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ORIGINAL ARTICLE

Impact of kinship support on child mortality in the Upper East Region of Ghana: assessing the Grandmother Hypothesis

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Background: The grandmother is an important kin member whose contribution to childcare and survival has been recognized in the literature, hence the Grandmother Hypothesis. This article examines the effect of the presence of a grandmother on child mortality.

Methods: Data were obtained from the Navrongo Health and Demographic Surveillance System, located in the Upper East Region of Ghana. Children born between January 1999 and December 2018 were included in the analysis. Person-months lived for each child were generated. The multilevel Poisson regression technique was employed to investigate the effect of a grandmother on child survival.

Results: In all, 57 116 children were included in the analysis, of which 7% died before age 5 y. Person-months were generated for the children, which produced 2.7 million records, with about 487 800 person-years. After controlling for confounders, results showed that children in households with paternal grandmothers are 11% less likely to die compared with those without paternal grandmothers. However, when other confounders were taken into accounts, the beneficial effect of maternal grandmothers disappeared.

Conclusions: We conclude that the presence of grandmothers improves child survival, thus sustaining the Grandmother Hypothesis. The experiences of these grandmothers should be tapped to improve child survival, particularly in rural areas.

Keywords: child mortality, grandmother, hypothesis, kinship, Navrongo, Poisson.

Introduction

Various forms of family support to young mothers have been found to contribute to child development in most societies.[1–3] For instance, in their review of 45 articles, Sear and Mace[4] found that mothers receive some assistance from family members or relatives. This offer of support to mothers is a consequence of the altricial nature of the human offspring, the rapid reproduction rate of the human population as well as the simultaneous care required by two or more siblings even after weaning.[5] Kinship support during pregnancy and the immediate post-partum period is a major buffer for post-partum depression and the hustle of childcare.[6,7] The contribution of kin members to childcare and survival depends on the type of living arrangements practiced by a particular society.[8] Thus women within the nuclear family system—the man, wife, children and sometimes home help—would receive support from only these family members.[8,9] The extended family system, practiced by most African communities, includes other family or kin members who can support mothers.[10,11] In both systems, non-resident household members often visit to assist during the immediate post-partum period.

One kin member who makes a significant contribution to childcare is the grandmother.[4,12–14] Recognition of this important contribution is at the basis for the Grandmother Hypothesis. The Grandmother Hypothesis, which is described as an adaptive mechanism, posits that the extended life span of human females beyond the end of their procreation period or menopause is a natural means by which they live to assist in the care of their grandchildren rather than engage in childbirth.[15–17] It has been suggested that early cessation of female reproduction evolved when extended maternal care became necessary for child survival.[18]

Several studies have examined the relationship between the presence of a grandmother and child health outcomes,[2,4,7] with some reporting beneficial effects of grandmothers on child survival while others found minimal or no effect.[4,12,19–21] These studies also reported varied results after examining the effect of other kin members on child development and survival. One reason that has been proffered for the variation in results is the differences in living arrangements in the various settings where these studies were conducted.[22]

In Africa and elsewhere, grandmothers have considerable influence on child health and general upkeep at the household and family levels.[23–25] In rural settings, elderly women (grandmothers) are expected to provide the needed expertise and knowledge transfer on issues related to child health and survival.[4,24] Even though several studies have examined this relationship, they have done so using cross-sectional data, which are informative but not suitable for the investigation of such relationships. For instance, Borjas[26] showed that the use of cross-sectional data provides unrealistic estimates of parameters that determine relationships over time. Thus this article seeks to assess the impact of the presence of grandmothers on mortality in children <5 y of age, by using longitudinal data spanning a period of 20 y from a rural setting in the Upper East Region of Ghana.

