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Motherhood versus Fatherhood: The Effect of Parent Death on Post-Neonatal and Child Mortality from 1850 - 1920.

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Abstract

This study examines the impact of a parent's death on infant and child mortality up to the age of 5 in the 19th century. Utilizing data from the Utah Population Data Basefrom 1850 -1920, infant and child survival are examined in a Cox Model with non-proportional effects. During infancy years, the results show death of either parent has a major impact on the survival chances of infants. The death of the mother has the largest impact on child survival likelihood. The impact of parent death is mitigated with child age and presence of siblings over age 10.

Keywords: Child Mortality, Survival Analysis, Nineteenth Century, Infant Death, Gender Roles

1. Introduction

The effect of a parental loss on the survival of children has been studied in various social sciences such as demography, sociology, and psychology and health economics. Most historical research on the survival prospect of children examinesthe effect of the loss of the mother or father on the mortality level of children (Derosas, 2002; Beekink, van Poppel&Liefbroer, 1999; 2002; Campbell & Lee, 2002; Tsuya &Kurosu, 2002; Pavard, Gagnon, Desjardins, &Heyer, 2005) but focuses exclusively on one small community. Other studies examine child mortality by focusing on the single parenthood family condition (Gay & Tong 1967; Blakely, Atkinson, Kiro, Blaiklock, & D'Souza, 2003; Weitoft, Hjern& Rosen, 2003). These studies rarely focus on variation in the risk of child mortality over time.

Only a few historical studiesdeal with the effect of a parent's death on the survival of children over time (Reher&Gonzales-Quinones 2003; Gagnon et al. 2005; Poppel&Gaalen, 2008). While most scholars agree on the importance of the mother on child mortality, the effect of the father on the survival rate of children and the impact of parent death on child mortality during the nineteenth century is somewhat controversial. For example, Reher and Gonzalez-Quinones (2003) argue that mothers become increasingly important for their children's health during the first year of life. However, Poppel and Gaalen (2008) found no difference in the negative effect of the absence of the mother on the survival chance of children across different ages of children; whereas, the negative effect of the absence of the father on survival of the child exists only for older children. By examining differential impacts of both mother and father on the survival chances of a child, this paper addresses a gap in the literature and provides additional evidence of parents' role in infant and child survival in the U.S. during the 19th century.

The primary challenge of historical research is the limitation of data, which requires large historical family information over time. Therefore, most historical demography studies on the effect of child mortality focus heavily on small communities in European countriessuch as France, Spain and Sweden (where better historical data exists).

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It is hard to find historical demography studies investigating the effects of parental loss on child mortality focusing on the nineteenth century in the US. The Utah Population Data Base (UPDB) provides a large amount of genealogical information on individuals in the U.S. over time. Utilizing the UPDB, which includes longitudinal data fora large population of the US, this study examines the effect of the loss of a parent on post-neonatal and child mortality over time in the nineteenth century. The paper also considers twoadditional factors, which can moderate or change the parental effect, the replacement effect of siblings on child mortality and institutional changes over time.

This study's motivation stems from the fact that the importance ofthe mother ona child's survivalisdifferent from that of the father and this difference could vary with a child's age. Given traditional gender ideology, the role of a wife is to be the caretaker for children andthe overall conditions of the household. Therefore, the risk of injury for young children as well as poor sanitization within the household increase when the mother is absent. Most importantly, the mother provides the necessary nutrition for infants through the act of breastfeeding. In addition, the absence of a father could also increase the risk of death from malnutrition for a child given the father's role as a breadwinner (i.e. providing economic resources for the family). Given that older children need more nutrition but have less need for breastfeeding from the mother than an infant, the importance of the father for the survival of a child would increase as children age.

Other conditions that are not directly related with parent death but possiblyinfluence child mortality are also considered. First, the existence of siblings of different ages is considered in the analysis given thatthe importance of parents on the survival of a young child may vary withnumber and age of siblings.While existing siblings can increase the risk of child mortality considering that siblings share resources (food) within a family, it is possible that the existence of older siblings might moderate risk of infant death when one parent dies, taking over the role of caretaker for any infant and young children. Second, the paper also considers the possible influence on survival of children resulting from institutional changes over time. Given that the well being of family members (including survival of children) are heavily affected by institutional and economic development, it is possible that different time periods could have differential influence on child mortality.

