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The Impact of Parental Death on Child Well-being: Evidence from the Indian Ocean Tsunami
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ABSTRACT

Identifying the impact of parental death on the well-being of children is complicated because parental death is likely to be correlated with other, unobserved, factors that affect child well-being. Population-representative longitudinal data collected in Aceh, Indonesia, before and after the December 2004 Indian Ocean tsunami are used to identify the impact of parental deaths on the well-being of children who were age 9 through 17 years old at the time of the tsunami. Exploiting the unanticipated nature of parental death due to the tsunami in combination with measuring well-being of the same children before and after the tsunami, models that include child fixed effects are estimated to isolate the causal effect of parental death. Comparisons are drawn between those children who lost one parent, both parents and those whose parents survived. Shorter-term impacts on school attendance and time allocation a year after the tsunami are examined as well as longer-term impacts on education trajectories and marriage. Shorter- and longer-term impacts are not the same. Five years after the tsunami, there are substantial deleterious impacts of the tsunami on older boys and girls whereas the effects on younger children are more muted.

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1. Introduction

On December 26, 2004, an earthquake measuring 9.3 on the Richter scale occurred off the coast of Indonesia. The earthquake, which generated a 1,200 km rupture in the earth's surface, spawned a tsunami that affected coastlines around the Indian Ocean. Within 15 minutes of the earthquake the tsunami reached the island of Sumatra and engulfed communities along 800 kilometers of the coastline of Aceh, the province closest to the earthquake's epicenter. It is estimated that the tsunami killed over 160,000 people, with women, young children and older adults the most likely to die (Rofi *et al.*, 2006; Doocy *et al.*, 2007; Frankenberg *et al*, 2011).

Many children lost one or both parents in the tsunami. We estimate that among children age 9 to 18 at the time of the tsunami, around 10,000 lost one parent and about 4,400 lost both parents. For these children, parental death was a major unanticipated shock. This research measures the impact of that death on the well-being of children in the aftermath of the tsunami. Establishing this impact is not straightforward, even after an unanticipated shock, if a family in which a parent dies differs from other families in ways that would have affected a child's outcomes had the parent survived. We directly address this concern by drawing on longitudinal data from the Study of the Tsunami Aftermath and Recovery (STAR), which we conducted in the Indonesian provinces that were affected by the December 2004 Indian Ocean disaster. The baseline survey was conducted ten months before the tsunami and is representative of the population living in districts with coastlines vulnerable to inundation. Re-interviews took place annually between 2005 and 2010. The first post-tsunami interview, about a year after the event, provides evidence on the short-term impact of parental death. Evidence regarding the longer term impact draws on data collected about 5 years after the tsunami.

Although Indonesia regularly experiences earthquakes, tsunamis are rare and the event in 2004 was largely unanticipated. Moreover the intensity of the tsunami varied within small areas as

a function of the topography, elevation, and orientation of the land relative to the direction and force of the waves. Survival was to large extent attributable to idiosyncratic factors revolving around the combination of where the waves hit and people's precise locations at that moment. For these reasons, it is possible that parental death is independent of prior behaviors, including previous investments in children. We show, however, that parental survival is related to several characteristics of children measured in the pre-tsunami baseline. Therefore, to identify the causal impact of parental death we compare changes in outcomes (measured before and after the tsunami) for children whose parents died in the tsunami with the changes in those outcomes for children whose parents survived. The combination of the longitudinal data on children who were living along the coast of Aceh and the unanticipated nature of the tsunami provide a unique window on how children's well-being is affected by parental death.

The results of this investigation are important given that in recent years, high-mortality natural disasters have caused surges in the number of orphaned children, bringing media attention and humanitarian concern to their plight. Little scientific evidence exists regarding the impact of parental death in these contexts on child well-being. This research contributes to filling that gap.

Our evidence also speaks to a long-standing interest among demographers, sociologists, economists and psychologists who have sought to understand how parental absence affects children's well-being. This interest has broadened as divorce, migration, and the HIV/AIDS epidemic have increased the number of children experiencing the absence or loss of a parent. Identification of causal effects in this literature has been a substantial challenge.

We examine indicators of child well-being related to human capital and time allocation that are measured in the surveys collected both before and after the tsunami. Parental death potentially affects other indicators of well-being, such as psycho-social health and aspirations for

the future, but because those measures are not available in the baseline data we do not examine those outcomes.

We find that the impact of parental death varies with the age and gender of the child and that shorter-term impacts do not reliably portend what the longer-term impacts will be. Few papers examine the impact of losing both parents. We find that the death of both parents has a large, negative impact on the human capital accumulation of 15-17 year olds of both genders, and likely of 9-14 year old females. In addition, loss of only a father has negative implications for older males, who acquire less education after the tsunami than similar males whose parents survived the tsunami. We find little evidence that parental death affects the human capital of 9-14 year old males. Maternal death has little impact on schooling outcomes of children but does affect their time allocation.

2. Background

A parent's death typically ends a child's relationship with someone of central emotional importance, with the attendant potential for straining relationships with the remaining parent or caregivers. Parental death usually worsens the family's economic status, creates pressures to take on responsibilities of the dead parent, and may isolate the child from friends (Worden 1996; Tremblay and Israel 1998, Stokes, Reid, and Cook 2009).

Parental absence is often accompanied by symptoms of poor psycho-social well-being with changes in behavior and school performance sometimes occurring. However, the results of studies on how children fare after a parental death are not uniform, which has motivated efforts to identify factors that mediate the impact of parental loss (Sandler, 2003).

