**AERC Thematic Research Work in Progress Report**

Child health, climate conditions and household characteristics nexus in Zimbabwe: A pseudo-panel analysis.

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**Abstract**

*Today’s children are the sources of human capital of tomorrow. Healthy children of today represents healthy and productive future human capital of any society. Yet the health of children under the age of five, particularly in developing countries such as Zimbabwe has been plagued by high mortality risks and undernutrition problems, particularly in recent years, where climate change has threatened food productivity and security in most African countries. Using a pseudo-panel analysis, this research proposal seeks to assess the dynamics and the determinants of health outcomes in children under the age of five in Zimbabwe. We also seek to understand if climate change is affecting health outcomes of children under the age of five. The research used secondary data from the Demographic and Health Surveys from Zimbabwe and climate change conditions at provincial level in Zimbabwe and it covered the period from 1994 to 2015. The study finds out that the health of children under the age five in Zimbabwe varies geographically (provincially). More so, the girl child was found to be healthier compared to the boy child. Other factors such antenatal care visits as well as maternal education were found to have a positive impact on the health of children. Conversely, rising temperatures have been found to have a negative effect on the health of children. The study therefore recommended that the government should improve access to prenatal health care, maternal education and skilled medical treatment facilities. Efforts to curb rising temperatures should also be prioritized. These include adoption and use of clean energy, although this need global efforts rather than national efforts.*

# **1. Introduction and Motivation**

It is in the natural order of things that children of today are the adults of tomorrow. This means that to build a strong future economy, nature advocates that we start by taking care of the children of today. More so, it has long been argued that a healthy population is also a productive population (Becker & Barro, 1986; Becker, 1993; Charmarbagwala, et al., 2012; de Onis, et al., 2004; Development Initiatives, 2018; Iversen, et al., 2021). Together with women, children are also considered the most vulnerable members of the society. This imply that the health of children reflects not only the “quality” of the future human capital assets of the country, but also the “quality” of the current human capital assets.[[1]](#footnote-1) Yet the health of children, particularly those under the age of five in developing countries, has been negatively affected by high mortality risks and malnutrition problems for quite a long period now (Development Initiatives, 2018; Iversen, et al., 2021).

At micro level, a person is predicted to have a better life ahead of them if they survive the first five years of their life well-nourished and healthy (Becker & Barro, 1986; Becker, 1993; Iversen, et al., 2021). These first five years are also crucial in building cognitive skills, which are an important element as far as building a strong human capital base at macro level is concerned. Coupled with the fact that every human being (children included) has a moral right to a healthy life[[2]](#footnote-2), safeguarding the health of children becomes not only economic duty but also a moral duty for policy makers (Iversen, et al., 2021).

In recent years, it has become clear that climate change has become real, causing untold suffering to the entire global population. More so, it is argued that children will be the most affected by climate change, starting during pregnancy through their entire life cycle, no matter how long that life cycle (Nakstad, et al., 2022). From a theoretical standpoint, climate change affects the health of children under the age of five through various avenues. For instance, climate change affects agricultural outputs and family incomes and productivity. These are essential inputs in child health production function (Becker, 1993). This becomes even worse for countries like Zimbabwe which are agro-based economies, with over 70% of the entire population depending on rainfed-agriculture for survival (Mujeyi & Mutambara , 2022).

Given the strong link between climate change, food production, the health of children, individual cognitive development, human capital development, and community prosperity highlighted above, it becomes imperative to have a deeper understanding of why a child is likely to have good health in their early years of life. These early years are also the most sensitive, delicate, and future-shaping years of every human being (Becker, 1993; Iversen, et al., 2021). Furthermore, the World Health Organisation (WHO) and the Intergovernmental Panel for Climate Change (IPCC) argue that undernutrition in children under the age of five as the most significant impact of climate change (Phalkey, et al., 2015). However, there has been lack of evidence to back this assertion, especially in Zimbabwe and other African countries. More so, quantifying the effects of climate change dynamics on health outcomes is also important. A question therefore arise, how has the recent climatic conditions have been affecting the health of the future human capital? This question is the backbone for this study.

This study will contribute to literature in two ways. Firstly, by extending the time perspective of analysis through the application of a pseudo panel approach, an idea first introduced by Deaton (1985), which less studies in the subject area have account for. This is important given that many socioeconomic outcome variables sometimes have a tendency of improving over time regardless of the policy environment, although sometimes at a slow pace than desired. Secondly, it contributes to literature by assessing whether climatic conditions affects health outcomes of the future human capital assets of the society, an area which is relatively new and has been neglected in empirical research.

## **1.1 Research objectives**

The main objective of this study will be to find ways of improving the health of children under the age of five in Zimbabwe, which in turn is expected to boost future human capital productivity and ultimately leading to economic development. The study intends on answering the following research questions:

* What socioeconomic factors are contributing to the improvement of health outcomes of children under the age of five in Zimbabwe?
* Are climate conditions shifts (rising temperatures or sporadic rainfall patterns) affecting health outcomes of children under the age of five in Zimbabwe?

Having identified the research problem and the research questions to be answered in this section, the following section will summaries the study context. Section 3 will look at literature review, Section 4 will provide the theoretical framework and the empirical strategy to be used in this study. Section 5 will provide the empirical results, their analysis and discussion. The paper will end with Section 6 providing the conclusions and policy recommendations.

# **2. Study Context**

This section will provide some preliminary data statistics (stylized facts) and the sources of the data, which is going to be used in this study, and how it is going to be used. Children are the most vulnerable and susceptible to climate change (Development Initiatives, 2018; Nakstad, et al., 2022). Despite increased efforts by Government of Zimbabwe (GoZ) to improve the health of children under the age of five, the problems still persist, with some arguing that it may be difficult to meet the SDGs on health if the status quo continue to prevail as it is.

Zimbabwe has not been spared from climate change. Since 1980, the country has experienced extreme weather conditions and droughts. The notable ones are the 1992, 2002 and 2008 droughts as well as 2002 Cyclone Elin and 2019 Cyclone IDAI.

**Figure 1: Trends in Average yearly temperatures in the ten Provinces in Zimbabwe**

*Source: Author's illustrations - Data from the World Bank (2022)*

Figure 1 shows the trends in average temperatures, which is one of the climate change variables to be used in this study, from 1980 to 2020. Evidence from the graph shows that different provinces have been experiencing different temperatures. More so, the trend shows increasing temperature levels, showing signs of worsening climatic conditions across the whole country. however, some provinces had a steeper increase compared to others, hence in the analysis it may be possible that there are other provinces which are going to show signs of poor nutrition in children (as a result of poor rainfall patterns).