Methods

Study setting

Data for the analysis were extracted from the Navrongo Health and Demographic Surveillance System (HDSS) database, which contains routine demographic data from the Kassena-Nankana Municipality (KNM) and the Kassena-Nankana West (KNW) District in the Upper East Region of Ghana. Together, these areas cover 1675 km^2 along the Ghana–Burkina Faso border to the north. Located in the Guinea savannah belt, the ecology is typically Sahelian (hot and dry). At the end of December 2018, the population was 166 993, with 52.3% being females. There are about 32 000 households in the study area, with an average household size of 4.7. About 12% of the population is <5 y of age. Total fertility is 3.5, with 36% of the population being polygamous. In terms of economy, subsistence agriculture is the mainstay of the people, complemented by some retail trading.

Regarding access to healthcare, there are 2 hospitals and 15 health centres, with 1 managed by the Catholic Church. There are also 2 privately owned clinics as well as 49 functioning Community-based Health Planning and Services compounds that are sited across the entire study area. An orphanage, manned by the Catholic Church, protects and cares for children who are perceived as 'spirit children' and given poisonous concoctions or tortured to death.[27] The main causes of morbidity and mortality, particularly in children, include malaria, diarrheal diseases, anaemia, acute respiratory infection and malnutrition.[28] Located in the meningitis belt, there are periodic recurrences of cerebrospinal meningitis outbreaks that cause widespread morbidity and mortality.[29,30] As a result, there is annual and periodic vaccination of the people against the disease.[31,32]

Data source

This study used data from the Navrongo HDSS, covering the period January 1999 to December 2018. The Navrongo HDSS was set up in 1992 to monitor the demographic dynamics in the Kassena-Nankana District of northern Ghana and to facilitate health and demographic research in the Navrongo Health Research Centre (NHRC). Under the HDSS, fieldworkers visit all households every 4 months to collect and update the health and sociodemographic information of household members. Data collected routinely include pregnancies, births, deaths, migrations and marriages. Annual updates are done on the educational status of all individuals ≥6 y of age. To assign the causes of death in the population, verbal autopsies are conducted on all deaths that occur to registered individuals of the HDSS.[33–35] Event dates are established through verbal reporting or through some documentation. For instance, dates of birth of children are established through their birth certificates and immunization and health insurance cards, among others. For adults who do not possess any dated document and who do not know their date of birth, the local events calendar method is used to establish their plausible date of birth.

Analytical method

The data relate to children who were born in the study area between 1 January 1999 and 31 December 2018. These are dichotomized into those who died before celebrating their fifth birthday and those who survived up to 5 y. Children who survived up to 5 y and beyond are censored. Therefore, the dependent variable is whether the child died or survived to age 5 y. The main independent variable is the survival status and thereby the presence of the grandmother of these children. Two types of grandmothers are present and considered in this analysis: paternal and maternal grandmothers. Other kin members included in the analysis are the grandfathers of these children (maternal and paternal). Other key variables included in the analysis are the survival status of the biological parents (mother/father) of the child, sex of the child, presence of an elder sibling, age of the mother at the birth of the child, educational status of the mother, location (rural, urban) of the household and the year of birth of the child.

A total of 57 116 children were included in this analysis. Person-months lived until death, outmigration or censored before age 5 y was generated for each child, which produced 2.7 million records, with about 487 800 person-years. Accordingly, time-variant covariates were appropriately assigned to each child. Multilevel Poisson regression, which is more appropriate for modelling count data as well as accounting for dependence, was used to examine the association between the presence or absence of a grandmother and child survival. The Poisson model was run on the data and the result showed a significant value of 1.0 relating to the α value, indicating that there is no dispersion and so the use of the multilevel Poisson model was justified. Test for multicollinearity showed a maximum variance inflation factor (VIF) value of 3.42 among the variables and a mean VIF value of 1.87, indicating the absence of multicollinearity. The confounding variables enumerated above were used as control variables to assess the net effect of each variable on child

Table 1. Age of children who died before age 5 y

Age at death (years)	n	%
<1	2580	64.3
≥1–<2	802	20.0
≥2–<3	361	9.0
≥3–<4	177	4.4
≥4–<5	92	2.3
Total	4012	100.0

mortality. Stata version 12.0 (StataCorp, College Station, TX, USA) was used for the analysis.

