000).

Tackling malnutrition is directly related with the first three Sustainable Development Goals: No poverty; Zero hunger; Good health and well-being[3]. Prevention is crucial in solving chronic malnutrition. One pathway of preventative health care takes place during pregnancy: prenatal care. The World Health Organization (WHO) stresses the importance of adequate health care during pregnancy and childbirth, as a mechanism to reduce maternal and infant mortality across the world. Throughout childbearing women need a continuum of care, that begins in their own home, and culminates in a positive childbirth experience. Health care provided by skilled attendants during pregnancy, childbirth and the postnatal period is crucial to improve reproductive health[4].

Motivated by the relevance of these issues, and by the context of Guinea-Bissau, our work analyses the impact of prenatal and natal care on child malnutrition. The existing literature on prenatal care focuses mainly on its determinants and on its impacts in terms of mortality and morbidity, usually analysing birthweight as an early life health indicator (see Corman et al., 2018). Medium run impacts of prenatal care have been overlooked. Our work partially closes this gap by looking at prenatal care impact on 5-year-old children's nutritional status. By delivering in a health facility, mothers interact with health professionals that can teach them how to properly breastfeed, and advise them regarding nutrition and neonatal care in general. We explore this information channel by examining the impact of both the place of delivery and the number of prenatal appointments on malnutrition of children under 5 years old.

We use data from a household survey conducted in rural Guinea-Bissau. Our dataset includes individual characteristics of mothers and the households they belong to, as well as anthropometric measures for children under 5 years old, and information from prenatal cards of these children, which contain records of prenatal appointments and childbirth. We use a Logistic Regression approach to study the impact of prenatal care on malnutrition, employing multiple malnutrition indicators. Bearing in mind the potential endogeneity problems of our method, we then employ an Instrumental Variable (IV), using the extent to which mothers believe that traditional healers can protect them or their children from unfortunate events as an instrument.

Our results show that the place of delivery has a significant impact on child malnutrition. Children who are born in hospitals or health centres have a lower probability of being considered malnourished according to the height for age indicator, when compared to children who are born at home. These findings are robust to multiple controls, related to mother's characteristics and ethnicity, household characteristics and to fixed effects at the village level. The relationship remains the same after applying the IV approach. Findings for the number of prenatal appointments are not as robust. Our results have important policy implications as they advocate for the efficacy of preventing malnutrition even before birth.

The paper is organized as follows. Section 2 reviews the existing literature on child health, malnutrition, and prenatal care. Section 3 presents the setting of the study. Section 4 depicts both the data collection and descriptive statistics. Section 5 describes our estimation strategy. Section 6 presents the main results. Section 7 concludes, drawing on potential policy implications of our work, as well as on recommendations for future research.

2. Literature Review

Some authors have looked at health as an important share of human capital. Strauss and Thomas (1998) show that, in the U.S., taller and heavier (given their height) men earn higher wages. Similarly, Schultz (2005) reviews evidence from Ghana, Cote D'Ivoire and Brazil concluding that health affects labour market outcomes, being a determinant of individual wages and labour productivity. These findings suggest that health has a long-lasting influence in diverse outcomes in adulthood.

As such, it is of utmost relevance to understand the factors behind health status. Barker and Clark (1997) review findings on the causes of multiple diseases in adulthood, such as coronary heart disease and stroke, stating that the origin of these conditions often lies on impaired growth and development during fetal life and infancy. Currie and Stabile (2003) focus on the well-studied relationship between socioeconomic status and health, showing that the health of children with low socioeconomic status deteriorates with age, mainly through a higher exposure to health shocks, such as accidents and nutrition-related disorders. Many authors have tried to understand the kind of interventions that might improve children's health status. Hoynes et al. (2016) analyse the impact of access to the Food Stamp Program in the U.S., arguing that this increase in availability of resources for mothers during pregnancy had an impact on their children's outcomes decades later. Duflo (2000) exploits the extension of the Old Age Pension program in South Africa to show that an increase in household resources, particularly if those resources were provided to women, has a positive impact in child's health and nutrition.

A standard indicator of poor child health is malnutrition. Periods of vulnerability, particularly in utero and during the first three years of life, seem to be critical to the emergence of this condition. Besides being associated with a large number of children's deaths across the world, malnutrition imprints a permanent mark, leading to functional disadvantages in adulthood, including diminished cognitive capacities and labour productivity (Martorell, 1999). Das and Rahman (2011) apply an ordinal logistic regression analysis to evaluate the determinants of child malnutrition in Bangladesh, finding that child's age, birth interval, mother's education level, household's wealth, maternal nutrition and incidence of fever, acute respiratory syndrome and diarrhea are all important predictors.

Some evidence suggests that the causes of malnutrition may be established even before the moment of birth. Rosenzweig and Schultz (1983) were the first to study the impact of prenatal care on birth outcomes. The authors estimate a household health production function using birthweight as an early life health indicator, and a set of behavioural variables such as prenatal medical care, working and smoking. They find that there are significant positive impacts of prenatal care on birthweight. Neonatal and early childhood health care have proven to be effective in the long run as well, for example, through their positive impact in cognitive development (Figlio et al., 2014) and in academic achievement (Bharadwaj et al., 2013). Corman et al. (2018) present a literature review regarding the effects of prenatal care on birth outcomes. According to the authors, the existing literature focuses mainly on birthweight as a health outcome, which can be too narrow and disregard other potential positive impacts related to different measures of health status, long-term and spillover effects (see Reichman et al., 2010). Another potential problem in this literature is the fact that prenatal care measures, such as the number or the time of initiation of prenatal appointments, are often self-reported, which can lead to considerable estimation biases (Reichman et al., 2009).

Montagu et al. (2017) examine data from 43 countries in Asia and Africa, analysing the changing landscape of childbirth over the past decade. The authors find that despite the verified increases in facility delivers across the sample, some regions still depict considerably low levels of this indicator, as it is the case for West Africa. Deliveries in health facilities are typically safer since they count with the presence of skilled attendants[5]. Deliveries outside health facilities are more likely to lead to neonatal death. Hence the place of delivery is an important predictor of neonatal mortality (Ajaari et al., 2012).

Looking into the literature regarding the determinants of children's birthplace, one can find several insights. Health services' availability does not seem to be a sufficiently strong guarantee of use, and factors such as the proximity of a traditional delivery assistant and marital age are important predictors of place of birth (Edmonds et al., 2012). Delivery services' quality also seems to be more relevant than distance or cost (Kruk et al., 2009). Women's perception of the poor-quality services in delivery facilities might partially explain why most women prefer to deliver at home, accompanied by a traditional birth attendant in whom they trust. Besides individual and household characteristics, community level factors also appear to be extremely relevant in explaining delivery place decision (Stephenson et al., 2006).

Building on the existing literature, our work combines the early origins studies, which focus on the long-term impacts of early childhood, with what we know so far regarding malnutrition, childbirth, and prenatal care. We try to capture whether there is a significant direct impact of prenatal and natal care on children's nutritional status years later.

3. Context

Located on the coast of West Africa, Guinea-Bissau is one of the poorest countries in the world, with a GDP per capita of 778$[6]. Despite having a population of just 1.9 million people[7], Guinea-Bissau comprises around 40 ethnic groups, making it one of the most diverse countries regarding ethnic and religious affiliations (Ferreira, 2004). Deeply punished by political instability since its independence from Portugal in 1974, the country faces serious development challenges. About two thirds of the population live below the poverty line[8], with women and children being disproportionately affected.

