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The Relationship Between Poverty and Children's Nutritional Status: Evidence from Nigeria

Bolaji Samson Aregbeshola * Luca Salmasi † Khalid W. A. Shomali ‡

Abstract

People living in poverty generally do not have proper access to food and nutrition, with negative consequences for their children's health and possible long-term negative effects in terms of human capital accumulation, health, and labor market achievements. In this paper, we examine the relationship between poverty and children's nutritional status using the 2008, 2013, and 2018 Nigeria Demographic and Health Surveys. We adopt an approach based on instrumental variables to control for endogeneity. Our study finds that poverty reduced weight-for-height, weight-for-age, and height-for-age Z-scores by 21.32, 30.33, and 27.67 percentage points, respectively. We also find that poverty increases the likelihood of a child being wasted, underweight, and stunted by 5.99, 5.49, and 6.99 percentage points. We show that the mechanisms underlying the relationship between poverty and children's nutritional status are health care service utilization, maternal health care service use, household nutrition, child-specific nutrition intake, maternal nutrition, and illness episodes.

Keywords: Poverty; Wasting; Underweight; Stunting; Nigeria

JEL classification: I10; I12; I31; I32; C18; C26

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1 Introduction

Child undernutrition is a global public health challenge and is measured considering indicators such as wasting (low weight-for-height), stunting (low height-for-age) and underweight (low weight-for-age) (World Health Organization (2020)). Globally, 1 in 9 people–820 million–were hungry or undernourished in 2020 (Global Nutrition Report (2020)). In 2022, the global prevalence of stunting was 22.3%, representing 148.1 million children under five years of age (World Health Organization (2023)). The prevalence of stunting in Africa was 31%, representing 56.2 million children under five years of age (World Health Organization (2023)) . Nigeria has the second-highest burden of stunted children globally, with a national prevalence rate of 37% of children aged 6-59 months (National Population Commission and ICF International (2019)). Furthermore, 7% of Nigerian children aged 6-59 months were wasted, 22% were underweight, and 2% were overweight at the end of 2018 (National Population Commission and ICF International (2019)). Undernutrition is responsible for 45% of the deaths of under-5 children, amounting to more than 3 million deaths each year (Black et al. (2013); World Health Organization (2020)). Child undernutrition leads to poor cognitive development, lowered performance in education, low productivity in adulthood and economic losses estimated to account for as much as 11% of Gross Domestic Product (GDP) (Black et al. (2008); Duflo (2000); Masiye et al. (2010); Adekanmbi et al. (2013); World Health Organization (2020); UNICEF (2020)). Childhood health has an impact on adult health and labour market status, as well as human capital accumulation (Case et al. (2002); Case et al. (2005); Currie & Stabile (2003); Duflo (2000)).

The relationship between socio-economic status (SES) and children's health is mixed and inconclusive (Apouey & Geoffard (2013);Condliffe & Link (2008); Cooper & Stewart (2021); Currie & Stabile (2003); Khanam et al. (2009); Kruk (2013); McInnis (2023)). While some studies found a strong and positive relationship between SES and children's health (Allin & Stabile (2012); Apouey & Geoffard (2013); Cameron & Williams (2009); Case et al. (2002); Case et al. (2008); Chen et al. (2006); Condliffe & Link (2008); Cooper & Stewart (2021); Currie & Stabile (2003); Currie (2009); Khanam et al. (2009); Kruk (2013);Kuehnle (2014); Petrou & Kupek (2010); Propper et al. (2007); Reinhold & Jürges (2012); Sepehri & Guliani (2015); Swaminathan et al. (2019)), others found weak or no relationship between SES and children's health (Cooper & Stewart (2021); Currie et al. (2007); Murasko (2008); Petrou & Kupek (2010); Propper et al. (2007)). Studies that found a positive and significant relationship between SES and children's health show that low-SES can affect health status and, consequently, human capital development. For example, Bhattacharya et al. (2004), Case et al. (2002), and Currie & Stabile (2003). However, it is still unclear whether SES has a causal effect on children's health or if there are false relationships resulting from unobserved variables (Cooper & Stewart (2021); Currie (2009); Kuehnle (2014); McInnis (2023)). Furthermore, evidence on whether the child health-SES gradient increases with age remains mixed and inconclusive (Apouey & Geoffard (2013); Case et al. (2008);Currie et al. (2007); Khanam et al. (2009); Propper et al. (2007); Reinhold & Jürges (2012); Sepehri & Guliani (2015)).

The mechanisms underlying the relationship between SES and children's health also remain a major source of concern for researchers and policymakers (Apouey & Geoffard (2013); Case et al. (2002); Currie & Stabile (2003); Currie et al. (2007); Khanam et al. (2009); Reinhold & Jürges (2012)). This is due to the fact that household SES may be correlated with children's health; children's health could affect household SES, while unobserved factors or parental characteristics (such as poor genetics and health-related behaviors) could also be responsible for the relationship between household SES and children's health (Apouey & Geoffard (2013); Cameron & Williams (2009); Condliffe & Link (2008); Currie & Stabile (2003); Khanam et al. (2009); Kruk (2013); Kuehnle (2014); McInnis (2023); Reinhold & Jürges (2012); Sepehri & Guliani (2015)). Understanding the mechanisms underlying the relationship between SES and children's health is important for informing policy decision-making to reduce health inequalities and poor health outcomes (Allin & Stabile (2012); Case et al. (2002); Khanam et al. (2009)).

In this context, Nigeria represents an interesting case of analysis because it has continued to struggle with poverty reduction since the 1980s with increasing levels of extreme poverty (Ajakaiye et al. (2014); Orokpo & Mutong (2018)), despite the implementation of different alleviation programs at the national and subnational levels (Orokpo & Mutong (2018)). About 30 poverty alleviation programs have been implemented over decades in Nigeria (Aibieyi & Dirisu (2010); Felix & Osunmakinde (2014); Hussaini (2014); Musa et al. (2016); Ogwumike (2001); Ugoh et al. (2009)). The factors responsible for the failure of poverty alleviation programs in Nigeria include inadequate political will, political instability, inadequate policy continuity, especially during the military era, corruption, mismanagement of resources allocated for poverty alleviation, violence, terrorism, insurgencies, communal and inter-religious conflicts, fall in the prices of petroleum products, budget deficits to finance the poverty reduction., the inadequate harmonization and collaborations between the all tiers of governments, private sector, civil society organisations, political and policy instability, poor mechanisms of sustainability, lack of transparency and accountability, inadequate coordination, inefficient budgetary management and failure of policy mechanism targets (Aibieyi & Dirisu (2010); Felix & Osunmakinde (2014); Hussaini (2014); Musa et al. (2016)).

Figure (1) shows the poverty rate trends in Nigeria between 1980 and 2019 (Ajakaiye et al. (2014); Anyanwu (2014); National Bureau of Statistics (2012); National Bureau of Statistics (2020)). According to data from the National Bureau of Statistics (NBS), 82.9 million people, or 40.1% of Nigeria's 201 million inhabitants, live in poverty as of 2019 (National Bureau of Statistics (2020)). According to World Bank estimates, the number of people living in poverty in Nigeria was projected to increase from 40.1% (82.9 million) in 2019 to 42% (89 million) in 2020 and 42.6% (95.1 million) in 2022 (World Bank (2023)). But according to the NBS, 133 million Nigerians, or 63% of the population, were multidimensionally poor in 2022 (National Bureau of Statistics (2022)). The multidimensional poverty measure is composed of six indicators: consumption or income, educational attainment, educational enrolment, drinking water, sanitation, and electricity (National Bureau of Statistics (2022)). Nigeria is now described as the world's poverty capital, behind India, with a population of 1.42 billion (World Data Lab (2023)). Additionally, the incidence of multidimensional poverty varies between urban and rural areas and across geopolitical zones (National Bureau of Statistics (2022)). While the incidence of multidimensional poverty in urban areas was 42% in 2022, it was 72% in rural areas (National Bureau of Statistics (2022)). The incidence of multidimensional poverty in Northern Nigeria is higher than that in Southern Nigeria (National Bureau of Statistics (2022)). Across the states, the incidence of multidimensional poverty ranged from 27.2% in Ondo State to 90.5% in Sokoto State (National Bureau of Statistics (2022)). An estimated four million Nigerians were impoverished between December 2022 and April 2023 (World Bank (2023)). This is in addition to the fact that 63% of the population was multidimensionally poor in 2022.

Our results show that poverty reduces weight-for-height, weight-for-age, and height-for-age Z-scores by 21.32, 30.33, and 27.67 percentage points, which correspond to 15.98%, 21.52%, and 14.87% of the corresponding standard deviations, respectively. We also find that poverty increases the likelihood of a child being wasted, underweight, and stunted by 5.99, 5.49, and 6.99 percentage points, which correspond to 18%, 12%, and 15% of the corresponding standard deviations, respectively.

We examine whether the negative relationship between poverty and children's nutritional status is due to prolonged exposure to challenges related to living in poverty. We find that for weight-for-age Z-score outcome, there is a significant increase in the relationship between poverty and children's nutritional status over the years. For weight-for-height Z-score, we find a significant increase in the relationship between poverty and children's nutritional status only from 2008 to 2013 and then does not quite change from 2013 to 2018. Finally, for height-for-age Z-score outcome, we see no significant change from 2008 to 2013, but we do find a significant increase in the relationship between poverty and children's nutritional status from 2013 to 2018. We also examine the role that the depth of poverty plays in strengthening the negative relationship between poverty and children's nutritional status. Focusing on weight-for-height, weight-for-age, and height-for-age Z-scores outcomes, the coefficients of poverty are negative and statistically significant for all outcomes and for all three levels (i.e., poorest quintile, poorer quintile, and middle quintile). We find no significant differences in the effect size across the three poverty levels.

We find that the child health-SES gradient increases with age from 6 to 59 months, meaning that the negative relationship between poverty and children's nutritional status increase with increasing child age, confirming that the negative relationship between poverty and children's nutritional status accumulates over the lifetime of children (Apouey & Geoffard (2013); Case et al. (2002); Condliffe & Link (2008); Currie & Stabile (2003)). While we did not find a significant relationship between poverty and children's nutritional status for the 0–5 month age group for all outcomes, we find a significant increase in the relationship between poverty and children's nutritional status by age increase for the 6–23 month and 24–59 month age groups in the "poorest" quintile, particularly for weight-for-age, and height-for-age Z-scores outcomes. Furthermore, while we find a significant relationship between poverty and children's nutritional status only for the 24–59 month age group for weight-for-age and height-for-age Z-scores, we find a significant increase in the relationship between poverty and children's nutritional status by age increase for the 6–23 month and 24–59 month age groups for weight-for-age Z-scores in the "poorer" quintile. Finally, in the "middle" quintile, while we find a significant relationship between poverty and children's nutritional status only for the 24–59 month age group for weight-for-age Z-score and for the 6–23 month and 24–59 month age groups for weight-for-age and height-for-age Z-scores, we did not find an increasing relationship between poverty and children's nutritional status by age increase.

We show that the mechanisms underlying the relationship between poverty and children's nutritional status are health care service utilization, maternal health care service use, household nutrition, child-specific nutrition intake, maternal nutrition, illness episodes, duration of breast feeding, and the mother's current breastfeeding. For instance, fewer people use health care services when poverty rises, which may harm children's nutritional status (Case et al. (2008)). Furthermore, children living in poverty are more vulnerable to the harmful impacts of poor nutrition on their nutritional condition (Case et al. (2008)).

We adopt an instrumental variable (IV) strategy to tackle endogeneity, which might emerge for (i) reverse causality if the health status of children affects parents' income or (ii) for the presence of unobservable characteristics correlated with both poverty status and children's nutrition (e.g., parental education which can translate into malnutrition (Aslam & Kingdon (2012); Doyle et al. (2005); Silles (2015); Vollmer et al. (2017)). We used time (in minutes) to reach the nearest drinking water source as an IV for poverty. Distance is a widely adopted instrument in the health economics literature (see, for example, Chandra & Staiger (2007) and Basu (2014)) because it allows comparisons between outcomes of groups of individuals differing by only some objective criteria, such as the distance of their municipality of residence from the hospital providing medical treatments. Similarly, we assume that it is reasonable to think that larger distances to drinking water sources imply a higher cost for individuals to find a job. This can influence SES through poor economic opportunities. This assumption is confirmed by the result of the regression of employment on our instrument. We believe that the exclusion restriction holds true because the distance to the drinking water source does not directly affect children's weight or health in general. Our findings are robust to several checks. First, we use the procedure proposed by Conley et al. (2012), which yields an operational tool to test for plausible exogeneity of instruments in the IV framework. We also re-estimate our equations only for a subsample of individuals who have always remained in the same place. This is because the study sample is expected to change location during the survey period, choosing to live in a municipality closest to drinking water, challenging the validity of our instrument and consequently biasing our estimates. Our baseline results are confirmed when we re-estimate our IV model using only the people who identified as permanent residents in order to test the robustness of the assumption that "drinking water distance" is as good as randomly assigned. Although there is concern about the exogeneity of access to water given the intergenerational persistence of poverty, evidence suggests that water distance, source or quality are not affected by intergenerational poverty (Bird (2013); Corak et al. (2014); National Academies of Sciences et al. (2023); Torche (2015)). The age of the children included in the Nigeria Demographic and Health Survey (NDHS) data sets is 0-59 months. To address the concern that might arise if a longer distance to drinking water (meaning harder access to drinking water) implies that it could be harder to make infant formula to keep a baby well-nourished, we show that longer distance from the drinking water source does not affect the number of times mothers gave infant formula or the number of times mothers breastfed their child. We also found no significant association between diarrhea and our instrument. In addition, the incidence of diarrhea, which may occur as a result of unclean or poorly cleaned produce occasioned by not having as much water to use to clean fruit and vegetables as a result of the longer distance to get drinking water, has no direct effect on children's nutritional status in the mediation analysis.

Our findings are significant considering the mixed and inconclusive evidence on the child health-SES gradient and how household SES is associated with children's health status (Khanam et al. (2009); Kruk (2013); Kuehnle (2014)). The findings of this paper reveal that improving health care service utilization, maternal health care service use, household nutrition, child-specific nutrition intake, maternal nutrition and illness episodes among children living in low-SES households is important to reduce the SES–gradient in children's health. Our results support the child health-SES gradient found in developed countries, proving its importance as a policy-relevant issue in developed and developing countries.