In addition to temperature, climate conditions dynamics can also be captured by precipitation, which is the amount of water vapor in the air (Warnatzsch & Reay, 2019). The higher the precipitation level, the better, since this water vapor will also mean higher rainfall patters. For a country like Zimbabwe, where around 70% of the individuals depend on rainfed agriculture for survival, this is a critical factor for child nutrition provision. The graph below shows the average precipitation levels in all the ten provinces in Zimbabwe.

**Figure 2: Stunting levels of the children in the countries of study**

*Source: Author's Illustrations - Data from the World Bank*

The graph above shows uneven distribution of precipitation in the country. provinces such as Masvingo, Matebeleland, Bulawayo and Midlands provinces have shown relatively low levels of precipitation relative to the other provinces. Historically, these provinces have been the one hard hit by poor rainfall patterns, leading to poor agricultural yields. More so, the graph generally shows that from 1980 to 2020, the average precipitation levels have been decreasing in all the provinces, with notable decreases in the last decade, that is, 2011 to 2020.

**Table 1: Stylized facts on Child Health Outcomes in Zimbabwe**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Health Indicator** | **1988 (%)** | **1994 (%)** | **1999 (%)** | **2005 (%)** | **2010 (%** | **2015 (%)** |
| Stunting | 31 | 29 | 34 | 35 | 32 | 27 |
| Underweight | 8 | 11 | 10 | 13 | 10 | 8 |
| Overweight | 5 | 7 | 10 | 8 | 6 | 6 |
| Wasting | 2 | 6 | 8 | 7 | 3 | 3 |

Source: Demographic and Health Surveys (DHSs)

Stylised facts from the ZDHSs presented in Table 1 above show that of all the health outcomes measures, stunting levels in Zimbabwe have been high. More so, they show that some of these levels are even way high above the 2030 SDG target which state that at most 20% of the children under the age of five should be stunted. More so, from the 2015 ZDHS, when disaggregated by province, there has been high stunting levels in Matebeleland South province, a province which is highly known for its erratic rainfall patterns (Zimstat, 2016).

# **3. Literature Review**

Economic analysis of child health outcomes is empirically linked to classical household models, healthcare demand and production models, nutrition provision models, and fertility models, where a household's utility is maximized subject to resource constraints. Application of these models is ultimately related to choices made in respect of some investment decisions, which also explain trade‐offs between the number of children and the ability to raise them qualitatively (Becker & Barro, 1986; Becker, 1965; Becker, 1993; Becker & Lewis, 1973).

On the issues of the relationship between household socioeconomic characteristics, and child health outcomes, the Becker – Lewis model (1973) predicts that if the household gets more utility from the quantity of kids they have, they are likely to suffer more child health problems compared to the household that focuses more on the “quality”[[3]](#footnote-3) of kids since relative childcare investment on each kid will be low. On the other hand, if more utility is enjoyed from the "quality" children compared to the number of children, then the problems of malnutrition and mortality are going to be few for this household (Becker, 1993). This is because relative expenditure on the quality of each kid in this household is higher compared to that of a similar kid in a household in which there are many children, *ceteris paribus.* However, this model suits well in circumstances when the analysis is done at household level, that is, when child healthcare decisions are being analyzed at household level.

It is from this theory that the researcher will derive the altruistic characteristics and behaviors of the parents’ (and specifically the mother) towards their children. This altruistic behavior (or lack of it) is the one which is expected to justify every decision the household members makes towards the health of the children. Because of this assumption, the mother specifically (and the whole household members in general) is expected to invest more in terms of material and moral support for their children there by enhancing better health outcomes for the child (Becker & Barro, 1986).

In addition, economic theory on child health production is highly anchored on the Grossman Model (1972). This model predicts that once a child is born, continuous investments need to be made on the healthcare of the child. If that is not the case, the initial health endowment that the child has been born with will depreciate leading to poor health outcomes, and in the worst-case scenario, the child will eventually die (Grossman, 1972; Grossman, 1999). These models predict the need for massive investments in child health, even before they are born by taking care of their mothers too. These investments usually take the form of nutritional foods, for which these nutritional foods come from agriculture produce which varies heavily depending on environmental and climatic conditions (Becker, 1993; Grace, et al., 2015). These investments can be taken well before the child is born, through antenatal care services and post-natal care services. Hence in this study, rather than taking the Grossman model at face value and assume only investments in health will affect health outcome of the children after they are born, an additional assumption that prebirth nutritional food productivity and availability, especially to the mother also affects health outcomes. This agricultural food productivity is the one which is assumed to be heavily affected by climate conditions (Grace, et al., 2015).

More so, the Mosley-Chen framework has shown the channels through which the investment in food and healthcare will eventually affect the healthcare outcomes of children under the age of five. This model came out of the acknowledgment that most disciplines (especially social scientists and medical scientists) have tried to solve the problem of child health differently, leading to different policy recommendations. The model incorporates both the biological and social variables and integrates research methods employed by medical and social scientists to model the problem of child health (Mosley and Chen, 1984). It is based on the premise that all social and economic determinants of child health necessarily operate through a common set of biological mechanisms or proximate determinants to affect the health of the child. Many empirical studies concur with this assertion (Makoka, 2013; Poda, et al., 2017; Sondai, et al., 2017). However, these studies suffer from the problem that they all used cross-sectional data.

More so, the relationship between climate change and health outcomes of children under the age of five is anchored on environmental economics and agricultural economics. Climate change affects the production of food, of which the food is an important ingredient on the health production. Both the quality and the quantity of nutrients comes from the agriculture of which agriculture is directly related to the climatic conditions. More so, climate change affects family income especially for farming families (Becker, 1965; Grace, et al., 2015). A number of studies have tried to quantify the impact of the climate conditions on health outcomes under the age of five, but less have been done from the developing countries perspective, particularly in Africa. A paper by Grace et al., (2015) is one of the first papers which tried to investigate the link between climate change and child health outcome in African children, using birthweight as health indicators. However, by using birthweight as the measure of child health, the study explicitly focused on child health during pregnancy (Grace, et al., 2015). The current study however will build on this study and look at health outcomes after the child is born.