A key challenge in this literature is that parental loss is potentially correlated with other unobserved factors that affect child well-being. Studies have contrasted impacts of parental

absence brought on by a death with absence because of divorce, arguing that the death of a parent is plausibly exogenous with respect to other factors that affect child welfare, whereas absence because of divorce is not. Using data from a British cohort study, Fronstin (2001) shows that parental absence when a child is 11-15 years old is associated with reduced educational attainment for males and females which, for males, is larger if the absence results from death rather than divorce. Norwegian registry data indicate that paternal death lowers transition rates from lower to upper secondary school; similar effects emerge for divorce in models with mother-specific random effects (Steele et al 2009). However, it is unclear that random effects absorb all unobserved differences between children whose parents divorce, those whose parent dies and those who live with both parents. More generally, although some parental deaths are likely to be random, it is unlikely that all are random or that parental death can be treated as 'exogenous' in these models.

In developing countries, much of the literature focuses on parental deaths from HIV-AIDS. Early studies relied on cross-sectional Demographic and Health Surveys and reported that, controlling age, school enrollment tended to be lower among children whose parent had died prior to the survey, recognizing that the results may be driven by unobserved heterogeneity. (Bicego et al. 2003; Case et al 2004).

Longitudinal data from Africa have been used to address concerns with unobserved heterogeneity and investigate the dynamic impact of AIDS-induced parental death on child outcomes. Using data from rural Kwa-Zulu/Natal, South Africa, Case and Ardington (2006) report that maternal death negatively affects subsequent enrollment, school attainment and education spending. The results are interpreted as causal since future maternal death does not predict baseline school outcomes. In contrast, paternal death has no effect on school outcomes; the authors suggest that effects of paternal death, if they exist, may operate through socio-economic status. Alternatively, also suggested by the authors, paternal death may matter less than maternal death

for children in rural Kwa-Zulu/Natal because many of the fathers are absent: less than 30% of children co-reside with the father while around two-thirds co-reside with the mother.

Changes in primary school participation of children whose parents died between 1999 and 2002 in Kenya are compared with changes for similar children whose parents did not die by Evans and Miguel (2007). A child is about 5% less likely to be in school after the mother dies. This effect appears about two years prior to the mother's death, which the authors attribute to the influence of parental illness due to HIV/AIDS, and persists for several years after the death. Effects of paternal death are smaller and not statistically significant.

In a study of longer-term impacts of orphanhood, Tanzanian children interviewed between ages 7 and 15 years when both parents were alive were re-interviewed ten years later. Children who had lost a parent during the hiatus were compared with those whose parents survived. Female orphans were more likely to be married (Beegle and Krustikova, 2008), orphans had completed one year less of schooling and they were 2 cms shorter than non-orphans (Beegle, DeWeerdt and Dercon, 2010). Because height is largely determined by the time a child is age 4 or 5 (Martorell and Habicht, 1986), the differences in height at follow-up likely reflect pre-existing differences between children who subsequently lost a parent and those who did not. This underscores a methodological issue in the literature on the impact of death from HIV/AIDS: because the parent is often ill for several years prior to death, behavioral responses by children and their families may precede the baseline measurement. Comparisons of trajectories of child well-being before and after the death of the parent potentially reflect the combination of these prior behaviors and the causal impact of the death itself. Longitudinal data alone may not be sufficient to identify the causal effect of parental death; it is important that parental death also be unanticipated.

This issue has been discussed in the literature. When a parent dies after a prolonged illness, the child may be better prepared for the eventual loss (Worden 1996). In a study of adolescents

who lost a parent to HIV/AIDS, emotional distress and contact with the juvenile justice system peaked in the year before the death, then steadily declined (Rotheram-Borus et al 2005). Results were similar for children who lost a parent to cancer (Siegel et al 1992, Siegel, Karus, Raveis 1996).

Investigators have argued that the causal effect of orphanhood can be identified when parental death is accidental. Using Indonesian data in which some deaths may be unanticipated, Gertler et al (2004) report that recent parental death is associated with reduced school enrollment among children and that older daughters with younger siblings, are at higher risk of dropping out when a parent dies. Drawing on administrative records from Taiwan, the relationship between parental deaths from accidents and college enrollment is examined (Chen, Chen, and Liu 2009). Comparing children at least 18 years of age when a parent died to younger siblings, the unexpected death of a mother results in a 4% lower probability of enrolling in college. Death of a father does not affect college enrollment. The authors interpret these patterns as evidence that maternal provision of non-financial support is more important for college-going behavior than paternal financial support, which can be replaced with resources provided to families after the father's death. Whereas some accidents can legitimately be treated as exogenous in these models, the concern remains that parents who are more likely to have accidents differ from other parents in unobserved ways that are related to investments in children.

Our research makes four contributions to the literature. First, we identify the effect of orphanhood based on the combination of, first, unexpected parental deaths that occurred because of the tsunami and, second, longitudinal data collected before and after the tsunami. The estimated effects are purged of contamination from unobserved heterogeneity that is fixed at the child and family level. From a methodological point of view, the combination of both dimensions of the research design are important to measure the impact of parental death on child well-being, at least

in the context of the Indian Ocean tsunami, which underlies our second contribution: little is known about the well-being of children orphaned in a large-scale natural disaster. Third, we examine both shorter- and longer-term impacts of parental death on child outcomes and find that shorter-term impacts are poor predictors of longer-term impacts. Fourth, we distinguish male from female children, older from younger children, and the loss of a mother from the loss of a father from the loss of both parents. We establish that all of these distinctions are important for understanding the impact of parental death on the well-being of the next generation.

3. Aceh and the 2004 Indian Ocean tsunami

Aceh, at the northern tip of Sumatra, lies at the periphery of the Indonesian archipelago which, along with historical factors, contributed to a desire for autonomy that has set the province apart from provinces closer to Jakarta. The exploitation of Aceh's abundant natural resources, particularly oil and natural gas at the beginning of the 1970s, fuelled aggregate economic growth in the province and sustained high rates of growth in Indonesia more broadly for three decades until the 1998 financial crisis. The distribution of the benefits caused conflicts between the Acehnese and the central government which, in combination with disagreements over the application of Islamic law, underlay the formation of a separatist movement, GAM (Free Aceh Movement). GAM was only disbanded in the year after the tsunami (Rist, 2010.)