This paper contributes to the existing literature by examining the relationship between poverty and children's health in Nigeria, a developing country with a poor record of poverty reduction over four decades (Ajakaiye et al. (2014); Orokpo & Mutong (2018)). Existing evidence on the relationship between SES and children's health has focused on developed countries, with limited evidence on this relationship in Africa, a continent that has been grappling with poverty for many decades (Cooper & Stewart (2021); Petrou & Kupek (2010); Swaminathan et al. (2019)). It is important to pay attention to the issues of poverty and poor children's health outcomes and address the causes of SES-related gradients in children's health status in Nigeria, as evidence suggests that poor health in childhood is linked to lower educational attainment, worse long-term health outcomes, and worse labor market outcomes in adulthood (Currie et al. (2007); Currie (2009)). In addition, the results from previous studies conducted in developed countries cannot be generalized to the Nigerian context, necessitating further studies to address this gap in the literature (Cooper & Stewart (2021). Thus, estimating how poverty affects children's nutritional status as a significant side effect of economic growth and development in Nigeria is a significant long-term challenge that needs to be explored.

Second, we examine whether the child health-SES gradient increases with age within the Nigerian context. To our knowledge, this is the first paper to examine whether the child health-SES gradient increases with age in Nigeria. There is conflicting and equivocal evidence regarding whether the child health-SES gradient rises with age (Apouey & Geoffard (2013); Case et al. (2008); Currie et al. (2007); Khanam et al. (2009); Propper et al. (2007); Reinhold & Jürges (2012); Sepehri & Guliani (2015)). This paper contributes to the debate on whether the child health-SES gradient increases with age.

Finally, we contextualize the findings of this paper and add to the depth of our results by examining the mechanisms underlying the relationship between poverty and children's nutritional status. Evidence suggests that the mechanisms underlying the relationship between SES and children's health are mixed and inconclusive (Case et al. (2002); Currie et al. (2007); Goode et al. (2014); Khanam et al. (2009); Kruk (2013); Reinhold & Jürges (2012)). Previous studies have explored mechanisms such as health care service use, health insurance, unmet need for care, chronic health conditions, nutrition, housing conditions, clothing, health shock, injuries, parental health consciousness, household sanitation conditions, household sources of drinking water, nutrition intake of children, and maternal physical and mental health with mixed findings (Allin & Stabile (2012); Apouey & Geoffard (2013); Case et al. (2002); Currie & Stabile (2003); Currie et al. (2007); Khanam et al. (2009); Kruk (2013); Propper et al. (2007); Reinhold & Jürges (2012)). Therefore, further studies are warranted to contribute to the debate on the mechanisms that explain the child health-SES gradient.

We also provide evidence of the difference between the types of maternal health care services used and SES quintiles. The relationship between maternal health care service use and the SES gradient in children's health has not been examined in the existing literature. It is possible that low health care service utilization, poor access to maternal health care services, inadequate household nutrition, inadequate child-specific nutrition intake, poor maternal nutrition and episodes of illness could be responsible for the relationship between poverty and children's nutritional status in Nigeria. This paper contributes to the ongoing debate on the mechanisms underlying the relationship between SES and children's health.

The remainder of this paper is organized as follows: Section 2 describes the data used. Section 3 outlines the empirical strategy. Section 4 presents the results of the econometric analysis. Section 5 presents the mechanisms underlying the relationship between poverty and children's nutritional status. Section 6 discusses the study's findings. Section 7 concludes.

2 Data

2.1 Data Source

Data were drawn from the 2008, 2013 and 2018 NDHS data sets. The NDHS is a nationally representative cross-sectional survey.[1]

Data for the NDHS were collected using a multistage cluster sampling technique. The surveys collected information on basic demographic and health indicators such as fertility, awareness and use of family planning methods, breastfeeding practices, nutritional status of women and children, maternal and child health, adult and childhood mortality, women's empowerment (National Population Commission and ICF International (2009, 2014, 2019)). We utilized data from the household and children's records module of the

[1] The NDHS is conducted every five years since 1990 by the National Population Commission (NPC) in collaboration with the National Malaria Elimination Programme (NMEP) of the Federal Ministry of Health, Nigeria, with funding from the United States Agency for International Development (USAID), Global Fund, Bill and Melinda Gates Foundation (BMGF), the United Nations Population Fund (UNFPA), and World Health Organization (WHO) and technical support from ICF International through the DHS program.

NDHS. Descriptive statistics for the main variables used in the analysis are presented in Table (1).

Figure (2) shows children's nutritional status by SES quintiles. There is a gradient from the poorest households to the richest households in the relationship between SES and children's nutritional status. Children living in the poorest households were likelier to have lower weight-for-age and height-for-age Z-scores than those living in the better-off households. A possible explanation for the major distributional story of height-for-age Z-score by wealth quintile and the fairly consistent distribution of weight-for-age Z-score across wealth quintiles is that children living in low-SES households are prone to stunting, while those living in higher-SES households are prone to being underweight. Figure (3) shows poverty by education level (high-skilled vs. low-skilled) and place of residence (rural vs. urban areas). It reveals that children living in low-income households were likelier to have low-educated mothers than those living in high-income households. The figure also shows that children living in low-income households were likelier to live in rural areas than those living in high-income households. The types of health care services that mothers received according to SES quintiles are displayed in Figure (4). Three measures are used to determine the use of maternal health care services: whether the mother had an institutional birth, whether she received skilled prenatal care, and whether she received skilled postpartum care. There is a gradient from the poorest to the richest mothers in the relationship between SES and maternal health care service use. Mothers in the poorest quintiles were less likely to use maternal health care services compared to mothers in the richer and richest quintiles. Figure (5) shows how the distance from the drinking water source differs across the SES quintiles. It clearly shows that poorer households spend longer to access drinking water sources than the richer ones. Figure (6) shows the variation in the incidence of diarrhea among children over SES quintiles. We can notice that children in the poorest households have higher incidence of diarrhea in comparison with children living in the richest households. A possible explanation is that those from poorest households have limited access to clean water.

Finally, Figure (7) shows the coefficients of the poverty effect on the three main outcomes of nutritional status of children (weight-for-height, weight-for-age, and height-for-age Z-scores) across the years 2008, 2013, and 2018. Looking at the confidence intervals, we find that for weight-for-age Z-score outcome, there is a significant increase in the effect over the years. For weight-for-height Z-score, we find a significant increase in the effect only from 2008 to 2013 and then does not quite change from 2013 to 2018. Finally, for the height-for-age Z-score outcome, we see no significant change from 2008 to 2013, but we do find a significant increase in the effect from 2013 to 2018. Figure (8) shows the distribution of the variable distance to drinking water sources (our instrument) over rural and urban areas. We can observe that, whereas households in rural areas spend on average around 19 minutes to reach the drinking water sources, urban households spend around 15 minutes.

3 Empirical strategy

We are interested in the relationship between poverty and children's nutritional status. We start by considering the following specification:

$$Y_{it} = \alpha + \beta_1 poor_{it} + \sum_{k=2}^{K} \beta_k X_{it}^k + \theta_s + \psi_t + \epsilon_{it} \tag{1}$$

Y_{it} is the outcome of interest for individual i at time t. $poor_{it}$ is poverty status, X_{it}^k is the vector of covariates, including the age of the child in months, child's sex, mother's education [2], age of household head, sex of household head, household size [3], and if respondents are permanent residents. θ_s and ψ_t are state- and time-specific fixed effects, whereas ϵ_{it} is the error term. The outcome variables are weight-for-height Z-score and the probability of a child being wasted (coded as one if a child had weight-for-height Z-score <-2 standard deviations (SD) and 0 otherwise); weight-for-age Z-score and the probability of a child being underweight (coded as one if a child had weight-for-age Z-score <-2 SD and 0 otherwise); height-for-age Z-score, and the probability of a child being stunted (coded as one if a child had height-for-age Z-score <-2 SD and 0 otherwise). Data from the household and children surveys were utilized.[4]

The wealth index of households is used to measure poverty, which is the main indepen-

[2] We control for father's educational level in Tables (8),(9),(10) Column (10).

[3] For further robustness, we also considered to re-run the analysis by taking into account only the households which have less than 5 children. The results do not substantially change.

[4] WHZ, WAZ and HAZ scores are the standard deviation scores of weight-for-height, weight-for-age and height-for-age, respectively. The assignment of anthropometric z-scores based on the WHO Child Growth Standards is done through a complicated interpolation function that considers sex, age, height in centimetres, and weight in kilograms (precise to 100 grams). WHZ refers to a child's weight compared to a child of the same height and sex. WAZ score refers to a child's weight compared to a child of the same age and sex. HAZ score refers to a child's height compared to a child of the same age and sex.

dent variable. The wealth index is an alternative and better welfare measure than income or expenditure (Namubiru (2014), Rutstein & Johnson (2004), Sahn & Stifel (2000)). This index is calculated using Principal Component Analysis (PCA) based on data from variables on household ownership of assets and housing conditions (Filmer & Pritchett (2001), Vyas & Kumaranayake (2006)).[5] In Table (A.1), we show descriptive statistics of these variables. Using this index, we have a more detailed picture of the situation of the household in terms of wealth, avoiding difficulties and high expenses that incur when collecting income and consumption data (Deaton & Zaidi (2002), Wiseman et al. (2015)). The resulting factor scores, generated through PCA, were standardized and used to generate the SES quintiles coded as follows: (i) poorest, (ii) poorer, (iii) middle, (iv) richer and (v) richest. Our independent variable is then constructed as a dummy variable, taking one if SES quintiles are poorest and poorer and zero otherwise.

Using ordinary least squares (OLS) to estimate equation 1 may lead us to biased estimates of the relationship between poverty and children's health status because of the presence of endogeneity. Endogeneity may arise for reverse causality if children's health status affects parents' income, for instance, if parents spend their income and devote their time to provide assistance and medicines, or other medical treatments to their children (Kuehnle (2014); Namubiru (2014)), or for the presence of unobservable characteristics correlated with both poverty status and children's nutrition, e.g. (i) parental education which can translate into malnutrition (Aslam & Kingdon (2012); Doyle et al. (2005); Silles (2015); Vollmer et al. (2017)), (ii) exogenous health factors that are known to the individual household but are unobserved by the researcher (Kabubo-Mariara et al. (2009); Mwa (2014); Rosenzweig & Zhang (2009)).

We adopt an IV approach using a two-stage least squares (2SLS) estimator to account for the endogeneity between poverty and children's nutritional status. The first stage is specified as follows:

$$poor_{it} = \pi_0 + \pi_1 log(distance\_to\_drinking\_water_{it}) + \sum_{k=1}^{K} \phi_k X_{it}^k + \theta_s + \psi_t + \mu_{it} \qquad (2)$$

[5]These variables include ownership of a car/truck, ownership of radio, ownership of refrigerator, ownership of bicycle, ownership of a motorcycle, main wall material, main floor material, main roof material, type of fuel for cooking, source of electricity, and type of toilet facility used.

$poor_{it}$ is poverty status of individual i at time t, π_0 is a constant, $distance\_to\_drinking\_water_{it}$ is our instrument, i.e. time, in minutes, to get to the nearest source of drinking water, X_{it} is a vector of controls, θ_s and ψ_t represents State- and year-specific fixed effects. μ_{it} is the error term.

A valid instrument should be correlated with poverty and not with parents' unobservable characteristics correlated to children's nutritional status. In this paper, we use minutes to get to the nearest drinking water source as an instrument for poverty. Distance is a widely adopted instrument in the health economics literature (see, for example, Chandra & Staiger (2007), and Basu (2014)) since it allows comparisons between outcomes of groups of individuals differing by only some objective criteria, say, the distance of their municipality of residence from the hospital providing medical treatments. In the same vein, we assume that it is reasonable to think that larger distances to drinking water sources imply a higher cost for individuals to find a job. This can influence their income or SES through worse economic opportunities. We believe the exclusion restriction holds since the distance to the drinking water sources should not directly affect children's weight and health in general.

It could be argued that lower access to drinking water due to a longer distance to get drinking water means having less water to use to clean fruits and vegetables, consequently increasing the incidence of diarrhea directly affecting child health. To account for this, we ran an OLS regression and found no significant association between diarrhea and our instrument. The equation is similar to equation (2), with diarrhea as the outcome (Column (1) in Table (11)). We also show results of the regression of diarrhea on our instrument by SES levels in Table (A.5) and we found no significant results across the SES levels. Furthermore, a concern might arise if a longer distance to drinking water (meaning harder access to drinking water) implies that it could be harder to make infant formula to keep a baby well-nourished. To tackle this issue, we control for infant formula by including it in the IV mediation analysis. We also ran an OLS regression to check whether the longer distance to the drinking water sources might affect the number of times mothers gave infant formula and the number of times mothers breastfed their child. The results were statistically insignificant (Columns (2) and (3) in Table (11)). Furthermore, we empirically test for the mechanisms through which our instrument might affect poverty. We assume that a longer distance from a drinking water source implies a higher probability of living in rural areas and a lower probability of being employed during the year. These assumptions are confirmed by the results of the standard (OLS) mediation analysis in Table (A.4). Furthermore, it might be argued that, as the IV setting covers both rural and urban areas, in the context of urban areas, access to piped water might affect the instrument. To account for this, we employed a robustness check by creating an instrument which takes zero if the households live in urban regions. We re-ran the previous first-stage equation and found that the coefficient remains consistent, where the coefficient is 0.10*** and SE of 0.002 and Kleibergen-Paap rk Wald F statistic is 1817.03.

Due to the fact that it can take a long time to get from home to a water source and sometimes more than one trip per day, collecting water in rural families can take a significant amount of time (Meeks (2017)). According to a number of studies, women in rural Sub-Saharan Africa (SSA) spend a significant portion of their days fetching water (Rosen et al. (1999); Blackden & Wodon (2006); Koolwal & Van de Walle (2013); Sorenson et al. (2011)). Rural households in Nigeria are also more likely to spend long hours collecting water for domestic use (Joshua et al. (2017)). In SSA, collecting drinking water in rural regions takes an average of 36 minutes per round trip, whereas in Asia, it takes only 23 minutes (United Nations, Department of Economic and Social Affairs (2010)). Urban areas in developing countries are not exempt from the challenges associated with collecting water in rural areas (Van der Bruggen et al. (2010)). Even piped water sources that are categorized as improved do not ensure the security or consistency of the water supply in urban areas (Hutton & Chase (2017)). Evidence also suggests that infrastructure is an important factor affecting economic opportunities among women (Koolwal & Van de Walle (2013); Meeks (2017)). As decision-making regarding the provision of basic infrastructure, including water, is not within the purview of women in developing countries, women are made to spend more time on tasks relating to domestic labor and have little or no time to participate in the labor force or income generating activities (Koolwal & Van de Walle (2013)). Furthermore, the lack of water infrastructure within households in developing countries makes women spend several hours collecting water for domestic use, thereby limiting the time available for income generating activities (Agénor & Agénor (2023); Cosgrove & Rijsberman (1998); Meeks (2017)). Therefore, a longer distance from a drinking water source implies a higher probability of living in rural areas and a lower probability of being employed during the year.