In the case of Zimbabwe, a study was carried out in order to identify the season with the highest prevalence of underweight in under-five children in Zimbabwe. This study was done using time series data, and the conclusion was that there are very significant, although being very small increases in underweight between the periods between January and March. These periods are characterised by food shortages since the periods are just before harvesting (Wright, et al., 2000). However, this study suffered from the fact that they was done in a single year, which means that the results produced were for the 2000 alone. More so, beyond this study, analysis of child health outcomes in Zimbabwe have not factored in climate conditions which may mean that the models estimated may have suffered from omitted variable bias (Balgati, 2005; Greene, 2003). In other regions, studies were done which showed different and inconclusive results (Phalkey, et al., 2015). More so, these studies used cross sectional data, which means that it was difficult for the studies to capture climatic conditions shifts. By constructing pseudo-panels, this study will rectify this problem, and carry out a study with long term dynamics views.

The UNICEF framework is also one of the widely used frameworks to study the determinants of child health. The framework incorporates both socioeconomic and biological determinants and encompasses causes at both macro and micro levels. In this framework, there is a sequence of events that determine the health of the child. At the bottom of this sequence are basic determinants and these affect underlying determinants. Underlying determinants in turn will affect immediate determinants and it is these immediate determinants that will eventually impact the health of the child (Scrimshaw, et al., 1968; United Nations Children’s Fund., 2015; Smith & Haddad, 1999). However, the framework did not show how the dynamics in these underlying and immediate determinants will influence health outcomes in children under the age of five. More so, the framework is also credited for incorporating environmental factors (including climate conditions) in the analysis of child health and also clearly showing how these distal factors affect child health (United Nations Children’s Fund., 2015).

Due to lack of genuine panel data on child malnutrition and other health outcomes in developing countries, many empirical studies in this subject area were done for a specific time period, i.e., using cross sectional data. What this means is that studies were done for a specific time periods, making it difficult for these studies to capture dynamics in socioeconomic characteristics and how they this affects health outcomes for children under the age of five. These studies gave a ‘snapshot’ view of the whole picture of the problem at hand (Charmarbagwala, et al., 2012; Poda, et al., 2017; Sondai, et al., 2017).

Furthermore, due to the mainly cross-sectional nature of analysis, the literature was unable to capture how the dynamics in socioeconomic variables such as family wealth, family size, and others are affecting health outcomes in children under the age of five. It was also not able to show the results driven by the trend, fluctuation around the trend or volatility. This study intends on eliminating this problem, by using pseudo-panel analysis which eliminates the problems of cross-sectional data.

## **4. Theoretical framework.**

The aim of every policy that policymakers introduce will be to improve the welfare (including the health) function of the country, which is made up of individual citizens utility functions. Since analysis will be done on household level, we also assume that the goal of every household heard is to improve the welfare of every household member, especially that of children under the age five. This means that the household heard is altruistic towards the children in the family, and his marginal utility with respect to each child’s utility is positive. The household heard gets satisfaction from their own good health as well as the good health of the children under the age of five in the family. Borrowing from Becker (1993), the utility function of the household heard is represented by the equation below:

Where, is the utility function of the household head *i* during period *t*; is the health of the household heard *i* during period *t*; is the utility function of child *i* during period *t* and is the health of child *i* during period *t*. To ensure that the altruistic characteristic of the household heard is realized, then the following equation should hold:

However, the health of each household member is a function of various factors which include the household wealth, the education level, family size, climatic conditions they are living in which has been recently strongly affected by climate change. On top of that, the health of the children in the family is also influenced by the health of the household head. If the household head is fit and in good health, he or she is more capable of working and providing for his family compared to the one who is not fit and healthy. Hence the health function of each child in the family can be represented by the following equation:

Where represents family wealth, maternal level of education, represents education level for the household head, representing the number of children under five and represents the climate change dynamics or climatic conditions which are being witnessed in the area which the child is living at specific time period *t*. We expect family wealth, level of education, and favorable climatic conditions to have a positive impact on the health of children. However, the number of children under the age of five is expected to have a negative impact on the health of the family members. As the number of children under the age of five increase, we expect this to strain the available family resources – leading to relatively fewer resources per child compared to a household with fewer children under the age of five. Moreover, other socioeconomic variables such as religion, gender and rural or urban residence are expected to influence child health outcomes, albeit ambiguously.

## **4.1 Empirical Analysis**

The existing literature on the subject matter has mainly focused on giving “snapshot” results by nature of using cross-sectional data. As a result, to strongly capture the dynamics of health outcomes, a panel data model needs to be estimated (Greene, 2003). The empirical strategy to be adopted follows work by Deaton, (1985), which suggest that in the absence of panel data, if repeated cross-section dataset is available, a panel data model can be estimated even if the cross-section does not track the same individuals. This is done by tracking cohorts of individuals rather than individuals themselves. These cohorts are made of individuals with well-defined time-invariant characteristics such as year of birth, gender etc. In empirical literature, this method was used in modelling transport demand (Chi-Hong, 2013), impact of food price volatility on household welfare (Ziegelh¨ofer, 2014), poverty analysis (Duong & Nghiem, 2014; Perez, 2019), health economics (Saksena & Maldonaldo, 2017; Özdamar & Giovanis, 2017) to mention but a few. To develop the empirical strategy, Deaton (1985) proposes beginning by specifying a genuine panel data model from T cross-sections as follows:

Where index *int* refers to a given individual *i*, at time *t*. It is important to note that the subscript *i* indicate new individuals which are likely to be different in each period, making these individuals time-variant. For ease of exposition, we continue the use of subscript *i* and assume that the same number of households *N* is randomly surveyed each period. Then define a set of cohorts K, each with fixed membership which remains fixed throughout the entire period of observation. Everyone observed belong to exactly one cohort throughout. Averaging the observations over individuals in each cohort, we get the following equation:

Where represents the average of over all individuals belonging to cohort *k* at time *t*. The health outcome measure to be used in this study will be child stunting. Since the relationship specified above involves a fixed effect, the corresponding relationship for the cohort also include a fixed cohort effect (Deaton, 1985). The approach also allows for combining climate data with microeconomic data on household health outcomes whilst at the same time controlling for individual effects (Chi-Hong, 2013; Ziegelh¨ofer, 2014). The idea is that when climate change is affecting health outcomes of children under the age of five positively (negatively), then there should be a positive (negative) relationship between the cohort health outcome proxy and climate change variables. A key advantage of using pseudo panel estimates is that it is possible to control for the regional, time invariant characteristics and to account for intercept heterogeneity (Deaton, 1985; Özdamar & Giovanis, 2017).