Despite its natural resources, the material well-being of the population of Aceh is close to the average for all Indonesians. At the time of the tsunami, the poverty rate in Aceh was slightly above the average for all of Indonesia and more Acehnese fell into poverty as a result of the destruction caused by the tsunami. However, within a few years, the poverty rate had returned to its pre-tsunami level, in part because of the massive reconstruction effort (Thorburn, 2009, World Bank, 2009.)

The Sumatra-Andaman earthquake of 2004 resulted in a 2,000 km rupture along the floor of the Indian Ocean. The displaced water generated a tsunami that slammed into the island of Sumatra shortly after the earthquake (Lay et al. 2005; Marris 2005) causing over 160,000 deaths and massive destruction.

Two features of the tsunami are important for our empirical approach. First, the tsunami was not expected. No early warning systems were in place. Moreover, geological evidence documents that mainland Sumatra had not experienced a tsunami for more than 600 years (the last tsunami in the region, in 1907, affected Simeulue Island off the coast of Sumatra) (Monecke et al 2008). Second, the severity of the impact varied in ways that could not be anticipated even within small areas. Areas where the water hit full force experienced the greatest damage, but sites nearby were protected from the water's force by topographical features of the coastline (Frankenberg et al, 2011). Because idiosyncratic features of the landscape played an important role in determining risk, parental deaths from the tsunami are driven less by genetic risk factors, prior behavioral choices, and socioeconomic status than is the case for parental absence caused by death from illness, floods, hurricanes or other natural hazards.

4. Data

The Study of the Tsunami Aftermath and Recovery (STAR) is a longitudinal survey of individuals who were living, prior to the tsunami, along the coast of Aceh and the neighboring province of North Sumatra. The baseline survey, STAR0, was conducted in February 2004, as part of the annual population-representative cross-sectional socioeconomic survey, SUSENAS, conducted by Statistics Indonesia.

With the assistance of Statistics Indonesia, we fielded the first follow up wave, STAR1, between May 2005 and July 2006. We targeted all SUSENAS respondents from the 2004 survey

who were living in any of 11 *kabupaten* (districts) in Aceh and 8 *kabupaten* in North Sumatra. The baseline sample survey includes 585 enumeration areas in 525 villages. The *kabupaten* were selected because they each have a coastline and so were, in principle, vulnerable to inundation from the tsunami waves. Tsunami effects varied within and across these *kabupaten* because the force and reach of the water varied considerably as a function of land topography.

In the baseline survey, informants reported the socioeconomic and demographic characteristics of themselves and other household members. In STAR1 we collected individual and household-level data, drawing on and augmenting the baseline questionnaire. In addition village leaders and informants at local schools and health facilities provided information as part of a large community-level survey.

STAR1 was the first of five annual post-tsunami surveys. We also use data from the fifth follow-up, STAR5, which took place between November, 2009 and November, 2010.

We focus on children and young adults who were between 9 and 17 years old at the time of the baseline survey and were living in 91 communities along the coast that sustained heavy damage from the tsunami, as measured by a combination of satellite imagery, direct observations of survey supervisors, and interviews with village leaders. In the larger STAR sample, the vast majority of deaths due to the tsunami occurred in these areas. In STAR1, and subsequently, we put considerable effort into identifying which baseline respondents had died and locating the survivors. When respondents could not be found in the baseline location, interviewers obtained proxy information about their whereabouts and tracked them to their new location. In about half these cases, survivors had moved to temporary camps; the majority of the others had moved to the homes of family or friends or rented housing elsewhere. One or more family members provided information about the survival status of each member of the baseline household. If no family member could be found, we drew on information collected from neighbors, village leaders and

local death registers that were compiled after the tsunami. Of 1,173 age-eligible children in the baseline, 345 (30%) are known to have died. Of the remaining 828 children, we interviewed 709 (86%) in the first follow-up. Persistent attempts to track all survivors in subsequent waves paid off: we found more of them and 737 (89%) were assessed in the final interview. [1]

About one in six of the children interviewed in the first follow-up lost at least one parent, as shown in panel A of Table 1. The literature suggests that the loss of a mother has a larger impact on child human capital outcomes than the loss of a father. In our empirical models we will distinguish the loss a mother from the loss of a father, as well as the loss of both parents to the tsunami. In our study sample of children, 7.9% lost a mother, 4.5% lost a father and about the same fraction, 4.4%, lost both parents to the tsunami.

We examine five shorter-term child outcomes and five longer-term outcomes, all of which are related to human capital and time allocation. The shorter-term outcomes are measured at the first follow-up interview, about a year after the tsunami, when the children were age 10 through 18 years. At that time 83% were enrolled in school, 9% had worked in the previous week and 36% had helped with housekeeping in the previous week (Panel B of Table 1). A scholarship program was instituted by a number of different humanitarian aid organizations across Aceh in an effort to encourage children to stay in school. As with much of the humanitarian response to the tsunami, the structure of the scholarships varied across programs. The modal scholarship covered all fees, costs of books and costs of exams for either one or two years. For example, among children of elementary and high school age, the scholarship funded by Education International paid, on a monthly basis, about Rp 10 million per year (approximately $100). Other donors included the Sampoerna Foundation, the Freeman Foundation, and the Organization of Islamic Conference.

[1] 1% of the children refused to participate in each wave, 2 children died between the first and final re-survey and the remaining children were lost to follow-up.

Many programs describe their primary targets as those children who lost one or both parents and children whose parents lost their livelihood due to the tsunami. About 19% of the children in our sample had received a scholarship after the tsunami.

By the time of the final interview, about five years later, fewer than two-thirds of the children were enrolled in school and the average child had completed 10.2 years of schooling. About 28% were working in the labor market (for a wage, in a family business or self-employed), 39% did housework in the week prior to the survey, and 11% had married.