Guinea-Bissau has a life expectancy at birth of just 58 years, and an average fertility rate of 4.5 births per woman[9]. The country has an under-five mortality of 81.5 per 1,000 live births, and a maternal mortality ratio of 667 per 100,000 live births, underperforming in both indicators when compared to Sub-Saharan Africa averages[10]. Access to health services is difficult to many, with 66% of the population living 5km or further from a health facility[11]. According to the most recently available Multiple Indicator Cluster Survey (MICS), 17% of all children in Guinea-Bissau are severely underweight, 27% are severely stunt and 6% are severely wasted[12]. While wasting is typically seen as a sign of recent and rapid weight loss, and thus can be more easily solved, stunting reflects chronic malnutrition, with effects on growth and cognitive development that last a lifetime[13].

4. Data

4.1 Data Collection

Our work employs data from the baseline survey of a Randomized Field Experiment on Health and Beliefs, developed by NOVAFRICA[14] in Guinea-Bissau, between September 2019 and March 2020. I had the pleasure to participate in the data collection, as a research assistant. The baseline includes villages from Cacheu and Biombo, two of the eight regions of Guinea-Bissau (see Appendix 2). Our work uses interviews conducted in 148 villages. The villages were randomly selected, considering some pre-conditions related to a minimum number of 30 households per village, and a minimum distance from a health centre of 5 km. In each village, three types of interviews were conducted: a household survey, a community survey, and a traditional healer survey.

The household survey was answered by approximately 10 women in each village. The households were randomly selected, using village's census records, provided by VIDA[15], an international NGO, present locally, and collaborating with NOVAFRICA. Women were eligible to answer the survey in case they had any child under 5 years old and/or were pregnant at the time. In case there was more than one person fulfilling these conditions within a household, one of them would be randomly selected to be interviewed. The household survey included questions about the mother's demographic characteristics, household's characteristics, pregnancy, childbirth and children's characteristics, health behaviours and children's healthcare, beliefs related to both religion and ethnicity, and anthropometric measures of all children under 5 years old, including height, weight and middle upper arm circumference. In addition, for the oldest and youngest child of each mother, prenatal cards were photographed. Prenatal cards include information on the pregnancy, such as the record of all prenatal appointments, besides information on childbirth and new-borns' characteristics.

The community survey and the traditional healer survey were conducted once in each village, to a relevant community leader, and to a *djambacus or mouro*, respectively. *Djambacus and mouros* are traditional healers in Guinea-Bissau who provide traditional health practices and medicines, offer spiritual guidance, and perform traditional ceremonies. Our work focuses on the general household survey, more specifically on the demographic data, the maternity-related data, and the anthropometric measures.

4.2 Descriptive Statistics

Table I presents descriptive statistics on our sample. Variables related to mother's characteristics, household's characteristics, prenatal care indicators and malnutrition measurements are described. Since in our sample each observation corresponds to one specific child, there are cases where more than one child has the same mother, in which case the variables related to mothers and households will be repeated for each observation.

On average, mothers in our sample are 28.22 years old, have around 4 years of education and have 1.36 children under 5 years old. About 77.4% of mothers are married. Mothers' main ethnicities are Manjaco, Balanta, and Pepel, which represent 32.9%, 32.2% and 12.3% of our sample, respectively. Considering households, 78.2% of our sample owns agricultural land, 12.8% of mothers are somehow involved in decisions regarding food purchases, and 32.1% of households have felt food insecurity in the past twelve months. 38.8% of our sample comprises children who were born in either a hospital or a health centre, while the remaining 61.2% were born at home (which can include the mother's house, a family member's house, or a traditional midwife's house). On average, mothers went to 4.4 prenatal appointments, which is slightly higher than the four recommended appointments[16]. When focusing on a subsample formed by children for whom there was a prenatal card available, we can see that the observations decrease significantly (from more than 900 to around 450), but average values remain roughly the same. A comparison of the distributions of these two samples can be found in Appendices 3 and 4, as well as a more detailed description of Table I variables (Appendix 5).

Malnutrition indicators were computed based on the anthropometric measurements collected during field work. The WHO defines multiple indicators to evaluate children's growth imbalances. The indicators' cut-offs, from which a child is considered malnourished, were defined by the WHO to standardize nutrition indicators, making their interpretation easier, and allowing to monitor changes over time[17]. A child is considered stunt if he or she has a *Height for Age* indicator that deviates from the WHO Child Growth Standards median by more than 2 standard deviations, that is, if the zscore is < -2. In our sample 25.5% are stunt, which represents more than a quarter of all measured children. A child is considered underweight if he or she has a *Weight for Age* < -2 standard deviations. In our sample 9.7% of children are underweight. A child is considered wasted if he or she has a *Weight for Height* < -2 standard deviation. In our sample 7.6% of children are considered wasted. *Arm Thickness for Age* is more appropriate to measure extremely severe cases of malnutrition. We can note that 3% of our sample has an *Arm Thickness for Age* < -2 standard deviations. The last two malnutrition indicators are aggregated measures, where the child is considered malnourished in case he or she is considered malnourished by at least one indicator. When combining the indicators *Height for Age* and

Table I: Descriptive Statistics

	Mean	Std. Dev.	Min	Max	N
Mother's Characteristics					
Age	28.22	7.02	17	53	924
Married	.774	.418	0	1	934
Years of Education	3.99	3.49	0	17	933
No. of Children (under 5 y.o)	1.36	.526	1	4	933
Mother's Ethnicity					
Balanta	.322	.467	0	1	933
Pepel	.123	.329	0	1	933
Manjaco	.329	.47	0	1	933
Other	.219	.414	0	1	934
Household's Characteristics					
Agricultural Land	.782	.413	0	1	934
Mother Decisions' Involvement	.128	.334	0	1	932
Lack of Food	.321	.467	0	1	928
Assets	1.15	.873	0	4	923
No. of Animals	5.67	11.70	.2	162.52	925
Prenatal/ Natal Care Variables					
Hospital Delivery	.388	.487	0	1	934
No. of Prenatal Appointments	4.40	1.91	0	9	917
Hospital Delivery (Prenatal Card) †	.381	.486	0	1	443
No. of Prenatal Appointments (Prenatal Card) †	4.19	1.83	0	8	443
Malnutrition Indicators ǂ					
Height for Age	.255	.436	0	1	934
Weight for Age	.097	.297	0	1	934
Weight for Height	.076	.265	0	1	934
Arm Thickness for Age	.03	.171	0	1	934
Height for Age + Weight for Age	.298	.457	0	1	934
Height/Age + Weight/Age + Arm Thickness/Age	.302	.459	0	1	934

Notes: The sample includes all children under 5 years old, for whom there were anthropometric measures available. If two children have the same mother, the mother's characteristics are registered repeatedly. *Mother Decisions' Involvement* takes the value of one in case the mother participates in the household's food purchase decisions. *Lack of Food* takes the value of one in case the household had difficulties in obtaining the necessary food in the past 12 months. *Assets* combines the household's possession of four different goods: electricity, solar panels, radio, and refrigerator. *No. of Animals* is a weighted sum of the total number of animals the household owns, with factors varying from 0.02 (in the case of chickens) to 1 (in case of cattle). † Sub-sample including only the children for whom a prenatal card was available. These variables were obtained from the card's registers. ǂ *Malnutrition Indicators* are binary variables indicating malnutrition, which take the value of one if the zscore<-2. Combined Malnutrition Indicators take the value of one in case the zscore<-2 for at least one of the included indicators.

