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Helpful Grandparents? A Study of the Effect of Grandparental Care on Child Survival in Nigeria

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1 Introduction

A common misconception suggests that rescuing children from underdeveloped countries would lead to the problem of an overpopulation, which would impede economic growth. However, it is important to clarify this viewpoint as it can be misleading. In fact, saving the lives of theses children is essential in curbing the global population growth. By reducing the child mortality rate, parents in developing countries no longer need to have additional children to compensate for those that might have passed away. To expedite the reduction of population growth, reducing of child mortality rate plays a pivotal role. Numerous studies have found a negative correlation between child mortality and fertility rates. When parents invest more resources and attention in the well-being of their children to prevent child death, they tend to have fewer children overall. This phenomenon reflects a trade-off between the quantity and quality of children, as highlighted by Hanushek (1992). Researchers (Millimet & Wang, 2009) confirmed the empirical validity of quantity and quality trade-off using data from Indonesia. In a historical context, Fernihough (2017) employed data from the 1911 Irish census, and illustrated that households prioritized investing resources in their children's education, resulting about 27% reduction in fertility rate. These contributes to human capital increasing and economic growth in Ireland the late 19th and early 20th century.

This leads to the crucial question: how can we effectively reduce child mortality rates in developing countries? Numerous studies (Ladusingh & Singh, 2006; Sear & Mace, 2008) have highlighted the significance of mothers in ensuring child survival, although the impact tends to diminish as the child grows older. However, the role of other relatives and their contribution to childcare cannot be overlooked. In the field of behavioral ecology and evolutionary biology, the concept of "helpers at the nest" suggests that individuals who are not currently reproducing often assist their kin in caregiving, thereby increasing their inclusive fitness (Pollet & Dunbar, 2008).

Families frequently seek support from their relatives in caring for their children. The effects of grandparental care on child survival are subject to two conflicting mechanisms. The first is known as the Grandmother Effect (Coall & Hertwig, 2010; Hawkes, 2004; Hrdy, 2011; Lahdenperä et al., 2004), which proposes that post reproductive grandmothers can enhance their inclusive fitness by supporting their reproductive daughters and grandchildren. By providing assistance with childcare and resources, they increase their daughters' fertility and improve their grandchildren's chances of survival and reproduction. On the other hand, the grandmother co-residence hypothesis and the local resource competition hypothesis (Schrijner & Smits, 2018) suggest that grandmothers' cohabitation and resource allocation may have a negative impact on child survival rates. This study aims to examine the effects of grandparental care on child survival rates, taking into consideration these two mechanisms.

The demographic structure of the world is expected to change drastically in this century, with the rates of population growth vary significantly across countries and regions. According to the United Nations' predictions, more than half of the projected increase in the global population between 2022 and 2050 is expected to be concentrated in just eight countries: the Democratic Republic of the Congo, Egypt, Ethiopia, India, Nigeria, Pakistan, the Philippines and the United Republic of Tanzania. In particular, countries of sub-Saharan Africa (SSA) are projected to continue growing through 2100 and to contribute more than half of the global population increase anticipated through 2050 (World Population Prospects 2022, 2022).

Given the effects of grandparental care are complex and not yet fully understood, this study uses the latest data to examine these hypotheses in Nigeria. The paper will focus on Nigeria for examining the relationship between grandparental care and child survival for several reasons. First, Nigeria has a recorded population of over 213.4 million (World Bank, 2021), making it the most populous of the SSA countries. Their diverse population includes more than 250 ethnic groups, which produces a rich family structure and kinship network, offering a broad range of research paradigms. Second, child survival is a significant challenge in Nigeria, with high rates of infant and child mortality caused by a range of factors such as poverty, malnutrition, and inadequate healthcare. The complex kinship structures may play a role in influencing child survival. Third, Nigeria maintains its position as the top-ranked economy in SSA. The country is undergoing rapid economic and social changes, with increasing urbanization and a shift away from traditional life style. This presents an opportunity to explore how kinship networks and family structures are adapting to these changes and how this affects child survival. Forth, considering the practical aspects of the research, Nigeria has the most-up-to date data in the DHS database. Overall, Nigeria provides a unique and complex context for studying the relationship between grandparental and child survivals, making it a ideal subject to study in this field.

In the following sections, this paper will proceed with a comprehensive review of the existing literature and formulate the hypotheses to be tested. Subsequently, the data sources and research methods utilized in this study will be outlined. The results of the research will be presented. Lastly, the conclusions section will underscore the practical applications and contribution of this paper, as well as highlight certain limitations encountered during the study. Additionally, potential avenues for future research will be suggested.

2 Literature Review

2.1 Grandparental Care and Child Survival

Parents often seek help from their parents. Studies conducted across various cultural and societal contexts consistently demonstrate the important role of grandparents in supporting their children and grandchildren. Scholars (Newson et al., 2007; Sear & Coall, 2011) found that when women have supportive kin networks around them, they are more likely to have children and have a larger number of children. Kin members can play an active role in encouraging childbearing, particularly when the conditions are favorable for successful child-rearing. In such situations, social norms tend to be more pro-childbirth in environments where women are surrounded by their kin.

By analyzing data collected from 1950 to 1974 in a rural area of the Gambia, researchers found that the presence of a living mother, maternal grandmother, or elder sisters had a positive effect on child survival. In contrast, the presence of a living father, paternal grandmother, grandfather, or elder brothers did not show a significant impact on child survival (Sear et al., 2002). Similarly, further research conducted in rural Ethiopia by Gibson and Mace (2005) demonstrated the beneficial influence of grandmothers on child survival. Their analysis of mortality rates indicated that having a grandmother present was associated with improved survival outcomes for children. However, in rural Malawi, the presence of maternal grandmothers and maternal aunts was associated with higher mortality rates for children, while no other male kin, including fathers, appear to have an significant effect on child mortality rates (Sear, 2008). A review of 45 studies by Sear and Mace (2008) further supports the notion that maternal grandmothers tend to improve child survival rates, while the effects of paternal grandmothers on child survival vary. Surprisingly, fathers have relatively little impact on child survival.

The role of grandparents in providing care for their grandchildren is significant in several European countries. According to a study conducted by Hank and Buber (2009) across 10 European countries, approximately 58.8% of grandmothers and 49% of grandfathers provided care for at least one grandchild under the age of 16 in the previous year when the parents were unavailable. Furthermore, Sear and Coall (2011) employ the cooperative breeding hypothesis (Hrdy, 2011) and the demographic transition (Caldwell, 1976) to demonstrate that the influence of grandparents on grandchild development differs between pre-transition and post-transition societies. In post-transition societies, grandfathers appear to have an equal or greater impact on grandchild development compared to grandmothers, unlike in pre-transition societies.

Turning to Asia, a study conducted in northeast India revealed that girls have a higher chance of surviving childhood compared to boys, and when children lived with their paternal grandmothers, the risk of child mortality during the first five years of life was reduced (Ladusingh & Singh, 2006). Similarly, research conducted in western China by Du et al. (2022) shed light on the positive influence that grandparents can have on the well-being of their grandchildren. This study found that when grandfathers were present in the household, the mortality rate among children under the age of five was lower. However, the study did not find a similar effect when grandmothers were living with their grandchildren.