Specifically, this study focuses on the following related questions: First, how does the loss ofthe mother versusfather affect the survival chances of a post-neonatalchild (i.e. infant less than 12 months old) and young child (i.e. between one and five years old) differently? Second, do institutional changes have any influence onthe probability that an infant or young child will survive? Third, does the existence of older siblings have a replacement effect when either of the parents dies? Reflecting these main questions, this paper considers five hypotheses about the survival of infants and children during the nineteenth century.

The first three hypotheses consider the importance of a parent's loss (mother or father) on post neonatal and child mortality, accounting for traditional gender roles in the family by gender and biological ability (i.e. breastfeeding for childcare).

Hypothesis 1: *The effect of the death of the mother is highest during a child's first year, and declines as the age of the child increases.* It is necessary that an infantreceives more specialized care from the mother (than an older child) when considering the importance of breastfeeding and caretaking for an infant's health.

Hypothesis 2: *The effect of the death of the father is limited during the first year of life, but increases later in childhood.* Considering the breastfeeding effect during infancya father's impact on child mortality is initially limited, but the importance of a father increases as children age because he is the provider of economic resources such as basic food and necessity goods for the family.

Hypothesis 3: *The death of the mother has a greater effect on infant and child mortality than the death of the father.* Although the effect of the death of the mother and father on child mortality with increasing age in nineteenth century is somewhat controversial, most previous studies agree on the greater importance of mother than father. Therefore, this paper alsotests the hypothesis that the mother is more important than the father for children's survival.

[3] Hypothesis 4 and 5 consider other conditions, which can moderate (or augment) the impact of parent deathon child mortality such as the existence of older siblings and institutional changes over time.

Hypothesis 4: *Infants and/or children who experience a parental death have better survival chances when they have older siblings.* It is possible that older siblings can take care of younger siblings when one of the parents dies.

In this case, the existence of an older sibling, old enough to take care of infants rather than be competitors for resources, can reduce the risk of child mortality.

Hypothesis 5: *Institutional changes during the nineteenth century impact a child's survival.* Consideringindustrialization and reform in America in the 1800s, it is possible that institutional changes may have had an influence on child mortality. Living conditions of the American population since about 1870 improved significantly, including better diet, clothing and shelter, as well as rapid reductions in infectious and parasitic diseases such as pneumonia, bronchitis, and cholera. Although the conditions of large cities in the nineteenth century U.S. were still very unhealthy with bad sanitization, thisbegan to change in the 1890s. Therefore, hypothesis 5 tests if there is any difference in child mortality caused by institutional changesoutside parental death.

1. Data and Methodology

The UPDBfrom 1895-1920 is utilized for this study. The dataset includes information on personal information such as the date-of-birth, date-of-death, sex, and sibling' demographics, and parents' demographics like the personal identification of the child's mother and father. With this longitudinal data, time-varying covariates are constructed for the death of the parent and contextual variables for individuals, families and households. In studying the effect of parental absence on the survival of infants and children, the sample is restricted to children born between 1850 and 1920 up to age 5. In addition, only children from the first marriage are included to capture the pure effect of a parent's death, and infants who died within the first month are not included in order to exclude observations not caused by parents' absence, such as Sudden Infant Death Syndrome. Coupling all restrictions regarding children and parents results in a sample size of 374,849 children of whom 48.85% are femalesand 51.14% are males.

1) The Cox model with non-proportional hazard

The mortality risk of children is estimated via an extended Cox model to allow non-proportional hazards. Using event-history analysis (survival analysis) instead of ordinary least squares (OLS) allows inclusion of right censored cases, children for which life course information is only available until a certain point in time (as we are interested in the effects of changing covariates on the death rate). The Cox model[2]is a proportional hazard model but introducing a time-dependent covariate into the model makes the ratio of hazard unstable. Therefore, interaction effects with time are used for the time-varying coefficients, ensuring the proportional hazard assumptions are satisfied for the Cox model. In order to compare the risk of mortality between infant and child, time-varying covariates of parent death are treated as a non-proportional effect.