Weight for Age, 29.8% of our sample is considered malnourished. When combining *Height for Age, Weight for Age* and *Arm Thickness for Age,* 30.2% of our sample is considered malnourished.

5. Estimation Strategy

Our estimation strategy is largely reliant on the fact that our dependent variable, child malnutrition, is a binary response variable. As such, the appropriate models are binary response models. Several non-linear functions have been advocated in the literature, being the Logistic Distribution and the Standard Normal the most common. Since these two functions have very similar shapes, the choice of one of them does not seem to have a significant impact on empirical estimations, as they comprise similar predictions and marginal effects. For estimation reasons, our work employs a Logit model, as it allows us to use specifications containing fixed effects, which would not be possible had we opted for a Probit model. Our initial specification is depicted below:

$$(1)\ y_i = \beta_0 + \beta_1 delivery_i + \beta_2 M' + \beta_3 H' + \beta_4 E' + u_i,$$

where $\boldsymbol{y}$, the dependent variable, is a malnutrition indicator that takes the value of one in case the child is malnourished; *delivery* is a binary variable that takes the value of one in case the child was born in either a hospital or a health centre; *M'* represents the mother's controls, which includes age, marital status, years of education and the number of children under 5 years old; *H'* represents the household's related controls, such as possession of agricultural land, mother's involvement in the household's food purchase decisions, food insecurity in the past twelve months, assets and animal ownership; *E'* represents the mothers' ethnicity controls, which were divided into the three main ethnicity groups, that are depicted in the regressions, and a fourth group which includes all other ethnicities and that is omitted from the regressions.

In every specification that does not include fixed effects at the village level, clustered standard errors at the village level were used.

Height for Age is our preferred malnutrition indicator as it reflects stunting, which is the most suitable measure to analyse permanent exposure to inadequate nutrition, echoing the inability of a child to reach its own growth potential. Moreover, *Height for Age* is less susceptible to measurement error, when compared to measures that include a child's weight. This relates to the fact that when measuring a child's height, the field teams would use only a simple measuring tape, while to record a child's weight they would have to use a scale with different units, which sometimes needed calibrating. This conviction is partly confirmed by comparing our Descriptive Statistics with the data from Guinea-Bissau MICS report, since stunting and wasting rates are quite similar in both samples, but underweight indicators show a larger discrepancy. Nonetheless, in Table III we present the same specifications, using the alternative malnutrition indicators.

To isolate the effect of birthplace in children's malnutrition we would need to guarantee that the delivery place is an exogenous variable. However, it is plausible, and even likely, that mothers who choose to deliver in a hospital are more likely to provide their children with better nutrition during early childhood. This can be attributed to two omitted variables: preferences and pre-conditions. The latter refers to all conditions that might influence the predisposition of the mother to choose the hospital as the delivery place. We believe most of these conditions are accounted for by our controls, whether they are related to mother's characteristics, or economic conditions. Yet, we cannot rule out that preferences are driving both the choice of delivery place and quality of early-life nutrition. It can be the case that mothers who are more willing to give birth in a hospital, and more informed about the health and risk-reduction benefits of doing so, might also be the ones who value higher good nutrition for their children, and are better informed about which kind of food offers proper nutrition. If this is the case, then we would be in the presence of an omitted variable bias, which would cause a correlation between the error term and our explanatory variable, thus providing biased and inconsistent estimates.

To tackle the possible endogeneity problem, we use a Two Stage Least Squares (2SLS) Instrumental Variable approach.

$$(2)\ delivery_i = \beta_0 + \beta_1 IV + \beta_2 M' + \beta_3 H' + \beta_4 E' + u_i,$$

$$(3)\ y_i = \beta_0 + \beta_1 delivery_i + \beta_2 M' + \beta_3 H' + \beta_4 E' + \varepsilon_i,$$

Specifications (2) and (3) depict the first and second stage regressions, respectively. A suitable IV must fulfil two conditions. On one hand, the instrument must be highly correlated with the potentially endogenous variable, in this case, it must have a clear effect on the delivery place. On the other hand, the instrument must be exogenous, that is, not affect malnutrition through any other channel than through the potentially endogenous variable, delivery place. By fulfilling these two conditions an instrument is considered relevant and exogenous, allowing us to claim a causal relationship.

Our instrument is a belief-related variable, which takes the value of one in case *the mother believes that djambacus or mouros (traditional healers) can protect herself and her children from unfortunate events*.

Traditional beliefs have been found to influence maternal health behaviours, by shaping risk assessment and hindering risk-learning processes (see Ashraf et al., 2017). In the context of Guinea-Bissau, traditional beliefs are quite interiorized, with traditional healers playing a significant role in their communities. Usually every village has at least one traditional healer. Their relevance is both spiritual and sanitary, as they are often consulted by their communities, providing spiritual guidance as well as traditional health care. The survey we ground our work on has a vast and rich section dedicated to health beliefs, where a lot of information regarding traditional healers can be found (see Appendix 6). Concerning the types of traditional healers commonly visited, 50% of our sample claims to have visited *djambacus or mouros* that are specialists in medicinal herbs, and that perform traditional treatments. 40% of mothers also refer to have visited *djambacus or mouros* that could tell fortune and performed traditional ceremonies. When asked about the motivations to visit these traditional healers, 91% of mothers refer health reasons, 29% say they do it to protect themselves against spells, 20% mention childbirth as a reason and 10% say they visit *djambacus or mouros* to learn about their future. Other motivations such as getting rich, finding a job, casting a spell on someone else or protecting themselves during travels are also mentioned, although rarely. Despite appearing to be very important in their communities it seems that mothers do not visit traditional healers quite often. In our sample 30% of mothers claimed they visited a *djambacus or mouro* at least once in the past 6 months. The average number of visits in the previous 6 months was 0.75, which indicates that, on average, people visited a traditional healer less than once. This average number of visits increases to 2.49 if we consider only mothers that went at least once. Bearing this in mind, the proposed instrument appears to respect both necessary conditions.

In terms of relevance it is plausible that mothers who have stronger beliefs regarding the power of traditional healers to protect them are also more likely to think that it is adequate to give birth at home. Mothers who delivered in a hospital or health centre visited a traditional healer in the past 6 months, on average, 0.59 times, while mothers who delivered at home performed on average 0.84 visits. By believing traditional healers can protect them, mothers can be less prone to see the benefits of the formal health system, and of traveling to the hospital when the time comes to give birth. In other words, mothers who do not believe traditional healers can protect them and their families are more likely to recognize the importance of giving birth in a hospital and being accompanied by skilled attendants during childbirth.

In terms of exclusion restriction, it seems plausible that believing in *djambacus and mouros'* protection powers does not directly impact malnutrition. Although traditional healers are usually consulted concerning either health problems or spiritual matters, they do not seem to have a particular influence in day-to-day habits of mothers. Malnutrition is a condition arising from permanent lack of adequate nutritional choices, which reflects frequent behaviours and choices towards childcare. For this exclusion restriction not to hold, it would be necessary that believing in the power or traditional healers to provide protection from unfortunate events had a direct effect on mother's nutritional choices for their children. This would only be true if we had reasons to believe that traditional healers can somehow influence mother's nutritional choices. We believe this link does not exist. From observing the available data regarding traditional healers' visits it is quite clear that mother's resort to them sporadically, when they face a problem of some kind, and not for routinely matters. For these reasons we argue that our instrument respects both relevance and exogeneity, hence being adequate for the implementation of a 2SLS approach.