Results

Descriptive statistics

Of the 57 116 children included in this analysis, 4012 (7%) died before celebrating their fifth birthday. Table 1 shows the distribution of the age at death of the children who died before reaching age 5 y. The number/percentage of children who died decreases with increasing age.

Table 2 shows the distribution of children by selected covariates and the proportion who died before age 5 y. The results show that 8.6% of children who did not have paternal grandmothers in their households died before age 5 y compared with 6.5% in those with paternal grandmothers. Similarly, a statistically significant difference was observed between children with maternal grandmothers in their households and those without maternal grandmothers, the former being advantaged in terms of child survival. Like grandmothers, the presence of a grandfather (paternal or maternal) also contributed positively to child survival; a lower proportion of children with grandfathers (paternal and maternal) died before age 5 y compared with those without grandfathers (Table 2).

Also, about 19% of children who lost their mothers died before age 5 y compared with 6.8% of children whose mothers were alive. Similarly, a higher proportion (11.2%) of children who lost their fathers died before attaining age 5 y compared with 6.6% in those whose fathers were alive (Table 2). Children with elder siblings also experienced a significantly lower proportion (5.7%) of deaths compared with those without elder siblings, while a relatively higher proportion (7.4%) of male children died before age 5 y compared with their female counterparts (6.6%).

Regarding the age of the mother at the time of birth of the child, the expected U-shape pattern of child mortality is observed. Specifically, children born to teenage mothers and to mothers >40 y of age experienced a higher proportion of deaths before age 5 y compared with children whose mothers were in the middle age groups (20–39 y). As expected, a higher proportion (8.3%) of children whose mothers had no education died compared with children whose mothers had some education (5.1%).

Table 2. Distribution of children and proportion who died before age 5 y by selected covariates

Covariates	Children, n	Dead by age 5 y, %
Paternal grandmother		
Yes	42 412	6.5
No	14 704	8.6
Maternal grandmother		
Yes	23 617	5.4
No	33 499	8.2
Paternal grandfather		
Yes	35 163	6.3
No	21 953	8.3
Maternal grandfather		
Yes	21 159	5.5
No	35 957	7.9
Mother died		
Yes	1025	18.7
No	56 091	6.8
Father died		
Yes	5 884	11.2
No	51 232	6.6
Presence of senior sibling		
Yes	34 851	5.7
No	22 265	9.1
Sex of child		
Male	28 793	7.4
Female	28 323	6.6
Age of mother at birth (years)		
15–19	5024	8.5
20–24	12 670	6.5
25–29	13 511	5.7
30–34	11 557	6.5
35–39	8356	8.1
40–44	4280	9.0
45–49	1718	9.4
Mothers' education		
None	33 817	8.3
Some	23 299	5.1
Place of residence		
Rural	50 144	7.3
Urban	6972	5.3

Multivariate results

The results of the multivariate regression analysis are shown in Table 3. Model 1 considers each of the kin members and other control variables to see the gross effect of each variable on child mortality. Model 2, on the other hand, considers all the kin variables along with some sociodemographic variables to see the net effect of the grandmothers' presence on child mortality.

The main focus of this article is whether the presence of a grandmother affects child survival. The results showed that paternal grandmothers contribute positively to child survival. According to model 1 (Table 3), a child whose paternal grandmother is present in the household is about 21% less likely to die before age 5 y compared with a child in a household without a paternal grandmother. When other kin members and sociodemographic variables are introduced, the survival advantage of children whose paternal grandmothers are alive still prevails.

Table 3. Rate ratios from Poisson regression of the effect of risk factors on mortality in children <5 y of age