**4.2 Creation of Pseudo-Panels in this Study.**

In this study, the researcher indents on forming cohorts using gender of the children, and province which the family of the child is living. After forming the pseudo panel dataset, a cohort is treated as a single observation in the dataset and the mean values of the variables are computed to represent the observations. Hence it is a panel data of cohorts, rather than of individual children. In summary, the aim will be to track the health outcomes behaviour of children under the age of five, with the same time invariant characteristics, at different time intervals and see how the province-level climatic conditions are affecting these health outcomes.

Basically, pseudo panel analysis will be tracking children under the age of five with time-invariant features (in this case these time invariant features are gender and province) over a period of time (DHS phases). The cohorts will be the cross-sectional elements, whilst the time component will be determined by the DHS phase. Just like a panel data will capture dynamics since they have a time dimension, pseudo panels which are going to be created in this study will also capture dynamics in the variables involved (Deaton, 1985).

**4.3 Empirical Model Specification and Identification Strategy**

After creating pseudo-panel dataset and integrating the various factors from the theoretical framework above, the following empirical model will be estimated.

**4.4 Justification of the Variable Selection**

In this study the child health anthropometric measures were used to measure the health status of the children. These anthropometric measures are the standards for assessing the health standards of the children under the age of five and they were developed by the world health organisation (WHO) (Food and Nutrition Council, 2018; Development Initiatives, 2018). These measures include the weight for age z score (WAZ), the height for age z scores (HAZ) and the height for age z scores (HWZ) (Zimbabwe National Statistics Agency & ICF International, 2016). Usually, HAZ is typically used for measuring stunting, whilst WAZ is typically used to measure malnutrition. These measures are expressed as the number of standard deviations below or above the reference mean or median.

As for the WAZ, a child is considered not be suffering from malnutrition if their WAZ is greater than -2, whilst those with a WAZ score between -3 and -2 are considered to be suffering from moderate malnutrition. Additionally, those with a z score which is less than -3 are considered to be suffering from severe malnutrition. With the same thinking in vein, when a child has a HAZ score of less than -3, they are said to be suffering from severe stunting. Those whose HAZ score lies between -3 and -2 are said to be suffering from moderate stunting whilst those with a z score above -2 are said to have normal levels of stunting (Development Initiatives, 2018). In this study, both these measures were used to measure the health status of children under the age of five and they were the dependent variables.

**Maternal Education**

This refers to the highest level of education attained by the maternal mother of the child under study. From the dataset for ZDHS this variable was already categorized into four categories namely no education, primary education, secondary education, and tertiary education. More so, the DHS record the actual number of years which the individual has spent in education. For this study however, the actual number of years the mother has spent in education was used. This was motivated by the fact that this is continuous variable, making it easy to interpret. This study hypothesized that the more the number of educational years the mother has, the more likely they can have more resources, both in terms of financial and knowledge for caregiving purposes (Food and Nutrition Council, 2018; UNICEF, 2019). Hence less child health problems are expected for children born to mothers with higher (tertiary) level education.

**Maternal Age**

Biologically, there are certain years in the woman’s age where there is an increased probability that a woman will get pregnant. Maternal fertility increases from the period of first menstrual period and reaches a peak in the mid to early 30s. Thereafter, from the mid-30s, it starts depreciating and it is during this period that can lead to child health complications during pregnancy (Sazedur, et al., 2017). These complications may negatively affect the health of the child, during pregnancy leading to the child experiencing difficult first five years of their life (World Bank, 2006). The variable was taken as is in the DHS, that is as a continuous variable. This was also motivated by the fact the methodology being used required the calculation of cohort means, hence a continuous variable seems appropriate.

**Child’s Sex**

Sex refers to the gender of the child under study and it is a dummy variable categorized as male (=1) or female (=0). This variable speaks to the genetic variability between the girl child and the boy child. With the survey data reporting more male children being undernourished compared to female ones, a priori expectations were that being a male children was expected to be more undernutrition compared to female children (Zimbabwe National Statistics Agency & ICF International, 2016).

**Residence**

This refers to the place in which the child resides. This was measured as a categorical variable, with ten categories. These categories represent the ten provinces in provinces in Zimbabwe. The fundamental differences in the socio-economic set up between these provinces makes this variable important in determining the health of children in these areas (Becker & Lewis, 1973). Poverty levels are relatively high in rural compared to urban (UNICEF Zimbabwe, 2016; Zimbabwe National Statistics Agency & ICF International, 2016). As such a priori expectation is that there are high cases of undernutrition in provinces which are predominantly rural areas, where residents are disadvantaged in terms of their socioeconomic standing as well as their accessibility to health services compared to urban areas.

**Age of the Child**

The relationship between child age and their health is a complex topic that can be influenced by many factors such as genetics, gender, nutrition, physical activity, health problems, environment, and hormones. As children grow and develop, their health needs change and it’s important to keep up with their changing needs (UNICEF Zimbabwe, 2016).

**Antenatal Care Visits**

Antenatal care visits were included in the model the capture the extent to which the mother (or the family) has invested in the health of the child even prior to the birth of the child. The hypothesis in this study is that the higher the number of these antenatal visits, the more chances that the child will have better health in the future (Sondai, et al., 2017; Kuhnt & Vollmer, 2017). This is because this antenatal care speaks to the child health investments, which are carried out prior to childbirth. The more these visits, the more the prior-birth health investments and the higher the chances that the child will have better health after they are born. This variable was measured as a continuous variable.

**Under five Family Size**

The world of economics is always characterised by competition on resources. According to the Quantity-Quality theory of Becker (1973) discussed earlier, the less the number of children within a single family the less the competition on these resources, including competition on childcare resources. Hence, the priori expectation is that the less the number of children living under the same household, the better their health status, since they will have less competition.

**Provincial Temperatures**

To capture temperatures in the model specified above, average yearly temperatures were taken at provincial level, during the first five years of the child. For instance, if the DHS collected data of children who were born between 1994 and 1999, the average yearly temperatures will be taken at provincial level, for the same time period. The priori expectation here is that the higher the provincial temperatures, the less likely that the child will be healthy. This is because higher temperatures give rises to sporadic rainfall patterns, which also negatively affect the agricultural productivity of the households in the respective province. Agriculture is the back born of livelihoods of Zimbabweans, with over 70% of the citizens surviving on rainfed agriculture. More so, higher temperatures also give raises to diseases, which may in turn negatively affect the health not only of children under the age of five but also of the entire population. Hence, the higher the temperature, the less likely that the child will be healthy.