6. Results

6.1 Logit Results

Table II depicts results from logistic regressions related to the impact of *Hospital Delivery* on child malnutrition, measured by the *Height for Age* indicator. Column (1) presents the simplest regression, with no controls. Column (2) includes mother's characteristics controls, more specifically age, marital status, years of education, and number of children under 5 years old. Column (3) adds household controls, such as ownership of agricultural land, mother's involvement on food purchase decisions, food insecurity, asset possession, and animal ownership. In column (4) we include mother's ethnicity controls as well. Colum (5) contains only observations from the sub-sample that had a prenatal card. Column (6) includes fixed effects at the village level. Column (7) combines both the sub-sample that had a prenatal card, and fixed effects at the village level.

In order to analyse results from Table II one must consider that coefficients' interpretation in the context of logistic regressions is not always straightforward. When using a logit model, coefficients represent log-odds ratios. Odds-ratios measure the probability of *y=1* relative to the probability of *y=0*, or, in our case, they measure the probability of a child being considered malnourished according to the *Height for Age* indicator, relative to the probability of a child not being considered malnourished. When looking at the coefficients, one can observe the effect of the explanatory variable on the log-odds ratio, particularly the sign and magnitude of that effect. Coefficients' signs are similar to the signs of the shift in probabilities, hence a positive sign tells us that the probability of malnutrition increases, while a negative sign tells us it decreases.

Results from Table II suggest that delivering at the hospital is negatively correlated with child's malnutrition. *Hospital Delivery* has a negative and significant coefficient in all presented specifications, which indicates that childbirth at the hospital decreases the log-odds ratio of being malnourished in a significant manner. Moving from column (2) and adding up controls, until column (4), we see that the magnitude of *Hospital Delivery* increases. In column (4) we obtain a coefficient of -0.494, significant at the 1% level, which indicates that giving birth in a hospital can reduce the log-odds of being malnourished by 0.494, when compared to giving birth at home. Employing fixed effects at village level we obtain a similar impact, represented by a coefficient of -0.429, which is slightly smaller than the previous one, but still significant at the 5% level. Fixed effects are a powerful tool, as they allow us to capture solely the variation within each village, by controlling for everything that varies from one village to the other, such as the quality of the health services nearby, or the access to them. When considering only the sub-sample that had a prenatal card, our coefficient of interest is even larger (-0.667), and increases with fixed effects application (-0.858), remaining significant at the 1% and 5% levels, respectively.

Table II: Logistic Regressions on Child Malnutrition

Dependent Variable	**Height for Age**						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Hospital Delivery	-0.525***	-0.459***	-0.468***	-0.494***	-0.667***	-0.429**	-0.858**
	(0.150)	(0.156)	(0.164)	(0.165)	(0.241)	(0.196)	(0.338)
Mother Controls							
Age		-0.018	-0.020	-0.014	-0.001	-0.014	-0.012
		(0.012)	(0.012)	(0.012)	(0.018)	(0.015)	(0.024)
Married		0.364	0.345	0.281	-0.085	0.377	0.244
		(0.224)	(0.226)	(0.224)	(0.334)	(0.268)	(0.423)
Years of Education		-0.041*	-0.038	-0.015	-0.022	-0.021	-0.018
		(0.023)	(0.024)	(0.025)	(0.035)	(0.033)	(0.049)
No. of Children (under 5 y.o)		0.171	0.194	0.157	0.282	0.298*	0.317
		(0.145)	(0.150)	(0.151)	(0.221)	(0.173)	(0.278)
Household Controls							
Agricultural Land			0.022	0.019	-0.410	0.010	-0.400
			(0.226)	(0.233)	(0.291)	(0.229)	(0.353)
Mother Decisions' Involvement			-0.261	-0.271	-0.194	-0.388	-0.054
			(0.250)	(0.259)	(0.345)	(0.285)	(0.415)
Lack of Food			0.259	0.208	0.559**	0.129	0.536*
			(0.163)	(0.165)	(0.238)	(0.198)	(0.306)
Assets			0.073	0.001	0.088	0.068	0.065
			(0.101)	(0.103)	(0.138)	(0.107)	(0.176)
No. of Animals			-0.001	-0.002	-0.006	-0.001	0.000
			(0.007)	(0.007)	(0.011)	(0.008)	(0.013)
Ethnicity Controls							
Balanta				-0.567**	-0.607*	-0.654*	-1.285**
				(0.224)	(0.313)	(0.365)	(0.636)
Pepel				-0.865***	-1.092**	-1.224	-2.134
				(0.302)	(0.469)	(0.891)	(1.654)
Manjaco				-0.830***	-0.664**	-0.654	-1.161
				(0.252)	(0.279)	(0.439)	(0.723)
Constant	-0.886***	-0.752*	-0.886*	-0.382	-0.398		
	(0.098)	(0.450)	(0.499)	(0.508)	(0.706)		
R2 adjusted	0.010	0.019	0.025	0.041	0.055	0.035	0.082
No. of Observations	934	924	901	901	433	738	292
Prenatal Card (only)	No	No	No	No	Yes	No	Yes
Fixed Effects	No	No	No	No	No	Yes	Yes

Notes: Logistic regressions. Dependent variable *Height for Age* indicates that a child is malnourished according to this indicator, that is, he or she deviates from the WHO standards by two or more standard deviations. Independent variable reports whether the child was born in a hospital/ health centre. All regressions, apart from the ones including fixed effects, are clustered at the village level. (1) No controls. (2) Includes mother controls. (3) Includes mother and household controls. (4) Includes mother, household, and mother's ethnicity controls. (5) and (7) Include only the sub-sample which had a prenatal card. (6) and (7) Include fixed effects at the village level. *significant at 10%, **significant at 5%, *** significant at 1%.

Regarding the controls used throughout different specifications we note that, even though they are rarely significant, they usually have the expected sign, for example higher education of the mother seems to decrease the odds of a child being malnourished, a higher number of children under 5 years old seems to increase the odds of a child being malnourished, and food insecurity in the past twelve months seems to have a positive, and sometimes significant impact in child malnutrition. Ethnicity controls appear to be highly significant, and always have a negative sign, relative to *Other,* although the coefficients lose significance once fixed effects are applied (except for *Balanta*, which remains significant). Given the non-uniform distribution of ethnicities in our sample, ethnicity controls might be capturing geographical effects that disappear once fixed effects at the village level are applied.

Table III presents logistic regressions using alternative malnutrition indicators. Columns (1) and (2) use *Weight for Age* as a malnutrition indicator, columns (3) and (4) employ *Weight for Height*, columns (5) and (6) apply the combined indicator *Height for Age + Weight for Age*, and columns (7) and (8) show the combined indicator *Height for Age + Weight for Age + Arm Thickness for Age*. The first column of each indicator presents a regression with mother, household and ethnicity controls (columns (1), (3), (5) and (7)), while the second regression of each indicator adds fixed effects at the village level (columns (2), (4), (6) and (8)).