5. Empirical strategy

Our goal is to identify the extent to which variation in these child human-capital related outcomes can be attributed to the death of a parent in the tsunami. A natural starting place is to estimate the relationship between each of the shorter-term and longer-term outcomes, Y_{it}, for child i at time t (where t spans the period before and after the tsunami), and parental death, D_{it}, controlling time varying and time invariant child and family characteristics, X_{it}, and X_i, respectively:

$$Y_{it} = \alpha + \beta D_{it} + \gamma X_{it} + \delta X_i + \varepsilon_{it} \qquad [1]$$

Parental death, D, is vector-valued distinguishing children who lost their mother, those who lost their father and those who lost both parents in the tsunami. An important advantage of our research is that parental death does not reflect prior health-related behaviors but is the consequence of a large and unexpected natural disaster. Estimates from [1] can be interpreted as causal if parental death in the tsunami is exogenous in the model; i.e., if unobserved heterogeneity ε_{it} is not correlated with covariates in the model including parental death. This strong assumption underlies much of the existing literature. In our context, it is reasonable to suppose that parents who survived the tsunami are stronger or better swimmers than other parents, or that they lived in

more robust houses. If those parents also invested more in the human capital of their children prior to the tsunami, then the assumption that ε_{it} is unrelated to parental death will be violated.

If such differences exist and reflect traits that do not change during the study period, they can be taken into account in [1] by including a child-specific fixed effect. Specifically, separating unobserved heterogeneity into two components, a fixed effect that is time invariant for each child, μ_i, and a component that varies over time, ω_{it}, re-write [1] as

$$Y_{it} = \alpha + \beta D_{it} + \gamma X_{it} + \mu_i + \omega_{it} \qquad [2]$$

The fixed effect absorbs all characteristics of the parent and child that do not change over time and affect the outcome, Y_{it}, in a linear and additive way. These include observed characteristics, X_i, in model [1] along with unobserved characteristics that are included in ε_{it} in that model. The latter might include, for example, parents' tastes for investments in their children, characteristics of the child such as ability and ambition, and characteristics of the family and community in which they were living at the time of the tsunami.

Estimates of [2] require repeated observations of the same child before and after the tsunami. We examine indicators of schooling and time allocation that were measured for the same child before the tsunami and again after the tsunami.

One indicator was only collected after the tsunami. In the first re-survey we asked about participation in programs implemented after the tsunami to assist families, including whether the child received a scholarship from such a program. Since this scholarship program did not exist at baseline, we assume no child received one of these scholarships at that time.

Before presenting our empirical results, we assess whether parental death can be treated as exogenous in model [2]. Indicators measured in the pre-tsunami baseline for children whose parents subsequently survived the tsunami are compared with indicators for children who lost one or both parents in the tsunami.

The first row of Table 2 shows that children whose parents survived the tsunami were, on average, 12.9 years old at baseline (column 1). Children who lost a parent were, on average, age 13.5 (column 2) and the difference of 0.6 years is significant (column 3). The differences for children who lost their mother, their father or both parents, relative to those whose parents survived are displayed in columns 4, 5 and 6, respectively (none is significant).

The second row of the table indicates that males constitute a significantly higher fraction of survivors among children who lost parents relative to children whose parents survived. The difference is largest for children who lost both parents – in this group 19.9% more young males survived than young females (this difference is also significant).

Children whose parents died in the tsunami were also significantly better educated and significantly more likely to be enrolled in school prior to the tsunami. They were less likely to be working or engaged in housekeeping in the week before the pre-tsunami survey relative to those whose parents survived, although these differences are not significant. The rest of Table 2 compares characteristics of parents and households of those children whose parents survived the tsunami relative to those whose parents did not survive. None of these differences is statistically significant. We also estimated models that include a community fixed effect, which compares children *within* each community. In these models we find no statistically significant differences in any of the indicators in the table between children who lost one or more parents and those who did not. Thus, part of the differences between orphans and non-orphans can be attributed to differences across study sites, including the likelihood of death of parents. For some outcomes, differences between children who were orphaned and those who were not are similar in magnitude in models with and without community fixed effects, suggesting the possibility that even within communities pre-existing differences may exist between children who were orphaned by the tsunami and those children who were not orphaned.

Results in Table 2 establish that children who lost parents in the tsunami had higher levels of human capital before the tsunami relative to those children whose parents survived the tsunami. To the extent that these pre-tsunami differences are not absorbed by observed characteristics in the model [1], unobserved heterogeneity in the model will be correlated with parental death and estimates in [1] will be biased. If, however, these pre-tsunami differences reflect influences that are fixed for a child over the study period, they will be absorbed in the child fixed effect and estimates in [2] can be given a causal interpretation. The results in Table 2 underscore the critical importance of having a pre-tsunami baseline in order to identify the causal effect of parental death on child outcomes.

We have established that males are more likely to have survived the tsunami than females. The male survival advantage also holds for adults. It has been attributed to the fact that males are stronger and, in Islamic Aceh, much more likely to know how to swim than females (Frankenberg et al, 2011). We estimate separate models for males and females.

We also explore whether other attributes are associated with children's survival status (Appendix Table 1). The only significant difference is that children who helped with housekeeping were also more likely to survive. This difference, however, is small in magnitude and both smaller in magnitude and not significant when comparisons are drawn within communities. The evidence indicates that net of age and sex, children's deaths are not significantly related to pre-tsunami own human capital, parental human capital or household resources.

The final three columns of Appendix Table 1 compare the same indicators for respondents who were interviewed in the first follow-up with those who were not. None of the differences is significant and, taken together, the indicators explain only 1.2% of the variation in the probability an individual is not interviewed in the follow-up survey (F statistic for the significance of all the

covariates in the appendix table is 1.2, p value is 0.31.) In short, we find no evidence that attrition is selected on observed characteristics measured at baseline.

