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The impact of maternal death on children's health and education outcomes

by
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1. Introduction

The HIV/AIDS pandemic continues to have a devastating impact, particularly on the lives of sub-Saharan African children. In addition to reversing the downward secular trend in infant and child mortality, HIV/AIDS has orphaned millions of children. Substantial progress has been made in reducing mother-to-child transmission, but rates of orphanhood continue to climb despite increased availability of antiretroviral therapy. UNAIDS estimates that in sub-Saharan Africa in 2014, 11 million children under the age of 18 had lost one or both of their parents to AIDS (UNAIDS 2016).

Recent empirical evidence suggests that children in sub-Saharan Africa who have suffered parental loss are at risk of poorer educational outcomes (Beegle, de Weerdt and Dercon 2006; Bicego, Bicego et al 2003; Case, Paxson and Ableidinger 2004; Evans and Miguel 2007; Guarcello et al. 2004; Monasch and Boerma 2004; Ardington and Leibbrandt 2010; Case and Ardington 2006; Ardington 2009). In South Africa, there are significant differences in the impact of a mother and a father's death. The loss of a child's mother is a strong predictor of poor schooling outcomes, while the loss of a child's father is a significant correlate of poor household socioeconomic status. In two localised longitudinal studies, Case and Ardington (2006) and Ardington and Leibbrandt (2009) use the timing of mothers' deaths relative to children's educational shortfalls to argue that mothers' deaths have a causal effect on children's education. They cannot, however, answer the question of why children whose mothers have died fall behind in school.

More research is needed to understand the multiple potential pathways through which this causal effect of parental death on a child's schooling operates. A growing body of research finds evidence of a strong association between nutritional status and educational outcomes in developing countries (Glewwe and Jacoby 1995; Mendez and Adair 1999; Glewwe, Jacoby and King 2001; Alderman et al. 2001Alderman, Hoddinott and Kinsey 2006; Yamauchi 2008; Ksoll 2007; Glewwe and Miguel 2008). It is possible that parental death impacts negatively on the health and nutritional status of children, thereby reducing their enrollment, attendance and ability to learn at school.

Orphans' health outcomes have received much less attention in the literature than orphans' educational outcomes, in part due to data limitations in developing countries. Beegle, de Weerdt and

Dercon (2010) use a panel study from Tanzania (1991-2004) to show the long term implications of orphanhood. On average, maternal orphans permanently lose close to one year of schooling, and maternal orphanhood is associated with height deficiencies in adolescence. This indicates that orphanhood at an early age has detrimental and lasting effects on health and nutrition. Ainsworth and Semali (2000) use the same panel study and find both mothers' and fathers' deaths to be negatively associated with child height. However, there are insufficient parental deaths between rounds of the survey to precisely estimate child-level fixed effect models.

In this paper we take advantage of nationally representative longitudinal data in South Africa that include four waves of data collection and span a period of seven years, from 2008 to 2015. Building on previous localised longitudinal and nationally representative cross-sectional studies, we investigate the impact of maternal death on the health and educational outcomes of South African children. We first document the association between nutritional and education outcomes in both adulthood and childhood and highlight stark inequalities along these dimensions. We find significant differences in these health and educational outcomes between maternal orphans and non-orphans. Using longitudinal data, we examine the timing of these deficits relative to the loss of the mother. Our evidence suggests that the loss of a mother has a causal impact on children's educational attainment. Our results are remarkably consistent with findings from two localised studies conducted a decade ago. We find no evidence that maternal death results in a decline in children's nutritional status or that a change in nutritional status is a channel through which maternal death affects a child's schooling. While the loss of a mother is correlated with poor nutritional outcomes, this correlation arises before the death of the mother.

The paper proceeds as follows. We first provide a brief introduction to the National Income Dynamics Study (NIDS) panel data and the other nationally representative datasets used in this paper. Section 3 documents the prevalence of maternal orphanhood over time and shows the impact of the provision of ART on rates of orphanhood. Section 4 documents the nutritional status of South African children, and section 5 examines the association between maternal death and both adult and child health and educational outcomes. We turn to investigating the causal impact of maternal death on these child outcomes in section 6. Section 7 concludes.

2. Data

This paper predominantly uses panel data from the South African National Income Dynamics Study (NIDS). To reflect trends over a broader time period, these data are supplemented by information from nationally representative cross-sectional datasets in South Africa: The 1993 Project for Statistics on Living Standards and Development (PSLSD) where approximately 9,000 households were interviewed; The October Household Surveys 1996-1998, (OHS), where between 16 000 and 30 000 households were interviewed; The South African General Household Surveys, 2002-2014 (GHS) which gather information on approximately 25 000 households in each year; and the South African Demographic and Health Survey 2003 (DHS), where 7,750 households were interviewed.

NIDS is a nationally representative panel survey in which 7 296 households (28 226 individuals) were interviewed in the first wave in 2008 (NIDS, 2013). Household and individual level questionnaires were administered for every adult and child in the sample, and measurements of weight and height were taken for all individuals who consented. In addition, a rich array of data was gathered on household living standards, and characteristics of household members such as their income and education. In the following waves, endeavours were made to trace all individuals who were interviewed in wave 1, and where the person had moved to a new household, all new household members were interviewed. Furthermore, all children born to original wave 1 respondents were added to the sample. In wave 2

(2010) 6 787 households with 28 551 individuals were successfully interviewed. Wave 3 (2012) and 4 (2014/5) both saw negative attrition, with 8 040 households (32 633 individuals) successfully interviewed in wave 3 and 11 895 households (42 337 individuals) in wave 4.

3. Rates of Maternal Orphanhood

South Africa continues to suffer a heavy disease and mortality burden due to persistently high rates of HIV and AIDS. Currently, 12.2% of the population are estimated to be HIV positive, with incidence worst concentrated amongst Africans (15% of the African population are HIV positive), amongst women (14.4% of women vs 9.9% of men) and amongst those aged 15-49 (18.8% of 15-49 year olds compared to less than 10% for others) (Shisana, 2014). In 2014, around 1.145 million children aged 0 to 17 are estimated to have lost their mother – this represents one in 12 children (GHS, 2014)[1].

When disaggregated by race, maternal orphanhood rates are worst amongst Africans. African children are currently over seven times more likely to have lost their mother by age 17 than white children (see Figure 1). This gap has been widening over the past decade, with maternal orphanhood rates rising among African children, while stable or falling among the other races. Due to the very low prevalence of maternal orphanhood among Indian and white children, this paper focuses exclusively on African and coloured children and adults[2].

That the likelihood of being a maternal orphan increases linearly with age can be seen in Figure 2 which shows rates of maternal orphanhood by age for African and coloured children aged 0 to 17. Rates are shown separately for seven years between 1993 and 2014. Between 1993 and 2008, the percentage of children who lost their mother increases steadily at every age. Thereafter, rates of maternal orphanhood fall for younger children, while they continue to climb for older cohorts.

September 2008 saw the departure of President Thabo Mbeki from office, and with that the termination of an AIDS policy deemed "wrong, immoral [and] indefensible" by the UN envoy on AIDS at the International AIDS conference in 2006 (Pillay, 2012). Rollout of antiretroviral therapy (ART) was slow, largely due to political delays and prevarication by Mbeki and his health minister Dr Manto Tshabala-Msimang, who promulgated denialism of the link between HIV and AIDS (Bekker, 2014). After the departure of Mbeki in late 2008, things turned around dramatically. In October 2009, President Jacob Zuma made a speech heralded by the Treatment Action Campaign as an historic comment on AIDS, banishing AIDS denialism, and significant changes to SA's ART policy were adopted - increasing coverage and launching national HIV counselling and testing programs (Pillay, 2012). By 2011, South Africa had been brought in line with WHO ART guidelines (Pillay, 2012), such that 1.8 million South Africans were receiving ART (85% of these receiving ART were from the public sector) (Johnson, 2012). Coverage grew from less than 10% in 2004 to an estimated 80% of individuals with a CD4 count less than 200. The majority of patients receiving treatment were women aged 15 and over (61% of those treated in 2011), suggesting that the ART rollout would have a significant effect on maternal orphanhood rates. Ardington et al. (2014) document a shift in the age-profile of mortality in

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[1] As described in the introduction, previous research leads us to focus on maternal orphanhood. We also note that there are substantially higher rates of missing data for father's vital status, and, where data exist, inconsistencies occur at a much higher rate than for mother's vital status. This is not surprising, given that the majority of South Africa children do not co-reside with their fathers.