The basic model (Model 1) is illustrated in equation (1) with a time-varying covariate of one parent death as an independent variable with non-proportional effects. The second regression model (Model 2) is based on equation (2) and includes the death of the mother as an independent variable (instead of one parent death), which focuses solely on the effect of a mother's absence. Model 3, based on equation (3), includesonly the death of the father as a time-varying covariate, focusing solely on the effect of a father's absence. The final regression model (Model 4) includes both the death of mother and father as time varying covariates, illustrated in equation (4). For all models (Model 1 to 4), the Cox model with non-proportional hazard is utilized to analyze differences in the effect of absence of mother versus father on mortality as well as differences in effectsbetween infant and child.

Model 1: $$\log h(t) = \alpha(t) + \beta_1 OPD + \beta_2 OPDt + \beta_3 Male + \beta_4 Twin + \beta_5 TP \quad (1)$$

Model 2: $$\log h(t) = \alpha(t) + \beta_1 MD + \beta_2 MDt + \beta_3 Male + \beta_4 Twin + \beta_5 TP \quad (2)$$

Model 3: $$\log h(t) = \alpha(t) + \beta_1 FD + \beta_2 FDt + \beta_3 Male + \beta_4 Twin + \beta_5 TP \quad (3)$$

Model 4: $$\log h(t) = \alpha(t) + \beta_1 FD + \beta_2 FDt + \beta_3 MD + \beta_4 MDt + \beta_5 Male + \beta_6 Twin + \beta_7 TP \quad (4)$$

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[2]The Cox model is: $h_t(t) = h_0(t)\exp(A(t)\infty)$ where $h_0(t)$ is baseline hazard rate, $\exp(A(t)\infty)$ is the relative hazard from influences of a covariate vector $A(t) = \beta_1 X_1 + \beta_2 X_2 \cdots \beta_k X_k$ on hazard rate $h_t(t)$. By taking thelogarithm in both sides, we can write an additive model such as $\log h_t(t) = \log h_0(t) + \beta_1 X_1 + \beta_2 X_2 \cdots \beta_k X_k$

The dependent variable is the log of *h(t)*which is the hazard of an event, here the event is death of child, at time t. This denotes the instantaneous probability that an event will occur at time t. The "*OPD*" variable denotes whether one parent died or not, and the interaction term between death of parent and time, *OPDt*, shows the non-proportional effect for young children over 12 months. *Male* and *Twins*are binary dummy variables for denoting gender of children and whether children are twins or not. Twins are controlled for considering the fact that twins have a significantly higher risk of both child and mother's death. *TP* is a categorical dummy variable, which reflects different time periods. It includes three different time periods to model different institutional changes which may impact mortality: P1 is 1850 to 1879; P2 is 1880 to 1889; and P3 is 1890 to 1920[3]. The "*MD*" and "*FD*" variables denote the death of mother and father respectively. "*MDt*"and "*FDt*" indicate interaction of mother's and father's death with time t.

2) The Cox model with interaction terms

For the replacement effect of siblings on infants, a separate model (Model 5) is estimated which adds an interaction term between the number of older siblings and the death of one parent into the basic model. Older siblings are classified as siblings over the age of 10 years old. Model 5 is illustrated in equation (5).

Model 5: $$\log h(t) = \alpha(t) + \beta_1 OPD + \beta_2 OPDt + \beta_3 Male + \beta_4 Twin + \beta_5 TP + \alpha OLDSIB + \delta OPD * OLDSIB \quad (5)$$

Here, "*OLDSIB*" indicates number of older siblings and "*OPD*OLDSIB*" is an interaction between older siblings and death of a parent. All households were clustered for all models (Model 1 to 5) to control for possible correlations such as an epidemic within a household. It is possible that an environmental contamination or nutritional deficiency, for example, impacts households and therefore the risk of death to child and parents are highly correlated within the same household.

In summary, Cox regressionswith non-proportional hazard are estimated for the first four models to analyse the effect of a parent's death on infant and child mortality. Also, the proportional Cox regression with interaction terms is estimated in a separate model to examine older sibling's replacement effect for a parent.Subsequently,the differences in the importance of the mother versus father on children's mortality, comparing infants and children, whether the effect of parental loss changes during different time periods due to changes in institutional conditions, and older sibling's replacement effect of a parent are investigated.