6. Results

The empirical model, [2], is estimated by ordinary least squares including child fixed effects. All estimates of variance-covariance matrices take into account clustering at the community level and are robust to arbitrary forms of heteroskedasticity. Results for older children (age 15 to 17 years at baseline) are reported in Table 3. Results for younger children (age 9 to 14 years at baseline) are reported in Table 4. All models are stratified by the child's gender and we distinguish short-term outcomes (measured a year after the tsunami) from longer-term outcomes (measured around five years after the tsunami). Each panel of the table reports the impact on the outcome listed in the first column of the table of death of the mother, death of the father and death of both parents relative to the excluded group (both parents survived the tsunami).

We begin with older children, who are likely to make the transition from school to work and possibly family formation during the study period. The shorter-term impacts of parental death are reported in the first column of Table 3 for older males. A year after the tsunami, they are less likely to be enrolled in school if a parent died – an impact that is large and statistically significant if the father died. There is no evidence that the scholarship programs introduced after the tsunami were effectively targeted at older children orphaned by the tsunami. In fact, the least likely to receive a scholarship were older males who lost both their mother and father in the tsunami.

Five years after the tsunami (column 2 of Table 3), relative to those who did not lose a parent, the older male children who lost both parents have completed 1.7 years less schooling since the tsunami and they are 40 percentage points less likely to be enrolled in school and 34 percentage points more likely to be working. These effects are both substantively large and

statistically significant. Relative to those whose parents both survived, if only the father died, the older males have completed 1.3 fewer years of schooling since the tsunami and they are less likely to be enrolled in school. (These gaps are not statistically significant.) Both double orphans and those who lost a father are 7 percentage points less likely to be married five years after the tsunami. None of the differences between the double orphans and those who lost their father is statistically significant. The results indicate that losing a father or both parents, has taken a toll on the trajectory of human capital accumulation of older male children as they have shifted out of school and into work earlier than similar males who did not lose a parent.[2] An examination of household rosters in the post-tsunami surveys establishes that in many cases, males who lost their father or both parents have taken on the role of the head of the new household including taking care of their younger siblings. We conclude that these older male orphans are likely to carry the costs of the tsunami into adulthood and possibly through the rest of their lives.

Results for older female children are reported in the third and fourth columns of Table 3. In the shorter-term, death of a father results in higher rates of school enrollment and lower rates of doing housework. However, death of the mother or both parents results in lower school enrollment (albeit not significantly) and substantially higher rates of doing housework (34% and 53% respectively). It appears that when the father dies, the mother seeks to protect older female children whereas the death of the mother results in the child stepping into the mother's role, at least in terms of housekeeping. Again, the scholarship program does not appear to have been targeted well. Among all older female children, those who lost both parents are the least likely to receive a scholarship.

[2] Prior to the tsunami, older boys who lost a parent in the tsunami were better educated than those who did not lose a parent, but after the tsunami, those who lost a parent had completed less education than those whose parents survived. For example, five years after the tsunami, boys who lost both parents had completed 10.8 years of schooling while those who did not lose a parent had completed 11.8 years.

Five years after the tsunami, the impacts of parental death are greatest on those older female children who lost both parents. Relative to similar females neither of whose parents died, older female children who lost both parents are 55 percentage points less likely to be enrolled in school, they are less likely to be in the work force, more likely to be keeping house and they are 62 percentage points more likely to be married.

Older female children who lost one parent are also more likely to be keeping house – presumably daughters substitute for the mother who died or assist the mother who was widowed and works in the labor market to replace income lost with the death of her husband. Whereas widowed mothers apparently tried to protect their daughters in the short run, this does not appear to have been sustained over the longer term. Nonetheless, in contrast with the substantially lower human capital of older male children who lost their fathers or both parents, there is no evidence that older female children who lost one of both parents have completed less education since the tsunami than similar females whose parents survived.

The fact that older female children who lost both parents are transitioning into the adult role of marriage earlier than other similar female children likely reflects at least two influences. First, the death of both parents left many of these older female children with fewer psycho-social and economic resources, and possibly a desire to form a new family earlier than would otherwise be the case. Second, the higher rates of mortality among prime age women, relative to prime age men, substantially changed the local area marriage markets. Five years after the tsunami, essentially all the prime age men who were widowered by the tsunami had re-married (Burrows et al, 2013). Whatever the reasons for the relatively early marriage of these girls, it is not clear whether the death of both parents will have an enduring impact on their well-being. Future waves of STAR will provide evidence on this important question.

We turn next to results for the younger children, who were between the ages of 9 and 14 at the pre-tsunami baseline. Results are reported for males in the first two columns of Table 4. Although younger males are no more or less likely to be enrolled in school if one or both parents died in the tsunami than are similar children whose parents survived, they are 32 percentage points more likely to have received a scholarship if the father died or both parents died. If both parents died, they are less likely to be working or doing housework, and if the father died, they are also less likely to be doing housework. It is possible that these effects on time allocation are driven by the scholarship program. There is little evidence suggesting significant longer-term impacts of orphanhood on these younger male children apart from a slightly higher probability of helping with housework if either the mother or father died.[3]

Results for younger female children are reported in the second two columns of Table 4. Those who lost their mother or both parents are significantly more likely to be enrolled in school. Effective targeting of scholarships to young girls who lost both parents may explain one piece of these results. It does not, however, explain the higher enrolment rates among girls whose mother died since they are no more likely to receive a scholarship than those female children whose mother and father both survived. Moreover, young female children who lost their father are more likely to receive a scholarship but their enrollment rates are the lowest of all groups. No significant differences emerge in the probability of working and doing housework among younger female children who lost one or both parents relative to those who did not.

Five years later, younger female children who lost both parents are 51 percentage points less likely to be enrolled in school. Loss of a father has effects in the same direction (but is half the magnitude and not statistically significant). Although there are no differences in the amount of

[3] Male children whose father died, or both parents died, are more likely to be working; while the estimated effect is substantively large, it is not statistically significant.

schooling completed since the tsunami for these young women, relative to those whose parents survived, the lower enrollment rates suggest that gaps in completed schooling may emerge in the coming years. Whereas loss of a mother or a father results in significantly lower rates of working in the market, loss of both parents results in a 24% increase in that probability – these double-orphaned girls have left school and entered the labor force earlier than similar girls whose parents did not die in the tsunami. Death of a father also results in higher rates of housekeeping suggesting that these young girls, like older female children, are substituting for their mothers.