[2] In addition to the very low rates of maternal orphanhood among Indians and whites, we focus exclusively on African and coloured children as we are concerned about non-random non-response and attrition at both the unit and the item level. Response rates for whites in the first wave are substantially lower than for other population groups and, conditional on participating in the survey, whites are significantly more likely to have missing anthropometric data (Ardington and Case, 2013).

Northern KwaZulu-Natal after ART rollout, specifically a reduction in the excess mortality in early middle age.

Returning to our discussion of Figure 2, the examination of maternal orphanhood by age allows us to follow children of age cohorts across the years. That the increased ART rollout has had a clear impact on the likelihood of maternal orphanhood for younger cohorts is clear. In 2010, children at every age below 6 have lower rates of maternal orphanhood than those of the same age in 2008. Older children still fare worse in 2010 than 2008, as the positive impact of increased ART rollout in 2008 would unfortunately be too late for the children already orphaned by 2008. This explains the persistently high maternal orphanhood rates for children aged 0-17 when comparing 2008 and 2014 data. Maternal orphanhood amongst children aged 0-6 between 2008 and 2014 has, however, fallen sharply from 3.54% in 2008 to 1.7% in 2014 (GHS).

With each year that passes, the graph intersects at a later age – by 2012 children at every age below 11 years have lower maternal orphanhood rates than those of the same age in 2008. By 2014, children below the age of 7 years have lower rates of maternal orphanhood than their same age peers in 2004, and those younger than 2 years face lower rates of maternal orphanhood than the same age group in the late 90s. The positive impact of ART rollout is therefore very clear. Nonetheless, due to the high rates of maternal orphanhood amongst young children in the years leading up to 2008, rates of maternal orphanhood remain stubbornly high for the age cohort of school-going children.

Measures of maternal orphanhood in the GHS are based on a question about the vital status of the biological parents of each household member listed in the household roster. Typically one "knowledgeable" household member answers the questions on behalf of all individuals in the household. NIDS includes a similar question in the household roster but also includes questions about mother's vital status in both the child and the adult questionnaire. We rely on the direct reports from the respondents rather than the household roster data, as this is likely to be more accurate. In wave 4 efforts were made to identify and match all children across waves 1 to 4 on the mother's birth history, by calling households to check the number of children a mother had given birth to, and confirming the mother's mortality status where there were discrepancies in previous waves. Where this information was obtained it was used to update the data from previous waves and correct any discrepancies. Appendix Table A1 presents statistics on the remaining discrepancies between individual questionnaires and the household roster. There are also 69 cases where a child reported that their mother was alive despite having said that they were deceased in a prior wave. A comparison of the maternal orphanhood rates in NIDS and GHS shown in Figure 3, reflect largely the same statistics, although NIDS shows slightly higher rates of orphanhood between 2010 and 2014. Rates of missing data on maternal orphanhood are 4.95%, 12.9%, 3.92% and 2.21% in waves 1, 2, 3 and 4 of NIDS respectively.

Before considering the relationship between maternal orphanhood and children's nutritional and educational outcomes, we briefly examine the nutritional status of South African children and how this interacts with educational attainment.

4. Nutritional outcomes

Child health and nutrition are important not only for their own sake but because the negative consequences of poor health in childhood are felt throughout the life course. There is significant evidence that malnourishment in childhood has negative effects on long-term physical development, development of cognitive skills, human capital attainment, labour market outcomes, and adult health (see Currie (2009) and Strauss and Thomas (2008) for reviews of the empirical evidence linking adult health and labour market outcomes to child health (see Glewwe and Miguel (2008) for a review of the literature on the positive impact of child health on educational outcomes). A growing body of evidence documents that adult height is positively associated with cognitive achievement, educational attainment, earnings, and mortality and that this association is stronger in lower-income countries (Mwabu 2008; Case and Paxson 2008; Strauss and Thomas 1998). Since much of the variation in adult height is due to nutrition in childhood, this work demonstrates links between child nutrition and adult health and economic status. The strong relationship between parental socioeconomic status and child health, and between child health and future socioeconomic outcomes, suggests that poor health in childhood could be an important mechanism in the intergenerational transmission of socioeconomic status (Currie 2009; Mwabu 2008).

There are a number of health measures available in the NIDS data ranging from self-reported health status and health care provider diagnosed conditions, to physical measurements such as height, weight and blood pressure. Self-reports, or primary caregiver reports in the case of young children, of current health status are frequently used as a measure of overall health. This measure is subjective and potentially biased if there are systematic differences in exposure to health care systems and perceptions of ill-health between parents of different socioeconomic backgrounds (Currie 2009; Strauss and Thomas 2008). Diagnosis by a health practitioner (which is considered less subjective than self-diagnosis) suffers from self-selection bias because pro-active, wealthier individuals living near health care facilities are more likely to visit the facility (and potentially be diagnosed) but may not be less healthy than individuals who are unable to visit.

While physical measurements may fail to capture nuanced health details (such as physical or mental symptoms) they do not face the same issues of subjectivity and self-selection described above. The height of an individual depends on genetic potential, but also on the socioeconomic and epidemiological circumstances faced from conception until early adulthood (Steckel 1995, Komlos and Cuff, 1998, McEvoy and Visscher 2009, Deaton 2007, Case and Paxson 2008, Strauss and Thomas 2008). Much of the variation in adult height is due to nutrition and disease in the vulnerable first three years of life, after which growth trajectories tend to proceed in parallel. Children's height is considered a good indicator of underlying health, as it reflects cumulative linear growth, and deficiencies show the effects of past or chronic inadequacies in nutrition or exposure to disease. Weight is determined by the combined effects of energy intake (food) and energy output (physical activity) (Strauss and Thomas 2008). Weight is considered a more contemporaneous measure of general health, reflecting short term deficiencies in nutritional intake. BMI is a relative height to weight measure that is an indicator of body fatness. While it is not a direct measure (such as skin-fold thickness or bioelectrical impedance), it has been shown to be correlated with direct measurements and is a useful screening tool to assess whether a child is underweight, overweight, or obese (Dietz, 1999).

The height and weight of South African children can be compared against the World Health Organisation's (WHO) international child growth standards (de Onis, 2003). Standardized z-scores for height-for-age, weight-for-age, weight-for-height, and BMI-for-age are used to create indicators for various measures of malnutrition. Children are considered stunted if their height-for-age z-score is two or more standard deviations below the median child from the international "healthy" reference population. Similarly, children are considered underweight if their weight-for-age or BMI-for-age z-score is less than -2. A height-for-age z-score of three or more standard deviations below the median is classified as severe stunting. A BMI-for-age z-score of between 1 and 2 is considered overweight and children with scores of 2 or more standard deviations above the median are considered obese. Stunting is often regarded as an indicator of "chronic" malnutrition, in the sense that it represents the "accumulated consequences of retarded growth" (WHO Working Group 1986:931) and while catch up in height is possible, it takes a relatively long time.

NIDS aims to measure the height and weight of all individuals aged six months and older. In the case of children under the age of six, the consent of the primary care-giver is required. Children aged six and older are asked if they agree to having their physical measurements taken. Around 7% of African and coloured children under the age of 18 are missing data on either height or weight in wave 4, either because they refused to be measured, or the recorded measure was outside the WHO range of biologically plausible values for their age. This is a vast improvement from wave 1, where 27% of African and coloured children were missing anthropometric measures.

