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Orphanhood and Critical Periods in Children's Human Capital Formation: Long-Run Evidence from North-Western Tanzania[1]

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Abstract

Losing a parent is a trauma that has consequences for human capital formation. Does it matter at what age this trauma occurs? Using longitudinal data from the Kagera region in Tanzania that span thirteen years from 1991-2004, we find considerable impact heterogeneity across age at bereavement, but less so for the death of opposite-sex parents. In terms of long-term health status as measured by body height, children who lose their same-sex parent before teenage years are hit hardest. Regarding years of formal education attained in young adulthood, boys whose fathers die before adolescence suffer the most. Maternal bereavement does not fit into this pattern as it affects educational attainment of boys and girls in a similar way. The generally strong interaction between age at parental death and sex of the late parent suggests that the preferences of the surviving parent partly protect same-sex children from orphanhood's detrimental effects on human capital accumulation.

Keywords: orphans, health, education, timing of parental death, child development, HIV/AIDS, Tanzania

JEL classification: I31, J19, C14, C23

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1 Introduction

About 150 million boys and girls, eight percent of the child population in developing countries, have lost at least one of their parents (UNICEF, 2009). While HIV/AIDS has dramatically increased prime-age mortality in various parts of the world, above all in sub-Saharan Africa, the high rates of orphanhood can be largely attributed to other diseases, accidents, wars and natural disasters.[3] Undoubtedly, parental bereavement is a trauma that has long-term consequences for child development. In this paper, we examine at what ages the loss of a parent is most critical for a child's human capital formation.

There is growing evidence that parental death, in particular the death of the mother, is detrimental to children's human capital formation, especially so in terms of educational attainment and health status in the short to medium run. So far, the literature has evaluated the effects of parental loss by comparing orphans and non-orphans, implicitly treating orphanhood as a binary event. We propose that the severity of impacts depends on the timing of parental death and investigate whether the long-term effects of parental death on orphans' human capital accumulation depend on the age at which a child is orphaned. For this purpose, we use longitudinal data from the Kagera region in North-Western Tanzania that follows children in several survey rounds from 1991-2004. Specifically, we estimate reduced-form equations to analyze the impact of age at bereavement on height and educational attainment in early adulthood.

Apart from evaluating the heterogeneous impact of orphanhood, this analysis contributes to the burgeoning literature on critical periods in child development. Is has been widely shown that conditions before age five are crucial for human capital development and have persistent impacts on later life (Almond and Currie, forthcoming). Yet, relatively little is known about the relevance of conditions after early childhood, especially when it comes to developing countries. By distinguishing between the timing of paternal and maternal bereavement, this paper also adds to the understanding of the importance of parental preferences for children's human capital formation.

We tackle the problem of unobserved heterogeneity by using a wide range of pre-orphanhood characteristics, including community fixed effects and showing that *future* age at bereavement is not significantly related to baseline outcomes. We also employ family fixed effects and exploit the exogenous variation created by the fact that siblings experience parental death simultaneously, but at different stages in their human capital formation. As we are interested in identifying the differential impact of parental death at different ages, we do not compare orphans and non-orphans. Accordingly, our sample is confined to children who lost at least one parent.

3 In fact, 41 out of 55 million orphans in sub-Saharan Africa lost their parents to causes other than HIV/AIDS (UNICEF, 2009).

We find considerable evidence that the effect of orphanhood on long-term human capital outcomes depends on the timing of parental death. Impact heterogeneity, however, appears to be conditional on the gender of the deceased parent. Children's growth is particularly stifled when they lose a parent of the same sex before teenage years. Similarly, the death of a father prior to age twelve brings about the largest reductions in years of attained schooling for boys. Only when considering educational attainment in the case of maternal bereavement do we find that both boys and girls are affected in a comparable way. Their educational outcomes are most vulnerable to maternal loss in early mid-teenage years. The generally strong interaction between age at parental death and sex of the late parent suggests that to a degree the preferences of the surviving parent can protect same-sex children from the detrimental effects of orphanhood.

In the following section, we present several mechanisms through which the death of a father or a mother could differentially affect child development. Section 3 provides a brief overview of the literature on the mean impact of parental loss. Methodological issues are discussed in section 4, which also describes the dataset and our estimation samples. Section 5 presents our results and conducts some robustness checks. Section 6 concludes.

2 Channels of Transmission

As health and education are complementary investments in human capital accumulation (Becker, 2007), we discuss them jointly at this point. Our focus is on children in developing countries, particularly in sub-Saharan Africa where the AIDS epidemic has led to exceptionally high rates of parental mortality. We discuss in how far each channel might cause heterogeneous impacts across different ages at bereavement.

2.1 Psychological Trauma

Parents are, without doubt, the most important caregivers and attachment figures providing emotional support and consistent nurture. In his works on early child development, Bowlby (1982) stresses the role of the relationship between caregivers, in particular mothers, and their children in shaping subsequent development and personality. In this context, losing a parent during childhood is a traumatic event that shapes child development beyond purely economic consequences. Above all, parental death can have a lasting effect on children's emotional status which, in turn, can keep them from studying or attending school altogether (Gertler et al., 2004). Dozier et al. (2008) review, inter alia, evidence on the relation between the loss of an attachment figure and psychological disorders in adulthood and find a strong correlation between depression and anxiety and early maternal loss. Depressive episodes, in turn, can have a profound effect on both educational performance and physical health (Needham, 2009; Katon, 2003). A report from the National Scientific Council on the Developing Child (2010) concludes that early experience of traumatic events which produce lasting fear and anxiety can have lifelong consequences by disrupting the developing architecture of the

brain, particularly in areas involved in emotions and learning. In the absence of the buffering protection of adult support, such chronic stress in early childhood can be toxic to the developing brain. Makame et al. (2002) find that orphans in Tanzania's capital Dar Es Salaam have more internalizing problems which put their long-term mental health at risk. For the case of Zimbabwe, Nyamukapa et al. (2008) show that orphanhood is associated with high levels of psychosocial distress. It is important to point out that children who have been orphaned by AIDS are likely to suffer from the direct trauma of parental illness and loss, as well as from stigma and discrimination. Such aggravating effects may result in even worse school performance and attendance/graduation rates (Sharma, 2006).

The nature of impact heterogeneity across age at bereavement is not obvious. In general, attachment during the first two years of life is crucial for later peer relations, effective emotional regulation and behavioral self-control (Deklyen and Greenberg, 2008). Infants and toddlers may, however, not yet fully realize the full significance of parental loss and might therefore be better able to relate to a new set of caregivers. In contrast, school-age children may be capable of grasping the significance of their parent's death but not emotionally equipped to cope with such loss. Evidence suggests that the death of a parent before the age of eleven has more severe psychological consequences than parental loss later in childhood or adolescence (Brown and Harris, 1978; Agid et al., 1999). Older adolescents, having lived through puberty, might be more capable of coping with the associated psychological burden. This is in line with Liu et al. (2009) who study the impact of parental absence on children's mental health in Chinese migrant households. They find that children approaching adulthood develop fewer symptoms of anxiety and depression than their younger counterparts. Overall, it is likely that the trauma of parental loss is particularly harmful for children in their early stages of human capital formation.

2.2 Lost Income

The loss of an income-generating household member is probably the single most important economic impact of parental death. This is particularly true for deaths due to AIDS which typically kills people in their most productive years of life. With low levels of wealth and the absence of well-functioning credit and insurance markets, households may be seriously compromised to respond to such income shocks and smooth consumption after the death of an adult member. Beegle et al. (2008) show that households in Tanzania see their per-capita consumption drop by seven percent within the first five years after the death of a prime-age adult. Severe financial constraints may force households to save on food expenditures and reduce nutritional intake which, in turn, is an important determinant of children's health and cognitive development (Alderman et al., 2009; Currie, 2009). Moreover, reduced household resources can impact orphans' schooling directly by making it impossible to pay for tuition fees and school materials. The severity of these effects is likely to depend on the gender of the deceased parent. The loss of a

father may be more critical as the death of a male household head typically brings about the largest reduction in material household welfare (Case and Paxson, 2004).

Insufficient or inferior nutrition in early childhood is particularly detrimental for subsequent health outcomes. This phenomenon has received ample attention in the literature on critical periods during child development (Alderman et al., 2006; Glewwe and King, 2001). Thus, younger children suffer more from malnutrition than older children. The impact on educational attainment is less clear. To reduce schooling expenditures, young children's first enrolment could be deferred or even cancelled. However, older siblings might also be pulled out of school.

2.3 Increased Opportunity Costs of Children's Time

Due to insufficient or non-existent public safety nets, credit and insurance markets in many parts of the developing world, children who lose a parent often play an important role in households' strategies to cope with the death of an adult (Subbarao and Coury, 2004; Sharma, 2006). For instance, child labor could be a substitute for the deceased parent's labor supply which would increase the opportunity costs of children's time. Hence, school attendance could not only become less affordable due to the new budget constraint of the household, but also in terms of orphans' forgone earnings and domestic labor (Ainsworth et al., 2005).

It is probable that the degree of substitutability depends on the age of the child at the time of the parental loss (Evans and Miguel, 2007). The sex of the child and the late parent may also play an important role, even more so in societies with strong gender roles. Older sons are clearly a better substitute for their deceased fathers than younger ones, particularly in the context of physically demanding farm work or informal employment. The same logic applies to girls and their mothers: Older girls would have a comparative advantage in household production over their younger sisters. This observation has also been made in the literature on the economics of child labor (Edmonds, 2006). Hence, older children are more likely than their younger siblings to spend time in activities that mitigate the negative impacts of the death of an adult and reduce time in formal education.