These findings underscore the importance of recognizing the diverse roles that grandparents play within different cultural and societal contexts. Factors such as gender, cultural norms, and family dynamics may influence the outcomes of grandparents on their grandchildren.

2.2 Determinants of Child Survival

Mosley and Chen (1984) established a framework to analyze the factors that influence child survival in developing countries by incorporating both social and biological variables. The proximate determinants includes five categories: (1) Maternal factors, (2) Environmental

Contamination, (3) Nutrient deficiency, (4) Injury, and (5) Personal illness control. While this framework is valuable, but not comprehensive, Berman, Kendall and Bhattacharyya (1994) expanded upon it by introducing the concept of Household Production of Health (HHPH), which is a dynamic behavioral process that further explains the factors impacting child survival.

In line with this research, several scholars (Kazembe et al., 2012) conducted studies using census data from three sub-Saharan African countries, namely Rwanda, Senegal, and Uganda. Their research provides compelling evidence of significant geographical variation in Under-five Mortality Rate (U5MR). Another study conducted in Nigeria by Ec et al. (2019) highlighted the disparities in health care availability and accessibility among different states, which in turn, have an impact on the U5MR. Notably, this study also demonstrated that having a mother who had minimum of secondary education reduced the U5MR significantly.

As mentioned earlier, in recent years, an increasing number of studies have incorporated kin care as a variable when studying child survival. This paper recognizes and further develops this research structure, understanding the role that grandparents play in supporting child well-being and survival.

2.3 Child Mortality in Nigeria

Child mortality has been a significant public health concern, particularly in Nigeria. In 2021, 5 million children died before turning 5 years old globally. The U5MR in Nigeria was shockingly high at 111 deaths per 1,000 live births. This is substantially higher than the global U5MR of 38 deaths per 1,000 live births and the sub-Saharan Africa U5MR of 74 deaths per 1,000 live births (Levels & Trends in Child Mortality, 2023). Recent report indicate a gradual decline in U5MR since 2008, dropping from 157 deaths per 1,000 live births to 132 deaths in 2019. Likewise, there has been a slight reduction in infant mortality, from 75 to 67 deaths per 1,000 live births. However, there has been no observable change in the neonatal mortality rate over the same period (National Population Commission - NPC & ICF, 2019). The consequences of high child mortality rates are severe and have implications for life expectancy. In 2021, life expectancy at birth in Nigeria was the lowest among countries globally, with levels below 54 years (*World Population Prospects 2022*, 2022).

Several factors contribute to the high child mortality rate globally, including infectious diseases, including pneumonia, diarrhea and malaria, along with pre-term birth complications, birth asphyxia and trauma and congenital anomalies remain the leading causes of death for children under 5 years (‘Child Mortality (under 5 Years)’, 2022).

These statistics highlight the urgent need for comprehensive efforts to address child mortality in Nigeria. It requires a focus on improving healthcare infrastructure, expanding access to quality healthcare services, promoting nutrition interventions, and addressing socio-economic factors that contribute to child mortality. Initiatives to improve maternal health, expand immunization coverage, and prevent and treat common childhood illnesses are crucial to reducing child mortality in the country.

2.4 Family Structure in Nigeria

Family is a deeply rooted value in the Nigerian culture, and the family structure in Nigeria is primarily based on the extended family system, which means the family activities and responsibilities are shared not only between parents and children, but also include other relatives such as grandparents, aunts, uncles, and even cousins.

Traditionally, the father is considered as the decision maker and provider of the family. The responsibility of mothers lays on taking care of the household and raising children. A working paper (Milazzo, 2014) shows that son preference is prevalent in Nigeria. In contrast to South and East Asian where sex-selective abortion, infanticide practices targeting unborn girls or children are prevalent, the harmful effects are reflected on the health status and well-being of adult women. Son preference is manifested through two main channels. The first one is known as the son-preferring stopping rules, whereby women who have daughters among their earlier-born children are more likely to continue having children and to have shorter interval between births. The second channel operates via changes in the marital status, such as polygyny, divorce, or separation.

However, Recent study (Wahab & Adedokun, 2013) suggested that the family structure in Nigeria is undergoing a transition from an extended family system to a more nuclear structure due to modernization. This change could pose new challenges to child survival. Despite this transition, the extended family system continues to play an essential role in child-raising settings.

To investigate the relationship between grandparents' co-inhabitance and children's survival in Nigeria, this paper aim to answer the following research questions: what is the overall relationship between grandmother, grandfather and their grandchildren's survival rate? The study intends to shed light on the role of family members in child survival, which can inform policy development focused on implementing cooperative breeding strategies and optimizing the human resources within families.

3 Methodology

3.1 Data Collection

The dataset used in this study is derived from the Demographic and Health Survey (DHS7) conducted in Nigeria, where household interviews took place between August and December 2018. It involves the utilization of two primary data files: the Household Members or Persons file (PR file)[1] and the All Births file (BR file)[2].

This study focuses on child survival rates for children under the age of 5, with a specific emphasis on those born in 2012. The selection of children born in 2012 allows for a targeted investigation into their survival outcomes within the first five years of life. The dataset includes data on 7,116 children from 6,618 households, providing a comprehensive understanding of demographic and health factors relevant to child survival.

3.2 Event History Analysis

This paper utilizes event history analysis, also known as survival analysis, to examine child survival duration in Nigeria, specifically focusing on the length of time it takes for a child to decease. Event history analysis is a statistical method. It is designed for the analysis of longitudinal data in which subjects are observed over a period of time until the occurrence of a specific event,

1 See Appendices Table 4 Variables employed from DHS7 PR file.

2 See Appendices Table 5 Variables employed from DHS7 BR file.

at which point they are removed from the sample (Allison, 1984). This approach is particularly suited for studying events of interest, such as child mortality, as it allows for the examination of the underlying causal factors. Firstly, it enables the consideration of time-to-event outcomes. Secondly, it allows for the handling of censored observations, which are cases where the event of interest (child death) has not yet occurred within the study period. Moreover, survival analysis enables the assessment of the impact of multiple covariates on child mortality rates. By considering various factors such as socio-demographic characteristics and grandparental care, this study can identify significant predictors of child survival and quantify their effects.

In this study, event history analysis is applied to predict the survival probabilities of children from birth to the age of 5, taking into account the presence of grandparents in the same household. The primary objective is to examine the duration of a child's survival within the dataset. Furthermore, the paper explores the risk of death by examining hazard rates. Hazard rates provide a measure of the likelihood of the event (child decease) occurring at a given time while the child remains at risk.

Overall, event history analysis provides a robust and comprehensive framework for studying child survival duration, estimating survival probabilities, and investigating the risk of child decease. RStudio[3] was used to perform the statistical analyses.