Figure 4 shows the kernel densities for height-for-age and BMI-for-age z-scores for African and coloured children aged 6 months to 17 years at wave 4 (2014/2015)[3]. The figure also shows the distribution of z-scores for the international reference population of healthy children (normal distribution with a mean of 0 and standard deviation of 1). Children's weights, as reflected in their BMI-for-age z-scores, are roughly in line with what would be expected for a healthy population, with less than 5% of children being classified as underweight. In sharp contrast, the median height of African and coloured children is around one standard deviation below the international norm and 12.9% of these children are considered stunted.

Figure 5 shows the age profile of height-for-age z-scores for African and coloured children aged 6 months to 17 in 2014/15. A distinct age profile is apparent, with height-for-age changing substantially with age. Height-for-age is adjusted for age in the sense that a child's height is compared to children in the international reference population of the same age. Despite this, height-for-age is strongly determined by age in developing countries and the age-profile in Figure 5 is similar to that observed in other less developed countries (Cummins 2013). This highlights the importance of adequately controlling for age when investigating the relationship between nutritional indicators and education and orphanhood, both of which are also strongly determined by age. In the analyses that follow, we will take care to either focus on children within a specific age cohort or to control for the confounding effects of age.

A comparison of nutritional status in waves 1 and 4 suggests that there have been improvements in all indicators of malnutrition. Table 1 shows that African and coloured children between the ages of 6 months and 17 years are taller on average (height-for-age z-scores have increased from an average of -0.952 in 2008 to -0.809 in 2014/5) and that the prevalence of stunting has fallen from 17% of children in 2008 to 13% in 2014/5. The prevalence of underweight children also fell over this period, but less dramatically (from 5.6% of children in 2008 to 3.5% in 2014/5).

These results should, however, be interpreted with caution due to the high rates of missing anthropometric data in wave 1 and possible selective attrition between the waves. Post-stratification weights should deal with the latter issue but as they only adjust for unit and not item non-response, they will not correct for any bias due to missing data in wave 1. In results estimated but not shown, we observe that children who attrit between waves, on average are taller in wave 1 than children that remain in the sample. Of the children who are present in both wave 1 and 4, those that have missing anthropometric data in wave 1 tend to be taller in wave 4 than children measured in both waves. This is not surprising as anthropometric measures in wave 1 were least likely to be missing for Africans, children living in rural areas and older children. Children in the richest income quintile were significantly less likely to have valid measurements than poorer children in wave 1. Estimates of malnutrition from wave 1 are therefore likely biased upwards and improvements in indicators of malnutrition between waves may just be an artefact of item missing data in wave 1.

[3] We do not examine weight-for-age and weight-for-height in this paper as the international reference population is only defined for children up to the age of 10 and 5 respectively.

Nutrition and educational outcomes

An extensive amount of research has documented the positive relationship between adult height and wellbeing. On average, taller individuals tend to earn more (Steckel 1995, Strauss and Thomas 1998, Persico et al. 2004, Case and Paxson 2008, among many), live longer and healthier lives (Waaler 1984), reach higher levels of education (Case et al. 2009, Cinnirella et al. 2011) and report higher levels of satisfaction in their lives (Deaton and Arora, 2009). Recent research also indicates that nutritional status is strongly associated with educational outcomes in children. Children who are stunted are less likely to enrol in school on time (or at all), less likely to make satisfactory grade progress, and more likely to have lower test scores, and, in some countries, have lower educational attainment (Glewwe and Jacoby 1995; Mendez and Adair 1999; Glewwe, Jacoby and King 2001; Alderman et al. 2001; Alderman, Hoddinott and Kinsey 2006; Yamauchi 2008; Monk 2011; Ksoll 2007). These results are robust to controls for household environment, income, and parent characteristics.

As documented for many other countries, we find an association between individual height and education for both children and adults. Figure 6 shows the years of completed education or grades passed for children who are in their final year of compulsory schooling at 14 years of age. Children who started school on time and progressed a grade each year should have completed at least eight grades (including Grade R/0) by age 14. Nearly a third of African and coloured children have completed seven or fewer grades due to a combination of delayed enrolment and grade repetition. One in seven children are two or more grades behind the appropriate level for their age. Table 2 shows the mean number of grades completed by height-for-age categories. There is a clear positive association between height and educational attainment, with severely stunted children having completed on average 1.5 fewer grades than children with height-for-age z-scores above zero. It is not just the children classified as stunted who perform worse than their peers. The gradient in educational attainment is apparent across the full distribution of heights. Children with height-for-age z-scores between -2 and -1 are significantly behind children with positive height-for-age z-scores. We take this into account in the analyses that follow, by using both the indicator of stunting and the continuous height-for-age z-scores.

Figure 7 shows the positive relationship between education levels and heights among African and coloured men and women between 25 and 50 years of age[4] . For each category of education we show the difference between the average height for that education level and the gender mean. Men and women with 7 or fewer years of education are shorter than average. Among men, the group with no education is on average 2.59cm shorter than the mean male height in our sample. The corresponding difference among women is 2.23cm. On the other end, men and women who have continued onto post-secondary studies are on average 1.63cm and 1.23cm taller than the corresponding gender average. In results estimated but not shown, we find that that, on average, tall people are more likely to identify themselves as healthy and have higher earnings than their shorter peers.

The next two sections turn to examine our key research question: the relationship between maternal orphanhood and nutritional and educational outcomes.

5. Maternal orphanhood and adult and child health and educational outcomes

The nature of the NIDS data allowed us to identify adults who lost their mother prior to the age of 15, and therefore to compare adult outcomes for those maternally orphaned in childhood with their non-orphaned peers. In addition to questions about mother's current vital status, NIDS respondents who reported that their mother was deceased were asked for her date of death. If the date of death was

[4] An examination of the height data suggest that, by age 25, maximum adult height has been reached.

unknown, adult respondents were asked whether they were younger than 15 years of age when their mother died. Together, these questions allow for the construction of an indicator that an individual became a maternal orphan before the age of 15.

In Table 3, we explore the association between losing one's mother before the age of 15 on a range of outcomes for African and coloured individuals who were aged 25 to 50 in 2014/15[5]. The asterisks in column three indicate whether differences in the means between maternal orphans and non-orphans are statistically significant with *** indicating significance at the 1% level, ** at the 5% level and ** at the 10% level. Adults who became maternal orphans before the age of 15 have, on average, 0.6 years less education and are around 10 percentage points less likely to have matric (Grade 12) than other adults. They are 4 percentage points less likely to be employed, although this difference is only significant at the 10% level. Adults who lost their mother before age 15 are, on average, about 1cm shorter than other adults, have lower BMIs, and are less likely to be obese. Adults orphaned prior to 15 are not statistically different to other adults on a range of other health measures.

An examination of African and coloured children aged 5 to 14 years of age reveals that maternal orphans are over a year older on average (Table 4). This is as expected but again highlights the importance of controlling for age when we examine both educational and nutrition outcomes. Maternal orphans have completed more years of education but only because they are older. Once we account for differences in the ages of maternal orphans and other children in the regressions that follow, we find that orphans are significantly behind children of the same age with regard to educational outcomes. Children who have lost their mother are shorter for their age than other children, and are five percentage points more likely to be stunted than non-orphans. They also weigh less than their non-orphan counterparts – with markedly lower BMI z-scores and lower rates of obesity and overweight. Maternal orphans report significantly worse overall health. In the next section, we will investigate the extent to which these deficits can be explained by socioeconomic status and we will examine whether maternal orphans were disadvantaged even prior to their mother's death, or whether the death resulted in declining nutritional and educational outcomes.

6. The causal effect of maternal death on children's educational and health outcomes

An association between maternal death and a child's health and educational outcomes may not represent a causal relationship, but rather unobserved factors that are correlated with both maternal mortality and poor child outcomes. Such factors could include poor genetics and health related behaviours, that both increase the likelihood of the mother's mortality and negatively affect the child's health (Case, Lubotsky and Paxson 2002; Currie 2009). The socioeconomic gradient in AIDS deaths suggests that children who later become orphans may come from households that were systematically poorer prior to their mother's death than children whose mother remains alive (Ardington et al. 2014). This may lead to correlations between maternal death, household poverty, and child health and educational outcomes.