2.4 Parental Preferences, Child Fostering and Lost Parental Inputs

Following parental death, orphans are typically subject to changed preferences of their (new) caregivers. Children who lose only one parent most often stay with the surviving parent (Beegle et al., 2009). Given that mothers tend to invest more in their children than fathers (Case and Paxson, 2001), the gender of the late parent is likely to affect orphans' human capital outcomes. Ceteris paribus, paternal death increases the importance of maternal preferences and may change a household's resource allocation in favor of children. Conversely, the death of a mother may reinforce paternal preferences and hence reduce child investments. Another dimension of differential treatment is the sex of the

child. Parental preferences in developing countries are normally believed to be in favor of sons (Strauss and Thomas, 1995). This effect, however, is due to the fact that fathers most often exert more bargaining power on the intra-household allocation of resources. Considering paternal preferences separately, mothers favor their daughters over their sons, while the reverse is true for fathers (Thomas, 1990 and 1994; Lamb, 2010). Thus, the loss of a mother would have even more adverse effects on girls than the loss of a father.

Given the importance of conditions in early childhood, young children's health status appears most sensitive to changes in parental preferences. Educational outcomes are likely to be affected, too, though it is less apparent whether younger or older children would be hit harder.

Double orphans are usually cared for within the extended family network, mostly by their grandparents or other close relatives (Beegle et al., 2009; UNAIDS et al., 2004). It has been argued that the ever rising numbers of orphans due to the AIDS crisis may overstrain the capacity of traditional coping systems in parts of sub-Saharan Africa and shift the burden of child fostering to households that are not willing or able to invest in orphans' development (Beegle et al., 2009).

As indicated above, the presence of parents is of crucial importance for a child's development. It is well-known from developmental psychology that children learn a lot from their parents both through encouragement and through direct teaching and emulation (WHO, 2004). Leibowitz (1974) argues that quality and quantity of time invested by parents are important for healthy child development and can partly explain the variation in children's cognitive abilities prior to the start of formal education. Foster parents can take over these roles, but they are unlikely to be perfect substitutes for biological parents. They may have reduced incentives to invest time and money in orphans' human capital formation if they expect smaller pay-offs because of the informal, non-binding structure of intergenerational contracts as compared to more binding expectations from the biological children (Sharma, 2006; Ainsworth et al., 2005). Subbarao and Coury (2004) discuss the quality of various fostering arrangements and conclude that the closer foster parents' kinship or relationship to the orphan, the more desirable is the arrangement. In general, however, they find that the lack of nurture and guidance, due to parental loss and inadequate compensatory care, may stifle orphans' socialization. Similarly, the World Health Organization (2004) concludes that the effects of inadequate and disrupted care-giving can persist into adolescence in the form of behavioral disorders, anxiety, and depression.

The fact that socialization is a non-uniform process over the child's age reveals the scope for the effects of this channel to depend on the age at bereavement. One the one hand, older children are increasingly shaped by their parents' attitudes, values and willingness to invest time and resources in their upbringing and education. Thus, they may be less reliant

on parental non-material inputs than younger children. On the other hand, being adopted at an earlier age means a higher chance of developing a close relationship with the caregiver (Odenstad et al., 2008; UNAIDS et al., 2004). Teenagers might thus be affected harder than others, if foster parents anticipate more pay-off to education of younger adopted children as a longer care-giving period results in stronger ties with the orphan.

2.5 Overall Impact on Human Capital Formation

The theoretical transmission channels discussed above strongly suggest that the impact of parental death on children's human capital formation depends on the age at which a child loses a parent. In addition, this differential impact is most likely to vary with the gender of the late parent and the child. The relative strength of the presented transmission channels, however, is not known a priori and likely to vary according to the context. As a result, the pattern of the overall effect remains theoretically ambiguous and is potentially non-linear in age at bereavement. Moreover, the importance of the various pathways is likely to differ for the two outcomes of interest, health and educational attainment. Losing non-material parental inputs, for instance, could be more relevant to orphans' adult health outcomes; increased opportunity costs should be primarily decisive for schooling outcomes; and changing parental preferences as well as lost household income are likely to affect both. Ultimately, it is an empirical question whether the aforementioned mechanisms are indeed at work and how they interact with each other.

Ideally, one would try to explicitly model health and educational outcomes by two separate production functions that contain, among other things, measures of parental time and care, monetary resources, measures of children's idiosyncratic endowments and abilities as inputs. However, given that the decisions regarding demand for children's health and education are jointly determined with other important factors influencing these outcomes, estimating such production functions is not feasible. Besides, the channels identified above are partly related and overlap to some extent in their predictions regarding the impacts. In the absence of experimental data, however, it is intrinsically difficult to distinguish between these transmission channels. We follow the empirical literature on the effects of orphanhood and employ reduced-form estimates. Thus, our analysis effectively examines the overall impact of parental loss on human capital accumulation across age at bereavement, irrespective of the channel through which it may operate.

It is important to bear in mind that all effects measured are net effects, i.e. they already take into account the mitigating impact of coping strategies at the household and community level. The availability of access to formal or informal credit and insurance or support from government, NGOs and the like is context-specific and should hence also affect the human capital formation of orphans.

3 Evidence on Mean Impacts

There is growing evidence that parental death stifles children's development. The empirical literature has primarily focused on orphans' educational attainment. Using data from Indonesia's National Socioeconomic Survey from 1994-1996, Gertler et al. (2004) find that recently orphaned children are substantially more likely to drop out of school than non-orphans. This effect is most pronounced for children at the transition between primary and lower secondary school and between lower secondary and higher secondary school. Regarding heterogeneity across age, they present some evidence that older children's enrolment is decreased more by the loss of a parent.

In South Africa, mother's death reduces children's likelihood to be enrolled by about two percentage points and depresses school-related expenditures by more than ten percentage points. Based on a longitudinal data from 2001 to 2004, Case and Ardington (2006) also show that given their age maternal orphans have completed about a quarter of a year less schooling. Paternal death, however, does not appear to be a significant determinant of orphan's educational outcomes. Older children (aged 11-16 at the last survey round in 2003-2004) experience larger reductions in completed years of schooling than younger children (aged 6-10), although the difference is not statistically significant. Note, however, that this finding refers to children's age as such, not to their age at bereavement.

Using Kenyan longitudinal data from 1998 to 2002, Evans and Miguel (2007) find parental loss to decrease school participation rates of children by seven percentage points. Their estimates suggest no sign of recovery of orphans' school attendance for at least three years after the death, which they interpret as indication of possible long-run effects. In line with other studies, the impact is primarily driven by maternal deaths. Younger children (below age 12 in the year of their parent's death) are somewhat more likely to drop out of school than older children. The authors suggest that this result may be due to the high drop-out rates in primary schools in rural Kenya. If students in higher grades are selected on academic ability, potentially higher returns to schooling might keep them at school.

Despite this evidence for reduced school enrolment or attendance in the short and medium run, it is not obvious whether such effects persist into adulthood. While impacts could be cumulative over the duration of orphanhood, they might as well vanish after a period of mourning and household adjustments (Beegle and de Weerdt, 2008). Long-run evidence, however, is still scarce as very few datasets follow orphans and non-orphans over a sufficient period of time.

An important exception is Beegle et al. (2010) who investigate the long-term impacts of parental loss on educational and body height attainment using the same data set from North-Western Tanzania as we do. Their sample consists of 718 non-orphaned children aged 6-15 surveyed in 1991-1994 who are at least 19 years of age by the final survey

round in 2004. About 20 percent of the children lost at least one parent prior to age 15 after the baseline. Beegle et al. (2010) find that maternal loss permanently reduces educational attainment by about one year and final body height attained by almost two centimeters. In a related study, Beegle et al. (2006) split the same sample into two groups based on children's age at bereavement to separate younger and older orphans. In general, the impact on schooling and health does not seem to differ for orphans above and below twelve years at parental death. However, maternal death is associated with a larger impact on final height attainment for younger orphans.

Taken together, there is considerable evidence that parental loss, in particular the loss of the mother, has detrimental effects on children's human capital formation. This paper contributes to the presented set of studies on the mean impact of orphanhood by analyzing at what ages parental death is most critical to children's human capital formation.

4 Empirical Strategy

4.1 Data and Setting

With a per-capita income of about $1100 adjusted for purchasing power parity and ranking 152 out of 179 countries on the Human Development Index, Tanzania is one of the world's poorest countries. While the national prevalence rate of HIV among individuals aged 15-49 has shown a slight downward trend from well over seven percent in the mid-1990s to just over six percent in 2007, the absolute number of AIDS orphans continued to rise from an estimated 610,000 in 2001 to around 970,000 in 2007 (UNAIDS, 2008). The total number of orphans irrespective of the cause of parental death is significantly higher at around 2.6 million in 2007.

Our analysis draws upon data from the Kagera Health and Development Survey (KHDS). The Kagera region is located in North-Western Tanzania and was one of the first areas in Africa to be hit by the HIV/AIDS epidemic. It thus provides a well-suited setting for the analysis of the long-run impact of parental death. The original dataset (KHDS-I) was collected between 1991 and 1994 and includes information on 915 households who were interviewed up to four times at 6-7 months intervals. In 2004, a large effort was undertaken to track and re-contact as many surveyed individuals as possible for a repetition of the survey referred to as KHDS-II. Individuals were followed even if their original households had dissolved, if they had left the household, or if they had migrated to neighboring regions or countries. Thanks to this rigorous tracking effort, the re-contact rate is as high as 93 percent and 82 percent on the household and individual level, respectively. The longitudinal dataset thus covers up to 13 years and contains up to five observations per individual.[4]

4 Detailed information about KHDS-I and KHDS-II can be found in World Bank (2004).

As explained below, we use slightly different samples to analyze the long-run effects of orphanhood on height and educational attainment. This different choice is made to maximize sample size and variation across age at bereavement on the one hand and minimize the possibility of catch-up in terms of human capital accumulation on the other hand. Both samples are based on the group of children who were non-orphaned at the first interview during KHDS-I (1991-1994), but lost their mother or father previous to the re-interview in KHDS-II (2004) and before the age of 18. The cut-off point at age 18 follows the most common definition of orphanhood (UNAIDS et al., 2004; Skinner et al., 2006).

