The economic impacts of premature adult mortality: panel data evidence from KwaZulu-Natal, South Africa

Michael R. Carter[a], Julian May[b], Jorge Agüero[c] and Sonya Ravindranath[a]

Measuring the household level economic impacts of AIDS-related deaths is of particular salience in South Africa, a country struggling with a legacy of poverty and economic inequality in the midst of an HIV epidemic. Household panel data that span more than a decade permit us to resolve many of the statistical problems that make it difficult to determine these impacts. After allowing for the impact of demographic adjustments and other coping strategies, we found evidence that these impacts are quite different across different types of households, and that the largest and most persistent effects were in the middle ranges of the South African income distribution, that is, households just above the poverty line. Households below that level seem less severely affected, whereas those above it seem to recover more quickly. All these results need to be treated with caution because their statistical precision is weak.

AIDS 2007, **21** (suppl 7):S67–S73

Keywords: Africa, economics

Introduction

A number of recent studies have measured the economic impacts of AIDS-related deaths on the economic wellbeing of affected households [1–3]. Measuring these impacts is of particular salience in South Africa, a country struggling with a legacy of poverty and economic inequality in the midst of an HIV epidemic. Among adults aged 15–49 years, the HIV prevalence rate is estimated to be 21.5%. As the epidemic moves from infection into impact, premature adult mortality rates are increasing rapidly, with an estimated 370 000 South Africans dying of AIDS-related illness in 2003, making the disease the leading cause of death in almost all South African provinces [4]. It is estimated that the majority of AIDS-related deaths have still to occur [4]. Three difficulties, however, confront efforts to measure these impacts reliably. First, measuring the economic impacts of an AIDS-related death requires an estimate of the counterfactual level of wellbeing that the household would have experienced in the absence of the death. Second, the impacts may be heterogeneous across the different households that experience an AIDS-related death. Third, and finally, the impacts may show differential persistence over time for households on the basis of their ability to cope with the death and the stress it places on household resources.

In an effort to deal with these difficulties, this study employs three waves of panel data on a sample of households from the KwaZulu-Natal province of South Africa. These data, which span the 1993–2004 period, effectively permit this study to use each household's trajectory in the period preceding the onset of AIDS-related deaths to estimate what the household's counterfactual economic status would have been without such deaths. Although the approach here is somewhat distinctive, several earlier studies have utilized panel data to examine the dynamics of poverty status and the impact that premature deaths have on pathways into or out of

From the [a]Professor, University of Wisconsin-Madison (Agricultural and Applied Economics), the [b]Associate Professor, University of KwaZulu-Natal (Development Studies), and the [c]Assistant Professor, University of California-Riverside (Economics), and Graduate student, University of Wisconsin-Madison (Agricultural and Applied Economics).

Correspondence to Julian May, Associate Professor and Head of School, School of Development Studies, Memorial Tower Building, University of KwaZulu-Natal, King George V Ave, Durban.

Tel: +27 31 2602841; fax: +27 31 2602359; e-mail: mayj@ukzn.ac.za

poverty [5–8]. In addition, the analysis here explores the heterogeneous impact of premature adult mortality by permitting its estimated impacts to vary according to the households' specific initial conditions.

Although the immediate economic effects of an AIDS-related death are of course important, its long-term impacts on poverty depend on whether households recover from the death economically, or whether they fall into a long-term poverty trap. Both the economic theory of poverty traps [9] and evidence on natural disasters [10] suggest that severe shocks can indeed push households below a critical level from which they cannot recover economically. Similar insights emerge from the anthropological literature that shows how a poverty trap situation can emerge for resource-poor households. The living standards of vulnerable households that face multiple shocks over time may ratchet down over time to the point at which they eventually become trapped in a situation of structural poverty [11,12].