**Family Wealth**

The financial muscle of the household will always have an effect on the health status of the child positively. The more the financial resources that are available, the better the quality of food and health services that are available to the health of the child. Food and healthcare services are essential ingredients in the child’s health production function as already highlighted earlier. This variable was measured using the wealth index, a variable which is already given in the DHSs. The variables used in this study and how they are going to be measured is summarised in the table below.

**Table 2: Summary Table the variables used.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Mathematical representation** | **Measurement** | **Data Source** | **Expected Sign** |
| Child Health Outcome |  | height-for-age z-score[[4]](#footnote-4) | Demographic and Health Surveys | Dependent Variable |
| Family Wealth |  | Wealth Index | Demographic and Health Surveys | Positive |
| Maternal Education |  | Number of years the mother of the child has spent in education | Demographic and Health Surveys | Positive |
| Child Age |  | Child Age in Months | Demographic and Health Surveys | Ambiguous |
| Child Age Square |  | The square of Child Age in Months | Demographic and Health Surveys | Parabolic |
| Number of children |  | Number of children who are under the age of five in the household | Demographic and Health Surveys | Negative |
| Maternal Age |  | Maternal Age in years | Demographic and Health Surveys | Parabolic |
| Maternal Age Sq |  | The square of Maternal Age | Demographic and Health Surveys | Negative |
| Antenatal Care Visits |  | The number of antenatal care visits | Demographic and Health Surveys | Positive |
| Province |  | The province in which the child is born and living | Demographic and Health Surveys | Ambiguous |
| Climate Change Variables |  | Average annual temperature and or average annual precipitation[[5]](#footnote-5) | World Bank | Negative |
| Gender of the Child |  | Whether the child is a boy or a girl | Demographic and Health Surveys | Ambiguous |

The choice of the model to be used in the paper will be made among pooled OLS, fixed effects and random effects model. It is important to note that each model has its own theoretical advantages and disadvantages and the decision between these models are therefore empirical rather than analytical, i.e., the decision will be made based on the data. This is because of the way in which the cohorts were created yielded a sample size with very small T dimension and also small cross-sectional units’ sample. Therefore, in panel data with small time dimensions and cross-sectional units, the coefficients can be identified using pooled OLS estimation (Balgati, 2005). However, the model has to pass the post-estimation assumptions tests (Balgati, 2005; Greene, 2003).

## **4.5 Data Sources**

The study will make use of the Demographic and Health Survey (DHS) datasets for Zimbabwe for the period from 1999/2000 to 2015. This imply that four waves of ZDHSs were used in the study. Data for climate change variables were gathered be from the World Bank. All these data sources are publicly available and can be used without copyrights infringements once granted access. The DHS datasets provide information on demographic and health outcomes of a country-representative sample and is carried out after every five years in most developing countries. These survey datasets are also standardized across different countries, which makes comparison relatively easy. Since this study is going to be looking at health outcomes of children under the age of five, the Kids Recode (KR) file combined with the Household Recode (HR) file were used in this study.

The curious reader at this juncture may be asking how the researcher will combine survey data (micro data) on health outcomes and time series (climate) to do the analysis. One of the ways which is going to be used to create these pseudo-panels is the DHS phase as well as the province. Because of this, the researcher will merge microeconomic and macroeconomic data in corresponding DHS phase and the province which the child is living. This will then be merged with climate data at provincial level, within the same DHS phase. **5.Presentation and Discussion of Results.**

## **5.1 Pre-estimation Tests.**

### **5.1.1 Panel Unit Root Tests**

Before the econometric model specified in the previous section was estimated, the researcher carries out a number of pre-estimation tests. These included the panel unit root tests and the autocorrelation tests. The panel unit root tests were carried out using the Harris-Tzavalis test. This test extends from the Dickey-Fuller test by allowing for serial correlation and heteroskedasticity of the error term (Harris & Tzavalis, 1999). The test is based on a regression of the first difference of the dependent variable on its lagged values and the other explanatory variables which has been specified in the model. In this test, the null hypothesis is that there is a unit root in the panel data, which implies that the data is not stationery (Harris & Tzavalis, 1999; Balgati, 2005). This null hypothesis can be rejected for any p-values which are less than 10%, and the conclusion in that case will be that the data is stationery. The results of this test are given in the table below.

**Table 3: Panel Unit Root Tests**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Statistic** | **Z Value** | **P-Value** | **Decision** |
| Child Age | -0.8635 | -9.7716 | 0.0000 | Stationery at Level |
| Antenatal Visits | -0.3740 | -5.9859 | 0.0000 | Stationery at Level |
| Maternal Age | 0.1234 | -2.1392 | 0.0162 | Stationery at Level |
| Under 5 family size | 0.2020 | -1.5310 | 0.0629 | Stationery at Level |
| Maternal Education | -0.6279 | -2.6386 | 0.0042 | Stationery at Level |
| Family Income | -0.7392 | -8.8102 | 0.0000 | Stationery at Level |
| Birth Weight | -0.4244 | -6.3753 | 0.0000 | Stationery at Level |
| HAZ Score | -0.2221 | -4.8113 | 0.0000 | Stationery at Level |
| WAZ Score | -0.3287 | -5.6351 | 0.0000 | Stationery at Level |
| Maternal BMI | -0.2531 | -5.0511 | 0.0000 | Stationery at Level |
| Temperature | -0.0744 | -3.6690 | 0.0000 | Stationery at Level |
| Precipitation | -0.1763 | -4.4572 | 0.0000 | Stationery at Level |

From the table above, it can be shown that the p-values of all the variables which have been used in the model are less than 10%. Hence according to the Harris-Tzavalis panel unit root test, the null hypothesis that the panel data is not stationery may be rejected and conclude that all the variables which were used in the model do not exhibit a unit root, that is, they are stationery at level (Balgati, 2005; Greene, 2003).