2. Results

Table I presents the regression results for all models described in equations 1 to 5. For instance, Model 1 is presented in the first column in Table I and shows the hazard rate of children's death when one parent dies. The regression results for the basic model indicates boys have more than an 8% higher risk of death than girls, and twins have more than double the risk of death. The absence of one parent increases the mortality rate of young children by a factor of 5.537 for infants while it increases the mortality rate of young children by a factor of 1.224 ($5.537 \times 0.221 = 1.223677$). The effect of one parent's death is more than 4times higher on the mortality rate of infants (under 12months of age) than children over 1 year of age.

[3]The period of time 30 years before 1880 (1850-1879) considers the completion of the Utah Central Railway (1869-1881) and the industrial revolution (1820-1870) in the US. This is generally considered a time of major improvement in the living conditions for the American population. The next 10 years are considered an adjustment period (P2: 1880-1889) after railroad construction and the country's industrialization. Consequently, the paper considers a 30 year time interval before and after the 10 year adjustment period. This allows an exploration of the change in institutional conditions from those experienced under P1 to those under P3.

Table I) Estimates of Cox Regression for Neonatal and Child Mortality (Ages 0-5)

	Non-Proportional Effects				Replacement Effects (Infant Only)
	Model 1	Model 2	Model 3	Model 4	Model 5
Time Varying Effects					
One Parents Dies	5.537***				6.834***
Mother Dies		6.714***		6.688***	
Father Dies			2.115***	1.991***	
Control Variables					
Male	1.082***	1.082***	1.080***	1.082***	1.060**
Twin	2.216***	2.214***	2.157***	2.124***	2.318***
Period					
P1 (1850-1879)	Ref	Ref	Ref	Ref	Ref
P2 (1880-1889)	0.923***	0.923***	0.923***	0.923***	0.966
P3 (1890-1920)	0.554***	0.564***	0.561***	0.564***	1.068**
Number_ Siblings at Birth	1.075***	1.075***	1.070***	1.075***	
Number _Older Siblings at Birth(10+ Years)					1.463***
Non-Proportional Effects					
One Parent Dies*Time>12mo	0.221***				
Mother Dies*Time>12mo		0.202***		0.203***	
Father Dies*Time>12mo			0.490***	0.523***	
Interaction Terms					
One Parent Dies*Number of Older Siblings at Birth(10+)					0.939***
Number of Subjects	374,849	374,849	374,849	374,849	374,849
Number of Failures	30,385	30,385	30,385	30,385	14,245
Number of Observations	5,454,457	5,454,457	5,454,457	5,454,457	4,046,035
Wald Chi_2 (p<0.001)	5727.18	5855.8	4746.56	5877.7	13469.45
Degree of Freedom	7	7	7	9	7

Reference category for statistical significance. *p<0.10; **p<0.05; ***p<0.01

In general, for the variables that are shared between the basic model and the other models (Models 2 to 5), the hazard rate and coefficients are similar qualitatively and quantitatively. Therefore, the remaining discussion focuses on the time varying covariates in Model 4, which considers both the absence of mother and the absence of father together. The fourth column in Table I presentsthe regression results for Model 4. The risk of children's death due to the death of the mother for infants (children under 12months of age) increases by a factor of 6.688 while it increases by a factor of 1.358 ($6.688\times0.203=1.357664$) for young children (between 1 and 5 years of age). Losing the father increases the mortality rate of infants by a factor of 1.991, while it increases that of young children by a factor of 1.041($1.991\times0.523=1.041293$). Thus, infants have a more than fivetimes greater hazard rate of death than young children due to the mother's absence, while they have a less than onetimes higher hazard rate than young children due to the father's absence.

Figure 1 illustrates the non-proportional effect on hazard of infants and children when a parent (mother or father) dies. The loss of eitherthe mother or the father has a statistically significant effect on the survival chances of a child, but the impact of the loss is greater for infants than young children in both cases. While the mother has a greater effect than the father for both infants and young children, the differential effects are significantly greater for infants than young children. For infants under 12months, a mother's death increases the probability of death about 5.69 times more, while a father's death only increases the probability of an infant's death about 0.99 times. For young children between one and five years old, a mother's death increases hazard of death about 0.36 times more, while a father's death does not influence the hazard of death much, only increasing the likelihood by 0.04 times.