7. Discussion and Conclusions

The potential repercussions for children of the death of a parent are likely to be multi-faceted and to evolve over time. The role in the family played by the parent who dies goes unfilled for at least some period of time. The surviving parent or care-giver may assume some of the deceased parent's responsibilities and, depending on the child's age and gender, the child may also take on some of those responsibilities. The child's relationship with the surviving parent (and/or other relatives and care-givers) likely changes and the child may strike out on his or her own earlier than if the parent had not died. Parental death is also likely to be accompanied by changes in the socioeconomic status of surviving family members. All these processes – and their impacts on the lives of the children -- evolve over time. We have investigated both the short and longer-term impacts of parental death on human capital related indicators of well-being of children.

Using data collected before and after the Indian Ocean tsunami, we examine the impact of death of one or both parents on child outcomes soon after the tsunami and over the longer-term. Because the tsunami was unexpected and survival depended largely on where people were located when the water came ashore, it is reasonable to assume that parents who died in the tsunami did not invest more (or less) in their children in anticipation of their children becoming orphans. This

assumption is less likely to be satisfied in studies of death of parents after an illness such as HIV. Nonetheless, it is a leap of faith to assume that those children who were orphaned by the tsunami can be treated as randomly drawn from the population of all children. The evidence indicates that, before the tsunami, children orphaned by the tsunami were different from those who were not orphaned. We therefore present estimates of the impact of parental death on child well-being in models of human capital accumulation and time allocation that take into account these pre-existing differences by including child fixed effects. These estimates depend on longitudinal data that measure child outcomes before and after the tsunami.

Estimates with child fixed effects can be given a causal interpretation under the assumption that pre-existing differences between children orphaned by the tsunami and children whose parents survived reflect characteristics that do not change for the child during the study period. Such characteristics might include, for example, parental desire to invest in the human capital of the child, the child's ability, and the ambitions of the parents and the child.

It is possible that children, families, and communities changed because of the tsunami. Parental death occurred in the context of considerable upheaval. On one hand, this period is likely to be a time when children particularly need their parents to navigate the new landscape. On the other hand, the extended family and community may respond to protect orphaned children. We conducted qualitative interviews with young adults who had lost parents seven years after the tsunami. Our interviews revealed cases where sets of siblings who were separated by the death of their parents at the time of the tsunami returned to their original communities to set up households with the help of more distant relatives who were also living in the area. It is important to interpret our estimates as inclusive of such responses by extended family members.

The communities included in this study were selected because they were heavily damaged by the tsunami, as measured by a comparison of satellite imagery before and after the tsunami. It

is possible that children who were orphaned by the tsunami are clustered in communities that suffered more damage than other areas and our results are driven by this heterogeneity. We find that this is not the case.

First, parents died and left orphaned children in over half the heavily damaged communities. In these communities, the proportion of children who were orphaned ranged from 5% to 85%. On average, slightly over one-quarter of children who survived the tsunami were orphaned. The models reported in Tables 3 and 4 have been re-estimated excluding the communities in which no child was orphaned by the tsunami. The estimates for this subset of communities are slightly less precise but none of our conclusions is affected. For example, in specifications using this smaller set of communities, over the longer term, older males who lost both parents have completed 1.9 fewer years of schooling (s.e.=0.5) since the tsunami and those who lost their fathers have completed 1.5 fewer years of schooling (s.e.=0.7) after the tsunami. The comparable estimates in Table 3 are 1.7 and 1.3 fewer years of education, respectively. Older females who lost both parents are 58 percentage points more likely to be married (s.e.=8) in the model with the reduced set of communities which compares with a 62 percentage point difference in Table 3.

Possibly the poorer education outcomes of older orphans are driven by their living in areas where the tsunami reduced access to schools. We find no evidence to support this hypothesis. The STAR community survey measures the damage to buildings, infrastructure and services, including schools, as well as changes in prices, access to markets and employment opportunities after the tsunami. The fraction of orphaned children in a community does not predict whether junior or senior secondary schools were damaged in the community or whether access to such schools worsened after the tsunami.

More generally, in an effort to take into account changes in communities in the aftermath of the tsunami, we have re-estimated the models in Tables 3 and 4 including measures of the extent of damage to the communities that resulted from the tsunami. These controls include indices of the degree of water inundation and visible destruction in the tsunami's aftermath, and a measure of reduced access to senior secondary schools. Adding these controls has no discernible impact on the magnitude or significance of the estimated effects reported above and affects none of our conclusions.

Changes in the children themselves and their extended families resulting from the experience of the tsunami cannot be separately identified from the impact of parental death. This affects the generalizability of our results. We find that the impact of parental death varies with the age and gender of the child and that shorter term impacts are not reliable indicators of the effects that emerge in the longer-term. An older male child who lost his father or both parents in the tsunami has substantially lower levels of education and is more likely to be working than a son whose parents survived the tsunami. It is likely that older females who lost both parents will also have less human capital than those that did not; these females are less likely to be in school or working and much more likely to be married five years after the tsunami. An older female is more likely to be doing housework if her mother, father, or both parents died, suggesting that she substitutes for the parent who died in a complex way. These children will likely carry the costs of parental death through their entire lives.

The impact of parental death on younger children is more muted. Younger males are largely protected from the deleterious impact of the death of either parent. Whereas this may be true for a younger female who lost either her mother or father, those who lost both parents appear to be on trajectories of lower human capital investments that have not fully played out. It is possible that scholarship programs targeting younger children who lost their fathers or both

parents offset negative impacts on enrolment among these children immediately after the tsunami. More generally, the impact of parental death may have been offset by the influx of assistance after the tsunami, which included opening temporary schools and subsequent reconstruction of infrastructure. Children whose parents survived were also able to take advantage of these services and those children serve as the controls in our models.