Longitudinal data in which one observes children at multiple time points, before and after a parental death, allow one to evaluate various explanations for children's outcomes after a parent's death. One can be more persuasive in arguing for a causal interpretation of the effect of parental death on children's schooling and health outcomes, by comparing within child changes of those that transition into orphanhood with those that remain non-orphans. In addition to the estimation of individual fixed

[5] We are unable to classify maternal orphan status at age 15 for 16.77% of African and coloured adults aged 25 to 50 in 2014/15.

effects models, such data allow one to control for baseline household and individual characteristics and to examine the impact of a mother's future death on baseline indicators.

We begin by examining the relationship between concurrent maternal orphan status and education and health outcomes, and assessing the impact of introducing controls for baseline outcomes and household socioeconomic status. We then investigate whether the association between maternal death and children's outcomes may be spurious, by examining the baseline outcomes of children who enter the sample as non-orphans, but subsequently lose their mother. If the mother's death is simply a signal that the child had always been at risk for poorer outcomes, even if their mother did not die, then we would expect mother's future death to predict poor outcomes for the child at baseline. This approach allows us to quantify possible individual selection into experiencing maternal death. We, finally, use within child changes between waves to compare children's endline outcomes with their own earlier outcomes when all their mothers were alive. By applying this methodology, we take into account selection issues, as the identification of effects is based solely on within-child changes. These individual fixed effect models allow one to control for all time invariant unobserved characteristics, but measurement error in the observed explanatory variables can result in serious attenuation bias.

Longitudinal dataset

Using all four waves of data, we construct a panel dataset with "baseline" and "endline" observations on mother's vital status and education and health outcomes for African and coloured children. The sample is restricted to children whose mother is alive at baseline. Baseline observations are taken from the first wave in which the child is aged 5 or older and has valid information on mother's vital status[6] and years of completed education. Endline observations are taken from the last wave with non-missing information in which the child is aged 14 or younger. We select children between the ages of 5 and 14, as South African children should enrol in Grade R at age 5 and 14 is the last year of compulsory schooling. Table 5 shows the composition of the sample by baseline and endline wave. Just over half (52%) of the baseline observations are taken from wave 1 and the majority (64%) of endline observations are taken from wave 4. The sample includes 7115 children, 337 (4.74%) of whom become maternal orphans by endline. The average age at baseline is 7.87 years and the average age at endline is 11.96 years[7].

In order to work out rates of attrition for this constructed panel sample, individuals are identified as having the potential to be in our sample if they have baseline observations and would have still been under the age of 15 on the last day of fieldwork for the wave following their baseline. Of these individuals, we have endline observations for 85%. Appendix Table A2 shows how the attritors compare to those in our panel on a range of baseline characteristics. Attritors are less likely to be African and are slightly older than those in the panel. They have higher educational attainment but the difference is not significant once age is accounted for. They are not more likely to be stunted, but are heavier than those in the panel with lower rates of underweight and higher rates of overweight. They appear to be from households with higher socioeconomic status – they are more likely to live in an urban area, with more highly educated mothers and live in households with a greater number of assets (items such as TVs, radios, and electrical stoves).

Regression analysis

Table 6 summarises baseline characteristics of children in the panel sample by their maternal orphan status at endline. At baseline, on most of the dimensions, children who will become maternal orphans are not systematically different to children whose mothers remain alive. They are, however, significantly more likely to be African (91% versus 86%), have lower household assets, and are more

[6] We exclude the handful of children whose mothers resurrect in wave 2 or 3.
[7] Age is measured in months and expressed in units of years.

likely to be missing information on their mother's years of completed education. In the regressions that follow we will include an indicator that mother's education is missing, and set her education to zero in order to avoid any possible selection issues related to missing information on this variable.

We begin to explore the relationship between maternal orphanhood and educational attainment in Table 7. The first three columns present results from OLS regressions of years of completed education at endline on an indicator that the mother is deceased at endline. The first column includes a quadratic in age, an indicator that the child is female, an indicator that the child is African and indicators for baseline and endline survey wave. Maternal orphans are on average 0.25 years behind other children of the same age at school. In the second column years of completed education at baseline is added to the regression as a control. Adding baseline education attainment reduces the maternal orphan coefficient but it is still substantive and statistically significant at -0.19. In column three, controls for household socioeconomic status are included in the regression. These controls include household size, number of household assets, household per capita income quintile, urban location, province, and mother's years of completed education. Introducing these household controls further reduces the coefficient on maternal orphanhood, but it is still statistically significant. Controlling for baseline attainment and household socioeconomic status, orphans are on average 0.14 years behind other children of the same age.

A sizeable part of the educational deficit that we observe for maternal orphans at baseline can be explained by educational attainment and socioeconomic characteristics measured at a time when the child's mother was still alive. This suggests that maternal orphans tend to come from worse educational and socioeconomic backgrounds than their non-orphaned peers. Nevertheless, the coefficient on the maternal orphan indicator is still substantial and significant when we control for this background. If maternal orphanhood is merely a signal that a child was from a poorer background with worse educational outcomes, then we would expect future maternal death to predict poor educational attainment for the child. We test this in column four by regressing years of completed education at baseline, when all children's mothers were alive, on the indicator that the mother is deceased at endline. The coefficient on maternal orphanhood at endline is negative but it is small and statistically insignificant. This supports the interpretation that future maternal orphans are not systematically different to other children at baseline and that, at least part of the maternal orphan deficit that we see at endline is a consequence of the loss of the mother between waves. We test this further in the final column using an individual fixed effects model. Given that we have two observations per child, we employ a first differencing model and regress the change in the years of completed education on the change in the mother's vital status and the change in age (or time between baseline and endline). This first differenced model controls for all time-invariant individual (and therefore household) characteristics. The fixed effect coefficient is highly statistically significant and is similar in magnitude to the coefficient from the regression in column three that included controls for baseline educational attainment and household characteristics.

In summary, we observe large educational deficits for maternal orphans that are only partly explained by earlier educational attainment and household socioeconomic status. Children whose mothers are going to die in the future are not significantly behind other children when we first observe them, and the death of a mother between waves is associated with a 0.16 year lower advancement in grades between those waves. These nationally representative results are remarkably consistent with previous research based on data collected in rural KwaZulu-Natal a decade earlier (Case and Ardington, 2006).

Our findings suggest that the death of a mother has a causal impact on children's schooling. We have also documented a strong positive relationship between nutritional status and educational outcomes. It is possible that a decline in health or nutritional status is one of the multiple channels through which maternal death affects schooling. We can investigate this by adding measures of nutritional status as explanatory variables in regressions similar to those in Table 7. If the effect of maternal loss on schooling operates in part through changes in child's nutritional status, we would expect the coefficient on maternal death to be smaller in regressions that control for nutritional status than those that do not.

The first column in Table 8 replicates column one of Table 7 for a sample that is restricted to children who have valid anthropometric data at both baseline and endline. We run this regression so that we can examine the impact of including controls for nutritional status on the mother deceased coefficient. Results are similar to those in Table 7, although the coefficient on maternal death is smaller in absolute magnitude. In the second column of Table 8 we add controls for baseline height-for-age z-scores and BMI-for-age z-scores. Children who are taller at baseline have higher educational attainment than shorter children of the same age and sex. Similarly, BMI is positively associated with years of education. In the third column we add controls for endline height-for-age and BMI-for-age. These contemporaneous measures of nutritional status have an even stronger relationship with educational attainment. Column four includes controls for both baseline and endline nutritional status and column five controls for changes in nutritional status between baseline and endline. Height at endline is more strongly associated with educational attainment than height at baseline, although the baseline coefficient is still significant. Once BMI at endline is taken into account, there does not appear to be a relationship between BMI at baseline and educational attainment. This possibly reflects the more "chronic" nature of measures of height and the more short term nature of measures of weight. Changes in height and BMI between waves are also positively associated with educational attainment.

The results in columns two to five show that controlling for nutritional status at baseline and/or endline has very little impact on the coefficient for mother deceased. Including controls for household socioeconomic status in column six has a substantial impact on the mother deceased coefficient but little impact on the coefficients for the nutritional outcomes.[8] To the extent that nutritional outcomes are correlated with current and longer-term socioeconomic status, they appear to capture different dimensions of socioeconomic status to the set of household controls included in the regressions.