	Model 1 (unadjusted)			Model 2 (adjusted)		
Variable	Rate ratio	p-Value	95% CI	Rate ratio	p-Value	95% CI
Paternal grandmother						
No	1.000	<0.001	–	1.000	–	–
Yes	0.814		0.800 to 0.829	0.897	<0.001	0.879 to 0.914
Maternal grandmother						
No	1.000	<0.001	–	1.000	–	–
Yes	0.771		0.756 to 0.787	1.005	0.72	0.979 to 1.031
Paternal grandfather						
No	1.000		–	1.000	–	–
Yes	0.891	<0.001	0.873 to 0.909	1.006	0.61	0.984 to 1.028
Maternal grandfather						
No	1.000		–	1.000	–	–
Yes	0.793	<0.001	0.774 to 0.811	0.997	0.87	0.969 to 1.027
Mother died						
No	1.000		–	1.000	–	–
Yes	2.665	<0.001	2.530 to 2.809	2.000	<0.001	1.903 to 2.104
Father died						
No	1.000		–	1.000	–	–
Yes	1.825	<0.001	1.776 to 1.876	1.185	<0.001	1.155 to 1.216
Senior sibling						
No	1.000		–	1.000	–	–
Yes	0.628	<0.001	0.617 to 0.640	0.932	<0.001	0.909 to 0.955
Child sex						
Male	1.000		–	1.000	–	–
Female	0.839	<0.001	0.824 to 0.854	0.841	<0.001	0.826 to 0.856
Maternal age						
15–19	–	–	–	1.000	–	–
20–24	0.816	<0.001	0.787 to 0.845	0.852	<0.001	0.822 to 0.884
25–29	0.768	<0.001	0.741 to 0.795	0.830	<0.001	0.799 to 0.862
30–34	0.815	<0.001	0.786 to 0.844	0.827	<0.001	0.795 to 0.861
35–39	0.993	0.70	0.957 to 1.030	0.939	0.003	0.901 to 0.979
40–44	1.184	<0.001	1.137 to 1.233	1.049	0.04	1.003 to 1.098
≥45	1.169	<0.001	1.109 to 1.233	1.035	0.24	0.978 to 1.096
Maternal education						
None	1.000	–	–	–	–	–
Some	0.644	<0.001	0.631 to 0.657	0.868	<0.001	0.850 to 0.887
Place of residence						
Rural	1.000	–	–	–	–	–
Urban	0.664	0.001	0.643 to 0.686	0.735	<0.001	0.711 to 0.761
Year of child's birth						
1999	1.000	–	–	1.000	–	–
2000	0.701	<0.001	0.673 to 731	0.711	<0.001	0.682 to 741
2001	0.827	<0.001	0.796 to 860	0.838	<0.001	0.806 to 871
2002	0.763	<0.001	0.734 to 794	0.804	<0.001	0.773 to 837
2003	0.643	<0.001	0.617 to 670	0.695	<0.001	0.665 to 726
2004	0.595	<0.001	0.570 to 620	0.652	<0.001	0.623 to 683
2005	0.520	<0.001	0.497 to 544	0.577	<0.001	0.550 to 606
2006	0.477	<0.001	0.455 to 499	0.539	<0.001	0.513 to 567
2007	0.554	<0.001	0.531 to 579	0.632	<0.001	0.603 to 662
2008	0.530	<0.001	0.507 to 554	0.615	<0.001	0.586 to 646
2009	0.359	<0.001	0.341 to 378	0.423	<0.001	0.401 to 447
2010	0.309	<0.001	0.292 to 326	0.362	<0.001	0.342 to 383
2011	0.279	<0.001	0.263 to 295	0.329	<0.001	0.311 to 350
2012	0.276	<0.001	0.261 to 293	0.333	<0.001	0.313 to 354
2013	0.308	<0.001	0.290 to 326	0.372	<0.001	0.350 to 396
2014	0.194	<0.001	0.181 to 208	0.236	<0.001	0.219 to 254
2015	0.213	<0.001	0.197 to 230	0.264	<0.001	0.243 to 286
2016	0.149	<0.001	0.134 to 166	0.184	<0.001	0.164 to 205
2017	0.123	<0.001	0.106 to 143	0.152	<0.001	0.131 to 177
2018	0.170	<0.001	0.136 to 213	0.218	<0.001	0.174 to 274

Specifically, the adjusted model (model 2) shows that children with their paternal grandmothers in the household are about 10% less likely to die compared with children whose paternal grandmothers are not present.