In the context of AIDS-related deaths, these ideas of repeated shocks and poverty traps have an important resonance. In countries in which there has been a high prevalence of HIV, death is preceded by comparatively lengthy episodes of illness (and corresponding episodes of care; Hornbrook *et al.* [13] have suggested framing analysis of protracted illness in terms of the costs of episodes of illness and care) that present households with a protracted series of shocks as the illness progresses. In the case of AIDS-related deaths in Tanzania, the average length of debilitating illness preceding death was 12 months [14]. Another Tanzanian study showed that on average, an adult experiences 17 different episodes of illness before dying [15]. Each of these episodes is likely to be accompanied by episodes of care, which become more costly as death approaches. Moreover, in many cultures, the death itself does not signal the end of the episode because funeral celebrations are required that necessitate further expenditure and possible indebtedness [16]. Even these expenditures may extend over several years if there are annual celebrations or customs that families observe. Some of these changes are not unique to the HIV epidemic. Discussing the impact of malaria, Sachs and Malaney [17] noted the costs associated with changes in the behavior of household members concerning decisions such as schooling, child-bearing, savings and work-seeking are often overlooked when measuring the economic impact of disease. Such changes have been documented in the case of AIDS-related illness or death in Tanzania, where it has been shown that children may marry earlier, drop out of school to help support the family, and take on informal labor schemes [18]. These observations all suggest that the economic effects of an AIDS-related death may be long lived, if not permanent. Following the lead of a study of Tanzania [8], the analysis here will exploit the available panel data to see whether households recover over time from the economic impacts of an AIDS-related death, or whether they become trapped in a permanently lower standard of living.

The KwaZulu-Natal Income Dynamics Study

Covering the 1993–2004 period, the KwaZulu-Natal Income Dynamics Study (KIDS) allows an analysis of household wellbeing both before and after the onset of AIDS-related deaths in South Africa. The first round of what became the KIDS data was part of the nationally representative survey conducted by the Project for Statistics on Living Standards and Development [19]. The key decision makers (or 'core' members) of the 1354 African and Indian households visited by the Project for Statistics on Living Standards and Development in the KwaZulu-Natal province became the basis for the follow-up KIDS surveys undertaken in 1998 and 2004 [20,21]. When subsequent survey rounds found that co-resident core members had split into separate residences, each core was interviewed along with their corresponding new household. In the 2004 survey round, adult children of the core members were also interviewed. In total, information was obtained in all three periods from at least one eligible respondent for 74% of the original 1354 Project for Statistics on Living Standards and Development KwaZulu-Natal households. Ethical approval for study was obtained through the appropriate committees at the University of Natal and the University of Wisconsin-Madison. Informed consent was obtained before interviews were undertaken. Although similar to that found in other panel studies, the attrition rate in the KIDS sample needs to be kept in mind when considering the results reported below. Maluccio [22,23] analysed the pattern of attrition over the 1993 to 1998 period, and noted that it came from both the upper and lower tails of the livelihood distribution. Although there has not yet been a similar analysis of attrition over the 1998–2004 period, the age-specific mortality patterns in the KIDS data are similar to those found in another study of South Africa [24]. Whereas these observations suggest that the KIDS data accurately reflect the reality of AIDS-related deaths, it is possible that sample attrition over the 1998–2004 period disproportionately reflected households most severely affected by AIDS-related deaths. If that indeed happened, then the results here will probably understate the true impacts of those deaths.

The KIDS data show that at ages 20–50 years, the proportion of individuals dying between the second and third waves was nearly three times the proportion dying between the first two waves [20]. In total, 309 members of KIDS households between the ages of 20 and 50 years died between 1998 and 2004. Of these deaths, 74 were the result of injury or accident. As we are interested in the impact of death associated with illness, we excluded this group and designated the remaining 235 deaths premature adult mortality (PAM). Premature mortality refers to death occurring before some standard age. We have used South African life expectancy in 2004 (51.4 years) as a guideline for this standard [25]. Other studies have used a slightly younger age group (15–50 years) on the grounds that this age range is the group most at risk of HIV infection [26].