In addition, we perform a robustness analysis testing for plausible exogeneity of our instrument as proposed by Conley et al. (2012) showing that, even allowing the instrument to have a small, near zero effect, direct effect on the outcome, we can still estimate a significant effect of poverty on the outcome of interest. Moreover, exploiting the availability of information about the location of respondents within Nigerian States, we test whether distance to a drinking water source influences the location choices of individuals.

4 Results

4.1 OLS

Table (2) shows OLS estimates. The coefficient of poverty is negative and statistically significant, suggesting that if the probability of being poor increases by one standard deviation (i.e. 49.94 percentage points), weight-for-height, weight-for-age and height-for-age Z-scores decrease by 2.35 (i.e. 0.0004×49.94), 13.66 (i.e. 0.0027×49.94) and 20.21 (i.e. 0.0040×49.94) percentage points, which correspond to 1.76%, 9.69% and 10.87% of one standard deviation of weight-for-height, weight-for-age and height-for-age Z-scores distributions, respectively. In addition, when considering probabilities rather than continuous outcomes, our estimates show that poverty has a positive and statistically significant effect on the probability of a child being underweight and stunted. In this case, if the probability of being poor increases by one standard deviation (i.e. 49.94 percentage points), the probability of a child being underweight and stunted would increase by 2.17 (i.e. 0.0004×49.94) and 2.61 (i.e. 0.0005×49.94) percentage points, which correspond to 5.72% and 6.36% of the probability of a child being underweight and stunted standard deviations, respectively.

4.2 First Stage

Table (3) shows estimates from the first-stage regression. We find that a 10% increase in the time to reach the closest drinking water source, i.e. 17 minutes, increases the probability of living in poverty by about 0.47 percentage points (i.e., 0.00047×10). The Kleibergen-Paap rk Wald F statistic equals 335.3, suggesting that our instrument is not weak (Stock & Yogo (2002)). We find similar results when using samples split by age group (Columns 2-4). The results of our first-stage analysis prove the relevance of our instrument.

4.3 Second Stage

Table (4) presents the results of the relationship between poverty and children's nutritional status. The coefficient of poverty is negative and statistically significant, indicating that an increase in the probability of living in poverty by one standard deviation, i.e., 49.94 percentage points, would result in a reduction of weight-for-height, weight-for-age, and height-for-age Z-scores by 21.32 (i.e., 0.0042×49.94), 30.33 (i.e., 0.0060×49.94), and 27.67 (i.e., 0.0055×49.94) percentage points, which correspond to 15.98%, 21.52%, and 14.87% of the corresponding standard deviations, respectively. We also show that poverty increases the likelihood of a child being stunted, wasted, and underweight, meaning that an increase of one standard deviation, i.e., 49.94 percentage points, in the probability of being poor increases the probability of a child being wasted, underweight, and stunted by 5.99 (i.e., 0.0012×49.94), 5.49 (i.e., 0.0011×49.94), and 6.99 (i.e., 0.0014×49.94) percentage points, which corresponds to 18%, 12%, and 15% of the corresponding standard deviations, respectively. This implies that children living in low-SES households are more likely to experience poor nutritional status compared to children living in higher-SES households. Furthermore, in Table (5), we show the results of the relationship between poverty and children's nutritional status by SES (poverty) levels: poorest quintile, poorer quintile, and middle quintile. Focusing on weight-for-height, weight-for-age and height-for-age Z-score outcomes, the coefficients of poverty are negative and statistically significant for all outcomes and for all three levels. We find no significant differences in the effect size among poverty levels. The results show that an increase in the probability of being in the "poorest" quintile by one standard deviation (i.e., 43.04 percentage points) would result in a reduction of weight-for-height, weight-for-age, and height-for-age Z-scores by 22.81, 32.28, and 29.69 percentage points, which correspond to 17.09%, 22.90%, and 15.96% of the corresponding standard deviations, respectively. Similarly, we find that an increase in the probability of being in the "poorer" quintile by one standard deviation (i.e., 46.38 percentage points) would result in a reduction of weight-for-height, weight-for-age and height-for-age Z-scores by 20.87, 32.92, and 33.39 percentage points, which correspond to 15.64%, 23.37%, and 17.95% of the corresponding standard deviations, respectively. Finally, an increase in the probability of being in the "middle" quintile by one standard deviation (i.e., 48.80 percentage points) would result in a reduction of weight-for-height, weight-for-age, and height-for-age Z-scores by 18.54, 32.69, and 33.67 percentage points, which correspond to 13.90%, 23.20%, and 18.10% of the corresponding standard deviations, respectively. This implies that children from low-SES households are more likely to experience poor nutritional status regardless of their poverty levels (i.e., poorest quintile, poorer quintile, or middle quintile).

In addition, some evidence in the literature shows that poverty might also increase the probability of being overweight or obese. While we acknowledge that this may not be a serious issue for children under 5 years of age in Nigeria, we address this concern by examining the relationship between poverty and children's weight by age. Table (A.3) presents the results. We observe that there is no positive relationship between poverty and children's weight; thus, the potential relationship between poverty and being overweight or obese must not be a concern in our study. Furthermore, in Table (A.2) we present the results of the reduced form analysis (regression of the outcome variables on our instrument).

4.4 Effect of poverty on children's nutritional status by child's age

Table (6) presents the results of the relationship between poverty and children's nutritional status by age using the IV strategy. We find that the relationship between poverty and children's nutritional status is significant for children over 5 months of age for all outcomes. In Table (6), Column (1), the relationship between poverty and children's nutritional status is not statistically significant for children aged 0–5 months. However, the relationship between poverty and children's nutritional status is statistically significant for children aged 6–23 months (see Table (6), Column (2)) and 24-59 months (see Table (6), Column (3)). This implies that children living in low-SES households experience poor health from birth, and their health status declines over time. Furthermore, Table (7) presents results on the relationship between the different levels of poverty (poorest quintile, poorer quintile, and middle quintile) and children's nutritional status (considering only weight-for-height, weight-for-age, and height-for-age Z-scores) by child age groups. While we do not find a significant relationship between poverty and children's nutritional status for the 0–5 month age group for all outcomes, we find a significant increase in the relationship between poverty and children's nutritional status by age increase for the 6–23 month and

24–59 month age groups in the "poorest" quintile, particularly for weight-for-age and height-for-age Z-scores outcomes. Furthermore, while we find a significant relationship between poverty and children's nutritional status only for the 24–59 month age group for weight-for-height and height-for-age Z-scores, we find a significant increase in the relationship between poverty and children's nutritional status by age increase for the 6–23 month and 24–59 month age groups for weight-for-age Z-scores in the "poorer" quintile. Finally, in the "middle" quintile, while we find a significant relationship between poverty and children's nutritional status only for the 24-59 month age group for weight-for-height Z-score and for the 6–23 month and 24–59 month age groups for weight-for-age and height-for-age Z-scores, we did not find an increasing relationship between poverty and children's nutritional status by age increase.

4.5 Robustness checks

In this section, we provide some evidence about the robustness of our estimates (Tables (4), (12) and Figures A.1-A.6) . First, we perform the Durbin–Wu–Hausman test to justify using the IV strategy (see Panel (b) of Table (4)). The p-value is smaller than the conventional 10% level for almost all outcomes.

Furthermore, in order to strengthen our assumption that our instrument (distance to water sources) affects children' nutritional status only through poverty (the exclusion restriction criteria), we apply the method by Conley et al. (2012) to test the plausible exogeneity of our instrument. The exclusion restriction of the instrument from the outcome equation is an important requirement for the validity of the IV strategy, but in many cases, this assumption is questionable. Conley et al. (2012) develop inference methods when relaxing the exclusion restriction, defining a parameter (Ψ in our case) that reflects how close the exclusion restriction is "satisfied" as in the following model:

$$Y_{it} = \beta poor_{it} + \Psi Distance\_to\_drinking\_water_{it} + \epsilon_{it} \tag{3}$$

Where $distance\_to\_drinking\_water$ is our instrument, which is assumed to be uncorrelated with the error term in the IV context, if $poor_{it}$ is endogenous, the parameters β and Ψ cannot be jointly identified, meaning that prior assumptions about Ψ must be used to obtain estimates of the parameters of interest β.

In this framework, the exclusion restriction equals the prior belief that Ψ is identically zero. We can relax this restrictive assumption by preceding information suggesting that Ψ is "close to" zero but not "exactly" zero. This way, we can relax the exclusion restriction while yielding an adequate method for estimating β.

Figures A.1-A.6 present the plausible exogeneity test results for the outcome variables of interest. The Figures show the 90% confidence intervals of our parameter of interest β in equation (1), following one of the methods proposed, the union of the Symmetric CI, where this method allows to change the support of Ψ, through "delta", where the interval is $[0,\ 5\delta]$ for the weight-for-height, weight-for-age, and height-for-age Z-scores variables. In contrast, the interval is $[0,\ 1\delta]$ for the probability of a child being wasted, underweight and stunted. The Figures on the plausible exogeneity test show that the effect of poverty on the outcome variables (weight-for-height, weight-for-age, and height-for-age Z-scores) turns insignificant when δ is around 0.02. In contrast, the effect of poverty on the probability of a child being wasted, underweight and stunted outcome variables turn insignificant when δ is around 0.003, 0.007, and 0.004, respectively.

Finally, for a further check, we perform a robustness check to account for the possibility that non-poor individuals move systematically to places closer to drinking water sources. It is reasonable to think that children born at different distances from drinking water sources, e.g. an additional km, are more likely to live in a low-income family because the additional distance implies a cost to accessing the labor market but has an identical distribution regarding family unobservable characteristics. This strategy is valid unless individuals living in poverty decide on their residence based on the distance to drinking water sources. To tackle this, we re-estimate our IV model only considering those individuals who declared themselves to be permanent residents. Table (12) presents the results of this check. Our baseline results are confirmed. The coefficients of poverty were negative and statistically significant, meaning that being from a low-SES household reduces the weight-for-height, weight-for-age, and height-for-age Z-scores by 18.81, 25.42 and 19.60 standard deviations, respectively. Although there is concern about the exogeneity of access to water given the intergenerational persistence of poverty, evidence suggests that water distance, source, or quality are not affected by intergenerational poverty (Bird (2013); Corak et al. (2014); National Academies of Sciences et al. (2023); Torche (2015)).

5 Mechanisms

In this section, we shed light on the mechanisms underlying the relationship between poverty and children's nutritional status. To examine these mechanisms, we employ the causal mediation analysis in the IV setting, introduced by Dippel et al. (2020). The identifying assumption is that treatment (T) is endogenous in a regression of Y on T, but endogeneity does not arise from confounders that jointly impact T and Y, and only form confounders that jointly impact mediator (M) and T. The method allows for confounders that jointly affect M and Y as well. Within this approach, there are two possible endogenous regressors in a regression of Y on both T and M, and only one instrument (Z) to address the endogeneity. This model estimates three effects: 1) total effect of T on Y, where T is instrumented with Z; 2) direct effect of T on Y, net of the effect of M; 3) indirect effect (mediation effect) of M through which T influences Y. The indirect effect is the product between (M on T) and (Y on M). Therefore, the mediation effect (as percentage of the total effect) is the indirect effect divided by the total effect per 100 [6]. We use STATA's *ivmediate* command which implements this framework. The results report two first-stages F statistics. The first is the standard test for the relevance of the instrument in the regression of treatment (i.e. poverty in our case) on the instrument (T on Z), and the second is in the regression of mediator on the instrument controlling for treatment (M on Z|T) which is employed in the estimation of the indirect effect.

We decide to test for the potential mechanisms of the following mediators: if mother visited health facility for care in the last 12 months, number of antenatal visits during pregnancy, if mother had postnatal check in the first two days (considering how long before and after discharge did the first check take place), if mother received antenatal care from a skilled provider (doctor, nurse or auxiliary midwife), if mother had institutional (public or private health facility based) delivery, if mother received skilled assistance during delivery (doctor, nurse or auxiliary midwife), father's education (high skilled), if child had diarrhea recently, if child had fever in last two weeks, if child had cough with short and rapid breath, maternal body mass index (BMI), mother's weight, child inadequate nutrition intake, if child had infant formula and improved quality of water. Father's education is a

[6] It is worth mentioning that, as Dippel et al. (2020) points out, in this mediation analysis either direct or indirect effect can have opposite sign. In other words, it is logically possible to have a negative treatment effect that is composed of a larger negative indirect effect that is partly counterbalanced by a positive direct effect, or vice versa. In such cases, the indirect effect could correctly explain more than 100 percent of the total effect. However, this requires a careful interpretation.

dummy, taking one if the education level is secondary or higher. Adequate child-specific nutritional intake is a dummy variable where it takes one if, in the last 24 hours, the child consumed bread/grains/tubers, vegetables and fruits, and eggs/fish/meat/dairy, and zero otherwise. Improved quality of water is a dummy variable where it takes one if the source of water is piped into a dwelling/piped to a yard/piped to a neighbour/public tap/tube well/protected well/protected spring/rainwater, and zero otherwise.

In Tables (8),(9),(10), we report the results of the IV mediation analysis for the outcomes weight-for-height, weight-for-age, and height-for-age Z-scores, respectively. We find similar results for weight-for-height and weight-for-age Z-scores, where the indirect effect is statistically (negatively) significant for almost all mediators except for postnatal check and diarrhea illness. However, for height-for-age Z-score, household nutrition and acute respiratory symptoms are statistically significant as mediators. The total effect coefficients controlling for the mediators do not substantially change. In the following sections, we devote more attention to these mediators.

5.1 Health care service utilization

Out-of-pocket (OOP) payments for health care remain the major source of financing health care in Nigeria (Aregbeshola & Khan (2018*a*)). Many households face barriers to accessing health care due to OOP payments. Therefore, difficulties in accessing health care services may be a mechanism underlying the relationship between poverty and children's nutritional status. Health care services allow parents to interact with health care workers, who provide information on children's appropriate diet and nutrition. Tables (8),(9),(10), Column (1), shows the relationship between poverty, health care service utilization as proxied by visits to a health facility, and children's nutritional status. The significant "indirect effect" coefficient shows that health care service utilization might be a mediating factor for the weight-for-height and weight-for-age Z-scores. The finding that health care service utilization mediates the relationship between poverty and weight-for-height and weight-for-age Z-scores implies that children living in low-SES households are less likely to utilize health care services when they fall sick; hence, they are unable to manage acute illnesses.

5.2 Maternal health care services use

In addition to utilizing general health care services, mothers also use specialized health care services such as antenatal care, postnatal care, health facility-based or institutional delivery, and skilled assistance during delivery. By utilizing these services, mothers may be sure that they are receiving care from qualified health care professionals, which enhances their knowledge and guarantees positive outcomes for the health of both the mother and the child. The association between poverty, maternal health care service utilization, and children's nutritional status is displayed in Tables (8),(9),(10), Columns (4–8). The indirect effect indicates that antenatal care visits are a mediating factor for the weight-for-height and weight-for-age Z-scores. Similarly, the indirect effect indicates that skilled antenatal care visits are a mediating factor for the weight-for-height and weight-for-age Z-scores. The "fetal origins" hypothesis posits that shocks that occur during pregnancy not only have immediate effects in utero but may also generate long-lasting health consequences for the child (Almond & Currie (2011); Barker (1990). This paper controlled for antenatal maternal health utilization to address this mechanism and the implications of the "fetal origins" hypothesis.