### **5.1.2 Multicollinearity Tests**

In addition to the panel unit root tests explained above, another pre-estimation test which was carried out was the multicollinearity test. Multicollinearity can be defined as a scenario in which one or two explanatory variables are highly correlated, to an extend that it will be difficult to know exactly the effect of individual dependent variables on the independent variable (Balgati, 2005; Greene, 2003). Multicollinearity can lead to unstable coefficients estimates of the regression model and highly inflated standard errors. In this study, multicollinearity was tested using the correlation coefficient between the explanatory variables themselves. The study concluded that the two explanatory variables exhibit the problem of multicollinearity if their correlation coefficient was greater or equal to 0.8. this is generally the conventional wisdom in econometrics (Balgati, 2005). The results from this test are given in **Appendix A.**

From the Appendix, the variables which exhibit multicollinearity include the family size (the total number of people living in the same household) and the under-five family size (that is the total number of children under the age of five which are living in the same household). The correlation coefficient between these two variables was 0.914. other combinations of variables which indicated the problem of multicollinearity were the age of the household heard and under-five family size (correlation coefficient = 0.811) and household heard age and under-five family size (correlation coefficient = 0.851). because of this, the researcher was forced to drop two variables from the model. The variables which were dropped are the age of the household heard and the family size. The motivation for initially including these variables in the model was that the will capture family income and competition on resources, which will ultimately affect the health of children under the age of five. However, the model already included a variable which can directly capture family income, that is the wealth index from the DHS. More so, the researcher also argued that for this study, the most important competition on family resources was the competition among children under the age of five instead of the competition among all the family members. This was motivated by the theory of ultraism as mentioned by Becker, (1993).

## **5.2 Summary Statistics.**

After the pre-estimation tests, all the variables which survived these tests were then summarised using descriptive statistics. The table below gives these descriptive statistics of the various forms of the dependent variables which were included in the model. These include the child health age z score, the child weight age z score and the child height weight z score. These three variables were included to check the quality of the results. The summary statistics of these variables are given in the table below.

**Table 4: Descriptive Statistics of the dependent variables**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Observations** | **Mean** | **Std. Dev.** | **Min** | **Max** |
| Child height age z score | 80 | -1.26 | 22.33 | -1.73 | -0.51 |
| Child weight ages z score | 80 | -0.60 | 19.48 | -0.97 | -0.16. |

The table above indicate that the weight for age z score for the children ranges from -0.97 to -0.16 whilst the height for age z score ranges from -1.73 to -0.51. these statistics indicate that, generally during the study period, children had between normal to good health status. Due to way which cohorts were created, there are only 80 observations in the dataset, which are disaggregated as 20 cross-sectional units being studied over four survey periods. The summary statistics for the independent variables which are used in the model are shown in the table below.

**Table 5: Descriptive Statistics of the Explanatory variables**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Observations** | **Mean** | **Std. Dev.** | **Min** | **Max** |
| Province | 80 | 5.5 | 2.89 | 1 | 10 |
| Child gender | 80 | 1.5 | 0.503 | 1 | 2 |
| Child age months | 80 | 27.794 | 1.664 | 23.994 | 31.736 |
| Antenatal visits | 80 | 4.873 | 0.569 | 3.757 | 6.62 |
| Maternal age | 80 | 27.931 | 0.756 | 26.117 | 29.659 |
| Under5 fam size | 80 | 1.611 | 0.18 | 1.249 | 2.071 |
| Maternal education | 80 | 8.311 | 1.266 | 5.689 | 10.791 |
| Family wealth | 80 | -18255.45 | 237315.96 | -590440.2 | 1051471.3 |
| Mean temperature | 80 | 21.339 | 1.106 | 19.377 | 22.758 |
| Precipitation levels | 80 | 147.396 | 56.076 | 56.341 | 268.13 |

There are only 10 groups of provinces which are in the sample. These provinces include Bulawayo, Harare, Manicaland, Mashonaland central, Mashonaland East, Mashonaland west, Masvingo, Matebeleland South, Matebeleland North as well as the Midlands provinces. More so, the gender of the child in question was categorised into two groups, that is whether the child in question is female or is a male. More so, from the table above it can also be noted that the variables included shows less variation among the values as shown by the associated standard errors, except for family wealth which was measured by the wealth index as well as the level of precipitation. The reason why these variables have less standard deviation may be attributed to the fact that cohort means were taken instead of the actual values. Cohorts were formed using the gender of the child as well as the province in which the child was born.

More so, the table indicated that the average of children who were studied in this paper ranges from approximately 24 months to approximately 32 months with the average age of the children being 28 months. Although the DHS collected data on children under the age of five, this cohort analysis indicated that the majority of these children were way past their first birthday and were some distance away from their fifth birthdays. Additionally, the table indicated that on average, the mother of the children in question would visit the clinic for routine pregnancy checks (antenatal care visits) for an average of five times during their pregnancy. Some mothers will have as many as seven such visits during the pregnancy days.

Furthermore, although the DHS usually collects the information on women between the ages of 15 and 49 (i.e., childbearing ages), the creation of cohorts pointed out that the average of the women whose children were included in this study was approximately 28 years, the minimum being 26 years and the maximum being 30 years. Biologically, at these ages, women are likely to give birth to children who are healthy and who do not suffer from diseases such as down’s syndrome, a disease which is usually associated with children born to women who are in their late 30s and above. More so, summary statistics in the table above indicated that there are approximately 1 to 2 children who are under the age of five per household. This implies that the childcare resources available in every household are likely to be shared among at most 2 children under the age of five, otherwise they are not shared at all. This smaller number of children may be as a result of the growing trend in Zimbabwe, in which families have start to understand the importance of having “quality” children as proposed by (Becker & Lewis, 1973).

More so, the cohort disaggregation also pointed out to the fact that the average years of maternal education in Zimbabwe during the study period was 8 years whilst the maximum years of education were 11 years. Put it into perspective, this means that women in Zimbabwe generally complete the primary level of education and they rarely goes beyond their ordinary levels. The average 8 years mentioned above are generally sufficient enough for an individual to complete their primary level of education, whilst the 11 years mentioned above are also generally sufficient for an individual to completed ordinary level of education in Zimbabwe.

On the issue of climatic conditions within the country during the period of the study, the table above shows that the average yearly temperature was 21 degrees Celsius, with a minimum of 19 degrees Celsius and a maximum of 23 degrees Celsius. These are not considered to be extreme levels of temperatures, but rather moderate temperatures. However, these temperatures will generally be different in different provinces, hence one of the reasons why the cohorts were formed using the province in which the children were born. More so, another climate variable which was used was the levels of annual precipitations, which speaks to the rainfall patterns in the country. The table above indicate that the average annual rainfall was approximately 147mm, whilst the minimum and the maximum were 56mm and 268mm respectively. Just as the case of temperatures above, these rainfall pattens also vary provincially.