Methodology and results

Evaluating the impacts of PAM on the economic status of a family is difficult because we cannot observe what the family's status would have been counterfactually in the absence of the death. The economic status of families unaffected by PAM may be a very bad proxy for this counterfactual status, especially in the case of the HIV epidemic in which specific behaviors and situations are known to make infection and death more likely.

Other studies have approached this statistical problem in several ways. One approach is to use propensity score methods to match affected with unaffected households, effectively using the latter as the counterfactual for PAM households [1]. Propensity score methods, however, only control for observable differences between affected and unaffected households. Alternatively, with panel data it is possible to use fixed effects estimation methods that can also control for any unobserved differences between households that do not vary over time [3,6].

The approach here is similar to this fixed effect approach except that the three periods of KIDS data permit us to work in rates of growth in wellbeing rather in levels of wellbeing. In particular, the KIDS data allow us to observe a family's economic trajectory (their growth in wellbeing) before the onset of the epidemic. Using this information, and a few modest statistical assumptions, we can use fixed effects methods to predict reliably what the affected family's economic status would have been in the absence of PAM. Effectively, this procedure allows each family's past experience to inform the counterfactual that is used to judge the impacts of PAM.

The KIDS data described above contain measures of household economic wellbeing at three points in time, 1993, 1998 and 2004. We denote the economic wellbeing of household i in time period t as, y_{it}. Economic wellbeing is measured as total household expenditures per capita. Expenditures include the imputed value of home-produced food, owner-occupied housing, etc. Although in principle this measure should be scaled for the demographic composition of the household, we have not done so here in order to maintain comparability with the de facto per capita standard used to define poverty in South Africa. In turn, we define the growth rate of household wellbeing between period $t-1$ and t as: $g_{it} = \frac{y_{it}-y_{it-1}}{y_{it-1}}$. Under our data structure, we observe g_{it} twice: once for $t=1998$, measuring the growth (positive or negative) in wellbeing between 1993 and 1998, and once in 2004 (measuring the growth since 1998).

Consider the following fixed effects regression model for this growth in economic wellbeing measure:

$$g_{it} = \beta_1 h_{it} + \delta_1 S_{it} + \delta_2[\ln(y_{it-1})] + \upsilon_i + \lambda_i + \varepsilon_{it} \qquad (1)$$

where h_{it} is a binary indicator variable that takes a value of 1 when family i experienced PAM between times $t-1$ and t, and is 0 otherwise. We here treat the 25 households with more than one PAM as identical to those with only one PAM. Efforts to identify different effects for additional PAM failed statistically, presumably because of small sample sizes. The variable S_{it} signifies other unfavorable shocks that struck the household between times $t-1$ and t, including crop loss, theft, spousal abandonment, and death of an elderly household member. The terms υ_i, λ_i, δ and β are all parameters to be estimated, and ε_{it} is a random error term that we assume is unrelated to the included variables.

Consistently estimating the coefficient β_1, which gives the impact of an adult death on the growth in wellbeing, is of course our primary interest. Note that this specification assumes that the impact of a premature adult death on wellbeing is the same for all households. This 'homogenous effect' regression model thus says that growth in household wellbeing over time depends on a household-specific growth factor that does not change over time (υ_i), as well as on a time-specific intercept (λ_i, $t=98$ or 04) that is assumed to be the same for all households.