According to the indirect effect estimates for postnatal health check, we observe that the postnatal health check could not be a mediating factor for the weight-for-height and weight-for-age Z-scores as this result is not statistically significant. Regarding facility-based or institutional delivery factor, the indirect effect shows that it could be a potential mediating factor for the weight-for-height and weight-for-age Z-scores. For skilled assistance during delivery factor, the significant indirect effect indicates that it is a mediating factor for weight-for-height and weight-for-age Z-scores. The results suggest that parents of children living in low-SES households are less likely to use maternal health care services than parents of children living in high-SES households.

5.3 Household nutrition

Household nutrition was assessed using 22 variables. In the NDHS data sets, respondents were asked if they ate food made from cereal grains, vegetables or roots that are orange colored inside, white root and tubers or plantains, dark green leafy vegetables, fruits that are dark yellow or orange inside, meat made from animal organs, eggs, fish or seafood, beans or peas, nuts or seeds, milk or milk products, red palm oil, savory and fried snacks, sweets, sweetened sugar beverage, among others. Factor analysis was used to create the nutrition outcome variable [7]. Tables (8),(9),(10) , Column (2), shows the relationship between poverty, household nutrition [8], and children's nutritional status. The indirect effect estimates that household nutrition is a mediating factor accounting for a reduction in the weight-for-height, weight-for-age, and height-for-age Z-scores. The finding that inadequate household nutrition mediates the relationship between poverty and weight-for-height, weight-for-age, and height-for-age Z-scores suggests that children living in low-SES households are less likely than those in high-SES households to have adequate nutrition.

5.4 Child-specific nutrition intake

Child-specific nutrition intake was assessed using 24 variables. Bread, grains, and tubers; fruits and vegetables; eggs, fish, meat, and dairy; and oils and fat were the categories into which liquids and foods were divided. If a child has eaten bread, grains, potatoes, fruits, vegetables, eggs, fish, meat, or dairy products in the past 24 hours, their intake of food was adequate; and zero otherwise. The relationship between poverty, child-specific nutrition intake, and children's nutritional status is shown in Tables (8),(9),(10), Column (16). The indirect effect suggests that, as a mediating factor, child-specific nutrient intake is responsible for a reduction in weight-for-height and weight-for-age Z-scores. The results suggest that children living in low-SES households are less likely to have adequate child-specific nutrition compared to those living in high-SES households.

5.5 Maternal nutrition

The relationship between poverty and children's nutritional status may be mediated by maternal nutrition. Mothers who are undernourished have a higher probability of giving birth to children with poor health, as children may have inherited health risks from their mothers or are raised in an unhealthful or unsupportive environment (Propper et al. (2007); Khanam et al. (2009)). It is crucial to take maternal nutrition into consideration

[7] The outcome variable is a continuous variable representing factor scores obtained by the factor analysis using the regression scoring method (command "predict" as post-estimation after "factor") based on the dummy variables mentioned above (respondents' answers on the 22 questions on food consumption).

[8] To see to what extent household nutrition is associated with children's nutrition measured by the child-specific nutrition intake variable, we ran an OLS and found a significant positive correlation (coefficient of 0.0137*** and SE of 0.003).

in the child health-SES gradient because mothers who are malnourished are also more likely to be poor since they may not be able to make enough money to meet their children's demands. We included measures of maternal nutrition, such as a mother's BMI and weight, in a mediation analysis to determine if maternal nutrition mediates the relationship between poverty and children's nutritional status in Nigeria. The relationship between poverty, maternal nutrition, and children's nutritional status is presented in Tables (8),(9),(10) Columns (14) and (15). The indirect effect indicates that maternal BMI acts as a mediating factor, accounting a reduction in weight-for-height and weight-for-age Z-scores. The mother's weight is estimated to be a mediating factor in reducing the weight-for-height and weight-for-age Z-scores, according to the indirect effect. The findings that mothers' BMI and weight act as mediating factors in the relationship between poverty and weight-for-height and weight-for-age Z-scores suggest that children whose mothers have poor nutrition are more likely to have poor nutritional status.

5.6 Illness episodes

Diarrhea, fever, and acute respiratory symptoms are examples of illness episodes that could mediate the relationship between poverty and children's nutritional status. Evidence from similar studies on the child health-SES gradient suggests a prevalence or incidence effect where children from poorer households are more likely to be subject to health shocks than those from richer households (Apouey & Geoffard (2013); Case et al. (2002)). The relationship between poverty, diarrhea, fever, acute respiratory symptoms, and children's nutritional status is displayed in Tables (8),(9),(10), Columns (11–13). The indirect effect, however, indicates that diarrhea might not be a potential mediating factor for weight-for-height, weight-for-age, and height-for-age Z-scores, as this result is not statistically significant. Fever, on the other hand, is estimated to be a mediating factor in reducing the weight-for-height and weight-for-age Z-scores, according to the indirect effect. Similarly, acute respiratory symptoms are found to be mediating factors and responsible for a reduction in the weight-for-height, weight-for-age, and height-for-age Z-scores. The results indicate that children living in low-SES households are more likely than children living in high-SES households to experience fever and acute respiratory symptoms. The fact that children living in low-SES households are more likely to experience health shocks means that their health will deteriorate over time.

6 Discussion

There is limited evidence on the child health-SES gradient in Africa. This is the first paper to examine the relationship between poverty and children's nutritional status, determine whether the relationship between poverty and children's nutritional status increases with age, and explore the mechanisms underlying the relationship between poverty and children's nutritional status within the Nigerian context. Using three rounds (2008, 2013, and 2018) of the NDHS dataset, we employed an approach based on IV to control for endogeneity. We also test for the robustness of our findings. The use of repeated cross-sectional surveys makes it difficult to infer a causal relationship between poverty and children's nutritional status in our paper. This makes it more difficult to take into consideration the overall impact of health or previous utilization of health care on child health production.

Our study finds that poverty reduced weight-for-height, weight-for-age, and height-for-age Z-scores by 21.32, 30.33, and 27.67 percentage points, respectively. A plausible explanation is that parents of children living in low-SES households are unable to invest in their children's health and access the needed health care services, thereby exposing their children to health shocks (Allin & Stabile (2012); Case et al. (2002); Propper et al. (2007)). This finding is consistent with results of similar studies in low- and middle-income countries (LMICs) that suggest that household SES has a significant relationship with children's health status (Cameron & Williams (2009); Goode et al. (2014); Petrou & Kupek (2010); Waibel & Hohfeld (2016); Sepehri & Guliani (2015); Swaminathan et al. (2019)). A comparison of the OLS and IV estimates shows that there is a downward endogeneity bias, meaning that the result of our study has taken into account the endogeneity problem. Studies in France, Canada, Australia, Germany, the UK, and US also reported a significant association between household SES and children's health (Apouey & Geoffard (2013); Case et al. (2002); Case et al. (2008); Chen et al. (2006); Condliffe & Link (2008); Currie & Stabile (2003); Currie et al. (2007); Khanam et al. (2009); Kruk (2013); Kuehnle (2014); Murasko (2008); Propper et al. (2007); Reinhold & Jürges (2012)). The magnitude of the relationship between poverty and children's health status is small compared to those of similar studies (Case et al. (2002); Case et al. (2008); Condliffe & Link (2008); Currie & Stabile (2003); Currie et al. (2007); Khanam et al. (2009); Kruk (2013);

Kuehnle (2014); Murasko (2008)). The smaller effect size may be due to the low coverage of health insurance and the lack of support for children from the poorest households in Nigeria (Aregbeshola & Khan (2018*b*); Ogwumike & Ozughalu (2018)). Our finding that poverty reduced weight-for-height, weight-for-age, and height-for-age Z-scores by 21.32, 30.33, and 27.67 percentage points has implications for policy. This implies that the effective implementation of an evidence-based poverty alleviation program may increase weight-for-height, weight-for-age, and height-for-age Z-scores among children living in low-SES households.

We also find that poverty increases the likelihood of a child being wasted, underweight, and stunted by 5.99, 5.49, and 6.99 percentage points. The finding that poverty increases the likelihood of a child being stunted and underweight is consistent with the results of similar studies in Ethiopia, India, and Peru (Petrou & Kupek (2010)). A comparison of the OLS and IV estimates also shows that there is a downward endogeneity bias, meaning that the result of our study has taken into account the endogeneity problem. The magnitude of the relationship between poverty and children's nutritional status is quite large compared to similar studies in Ethiopia, India, and Peru (Petrou & Kupek (2010)). Our finding that poverty increases the likelihood of a child being wasted, underweight, and stunted by 5.99, 5.49, and 6.99 percentage points also has implications for policy. This implies that the issues of wasting, underweight, and stunting among children living in low-SES households could be addressed with the effective implementation of an evidence-based poverty alleviation program.

We find a child health-SES gradient increasing with age from 6 to 59 months, meaning that the negative relationship between poverty and children's nutritional status increases with child age and is expected to compound throughout the course of a child's lifetime. Besides, these negative relationships between poverty and children's nutritional status accumulate over the lifetime of children (Apouey & Geoffard (2013); Case et al. (2002); Condliffe & Link (2008); Currie & Stabile (2003)). Our finding is consistent with results of similar studies in developing countries such as China, Ethiopia, India (Andhra Pradesh), and Peru that found that the child health-SES gradient increases with age (Goode et al. (2014); Petrou & Kupek (2010)), but in contrast to findings from Indonesia and Vietnam that found that the child health-SES gradient does not increase with age (Cameron & Williams (2009); Sepehri & Guliani (2015)). Some empirical studies conducted in the US, UK, Canada, and Australia also reported a child health-SES gradient increasing with age (Allin & Stabile (2012); Case et al. (2002); Case et al. (2008); Condliffe & Link (2008); Currie & Stabile (2003); Khanam et al. (2009); Murasko (2008)). In contrast, some studies in developed countries found that the child health-SES gradient does not increase with age (Apouey & Geoffard (2013); Chen et al. (2006); Currie et al. (2007); Kuehnle (2014); Propper et al. (2007); Reinhold & Jürges (2012)). The magnitude of the child health-SES gradient in this study cannot be compared to those of studies conducted in the US, UK, Canada, and Australia, as our data comprise of children aged 0-59 months while studies from these developed countries have data on children aged 0–17 years (Currie & Stabile (2003); Currie et al. (2007); Khanam et al. (2009)). However, the magnitude of the child health-SES gradient in our study is small in contrast with findings of similar studies (Allin & Stabile (2012); Case et al. (2002); Case et al. (2008); Condliffe & Link (2008); Currie & Stabile (2003); Goode et al. (2014); Khanam et al. (2009); Murasko (2008); Petrou & Kupek (2010)). One reason for the differences in the nature of gradients between developed and developing countries could be that the types of illnesses that endanger children's health vary between developed and developing countries (Cameron & Williams (2009);; Sepehri & Guliani (2015)). In developing countries, parent assessments of children's health tend to be more influenced by acute illnesses like diarrhea and acute respiratory infections than by chronic ones (Cameron & Williams (2009); Sepehri & Guliani (2015)). Furthermore, acute illnesses are typically less common and milder in older children than chronic problems, which tend to manifest as children get older (Sepehri & Guliani (2015)). Acute diseases are more common in children from lower-income families, but because they are transient, they are less likely than chronic problems to have a cumulatively detrimental influence on health (Sepehri & Guliani (2015)).

We show that the mechanisms underlying the relationship between poverty and children's nutritional status are health care service utilization, maternal health care service use, household nutrition, child-specific nutrition intake, maternal nutrition and illness episodes. For instance, fewer people use health care services when poverty rises, which may harm children's nutritional status (Case et al. (2008)). This is the first paper to show that health care service utilization mediates the relationship between poverty and children's nutritional status in LMICs. However, this finding contrasts with results from similar studies in the US, UK, and Canada, which show that the use of health care services does not mediate between household SES and children's health (Allin & Stabile (2012); Apouey & Geoffard (2013);Case et al. (2002)). A plausible explanation is that access to health care services is easier in these countries than it is in Nigeria (Peters et al. (2008)). The use of maternal health services such as antenatal care visits, skilled antenatal care visits, health facility-based or institutional delivery, and skilled assistance during delivery mediate the relationship between poverty and weight-for-height and weight-for-age Z-scores. This is also the first paper to show that maternal health care services use mediates the relationship between poverty and children's nutritional status. A possible explanation is that there is poor access to maternal health care services in Nigeria (Adedokun et al. (2023)).

Household nutrition mediates the relationship between poverty and weight-for-height, weight-for-age, and height-for-age Z-scores in this paper. Therefore, poverty exposes children to the negative effects of inadequate household nutrition on children's nutritional status (Case et al. (2008)). This is the first paper to show that household nutrition mediates the relationship between poverty and children's nutritional status in LMICs. This finding is consistent with results from similar studies in the UK, and England that find that nutrition is an essential pathway through which family income affects children's health (Currie et al. (2007); Kuehnle (2014)). In contrast, a similar study in the UK finds that nutrition is not a mechanism through which family income affects children's health status (Apouey & Geoffard (2013)).

The results of this paper show that inadequate child-specific nutrition intake also mediates the relationship between poverty and weight-for-height and weight-for-age Z-scores. A possible explanation is that parents of children living in low-SES households are unable to afford adequate nutrition for their children. Furthermore, children living in low-SES households are more vulnerable to the harmful impacts of poor nutrition on their nutritional condition (Case et al. (2008)). This finding is consistent with the results of a similar study conducted in China that found that the nutrition intake of children is an important mechanism underlying the relationship between household SES and children's health (Goode et al. (2014)). This paper revealed that a mother's BMI and weight act as mediating factors in the relationship between poverty and weight-for-height and weight-for-age Z-scores. This finding is consistent with the results of similar studies in Vietnam and India, which reported that maternal or parental health mediates the relationship between SES and children's health (Sepehri & Guliani (2015); Swaminathan et al. (2019)). In contrast, a similar study in Indonesia reported that parental health is not a mechanism underlying the relationship between SES and children's health (Cameron & Williams (2009)). The results of similar studies in the US, UK and Germany show that maternal nutrition is not an important mechanism underlying the relationship between SES and children's health (Case et al. (2002); Propper et al. (2007);Reinhold & Jürges (2012)). While similar studies in the UK, Canada, and Australia found that maternal health, specifically a mother's physical and mental health, are the mechanisms underlying the relationship between SES and children's health (Allin & Stabile (2012); Khanam et al. (2009); Propper et al. (2007)), others found that parental health, especially maternal health, did not mediate the relationship between SES and children's health (Apouey & Geoffard (2013); Kruk (2013); Kuehnle (2014)).