3.2.1 Survival Function

The survival function in equation can be expressed as follows

$$y = Surv(t, e)$$

Hazard λ is the probability of a child survive will end after time t, given he/she is alive until time t

$$\lambda = \frac{f(t)}{Surv(t)}$$

3 RStudio version: RStudio 2023.06.0+421 "Mountain Hydrangea" Release (583b465ecc45e60ee9de085148cd2f9741cc5214, 2023-06-05) for windows Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) RStudio/2023.06.0+421 Chrome/110.0.5481.208 Electron/23.3.0 Safari/537.36

Hazard ratio (HR) indicates the one child who is exposed to risk factors relative to another child who is not exposed to risk factors. For example, If the HR is 2, it means a child who is exposed to the risk factors, their risk of dying is double in compare to one child who is not exposed.

$$HR = \frac{\lambda, x = 1}{\lambda, x = 0}$$

This paper employs two tools. One is Kaplan-Meier survival function (KM), and the other one is Cox Proportional Hazards Model (CPHM). As each model have their pros and cons, this paper use these two models to study the research question as it could give a more comprehensive explanation to it.

3.2.2 Nonparametric Analysis: Kaplan-Meier Survival Model

The Kaplan-Meier method (Kaplan & Meier, 1958) is a sophisticated statistical technique used for analyzing time-to-event data. This method takes into account these censored observations and utilizes the available information from them up to the point of censoring. By doing so, it provides a more accurate estimation of the survival or event probabilities over time (Kishore et al., 2010).

3.2.3 Semi-Parametric Models: Cox Proportional Hazards Model

To gain a better understanding of the Cox Proportional Hazards Model (CPHM), it is necessary to first explore the Exponential Survival Model (ESM), which is an advanced version of the Kaplan-Meier survival function (KM).

In the context of child mortality, the time until a child diseases can be modeled by using the exponential distribution function where rate lambda λ representing the rate of occurrence.

$$f(t) = \mathrm{P}(T = t) = \lambda e^{-\lambda t}$$

The probability of a child deceased under the age of 5 (duration time $\leq$ 59 months) can be expressed by the following equation:

$$F(t) = \mathrm{P}(T \leq 59) = 1 - e^{-\lambda t}$$

Survival function is the probability of a child survived over 5 years old, it can be expressed as below

$$Surv(t) = P(T > 59) = 1 - P(T \leq 59)$$

Substitute into the exponential distribution function

$$Surv(t) = 1 - F(t) = 1 - \left[1 - e^{-\lambda t}\right] \; = \; e^{-\lambda t}$$

Therefore, the survival function is a negative exponential curve.

$$\lambda = e^{b_0 + b_1 x_1 + \, b_2 x_2 + \cdots + b_n x_n}$$

$$\ln \lambda = b_0 + b_1 x_1 + \; b_2 x_2 + \cdots + b_n x_n$$

Where x_n are the factors that influences the hazard, rate of a child disease.

Assumptions of ESM

1. Censoring is non-informative. It implies that censoring of an observation is unrelated to the likelihood of the event occurring. In other word, if a observation is censored, it does not indicate a higher or lower likelihood of survival or decease. Censoring is completely random. In this study, if a child relocates to another region and is no longer included in the survey, this corresponding data point will be censored. It does not give any information of the possibility of the child's survival.
2. Survival times t, are independent. This indicates that child A's survival time does not depend on child B.
3. Hazards are proportional, hazard ratio is constant over time.
4. $\ln \lambda$ is a linear function of the x's

Considering the strict assumption of the ESM, this paper utilizes the CPHM. The CPHM, developed by David Cox in 1972, allows for the estimation of robust covariate effects while assuming proportional hazards (Deo et al., 2021). One significant advantage of the CPHM is its ability to account for the time-varying nature of the hazard λ. Additionally, it enables the estimation of hazard ratios, which provide valuable insights into the effects of predictors on the hazard function. By employing the CPHM, this study can effectively capture the dynamic changes in the hazard rate over time and examine the relationships between predictors and survival outcomes.

In contrast to ESM, where b_0 is constant, in CPHM, $H(t)$ is a function of time that fluctuates. Thus,

$$\ln \lambda = H(t) + b_1 x_1 + \; b_2 x_2 + \cdots + b_n x_n$$

$$\lambda = e^{H(t)+b_1x_1+\ b_2x_2+\cdots+b_nx_n}$$

$$\lambda = H(t)\ \ e^{b_1x_1+\ b_2x_2+\cdots+b_nx_n}$$

Since we cannot specify the baseline hazard function, we cannot have estimation of the intercept b_0 , furthermore, neither the hazard λ nor the survival function can be estimate, which makes this model semi-parametric. However, it give us the benefit of estimating hazard ratio, which allows us to compare the survival rate affected different treatment.

3.3 Data Construction

Given that the DHS7 data is not specifically designed for event history analysis, I identified the event of interest, determine censoring criteria, and identify relevant covariates that may influence the occurrence of the event. To address this, the paper constructs variables [4] in the following manner:

The event of interest in this study is child survival, which serves as the dependent variable. Child survival is determined by two components:

- Time variable: This variable denotes the length of time until the occurrence of death. Given that the study specifically focuses on the Under-5 Mortality Rate (U5MR), the maximum time period considered is 60 months.
- Event variable: This variable is created to indicate whether the event (death) has occurred or not. In this paper, the value “1” is assigned to represent deceased children, while “0” is used to denote children who have survived.

The independent variables are two dummy variables, which are created to represent the living arrangements of children in six different scenarios. I extended from the research conducted by Schrijner and Smits (2018). The variables indicate whether (1) or not (0) the children are residing with their grandmother/ grandfather, and the scenarios are as follows:

- Scenario 1: they are grandchildren of a female/ male household head;

4 See Appendices Table 6 Variables used in the final data file.

- Scenario 2: they are grandchildren of a male/ female household head whose wife/ husband is also living in the household;
- Scenario 3: they are children of the household head, and the mother/ father of the household head is also living in the household;
- Scenario 4: they are children of the household head, and the mother-in-law/ father-in-law of the household head is also living in the household;
- Scenario 5: they are children of a biological brother/ sister of the household head, and the mother/father of the household head is also living in the household;
- Scenario 6: they are children of a brother/ sister by marriage of the household head, and the mother-in-law/ father-in-law of the household head is also living in the household.

Children who do not fall into any of these scenarios, including adopted and foster children, are considered not to be living with their grandmother/ grandfather.

It is important to consider the censoring criteria in this study. Censoring refers to the situation where we do not have complete information on the survival duration for these children. For this study, there is no need to account for left censoring since all the children were born in the year 2012. However, right censoring criteria need to be considered, which are as follows:

- When the event of interest (child death) has not occurred for some children within the observation period (60 months). Their survival duration extends beyond the study period.
- Right censoring also applies when a child has moved out of the study area.

By considering these censoring criteria, the study can appropriately handle and account for the incomplete information in the analysis.

Table 1 below provides descriptive statistics on various variables related to children survival. The findings reveal that 9.7% of the children are living with their grandmother, while 5.1% live with their grandfather. Mothers, on average, have completed only 2.375 years of education at the time of giving birth, with an average age of 26.99. Moreover, the data indicates that the majority of the children in the sample reside in households with relatively poorer living standards, as reflected by the wealth index.