4.2 Height Attainment

Although health is clearly a multidimensional phenomenon, body height is frequently taken as a marker of long-term health status. It has been shown to capture chronic malnutrition and under-nutrition as well as frequent or chronic illness during childhood and adolescence (Case and Paxson, 2010; O'Donnel et al., 2008). Thus, if losing a parent really has an adverse impact on children's overall health in addition to what coping strategies can mitigate, this impact is likely to show up in orphans' final height.

Apart from capturing health and nutrition status during childhood, it is widely acknowledged that body height is also correlated with important determinants and indicators of individual welfare later in life. Almond and Currie (forthcoming) review the related literature and conclude that health and socio-economic status during childhood have a significantly positive impact on educational and labor market outcomes in adulthood. This underlines the central role of health in human capital and its predictive power for other outcomes relevant to individual welfare.

To maximize sample size, we use a relative measure of height referred to as height-for-age z-score. An individual's height-for-age z-score is the difference between her height and the average height in her specific reference group, that is, individuals of the same sex and age, expressed in standard deviations of this reference group. Accordingly, height-for-age z-scores can take any real values, typically in the range of -5 to 5. Most importantly in our context, z-scores have the advantage of being standardized by gender and age in such a way that the z-score of an individual who follows a normal growth path does not follow a time trend. Thus, including adolescents who are still in the process of physical growth does not generate a problem of truncation because their z-scores can still take arbitrary values and are not confined to a certain range due to their lower age.

Considering all orphans who were aged below 18 at baseline (first interview during KHDS-I), our health sample contains 369 individuals. Since some of them did not reach adulthood at the time of KHDS-II in 2004, however, catch-up growth among the younger children in our sample cannot be excluded. Yet, as noted by Case and Paxson (2010), there is considerable correlation between height at any given age and final height

attained. Moreover, a large fraction of our sample should have lived through the adolescent growth spurt which coincides with the onset of puberty and reaches its peak at age 12 for girls and age 14 for boys (Ulijaszek et al., 1998). We are thus confident that there is only limited potential for catch-up growth in our sample.

The average z-score is about -1.6, which implies that the individuals in our sample are considerably smaller than their counterparts in the UK reference group. This can be understood as evidence of a generally poorer health and nutritional status during childhood and adolescence. It is important to note that the choice of the reference group should not have an impact on our results. The reference group merely serves as an anchor affecting the absolute values, but not the variation of z-scores. Across populations, growth patterns are predominantly determined by environmental factors and individuals from different ethnic backgrounds would on average be equally tall if they grew up under similar circumstances (Bogin, 1999; Ulijaszek et al., 1998; Steckel, 1995). Using a different reference group would only result in a parallel shift of the distribution of observed z-scores as the shape of growth paths across age is predominantly determined by biological factors and thus unlikely to vary significantly across countries.

4.3 Educational Attainment

The sample used to analyze the long-run effect of age at bereavement on educational attainment only includes those orphans who were aged below 18 at baseline and at least 19 years old at the time of KHDS-II in 2004. After this age, a significant catch-up in terms of formal education is unlikely to occur. Most adolescents have left school by this age and re-enrolment after having entered the labor force is rare. This restricts our education sample to 184 orphans and leaves us with no children who have lost a parent prior to 6 years of age. This limited age range is a shortcoming of our education sample since we want to look at heterogeneity across different ages at bereavement and pre-school years could be of particular interest.

Primary schooling in Tanzania is completed after grade seven, lower secondary schooling after grade 11 and upper secondary schooling after grade 13 (Ainsworth et al., 2005). While statutory enrolment age is seven, about 84 percent of all children actually started school significantly later in the mid-1990s, when our baseline data were gathered (World Bank, 1999). Average enrolment age was about ten and nine years for boys and girls, respectively. Thus, the youngest individuals in our sample (aged 19 in 2004) could still have been visiting school at the time of KHDS-II if they were enrolled at age nine. However, this case only applies to seven individuals in our sample; two of them were still in primary school.

We follow Beegle et al. (2010) and take the highest grade completed by age 19 or older as our dependent variable. We refer to this variable *years of schooling*, counting each grade as one year. Ideally, one would of course investigate the impacts on a more holistic measure

of education or perhaps even cognitive ability. We are aware that educational attainment and cognitive ability can vary largely between adolescents who have completed the same grade. Ignoring this potentially reduces the variation in our dependent variable which could be alleviated by incorporating information on standardized test scores, average grades or the like. However, given the lack of such data, we have to resort to analyzing years of schooling as the arguably best proxy for educational attainment available.

4.4 Econometric Setup

We exploit the longitudinal dimension of the dataset by regressing final outcomes (KHDS-II, 2004) on age at parental loss and a set of pre-orphanhood characteristics, which are taken from the first interview during KHDS-I (1991-1994). If available, we include information on orphans' month of birth and month in which the parental death occurred in order to use as much variation in age at bereavement as the dataset allows for.

Our econometric setup is summarized by the following equation:

$$\begin{aligned} Y_{iT} = \; & c + a_1 A_i + \beta_1 [A_i * P_i] + \gamma_1 [A_i * M_i] + \delta_1 [A_i * P_i * M_i] + \varkappa P_i + \lambda M_i + \mu [P_i * M_i] + \nu D_i + \\ & a_2 A_i^2 + \beta_2 [A_i^2 * P_i] + \gamma_2 [A_i^2 * M_i] + \delta_2 [A_i^2 * P_i * M_i] + \\ & x_{ijt}' \chi_j + f_{ikt}' \psi_k + a_{iIT}' \omega_I + \varepsilon_{iT} \end{aligned} \qquad (1)$$

where Y_{iT} is the outcome of interest, height-for-age z-score or highest grade completed, of individual i at time T (2004) and A_i is the age at bereavement. To determine whether the impact of parental loss differs by the gender of the deceased (or surviving) parent, one could generate a variable for both age at maternal and paternal death. However, the fact that most children in our sample are single orphans (79 percent and 83 percent in the health and education sample, respectively) would create many missing values for these variables. We circumvent this problem by only considering age at *first* bereavement and interacting A_i with a dummy variable P_i indicating whether it was the father who died (first). For this purpose, we center A_i by subtracting its mean to make interpretation more meaningful. As the effects of orphanhood are likely to vary for boys and girls, we also add interactions with a dummy variable for boys (M_i). Given the limited sample size, this procedure is preferred to splitting the sample into female and male subsamples. Besides, it facilitates interpretation as the significance of possible asymmetries is simply revealed by the p-values of the respective interaction terms. Squared terms of A_i and its interactions allow for potentially non-linear effects across A_i (second line of equation 1). The possibly more adverse impact of double orphanhood on a child's human capital formation is captured by the dummy variable D_i. The third line of equation 1 displays other covariates included in the regression. Pre-orphanhood characteristics x_{ijt} at the household and individual level are measured at baseline (time t). Depending on the identification strategy used, we also add baseline fixed effects f_{ikt} at the community or family level. The last term represents control for cohort effects via age dummies a_{iIT} at time T. ε_{iT} is an individual-specific independent and identically distributed error term. The above model is estimated

using Ordinary Least Squares. Standard errors are clustered at the household level to take into account that outcomes of children living in the same household are likely to be correlated.[5]

4.5 Identification

We follow two complementary strategies to identify the effect of age at bereavement on human capital formation. First, we propose that, controlling for pre-orphanhood characteristics, the timing of parental loss is exogenously distributed across children's ages. Second, we add family fixed effects to the above equation and exploit the exogenous variation created by the fact that siblings lose their parent at the same time, but at different periods in their human capital formation.

Orphanhood as such is unlikely to be a random event. In Africa, HIV is a disease that is predominantly transmitted sexually and hence subject to "self"-selection into risky sexual behavior or dependencies (Beegle and de Weerdt, 2008). If factors attributable to parental self-selection are correlated with children's health and educational outcomes, however, any observed differences between orphans and non-orphans might have already existed before orphanhood. Nonetheless, this problem does not apply to our analysis. Being interested in the ages at which orphanhood is most critical, we do not compare orphans and non-orphans; our sample only includes children who lost at least one parent.

Still, this does not exclude the possibility that the *timing* of parental death is endogenously determined. There might be confounding factors that affect both age at bereavement and children's human capital accumulation. In this case, observed differences in the dependent variables between children who were orphaned at younger age and those who lost their parents later in their development process might be driven by pre-orphanhood characteristics, too. For instance, children from initially richer households could not only have completed more years of schooling at the time of parental death. Ceteris paribus, their average age at parental loss could also have been higher on average because more resources could have been devoted to parents' treatment and care. A similar argument can be made when considering coping strategies. Arguably, initially richer households are better equipped to cope with the death of an adult. They can more easily afford to send their children to school and forgo their potential earnings or labor supply at home. Their higher ability to safeguard (food) consumption may also positively influence orphans' health.[6] Even after controlling for such observable pre-orphanhood characteristics, the alleged impact of timing of parental death may still be driven by unobservable factors.

5 For years of education censoring to the left is a potential source of concern as this variable can only take positive values if a child was ever enrolled in school. However, only 15 orphans in the education sample have never attended school. Given this low share and the difficulties of interpreting interaction terms in non-linear models (Ai and Norton, 2003), we follow Beegle et al. (2010) and use linear regression models.

6 Lundberg et al. (2000) discuss households' coping strategies and sources of external funding following an adult death in Kagera. However, nothing suggests that external support in Kagera during the time of the survey benefited children differently across age at bereavement.

While it is conceivable that such factors are related to selection into orphanhood as such, it is, however, much less obvious why they should be systematically associated with age at bereavement.