Results from Table III indicate that *Hospital Delivery* is negatively correlated with the odds of a child being malnourished by the *Weight for Age* indicator, despite lacking statistical significance. When considering malnutrition measured by the *Weight for Height* indicator, *Hospital Delivery* bears no significance, has a slightly positive coefficient in the first regression, and a negative coefficient when fixed effects are applied. We believe these results can be explained by the modest manifestation of malnourished individuals in our sample, according to these measures, which, in the case of *Weight for Age*, significantly differs from the one found in the MICS report for Guinea-Bissau[18]. Regressions containing combined indicators (columns (5) to (8)) all show negative and significant coefficients, suggesting that by these measures of malnutrition, *Hospital Delivery* significantly decreases the odds of a child being malnourished. Despite their sign and significance, *Hospital Delivery*'s coefficients have a smaller magnitude than the coefficients in Table II, where *Height for Age* was the employed malnutrition indicator.

Table III: Logistic Regressions on Alternative Malnutrition Indicators

Dependent Variable	Weight for Age		Weight for Height		Height for Age + Weight for Age		Height for Age + Weight for Age+ Arm Thickness	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hospital Delivery	-0.236	-0.167	0.025	-0.079	-0.410***	-0.376**	-0.366**	-0.316*
	(0.241)	(0.283)	(0.273)	(0.328)	(0.158)	(0.185)	(0.153)	(0.183)
Mother Controls								
Age	0.015	0.031	0.016	0.026	-0.008	-0.007	-0.004	-0.001
	(0.018)	(0.021)	(0.023)	(0.025)	(0.011)	(0.015)	(0.011)	(0.014)
Married	0.208	-0.078	0.029	-0.105	0.313	0.341	0.313	0.321
	(0.356)	(0.394)	(0.405)	(0.428)	(0.207)	(0.252)	(0.210)	(0.251)
Years of Education	-0.036	-0.037	-0.062	-0.025	-0.017	-0.019	-0.019	-0.019
	(0.043)	(0.049)	(0.055)	(0.058)	(0.024)	(0.031)	(0.024)	(0.031)
No. of Children (under 5 y.o)	0.179	0.364	0.223	0.120	0.127	0.277*	0.144	0.306*
	(0.223)	(0.237)	(0.235)	(0.268)	(0.141)	(0.164)	(0.144)	(0.163)
Household Controls								
Agricultural Land	0.230	0.373	0.353	0.661	0.135	0.163	0.126	0.146
	(0.319)	(0.351)	(0.362)	(0.422)	(0.226)	(0.217)	(0.228)	(0.216)
Mother Decisions' Involvement	-0.295	-0.332	0.151	0.208	-0.302	-0.377	-0.333	-0.414
	(0.375)	(0.418)	(0.394)	(0.428)	(0.255)	(0.271)	(0.256)	(0.270)
Lack of Food	0.349	0.475*	-0.105	0.011	0.192	0.185	0.202	0.198
	(0.215)	(0.281)	(0.270)	(0.330)	(0.161)	(0.189)	(0.158)	(0.188)
Assets	-0.016	-0.060	0.167	0.032	0.046	0.094	0.043	0.091
	(0.133)	(0.158)	(0.177)	(0.169)	(0.098)	(0.101)	(0.097)	(0.101)
No. of Animals	-0.004	-0.001	-0.003	-0.005	-0.001	-0.001	-0.002	-0.001
	(0.008)	(0.014)	(0.015)	(0.013)	(0.006)	(0.008)	(0.006)	(0.008)
Ethnicity Controls								
Balanta	-0.059	0.117	0.208	1.316*	-0.447**	-0.441	-0.454**	-0.425
	(0.307)	(0.581)	(0.350)	(0.732)	(0.218)	(0.355)	(0.217)	(0.355)
Pepel	-0.471	-1.437	0.216	1.566	-0.706**	-1.375*	-0.679**	-1.203
	(0.432)	(1.172)	(0.448)	(1.402)	(0.300)	(0.815)	(0.295)	(0.775)
Manjaco	-0.069	0.344	0.129	1.175	-0.664***	-0.692*	-0.638***	-0.669
	(0.321)	(0.731)	(0.362)	(0.857)	(0.237)	(0.419)	(0.237)	(0.418)
Constant	-2.991***		-3.649***		-0.573		-0.691	
	(0.837)		(1.082)		(0.494)		(0.499)	
R2 adjusted	0.024	0.048	0.017	0.044	0.034	0.033	0.033	0.032
No. of Observations	901	474	901	399	901	783	901	783
Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes

Notes: Logistic regressions. Dependent variables *Weight for Age* and *Weight for Height* indicate that a child is malnourished according to that indicator, that is, he or she deviates from the WHO standards by two or more standard deviations. Regressions (5) to (8) use combined dependent variables, in which the child is considered malnourished in case he or she deviates from the WHO standards by two or more standard deviations in at least one indicator. Independent variable reports whether the child was born in a hospital/ health centre. All regressions include mother controls, household controls and mother's ethnicity controls. Regressions (1), (3), (5) and (7) include clustered standard errors at the village level. Regressions (2), (4), (6) and (8) include fixed effects at the village level. *significant at 10%, **significant at 5%, *** significant at 1%.

6.2 Instrumental Variable Approach Results

The Instrumental Variable approach results can be found in Table IV. These results confirm the Logistic Regression approach conducted before, as *Hospital Delivery* seems to have a causal impact on child malnutrition, measured through the *Height for Age* indicator. Column (1) uses mother's characteristics' controls, column (2) adds household controls, and column (3) includes mother, household, and ethnicity controls, but focuses on the sub-sample that had a prenatal card. Our last regression, presented in column (4) includes the full sample, including mother, household, and ethnicity controls. All regressions in Table IV include an instrument that takes the value of one in case *the mother believes that djambacus or mouros (traditional healers) can protect herself and her children from unfortunate events.*

Results from second stage regressions in both columns (1) and (2) suggest that *Hospital Delivery* has an impact on the probability of a child being malnourished of -0.554 and -0.592, significant at the 5% and 10% respectively. Column (1) presents an F-statistic from the first stage of 13.28, while column (2) presents an F-statistic of 11.55, both larger than the rule of thumb suggested by Stock and Yogo (2002) (F-statistic > 10), dismissing concerns regarding the presence of a weak instrument. Column (3) depicts a negative, and of large magnitude, coefficient, but with no significance. Besides, by following the same rule of thumb for the F-statistic from the first stage, one can observe that the instrument did not pass this test, presenting an F-statistic of 3.70. One possible explanation for the lack of significance is that since the regression in question considers only a sub-sample of our individuals, the total number of observations is quite low when compared to other specifications, which can significantly increase the standard error of the effect of interest. Results from column (4) suggest that when considering the full sample, with all categories of controls, *Hospital Delivery* does have a significant and negative impact on child malnutrition. The F-statistic from the first stage depicts a value of 13.84, which is again above the commonly used rule of thumb. Furthermore, by considering a more sophisticated approach proposed by Stock and Yogo (2002), one can compare the F-statistic with the critical values for a single stage regressor, concluding that the F-statistic from the first stage is also above the critical value for a 15% maximal IV size (8.96).