TABLE 1 DESCRIPTIVE STATISTICS

Variables	Mean	Min.	Max.	Std.
Time	67.77	0	83	21.8150
Event	0.135	0	1	0.3418
Gender of child	1.489	1	2	0.5000
Grandmother in household	0.09668	0	1	0.2955
Grandfather in household	0.05059	0	1	0.2192
Mother is alive	0.9687	0	1	0.1742
Age of mother	26.99	12	44	6.7474
Education of mother (years)	2.375	0	8	2.6349
Father is alive	0.9524	0	1	0.2130
Wealth Index	2.662	0	5	1.3539

4 Results

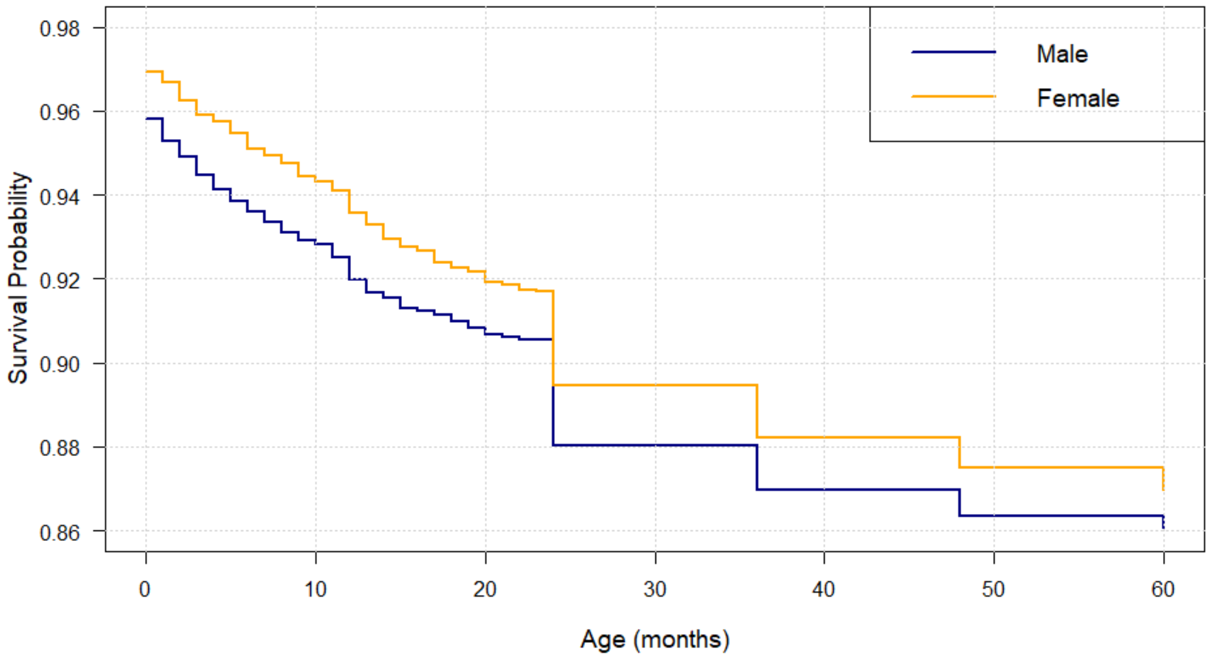
4.1 Kaplan-Meier Model – Gender Difference

The Kaplan-Meier survival curve (Figure 1) depicted below illustrates the survival probabilities for males and females throughout the 60-month period. The curve demonstrates that being female is associated with a higher likelihood of survival for the entire period.

Within the first 24 months, the survival probability for males declines from approximately 96% to 91%. This implies that 91% of boys continue to survive beyond this time frame. In comparison, the survival probability for females decreases from around 97% to 92%, indicating that 92% of girls remain alive after this duration.

After reaching 2 years of age, both males and females experience a shallower decline in survival probability, decreasing to 87% and 86%, respectively. This suggests that approximately 87% of children remain alive after the 60-month period. The survival probability for females remains consistently higher than that of males, indicating a gender disparity in survival rates.

FIGURE 1 KAPLAN-MEIER SURVIVAL CURVE BY GENDER



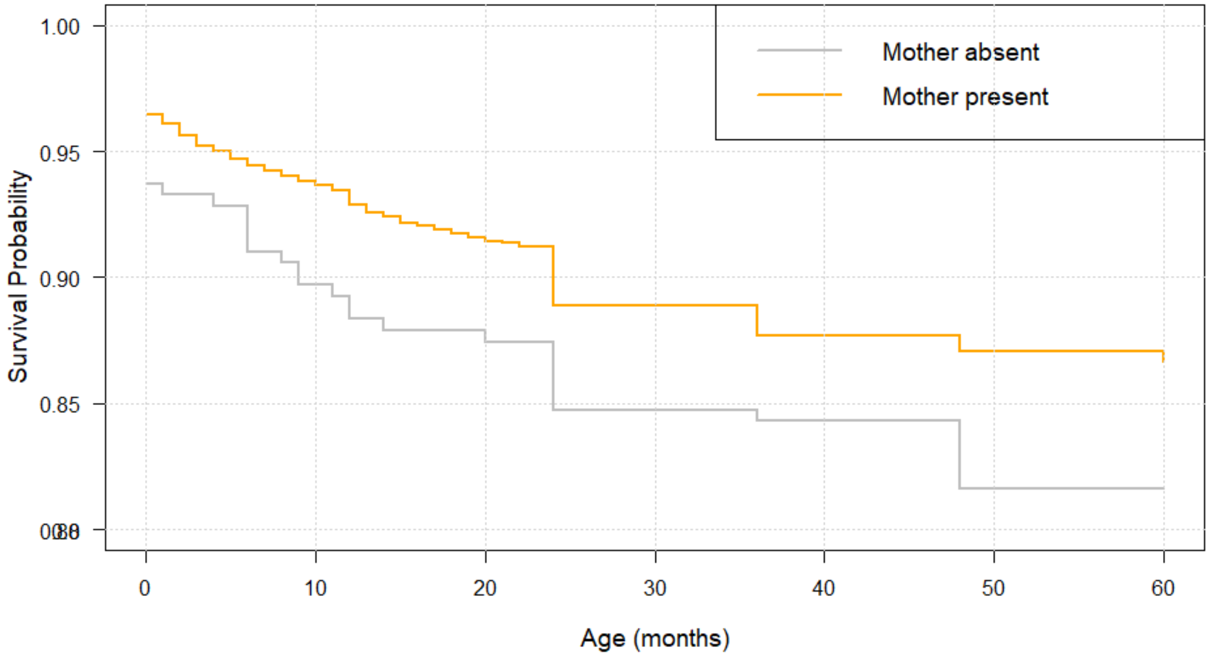
4.2 Kaplan-Meier Model – Mother

The KM curve (Figure 2) displays below illustrates the survival probabilities for children with a mother present and without a mother present after birth over a 60-month period. The curve clearly demonstrates that having a mother present significantly improves the probability of a child's survival.