Nonetheless, we address the concern of unobserved heterogeneity by regressing baseline outcomes of interest on *future* age at bereavement and the full set of baseline controls (compare Beegle et al., 2010; Case and Ardington, 2006). Only if timing of parental loss is correlated with omitted variables we do not control for, would we expect future age at bereavement to be a significant predictor of baseline outcomes. The underlying assumption is that such unobserved variables would adversely affect outcomes already before orphanhood. Yet, Table A4 in the appendix shows that the timing of parental death is not significantly related to height or educational attainment. We are hence confident that age at bereavement is sufficiently exogenous to warrant identification, at least after controlling for important pre-orphanhood characteristics.

An alternative identification strategy is to compare siblings by using family fixed effects. This approach effectively neutralizes any observed and unobserved confounding factors at the family level. Before parental death, siblings share the same environment including genetic factors, extended family, family norms, neighborhoods as well as parents' general attitudes towards education and health. However, they experience the loss of a parent at different stages in their development. We exploit this exogenous variation for identification. In addition, this approach takes care of sample selection bias. To the extent that selection into orphanhood is related to family-level factors, the fixed-effects results for our orphan sample are valid for the entire child population in Kagera.[7]

The use of family fixed effects, however, ignores differential treatment of children *within* households. First of all, human capital outcomes might have been affected by the date of birth, as the economic condition of a given household is likely to change over time. Depending on their age difference, children of the same parents might have grown up under circumstances more or less favorable for their human capital formation. Birth order may also play a role. First-born children are often found to fare better in terms of both health (e.g. Horton, 1988) and educational attainment (e.g. Black et al., 2005). Such discrimination against later-born siblings might be explained by increased competition for parental resources. In the case of parental death, however, first-born children may also bear a disproportionately large burden, as older children are more likely to take over some of the tasks that were previously performed by the deceased parent. To address these complications, we include a dummy marking first-born children. We also add a full set of age (in 2004) dummies to control for cohort effects. While the age dummies pick up general trends in living conditions, the indicator of being first-born captures heterogeneity between siblings related to order and timing of birth.

7 A similar argument is made by van den Berg et al. (2009).

The elimination of any confounding factors at the family level is a clear advantage of the siblings analysis. However, it comes at the cost of reduced sample size. Under this approach, the sample only includes orphans with at least one sibling. This lowers the number of observations to 104 in the education sample and to 267 in the health sample. By contrast, the other proposed identification strategy uses the full sample. Relying on variation between families, it is also more robust to concerns regarding differential treatment of children within families.

4.6 Control Variables

Our regression models include various baseline characteristics at the individual and household level.[8] These are meant to (i) control for confounding pre-orphanhood differences, (ii) capture heterogeneous adoption of coping strategies with adverse impact on human capital accumulation and (iii) increase statistical precision.

Short to medium-term welfare of a household before parental death is reflected by the level of per-adult equivalent consumption expenditures. A household's longer term socio-economic status is approximated by a wealth index which is the first principal component of a set of important household assets and durable consumption goods.[9]

Given the importance of parental inputs and parents' attitude for children's schooling and health outcomes, we control for parents' own educational background (Kenkel, 1991; Thomas et al., 1991). Specifically, we include dummy variables indicating whether mothers and fathers have attended school and whether they were present in the household at baseline. The latter should also provide a proxy for the level of nurture given by each parent. Unfortunately, numerous missing values impede including parents' highest grade completed in our regressions which would give a more detailed picture of the family's educational background.

To capture competition for parental resources as well as a household's demographic possibilities to cope with the loss of an adult, we add measures of the size and composition of the household. Potential differences in preferences for children's well-being by different decision-makers are proxied by characteristics of the household head's gender and educational attainment.

Orphans' baseline educational and health outcomes are included to further isolate the impact of parental death from effects of unobserved background characteristics that might influence children's human capital formation. In the education regressions, we control for initial enrolment status and highest grade completed at baseline. It is conceivable that children are more likely to be kept in school after a parent's death if they

8 In the case of family fixed effects, only individual characteristics are included.

9 The set of household assets and durable consumption goods includes per-adult equivalent land holdings, ownership of a motor vehicle, the number of rooms in the dwelling and ownership of the dwelling as well as indicators of housing quality (electrical lighting, building materials of roof, walls and floor, and access to a private toilet, a private or public water source and type of water source).

have already been enrolled in school. In the health regressions, we include orphans' baseline height-for-age z-score to capture individual health histories and heterogeneous endowments before losing a parent.

We also try to control for genetic factors which should play an important role in determining children's body height. A natural step would be to include both mother's and father's anthropometrics as control variables. Because of many missing values for father's height, however, we follow Beegle et al. (2010) and only include mother's height.[10] Doing so should at least partially capture genetic endowments and might even be more reliable than using father's measures who may not even be the biological father.

Community fixed effects are added to eliminate the confounding impact of community characteristics that have not changed over the 13-year period covered by the survey. Certainly, communities develop over time and infrastructure including the accessibility and quality of schools as well as health facilities is likely to change. However, in order to bias the parameter estimates of interest, these characteristics would have to have changed differentially across orphans' average age at parental death in different communities. This case seems very unlikely. Besides, the set of age dummies take care of general trends or shocks that occur at the regional or national level.

5 Main Results

The following two sub-sections present the main findings from our econometric analysis of orphans' height and educational attainment. Due to the multiple and non-linear interaction effects the interpretation of the regression results is most easily done graphically. Full regression tables are provided in the appendix. Following our econometric framework, we distinguish between four types of orphans: male and female paternal orphans as well as male and female maternal orphans. For each type we evaluate the impact of age at bereavement on human capital outcomes at the mean or most typical values of the other independent variables, depending on whether they are continuous or binary. Together with the confidence intervals, these predicted values show at which ages parental loss is most critical for the outcome under consideration. The differential impact of orphanhood can further be assessed by the slope of the fitted line, which is given by the marginal effect of age at bereavement:

$$\partial Y_{iT}/\partial A_i = a_1 A_i + \beta_1 P_i + \gamma_1 M_i + \delta_1 [P_i * M_i] + 2a_2 A_i + 2\beta_2 [A_i * P_i] + 2\gamma_2 [A_i * M_i] + 2\delta_2 [A_i * P_i * M_i] \quad (2)$$

10 Another potentially useful control variable is parents' age at baseline. Many missing values, however, prevent us from doing so. Still, running the regression on the reduced sample for which mother's age is available does not change our results. This may be due to the fact that parents' age is not perfectly correlated with children's age. Some parents have their first child earlier than others, parents may be of different ages, and they typically have several children in the first place.

Age periods in which the marginal effect is significantly different from zero indicate when and how the relationship between age at paternal loss and health and education later in life changes. An upward-sloping curve would imply that parental death is more detrimental to younger children, while the reverse would be true in the case of a downward-sloping curve.

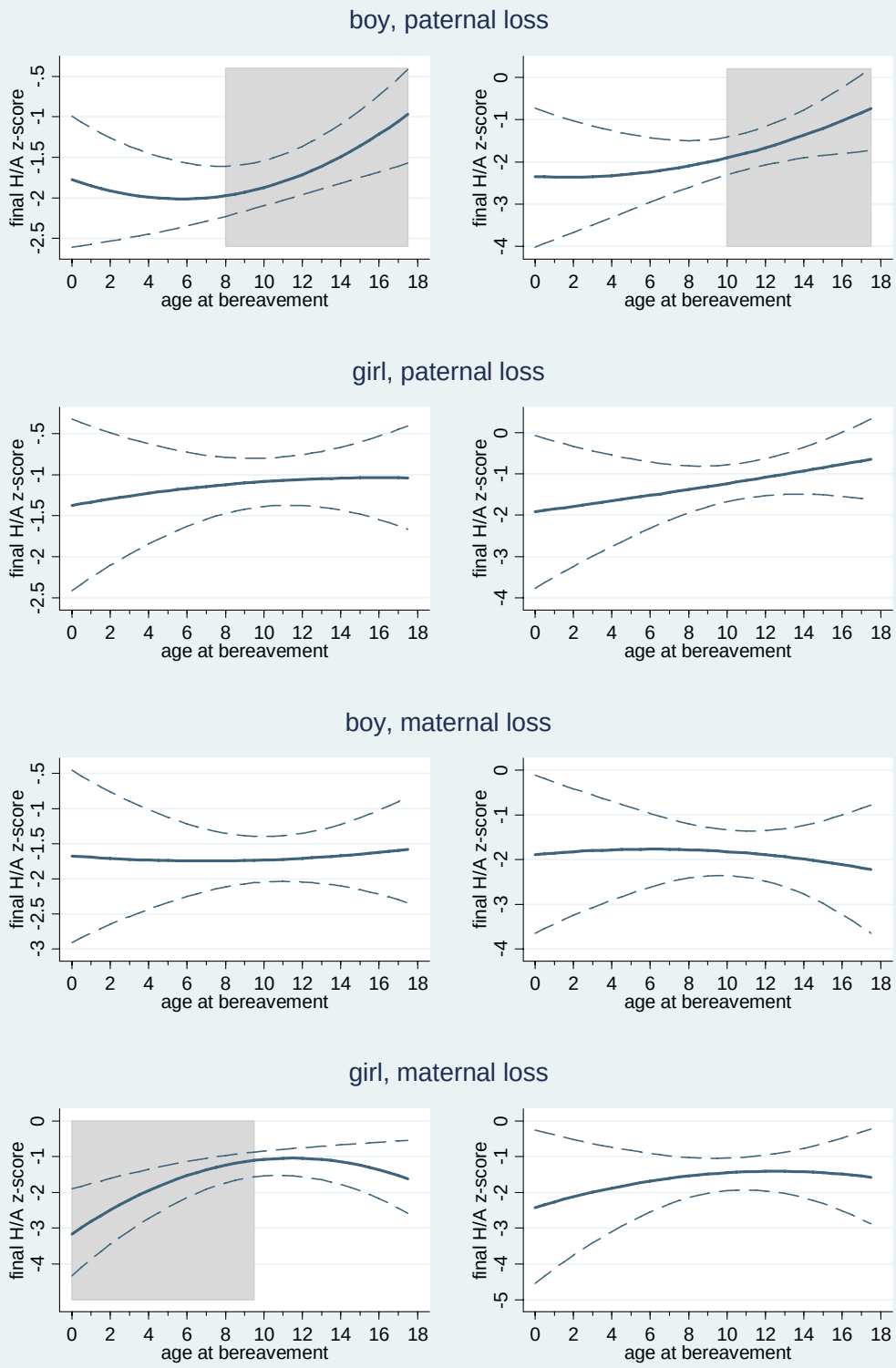
Since we do not perform a comparison with the counterfactual scenario of both parents being alive, our estimation results should not be confused with the impacts of parental loss as such. Our focus is on investigating at what ages parental loss is most critical to children's human capital formation.