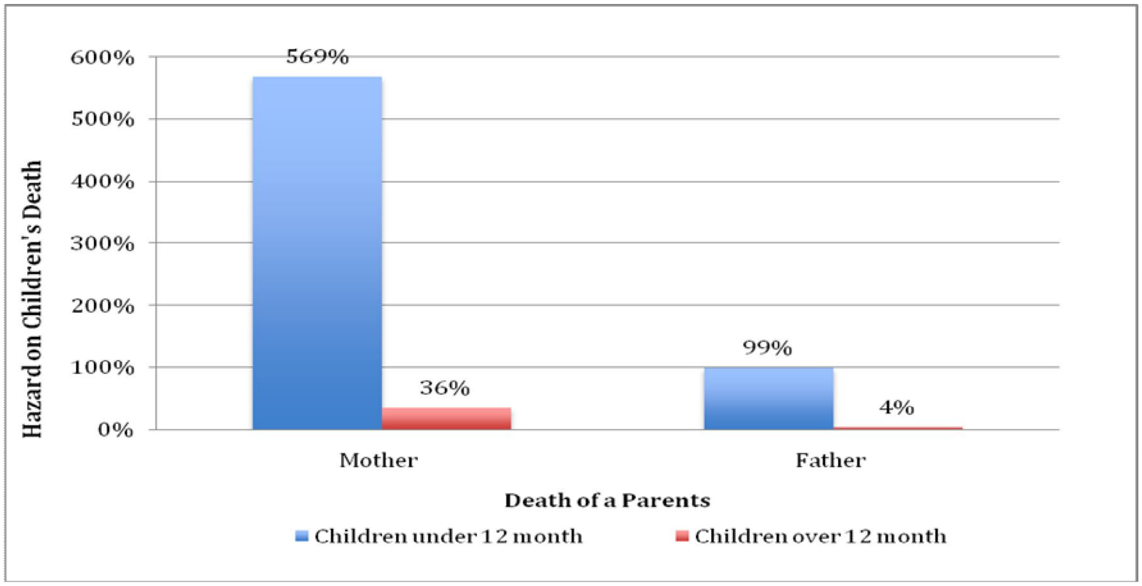

Figure 1) Effects of the Absence of a Parent on the Mortality Rate of Children (Model 4)

These results strongly support hypothesis 1(*The effect of death of the mother is highest during the first year, and declines as age of the child increases*) and hypothesis 3(*The death of the mother has a greater effect on infant and child mortality than the death of the father*). The results do not appear to support hypothesis 2(*The effect of death of the father is limited during the first year of life, but increases later in childhood*).

The replacement effect of older siblings is presented in the fifth column of Table I. According to the regression results of Model 5, the death of one parent increases the mortality rate of infants by a factor of 6.834 but this risk of death diminishes by a factor of 0.939with the existence of one older sibling. Although the existence of one older sibling increasesthe risk of death for infants by a factor of 1.463, it reduces the risk of infant death by a factor of 0.939 when one parent dies. Thus, when one parent dies, the existence of one older sibling, who is at least 10 years of age or older, reduces the risk of infant death,from a factor of 8.297(=6.834+1.463) to 7.790(8.297× 0.939), about 50 percent. This result strongly supports hypothesis 4 (*Infants and/or children who experience a parental death have better survival chances when they have older siblings*).

As the time period changes from *P1*(1850-1879) to *P2*(1880-1889), the risk of children's death decreased about 10%, and as the time period changes from *P2* to *P3*(1890-1920) a 50% decrease in the risk of mortality is observed. Results from all models support hypothesis 5 (*Institutional changes during the nineteenth century impact a child's survival*). *P2* and*P3*coefficients are stable across all models, although are slightly larger in Models 5 for P3, but are not statistically significant for P2.