Our ability to use fixed effects panel data methods to control for the household-specific effect is key to our effort to identify the impact of a prime age adult mortality on economic wellbeing. Note that υ_i will capture time invariant observable and unobservable factors that influence the growth in household wellbeing. It is precisely these unobservable differences between households that make it difficult to estimate the impact of premature adult death. Once we control for the fact that households with adult deaths are likely to grow more slowly (or perhaps more rapidly) than the typical household, we can be more confident in our estimate of β_1. More formally, failing to control for the household-specific fixed effect would tend to exaggerate the impact of a premature death if households that suffer such deaths tend on average to experience lower growth even in the absence of the death. Given that the performance of the South African economy improved over the 1998–2004 period, a change that is reflected in the profile of poverty of the KIDS sample, we would expect $\lambda_{04} > \lambda_{98}$. Note, however, that our methodology does not account for the spillover effects of premature death. An analysis of Zambia estimated that local economic growth was negatively influenced by high concentrations of AIDS-related deaths [7]. Although such macro effects may occur in South Africa, the urbanized and well-integrated nature of the South African economy makes it less likely that these effects can be picked up at the local community level. Similar to Grimm [6], we controlled for other shocks that potentially affect the growth rate of household economic wellbeing. As measures of these shocks, we employed binary indicator variables as to whether the household experienced the shock. The study by Grimm [6] also controlled for changes in household demographic composition. We chose explicitly not to control for demographic changes as we suspected that such changes are themselves coping strategies employed by families that suffer PAM. Statistically, demographic changes would be directly related to the error term ε_{it} in (1), and including it would yield biased estimates of the effect of PAM. Although it would be possible to employ simultaneous equation methods to address the statistical endogeneity of demographic changes, we prefer here to estimate reduced form models such as (1). The parameter estimates we obtained thus give us the full or bottom line effect of a PAM on household wellbeing after the household has utilized available coping strategies (including demographic changes).

Note also that model 1 does not condition on the characteristics of the adult who has died (as in Yamano and Jayne [3]). Although we have no doubt that these characteristics matter, we are here interested in identifying the average or typical effect of PAM in our South Africa data.

Finally, the basic regression model includes a term that allows the expected growth in economic wellbeing to be different depending on the household's initial level of wellbeing (measured as the natural logarithm of the household's level of wellbeing at the beginning of the period, y_{it-1}). Conventional economic theory predicts that $\delta < 0$, indicating that initially less well-off households experience more rapid growth. Other theory suggests the opposite [9]. For the purposes of this study, we are simply concerned to control for the impact of initial levels of wellbeing on subsequent changes.

Table 1 displays the fixed effects estimates for the homogenous effects model. As the underlying data were collected through cluster design, robust standard errors were calculated that allow for intracluster correlation in the regression errors. For the key variables of interest, the P value (the level of statistical significance at which it is possible to reject the hypothesis that the reported coefficient is zero) is reported in square brackets. The estimated coefficient of the PAM variable is negative, but, surprisingly, it is not statistically significant. Its value (−0.21) means that PAM would be expected to lower a household's 5-year growth rate by 21%, controlling for the unobserved time-invariant factors that influence each household's growth rate (υ_i) and other variables.

The estimated coefficient of the initial level of wellbeing is statistically significant and signals a convergent process, with initially less well-off households estimated to grow faster than others. None of the shock variables are statistically significant, although most are negative. Their insignificance may signal that most of these shocks are of a short-term nature, and that whatever their short-term effects on consumption, households had largely recovered

Table 1. Fixed effects estimates of the impact of premature adult mortality on the growth rate of economic wellbeing.

Explanatory variables	Homogenous effects model	Heterogeneous effects model	Impact persistence model
PAM impact			
Common effect, β_1	−0.21 [25%]	1.8 [22%]	5.4 [27%]
Differential effect, β_2	–	−0.370 [14%]	−0.96 [25%]
Persistence of PAM effect			
Common effect, β_3	–	–	−0.10 [33%]
Differential effect, β_4	–	–	0.02 [35%]
Convergence, δ	−1.8**	−1.8**	−1.8**
Time effects			
1998 intercept, λ_{98}	10.8**	10.4**	10.4**
2004 intercept, λ_{04}	11.3**	10.9**	10.9**
Other shocks			
Illness	0.15	0.16	0.16
Job loss	−0.05	−0.05	−0.05
Lose remittances	−0.12	−0.12	−0.17
Lose grant	−0.02	−0.02	−0.01
Abandonment	−0.34	−0.27	−0.24
Theft	0.02	0.01	0.02
Crop loss	−0.27	−0.26	−0.25
Elderly death	0.33	0.32	0.32
Household fixed effects, υ_i	Included	Included	Included
R^2 within	0.34	0.34	0.35