## **5.3 Regression Results**

The researcher estimated four pooled OLS regressions in order to try and the research questions. The results are shown in the table below.

**Table 6: Regression Results**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Explanatory Variables** | **WAZ** | **HAZ** | **WAZ** | **HAZ** |
| Province: Harare | -0.302\*\*\* | -0.573\*\*\* | 0.432\*\* | 0.169 |
| Province: Manicaland | 0.428\*\* | 0.751\*\*\* | 0.498\*\* | 0.174 |
| Province: Mashonaland Central | 1.654\*\*\* | 3.306\*\*\* | 0.314\* | -0.087 |
| Province: Mashonaland East | 0.332\* | 0.949\*\*\* | 0.340\*\* | -0.077 |
| Province: Mashonaland West | 1.763\*\*\* | 3.464\*\*\* | 0.269\* | -0.067 |
| Province: Masvingo | 1.699\*\*\* | 3.081\*\*\* | -0.142 | -0.092 |
| Province: Matebeleland North | 1.662\*\*\* | 3.245\*\*\* | -0.151 | -0.225\*\* |
| Province: Matebeleland South | 0.977\*\*\* | 1.888\*\*\* | -0.616\*\*\* | -0.365\*\*\* |
| Province: Midlands | 1.004\*\*\* | 2.003\*\*\* | -0.009 | -0.141 |
| Child Gender: Female | 0.101\*\* | 0.098 | 0.124\* | 0.117\*\* |
| Child Age (Months) | 0.224 | 0.390 | 0.353 | 0.222 |
| Antenatal Care Visits | 0.040 | -0.018 | 0.016 | 0.072\*\* |
| Maternal Age (years) | -0.926 | -0.958 | -2.000 | -1.625 |
| Number of children < 5 yrs. | -0.212 | -0.026 | 0.107 | -0.150 |
| Maternal Education (years) | 0.090\*\*\* | 0.133\*\*\* | -0.005 | 0.021 |
| Wealth Index | 0.000 | 0.000\* | 0.000 | 0.000 |
| Child Age Squared | -0.004 | -0.007 | -0.006 | -0.004 |
| Maternal Age Squared | 0.016 | 0.015 | 0.033 | 0.028 |
| Childbirth Weight | 0.000 | -0.000 | -0.000 | 0.000 |
| Mean Temperature | -0.650\*\*\* | -1.153\*\*\* | - | - |
| Precipitation SD | - | - | -0.002\*\*\* | -0.001\*\* |
| Constant | 21.729 | 31.602 | 25.494 | 19.064 |
| Observations | 80 | 80 | 80 | 80 |
| R-squared | 0.758 | 0.626 | 0.623 | 0.735 |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**5.4 Post-estimation tests**

Before the interpretation of the results shown in the above table, some post-estimation tests need to be carried out so as to validate the results shown in the table with some reasonable level of certainty. The table below indicate the heteroskedasticity test as well as the model (mis)specification test.

**Table 7: Post-Estimation Tests**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Test | Test-Statistic | P-Value | Decision |
| Model 1 | Specification Test | 2.05 | 0.117 | Passed |
| Heteroskedasticity Test | 0.59 | 0.441 | Passed |
| Model 2 | Specification Test | 2.19 | 0.099 | Failed |
| Heteroskedasticity Test | 1.94 | 0.164 | Passed |
| Model 3 | Specification Test | 1.36 | 0.264 | Passed |
| Heteroskedasticity Test | 4.10 | 0.043 | Failed |
| Model 4 | Specification Test | 0.82 | 0.487 | Passed |
| Heteroskedasticity Test | 0.01 | 0.908 | Passed |

From the table above, it can be shown that **Model 1 and Model 4** from **Table 6** above have passed all the post-estimation tests carried out in this study. Hence only results from these models will be interpreted.

## **5.5 Interpretation and Discussion of Results**

Results from the table above indicated that there is a significant disparity on the in the health status of children under the age of five in different provinces. For instance, at provincial level and taking the Bulawayo province to be the reference category, the weight-for-age z score for the children from Harare province is likely to 0.302 lower compared to that of a child who is born in Bulawayo province. In short, children born in Bulawayo province are healthier compared to children who are born in Harare province, ceteris paribus. This assertion is true at 1% level of significance.

Discussed in the context of climatic conditions, this was somewhat surprising given that Bulawayo is situated in the parts of the country which receive less rainfall, meaning that agricultural productivity in Harare should be better compared to Bulawayo province. However, given that Harare and Bulawayo are metropolitan provinces (city provinces), agricultural productivity is not that prominent compared to other provinces. These are the only provinces of which the majority of the populations in these provinces do not depend that much on agriculture for a living (Food and Nutrition Council, 2018; Zimbabwe National Statistics Agency & ICF International, 2016). Hence, rising temperatures induced rainfall patterns do not matter much as far as determining livelihoods is concerned. However, the weight-for-age z score for those children who are living in Manicaland province is 0.428 better compared to that of children living in Bulawayo province. This is true at 5% level of significance.

More so, those children who were living in Mashonaland central province had a z score which is 1.65 better compared to those who were born in Bulawayo. This was found to be true and statistically significant at 1%. The same results were echoed for the children who are living in Mashonaland west and east province, which children living in Mashonaland west likely to have a weight for age z score of 1.67 more compared to those children who were born in Bulawayo province. Those who were living in Mashonaland east were found to have weight for age z score which was 0.33 more compared to that of children living in Bulawayo. The same story was found for those children living in Masvingo, Matebeleland north and south and midlands provinces. In terms of how child health status in Zimbabwe fared across the provinces, this area has not been explored enough previously. The best analysis found thus far was in a descriptive, particularly from DHSs reports. Probably a further study on why these disparities exist across provinces will help in this regard.

More so, the gender of child was found to be a significant factor affecting the health of children under the age of five in Zimbabwe during the study period. This study has found out that compared to male children, the female child is likely to have a weight for age z score which is 0.10 (5% level of significance) in the first model, and 0.12 (10% level of significance) in the third model in the table above. From the fourth model which were estimated with height-for-age z score as the dependent variable, the results showed that the height-for-age z score for the girl child was 0.117 better compared to that of the boy child. This was found to be true at 5% level of significance. These results are in contrast with the results which were found by Makoka (2013). Using the only the 2005 ZDHS, Makoka (2013) found that the boy child was healthier compared to the girl child. Given that the current study used not only one DHS in analysis (four waves were used), the current did not give the comparison for a period of time but rather over a period of time. In this regard, probably efforts may be made by the government and other development partners to improve the health of the boy child. This may be done after the child is born through offering supplementary foods to this population subgroup.