In column seven we replace height-for-age and BMI-for-age with indicators that the child is classified as stunted and underweight. Children who are stunted at either baseline or endline are significantly behind in schooling compared with other children of the same age, with stronger effects for endline. Children who are stunted at both baseline and endline have the largest educational deficits – they are, on average, 0.446 years behind other children of the same age. Children who are underweight at endline are also significantly behind other children. As with the z-scores, including these indicators of malnutrition has no impact on the mother deceased coefficient.

In the final column of Table 8, we examine whether the impact of maternal death on children's educational attainment differs by their nutritional status at baseline. We include an interaction term between mother deceased and stunting at baseline. The interaction term is not statistically significant but the point estimates suggest lower educational attainment for future maternal orphans who were stunted at baseline compared to taller children who lose their mother between waves.

We next turn our attention to nutritional status as an outcome and examine whether there is a decline in the nutritional status of children following the death of their mother. Table 9 presents results from OLS regressions of endline height-for-age z-scores and BMI-for-age z-scores on the indicator that the child is a maternal orphan at endline. Although the point estimate is negative, maternal orphans do not have significantly lower height-for-age z-scores than children whose mother is still alive. In the

[8] Findings are similar when we introduce baseline household controls for any of the regressions in columns two, three or five.

second column, however we see that maternal orphans have BMI-for-age z-scores that are significantly lower than non-orphans. Controlling for baseline BMI-for-age scores has little impact on this deficit (column three). The deficit is however no longer significant once household controls are introduced into the regression suggesting that the lower BMI of maternal orphans can be explained by poorer socioeconomic conditions at baseline (column four). Although point estimates are negative, future orphans do not have significantly lower BMI at baseline, nor do we see a significant reduction in their BMI-for-age when their mother dies.

Our evidence does not support the hypothesis that a decline in nutritional status is a mechanism through which maternal death affects schooling. In all our specifications, the inclusion of measures of nutritional status have very little impact on the coefficient for the indicator that the mother is deceased at endline. While measurement error is a concern, particularly with the anthropometric data, instrumental variable estimates that attempt to deal with this problem yield stronger relationships between height and educational attainment but still show no impact on the association between maternal death and schooling. When we examine nutrition as an outcome, we find no evidence that the loss of a mother is associated with declines in nutritional status. It is possible that the periods that we examine are either too short to pick up changes in chronic malnutrition or too long to pick up acute changes. Much of adult stature is determined in the years prior to entering school and it is possible that we are examining a sample where we are unlikely to observe an impact of maternal death on either height or weight. We therefore next examine whether nutritional deficits are present in a younger sample.

Table 10 presents results from regressions that estimate the association between maternal orphanhood and nutritional outcomes for a younger sample. The sample is constructed in the same way as the older sample except that children are aged six months or older at baseline and seven years or younger at endline and we restrict the sample to observations with valid mother's vital status and anthropometric measures. The sample is further restricted to children whose mother is alive at baseline. Our young panel sample comprises 4512 children, 141 (3.13%) of whom become maternal orphans between baseline and endline.[9] The regressions in Table 10 are analogous to those in Table 7 and include the same individual and household level controls. Starting with height-for-age, we see that, at endline, maternal orphans have z-scores that are 0.241 standard deviations lower than non-orphans of the same age and sex. The coefficient on mother being deceased drops substantially when controls for baseline height-for-age are included in the regression. Including household controls further reduces the coefficient and it is no longer statistically significant. In column four we regress baseline height-for-age on future maternal death. Children who will become maternal orphans are 0.242 standard deviations shorter than other children at baseline when their mothers are still alive. Individual fixed effect estimates show no declines in height-for-age z-scores on the death of a mother between waves. The deficits in stature that we see for maternal orphans at endline are therefore largely driven by the fact that children with poor nutritional outcomes are at higher risk of experiencing maternal death, rather than the death resulting in declining nutritional status. Turning to BMI-for-age, we see similar results with future maternal orphans having lower BMIs when their mother is still alive. While maternal orphans are significantly shorter and lighter than other children at endline, they are also significantly shorter and lighter at baseline before their mothers have died. In terms of nutrition, poor outcomes for orphans appear to be driven by selection rather than mothers' deaths having a negative impact on the children's height and weight.

[9] Our sample choice was a trade-off between wanting to observe children at younger ages and the need for sufficient maternal deaths between baseline and endline.

7. Conclusion

In spite of the positive impact of increased ART rollout on mortality in South Africa since 2008, maternal orphanhood remains stubbornly high amongst African and coloured children, particularly amongst the school-going age cohort. The implications of this are worrying, given the long-term implications of losing one's mother. African and coloured adults who lost their mother prior to age 15 on average attained fewer years of education, earn less on average, and report worse health. Leveraging the longitudinal nature of the 7 year NIDS panel, we identify a causal effect of losing one's mother on a child's educational outcomes.

A simple comparison of maternal orphans with their non-orphan peers of the same age, race and gender suggests that orphans are 0.25 years behind in school. Although this deficit falls to 0.14 years after controlling for socioeconomic status and initial schooling level, maternal orphanhood remains an important determinant of education. Notably, these are children that are largely similar to start off with, when both groups are non-orphans and the future loss of one's mother is not a significant determinant of one's initial education. Our results are confirmed by the fixed effect model, comparing within child changes over the panel.

Cognisant of the strong relationship between nutritional status (reflected in a child's height or BMI) and education, we explore the extent to which maternal orphanhood operates through poor nutrition but do not find evidence to support the hypothesis that weakening health is one of the channels through which losing one's mother operates. In addition, maternal orphanhood does not appear to have the same causal effect on early childhood health (for children aged 6 months to 7 years) as it does on education. Although maternal orphans are both shorter and have lower BMI for their age than non-orphans they are worse off health-wise even prior to the loss of their mother.

With additional waves of data, we will be able to more carefully trace out the timing of orphans falling behind in school and disentangle whether nutritional deficits in younger children are merely selection or could be an indicator that the mother (and possibly child) are ill prior to her death.