PAM, Premature adult mortality. Reported significance based on robust standard errors corrected for clustering. Figures in square brackets are P values.
*Statistically significant at the 10% level.
**Statistically significant at the 5% level.

their expected level of economics by the time of the survey. The death of an elderly household member, however, is not a short-term event like an illness. The positive, but statistically insignificant, coefficient on the elderly death variable may seem surprising in the context of South Africa, where the death of an older person nearly always results in the loss of significant pension income. Its insignificant effect may reflect the fact that the households were prepared (economically) for the death. One such coping strategy may be through the shedding of the household members who other studies have shown tend to immigrate into households when an elderly person becomes of pensionable age.

Whereas it is common to think of a premature adult death reducing household economic wellbeing, of course it need not be so, especially when large numbers of adults are unemployed or underemployed. Negative effects could also be muted if other family members involved in care-giving were also unemployed or underemployed at the time of the onset of an AIDS-related illness. In this circumstance, an adult death may actually increase the living standards of those remaining alive in the household as there are now fewer needs to meet from the family's modest resources [27]. It should be stressed that the analysis here ignores other benefits (even those that are solely economic) that an individual may bring to the household, including support for children, their socialization and education [28]. The opposite could of course be the case for somewhat better-off households, in which the premature death of an adult results in a net reduction of the goods available for others.

From a statistical perspective, these observations suggest that our basic regression model (1) mixes together two different regimes, one in which the immediate livelihood effects of PAM are negative, and another in which they are positive. The average effect estimated in Table 1 would, in this case, be a data-weighted average of the two underlying regimes or regression relationships. From this perspective, we see that this data-weighted average effect is negative, but not surprisingly, it is insignificant.

In an effort to pull these two regimes apart, and allow for heterogeneous PAM effects, we modified the basic fixed effect regression equation as follows:

$$g_{it} = \beta_1 h_{it} + \beta_2[h_{it}\ln(y_{it-1})] + \delta_1 S_{it} + \delta_2[\ln(y_{it-1})] + \upsilon_i + \lambda_t + \varepsilon_{it}, \qquad (2)$$

where the new coefficient β_2 allows the PAM impact to change with the household's level of initial economic wellbeing. As discussed above, we might expect $\beta_2 \leq 0$ and $\beta_1 \geq 0$.

The second column in Table 1 shows the results of this expanded, heterogeneous effects model. The impact coefficients have the anticipated signs, indicating the positive effects of PAM for poorest households and negative effects as households become better off. The estimated coefficients are, however, not statistically different from zero at conventional probability levels. We re-estimated the reported models using a lower age cutoff to define PAM (40 and 45 years instead of 50 years). Lowering the cutoff had little effect on the magnitude of the estimated coefficients, but did improve their statistical significance. Increasing the PAM age cutoff towards 60 years also left the point estimates of the PAM coefficients stable, but made them even less precise. This pattern is consistent with the notion that the earning power of adults begin to fall off as they enter their 50s. In addition, households presumably become better prepared for an adult death as that death becomes (statistically) more likely. This insignificance reflects the heavy demands put on the data by fixed effects procedures, as well as the clustering of the underlying data that further reduces the precision obtainable from a sample of the size of the KIDS. When the impact of clustering on the standard errors is ignored, the estimated coefficients are significant at conventional levels. The estimated impacts of the other shock variables are qualitatively identical to those in the homogenous effect model.