Table IV: 2nd Stage IV Regressions on Child Malnutrition

Dependent Variable	**Height for Age**			
	(1)	**(2)**	**(3)**	**(4)**
Hospital Delivery	-0.554**	-0.592*	-0.981	-0.558**
	(0.281)	(0.307)	(0.662)	(0.276)
Mother Controls				
Age	-0.004	-0.004	0.001	-0.003
	(0.003)	(0.003)	(0.005)	(0.003)
Married	0.015	0.004	-0.146	0.008
	(0.053)	(0.057)	(0.128)	(0.051)
Years of Education	0.003	0.003	0.011	0.007
	(0.008)	(0.008)	(0.015)	(0.008)
No. of Children (under 5 y.o)	0.019	0.030	0.065	0.024
	(0.032)	(0.033)	(0.056)	(0.032)
Household Controls				
Agricultural Land		-0.029	-0.103	-0.028
		(0.045)	(0.074)	(0.043)
Mother Decisions' Involvement		-0.065	-0.126	-0.069
		(0.051)	(0.108)	(0.051)
Lack of Food		0.040	0.081	0.026
		(0.036)	(0.064)	(0.036)
Assets		0.034	0.081	0.023
		(0.023)	(0.060)	(0.023)
No. of Animals		-0.001	-0.004	-0.001
		(0.002)	(0.003)	(0.001)
Ethnicity Controls				
Balanta			-0.363*	-0.195***
			(0.200)	(0.064)
Pepel			-0.163	-0.141**
			(0.116)	(0.061)
Manjaco			-0.148*	-0.173***
			(0.076)	(0.047)
Constant	0.526***	0.521***	0.765**	0.635***
	(0.156)	(0.171)	(0.341)	(0.173)
R2 adjusted	-0.251	-0.289	-0.751	-0.225
Observations	924	901	433	901
Prenatal Card (only)	No	No	Yes	No
Kleibergen-Paap (F-statistic)	13.28	11.55	3.70	13.84

Notes: 2nd stage IV regressions. Dependent variable *Height for Age* indicates that a child is malnourished according to this indicator, that is, he or she deviates from the WHO standards by two or more standard deviations. Independent variable reports whether the child was born in a hospital/ health centre. Instrumental variable is a binary variable that takes the value of one if the mother beliefs that traditional healers can protect her and her children from unfortunate events. (1) Includes mother controls. (2) Includes mother and household controls. (3) Includes only the sub-sample which had a prenatal card. (4) Full sample. Includes mother, household, and mother's ethnicity controls. Kleibergen-Paap (F-statistic) reported from first stage regressions. *significant at 10%, **significant at 5%, *** significant at 1%.

Our results imply that children who were born in either a hospital or a health centre are less likely to suffer from malnutrition, specifically from stunting, in the early years of their childhood, when compared to children who were born at home.

6.3 Alternative Prenatal Care Indicator Results

Table V presents the results obtained from an approach that considers the *Number of Prenatal Appointments* as the main explanatory variable, instead of *Hospital Delivery*, thus presenting an alternative prenatal care indicator. Columns (1) to (5) use *Height for Age* as the malnutrition indicator. Column (1) employs no controls, column (2) controls for mother's characteristics, households' characteristics and mothers' ethnicity, column (3) focuses on the sub-sample that had a prenatal card, column (4) uses fixed effects at the village level, and column (5) shows the second stage regression from the IV approach, considering the same instrument as before (which takes the value of one in case *the mother believes that djambacus or mouros (traditional healers) can protect herself and her children from unfortunate events*). Column (6) to (9) all consider the full sample, with mother, household and ethnicity controls. Column (6) uses *Weight for Age* as the dependent variable, column (7) uses *Weight for Height*, column (8) employs the combined indicator *Height for Age + Weight for Age*, and column (9) uses the combination *Height for Age + Weight for Age + Arm Thickness for Age*. All regressions, except fixed effects and IV regressions (columns (4) and (5)), include clustered standard errors at the village level.

Results from columns (1) and (2) suggest that a higher *Number of Prenatal Appointments* has a significant negative impact on child's malnutrition, even though when focussing on the coefficient from the second column we see that its magnitude is quite small in comparison with the magnitudes found previously for *Hospital Delivery*. Yet, this effect seems to vanish once we focus on the sub-sample that owned a prenatal card (column (3)), as well as when fixed effects at the village level are applied (column (4)). Despite showing a negative and significant coefficient, the IV approach does not seem to have been successful, since the F-statistic from the first stage is equal to 7.51, thus not passing the rule of thumb. Likewise, considering once more the approach proposed by Stock and Yogo (2002), and comparing the

Table V: Malnutrition Estimations Using the Number of Prenatal Appointments

Dependent Variable	**Height for Age**					**Weight for Age**	**Weight for Height**	**Hei/Age + Wei/Age**	**Hei/Age + Wei/Age + Arm/Age**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
No. Prenatal App.	-0.117***	-0.095**	-0.057	-0.068	-0.179*	-0.031	0.114	-0.077*	-0.079*
	(0.040)	(0.044)	(0.058)	(0.049)	(0.103)	(0.063)	(0.077)	(0.041)	(0.041)
Mother Controls									
Age		-0.015	-0.001	-0.013	-0.001	0.016	0.016	-0.008	-0.004
		(0.013)	(0.018)	(0.015)	(0.003)	(0.019)	(0.024)	(0.011)	(0.011)
Married		0.329	0.005	0.423	0.039	0.314	0.124	0.388*	0.384*
		(0.229)	(0.335)	(0.269)	(0.051)	(0.366)	(0.418)	(0.211)	(0.215)
Years of Education		-0.025	-0.031	-0.027	0.002	-0.039	-0.064	-0.024	-0.025
		(0.025)	(0.035)	(0.033)	(0.007)	(0.044)	(0.054)	(0.024)	(0.023)
No. of Children		0.155	0.268	0.313*	0.008	0.193	0.257	0.133	0.150
(under 5 y.o)		(0.152)	(0.224)	(0.173)	(0.037)	(0.219)	(0.237)	(0.138)	(0.142)
Household Controls									
Agricultural Land		0.003	-0.370	-0.031	-0.048	0.195	0.334	0.108	0.095
		(0.235)	(0.292)	(0.230)	(0.053)	(0.324)	(0.364)	(0.229)	(0.231)
Mother Decisions' Involvement		-0.219	-0.117	-0.343	-0.061	-0.397	0.064	-0.304	-0.339
		(0.253)	(0.337)	(0.286)	(0.055)	(0.389)	(0.416)	(0.253)	(0.255)
Lack of Food		0.197	0.560**	0.110	0.037	0.354	-0.118	0.182	0.192
		(0.159)	(0.232)	(0.197)	(0.038)	(0.217)	(0.272)	(0.158)	(0.156)
Assets		0.007	0.046	0.065	0.037	-0.031	0.132	0.046	0.046
		(0.102)	(0.137)	(0.107)	(0.031)	(0.133)	(0.187)	(0.095)	(0.095)
No. of Animals		-0.002	-0.004	-0.002	-0.002	-0.004	-0.001	-0.002	-0.002
		(0.007)	(0.011)	(0.008)	(0.002)	(0.008)	(0.014)	(0.006)	(0.006)
Ethnicity Controls									
Balanta		-0.455**	-0.407	-0.586	-0.065	-0.051	0.129	-0.373*	-0.387*
		(0.224)	(0.306)	(0.360)	(0.054)	(0.298)	(0.338)	(0.217)	(0.216)
Pepel		-0.941***	-1.105**	-1.358	-0.258***	-0.500	0.275	-0.769**	-0.742**
		(0.300)	(0.456)	(0.889)	(0.079)	(0.444)	(0.452)	(0.300)	(0.294)
Manjaco		-0.710***	-0.582**	-0.545	-0.007	-0.014	0.048	-0.561**	-0.535**
		(0,260)	(0.293)	(0.432)	(0.100)	(0.316)	(0.377)	(0.247)	(0.247)
Constant		-0.166	-0.494		1.099**	-3.029***	-4.170***	-0.426	-0.516
		(0.542)	(0.713)		(0.432)	(0.903)	(1.165)	(0.530)	(0.538)
R2 adjusted		0.038	0.043	0.031	-0.434	0.025	0.023	0.032	0.033
No. of Observations		887	433	731	887	887	887	887	887
Prenatal Card (only)	No	No	Yes	No	No	No	No	No	No
Fixed Effects	No	No	No	Yes	No	No	No	No	No
Kleibergen-Paap (F-statistic)	-	-	-	-	7.51	-	-	-	-