Prior to the 24-month mark, the KM curve shows a distinct separation, indicating a higher likelihood of survival for children with a mother present. The survival probability for children with a mother present declines from 96% to 89% during this period. In comparison, the survival probability for children without a mother present decreases from around 94% to 85%, implying that only 85% of children in this group remain alive after this duration. The difference in survival probability between children with a mother present and those without becomes more pronounced by the end of 60 months, increasing from approximately 2.5% to 4%.

These findings highlight the critical role of maternal presence in improving the survival chances of children during the initial years of life.

FIGURE 2 KAPLAN-MEIER SURVIVAL CURVE BY MOTHER



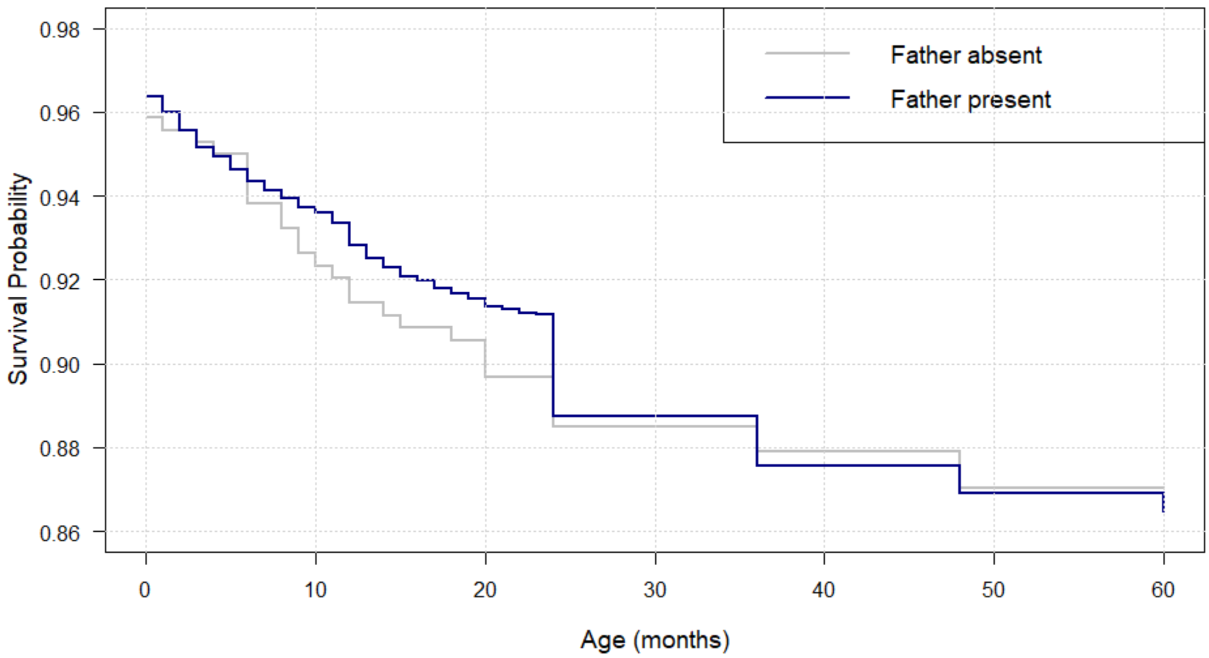
4.3 Kaplan-Meier Model – Father

The KM curve in Figure 3 illustrates the survival probabilities for children with and without a father present after birth over a 60-month period.

Up to the 24-month mark, the KM curve exhibits a slight separation, indicating a higher likelihood of survival for children with a father present. During this period, the survival probability for children with a father present declines from 96.5% to 89%. On the other hand, the survival probability for children without a father present declines at a faster rate.

However, after the 24-month mark, the difference in survival probability between children with a father present and those without becomes less pronounced. This suggests that the presence of a father may not have as significant an impact on child survival as during the earlier period. It implies that fathers may potentially serve as resource competitors to their children.

FIGURE 3 KAPLAN-MEIER SURVIVAL CURVE BY FATHER



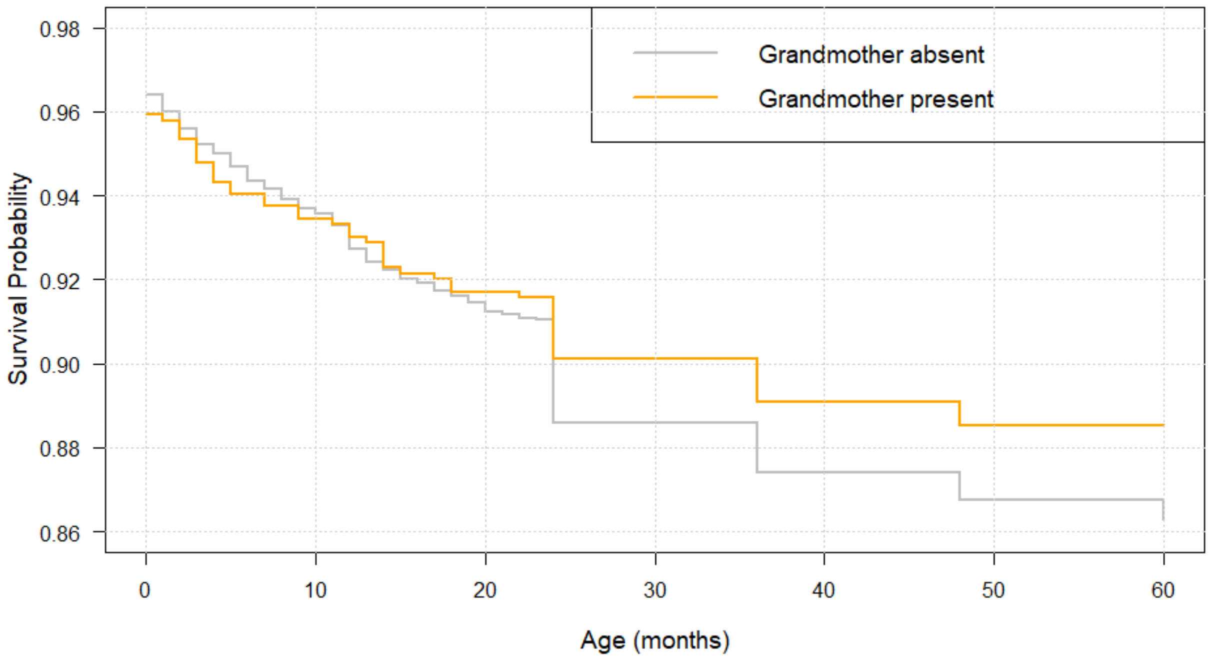
4.4 Kaplan-Meier Model – Grandmother

The KM curve below (Figure 4) displays the survival probabilities for children with a present grandmother and without a present grandmother over a 60-month period. During the initial 24 months, the survival probability for children with a present grandmother declines from 96% to 91.5%. In contrast, the survival probability for children without a present grandmother decreases at a higher rate, dropping from about 96.5% to 91%.

Between month 0 and month 12, the absence of a grandmother is associated with a slightly higher survival probability. However, after the child turns 1 year old, having a present grandmother is correlated with a higher survival probability. Particularly after the child turns 2 years old, the difference in survival probability between having a present grandmother and not having one is 2%. This indicates that having a present grandmother is associated with a 2% higher survival probability for children aged 2 years and older.