Given that the estimated impact of PAM now depends on the household's initial level of wellbeing, we used the estimated coefficients from Table 1 to calculate the impact of PAM on the livelihood trajectories for three typical households: one that began in the 20th percentile of the initial wellbeing distribution, another at the 50th and a third at the 80th percentile. For each of these typical households, we took the average of the fixed effect terms (the υ_i) for economically similar households. For example, for the 20th percentile household, we took the average fixed effect estimates for all households between the 15th and the 25th percentile. A similar band was used for the other two household estimates. Using this estimate, plus the household's initial level of wellbeing (y_{i93}) we then calculated the predicted growth that would be expected for such a household over the 1993–1998 period, the period before the onset of significant AIDS-related deaths. Using this predicted growth, we then calculated the household's predicted standard of living for 1998. To make this value more easily interpretable, we have divided it by the poverty line such that a standard of living of 1 would imply a living standard exactly equal to the poverty line, 2 a living standard double the poverty line, and so forth. For this analysis, we used the de facto official South African poverty line of R322 per month per person (in year 2000 prices) [29]. Figure 1 shows these pre-PAM estimates for each of the three typical households. As can be seen, all but the least well-off households experienced negative growth in wellbeing over the 1993–1998 period.

In order to assess the predicted impact of PAM, we then performed the same exercise for the 1998–2004 period

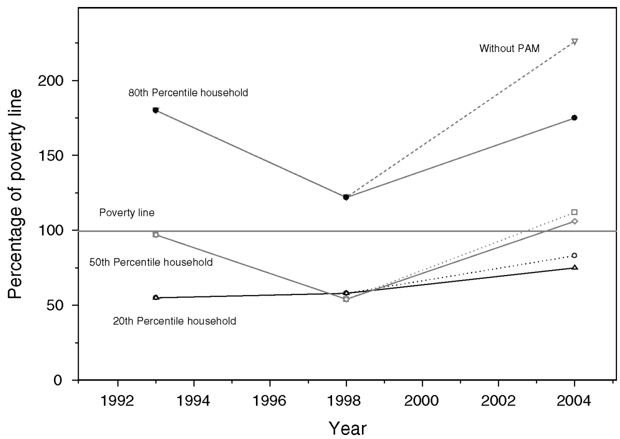

Fig. 1. Impact of premature adult mortality on livelihood trajectories. PAM, Premature adult mortality.

for the three typical households. The starting point for each household was their predicted level of wellbeing for 1998, as described above. For each household a growth rate (and resulting living standard level) was calculated both with and without a premature adult death. As can be seen, the predicted impact of PAM on the household that began at the 20th percentile is slightly negative, but imperceptibly so. Households at the 50th percentile in 1993 (whose wellbeing levels had collapsed over the mid-1990s) show a similar pattern. In contrast, households at the 80th percentile show a large predicted drop in wellbeing. Without PAM, the household would have grown to a living standard in excess of 225% of the poverty line. With PAM, the household's wellbeing is only 175% of the poverty line. This 50% drop is correctly interpreted as the impact of PAM on initially better-off households.

Finally, our data permit us to explore whether these estimated PAM impacts tend to dissipate over time. To do this, we modified the model by including an additional variable that indicates the number of months between the premature death and the date of the survey. This specification implies a linear relationship between time since death and effects. We also estimated a more general specification (with different dummy variables for different periods since death) and obtained qualitatively similar results. We also tried a specification in which we looked for effects based on the period of time when the individual who eventually died first became unable to perform his ordinary economic activity. These specifications proved to be uninformative. This same variable was also interacted with initial expenditures to give the following 'impact persistence model':

$$g_{it} = \beta_1 h_{it} + \beta_2[h_{it}\ln(y_{it-1})] + \beta_3 p_{it} + \beta_4[p_{it}\ln(y_{it-1})] + \delta_1 S_{it} + \delta_2[\ln(y_{it-1})] + \upsilon_i + \lambda_i + \varepsilon_{it} \quad (3)$$

where the new variable p_{it} measures the passage of time (in months) between the PAM death and the survey. Note that this model permits the rate of recovery from PAM to vary by income level. If households tend eventually to recover after PAM, we would expect the effect of time-since-death to be positive, as found in an analysis of Tanzania [8]. In contrast, a study of Kenya [3] did not find evidence that PAM effects dissipate over time (although their period of observation was shorter than that in Beegle *et al.* [8]).