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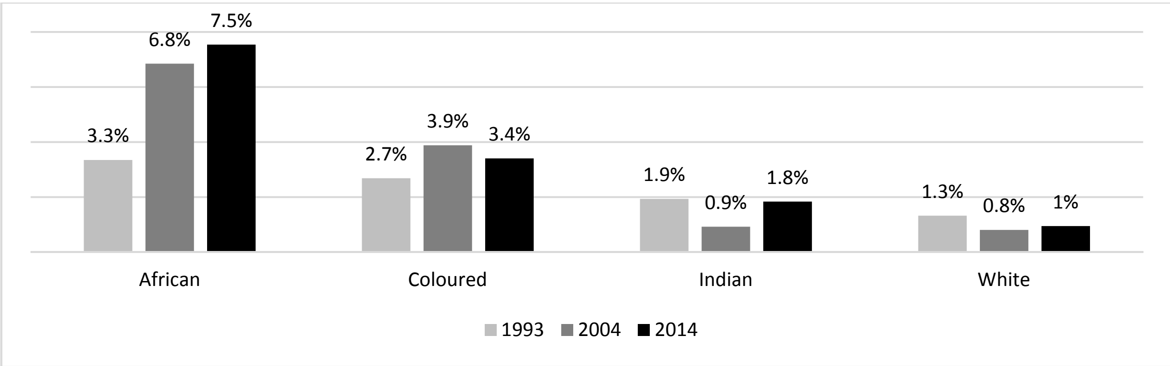
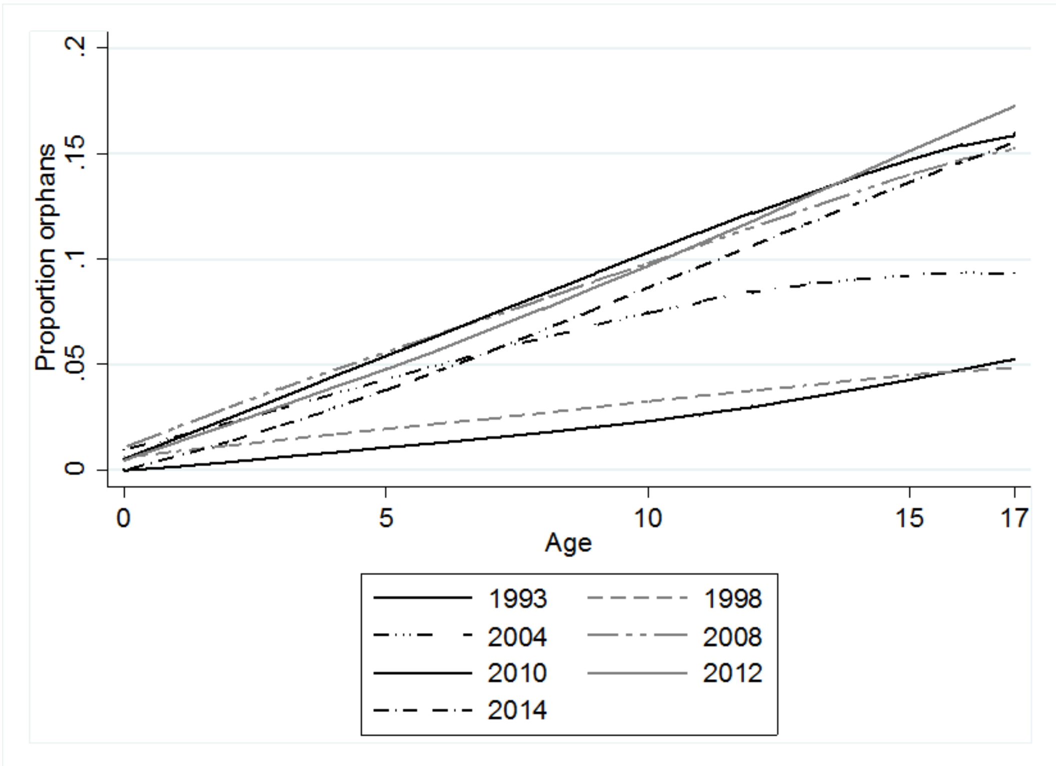
Figure 1: Rates of maternal orphanhood by race, 1993 - 2014



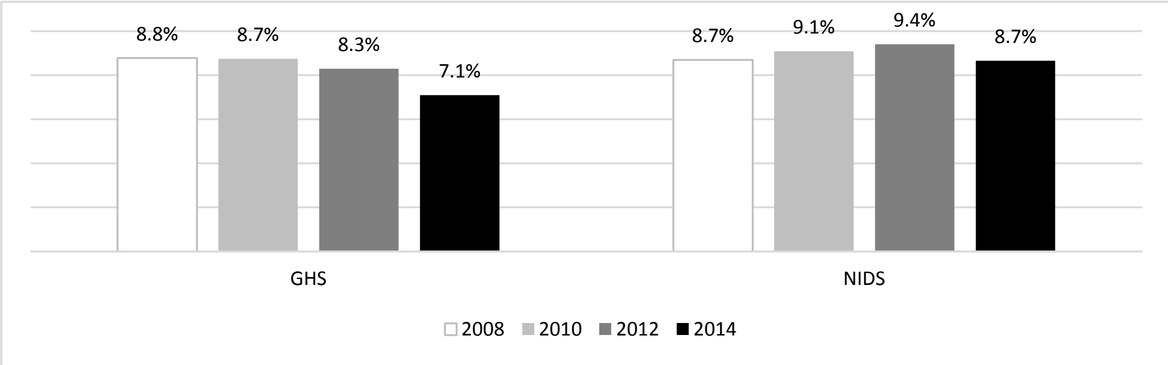
Notes: Data: PSLSD, 1993, GHS 2004 & 2014; All children aged 0-17 years. Results are weighted to be nationally representative.

Figure 2: Rates of orphanhood by age, 1993-2014



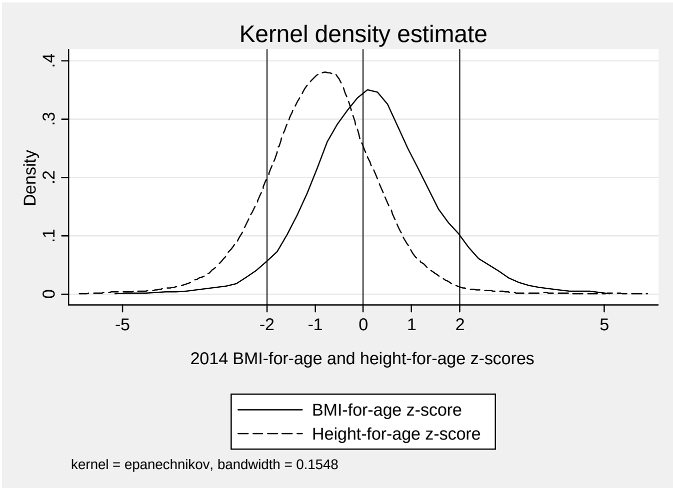
Notes: Data: PSLSD 1993, OHS 1998 GHS 2004-2014; African and coloured children aged 0-17 years. Results are weighted to be nationally representative.

Figure 3: Comparing NIDS and GHS rates of maternal orphanhood, South Africa



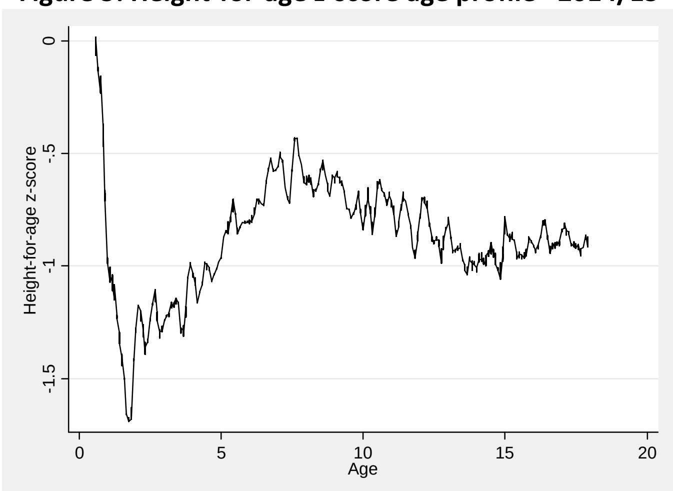
Notes: Data: GHS, 2008-2014; NIDS 2008, -2014/15; African and coloured children aged 0-17 years. Results are weighted to be nationally representative. Post stratification weights used in NIDS.

Figure 4: 2014/5 distribution of children's BMI and HFA z-scores



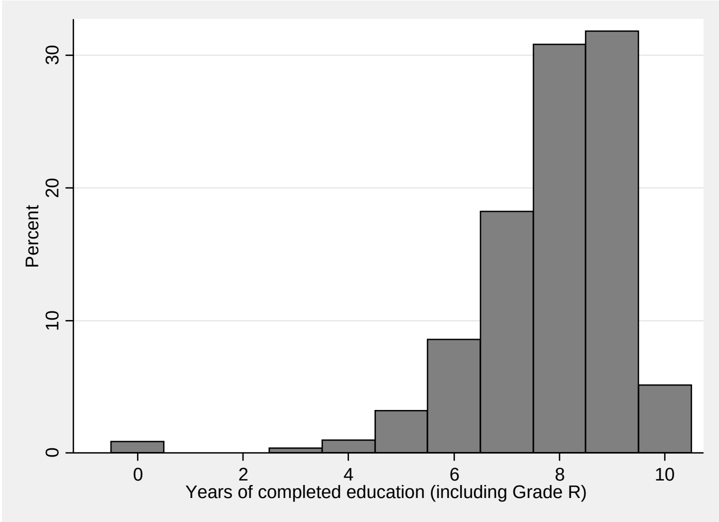
Notes: Data: NIDS, 2014/5; African and coloured children aged 6 months to 17 years.