The literature on HIV/AIDS mortality in Africa indicates that death of a mother typically has significant negative consequences for child education whereas death of a father has negligible and insignificant effects. It has been suggested that this may, in part, reflect the fact that many children do not co-reside with their fathers in Africa. As shown in Table 1, the vast majority of children co-reside with both their mother and their father in Aceh. In contrast with the African literature, we find that death of a father in the tsunami has significant negative consequences for the educational attainment of older sons whereas the impact of maternal death is more muted. The evidence suggests that both the children and the surviving parent substitute for the parent that died. However, the death of both parents has the largest and substantively most important impacts on older males, older females and possibly younger females. These double-orphans are the most vulnerable, at least in the context of the tsunami. This is an important result since no population-based study has examined the impact of the loss of both parents in a longitudinal design that compares children before and after the death of the parents.

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Table 1: Parental death, shorter term and longer-term child outcomes

A. Parental death as a result of the tsunami	
% of children who lost one or both parents	16.8
% of children whose	
mother died	7.9
father died	4.5
mother and father both died	4.4
B. Child outcomes	
B.1 Shorter-term outcomes (at first follow-up interview)	
% of children	
enrolled in school at time of follow-up interview	83.2
received scholarship[a]	19.2
working in market sector in week before interview	9.2
housekeeping in week before interview	35.7
Sample size	709
B.2 Longer-term outcomes (at final follow-up interview)	
Completed years of education	10.2
% of children	
enrolled in school at time of interview	62.1
working in market sector in week before interview	28.2
housekeeping in week before interview	38.5
ever married by time of interview	11.1
Sample size	737

Notes: Sample consists of tsunami survivors who were, at baseline interview age 9 through 17 years and living in a community that was subsequently heavily damaged by the tsunami.
Shorter-term outcomes measured during first post-tsunami interview, about a year after tsunami.
Longer-term outcomes measured in final interview, about 5 years after the tsunami.
[a] Between time of tsunami and first follow-up interview.

Table 2: Child and family characteristics at pre-tsunami baseline
Stratified by survival status of parents

	Both parents survived tsunami [1]	One or both parents died during tsunami [2]	Difference (relative to both parents survived)			
			Any parent died [3]	Mother died [4]	Father died [5]	Both parents died [6]
Age (years)	12.9	13.5	0.6	0.6	0.2	0.8
	[0.1]	[0.2]	[0.3]	[0.4]	[0.5]	[0.4]
Male (%)	54.2	65.5	11.3	8.2	8.2	19.9
	[2.1]	[4.7]	[5.1]	[8.3]	[9.1]	[8.8]
Education (years)	5.3	6.4	1.14	1.1	0.9	1.5
	[0.2]	[0.2]	[0.28]	[0.4]	[0.6]	[0.5]
Enrolled in school (%)	91.4	96.6	5.25	5.0	5.5	5.4
	[1.5]	[1.5]	[2.17]	[2.8]	[3.5]	[3.6]
Working for a wage (%)	4.6	2.8	-1.82	-2.7	3.1	-4.6
	[1.6]	[1.5]	[2.19]	[2.5]	[5.5]	[1.6]
Engaged in housekeeping (%)	8.2	3.8	-4.40	-4.3	-8.2	-1.3
	[1.8]	[2.9]	[3.39]	[4.2]	[1.8]	[5.1]
Mother's education (years)	8.5	8.6	0.10	0.5	-0.8	0.3
	[0.4]	[0.4]	[0.52]	[0.8]	[0.8]	[0.6]
Father's education (years)	9.4	9.0	-0.39	-0.5	-0.9	0.3
	[0.4]	[0.4]	[0.52]	[0.7]	[0.8]	[0.7]
Mother alive at baseline (%)	98.1	99.2	1.02	1.9	-1.3	1.9
	[0.7]	[0.9]	[1.08]	[0.7]	[3.2]	[0.7]
Father alive at baseline (%)	95.4	90.8	-4.68	-0.8	-4.8	-11.6
	[1.0]	[4.0]	[4.03]	[5.3]	[9.0]	[7.3]
Per capita expenditure (Rp10,000 per month)[a]	40.0	41.8	1.84	7.9	-10.1	3.1
	[2.7]	[5.7]	[5.94]	[11.0]	[3.7]	[5.6]
Household size	5.9	5.8	-0.13	0.0	-0.1	-0.5
	[0.2]	[0.2]	[0.22]	[0.3]	[0.4]	[0.3]

Notes: In the first post-tsunami survey, 590 children were interviewed, both of whose parents survived (column 1) and 119 children wee interviewed who lost one or both parents (column 2). Column 3 is the difference between columns 2 and 1. Standard errors (in parentheses) are adjusted for clustering at the community level and take into account heteroskedasticity.. [a]Rp10,000 is approximately equal to US$1.

Table 3: Effects of death of a parent on outcomes for children age 15-17 at baseline
Regression estimates compare post- tsunami outcomes with pre-tsunami outcomes for children who lost one or both parent with those children whose parents survived the tsunami
All models include child fixed effects.