Notes: Logistic and IV regressions. Dependent variables *Height for Age, Weight for Age* and *Weight for Height* indicate that a child is malnourished according to that indicator, that is, he or she deviates from the WHO standards by two or more standard deviations. Regressions (8) and (9) use combined dependent variables, in which the child is considered malnourished in case he or she deviates from the WHO standards by two or more standard deviations in at least one indicator. Independent variable reports the total number of prenatal appointments the mother went to during pregnancy. Regression (1) includes no controls. All other regressions include mother controls, household controls and mother's ethnicity controls. All regressions, except fixed effects and IV regressions, include clustered standard errors at the village level. (3) Includes only the sub-sample which had a prenatal card. (4) Includes fixed effects at the village level. (5) Shows the 2nd stage outcomes from the IV approach. Instrumental variable is a binary variable that takes the value of one if the mother beliefs that traditional healers can protect her and her children from unfortunate events. Kleibergen-Paap (F-statistic) reported from first stage regression. *significant at 10%, **significant at 5%, *** significant at 1%.

F-statistic with the critical values for a single stage regressor, one can conclude that the F-statistic from the first stage is above the critical value only for a 20% maximal IV size. Hence, the proposed instrument is not as strong when applied to the *Number of Prenatal Appointments*, not allowing further conclusions involving a possible causal impact. Results for the *Weight for Age* indicator (column (6)) show no significance, and when considering *Weight for Height* indicator (column (7)), the coefficient depicts a once again puzzling positive sign, although non-significant. Results from the combined indicators in columns (8) and (9) suggest negative impact of the *Number of Prenatal Appointments* on malnutrition, even though coefficients show a feeble magnitude, -0.077 and -0.079 respectively, being significant only at the 10% level.

7. Concluding Remarks

Child chronic malnutrition is still a widespread condition across African countries, with Guinea-Bissau being no exception. Our work builds on existing literature regarding this health disorder, as well as on prenatal care and childbirth impacts. By using recently collected data from a household survey in rural Guinea-Bissau we conducted both a Logistic Regression approach and an Instrumental Variable approach. Our works benefits immensely from some specificities in the dataset, as the availability of anthropometric measurements as well as information on prenatal care conditions of children from the time they were born.

We find that, even after controlling for multiple individual and household characteristics, delivering a child in a hospital or health centre has positive and significant impacts in reducing malnutrition in children under 5 years old. We believe these results reflect the information to which mothers are exposed to when giving birth in health facilities. The contact with skilled attendants in the moment of birth is likely to involve benefits that go beyond decreased neonatal mortality. This contact can improve mother's knowledge concerning neonatal care, particularly relating to breastfeeding and nutrition, as well as increasing awareness about alarming symptoms of certain health conditions. We were not able to find the same robust relationship between malnutrition and the number of prenatal care appointments. One possibility is that this relationship exists, and that we are simply not catching it, perhaps due to some dataset restrictions.

We are aware of our work's limitations, particularly the dependence on self-reported data, which refers to years before the moment of the data collection. However, we believe this is more likely to affect the *Number of Prenatal Appointments*, where we find no results, and less disturbing in the *Hospital Delivery* variable, as it is plausible that mothers remember well their children's birthplace, even if years have passed since. Furthermore, we are conscious that our findings reflect a very specific and acutely poor rural context, thus extrapolations of these results can only be applied to similar contexts.

Nonetheless our results bear important policy implications, that can be relevant in the context of rural Guinea-Bissau. The place where children are born seems to influence their nutritional status years later, which will influence their health and other outcomes throughout their life. Our findings suggest that decreasing the amount of births occurring at home can have positive and long-term impacts. Thus, this goal should be pursued by both increasing investment in availability and quality of delivery facilities, and influencing mother's behaviour regarding the choice of the delivery place. Although we speculate about the mechanism behind our results, we have no suitable way of proving it. Hence, future research on this topic should focus on trying to grasp the mechanisms through which place of delivery can impact mother's behaviour in terms of childcare, ultimately influencing children's health.

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9. Appendices

9.1 Appendix 1: Endnotes

1- UNICEF Data 2020

2, 9, 13- UNICEF/ WHO/ World Bank Group: Levels and Trends in Child Malnutrition (2017)

3- United Nations: Sustainable Development Goals

4, 5- World Health Organization: Making Pregnancy Safer, Department of Reproductive Health and Research (2004)

6- World Bank 2018 GDP per capita current USD

7, 9, 10- World Bank Data 2018

8- Word Bank Group: Poverty & Equity Brief, Guinea-Bissau (April 2020)

11- UNICEF Community Health Programme 2018

12, 18- UNICEF: Multiple Indicator Cluster Survey, Guinea-Bissau (2014)

14- NOVAFRICA is a knowledge centre based in Nova School of Business and Economics. Its mission is to produce expertise with an impact on business and economic development. More information can be found on their website: http://novafrica.org.

15- VIDA is a portuguese NGO which has been working in Guinea-Bissau for over 20 years. More information can be found on their website: http://vida.org.pt.

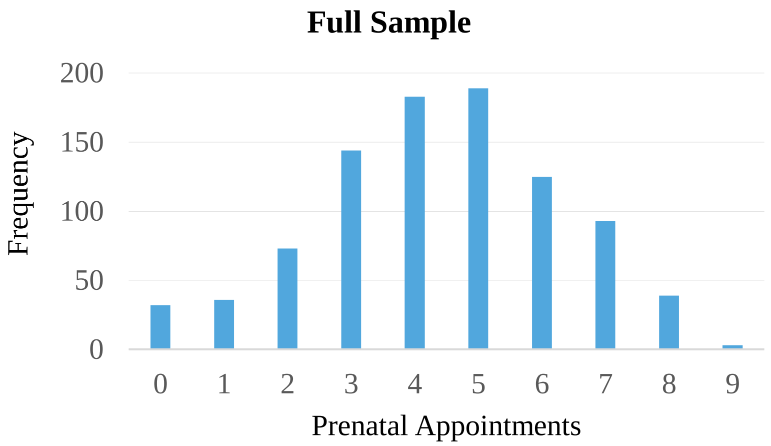
16- World Health Organization: The WHO Reproductive Health Library