5.1 Height Attainment

Figure 1 summarizes our findings on heterogeneous impacts of parental death on children's long-term health outcomes. For the four different kinds of orphans, the left column presents the results from the regressions with community fixed effects, while the right column presents the results from the siblings analysis. Overall, both identification strategies produce very similar results.

For boys, paternal loss has the most adverse impacts on their long-term health status early in their lives. Boys whose father died before their teenage years achieve height-for-age z-scores that are on average about one unit lower than those of boys who lost their father close to reaching adulthood. The predicted values suggest that the detrimental impact of age at bereavement on height attainment is relatively flat until age eight. In fact, the marginal effect of age at bereavement is not significantly different from zero within this age range. After age eight, however, the unfavorable health impact of paternal orphanhood significantly decreases with age at bereavement. Up to the age of 18, the marginal effect of age at paternal loss is significantly positive for boys. Basically the same observations can be made for brothers. Boys who lose their father in early ages grow significantly shorter than their older brothers. This finding is in line with the medical literature suggesting that pre-adolescent growth is generally more sensitive to environmental factors than adolescent growth (Bogin, 1999). It also corresponds to the theoretical predictions from various transmission channels. Outcomes resulting from psychological trauma and lost income such as chronic stress and malnutrition stifle young children's development the most. The result can also be explained by the change of parental preferences. The loss of a father and the increasing importance of maternal preferences might imply that boys lose their privileged status and receive relatively less investments. Given the importance of early child development, the discontinuation of positive discrimination may be particularly harmful for boys' health formation when they are young.

Figure 3.1: Body Height Attainment in Early Adulthood



Notes - column 1: predicted values (community fixed effects), column 2: predicted values (family fixed effects); dashed lines: 90% confidence interval; shaded areas: marginal effect of age at bereavement significantly different from zero.

As regards girls, the long-run health impact of paternal death does not appear to depend on the age at bereavement. Although the curve is slightly upward-sloping the marginal effect of age at paternal loss is not significantly different from zero. Psychological and income-related factors are unlikely to account for the divergent effects of father's death on girls and boys, as they should apply regardless of the sex of the child. However, as indicated above, the death of a male household head may change a household's resource allocation in favor of girls and thus compensate for income losses and distress. Young girls may particularly benefit from a growing role of maternal preferences.

Our findings for the death of a mother mirror those for the death of a father. While age at maternal bereavement does not seem to affect boys' long-term health status, girls suffer most in terms of height attainment when they lose their mother prior to age ten. In contrast to paternally orphaned boys, however, the marginal effect of age at bereavement for maternally orphaned girls is positive before teenage years and then becomes insignificant. A girl whose mother passes away around her first birthday attains height-for-age z-scores in young adulthood which are about two units lower than those of a girl whose mother survives until she becomes a young teenager. These effects are not significant at the family level though. Younger and older sisters do not appear to be affected differentially by their mother's death. Again, the change in parental preferences may explain why maternal loss has heterogeneous impact across age at bereavement for girls, but not for boys. The lack of maternal safeguarding of sufficient resource allocation towards girls is likely to be most adverse for health formation in early childhood.

The estimates of the other explanatory variables are mostly in line with expectations. Orphans' baseline height-for-age z-score and mothers' height are statistically highly significant predictors of higher 2004 z-scores. Thus, children who are relatively short at a given age are also likely to reach a relatively low height in adulthood. This relation is probably driven by individual nutritional and health histories. Parental education has a positive but insignificant association with children's long-term health for both fathers and mothers. The measures of socioeconomic status are also not significant.

5.2 Educational Attainment

Figure 2 shows our findings on the relationship between age at bereavement and years of schooling attained in early adulthood. It is important to keep in mind that the education sample does not include children who lost a parent prior to age six.

Concerning paternal death, the results resemble those for long-term health status. Educational outcomes of boys are most severely affected when their father dies before adolescence. This effect is particularly pronounced for brothers. Boys who lose their father at age six attain up to five years less of schooling than their older brothers. Age at paternal bereavement, however, does not significantly matter for girls' educational level in young adulthood. As in the case of health, it seems that maternal preferences protect

younger girls from adverse income effects typically associated with the death of the male household head. Regarding opportunity costs, we do not find evidence that older boys or girls spend less time in formal education than younger children following their fathers' death. This result might be due to the fact that men often engage in wage employment and can hence not easily be substituted.

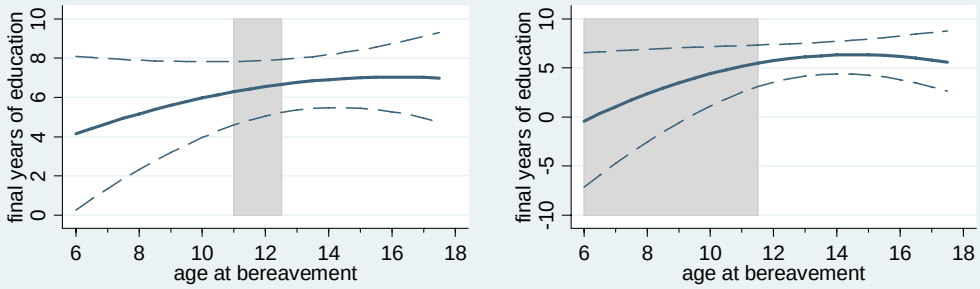
For maternal death, the picture looks different. While we do not see heterogeneous impact across age at maternal bereavement using community fixed effects, older siblings experience larger reductions in formal education than their younger brothers and sisters. Children, in particular girls, whose mother dies in their mid-teenage years have the lowest schooling outcomes. It is likely that this effect mainly works though increased opportunity costs of children time. For domestic work previously done by the deceased mother, the degree of substitutability between female adult labor and child labor is comparatively higher for older children and even more so for older daughters.

Lacking transition from primary to secondary school is unlikely to account for this pattern. The most critical age for long-run educational attainment is around 14 years. With average enrolment age being about ten years and duration of primary schooling being seven years, children at this age are not yet close to finishing primary school. Besides, less than ten percent of the surveyed children acquire a formal education beyond primary schooling to start with. This schooling pattern also explains why girls experiencing maternal loss beyond age 16 are less severely affected. Most likely, many of them would have already had completed their education at the time of their mother's death. It thus seems that affected children rather permanently drop out of school before completing primary education. This hypothesis is supported by a complementary regression investigating whether the likelihood of incomplete primary schooling is affected by the timing of maternal death. Although this is a binary outcome, we resort to a linear probability model to facilitate interpretation of the multiple and non-linear interaction terms. Based on the same explanatory variables as before, Figure 3 shows that for maternally orphaned girls the estimated likelihood of incomplete primary schooling significantly increases after age ten and is particularly high in mid-teenage years. We do not find such effects for boys though.

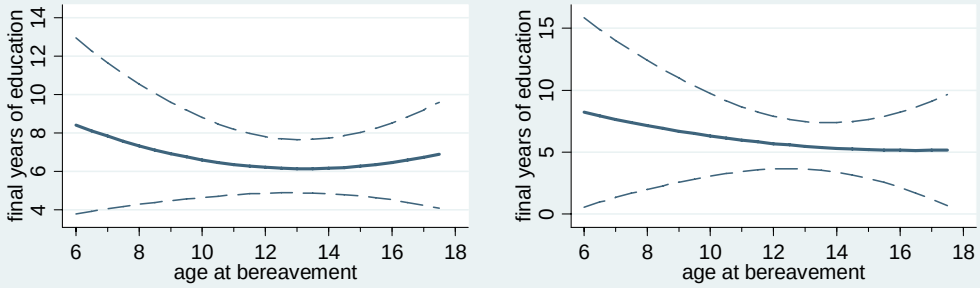
As regards other covariates, maternal education strongly improves orphans' long-run educational attainment. Fathers' schooling status, however, does not play a significant role. As expected, higher socio-economic status as measured by pre-orphanhood consumption levels improves children's schooling outcomes. So does the presence of an elderly woman. Cohabiting with a female pensioner appears to ensure adequate supervision and care and may also keep the opportunity costs of orphans' time at lower levels, thus allowing them to stay in school.