In terms of antenatal care visits during pregnancy, the results from the fourth model in the table above indicated that an additional antenatal care hospital by the mother during pregnancy was associated with a 0.072 increase in the height for age z score of the child. This was found to be true at 5% level of significance. However, from model two, this variable was found to have a negative effect although it was not significant at all the acceptable levels of significance (1%, 5% and 10%). More so, this variable was also found to have no effect on the weight-for age z score as indicated by the first model and the second model. Comparing these results from other studies which have been done in other areas, a study using 69 developing countries has also confirmed that increases in antenatal visits are associated with improved birth weight, long term reductions in child mortality as well as malnutrition (Kuhnt & Vollmer, 2017). However, the study emphasised the issue of the quality and skills of the health workforce.

Furthermore, another variable which was found to have an effect on the health of children was the education of the mother. For instance, from the first model, an additional year of maternal education will lead to an increase in the weight-for-age z score of the child by 0.09 units whilst it will lead 0.133 units increase in the height for age z score of the child. Both these assertions were found to be statistically significant at 1% level of significance. This was in line with the priori expectations discussed earlier. From literature review, other studies echoed the same views (Sondai, et al., 2017; Sazedur, et al., 2017; Makoka, 2013).

In terms of the climate conditions variables which were included in the model, the study found that rising temperatures have a negative effect on the health of children under the age of five in Zimbabwe. For instance, the first model indicated that a 1-degree Celsius increase in the temperature levels will lead to a decrease in the child’s weight for age z score by 0.65 units. These propositions were found to be statistically significant at 1% level of significant. In the various COP meetings, there has always a sterner warning on trying to safeguard rising temperatures. For instance, Grace *et al.,* (2015) found out that precipitation and temperatures has an effect on the birthweight of the child. This implies that climatic conditions affect the health of the child even prior to the birth of the child (Grace, et al., 2015), which is one of the hypotheses provided in this study. They even argued that these climatic conditions have an effect which is higher than the effect of prominent factors such as maternal education. This assertion can also be seen in the current study, which may mean that authorities may have to treat rising temperatures with even more urgency than education.

## **6. Conclusion and Policy Recommendations**

In conclusion, this study was carried out with the aim of finding the effect of climatic conditions, i.e., rising temperatures and precipitation levels, on the health of children under the age of five in Zimbabwe. Four waves of ZDHSs and climate data from the World Bank were used as data sources. The results indicated that the health outcomes of children under the age of five in Zimbabwe are heterogeneous at provincial level. Gender of the child was also another factor which was found to have an effect on the health of children under the age of five, with girls being found to be healthier compared to boys. More so, maternal education and antenatal care visits were found to have a positive effect on the health of children under the age of five. Conversely, rising temperatures were found to have a negative effect on the health outcomes of children under the age five. With these results being found in the study, the study proposes the following policy recommendations.

* Increase the availability of medical facilities in to improve prenatal care. More so, improving the skills of the medical officers in these medical facilities through training and retraining exercises may help in improving the health of children under the age of five in Zimbabwe.
* Subsidising education for the girl child so as increases educational intake by women in the country may also help to improve the health of children under the age of five in Zimbabwe.
* More so, campaigns to make sure that even the girls who gets pregnant before finishing their ordinary levels are encouraged to go back to school and finish their education are also key.
* There is need to make efforts to at least keep the temperatures at the current levels, or even reduce them. Adopting clean energy sources may be key in this regard. However, this works well with coordinated efforts on the global stage rather than at country level.
* Making available the finance mechanisms to finance green energy start ups can also go a long way in climate change mitigation.
* The government can also put climate change strategy within the National Development Strategy documents to ensure coordinated efforts among various ministries to reduce or curb rising temperatures.

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# **Appendix A: Multicollinearity Test**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
| (1) Province | 1.000 |
| (2) Gender of the Child | 0.000 | 1.000 |
| (3) Age of the Child (Months) | -0.013 | 0.152 | 1.000 |
| (4) Antenatal Care Visits | -0.139 | -0.013 | 0.400 | 1.000 |
| (5) Maternal Age | 0.074 | 0.056 | 0.578 | 0.170 | 1.000 |
| (6) Under five family size | 0.596 | 0.071 | 0.052 | -0.120 | 0.309 | 1.000 |
| (7) Family Size | 0.548 | 0.017 | 0.062 | -0.047 | 0.318 | 0.914 | 1.000 |
| (8) Maternal Education (years) | -0.391 | -0.002 | 0.042 | 0.177 | -0.125 | -0.691 | -0.693 | 1.000 |
| (9) Household heard age | 0.584 | 0.021 | 0.097 | -0.081 | 0.365 | 0.811 | 0.851 | -0.469 | 1.000 |
| (10) Family Wealth (Wealth Index) | -0.396 | 0.022 | 0.041 | 0.063 | -0.103 | -0.281 | -0.223 | 0.330 | -0.215 | 1.000 |
| (11) Child Birth Weight | 0.189 | -0.768 | -0.172 | 0.012 | -0.030 | 0.028 | -0.011 | 0.014 | 0.089 | -0.075 | 1.000 |
| (12) Mean Temperature | 0.627 | 0.000 | -0.042 | -0.295 | 0.117 | 0.426 | 0.411 | -0.629 | 0.363 | -0.469 | 0.079 | 1.000 |
| (13) Mean Precipitation | -0.507 | -0.000 | -0.114 | -0.232 | -0.176 | -0.273 | -0.317 | -0.109 | -0.431 | -0.018 | -0.040 | -0.263 | 1.000 |
|  | | | | | | | | | | | | | |

1. The belief here is that if the vulnerable are healthy, then the non-vulnerable too are healthy. [↑](#footnote-ref-1)
2. As indicated by the UN Agenda 2030, SDG number 3 [↑](#footnote-ref-2)
3. Quality here can be their health and education. However, since we are modelling children under the age of five who have not yet gone to school, we assume that their health is the only “quality” aspect. [↑](#footnote-ref-3)
4. To test the consistency of the results, another anthropometric measures that is weight-for-age z-score will also be used. This is also reported in the DHSs. [↑](#footnote-ref-4)
5. Average annual precipitation is going to be measured for the farming seasons. The idea is that this is the most critical season for food production. [↑](#footnote-ref-5)