The maternal grandmother is another important kin member whose contribution to child health and survival is notable and is shown to exist in this setting. Children with maternal grandmothers are about 26% less likely to die compared with children without maternal grandmothers (model 1, Table 3). However, the survival benefit of a maternal grandmother disappears once other kinship types and some socio-economic variables are introduced into the model as confounders (model 2).

The results also show that the presence of grandfathers (maternal and paternal) has some effect on child survival (model 1, Table 3). Children with paternal grandfathers are 11% less likely to die before age 5 y compared with children without paternal grandfathers. Also, children with maternal grandfathers are about 21% less likely to die compared with children without maternal grandfathers. However, the survival benefits of having grandfathers disappears when other variables are introduced into the model (model 2, Table 3).

Biological parents contribute significantly to child survival, as confirmed by the results of this study. Children whose mothers died were about 2.7 times more likely to die compared with children whose mothers were alive (model 1, Table 3). Similarly, children who lost their fathers were about 1.8 times more likely to die compared with children whose fathers were alive. When other confounding variables were introduced into the model, the survival benefits of having biological parents still prevailed. Specifically, children who lost their mothers were about twice as likely to die compared with children whose mothers were alive. Similarly, for the adjusted model, children whose fathers died were about 18% more likely to die before age 5 y compared with children whose fathers were alive.

The presence of a senior sibling also contributes to child survival. For instance, the results show that children with a senior sibling were about 37% less likely to die compared with children without a senior sibling in the household. In model 2, when other kinship types and socio-economic variables were introduced as confounders, the survival benefits of having a senior sibling still exist, but were rather minimal.

Discussion

This study examined the effect of the presence of a grandmother at the household level on child mortality in the Upper East Region of Ghana. The results show that children in households with a paternal grandmother have higher survival chances than children in households without a paternal grandmother. While some studies have produced similar results, others are at odds with the results of this study. For instance, in their review of a number of studies on kin and child survival, Sear and Mace[4] and Sear and Coall[12] found that the presence of paternal grandmother was often associated with positive child survival outcomes, although less consistently. On the other hand, they found that maternal grandmothers contribute substantially to child survival outcomes. These findings are at odds with the findings of this study after controlling for other variables. The variance could be attributed to differences in the traditional living arrangements in the respective study areas, as suggested by Clark et al.[36] In the current study setting, mothers typically stay in their husbands' home where the paternal grandparents also reside, while the maternal grandmother stays in a different location from the child. It is thus not surprising that the influence of paternal grandmothers on child survival in this cultural setting is found to be more positive than that of maternal grandmothers. Other studies suggest that the effect of paternal grandmothers on child survival is stronger during the early days of the child's life, when the risk of death is very high, while the maternal grandmother's influence is greater at the time of weaning, when the risk of death is relatively lower.[37]

Generally, in this setting, mothers typically stay in the same households with their mothers-in-law (paternal grandmothers of their children). As a result, grandchildren get full benefits of the expertise and support of their grandmothers who provide critical guidance to their daughters-in-law on proper handling of their pregnancies, assisting them during delivery and proper maintenance of their children.[35,48] During pregnancy, grandmothers share important information with their pregnant daughters-in-law pertaining to proper handling of pregnancies.[39] They also remind their pregnant daughters-in-law about clinic attendance, adherence to therapy and proper dieting, as well as run errands for them. Grandmothers also feed, bath, administer drugs and monitor the children to prevent exposure to danger. In rural settings where access to healthcare is scarce, some grandmothers serve as 'midwives' in the delivery process.

In rural settings, living arrangements include extended family members, where several households stay together, or at least in close proximity, while in urban settings, the nuclear type of household is common. Again, in urban settings, one rarely finds grandparents in those households, unless the need arises. In such settings, it is the maternal grandmother who most likely visits and assists her daughter during pregnancy and childbirth in order to prevent the conflicts that often occur between wives and their mothers-in-law. In such situations, the importance of the maternal grandmother comes to bear on child health outcomes. However, separate analysis for the urban population in this study showed no such net effect of the maternal grandmother on child survival with respect to urban nuclear living arrangements. This means that overall, paternal instead of maternal grandmothers have a dominant influence on child survival in the study area.