The observed differences in survival probabilities suggest that the presence of a grandmother may have a positive impact on the survival of children, especially for children aged 2 years and older.

FIGURE 4 KAPLAN-MEIER SURVIVAL CURVE BY GRANDMOTHER



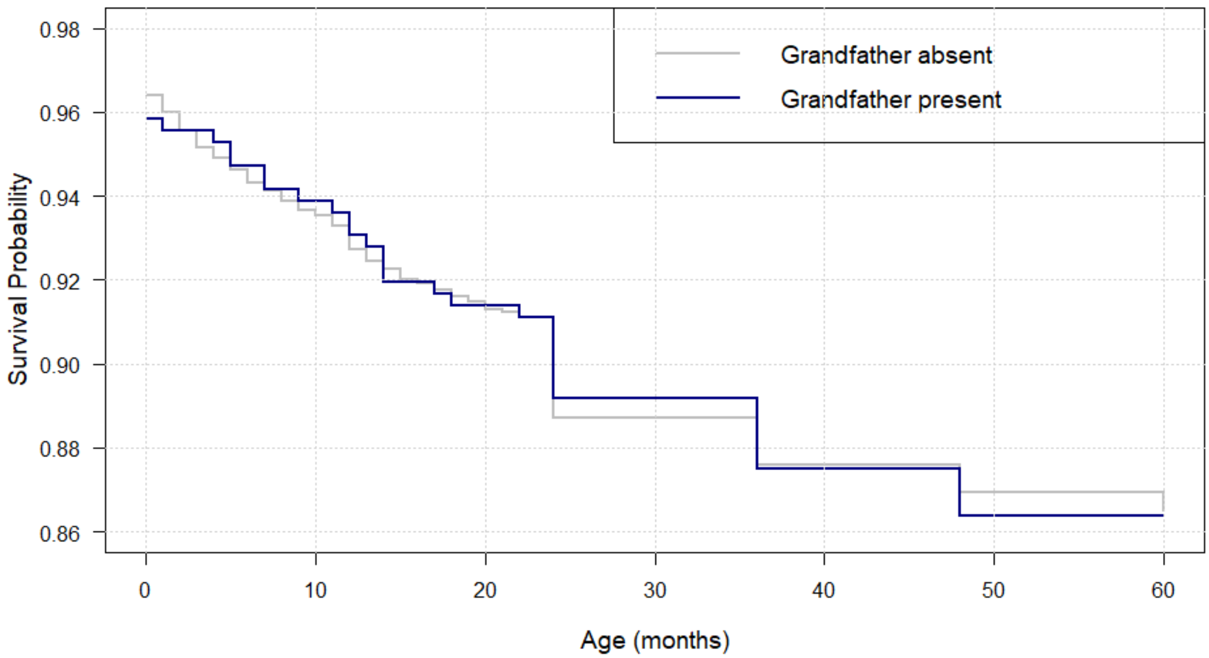
4.5 Kaplan-Meier Model – Grandfather

The KM curve (Figure 5) depicted below illustrates the survival probabilities for children with a present grandfather and without a present grandfather over a 60-month period. During the first 2 years after a child's birth, the survival probabilities for children with a present grandfather and those without a present grandfather are more or less the same. This indicates that the presence or absence of a grandfather does not significantly affect the survival probabilities of children during this period.

However, when the child reaches 3 years old, having a present grandfather is associated with slightly higher child survival probabilities. This suggests that the presence of a grandfather may have a positive influence on the survival of children at this stage. By the time the child reaches 4 years old, there is no significant difference in survival probabilities between children with a present grandfather and those without one. This indicates that the presence or absence of a grandfather does not appear to have a noticeable effect on child survival probabilities at this point. Interestingly, when the child reaches 5 years old, the data shows that having a present grandfather is associated with slightly lower child survival probabilities.

Overall, the KM curve suggests that the presence of a grandfather may have a modest impact on child survival probabilities, with a slight advantage observed at 3 years old and a potential slight disadvantage at 5 years old.

FIGURE 5 KAPLAN-MEIER SURVIVAL CURVE BY GRANDFATHER



4.6 Cox Proportional Hazards Model

The Kaplan-Meier survival curves presented above provide clear evidence that the effects of variables differ significantly between children under 2 years old and those above 2 years old. In order to account for and explore this observed discrepancy, two steps were taken to enhance the analysis of the relationship between these variables and child survival.

Firstly, a categorical variable called “age_group” was created, which consists two categories “Under 2” and “Above 2”. This variable allows for the differentiation between the two age groups in subsequent analyses. This allows for a comparison of survival outcomes and the effects of other variables between these two age groups.

Secondly, two interaction terms between variable “age_group” and the variables “Grandmother in household” and the variables “Grandfather in household” were included in the CPHM. By incorporating these two interaction terms, the modified Cox model can capture the differences in the effects of these variables on child survival, depending on whether the child is under 2 years old or above.

4.6.1 CPHM – Entire Sample

Table 2 presents the results of the CPHM regression analysis for the entire sample. The dataset includes 7,116 observations, out of which 961 resulted in deaths, while the remaining 6,155 observations are censored.

TABLE 2 CPMH REGRESSION ANALYSIS RESULTS – ENTIRE SAMPLE

	exp (coef.)	SE	Lower .95 u	Upper .95
Grandmother in household	0.1351***	0.3415	0.0692	0.2638
Grandfather in household	0.9203	0.3581	0.4562	1.8567
Mother is alive	0.5086 ***	0.1943	0.3475	0.7445
Age of mother	0.9973	0.0048	0.9880	1.0068
Education of mother (years)	0.9275 ***	0.0157	0.8995	0.9564
Father is alive	1.2920	0.1902	0.8899	1.8756
Wealth Index	0.8435***	0.0298	0.7958	0.8942
Interactions with age_group_Under 2				
U2 × Grandmother in household	207.9412 ***	0.3903	96.7716	446.8203
U2 × Grandfather in household	0.6928	0.4359	0.2948	1.6280

Significant codes: *** p <0.001, ** p <0.01, * p <0.05, * p <0.05, . p < 0.10

The exponential of the coefficients in this analysis provides the hazard ratio (HR) for each variable. When the HR is greater than 1, it signifies a shorter duration, indicating that the event (child death) is more likely to occur sooner. This higher HR suggests an increased risk, which may contribute to a shorter lifespan for children. Each unit increase in the predictor variable multiplies the hazard rate by the hazard ratio. Conversely, when the HR falls between 0 and 1, it indicates a longer duration, implying that the event (child death) is less likely to happen. This lower HR suggests a reduced risk of the event occurring, pointing to factors that may have a protective effect and promote longer survival for children.

4.6.2 CPHM – Girls

Table 3 presents the results of the CPHM regression analysis for girls and boys respectively.

The dataset for girls includes 3,481 observations, out of which 454 resulted in deaths, leaving the remaining 3,027 observations are censored.