Figure 5: Height-for-age z-score age profile –2014/15



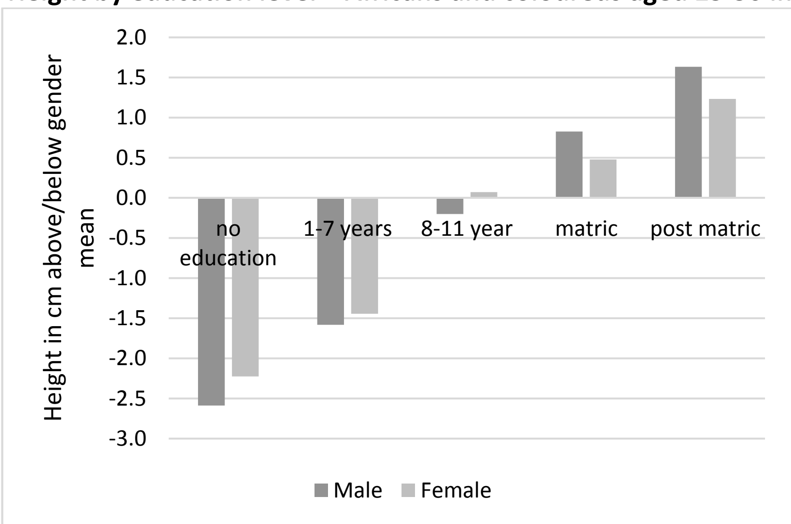
Notes: Data: NIDS, 2008 & 2014/5; African and coloured children aged 6 months to 17 years

Figure 6: 2014/5 years of completed education at 14 years of age



Notes: Data: NIDS, 2014/5; African and coloured children aged 14 years old

Figure 7: Height by education level – Africans and coloureds aged 25-50 in 2014/15



Notes: Data: NIDS, 2014/5; African and coloured adults aged 25 to 50 years old

Table 1: Changes in indicators for malnutrition, 2008 – 2014/2015

	2008	**2014/2015**
Height-for-age		
z-score	-0.952	-0.809
Severely stunted	0.055	0.027
Stunted	0.115	0.102
z-score between -2 and -1	0.315	0.302
z-score between -1 and 0	0.318	0.348
z-score above 0	0.197	0.222
BMI-for-age		
z-score	0.147	0.229
Underweight	0.056	0.035
Healthy weight	0.705	0.718
Overweight	0.146	0.163
Obese	0.070	0.064
Morbidly obese	0.022	0.021
Observations	8081	14145

Notes: Data: NIDS, 2008 & 2014/5; African and coloured children aged 6 months to 17 years. Post stratification weights used.

Table 2: Years of completed education at age 14 by height-for-age categories–2014/2015

	Average years of completed education	**Observations**
Height-for-age z-score category:		
Severely stunted (less than -3)	6.57	21
Stunted (-3 to -2)	7.34	104
-2 to -1	7.92	250
-1 to 0	8.02	277
Greater than 0	8.09	139
Total	7.87	791

Notes: Data: NIDS 2014/5; African and coloured children aged 14 years.

Table 1: 2014/2015 comparison of adults who were orphaned before 15 years old and those whose mother is alive or died after 15 years

	Mother died before individual was aged 15	Non-orphan or mother died when individual was aged 15 or older	Level of significance for test of difference in means	Observations
Age	34.40	35.68	***	9149
Years of education (including Grade R)	10.43	11.04	***	9149
Matriculated (at least Grade 12)	0.27	0.36	***	9149
Employed	0.54	0.58	*	9142
Household assets	7.17	7.66	***	9146
Height	1.62	1.63	**	9061
Weight	69.89	73.12	***	9042
BMI	26.59	27.51	***	8782
Underweight	0.05	0.05		8782
Overweight	0.232	0.238		8782
Obese	0.274	0.325	**	8782
Self-reported health status	2.181	2.124		9144
Reports poor or fair health	0.096	0.078		9144
CESD 10 (depression scale)	6.839	6.732		9148
Any chronic conditions	0.177	0.167		9149
Moderate to severe hypertension	0.189	0.175		9063

Notes: Data: NIDS, 2014/5. African and coloured adults, aged 25-50 years. Standard errors for tests of differences in means allow for correlation in the unobservables between individuals from the same wave 1 sampling cluster (*** p<0.01, ** p<0.05, * p<0.1).

Table 2: 2014/2015 comparison between maternal orphans and children whose mother is alive

	Maternal orphan	Mother alive	Level of significance for test of difference in means	Observations
Age	10.88	9.66	***	8443
Years of education (including Grade R)	4.63	3.72	***	8432
Height-for-age z-score	-0.931	-0.739	***	8277
BMI-for-age z-score	-0.177	0.028	***	8259
Stunted	0.158	0.107	***	8277
Underweight	0.042	0.039		8259
Overweight	0.137	0.179	***	8259
Obese	0.024	0.053	***	8259
Self-reported health status	1.811	1.724	**	8433

Notes: Data: NIDS, 2014/5. African and coloured children aged 5-14 years. Standard errors for tests of differences in means allow for correlation in the unobservables between children from the same wave 1 sampling cluster (*** p<0.01, ** p<0.05, * p<0.1).

Table 5: Distribution of sample by baseline and endline survey wave

	Endline:			
	Wave 2	Wave 3	Wave 4	Total
Baseline:				
Wave 1	13.34	18.07	20.72	52.13
Wave 2		4.76	21.15	25.92
Wave 3			21.95	21.95
Total	13.34	22.84	63.82	100

Table 6: Baseline characteristics of children whose mother is alive at baseline by maternal orphan status at endline

	Maternal orphan at endline	Mother alive at endline	Level of significance
Female	0.493	0.496	
African	0.914	0.861	***
Age	7.87	7.84	
Years of education (including Grade R)	2.036	2.085	
Height-for-age z-score	-0.960	-0.856	
BMI-for-age z-score	0.057	0.137	
Weight-for-age z-score	-0.523	-0.375	
Underweight	0.072	0.056	
Overweight	0.211	0.222	
Obese	0.072	0.095	
Stunted	0.175	0.157	
Mother's years of education	8.386	8.721	
Mother's years of education missing	0.178	0.073	***
Household assets	5.694	6.272	***
Urban	0.380	0.399	
Household size	7.000	6.691	
Observations	337	6778	

Notes: African and coloured children who were seen at least twice between the ages of 5 and 14. Mother alive at baseline. Standard errors for tests of differences in means allow for correlation in the unobservables between children from the same wave 1 sampling cluster (*** p<0.01, ** p<0.05, * p<0.1).

Table 7: Education and maternal orphanhood

	I	II	III	IV	V
	Years of completed education at endline	Years of completed education at endline	Years of completed education at endline	Years of completed education at baseline	Change in years of completed education
Mother deceased (endline)	-0.267***	-0.195***	-0.158***	-0.074	-0.162***
	(0.062)	(0.052)	(0.051)	(0.052)	(0.053)
Age in years (endline)	0.953***	1.023***	1.000***		
	(0.076)	(0.063)	(0.060)		
Age squared (endline)	-0.004	-0.029***	-0.027***		
	(0.003)	(0.003)	(0.003)		
Female	0.379***	0.249***	0.254***	0.166***	
	(0.028)	(0.023)	(0.023)	(0.021)	
African	0.114**	0.033	0.001	0.062	
	(0.058)	(0.047)	(0.062)	(0.038)	
Years of education (baseline)		0.819***	0.799***		
		(0.021)	(0.021)		
Mother's education (baseline)			0.029***		
			(0.004)		
Household assets			0.028***		
			(0.005)		
Urban			-0.104**		
			(0.047)		
Household size			0.001		
			(0.004)		
Per capita income quintile 2			0.007		
			(0.032)		
Per capita income quintile 3			-0.017		
			(0.033)		
Per capita income quintile 4			-0.023		
			(0.035)		
Per capita income quintile 5			-0.083*		
			(0.049)		
Age in years (baseline)				0.376***	
				(0.039)	
Age squared (baseline)				0.025***	
				(0.002)	
Years between baseline and endline					0.842***
					(0.008)
Observations	7,112	7,112	7,098	7,112	7,115

Notes: Standard errors that allow for correlation in the unobservables between children from the same wave 1 sampling cluster in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Regressions in columns I through III include a full set of indicators for baseline wave and endline wave. Regression in column III includes indicators for province and indicators that household assets and mother's education at baseline are missing.