Figure 3.2: Educational Attainment in Early Adulthood

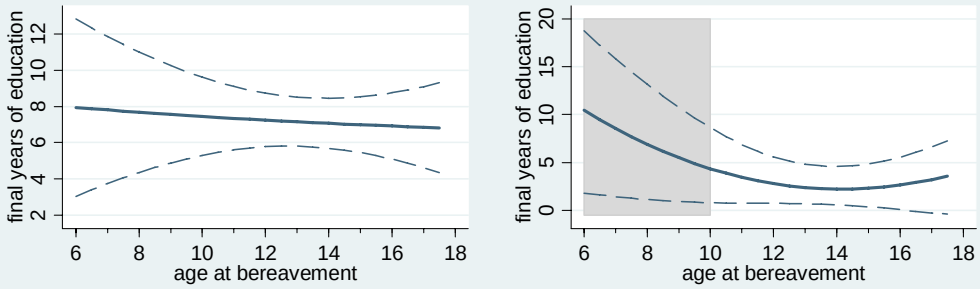
boy, paternal loss



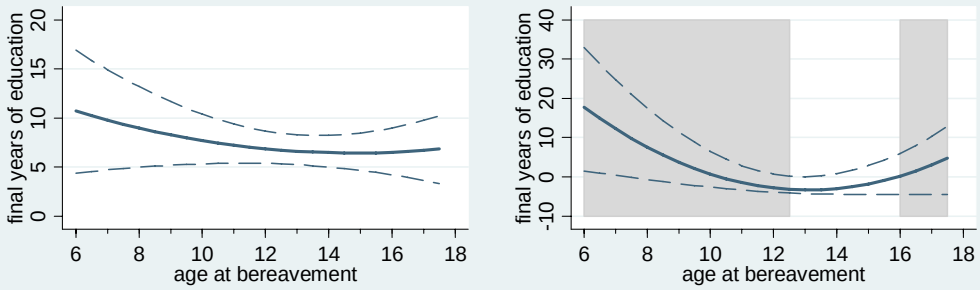
girl, paternal loss



boy, maternal loss

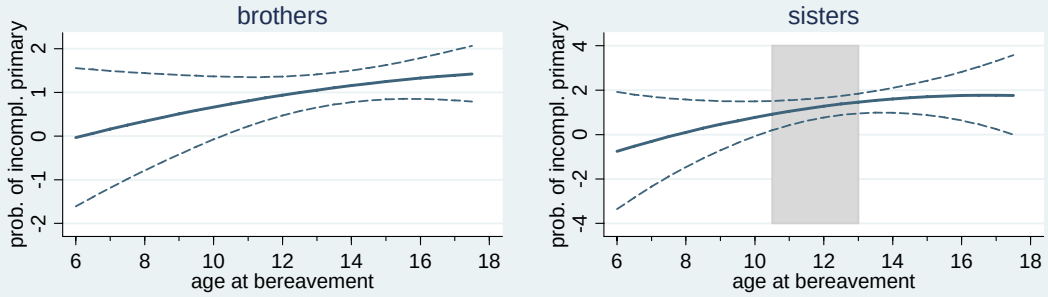


girl, maternal loss



Notes - column 1: predicted values (community fixed effects), column 2: predicted values (family fixed effects); dashed lines: 90% confidence interval; shaded areas: marginal effect of age at bereavement significantly different from zero.

Figure 3.3: Incomplete Primary Schooling for Maternally Orphaned Siblings



Notes - dashed lines: 90% confidence interval; shaded areas: marginal effect of age at bereavement significantly different from zero.

5.3 Robustness Checks

Despite the high re-contact rates of 93 percent and 82 percent on the household and individual level respectively, non-random attrition poses a potential source of bias. We address this problem by predicting the probability of an individual to be re-interviewed in 2004 based on the same baseline characteristics used above. We then use the inverse of these probabilities as weights in our regressions. Our results, however, are fully robust to this weighting procedure (available upon request). This finding does not come as a surprise given the low overall attrition rates and similar findings by Beegle et al. (2010) who also find that their results on the human capital impact of orphanhood as such remain unchallenged after accounting for potential attrition bias.

Another issue of concern is the role of parental morbidity. If the death of a parent was preceded by a long period of severe illness, orphans' health and educational status at baseline could already be contaminated by their parents' chronic disease. For instance, AIDS-related deaths, which are common in the study area, typically follow up to two years of opportunistic diseases like diarrhea, tuberculosis and acute respiratory infections (Morgan et al., 2002).[11] Such episodes inflict a heavy financial and emotional burden upon affected households and could adversely affect human capital accumulation of orphans before the actual death. Since we do not reliably observe the cause of parental death, we control for parents' health status by including a dummy variable indicating whether they reported to have been chronically ill during the six months prior to the baseline survey. Again, our results remain virtually unchanged (available upon request) and are thus unlikely to be biased by earlier parental morbidity. This finding is also in line with the previous observation that future age at bereavement is not significantly related to baseline height or educational attainment.

11 41 percent and 31 percent of the orphans in the education and health sample, respectively, have lost a parent up to two years after their baseline interview.

6 Conclusion

There is ample theoretical ground to suspect that the age at which a child loses her parent(s) affects the magnitude of the resulting impacts on her overall human capital formation. Using longitudinal data from North-Western Tanzania, we provide empirical evidence in support of this view. Overall, however, the impact of orphanhood is less heterogeneous for the death of opposite-sex parents. Thus, preferences of the surviving parent or the foster family seem to partly make up for income losses and psychological stress which typically accompany the loss of a parent. This finding also indicates that risks are not shared equally within households.

Our results may inform policy interventions to take an age-specific approach. Yet, optimal targeting of particularly vulnerable orphans remains challenging in the context of broad-based support schemes as the adverse effects of orphanhood not only vary with age at bereavement, but also with the sex of the deceased parent and the type of human capital. On the whole, our findings suggest that losing the same-sex parent is particularly detrimental before early teenage years. Hence, efforts to support orphans may extend well beyond early childhood, which is generally seen as the most critical period of child development. Interventions after age five might be crucial for providing favorable conditions to reap the benefits of previous parental investments.

Literature

Agid, O., B. Shapira and J. Zislin (1999). Environment and Vulnerability to Major Psychiatric Illness: A Case Control Study of Early Parental Loss in Major Depression, Bipolar Disorder and Schizophrenia. *Mol Psychiatry,* 4(2): 163-172.

Ai, C., and E.C. Norton (2003). Interaction Terms in Logit and Probit Models. *Economics Letters,* 80(1): 123-129.

Ainsworth, M., K. Beegle and G. Koda (2005). The Impact of Adult Mortality and Parental Deaths on Primary Schooling in North-Western Tanzania. *Journal of Development Studies*, 41(3): 412-439.

Alderman, H., H. Hoogeven and M. Rossi (2009). Preschool Nutrition and Subsequent Schooling Attainment: Longitudinal Evidence from Tanzania. *Economic Development and Cultural Change*, 57(1): 239-260.

Alderman, A., J. Hoddinott and B. Kinsey (2006). Long Term Consequences of Early Childhood Malnutrition. *Oxford Economic Papers*, 58(3): 450-474.

Almond, D., and J. Currie (forthcoming). Human Capital Development Before Age Five. In O. Ashenfelter and D. Card (Eds.), *Handbook of Labor Economics, Volume 4*. Amsterdam: Elsevier.

Becker, G. (2007). Health as Human Capital: Synthesis and Extensions. *Oxford Economic Papers*, 59(3): 379-410.

Beegle, K., J. de Weerdt, and S. Dercon (2010). Orphanhood and Human Capital Destruction: Is There Persistence Into Adulthood? *Demography*, 47(1): 163-180.

Beegle, K., J. de Weerdt, and S. Dercon (2008). Adult Mortality and Consumption Growth in the Age of HIV/AIDS. *Economic Development and Cultural Change*, 56(2): 299-326.

Beegle, K., J. de Weerdt, and S. Dercon (2006). Orphanhood and the Long-Run Impact on Children. *American Journal of Agricultural Economics*, 88(5): 1266-1272.

Black, S., P.J. Devereux and K.J. Salvanes (2005). The More the Merrier? The Effect of Family Size and Birth Order on Children's Education. *Quarterly Journal of Economics*, 120(2): 669-700.

Beegle, K., D. Filmer, A. Stokes and L. Tiererova (2009). Orphanhood and the Living Arrangements of Children in sub-Saharan Africa. World Bank Policy Research Working Paper 4889.

van den Berg, G., P. Lundborg, P. Nystedt and D.-O. Rooth (2009). Critical Periods During Childhood and Adolescence: A Study of Adult Height Among Immigrant Siblings, IZA Discussion Paper 4140.

Bogin, B. (1999). *Patterns of Human Growth*. Cambridge: Cambridge University Press.

Bowlby, J. (1982). *Attachment and Loss: Volume 3: Loss, Sadness and Depression*. New York, NY: Basic Books.

Brown, G.W., and T.O. Harris (1978). *The Social Origin of Depression: A Study of Psychiatric Disorder in Women*. New York, NY: Free Press.

Case, A., and C. Ardington (2006). The Impact of Parental Death on School Outcomes: Longitudinal Evidence from South Africa. *Demography*, 43(3): 401-420.

Case, A., and C. Paxson (2010). Causes and Consequences of Early Life Health. NBER Working Paper 15637.

Case, A., and C. Paxson (2004). Orphans in Africa: Parental Death, Poverty, and School Enrollment. *Demography*, 41(3): 483-508.

Case, A., and C. Paxson (2001). Mothers and Others: Who Invests in Children's Health? *Journal of Health Economics*, 20(3): 301-328.

Currie, J. (2009). Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development. *Journal of Economic Literature*, 47(1): 87-122.

Deklyen, M., and M. Greenberg (2008). Attachment and Psychopathology in Childhood. In J. Cassidy and P. Shaver (Eds.), *Handbook of Attachment*. New York, NY: Guilford Press.

Dozier, M., K. Stovall-McClough and K. Albus (2008). Attachment and Psychopathology in Adulthood. In J. Cassidy and P. Shaver (Eds.), *Handbook of Attachment*. New York, NY: Guilford Press.

Edmonds, E. (2006). Understanding Sibling Differences in Child Labor, *Journal of Population Economics*, 19(4): 795-821.

Evans, D., and E. Miguel (2007). Orphans and Schooling in Africa: A Longitudinal Analysis. *Demography*, 44(1): 36-57.

Gertler, P., D. Levine and M. Ames (2004). Schooling and Parental Death. *Review of Economics and Statistics*, 86(1): 211-225.

Glewwe, P., and E. King (2001). The Impact of Early Childhood Nutritional Status on Cognitive Development: Does the Timing of Malnutrition Matter? *World Bank Economic Review*, 15(1): 81-113.

Horton, S. (1988). Birth Order and Nutritional Status: Evidence from the Philippines. *Economic Development and Cultural Change*, 36(2): 341-354.

Katon, W.J. (2003). Clinical and Health Services Relationships between Major Depression, Depressive Symptoms, and General Medical Illness. *Biological Psychiatry*, 54(3): 216-226.