The estimates (reported in the third column of Table 1) are again not statistically significant at conventional levels. Although this evidence is thus a bit weak, the estimated coefficients imply that a household that began in the 80th percentile of the wellbeing distribution would have begun to recover its growth rate 5 years after the PAM. Better-off households would be estimated to recover more quickly. Less well-off households (for whom the effects are less pronounced) are estimated to recover less quickly.

In conclusion, this paper has explored the ability of panel data to permit more reliable inferences on the impact of AIDS-related deaths on household economic wellbeing. The results obtained, which allow us to compare the economic wellbeing of AIDS-affected households with what their wellbeing would have been in the absence of AIDS, are less strong statistically than they might be. They do, however, suggest a consistent story in which the immediate impacts of an AIDS-related death are most severe for somewhat better-off households. It should be stressed that the analysis here gives a 'bottom line' impact estimate that reflects households' adaptation to the shock, including demographic adjustments in which severely affected households may send dependent members to better-off friends and relatives. Demographic adjustments of this sort would improve the economic wellbeing of the remaining members, but would also hide some of the effects of the AIDS shock.

Although somewhat at odds with the conventional wisdom that the HIV/AIDS crisis most severely affects the poorest households, our findings are consistent with the observation that premature death may actually reduce poverty as we measure it [27]. These findings also suggest that an analysis of the impacts of AIDS-related deaths needs to allow for the possibility that these impacts could be quite variable across household types.

Finally, the analysis here has explored the question of whether households are able to recover over time from the immediate impacts of an AIDS-related death. The results are again statistically weak, but they suggest that better-off households do manage to recover their rate of economic progress eventually. Although further investigation is needed, the results do suggest that households in the middle range of the South African income distribution are more vulnerable to experience an AIDS-related death as a permanent setback in household wellbeing.

The work reported here is an outcome of a collaborative project between the University of KwaZulu-Natal, the University of Wisconsin-Madison, the London School of Hygiene & Tropical Medicine, UK Economic Research Council, the International Food Policy Research Institute (IFPRI) and the South African Department of Social Development. Further financial support was provided by: Department for International Development (DFID); the United States Agency for International Development (under agreement No. LAG-A-00-96-90016-00 through the BASIS Collaborative Research Support Program); the Mellon Foundation; and a project grant (RES-167-25-0076) from the UK Economic and Research Council. The authors have no conflicts of interest, including financial, consultant, institutional and other relationships that might lead to bias or a conflict of interest.