Table 8: Maternal orphanhood, education, and nutrition

	I	II	III	IV	V	VI	VII	VIII
	Years of completed education at endline	Years of completed education at endline	Years of completed education at endline	Years of completed education at endline	Years of completed education at endline	Years of completed education at endline	Years of completed education at endline	Years of completed education at endline
Mother deceased (endline)	-0.197***	-0.183***	-0.186***	-0.182***	-0.199***	-0.141**	-0.143**	-0.168**
	(0.066)	(0.063)	(0.064)	(0.062)	(0.065)	(0.059)	(0.059)	(0.072)
Height-for-age z-score (baseline)		0.105***		0.047***		0.037***		
		(0.013)		(0.013)		(0.012)		
BMI-for-age z-score (baseline)		0.025**		0.002		-0.005		
		(0.011)		(0.012)		(0.011)		
Height-for-age z-score (endline)			0.144***	0.123***		0.114***		
			(0.017)	(0.017)		(0.016)		
BMI-for-age z-score (endline)			0.042***	0.034***		0.025**		
			(0.012)	(0.012)		(0.012)		
Change in height-for-age z-score					0.023**			
					(0.011)			
Change in BMI-for-age z-score					0.025**			
					(0.010)			
Stunted (baseline)							-0.159***	-0.303***
							(0.045)	(0.048)
Underweight (baseline)							0.037	
							(0.061)	
Stunted (endline)							-0.287***	
							(0.047)	
Underweight (endline)							-0.176***	
							(0.062)	
Interaction: mother dead x stunted (baseline)								-0.127
								(0.196)
Includes baseline household controls	No	No	No	No	No	Yes	Yes	No
Observations	5,458	5,229	5,429	5,200	5,200	5,194	5,194	5,458

Notes: Standard errors that allow for correlation in the unobservables between children from the same wave 1 sampling cluster in parentheses (*** p<0.01, ** p<0.05, * p<0.1). All regressions include a quadratic in age at endline, an indicator that the child is African, an indicator that the child is female, a set of indicators for baseline wave and a set of indicators for endline wave. Regressions in columns VI and VII include the same set of baseline household controls used in Table 7.

Table 9: Nutrition and maternal orphanhood

	I Height-for-age z-score at endline	II BMI-for-age z-score at endline	III BMI-for-age z-score at endline	IV BMI-for-age z-score at endline	V BMI-for-age z-score at baseline	VI Change in BMI-for-age z-score
Mother deceased (endline)	-0.071	-0.134*	-0.119*	-0.078	-0.093	-0.052
	(0.081)	(0.077)	(0.070)	(0.072)	(0.091)	(0.096)
BMI-for-age z-score (baseline)			0.322***	0.300***		
			(0.019)	(0.019)		
Includes baseline household controls	No	No	No	Yes	No	No
Observations	5,458	5,251	5,251	5,245	5,639	5,251

Notes: Standard errors that allow for correlation in the unobservables between children from the same wave 1 sampling cluster in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Regressions in columns I through IV include a quadratic in age at endline, an indicator that the child is African, an indicator that the child is female, a set of indicators for baseline wave and a set of indicators for endline wave. Regression in column IV includes the same set of baseline household controls used in Table 7. Regression in column V includes a quadratic in age at baseline, an indicator that the child is African and an indicator that the child is female. Regression in column VI includes months between baseline and endline.

Table 10: Nutrition and maternal orphanhood - children aged 6 months to 7 years

	I Height-for-age z-score at endline	II Height-for-age z-score at endline	III Height-for-age z-score at endline	IV Height-for-age z-score at baseline	V Change in height-for-age z-score	VI BMI-for-age z-score at endline	VII BMI-for-age z-score at endline	VIII BMI-for-age z-score at endline	IX BMI-for-age z-score at baseline	X Change in BMI-for-age z-score
Mother deceased	-0.241**	-0.181*	-0.151	-0.242*	0.033	-0.179	-0.182*	-0.162	-0.268**	0.017
	(0.099)	(0.094)	(0.094)	(0.142)	(0.145)	(0.110)	(0.109)	(0.109)	(0.135)	(0.156)
Includes baseline outcome	No	Yes	Yes	No	No	No	Yes	Yes	No	No
Includes baseline household controls	No	No	Yes	No	No	No	No	Yes	No	No
Observations	4,512	4,512	4,508	4,512	4,512	4,433	4,121	4,117	4,196	4,121

Notes: Standard errors that allow for correlation in the unobservables between children from the same wave 1 sampling cluster in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Regressions in columns I through III and VI through VIII include a quadratic in age at endline, an indicator that the child is African, an indicator that the child is female, a set of indicators for baseline wave and a set of indicators for endline wave. Regressions in columns III and VIII include the same set of baseline household controls used in Table 7. Regressions in columns IV and IX include a quadratic in age at baseline, an indicator that the child is African and an indicator that the child is female. Regressions in columns V and X include months between baseline and endline. Regressions in columns II and III include baseline height-for-age z-score. Regressions in columns VII and VIII include baseline BMI-for-age z-score.

Appendix Table A1 Discrepancies between household roster and individual questionnaire reports of mother's vital status

	Wave 1	Wave 2	Wave 3	Wave 4
Roster states mother is deceased but child reports mother is alive	51	114	36	28
Roster states mother is alive and has valid identification number but child reports mother is deceased	20	88	81	62
Child reports mother is alive when asked directly, but also states mother died before child was 5 or 15 years old or gives a year for when the mother dies	0	0	16	0

Notes: African and coloured children aged 0-17 years

Appendix Table A2 Attrition in the panel

	Attritors	Panel members	Level of significance	Observations	Level of significance controlling for age
Female	0.495	0.496		8308	
African	0.682	0.863	***	8316	***
Age	8.188	7.845	***	8317	N/A
Years of education (including Grade R)	2.418	2.083	***	8317	
Height-for-age z-score	-0.763	-0.861	*	6790	*
BMI-for-age z-score	0.284	0.133	***	6573	***
Underweight	0.039	0.057	***	6573	***
Overweight	0.271	0.222	***	6573	***
Obese	0.114	0.093	*	6573	*
Stunted	0.156	0.158		6790	
Mother's years of education	9.735	8.707	***	7610	***
Mother's years of education missing	0.126	0.078	***	8317	***
Household assets	7.947	6.244	***	8207	***
Urban	0.558	0.398	***	8288	***
Household size	6.642	6.706		8316	

southern africa labour and development research unit

The Southern Africa Labour and Development Research Unit (SALDRU) conducts research directed at improving the well-being of South Africa's poor. It was established in 1975. Over the next two decades the unit's research played a central role in documenting the human costs of apartheid. Key projects from this period included the Farm Labour Conference (1976), the Economics of Health Care Conference (1978), and the Second Carnegie Enquiry into Poverty and Development in South Africa (1983-86). At the urging of the African National Congress, from 1992-1994 SALDRU and the World Bank coordinated the Project for Statistics on Living Standards and Development (PSLSD). This project provide baseline data for the implementation of post-apartheid socio-economic policies through South Africa's first non-racial national sample survey.

In the post-apartheid period, SALDRU has continued to gather data and conduct research directed at informing and assessing anti-poverty policy. In line with its historical contribution, SALDRU's researchers continue to conduct research detailing changing patterns of well-being in South Africa and assessing the impact of government policy on the poor. Current research work falls into the following research themes: post-apartheid poverty; employment and migration dynamics; family support structures in an era of rapid social change; public works and public infrastructure programmes, financial strategies of the poor; common property resources and the poor. Key survey projects include the Langeberg Integrated Family Survey (1999), the Khayelitsha/Mitchell's Plain Survey (2000), the ongoing Cape Area Panel Study (2001-) and the Financial Diaries Project.

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