TABLE 3 CPMH REGRESSION ANALYSIS RESULTS – GIRLS AND BOYS

	Girls		Boys	
	exp (coef.)	**SE**	**exp (coef.)**	**SE**
Grandmother in household	0.1506 ***	0.4737	0.1220 ***	0.4954
Grandfather in household	0.9944	0.4741	0.8231	0.5536
Mother is alive	0.5535 *	0.2974	0.4767 **	0.2589
Age of mother	0.9978	0.0071	0.9973	0.0065
Education of mother (years)	0.9195 ***	0.0231	0.9344 **	0.0214
Father is alive	1.5733	0.2960	1.1321	0.2510
Wealth Index	0.8239 ***	0.0443	0.8591 ***	0.0403
Interactions with age_group_Under 2				
U2 × Grandmother in household	219.4562 ***	0.5476	204.5254 ***	0.5603
U2 × Grandfather in household	0.5859	0.6137	0.8069	0.6450

Significant codes: *** p <0.001, ** p <0.01, * p <0.05, * p <0.05, . p < 0.10

The HR for the variable "grandmother" is 0.1506. This indicates that girls living with their grandmother in the same household have a 84.94% (1-0.1506) lower hazard of the death compared to girls who do not live with their grandmother. In other words, each unit increase in the variable "grandmother" multiplies the hazard rate by the hazard ratio of 0.1506, indicating a protective effect. Nevertheless, despite the overall positive effect of grandmother, girls under 2 years old living with their grandmother have a remarkably high hazard ratio, suggesting a significantly increased risk of death compared to girls who do not live with their grandmother in the same household. This discrepancy suggests that grandmothers may act as resource competitors to their granddaughters.

The HR for the variable "grandfather" is estimated to be 0.9944. This suggests a slight decrease (0.56%) in the hazard of death for girls living with their grandfather compared to girls who do not have a grandfather present, while holding other variables constant. However, the coefficient is not statistically significant. The slight positive effect of having a grandfather present on the hazard of death is debatable.

The findings from this analysis align with previous studies, providing further evidence of the significant influence of mothers on their daughters' survival. The HR for the variable "Mother is alive" indicates that girls whose mothers are alive have a 44.65% (1 - 0.5535) lower hazard of death compared to those whose mothers are not alive, while holding other variables constant. This finding underscores the protective role that a living mother plays in child survival. Additionally, the education level of the mother emerged as a significant factor. Each additional year of maternal education was associated with an approximately 8.05% (1 - 0.9195) decrease in the hazard rate. This emphasizes the importance of investing in maternal education as a means to enhance child well-being and increase the chances of survival.

Another important variable is the wealth index, which has a notable effect on the risk of death. An increase in the wealth index was associated with a lower risk of death, with an HR of 0.8239. This suggests that higher socioeconomic status of a household is associated with improved child survival.

4.6.3 CPHM – Boys

Table 3 provides the findings of the CPHM regression analysis conducted for boys. The dataset consists of 3,635 observations, among which 507 were recorded as deaths, while the remaining 3,128 observations were censored.

The presence of a grandmother in the household has a significant protective effect on their grandsons. Boys living with their grandmother experience a substantial 87.80% (1 - 0.1220) lower hazard of death compared to those without a grandmother present, after accounting for other variables. This finding highlights the positive influence of grandmothers in promoting the survival of boys. However, when considering boys under 2 years old living with their grandmother, the HR is remarkably high, indicating a significantly increased risk of death compared to boys who do not live with their grandmother in the same household. This finding suggests that grandmothers may act as resource competitors to their grandsons, potentially impacting their health and well-being in early childhood.

The HR for the variable "grandfather" is estimated to be 0.8231, indicating a 17.69% (1 - 0.8231) lower hazard of death for boys living with their grandfather compared to boys who do not have a grandfather present, while controlling for other variables. However, the coefficient for this variable is not statistically significant, suggesting that the observed effect could be attributed to random variation in the data.

The results are in line with the existing literature, which consistently emphasizes the importance of maternal care and presence in contributing to positive health outcomes for children. The presence of a living mother significantly decreases the hazard of death for boys. Boys with living mothers experience a substantial 52.33% (1 - 0.4767) lower hazard of death compared to those whose mothers are not alive, after accounting for other variables. Moreover, the variable "education level of the mother" shows a significant negative association with the hazard of death. For each additional year of maternal education, there is a 6.56% (1 - 0.9344) decrease in the hazard rate for boys.

In the dataset of boy, the coefficient of wealth index is also statistically significant. Higher wealth index is associated with a 14.09% (1 - 0.8591) lower hazard of death for boys.

5 Conclusion

This paper investigate child survival in Nigeria based on data on 7,116 children who are born in 2012. The Grandmother Effect is only observed after two years of age in both data samples, while prior to that age, living with a grandmother in the household is associated with a higher risk of child mortality, indicating support for the local resource competition hypothesis.

On the other hand, the presence of a grandfather in the household seems to have a potentially protective effect on child survival, although the regression results did not yield statistically significant coefficients in both datasets. Thus, further research is needed to look into the underlying factors at play.

Another important finding is the gender disparity in the influence of grandparents on child survival. Grandparents have a more pronounced positive impact on the survival of boys compared to girls.

Moreover, the study emphasizes the significance of maternal education and household wealth in reducing child mortality, regardless of the child's gender. Higher levels of maternal education and greater household wealth are significantly associated with improved child survival outcomes.

5.1 Contribution

This paper focuses on Nigeria and provides evidence that grandmothers have a positive influence on child survival. The findings hold important policy implications for improving child well-being in the country.

One key policy could be explored is the implementation of grandmother support programs. These programs would aim to provide targeted resources and knowledge to grandmothers who actively participate in the care their grandchildren. It is crucial to consider the broader issue of overpopulation when formulating such policies. This may involve initiatives focused on family planning, reproductive health education.

5.2 Limitation

This paper acknowledges certain limitations in both data collection and methodology.

Firstly, the data used in this paper is derived from the DHS7, which is a cross-sectional dataset. Due to the nature of the data, this dataset does not provide specific information for conducting survival analysis. Although the dataset indicates whether the child's grandparents are living in the same household at a particular time point, it lacks information on the duration of their cohabitation. To address this limitation, the paper assumes that if the grandparents were/ were not residing with the child in 2018, they have been doing so since the child's birth in 2012. While this assumption enables an examination of the impact of grandparents' presence on child survival, it is important to recognize potential limitations and biases. For instance, changes in living arrangements over time or grandparents joining the household after the child's birth are not captured.

Secondly, there is a difference between the Household members or Persons file (PR file) and the All Births file (BR file). The BR file contains data for every child ever born to interviewed women, including up to 20 births. It should be emphasized that not all children in a household are included in the BR file. For instance, if there is a child in the household of a non-interviewed mother, they will not be included in the BR file. However, the basic information of such children will be included in the PR file. This research paper utilizes both data files, but primarily relies on the BR file. The PR file serves as supplementary information. Therefore, the children included in this study are exclusively those whose mothers were interviewed.