In this paper, fever mediates the relationship between poverty and weight-for-height and weight-for-age Z-scores, while acute respiratory symptoms act as a mediating factor in the relationship between poverty and weight-for-height, weight-for-age, and height-for-age Z-scores. Our finding is consistent with the results of similar studies in Indonesia and Vietnam that reported illness episodes as the mechanism underlying the relationship between SES and children's health (Cameron & Williams (2009)); Sepehri & Guliani (2015)). However, this finding contrasts with results of similar studies in the US, UK, and Canada that show chronic health conditions such as asthma, diabetes, epilepsy, and mental retardation explain the child health-SES gradient (Allin & Stabile (2012); Apouey & Geoffard (2013); Case et al. (2002) and Currie et al. (2007)). A plausible explanation is that children in developing countries face acute illnesses such as diarrhea, fever, and acute respiratory symptoms compared to children in developed countries that experience chronic health conditions such as asthma allergies, bronchitis, and mental health problems (Cameron & Williams (2009); Sepehri & Guliani (2015)). From a policy perspective, our findings imply that policies aimed at reducing social health inequalities in childhood should address the reasons why children living in low-SES households are more likely to have specific health problems and why these specific problems are more severe for them. In particular, reducing gaps in access to health care may decrease the severity of specific problems for children from the poorest households (Currie & Stabile (2003)).

Our finding that the mechanisms underlying the relationship between poverty and children's nutritional status are health care service utilization, maternal health care service use, household nutrition, child-specific nutrition intake, maternal nutrition and illness episodes has implications for policy. This implies that addressing the barriers that children living in low-SES households face in accessing health care may reduce the SES–gradient in children's health. Furthermore, the SES–gradient in children's health may be reduced by the design and effective implementation of strategies targeted to specific issues such as poor utilization of health care services, poor access to maternal health care services, inadequate household nutrition, inadequate child-specific nutrition intake, poor maternal nutrition and illness episodes among children living in low-SES households. The findings of this paper are significant in light of the mixed and inconclusive evidence on the relationship between SES and children's health, the child health-SES gradient, and the mechanisms underlying the relationship between SES and children's health.

The findings of this paper have implications for achieving Sustainable Development Goal (SDG) targets 1.0, which aim to eradicate poverty, and 2.2, which aim to eradicate all kinds of malnutrition by 2030. This includes meeting the internationally set targets for stunting and wasting in children under the age of five by 2025. The design and effective implementation of cost-effective interventions and policies aimed at reducing poverty would be critical to improving children's nutritional status. Children living in low-SES households are more likely to experience health shocks because their parents are unable to invest in their health and provide them with access to the needed health care services. Therefore, policymakers should implement evidenced-based social welfare programs targeting the health of children from low-SES households. Research indicates that the implementation of evidence-based social welfare programs aimed at improving the health and education of children from low-SES households has the highest marginal value of public funds because the government can eventually recover its investment from adult social welfare program beneficiaries (García et al. (2020); Hendren & Sprung-Keyser (2020)). Furthermore, the results of this paper show that health care service utilization, maternal health care service use, household nutrition, child-specific nutrition intake, maternal nutrition, and illness episodes are the mechanisms underlying the relationship between poverty and children's nutritional status, suggesting that it would be important to prioritize interventions aimed at improving health care service utilization, maternal health care service use, household nutrition, child-specific nutrition intake, maternal nutrition, and illness episodes. A major lesson from the findings of this paper is that a multicomponent intervention, including evidence-based social welfare programs complemented with effective strategies targeted to specific issues such as low health care service utilization, poor access to maternal health care services, inadequate household nutrition, inadequate child-specific nutrition intake, poor maternal nutrition, and illness episodes, would be important to achieve poverty reduction and improve children's nutritional status in Nigeria. The achievement of SDG targets 1.0 and 2.2 would be dependent on the political will and commitment of poverty alleviation program implementers as well as policymakers in charge of anti-poverty or nutrition policies to address the problem of poverty and poor child nutritional status based on scientific evidence rather than anecdotal evidence. The need to alter the current approach is indicated by the rising rates of extreme poverty since the 1980s, despite the adoption of several programs aimed at reducing poverty. Our results support evidence about the child health-SES gradient found in some developed countries, showing that the child health-SES gradient is a policy-relevant issue in both developed and developing countries. These findings also support the SDG targets 1.0 and 2.2.

6.1 Limitations and strengths

The findings of this paper should be interpreted with caution. We use repeated cross-sectional survey data to examine the relationship between poverty and children's nutritional status, rather than panel data. Therefore, it is impossible to infer causality. However, we addressed issues related to the use of repeated cross-sectional data and the pooling of three different survey years together for the analysis by ensuring that data and variables are comparable over time, thereby ensuring that differences between years reflect real variation as opposed to artefacts of changes in survey methodology, question design, or variable coding. The datasets used in this paper were also researched. In addition, we read the accompanying documentation thoroughly before starting dataset construction. Another strength of this study is that we use objective measures of children's health status, such as weight-for-height, weight-for-age, and height-for-age Z-scores. We could not control for the child's birth height due to its unavailability in the NDHS data sets. Maternal smoking could also not be controlled for in our study due to the small sample size of smokers compared to non-smokers.

7 Conclusions

This paper examine the relationship between poverty and children's nutritional status using the 2008, 2013, and 2018 NDHS data sets. The relationship between household SES and children's health is mixed and inconclusive, with some studies finding a strong and positive relationship and others finding no relationship or a weak relationship. The mechanisms underlying the relationship between household SES and children's health are not well understood and could be due to unobserved variables or parental characteristics. Nigeria is an interesting case for analysis as it has struggled with poverty reduction since the 1980s despite implementing various poverty alleviation programs. This paper contributes to the debate on whether the child health-SES gradient increases with age as well as the mechanisms underlying the relationship between household SES and children's health.

We find that poverty reduced weight-for-height, weight-for-age, and height-for-age Z-scores by 21.32, 30.33, and 27.67 percentage points, respectively. We also find that poverty increases the likelihood of a child being wasted, underweight, and stunted by 5.99, 5.49, and 6.99 percentage points. We show that the mechanisms underlying the relationship between poverty and children's nutritional status are health care service utilization, maternal health care service use, household nutrition, child-specific nutrition intake, maternal nutrition, and illness episodes. The utilization of health care services acts as a mediating factor in the relationship between poverty and weight-for-height and weight-for-age Z-scores. The use of maternal health care services such as antenatal care visits, skilled antenatal care visits, health facility-based or institutional delivery, and skilled assistance during delivery mediate the relationship between poverty and weight-for-height and weight-for-age Z-scores. Household nutrition mediates the relationship between poverty and weight-for-height, weight-for-age, and height-for-age Z-scores. Inadequate child-specific nutrition intake also mediates the relationship between poverty and weight-for-height and weight-for-age Z-scores. Mother's BMI and weight act as mediating factors in the relationship between poverty and weight-for-height and weight-for-age Z-scores. Fever mediates the relationship between poverty and weight-for-height and weight-for-age Z-scores, while acute respiratory symptoms act as a mediating factor in the relationship between poverty and weight-for-height, weight-for-age, and height-for-age Z-scores. Duration of breastfeeding and the mother's current breastfeeding act as mediating factors in the relationship between poverty and weight-for-height and weight-for-age Z-scores.

Our findings reveal that improving health care service utilization, maternal health care service use, household nutrition, child-specific nutrition intake, maternal nutrition, and illness episodes among children living in low-SES households is important to reduce the SES–gradient in children's health. Policymakers should implement evidenced-based social welfare programs targeting the health of children from low-SES households. A multicomponent intervention including evidence-based social welfare programs complemented with effective strategies targeted to specific issues that mediate the relationship between poverty and children's nutritional status would be important to achieve poverty reduction and improve children's health in Nigeria.

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Figures

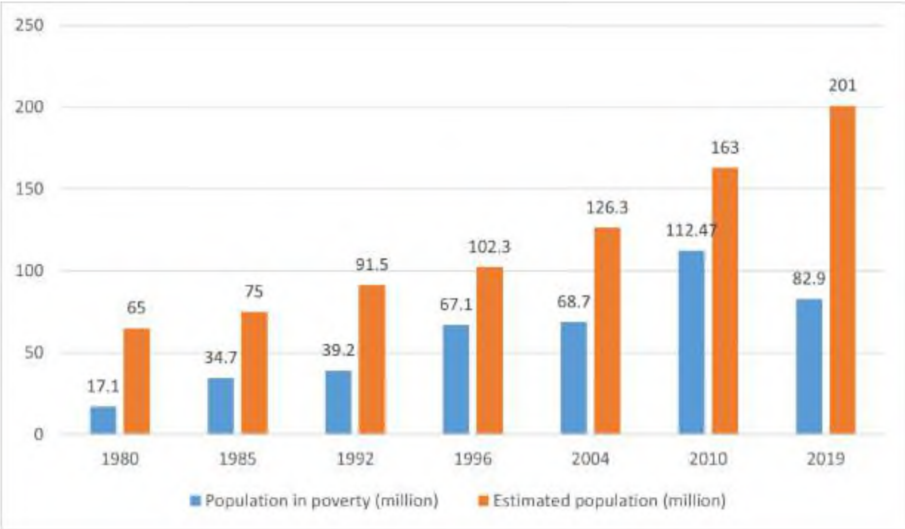

Figure 1: Trends in the poverty rate in Nigeria between 1980 and 2019.
Source: Authors' elaboration based on literature review.

Notes: This Figure shows the trends of poverty rate in Nigeria between the years 1980 and 2019, where the blue bar represents poor population (in millions) and the red bar represents the total population (in millions).

Figure 2: Children's nutritional status by SES quintiles.
Source: Authors' elaboration using NDHS.

Notes: This Figure shows the children's nutritional status measures (WAZ and HAZ) by the SES categories (from poorest to richest). WAZ and HAZ scores are multiplied by 100.

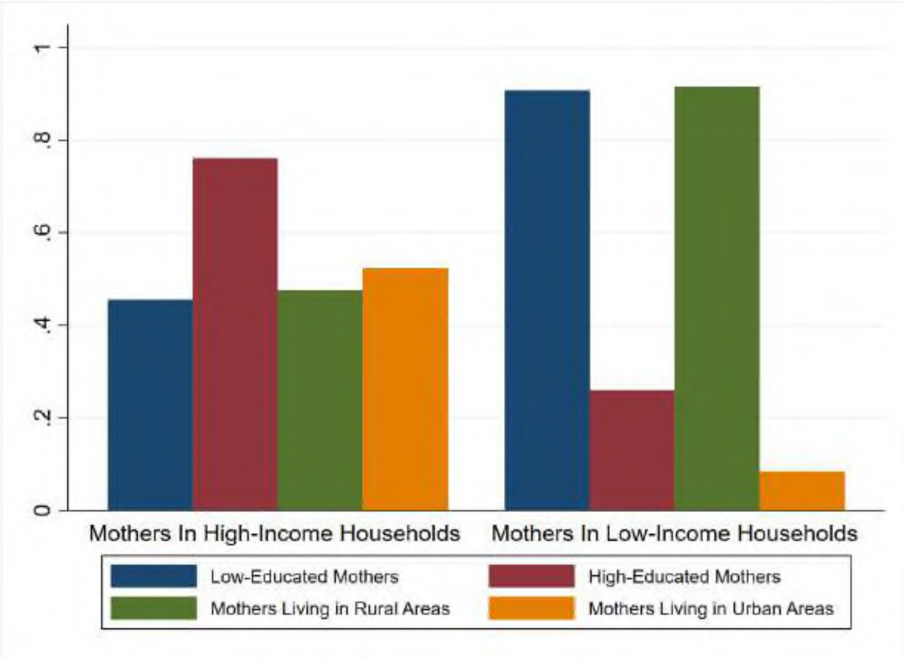

Figure 3: Poverty by Education Level and Place of Residence
Source: Authors' elaboration using NDHS.

Notes: This Figure shows poverty (mothers with high income vs. mothers with low income) by education level of mothers (low-educated vs. high-educated) and place of residence (rural vs urban areas)

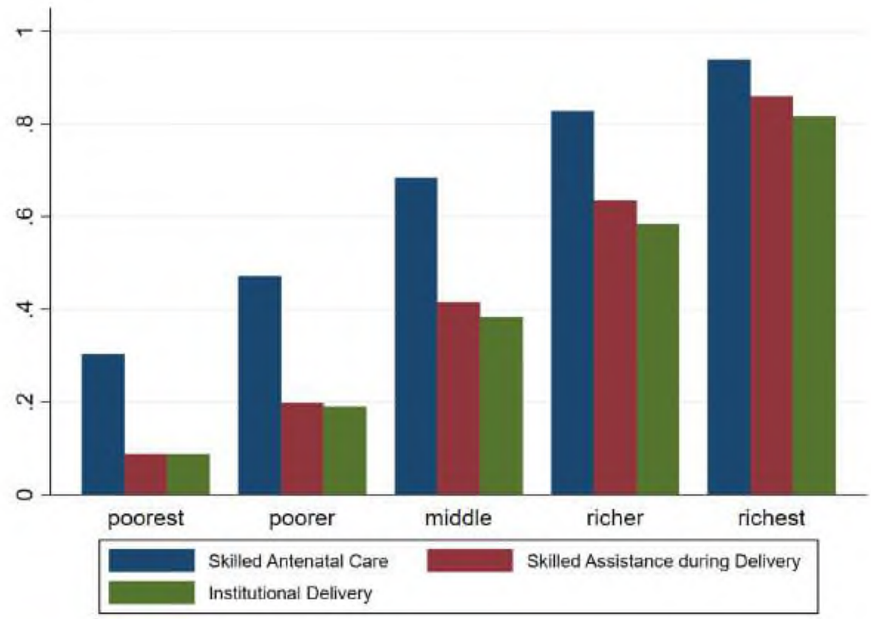

Figure 4: Maternal Health Care Services by SES quintiles
Source: Authors' elaboration using NDHS

Notes: This Figure shows the variation of health care services (antenatal care received by skilled provider, assistance during delivery by skilled provider and institutional delivery) by SES levels (from poorest to richest).