		Older males		Older females	
		Short-term	Long-term	Short-term	Long-term
Child outcome	Status of parent	[1]	[2]	[3]	[4]
% of enrolled in school	Mother died/father alive	-11.6	7.0	-22.2	-0.1
		[18.0]	[15.2]	[17.4]	[21.1]
	Father died/mother alive	-37.7	-24.7	14.5	11.8
		[18.6]	[16.5]	[4.9]	[29.4]
	Both mother and father died	-9.2	-40.2	-15.9	-55.3
		[14.7]	[10.6]	[28.7]	[4.5]
% received scholarship	Mother died/father alive	-13.3		10.2	
		[7.3]		[9.2]	
	Father died/mother alive	0.6		19.3	
		[15.4]		[26.8]	
	Both mother and father died	-21.8		-16.9	
		[4.3]		[4.3]	
Years of education (completed)	Mother died/father alive		-0.9		0.9
			[0.6]		[1.1]
	Father died/mother alive		-1.3		-0.1
			[0.9]		[0.5]
	Both mother and father died		-1.7		0.0
			[0.4]		[0.7]
% working (previous week)	Mother died/father alive	12.8	-10.1	8.1	7.5
		[13.5]	[13.6]	[11.3]	[21.0]
	Father died/mother alive	2.0	3.7	-37.5	-26.3
		[11.7]	[17.8]	[28.0]	[48.1]
	Both mother and father died	27.1	34.2	-5.0	-26.0
		[16.2]	[14.3]	[3.0]	[4.9]
% doing housework (previous week)	Mother died/father alive	15.0	0.8	34.0	15.3
		[21.9]	[7.6]	[12.8]	[3.8]
	Father died/mother alive	18.9	7.8	-39.0	15.5
		[13.6]	[2.8]	[8.5]	[4.0]
	Both mother and father died	-5.5	7.7	53.2	16.0
		[10.8]	[2.8]	[6.5]	[3.8]
% ever married	Mother died/father alive		-0.1		6.7
			[7.7]		[20.5]
	Father died/mother alive		-7.3		-5.1
			[2.9]		[27.3]
	Both mother and father died		-7.2		62.0
			[2.8]		[5.6]
Number of children		181	185	151	159

Notes: Excluded category in each regression is both parents survived the tsunami. Short-term models compare pre-tsunami outcomes with outcomes one year after the tsunami. Long-term models compare pre-tsunami outcomes with outcomes five years after the tsunami. There are two observations for each child. All models control age of child. Standard errors in parentheses take into account clustering at the community level and heteroskedasticity of arbitrary form.

Table 4: Effects of death of a parent on outcomes for children age 9-14 at baseline
Regression estimates comparing post- tsunami outcomes with pre-tsunami outcomes
All models include child fixed effects.

		Younger males		Younger females	
		Short-term	Long-term	Short-term	Long-term
Child outcome	Status of parent	[1]	[2]	[3]	[4]
% of enrolled in school	Mother died/father alive	2.5	-13.0	7.5	9.0
		[2.2]	[13.5]	[3.4]	[8.3]
	Father died/mother alive	2.8	-2.1	-4.1	-26.9
		[2.5]	[22.9]	[11.1]	[21.8]
	Both mother and father died	2.8	-13.6	6.3	-50.8
		[2.5]	[12.4]	[2.8]	[16.7]
% received scholarship	Mother died/father alive	3.2		6.7	
		[8.3]		[14.7]	
	Father died/mother alive	32.0		22.2	
		[19.7]		[13.2]	
	Both mother and father died	32.0		40.0	
		[11.9]		[24.9]	
Years of education (completed)	Mother died/father alive		-0.2		0.4
			[0.3]		[0.5]
	Father died/mother alive		-1.4		1.1
			[1.1]		[0.9]
	Both mother and father died		-0.1		0.1
			[0.7]		[0.4]
% working (previous week)	Mother died/father alive	0.0	2.6	-2.4	-9.9
		[5.4]	[12.3]	[1.6]	[4.8]
	Father died/mother alive	7.1	26.7	8.9	-9.8
		[12.2]	[25.9]	[9.6]	[4.8]
	Both mother and father died	-5.4	22.3	-2.0	23.6
		[2.2]	[16.1]	[1.4]	[21.6]
% doing housework (previous week)	Mother died/father alive	12.6	2.6	-1.1	0.5
		[10.5]	[1.2]	[17.0]	[7.5]
	Father died/mother alive	-12.7	2.3	15.0	7.8
		[3.6]	[1.3]	[21.2]	[2.6]
	Both mother and father died	-21.0	-6.3	-26.5	-8.8
		[9.0]	[9.0]	[30.3]	[16.2]
Number of children		217	223	160	170

Notes: Excluded category in each regression is both parents survived the tsunami. Short-term models compare pre-tsunami outcomes with outcomes one year after the tsunami. Long-term models compare pre-tsunami outcomes with outcomes five years after the tsunami. There are two observations for each child. All models control age of child. Standard errors in parentheses take into account clustering at the community level and heteroskedasticity of arbitrary form.

Appendix Table 1: Attrition - Comparison of characteristics at baseline
Means, differences and [standard errors] of survivors (relative to those who died) and among survivors, those who were interviewed (relative to those not interviewed)

Baseline characteristics	All age eligible children	Died in tsunami	Survived tsunami	Difference (Surv-Died)	Interviewed in first resuvey	Not ivwed in first resurvey	Difference (Ivw-Not ivw)
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Age (years)	13.0	13.0	13.0	0.03	13.0	12.9	0.12
				[0.14]			[0.24]
Male	52.34	46.09	54.95	8.86	56.14	47.90	-8.24
				[4.3]			[5.2]
Education (years)	5.6	5.7	5.5	-0.18	5.5	5.7	-0.20
				[0.25]			[0.41]
Enrolled in school (%)	92.0	93.0	91.7	-1.36	92.5	86.3	6.20
				[1.82]			[4.76]
Working for a wage (%)	4.1	3.1	4.5	1.37	4.3	5.7	-1.39
				[1.72]			[3.44]
Engaged in housekeeping (%)	6.5	3.7	7.7	3.97	7.4	9.5	-2.12
				[1.84]			[3.31]
Per capita expenditure (Rp10,000 per month)[a]	39.7	38.3	40.2	1.93	40.3	39.6	0.78
				[3.84]			[5.15]
Household size	5.9	5.7	5.9	0.21	5.9	6.1	-0.16
				[0.22]			[0.71]
Sample size	1,173	345	828		709	119	

[a]Rp10,000 is approximately equal to US$1