While the presence of grandmothers can contribute positively to child health and survival, their presence can also be detrimental.[40–43] Some grandmothers have conservative ideas and practices that tend to negatively affect child health and survival. Due to the trust placed in these older women, sometimes professional advice is ignored in favour of their guidance, which may negatively affect child health.[39] There is also the resource dilution hypothesis,[44] whereby some grandmothers add to the already precarious economic situation of households with limited resources. This is further complicated where the grandmother is unwell or bedridden and requires the scarce resources of the household to stay alive and healthy.

With respect to the other independent variables, the results confirmed the expected relationship with child mortality. The effect of maternal age on child mortality exhibits the usual

U-shaped pattern. Children of mothers at the extreme ends of the reproductive age spectrum are more likely to die compared with children of mothers in the middle age groups. This is consistent with findings from several studies[45–47] and is consistent with the results of the bivariate analysis.

Maternal education is an important factor in child survival, as children whose mothers had some education (primary school and beyond) were about 36% less likely to die compared with children whose mothers had no education. The benefit of maternal education on child survival persisted in the adjusted model (model 2, Table 3).

Female children were about 16% less likely to die compared with their male counterparts in both models. As expected, children in urban settings were about 34% less likely to die compared with children in rural areas. When adjusted for confounders, the urban child survival advantage continued to persist, where urban children showed about 26% less likelihood of dying before age 5 y compared with their rural counterparts.

The results also indicate that child survival has improved generally in this community over the years. Although not consistent, a pattern emerges where the probability of dying before age 5 y decreases gradually over time.

Limitations of the study

First, grandparents who reside in the HDSS area were used for the analysis. Even though they constitute the majority, there are some target grandparents who reside outside the coverage area and therefore were not included in the analysis. The best approach would have been to include all grandparents, regardless of their location, but this was not possible due to the data limitation of the HDSS. However, we assume that these grandparents are fairly distributed among surviving and dead children and so do not affect the results.

Second, the Navrongo HDSS was established in 1992 and the first update round was conducted in 1993. However, this analysis was restricted to the period 1999–2018 because data collection prior to 1999 did not capture many of the variables used for the current analysis. Despite these limitations, we think that this longitudinal platform provides a unique dataset for examination of the influence of grandmothers on child survival.

Conclusions

The findings of this study revealed that the presence of a grandmother enhances child survival. However, the results showed that paternal grandmothers contribute more to child survival than maternal grandmothers. In settings such as the Kassena-Nankana District, paternal grandmothers reside in households where the child and mother also reside, hence the impact of paternal grandmothers being more pronounced than maternal grandmothers, who stay in different locations from the child. Results from some studies show that maternal, instead of paternal, grandmothers contribute more to child survival.[2,4] This means that the level of contribution of grandmothers to child survival depends on the living arrangement in a particular geographical and cultural setting. In general, therefore, the presence of grandmothers contributes to child survival, hence sustaining the Grandmother Hypothesis. However, improvements in healthcare delivery over the years and the nucleation of families appears to dwarf the impact of grandmothers on child health and survival. Despite this change, taking into account their potential benefits in child health and survival, grandmothers' contribution could significantly reduce child mortality, particularly in rural settings where healthcare services are scarce.

Authors' contributions: GW and MB conceived the idea. GW designed the study, performed the data analysis, interpreted the results and wrote the first draft. MB and SK contributed to the interpretation and analysis of the results. RA, JA and SK were responsible for critical revision of the manuscript. All authors read and approved the final version and take responsibility for any issues that may arise.

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Competing interests: None declared.

Ethical approval: This analysis was based on secondary data from the Navrongo HDSS. Ethical approval was obtained for the HDSS operations and relevant consent was obtained from participating households. For anonymity, the identities of individuals and their locations were not included in the analysis.

Data availability: Data for this study came from the Navrongo HDSS, which has been collecting longitudinal data since 1993. Due to the huge volumes of data collected over a long period, it is not practicable to share the data. Another important reason why data cannot be shared is the issue of privacy. However, upon special request, some aspects of the data that are directly related to this study may be made available.

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