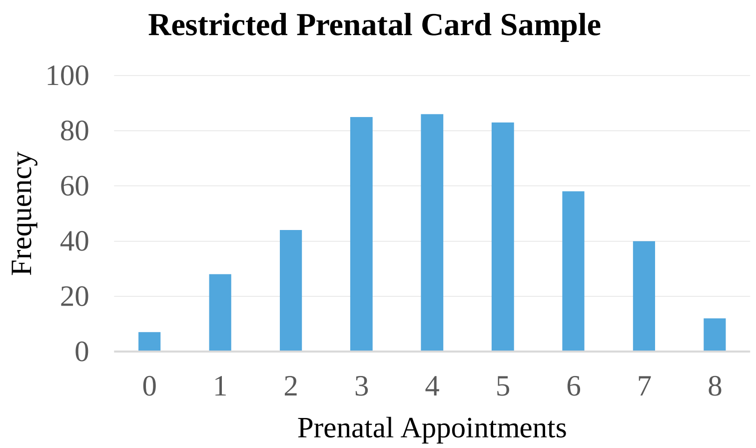
17- World Health Organization: Nutrition Landscape Information System, Country Profile Indicators (2010)

9.2 Appendix 2: Guinea-Bissau Regional Map

Source: afro.who.int

9.3 Appendix 3: Prenatal Appointments Sample Distributions





9.4 Appendix 4: Descriptive Statistics Sample Comparison

Appendix Table I: Descriptive Statistics

	Full Sample		Restricted Prenatal Card Sample	
	Mean	**N**	**Mean**	**N**
Mother's Characteristics				
Age	28.22	924	27.85	439
Married	.774	934	.756	443
Years of Education	3.99	933	4.17	443
No. of Children (under 5 y.o)	1.36	933	1.39	443
Mother's Ethnicity				
Balanta	.322	933	.271	443
Pepel	.123	933	.088	443
Manjaco	.329	933	.379	443
Other	.219	934	.257	443
Household's Characteristics				
Agricultural Land	.782	934	.792	443
Mother Decisions' Involvement	.128	932	.135	443
Lack of Food	.321	928	.347	441
Assets	1.15	923	1.19	440
No. of Animals	5.67	925	5.84	441
Prenatal/ Natal Care Variables				
Hospital Delivery	.388	934	.381	443
No. of Prenatal Appointments	4.40	917	4.21	441
Malnutrition Indicators ǂ				
Height for Age	.255	934	.273	443
Weight for Age	.097	934	.104	443
Weight for Height	.076	934	.074	443
Arm Thickness for Age	.03	934	.03	443
Height for Age + Weight for Age	.298	934	.314	443
Height for Age + Weight for Age + Arm Thickness for Age	.302	934	.318	443

Notes: The sample includes all children under 5 years old, for whom there were anthropometric measures available. If two children have the same mother, the mother's characteristics are registered repeatedly. *Mother Decisions' Involvement* takes the value of one in case the mother participates in the household's food purchase decisions. *Lack of Food* takes the value of one in case the household had difficulties in obtaining the necessary food in the past 12 months. *Assets* combines the household's possession of four different goods: electricity, solar panels, radio, and refrigerator. *No. of Animals* is a weighted sum of the total number of animals the household owns, with factors varying from 0.02 (in the case of chickens) to 1 (in case of cattle). Restricted sample includes only the children for whom a prenatal card was available. The variables in the Restricted Sample column were obtained from the card's registers. ǂ *Malnutrition Indicators* are binary variables indicating malnutrition, which take the value of one if the zscore<-2. Combined Malnutrition Indicators take the value of one in case the zscore<-2 for at least one of the included indicators.

9.5 Appendix 5: Variables Detailed Description

Appendix Table II: Variables Description

Mother's Characteristics	
Age	Mother’s age in years.
Married	Marital status. Takes the value of 1 in cade the mother is married.
Years of Education	Mother’s years of education.
No. of Children (under 5 y.o)	Number of children under 5 years old.
Mother's Ethnicity	
Balanta	Takes the value of 1 in case the mother belongs to the *Balanta* ethnicity.
Pepel	Takes the value of 1 in case the mother belongs to the *Pepel* ethnicity.
Manjaco	Takes the value of 1 in case the mother belongs to the *Manjaco* ethnicity.
Other	Takes the value of 1 in case the mother belongs to one of the 6 etnicities with less expression in the sample: *Mandinga, Balanta-Mane, Mancanha, Felupe, Fula, Mansoaca.*
Household's Characteristics	
Agricultural Land	Takes the value of 1 in case the household owns agricultural land.
Mother Decisions' Involvement	Takes the value of 1 in case the mother participates in the household’s food purchase decisions.
Lack of Food	Takes the value of one in case the household has felt they did not have enough food to eat at least once in the past twelve months.
Assets	Combines the household’s possession of four different goods: electricity, solar panels, radio, and refrigerator.
No. of Animals	Weighted sum of the total number of animals the household owns, considering the following factors: cattle=1; goat=0.2; chicken=0.02; equine=0.5; sheep=0.2; equine=0.3.
Prenatal/ Natal Care Variables	
Hospital Delivery	Takes the value of 1 in case the child was born in a hospital or health centre.
No. of Prenatal Appointments	Number of prenatal appointments the mother went to during pregnancy.

Hospital Delivery (Prenatal Card)	Takes the value of 1 in case the child was born in a hospital or health centre. Information retrieved from the child's Prenatal Card.
No. of Prenatal Appointments (Prenatal Card)	Number of prenatal appointments the mother went to during pregnancy. Information retrieved from the child's prenatal card.
Malnutrition Indicators	
Height for Age	Takes the value of 1 in case the child is considered stunted.
Weight for Age	Takes the value of 1 in case the child is considered underweight.
Weight for Height	Takes the value of 1 in case the child is considered wasted.
Arm Thickness for Age	Takes the value of 1 in case the arm thickness for age measurement zscore < -2, in comparison with the WHO standards.
Height for Age + Weight for Age	Takes the value of 1 in case the child is either stunt or underweight, or both.
Height for Age + Weight for Age + Arm Thickness for Age	Takes the value of 1 in case the child is stunt or underweight, or falls below the arm thickness threshold, or any combination of the three.

Notes: Variables belonging to Mother's Characteristics, Mother's Ethnicity, Household's Characteristics and Prenatal/ Natal Care Variables categories were all obtained directly from the household survey referred in this paper. Malnutrition indicators were obtained using anthropometric indicators, which were available for each child. By using a WHO STATA macro program (igrowup STATA package), we were able to use these individual anthropometric indicators, which were compared to the WHO standards, allowing us to obtain zscores for each indicator, that could later be compared to the WHO cut-offs (zscore<-2).

9.6 Appendix 6: Descriptive Statistics on Traditional Healers' Visits

Appendix Table III: Descriptive Statistics

	Mean	**N**
Visits		
Visited *djambacus/mouro* in the last 6 months	.30	934
Number of visits in the last 6 months	0.75	932
Number of visits in the last 6 months (if visited at least once)	2.49	280
Number of visits in the last 6 months (if Hospital Delivery=1)	0.59	361
Number of visits in the last 6 months (if Hospital Delivery=0)	0.84	571
Type of *djambacus/mouros* visited		
Specialist in herbal medicines	.50	932
Performs traditional treatments	.50	850
Can tell fortune	.40	925
Performs traditional ceremonies	.39	929
Motivations for visiting *djambacus/mouros*		
Health	.91	646
Childbirth	.20	646
Learn about the future	.10	646
Security when travelling	.07	646
Money	.03	646
Find a job	.02	646
Cast a spell on someone	.01	646
Protect themselves from spells	.29	646

Notes: *Djambacus and mouros* are traditional healers in Guinea-Bissau. All variables were obtained directly from the household survey referred in this paper.