Kenkel, D. (1991). Health Behavior, Health Knowledge, and Schooling. *Journal of Political Economy*, 99(2): 287-305.

Lamb, M.E. (Ed.) (2010). *The Role of the Father in Child Development*. Hoboken, NJ: Wiley.

Leibowitz, A. (1974). Home Investments in Children. *Journal of Political Economy*, 82(2): 111-131.

Liu, Z., X. Li and X. Ge (2009). Left Too Early: The Effects of Age at Separation. *American Journal of Public Health*, 99(11): 2049-2054.

Lundberg, M., M. Over and P. Mujinja (2000). Sources of Financial Assistance for Households Suffering an Adult Death in Kagera, Tanzania. *South African Journal of Economics*, 68(5): 948-984.

Makame, V., C. Ani and S. Grantham-McGregor (2002). Psychosocial Well-being of Orphans in Dar-Es-Salaam, Tanzania. *Acta Paediatrica*, 91(4): 459-465.

Morgan, D., C. Mahe, B. Mayanja, J.M. Okongo, R. Lubega and J.A.G. Whitworth (2002). HIV-1 Infection in Rural Africa: Is There a Difference in Median Time to AIDS

and Survival Compared with That in Industrialized Countries? *AIDS*, 16(4): 597-603.

National Scientific Council on the Developing Child (2010). Persistent Fear and Anxiety Can Affect Young Children's Learning and Development. Working Paper 9.

Needham, B. (2009). Adolescent Depressive Symptomatology and Young Adult Educational Attainment: An Examination of Gender Differences. *Journal of Adolescent Health*, 45(2): 179-186.

Nyamukapa, C.A., S. Gregson, B. Lopman, S. Saito, H.J. Watts, R. Monasch and M.C.H. Jukes (2008). HIV-Associated Orphanhood and Children's Psychosocial Distress: Theoretical Framework Tested with Data from Zimbabwe. *American Journal of Public Health*, 98(1): 133-141.

Odenstadt, A., A. Hjerna, F. Lindblad, F. Rasmussena, B. Vinnerljung and M. Dalen (2008). Does Age at Adoption and Geographic Origin Matter? A National Cohort Study of Cognitive Test Performance in Adult Inter-Country Adoptees. *Psychological Medicine*, 38(12): 1803-1814.

O'Donnel, O., E. van Doorslaer, A. Wagstaff, and M. Lindelow (2008). *Analyzing Health Equity Using Household Survey Data: A Guide to Techniques and Their Implementation*. Washington, D.C.: World Bank.

Sharma, M. (2006). Orphanhood and Schooling Outcomes in Malawi. *American Journal of Agricultural Economics*, 88(5): 1273-1278.

Skinner, D., N. Tsheko, S. Mtero-Munyati, M. Segwabe, P. Chibatamoto, S. Mfecane, B. Chandiwana, N. Nkomo, S. Tlou, G. and Chitiyo (2006). Towards a Definition of Orphaned and Vulnerable Children. *AIDS and Behavior*, 10(6): 619-626.

Steckel, R.H. (1995). Stature and the Standard of Living. *Journal of Economic Literature*, 33(4): 1903-1940.

Strauss, J., and D. Thomas (1995). Human Resources: Empirical Modeling of Household and Family Decisions. In H. Chenery and T.N. Srinivasan (Eds.), *Handbook of Development Economics, Volume 3A*. New York, NY: Elsevier.

Subbarao, K., and D. Coury (2004). *Reaching Out to Africa's Orphans: A Framework for Public Action*. Washington, D.C.: World Bank.

Thomas, D. (1994). Like Father, Like Son; Like Mother, Like Daughter: Parental Resources and Child Health. *Journal of Human Resources*, 29(4): 950-988.

Thomas, D. (1990). Intrahousehold Resource Allocation: An Inferential Approach. *Journal of Human Resources*, 25(4): 635-664.

Thomas, D., J. Strauss and M. Henriques (1991). How Does Mother's Education Affect Child Height? *Journal of Human Resources*, 26(2): 183-211.

Ulijaszek, S., F. Johnston and A. Preece (1998). *The Cambridge Encyclopedia of Human Growth and Development*. Cambridge: Cambridge University Press.

UNAIDS (2008). *Report on the Global HIV/AIDS Epidemic 2008*. Geneva: UNAIDS.

UNAIDS, UNICEF and USAID (2004). *Children on the Brink 2004: A Joint Report on New Orphan Estimates and a Framework for Action*. New York, NY: USAID.

UNICEF (2009). *The State of the World's Children*. New York, NY: UNICEF.

WHO (2004). *The Importance of Caregiver-Child Interactions for the Survival and Healthy Development of Young Children: A Review*. Geneva: WHO.

World Bank (2004). User's Guide to the Kagera Health and Development Survey Datasets, mimeo.

World Bank (1999). *Tanzania: Social Sector Review*. Washington, D.C.: World Bank.

Appendix

TABLE A1: NUMBER OF ORPHANS BY SAMPLE AND CATEGORY

	Education sample	Health sample
Maternal	80	169
Paternal	136	267
Double	32	77
Total	184	369

Notes - The gender distribution is very even. Boys represent 49.5 percent and 48.8 percent of the education and health sample, respectively. Entries in one column do not sum to the total because double orphans are also included as both maternal and paternal orphans.

TABLE A2: SUMMARY STATISTICS FOR HEALTH SAMPLE (N=367)

	Mean	Std. Dev.	Min	Max
height-for-age z-score in 2004	-1.56	1.04	-4.31	1.49
age at bereavement	10.90	4.44	0.75	17.92
father died first	0.70	0.46	0.00	1.00
double orphan	0.27	0.44	0.00	1.00
male	0.49	0.50	0.00	1.00
height-for-age z-score at baseline	-1.76	1.34	-4.98	3.28
first-born	0.28	0.45	0.00	1.00
mother present at baseline	0.76	0.43	0.00	1.00
father present at baseline	0.69	0.46	0.00	1.00
# children 0-6	2.25	1.31	0.00	6.00
# same-sex siblings 0-18	2.25	1.74	0.00	14.00
# other-sex siblings 0-18	2.24	1.54	0.00	8.00
# same-sex siblings 19-60	1.19	0.85	0.00	7.00
# other-sex siblings 19-60	1.20	0.84	0.00	7.00
# elderly members 61+	0.52	0.58	0.00	2.00
female hh member 61+	0.19	0.39	0.00	1.00
male hh head	0.82	0.39	0.00	1.00
age hh head	52.87	15.30	20.00	95.00
asset index	-0.07	1.53	-1.67	7.46
log consumption expenditures	10.92	0.63	8.87	13.35
mother attended school	0.73	0.44	0.00	1.00
father attended school	0.92	0.28	0.00	1.00
height of mother	157.73	5.95	142.50	173.20
height of mother missing	0.20	0.40	0.00	1.00
age in 2004	18.11	4.69	9.00	30.00

TABLE A3: SUMMARY STATISTICS FOR EDUCATION SAMPLE (N=184)

	Mean	Std. Dev.	Min	Max
years of schooling in 2004	5.99	2.68	0.00	13.00
age at bereavement	13.59	2.93	6.67	17.92
father died first	0.69	0.46	0.00	1.00
double orphan	0.30	0.46	0.00	1.00
male	0.49	0.50	0.00	1.00
enrolled at baseline	0.51	0.50	0.00	1.00
years of schooling at baseline	1.08	1.73	0.00	7.00
first-born	0.33	0.47	0.00	1.00
mother present at baseline	0.70	0.46	0.00	1.00
father present at baseline	0.71	0.46	0.00	1.00
# children 0-6	1.77	1.31	0.00	6.00
# same-sex siblings 0-18	2.26	1.86	0.00	14.00
# other-sex siblings 0-18	2.17	1.44	0.00	7.00
# same-sex siblings 19-60	1.18	0.89	0.00	6.00
# other-sex siblings 19-60	1.19	0.83	0.00	4.00
# elderly members 61+	0.57	0.60	0.00	2.00
female hh member 61+	0.22	0.42	0.00	1.00
male hh head	0.84	0.37	0.00	1.00
age hh head	55.50	14.66	25.00	95.00
asset index	-0.03	1.42	-1.62	5.86
log consumption expenditures	10.85	0.66	8.87	13.35
mother attended school	0.64	0.48	0.00	1.00
father attended school	0.91	0.28	0.00	1.00
age in 2004	22.63	2.80	19.00	30.00

TABLE A4: PREDICTING BASELINE OUTCOMES WITH FUTURE AGE AT BEREAVEMENT AND A FULL SET OF BASELINE COVARIATES

Baseline outcome	Estimation method	Coefficient	Std. err.	P-value	Observations
Health					
height-for-age z-score	OLS	-0.012	0.024	0.625	369
Education					
years of schooling	OLS	-0.020	0.034	0.561	184
years of schooling	Tobit	-0.025	0.037	0.505	184
enrolled	Probit	-0.013	0.045	0.770	184

TABLE A5: EFFECTS OF AGE AT BEREAVEMENT ON BODY HEIGHT ATTAINMENT IN EARLY ADULTHOOD

	Community fixed effects		Family fixed effects	
	coef	se	coef	se
age at bereavem.	0.019	0.039	0.021	0.060
age at bereavem.*male	-0.007	0.046	-0.054	0.078
age at bereavem.*father died	-0.006	0.039	0.054	0.053
age at bereavem.*father	0.072+	0.049	0.099	0.080
(age at bereavem.)^2	-0.016**	0.007	-0.006	0.011
(age at bereavem.)^2*male	0.018**	0.009	0.003	0.013
(age at bereavem.)^2*father died	0.015*	0.008	0.007	0.012
(age at bereavem.)^2*father	-0.009	0.009	0.003	0.015
male	-0.679**	0.244	-0.428	0.419
father died	-0.027	0.222	0.258	0.852
father died*male	-0.057	0.264	-0.210	0.459
double orphan	0.136	0.115	-0.442	0.326
baseline H/A z-score	0.354**	0.042	0.358**	0.073
first-born	0.131	0.119	-0.094	0.192
mother present at baseline	0.190	0.310	-0.319	0.302
father present at baseline	0.145	0.133	0.355	0.587
# same-sex siblings 0-18	-0.008	0.031		
# opposite-sex siblings 0-18	0.013	0.043	0.004	0.074
# same-sex adults 19-60	0.033	0.064		
# opposite-sex adults 19-60	-0.021	0.065	-0.018	0.138
# children 0-6	-0.014	0.060		
# elderly members 61+	0.436**	0.176		
female hh member 61+	-0.179	0.170		
male hh head	-0.043	0.148		
age hh head	-0.013**	0.005		
asset index	-0.033	0.045		
consumption expenditures	-0.113	0.107		
mother attended school	0.068	0.113		
father attended school	0.137	0.191		
mother's height	0.039**	0.007		
mother's height missing	6.511**	1.189		
constant	-6.427**	1.765	-3.059**	0.749
age dummies	yes	yes	yes	yes
Number of observations	369		267	
Adjusted R2	0.418		0.370	

**/*/+ denote significance at the 5/10/15 percent level respectively. Standard errors are clustered at the household level.