References

1. Gertler P, Levine D, Ames M. **Schooling and parental death.** *Rev Econ Stats* 2004; **86**:211–225.
2. Naidu V, Harris G. **The impact of HIV/AIDS morbidity and mortality on households–a review of household studies.** *S Afr J Econ* 2005; **73**:533–544.
3. Yamano T, Jayne T. **Measuring the impact of working age adult mortality on small-scale farm households in Kenya.** *World Dev* 2004; **32**:91–119.
4. Medical Research Council. *South African National Burden of Disease Study 2000*: *provincial estimates of mortality*. Medical Research Council; 2004.
5. Chapoto A, Jayne TS. **Socio-economic characteristics of individuals afflicted by AIDS-related prime-age mortality in Zambia.** In: *IFPRI/Renewal Conference on HIV/AIDS and Food and Nutrition Security*. Durban, South Africa, 14–16 April 2005.
6. Grimm M. *Mortality and survivors' consumption*. Discussion paper 611. German Institute for Economic Research; 2006.
7. Jayne TS, Chapoto A, Byron E, Ndiyoi M, Hamazakaza P, Kadiyala S, Gillespie S. **Community-level impacts of AIDS-related mortality: panel survey evidence from Zambia.** *Rev Agr Econ* 2006; **28**:440–457.
8. Beegle K, De Weerdt J, Dercon S. *Adult mortality and economic growth in the age of HIV/AIDS*. Working paper series. World Bank; 2006.
9. Carter MR, Barrett CB. **The economics of poverty traps and persistent poverty: an asset-based approach.** *J Dev Studies* 2006; **42**:178–199.
10. Carter MR, Little P, Mogues T, Negatu W. **Poverty traps and the long-term consequences of natural disasters in Ethiopia and Honduras.** *World Dev* 2006; **35**:835–856.
11. Moser C. **The asset vulnerability framework: reassessing urban poverty reduction strategies.** *World Dev* 1998; **26**:1–19.
12. Davies S. *Adaptable livelihoods: coping with food insecurity in the Malian Sahel.* London: MacMillan Press; 1996.
13. Hornbrook MC, Murtado RV, Johnson RE. **Health care episodes: definition, measurement, and use.** *Med Care Res Rev* 1985; **42**:163–218.
14. Beegle K. *Labor effects of adult mortality in Tanzanian households*. Policy research working paper 3062. World Bank; 2003.
15. Bollinger L, Stover J, Riwa P. *The economic impact of AIDS in Tanzania*. Policy working paper. 1999. Available at: http://www.policyproject.com/pubs/SEImpact/tanzania.pdf. Accessed: 22 May 2006.
16. Stover J, Bollinger L. *The economic impact of AIDS.* Washington, DC: Futures Group; 1999.
17. Sachs J, Malaney P. **Insight review article: the economic and social burden of malaria.** *Nature* 2002; **415**:7.
18. Ainsworth M, Semali I. *The impact of adult deaths on children's health in North-Western Tanzania*. Policy research working paper 2266. World Bank; 2000.
19. Project for Statistics on Living Standards and Development. *South Africans rich and poor: baseline household statistics*. South African Labour and Development Research Unit, University of Cape Town; 1994.
20. May J, Agüero J, Carter MR, Timaeus I. **The KwaZulu-Natal Income Dynamics Study (KIDS) 3rd wave: methods, first findings and an agenda for future research.** *Dev Southern Afr* 2007; in press.
21. May J, Carter MR, Haddad L, Maluccio J. **KwaZulu-Natal Income Dynamics Study (KIDS) 1993–1998: a longitudinal household data set for South African policy analysis.** *Dev Southern Afr* 2000; **17**:567–581.
22. Maluccio JA. **Using quality of interview information to assess nonrandom attrition bias in developing-country panel data.** *Rev Dev Econ* 2004; **8**:91–109.
23. Maluccio JA. *Attrition in the KwaZulu-Natal Income Dynamics Study 1993–1998*. Food Consumption and Nutrition Division discussion paper no. 95. International Food Policy Research Institute; 2000.
24. Hosegood V, Vanneste A-M, Timaeus I. **Levels and causes of adult mortality in rural South Africa.** *AIDS* 2004; **18**:663–671.
25. Statistics South Africa. *Mid-year population estimates, statistical release, P302.* Pretoria: Statistics South Africa; 2006.
26. Ainsworth M, Dayton J. **The impact of the AIDS epidemic on the health of older persons in northwestern Tanzania.** *World Dev* 2003; **31**:131–148.
27. Kanbur R. *Conceptual challenges in poverty and inequality: one development economist's perspective.* 2002. Available at: http://www.chronicpoverty.org/pdfs/conferencepapers/kanbur.pdf. Accessed: 12 May 2006.
28. Bell C, Shantayanan D, Gersbach H. *The long-run economic costs of AIDS: theory and an application to South Africa*. Working paper. Heidelberg, Germany: University of Heidelberg; 2003.
29. Hoogeveen JG, Özler B. *Not separate, not equal: poverty and inequality in post-apartheid South Africa*. Working paper no. 739. William Davidson Institute; 2005.