Thirdly, due to the presence of polygamous households in Nigeria, it is possible that the parents-in-law of a household may not always be the biological grandparents of the children or nieces/ nephews of the household head. However, it is important to note that the occurrence of such households with co-sponsors is limited in the context of this study. Out of the total 6,618 households considered in the analysis, only three households were identified as having co-sponsors. As a simplification, for scenarios 4 and 6, which involve parents-in-law, it was assumed that they are the biological grandparents of the children residing in the household. While this assumption may not hold true in all cases, the impact on the overall analysis is expected to be minimal due to the limited occurrence of households with co-sponsors.

Last, event history analysis involves analyzing the occurrence of events over time, taking into account factors such as censoring and time-varying explanatory variables. However, the inclusion of time-varying explanatory variables poses challenges for standard statistical procedures, such as multiple regression. In fact, attempting to apply these methods can result in significant bias or loss of information (Allison, 1984). The Exponential Survival Model is built on a not always realist assumption. ESM assumes a constant hazard, x don't change over time, which indicates the probability of a child dying is constant as he/ she age. However, in reality the data shows that in 2020 an estimated 5 million children under the age of 5 years died, approximately half of those deaths, 2.4 million, occurred among newborns (in the first 28 days of life) ('Child Mortality (under 5 Years)', 2022).

5.3 Possible Extensions

5.3.1 Other Kin Care and Child Survival

In a resource-limited environments, raising a child is a challenging task which often requires the collective effort of the entire family. As a result, it is expected that relative to help taking care of children in times of need, and children are often raised by extend family members as well.

Bereczkei and Dunbar (2002) conducted a study among Hungarian Gypsy communities, it was found that older siblings also play crucial roles as helpers. Gypsy girls, in particular, actively contribute to the upbringing of younger children. Their parents have expectations for them to engage in various responsibilities, including looking after babies, playing with children.

In another study conducted by Pollet and Dunbar (2008), they utilized demographic data from the U.S. in 1910 to test their hypothesis. Their finding provided evidence that childless couples are significantly more inclined to assume the responsibility of caring for a niece or nephew compared to couples with children. Additionally, if the spouse was older and the couple did not have children, they were particularly more likely to take on the role of caring for a niece or nephew.

A study (Nitsch et al., 2014) conducted in Finland was the first to look into the effects of having childless adult aunts and uncles on the fitness of a family. The results showed that the presence of non-reproductive uncles and aunts in the parish had no effect on the offspring survival, with only old childless uncles weakly improving their niece's survival.

The result of a study (Gaydosh, 2019) conducted in Tanzania shows that despite the fact that family members are often relied upon to provide caregiving, living with them does not necessarily lead to positive outcomes, and they are not able to make up for the lack of parental presence. Biological parents remain of primary importance in child survival.

Overall, these findings underscore the importance of other family members, particularly older siblings, aunts, and uncles, in promoting child survival and well-being. However, due to limitations in available data, this paper did not specifically investigate the impact of other kin caregivers on child survival.

5.3.2 Child Care and Grandparental Health

In order to gain a comprehensive understanding of family dynamics, further research is needed to investigate the impact of caring for grandchildren on the health of grandparents. A previous longitudinal study across 11 European countries found a positive association between grandchild care provision and better physical health among grandmothers, while no significant association was observed for grandfathers (Di Gessa et al., 2016). Future studies could explore factors such as caregiving frequency, duration, as well as potential gender differences, to deepen our understanding of this topic.

Nonetheless, studying the impact of grandparents on child survival and considering the roles and contributions of extended family members provide valuable insights into family dynamics, living arrangements, and the application of cooperative breeding theory to humans. These insights can inform the design of policies aimed at implementing cooperative breeding strategies and optimizing human resources within families.

5.3.3 Other Countries

This paper only conduct survival analysis in Nigeria. Extending the analysis other developing countries, especially in Sub-Saharan Africa, would be a worthwhile pursuit. By conducting cross-country comparisons, we can identify similarities and differences in the relationships between variables across these countries. This approach can shed light on unique factors that are specific to each country or have broader applicability across the region.

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7 Appendix

TABLE 4 VARIABLES EMPLOYED FROM DHS7 PR FILE

Variable	Item Label	Variable Explained	
HHID	Household Case Identification		
HV001	Cluster number		
HV002	Household number		
HV006	Month of the household interview	1:12	
HV007	Year of the household interview	2015:2025	
HV101	Relationship to the head of the household	1 Head 2 Wife or husband 3 Son/daughter 4 Son/daughter-in-law 5 Grandchild 6 Parent 7 Parent-in-law 8 Brother/sister 9 Co-spouse	10 Other relative 11 Adopted/foster child 12 Not related 13 Niece/nephew by blood 14 Niece/nephew by marriage 98 Don't know (m) 99 Missing
HV104	Sex of household member	1 Male 2 Female	(m) 9 Missing
HV111	Whether the mother of the household member is still alive. (BASE: All children in the household aged less than 18.)	0 No 1 Yes 8 Don't know	(m) 9 Missing (na) Not applicable
HV113	Whether the father of the household member is still alive. (BASE: All children in the household aged less than 18.)	0 No 1 Yes 8 Don't know	(m) 9 Missing (na) Not applicable
HV219	Sex of head of household	1 Male 2 Female	(m) 9 Missing
HV270	The wealth index is a composite measure of a household's cumulative living standard.	1 Poorest 2 Poorer 3 Middle	4 Richer 5 Richest

TABLE 5 VARIABLES EMPLOYED FROM DHS7 BR FILE

Variable	Item Label	Variable Explained	
CASEID	Case Identification		
V001	Cluster number		
V002	Household number		
V010	Year of birth of respondent	1951 to 2000	
V106	Highest education level attended	0 No education, preschool 1 Primary 2 Secondary	3 Higher 8 Don't know 9 Missing
V107	Highest year of education gives the years of education completed at the level given in V106	0 No years completed at level V106 1:15	(m) 99 Missing (na) Not applicable
B1	Month of birth of child	1 to 12	
B2	Year of birth of child	1960 to 2015	
B4	Sex of child	1 Male	2 Female
B5	Whether child was alive or dead at the time of interview.	0 No	1 Yes
B7	Age at death (months, imputed) (BASE: Dead children (B5 = 0))	0:420 (na) Not applicable	

TABLE 6 VARIABLES USED IN THE FINAL DATA FILE

Variable	Item Label	Variable Explained	
CASEID	Case Identification		
HHID	Household Case Identification		
time	Age at death in month	0 to 83	
event	Whether death occurred with in 5 year of birth	0 survive	1 death
gender	Gender of child	1 Male	2 Female
gm	Whether the grandmother of the child is in household.	0 absent	1 present
gf	Whether the grandfather of the child is in household.	0 absent	1 present
mo	Whether the mother of the child is still alive.	0 dead	1 alive
mo_age	Mother's age when give birth to her child	12 to 44	
mo_edu	Highest year of education gives the years of education completed at the level	0 to 8	
fa	Whether the father of the child is still alive.	0 dead	1 alive
wi	The wealth index is a composite measure of a household's cumulative living standard.	1 Poorest 2 Poorer 3 Middle	4 Richer 5 Richest

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