TABLE A6: EFFECTS OF AGE AT BEREAVEMENT ON EDUCATIONAL ATTAINMENT IN EARLY ADULTHOOD

	Years of schooling in 2004				Incomplete primary schooling			
	Community fixed effects		Family fixed effects		Community fixed effects		Family fixed effects	
	coef	se	coef	se	coef	se	coef	se
age at bereavem.	-0.132	0.192	0.400	0.459	-0.012	0.042	0.138	0.112
age at bereavem.*male	0.048	0.224	-0.541	0.589	0.067	0.048	-0.035	0.137
age at bereavem.*father died	0.158	0.231	-0.559	0.628	-0.001	0.044	0.006	0.134
age at bereavem.*father	0.071	0.274	0.885	0.728	-0.111**	0.055	-0.029	0.146
(age at bereavem.)^2	0.055	0.066	0.418**	0.206	-0.007	0.014	-0.022	0.038
(age at bereavem.)^2*male	-0.052	0.082	-0.294+	0.189	0.017	0.016	0.015	0.037
(age at bereavem.)^2*father died	-0.013	0.075	-0.389*	0.200	0.002	0.015	0.028	0.037
(age at bereavem.)^2*father	-0.019	0.092	0.174	0.221	-0.017	0.018	-0.009	0.039
male	0.585	1.051	5.476**	1.616	-0.167	0.191	-0.441	0.339
father died	-0.363	1.082	8.585**	2.322	-0.031	0.207	-1.068**	0.444
father died*male	0.112	1.387	-4.578**	1.647	0.320	0.230	0.629*	0.334
double orphan	-0.509	0.410	-0.179	3.097	0.109	0.090	-0.461	0.446
enrolled at baseline	0.947	0.750	1.163	1.263	-0.055	0.090	-0.126	0.136
completed grades at baseline	0.462**	0.141	0.975**	0.263	-0.038	0.028	-0.057	0.044
first-born	-0.070	0.505	-0.115	0.944	0.059	0.102	0.188	0.168
mother present at baseline	0.119	0.482	-0.706	1.575	0.040	0.092	0.084	0.274
father present at baseline	-0.366	0.551	-5.905*	3.228	-0.116	0.121	0.772*	0.416
# same-sex siblings 0-18	0.176+	0.120	0.690**	0.347	-0.038	0.027	-0.142**	0.059
# opposite-sex siblings 0-18	0.101	0.185			-0.003	0.035		
# same-sex adults 19-60	0.142	0.247			-0.050	0.039		
# opposite-sex adults 19-60	-0.272	0.276	-0.251	0.536	0.007	0.052	0.046	0.104
# children 0-6	-0.158	0.283			0.055	0.054		
# elderly members 61+	-0.433	0.655			-0.056	0.140		
female hh member 61+	1.198+	0.792			0.134	0.137		
male hh head	0.112	0.912			0.164	0.163		
age hh head	0.005	0.018			0.001	0.004		
asset index	0.158	0.245			0.006	0.054		
consumption expenditures	0.796**	0.323			-0.071	0.066		
mother attended school	1.186**	0.493			-0.064	0.096		
father attended school	-0.248	0.819			-0.489**	0.151		
constant	-3.845	3.971	2.262	2.863	1.248*	0.717	1.176**	0.551
age dummies	yes	yes	yes	yes	yes	yes	yes	yes
Number of observations	184		104		184		104	
Adjusted R2	0.188		0.228		0.143		0.261	

**/*/+ denote significance at the 5/10/15 percent level respectively. Standard errors are clustered at the household level.

FIGURE A1: SCATTER PLOT AND HISTOGRAMS OF HEIGHT-FOR-AGE Z-SCORES AND AGE AT BEREAVEMENT

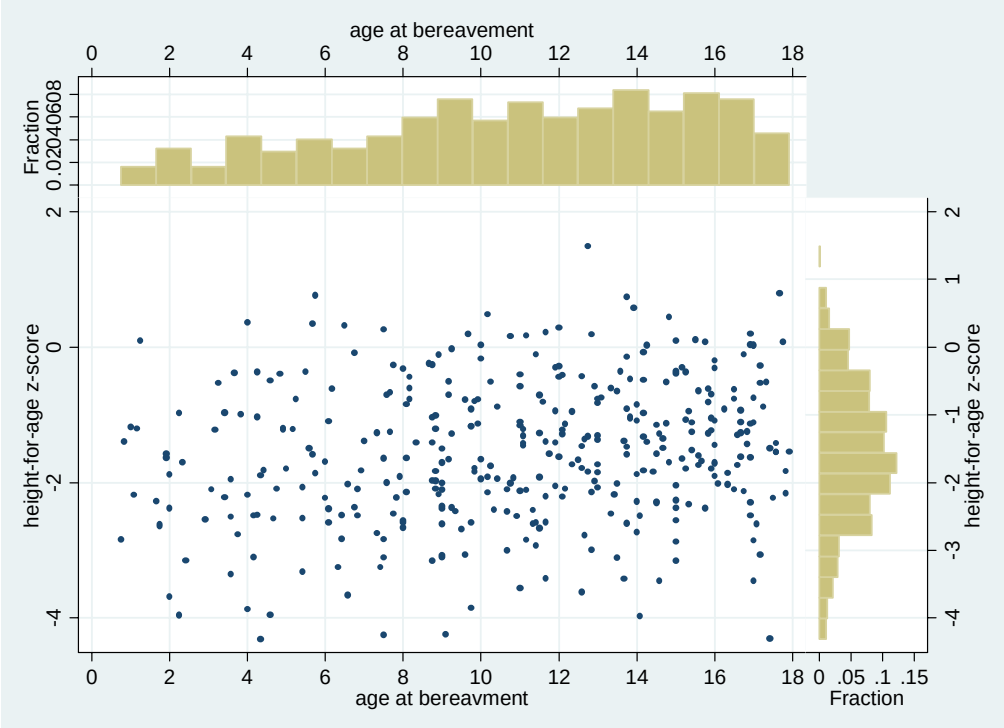
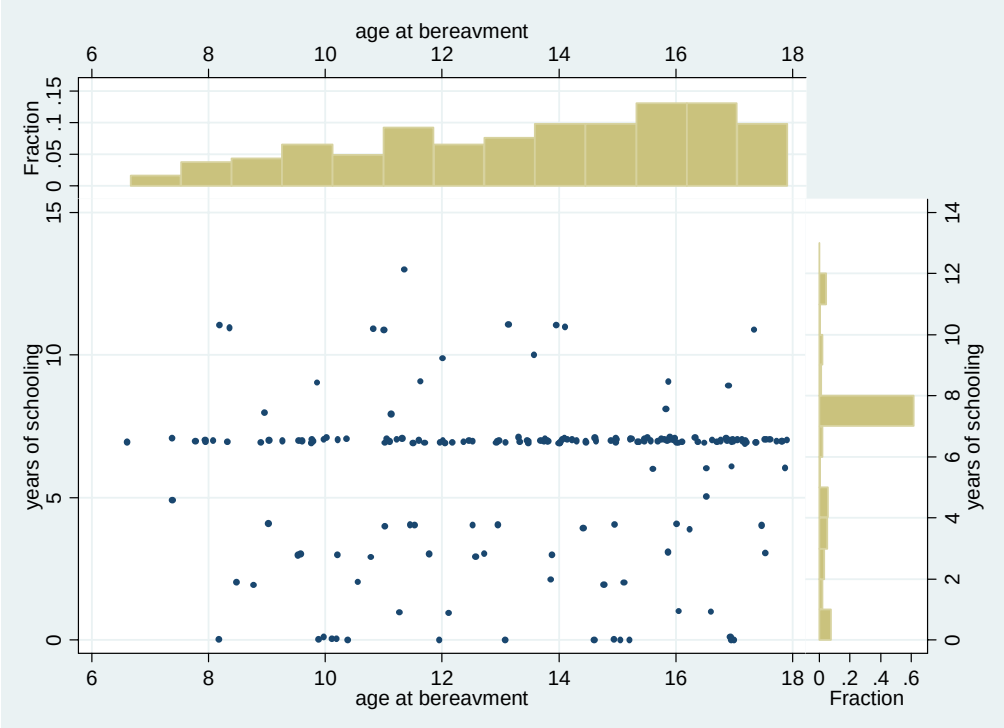


FIGURE A2: SCATTER PLOT AND HISTOGRAMS OF YEARS OF SCHOOLING AND AGE AT BEREAVEMENT



Note: To enhance the visibility of multiple observations per grade, this scatter plot introduces some random variation in the discrete variable *years of schooling*.