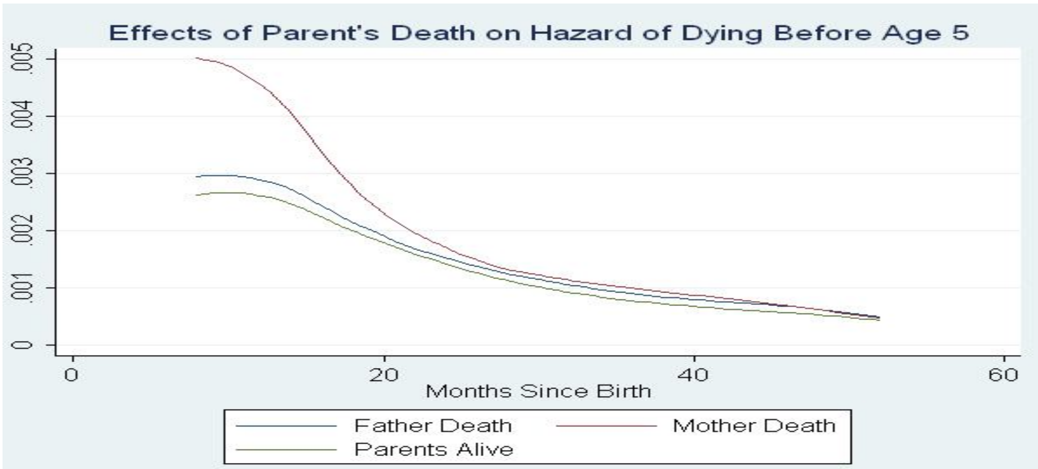

Figure 2) Baseline Hazard of Children's Death under Age 5 - Children whose mother died, Children whose father died, Children whose parents both survived (Model 4).

Figure 2 provides the estimated baseline cumulative hazard of neonatal and child mortality for Model 4. The three graphs in Figure 2 reflect the risk of death accumulated up to a certain time for three different groups of children, based on different parental conditions before age 5; children whose mother dies, children whose father dies, children whose parents both live. The cumulative hazard for all groups appear to decrease atan increasing rate up to around 18-20 months but decrease at a decreasing rate after 20 months. Thus, hazard itself is decreasing fast during the neonatal infant period (when babies survive longer), while it decreases slowly as young children grow up. At every point, children who experience mother's death face a larger accumulated hazard than any other group, therefore theaccumulated probability of surviving is the least among all groups. As expected, children whose parents both live have a lower probability of death at every point in time. For all groups of different parental conditions, probability of children's death is reduced as children get older. The basic diagnostic estimations for all models are conducted for muliticollinearity and no issues were found.

4. Conclusion

Most studies analyzing the effect of parental loss on child mortality with historical data focus exclusively on the mortality level of children predominantly fromsmall counties in European countriesrather than the survival of children over time for large populations. Empirical studies examining the sibling replacement effect could not be found.

Using the Utah Population Data Base(UPDB)for the nineteenth century U.S., this study provides empirical evidence for the effect of parental loss on the mortality of children under age five and the effect of older siblings' replacement of parents when one of the parents die. The study finds stronger (but qualitatively similar) results for the effect of the absence of a mother on child mortality than other studies (such as, Reher et al., 2003; Poppel&Gaalen, 2008). Instead of using the method of episode splitting like Poppel andGaalen (2008), a non-proportional hazard model is employed to test the effect of the absence of a parent. In particular, the model includes factors unrelated to the death of a parent but which may effect the survival of a child. Therefore, this paper addresses the deficiency in theliterature on the topic with a large population, which is not limited to small geographic regions or European countries[4], includes controls for institutional change and examines the replacement effect of older siblings.

In summary, this study suggests the following results. First, the analysis clearly shows the larger importance of the mother on child mortality under age 5 compared to the father. Second, it provides evidence that the effect of parental loss (both mother and father) on the survival chances of children significantly decreases after infancy. Different from Poppel and Gaalen (2008) and similar toReher and Gonzales-Quinones (2003), the father's absence had a bigger impact on infants and little negative effect on young children's survival. Third, when a parent dies, having siblings who are at least 10 years old or older decreases the hazard of dying for children under age 5.

[4]The Utah Population Data Base includes people who not only resided in Utah but also anyone who had an ancestor who resided once in their lifetime in Utah during the pioneer period. Therefore, people who lived in other states in the US can be included if they had an ancestor who once resided in Utah.

This suggests that older siblings can at least partiallyreplace the loss of a parent. Finally, the survival rate of a young child is also influenced by institutional changes, showing decreased hazard inchild mortality between 1890 and 1920 relative to earlier time periods. These results help to demonstratefundamental pre- and post-industrial demographic dynamicswithin the family and household, emphasizing the important role of the mother on children's health and survival.

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