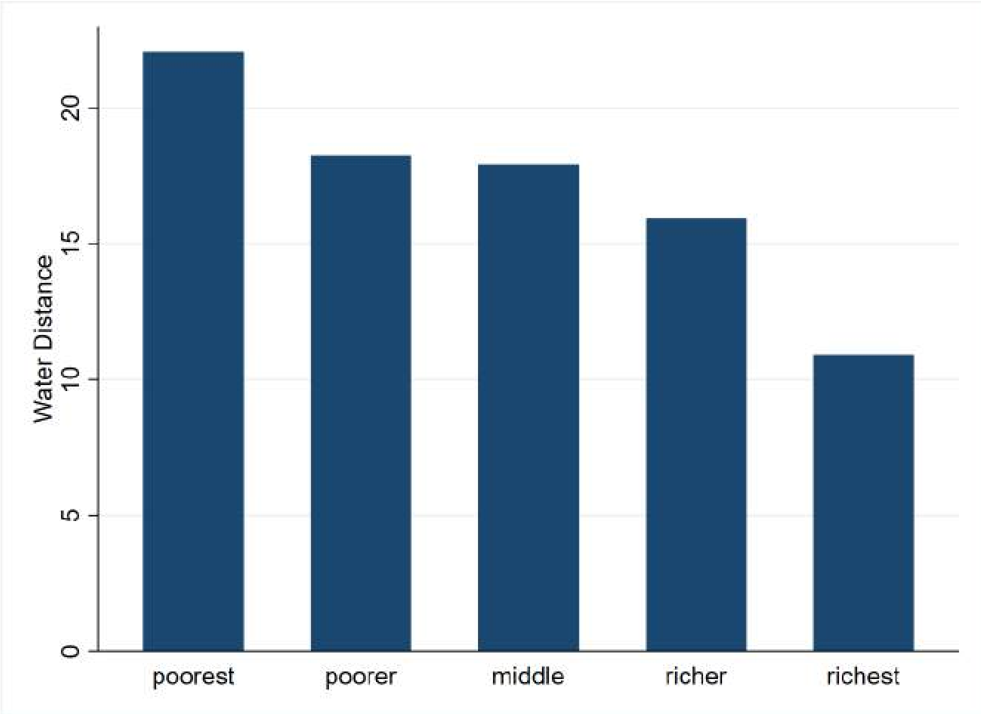

Figure 5: Distance to drinking water sources by SES quintiles
Source: Authors' elaboration using NDHS

Notes: This Figure shows how distance from water source (our instrument) varies by SES levels (from poorest to richest).

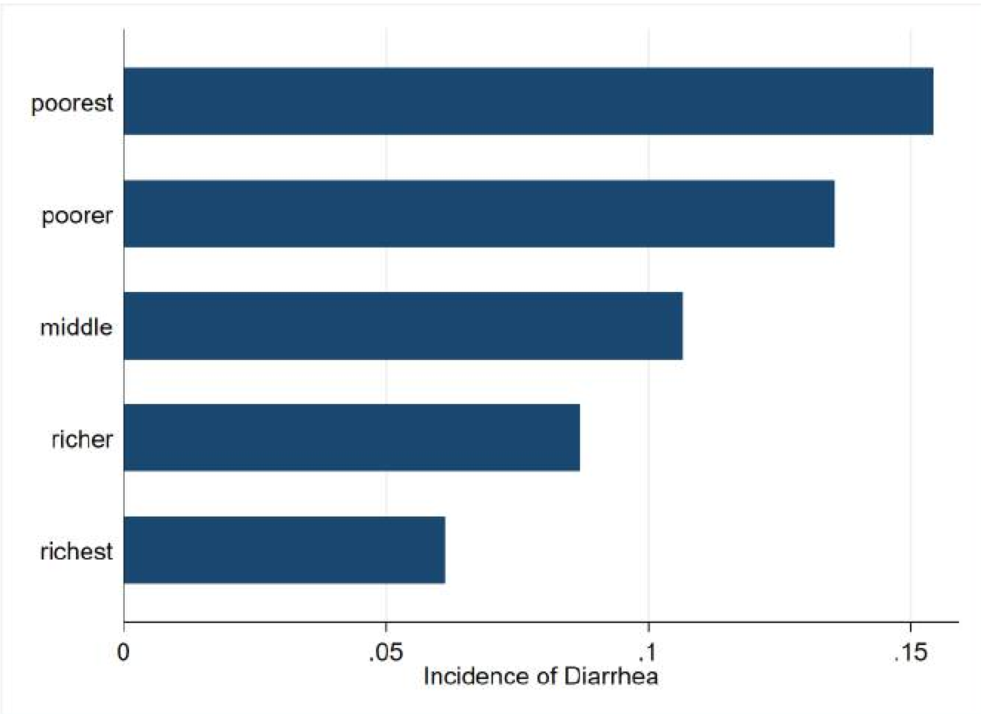

Figure 6: Child's Incidence of Diarrhea by SES quintiles
Source: Authors' elaboration using NDHS

Notes: This Figure shows the child's incidence of diarrhea (if child had diarrhea recently) by SES levels (form poorest to richest).

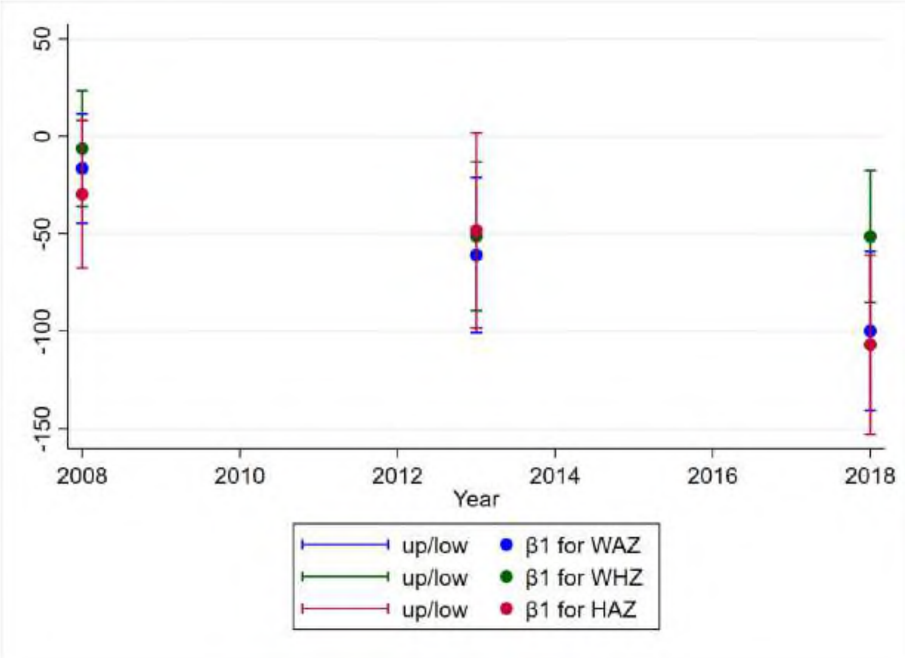

Figure 7: Effect of Poverty on WHZ, WAZ and HAZ over the Years 2008, 2013 and 2018.
Source: Authors' elaboration using NDHS

Notes: This Figure shows how the effect of poverty on nutritional status of children (WHZ, WAZ and HAZ) evolved over the years (from 2008 to 2018).

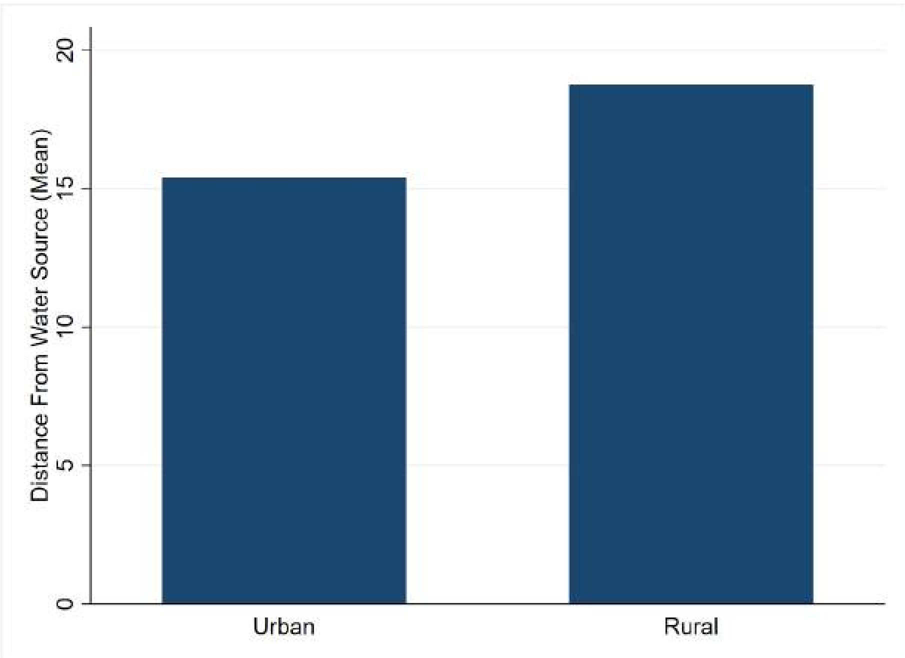

Figure 8: Distribution of distance to drinking water sources by rural/urban areas.
Source: Authors' elaboration using NDHS

Notes: This Figure shows the distribution of our instrument (distance from water source) over the rural and urban areas.

Tables

Table 1: Descriptive statistics

Variables	Obs	Mean	%	Std. Dev.
Individual-level variables				
WHZ	54,956	-0.5200		1.3341
Prob. of being wasted	54,956		0.12	0.32
WAZ	54,944	-1.2215		1.4091
Prob. of being underweight	54,944		0.29	0.45
HAZ	54,944	-1.2970		1.8601
Prob. of being stunted	54,944		0.34	0.47
Poverty	94,053		0.47	0.49
Poverty (poorest)	92,370		0.24	0.43
Poverty (poorer)	69,682		0.31	0.46
Poverty (middle)	47,845		0.39	0.48
Distance to water source	92,300	17.67		30.13
Child age (months)	63,633	27.84		17.27
Child sex (male)	94,053		0.50	0.49
Current age of mothers	94,053	29.43		6.95
Age of household head	93,930	41.30		12.05
Sex of household head (male)	94,053		0.90	0.29
N. of household members	94,053	7.05		3.66
Always lived in the place of (permanent) residence	94,053		0.29	0.45
Place of residence (Rural)	94,053		0.68	0.46
Mothers' education (low-skilled)	94,053		0.66	0.47
Visited Health Facility	92,072		0.37	0.48
Household nutrition (factor)	33,459	-7.31e-10		0.86
Breastfeeding (months)	90,176	6.23		8.19
Antenatal visits	56,832	4.69		5.34
Postnatal check	16,854		0.92	0.26
Skilled antenatal care	58,695		0.60	0.48
Institutional delivery	90,868		0.35	0.47
Skilled assistance during delivery	91,544		0.38	0.48
Current breastfeeding	91,286		0.31	0.46
Father's education (high-skilled)	88,456		0.42	0.49
Diarrhea	82,385		0.11	0.31
Fever	82,333		0.18	0.38
Acute Respiratory Symptoms	35,738		0.11	0.31
Maternal BMI	70,954	22.86		4.36
Mother's weight	71,197	57.40		12.70
Adequate child intake	40,916		0.010	0.10
Infant formula	63,269		0.056	0.22
Times child had infant formula	2,240	2.42		1.10
Times child was breasfed	15,062	8.93		5.19
Improved quality of water	88,688		0.55	0.49
Mother's all-year employment	64,596		0.73	0.43

Notes: This Table shows descriptive statistics for the variables employed in our estimations. WHZ is Weight-for-Height Z score, WAZ is Weight-for-Age Z Score, HAZ is Height-for-Age Z Score; The source of all variables is Nigeria Demographic and Health Survey (NDHS)

Table 2: Effect of poverty on children's nutritional status outcomes: OLS Estimates

Variables	WHZ	pr. wasted	WAZ	pr. underweight	HAZ	pr. stunted
	(1)	(2)	(3)	(4)	(5)	(6)
Poverty	-0.0004***	-0.00003	-0.0027***	0.0004***	-0.0040***	0.0005***
	(0.0001)	(0.00005)	(0.0001)	(0.00004)	(0.0002)	(0.00004)
Observations	54,864	54,864	54,852	54,852	54,852	54,852
R-squared	0.05	0.03	0.13	0.06	0.14	0.07
Mean	-0.5200	0.66	-1.2215	0.81	-1.2970	0.77
SD	1.3341	0.47	1.4091	0.38	1.8601	0.41
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
N. of States	37	37	37	37	37	37

*Notes: This Table shows the OLS estimates of the effect of poverty on children's nutritional status. Columns (1), (3) and (5) show the OLS estimates of the effect of poverty on WHZ, WAZ and HAZ, respectively. Columns (4) and (6) present the positive and significant effect of poverty on the probability of being underweight and the probability of being stunted, respectively. The results correspond to equation (1). The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors are in parentheses. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Table 3: First Stage Results

	Poverty: All	0-5	6-23	24-59
	(1)	(2)	(3)	(4)
Water Distance	0.0479***	0.0435***	0.0458***	0.0497***
	(0.003)	(0.005)	(0.003)	(0.003)
Observations	53,774	5,402	16,985	31,387
Kleibergen-Paap rk Wald F statistic	335.3	84.96	213	313.3
Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
N. of States	37	37	37	37

*Notes: This Table shows the first-stage regression estimates where poverty was regressed on water distance (our instrument). Water distance is log-transformed. Column (1) takes into consideration the whole sample, whereas columns (2)-(4) are for samples split by children's age group. The results correspond to equation (2). The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors are in parentheses. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Table 4: Effect of poverty on children's nutritional status outcomes: Second Stage Estimates (IV)

Variables	WHZ	pr. wasted	WAZ	pr. underweight	HAZ	pr. stunted
	(1)	(2)	(3)	(4)	(5)	(6)
Panel (a)						
Poverty	-0.0042***	0.0012***	-0.0060***	0.0011***	-0.0055***	0.0014***
	(0.0010)	(0.0003)	(0.0010)	(0.0002)	(0.0012)	(0.0003)
Observations	53,774	53,774	53,762	53,762	53,762	53,762
Mean	-0.5200	0.66	-1.2215	0.81	-1.2970	0.77
SD	1.3341	0.47	1.4091	0.38	1.8601	0.41
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
N. of States	37	37	37	37	37	37
Panel (b)						
endog. test	14.27	13.85	11.46	6.183	1.502	9.652
p. value (endog.)	0.000158	0.000198	0.000712	0.0129	0.220	0.00189

*Notes: Panel (a) presents the IV results. Columns (1), (3) and (5) show the negative and significant effects of poverty on WHZ, WAZ and HAZ, respectively. Columns (2), (4), and (6) present the positive and significant effect of poverty on the probability of being wasted, the probability of being underweight and the probability of being stunted, respectively. The results correspond to equation (1). The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors are in parentheses. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1. The coefficient of the First Stage is 0.0479*** with a standard error of 0.003 and an F Statistic of 335.3. Panel (b) shows the endogeneity test results.*

Table 5: Effect of poverty on children's nutritional status outcomes: Second Stage Estimates (IV) by SES levels

Variables	WHZ	pr. wasted	WAZ	pr. underweight	HAZ	pr. stunted
	(1)	(2)	(3)	(4)	(5)	(6)
Panel (a)						
Poverty (poorest)	-0.0053***	0.0015***	-0.0075***	0.0013***	-0.0069***	0.0018***
	(0.0013)	(0.0004)	(0.0013)	(0.0003)	(0.0016)	(0.0004)
Observations	52,881	52,881	52,869	52,869	52,869	52,869
Panel (b)						
Poverty (poorer)	-0.0045***	0.0014**	-0.0071***	0.0017***	-0.0072***	0.0024***
	(0.0016)	(0.0005)	(0.0017)	(0.0004)	(0.0020)	(0.0005)
Observations	41,005	41,005	40,993	40,993	40,993	40,993
Panel (c)						
Poverty (middle)	-0.0038***	0.0013***	-0.0067***	0.0021***	-0.0069***	0.0022***
	(0.0013)	(0.0004)	(0.0014)	(0.0004)	(0.0016)	(0.0004)
Observations	29,147	29,147	29,138	29,138	29,138	29,138
Mean	-0.5200	0.66	-1.2215	0.81	-1.2970	0.77
SD	1.3341	0.47	1.4091	0.38	1.8601	0.41
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
N. of States	37	37	37	37	37	37

*Notes: This Table presents the IV results by SES (poverty) levels. Panels (a), (b) and (c) show the results when the independent variable takes the "poorest", "poorer" and "middle" SES categories, respectively. Columns (1), (3) and (5) show the negative and significant effects of poverty on WHZ, WAZ and HAZ, respectively. Columns (2), (4), and (6) present the positive and significant effect of poverty on the probability of being wasted, the probability of being underweight and the probability of being stunted, respectively. The results correspond to equation (1). The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors are in parentheses. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1. The coefficient of the First Stage for Panel (a) is 0.0373*** with a standard error of 0.002 and an F-Statistic of 274.92, for Panel (b) is 0.0333*** with a standard error of 0.002 and F-Statistic of 174.19, and for Panel (c) is 0.0469*** with a standard error of 0.003 and F-Statistic of 230.10.*

Table 6: Effect of poverty on children's nutritional status by child's age using IV/2SLS

Outcome Vars	0-5	6-23	24-59
	(1)	(2)	(3)
WHZ	-0.0018	-0.0038**	-0.0048***
	(0.0036)	(0.0018)	(0.0011)
Mean	0.0106	-0.7530	-0.4857
SD	1.5305	1.4222	1.2131
pr. wasted	0.0001	0.0012**	0.0014***
	(0.0011)	(0.0005)	(0.0004)
Mean	0.49	0.72	0.65
SD	0.50	0.44	0.47
WAZ	-0.0002	-0.0049***	-0.0079***
	(0.0031)	(0.0017)	(0.0012)
Mean	0.0222	-1.4382	-1.3195
SD	1.4059	1.3857	1.3113
pr. underw.	0.0016	0.0001	0.0016***
	(0.0011)	(0.0004)	(0.0003)
Mean	0.51	0.86	0.84
SD	0.49	0.34	0.36
HAZ	0.0010	-0.0039*	-0.0076***
	(0.0036)	(0.0022)	(0.0015)
Mean	-0.0821	-1.2826	-1.5153
SD	1.6590	1.8239	1.8307
pr. stunted	0.0016	0.0009*	0.0017***
	(0.0011)	(0.0005)	(0.0003)
Mean	0.54	0.77	0.80
SD	0.49	0.41	0.39
Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
N. of States	37	37	37
Obs	5,402	16,985	31,387

*Notes: Columns (1)-(3) show the IV estimates of the effect of poverty on children's nutritional status by age (in months). The effect is statistically significant for child age above 5 months. The results correspond to equation (1). The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors are in parentheses. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Table 7: Effect of poverty on children's nutritional status outcomes: Second Stage Estimates (IV) by SES levels and age groups

Outcome Variables	0-5	6-23	24-59	0-5	6-23	24-59	0-5	6-23	24-59
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Poverty Level		Poorest			Poor			Middle	
WHZ	-0.0023	-0.0049**	-0.0063***	-0.0054	-0.0038	-0.0050***	-0.0066	-0.0034	-0.0040***
	(0.004)	(0.002)	(0.002)	(0.006)	(0.003)	(0.002)	(0.005)	(0.002)	(0.002)
Mean	0.0106	-0.7530	-0.4857	0.0106	-0.7530	-0.4857	0.0106	-0.7530	-0.4857
SD	1.5305	1.4222	1.2131	1.5305	1.4222	1.2131	1.5305	1.4222	1.2131
WAZ	-0.0003	-0.0062***	-0.0104***	-0.0012	-0.0054*	-0.0100***	-0.0028	-0.0068***	-0.0081***
	(0.004)	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)	(0.005)	(0.002)	(0.002)
Observations	5,324	16,690	30,855	4,090	12,956	23,947	2,876	9,192	17,070
Mean	0.0222	-1.4382	-1.3195	0.0222	-1.4382	-1.3195	0.0222	-1.4382	-1.3195
SD	1.4059	1.3857	1.3113	1.4059	1.3857	1.3113	1.4059	1.3857	1.3113
HAZ	0.0013	-0.0049*	-0.0100***	0.0028	-0.0050	-0.0111***	0.0020	-0.0073**	-0.0087***
	(0.005)	(0.003)	(0.002)	(0.005)	(0.004)	(0.003)	(0.005)	(0.003)	(0.002)
Observations	5,324	16,690	30,855	4,090	12,956	23,947	2,876	9,192	17,070
Mean	-0.0821	-1.2826	-1.5153	-0.0821	-1.2826	-1.5153	-0.0821	-1.2826	-1.5153
SD	1.6590	1.8239	1.8307	1.6590	1.8239	1.8307	1.6590	1.8239	1.8307
First stage	0.035***	0.036***	0.038***	0.031***	0.031***	0.034***	0.040***	0.046***	0.048***
	(0.004)	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)	(0.006)	(0.003)	(0.003)
F-stat	71.18	200.62	235.78	38.62	95.14	160.89	35.81	141.51	207.48
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of States	37	37	37	37	37	37	37	37	37

*Notes: This Table shows the IV results of the effect of poverty (by SES levels) on the children's nutritional status outcomes (WHZ, WAZ and HAZ). The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors are in parentheses. Standard errors are clustered at the State level. Significant levels: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. F-stat is the Kleibergen-Paap rk Wald F statistic.*

Table 8: Mediation Analysis (IV) - WHZ

Effect	Visited	Nutrition	Antenatal	Post-natal Check	Antenatal Skilled	Health Facility	Skilled Assistance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Tot. Eff.	-0.0042***	-0.0062***	-0.0038***	-0.0051***	-0.0036***	-0.0041***	-0.0041***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Direct Eff.	0.0106*	0.0037**	0.0022**	-0.0007	0.0025**	0.0032***	0.0032***
	(0.006)	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Indirect Eff.	-0.0149*	-0.0098**	-0.0059**	-0.0014	-0.0062**	-0.0073***	-0.0073***
	(0.008)	(0.004)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
% of Tot. Eff.	3.5075	1.5975	1.5818	0.2748	1.7125	1.7761	1.77
Observations	52,653	10,976	33,494	8,750	34,701	52,154	52,522
Mean	0.37	-7.31e-10	4.69	0.92	0.60	0.35	0.38
SD	0.48	0.86	5.34	0.26	0.48	0.47	0.48
First Stage I	1198.23	1193.99	1197.59	1192.63	1197.65	1198.22	1198.23
First Stage II	4.39	13.88	55.56	8.52	84.85	106.66	132.03

	Father's Education	Diarrhea	Fever	ARS	Maternal BMI	Mother's Weight	Adequate Intake	Infant formula
	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Tot. Eff.	-0.0040***	-0.0041***	-0.0040***	-0.0045***	-0.0043***	-0.0043***	-0.0065***	-0.0037***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Direct Eff.	0.0056***	-0.0017	0.0001	0.0004	0.0025***	0.0027***	0.0012**	0.0010**
	(0.001)	(0.002)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
Indirect Eff.	-0.0097***	-0.0023	-0.0041**	-0.0056**	-0.0068***	-0.0070***	-0.0078**	-0.0048***
	(0.002)	(0.006)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)
% of Tot. Eff.	2.4105	0.5632	1.0238	1.2385	1.5806	1.6343	1.2013	1.3003
Observations	51,027	52,685	52,634	15,597	52,431	52,573	23,198	38,604
Mean	0.42	0.11	0.18	0.11	22.86	57.40	0.01	0.05
SD	0.49	0.31	0.38	0.31	4.36	12.70	0.10	0.22
First Stage I	1198.19	1198.23	1198.23	1195.58	1198.22	1198.23	1196.81	1197.82
First Stage II	59.45	0.56	11.77	15.82	68.57	64.45	13.84	35.09

*Notes: This Table show the results of the mediation analysis for the outcome WHZ. The results were obtained by using Stata's ivmediate command, which performs the causal mediation analysis for IV models introduced by Dippel et al. (2020). The mediators are: if mother visited health facility for care in the last 12 months, household nutrition (factor variable), number of antenatal visits during pregnancy, if mother had postnatal check in the first two days (considering how long before and after discharge did the first check take place), if mother received antenatal care from a skilled provider (doctor, nurse or auxiliary midwife), if mother had institutional (public or private health facility based) delivery, if mother received skilled assistance during delivery (doctor, nurse or auxiliary midwife), father's education (high skilled), if child had diarrhea recently, if child had fever in last two weeks, if child had cough with short and rapid breath (or Acute Respiratory Symptoms (ARS)), maternal BMI, mother's weight, child adequate nutrition intake and if child had infant formula. Father's education is a dummy taking one if education level is secondary or higher. Adequate intake is a dummy variable where it takes one if in the last 24 hours, child consumed bread/grains/tubers (BGT), vegetables and fruits (VF) and eggs/fish/meat/dairy (EFMD), and zero otherwise. The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. The model includes Year and State fixed effects as well. Robust standard errors are used. Significant levels: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.*

Table 9: Mediation Analysis (IV) - WAZ

Effect	Visited	Nutrition	Antenatal	Post-natal Check	Antenatal Skilled	Health Facility	Skilled Assistance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Tot. Eff.	-0.0060***	-0.0100***	-0.0052***	-0.0045***	-0.0051***	-0.0058***	-0.0059***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Direct Eff.	0.0071	0.0025	-0.0005	-0.0027***	-0.0001	0.0005	0.0005
	(0.005)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Indirect Eff.	-0.0131*	-0.0125***	-0.0046**	-0.0021	-0.0051**	-0.0063***	-0.0063***
	(0.007)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
% of Tot. Eff.	2.1901	1.2502	0.8824	0.4726	1.0085	1.0798	1.0841
Observations	52,641	10,970	33,491	8,748	34,698	52,142	52,510
Mean	0.37	-7.31e-10	4.69	0.92	0.60	0.35	0.38
SD	0.48	0.86	5.34	0.26	0.48	0.47	0.48
First Stage I	1198.23	1193.99	1197.59	1192.63	1197.65	1198.22	1198.23
First Stage II	4.39	13.88	55.56	8.52	84.85	106.66	132.03

	Father's Education	Diarrhea	Fever	ARS	Maternal BMI	Mother's Weight	Adequate Intake	Infant formula
	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Tot. Eff.	-0.0057***	-0.0058***	-0.0057***	-0.0075***	-0.0060***	-0.0060***	-0.0076***	-0.0043***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Direct Eff.	0.0025	-0.0038**	-0.0022***	-0.0017***	-0.0001	0.0001	-0.0013***	-0.0016***
	(0.001)	(0.002)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Indirect Eff.	-0.0082***	-0.0019	-0.0035**	-0.0067**	-0.0059***	-0.0060***	-0.0063**	-0.0027*
	(0.002)	(0.005)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.001)
% of Tot. Eff.	1.4461	0.3363	0.6106	0.8904	0.9799	1.0092	0.832	0.6311
Observations	51,015	52,673	52,622	15,590	52,419	52,561	23,190	38,596
Mean	0.42	0.11	0.18	0.11	22.86	57.40	0.01	0.05
SD	0.49	0.31	0.38	0.31	4.36	12.70	0.10	0.22
First Stage I	1198.19	1198.23	1198.23	1195.58	1198.22	1198.23	1196.81	1197.82
First Stage II	59.45	0.56	11.77	15.82	68.57	64.45	13.84	35.09

*Notes: This Table show the results of the mediation analysis for the outcome WAZ. The results were obtained by using Stata's ivmediate command, which performs the causal mediation analysis for IV models introduced by Dippel et al. (2020). The mediators are: if mother visited health facility for care in the last 12 months, household nutrition (factor variable), number of antenatal visits during pregnancy, if mother had postnatal check in the first two days (considering how long before and after discharge did the first check take place), if mother received antenatal care from a skilled provider (doctor, nurse or auxiliary midwife), if mother had institutional (public or private health facility based) delivery, if mother received skilled assistance during delivery (doctor, nurse or auxiliary midwife), father's education (high skilled), if child had diarrhea recently, if child had fever in last two weeks, if child had cough with short and rapid breath (or Acute Respiratory Symptoms (ARS)), maternal BMI, mother's weight, child adequate nutrition intake and if child had infant formula. Father's education is a dummy taking one if education level is secondary or higher. Adequate intake is a dummy variable where it takes one if in the last 24 hours, child consumed bread/grains/tubers (BGT), vegetables and fruits (VF) and eggs/fish/meat/dairy (EFMD), and zero otherwise. The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. The model includes Year and State fixed effects as well. Robust standard errors are used. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Table 10: Mediation Analysis (IV) - HAZ

Effect	Visited	Nutrition	Antenatal	Post-natal Check	Antenatal Skilled	Health Facility	Skilled Assistance	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Tot. Eff.	-0.0055***	-0.0094***	-0.0050***	-0.0009	-0.0049***	-0.0054***	-0.0054***	
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	
Direct Eff.	0.0005	-0.0003	-0.0024*	-0.0034***	-0.0020	-0.0026**	-0.0025**	
	(0.004)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	
Indirect Eff.	-0.0060	-0.0090**	-0.0025	-0.0024	-0.0031	-0.0028	-0.0030	
	(0.005)	(0.004)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	
% of Tot. Eff.	1.0826	0.9667	0.495	2.6129	0.633	0.52	0.544	
Observations	52,641	10,970	33,491	8,748	34,698	52,142	52,510	
Mean	0.37	-7.31e-10	4.69	0.92	0.60	0.35	0.38	
SD	0.48	0.86	5.34	0.26	0.48	0.47	0.48	
First Stage I	1198.23	1193.99	1197.59	1192.63	1197.65	1198.22	1198.23	
First Stage II	4.39	13.88	55.56	8.52	84.85	106.66	132.03	
	Father's Education	Diarrhea	Fever	ARS	Maternal BMI	Mother's Weight	Adequate Intake	Infant formula
	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Tot. Eff.	-0.0053***	-0.0053***	-0.0053***	-0.0074***	-0.0055***	-0.0055***	-0.0054***	-0.0034**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Direct Eff.	-0.0017	-0.0045***	-0.0038***	-0.0034***	-0.0028***	-0.0027***	-0.0034***	-0.0036***
	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Indirect Eff.	-0.0035	-0.0008	-0.0015	-0.0046*	-0.0026	-0.0027	-0.0020	0.0002
	(0.003)	(0.002)	(0.001)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)
% of Tot. Eff.	0.6718	0.1578	0.2853	0.6148	0.4826	0.4999	0.3634	-0.0585
Observations	51,015	52,673	52,622	15,590	52,419	52,561	23,190	38,596
Mean	0.42	0.11	0.18	0.11	22.86	57.40	0.01	0.05
SD	0.49	0.31	0.38	0.31	4.36	12.70	0.10	0.22
First Stage I	1198.19	1198.23	1198.23	1195.58	1198.22	1198.23	1196.81	1197.82
First Stage II	59.45	0.56	11.77	15.82	68.57	64.45	13.84	35.09

*Notes: This Table shows the results of the mediation analysis for the outcome HAZ. The results were obtained by using Stata's ivmediate command, which performs the causal mediation analysis for IV models introduced by Dippel et al. (2020). The mediators are: if mother visited health facility for care in the last 12 months, household nutrition (factor variable), number of antenatal visits during pregnancy, if mother had postnatal check in the first two days (considering how long before and after discharge did the first check take place), if mother received antenatal care from a skilled provider (doctor, nurse or auxiliary midwife), if mother had institutional (public or private health facility based) delivery, if mother received skilled assistance during delivery (doctor, nurse or auxiliary midwife), father's education (high skilled), if child had diarrhea recently, if child had fever in last two weeks, if child had cough with short and rapid breath (or Acute Respiratory Symptoms (ARS)), maternal BMI, mother's weight, child adequate nutrition intake and if child had infant formula. Father's education is a dummy taking one if education level is secondary or higher. Adequate intake is a dummy variable where it takes one if in the last 24 hours, child consumed bread/grains/tubers (BGT), vegetables and fruits (VF) and eggs/fish/meat/dairy (EFMD), and zero otherwise. The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. The model includes Year and State fixed effects as well. Robust standard errors are used. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Table 11: Regression of diarrhea, number of times child had infant formula and number of times child was breastfed on the instrument (Drinking water distance)

VARIABLES	Diarrhea	Times Child Had Infant Formula	Times Child Breastfed
	(1)	(2)	(3)
Water Distance	-0.0005	-0.043	-0.024
	(0.0009)	(0.030)	(0.041)
Obs	60,793	1,391	13,267
Mean	0.1156	2.42	8.93
SD	0.3197	1.10	5.19
Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
N. of States	37	37	37

*Notes: This Table shows the OLS regression results of the following variables on the instrument (water distance): if child had diarrhea, number of times child had infant formula and number of times child was breastfed during day. The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors are in parentheses. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Table 12: Robustness Check: Effect of Poverty on WHZ, WAZ, and HAZ (permanent residents only) (IV)

VARIABLES	WHZ	WAZ	HAZ
	(1)	(2)	(3)
Poverty	-0.0037**	-0.0050***	-0.0039*
	(0.0018)	(0.0017)	(0.0021)
Observations	11,643	11,641	11,641
Mean	-0.5200	-1.2215	-1.2970
SD	1.3341	1.4091	1.8601
Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
N. of States	37	37	37

*Notes: This Table shows the IV results of the negative and significant effect of poverty on WHZ, WAZ and HAZ, considering only the sub-sample of the individuals who declare to be permanent residents. The results correspond to equation (1). The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size. Standard errors are in parentheses. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Appendix A

Table A.1: Descriptive statistics (Wealth Index Components)

Variables	Obs	Mean	%	Std. Dev.
Individual-level variables				
Ownership of car	91,185		0.084	0.277
Ownership of radio	91,400		0.658	0.474
Ownership of refrigerator	91,366		0.146	0.353
Ownership of bicycle	91,183		0.229	0.420
Ownership of motorcycle	91,181		0.366	0.481
Ownership of electricity	91,375		0.445	0.496
Adequate roof	93070		0.023	0.15
Adequate wall	92996		0.50	0.49
Adequate floor	93069		0.49	0.49
Cooking fuel (biomass)	91,391		0.807	0.394
Cooking fuel (transition)	91,391		0.158	0.364
Cooking fuel (clean)	91,391		0.034	0.183
Type of toilet (improved)	91,095		0.478	0.499

Notes: This Table shows descriptive statistics for the variables used in constructing our main independent variable; The source of all variables is Nigeria Demographic and Health Survey (NDHS)

Table A.2: Reduced Form

Variables	WHZ	pr. wasted	WAZ	pr. underweight	HAZ	pr. stunted
	(1)	(2)	(3)	(4)	(5)	(6)
Time Water	-0.0204***	0.0059***	-0.0291***	0.0053***	-0.0265***	0.0068***
	(0.0048)	(0.002)	(0.0048)	(0.001)	(0.0061)	(0.001)
Constant	-30.1250***	0.6193***	-45.9067***	0.6508***	-27.5102***	0.5929***
	(5.307)	(0.020)	(5.462)	(0.017)	(6.521)	(0.016)
Observations	53,774	53,774	53,762	53,762	53,762	53,762
Mean	-0.5200	0.66	-1.2215	0.81	-1.2970	0.77
SD	1.3341	0.47	1.4091	0.38	1.8601	0.41
R-squared	0.05	0.03	0.12	0.06	0.13	0.07

*Notes: This Table shows the Reduced Form results (i.e. the effect of the instrument on the outcome variables). The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors in parentheses. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Table A.3: Effect of Poverty on Weight of Children - By Age (IV)

Weight	All	0-5	6-23	24-59
	(1)	(2)	(3)	(4)
Poverty	-0.0096***	0.0089	-0.0053**	-0.0153***
	(0.0018)	(0.0063)	(0.0024)	(0.0024)
Mean	10.68	5.62	8.50	12.94
SD	3.85	2.35	2.21	3.08
Observations	60,645	6,824	19,601	34,220
Year FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
N. of States	37	37	37	37

*Notes: This Table shows the results of the effect of poverty on children's weight by age. The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Table A.4: Standard Mediation Analysis (Mechanisms through which the instrument affects poverty)

Variables	**Poverty**	Rurality	All-Year Employment
	(1)	(2)	(3)
Water Distance	0.032***	0.038***	-0.033***
	(0.001)	(0.001)	(0.001)
Rurality	0.502***		
	(0.002)		
Water Distance	0.042***		
	(0.001)		
All-Year Employment	-0.255***		
	(0.004)		
Mean		0.68	0.73
SD		0.46	0.43
Observations		90,688	63,459
Effect (mean)			
ACME		0.019	0.0085
Direct Effect		0.032	0.042
Tot. Effect		0.051	0.051
% of total effect mediated		0.37	0.16

*Notes: This Table shows the results of the standard mediation analysis (using STATA's medeff command), where the treatment is water distance (our instrument) and outcome is poverty. The mediators are a) whether respondent lives in rural areas and b) whether respondent was employed all year (vs. seasonal or occasional). The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Robust standard errors are used. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

Table A.5: Regression of diarrhea and number of times child was breastfed on the instrument (Drinking water distance) by SES Level

Variables	Diarrhea	Times Child Breastfed
	(1)	(2)
Panel (a)		
Poverty (poorest)	-0.0035	-0.0143
	(0.002)	(0.090)
Observations	14,475	3,942
Panel (b)		
Poverty (poorer)	0.0004	-0.0346
	(0.002)	(0.076)
Observations	14,042	3,390
Panel (c)		
Poverty (middle)	0.0023	-0.0387
	(0.002)	(0.085)
Observations	12,431	2,570
Mean	0.1156	8.93
SD	0.3197	5.19
Year FE	Yes	Yes
State FE	Yes	Yes
N. of States	37	37

*Notes: This Table shows the OLS regression results of the following variables on the instrument (water distance) by SES levels: if child had diarrhea and number of times child was breastfed during day. This Table does not show the results for outcome "Times child had infant formula" due to the few number of observations. The model includes a vector of covariates, namely age of the child in months, child's sex, mother's education, age of household head, sex of household head, household size, and permanent residence. Standard errors are in parentheses. Standard errors are clustered at the State level. Significant levels: *** p<0.01, ** p<0.05, * p<0.1.*

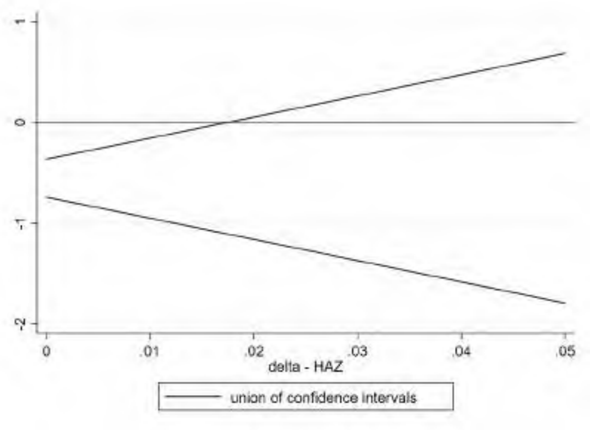

Figure A.1: Plausible Exogeneity test for outcome variable HAZ

Source: Authors' elaboration on the plausible exogeneity test

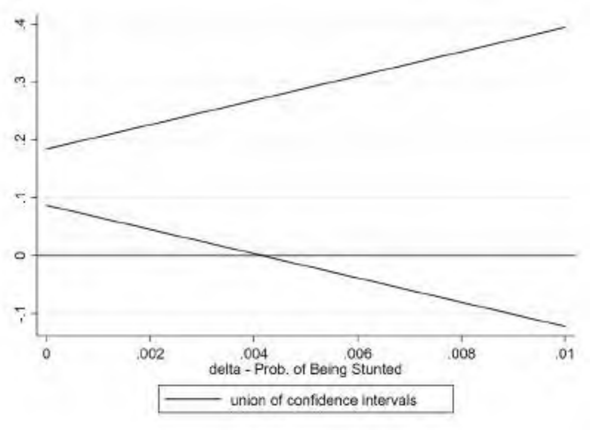

Figure A.2: Plausible Exogeneity test for outcome variable Prob. of Being Stunted

Source: Authors' elaboration on the plausible exogeneity test

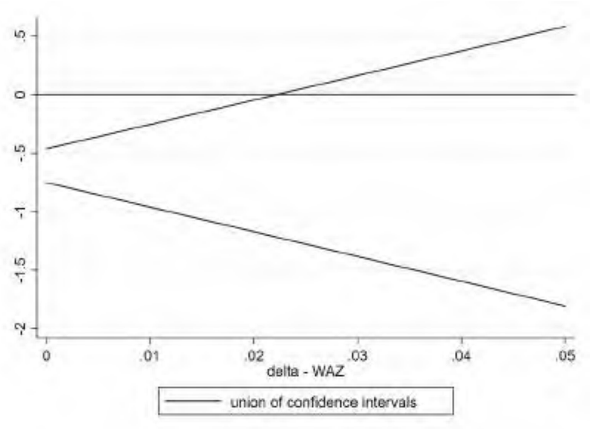

Figure A.3: Plausible Exogeneity test for outcome variable WAZ

Source: Authors' elaboration on the plausible exogeneity test

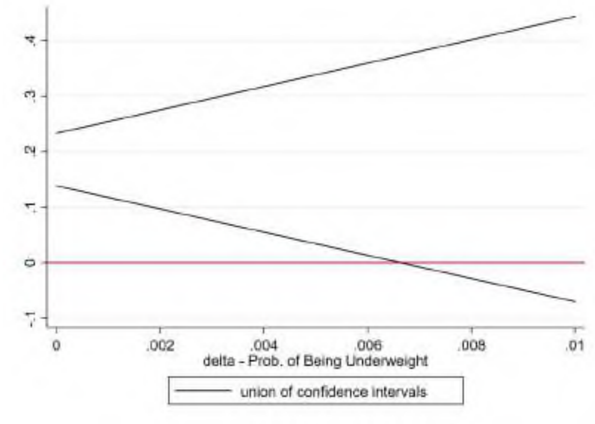

Figure A.4: Plausible Exogeneity test for outcome variable Prob. of Being Underweight

Source: Authors' elaboration on the plausible exogeneity test

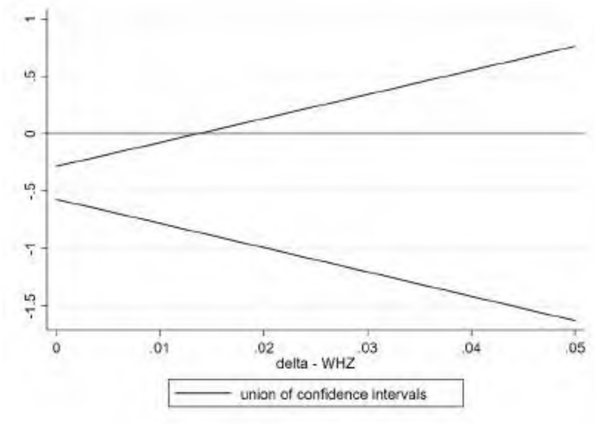

Figure A.5: Plausible Exogeneity test for outcome variable WHZ

Source: Authors' elaboration on the plausible exogeneity test

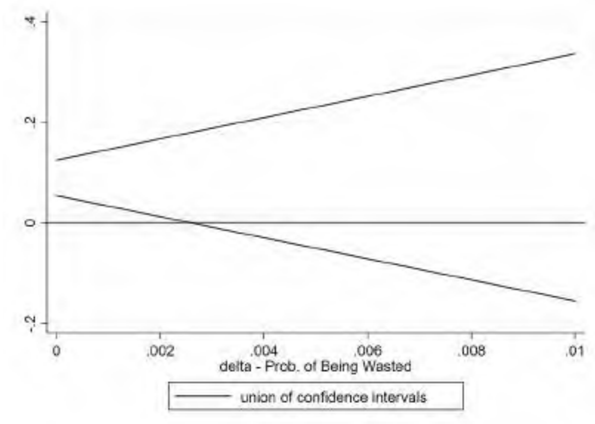

Figure A.6: Plausible Exogeneity test for outcome variable Prob. of Being Wasted

Source: Authors' elaboration on the plausible exogeneity test