

Socioeconomic Characteristics of Individuals Afflicted by AIDS-Related Prime-Age Mortality in Zambia

Antony Chapoto and Thomas S. Jayne

Introduction

Campaigns to prevent the spread of HIV/AIDS require accurate knowledge of the characteristics of those most likely to contract the disease. Studies conducted in Sub-Saharan Africa during the 1980s generally found a positive correlation between socioeconomic characteristics such as education, income, and wealth and subsequent contraction of HIV (see Ainsworth and Semali 1998; Gregson, Waddell, and Chandiwana 2001). However, as the disease has progressed, the relationship between socioeconomic status and HIV contraction may have changed in many areas of Sub-Saharan Africa, although there is little hard evidence to support this. For example, it is increasingly believed that poverty forces some household members to adopt more risky behaviors that contribute to HIV infection, which could mean that AIDS-related mortality is disproportionately affecting relatively poor households. This chapter seeks to determine the ex ante socioeconomic characteristics of individuals who die between the ages of 15 and 59 years of age (hereafter called “prime-age” mortality), using nationally representative panel data on 18,821 individuals in 5,420 households surveyed in 2001 and 2004 in rural Zambia.

We estimate several probit models of disease-related mortality of prime-age (PA) individuals in rural Zambia between May 2001 and May 2004. The results of these models are used to report the probabilities of mortality over a three-year period for a range of individual profiles that differ according to their gender, level of income,

education, months residing away from home, distance to district town, and other individual and household characteristics.

Generally, we find that single women are two to five times more likely to die of disease-related causes as women who are the heads or spouses of their households. Somewhat consistent with findings in the 1980s and early 1990s, relatively wealthy men are more likely to die of disease-related causes than men from poor households. When ranked by asset levels, relatively nonpoor men are 43 percent more likely to die of disease-related causes than men in poor households. In contrast, women in the lower and upper halves of the asset distribution are equally likely to die of disease-related causes, with the probability of mortality over the 3-year period being roughly 1.0 percent regardless of their households' income or asset levels. However, among relatively poor women, those having some form of formal or informal business income are 15 percent less likely to die of disease-related causes than those without any form of business income, but this effect is statistically weak. Although among relatively nonpoor women, those with business income were 7 percent more likely to die than those without any business income. This finding, coupled with the finding that poor and nonpoor women are equally likely to die of disease-related causes, calls into question the view that poverty leading to risky behavior is the major pathway through which the disease is spread, although this may certainly be one of many pathways. There is no clear relationship between educational attainment and probability of dying; both well-educated and poorly educated men and women should continue to be targeted for HIV/AIDS behavior change campaigns. Prime-aged men and women experiencing a prior death in their household are more likely to die of disease-related causes than men and women in households with no prime-age deaths in the past 8 years. These findings will help policymakers and development agencies better understand the transmission pathways of HIV/AIDS, which should help in the formulation of AIDS prevention and mitigation strategies.

Data and Methodology

Data and Attrition

The study uses nationally representative longitudinal data on 18,821 prime-age individuals (15–59 years of age) in 6,922 households in 393 standard enumeration areas (SEAs)¹ in Zambia surveyed in May 2001 and May 2004. The survey was carried out by the Central Statistical Office (CSO) in conjunction with the Ministry of Agriculture and Cooperatives (MACO) and Michigan State University's Food Security Research Project. For sampling procedures see Megill (2004). Of the

6,922 households interviewed in 2001, 5,420 (78.3 percent) were reinterviewed in May 2004. If attrition caused by enumerators not revisiting several SEAs in 2004 that were included in the 2001 survey is excluded, the reinterview rate rises to 88.7 percent. And if attrition caused by adult household members being away from home during the enumeration period and those refusing to be interviewed is excluded, the reinterview rate rises to 94.5 percent.

An examination of the relationship between household attrition, dissolution, and household size in 2001 shows that the percentage of households lost to attrition is inversely related to household size. Whereas 8.4 percent of the households sampled in 2001 contained either one or two members, these households accounted for over 12 percent of the cases of attrition and 18 percent of the cases of household dissolution. In contrast, 65.5 percent of the sample contained households with five or more members, and among these households, only 47 percent of attrition as a result of dissolution is observed. In addition, the results show that dissolution was a more important cause of household attrition among smaller households than among larger households. By contrast, larger households were more likely to incur a prime-age adult death. This is because the probability that a household will incur a prime-age adult death is positively correlated with the number of adult members in the household.

Basic information on the households surveyed, reinterview rates, and prevalence of disease-related mortality over the 2001–04 period is presented in Table 2.1. Of the 5,420 households successfully reinterviewed, 362 of these households (6.3 percent) had at least one disease-related prime-age (PA) death over the 3-year period.² Of these 362 households incurring a prime-age disease-related death, 53 of them suffered multiple prime-age deaths, with 45 households experiencing two deaths, 6 households experiencing three deaths, and 2 households experiencing four prime-age deaths. Survey design problems made it difficult to determine the relationships between the deceased in households suffering multiple deaths. Using the World Health Organization (WHO) standard algorithm for diagnosis of HIV infection in the absence of blood tests, 24 percent of the deaths from diseases are estimated to be AIDS related.³ However, because information was not collected on all of the WHO minor symptoms, it is likely that our classification of AIDS and non-AIDS deaths underestimates the percentage of deaths related to AIDS. Therefore, our analysis is confined to correlates of prime-age mortality from disease in general.

There were 419 prime-age deaths recorded in the sample, 21 of which resulted from accidents or homicide, and 398 cases of illness-related PA mortality. Of the 398 cases of illness-related PA mortality, 165 (41 percent) were men, and 233 (59 percent) were women.⁴ Of the 18,821 prime-age adults recorded in 2001, 36 percent

Table 2.1 Prevalence of prime-age (PA) mortality^a by province, rural Zambia, between 2001 and 2004

Province	Households										Prime-age deaths from illness		Predicted AIDS-related deaths ^d		Median age of adults dying from diseases from 15–59 years of age (h) Years
	Households interviewed in 2001		Households reinterviewed in 2004 ^b		Households with at least one prime-age adult death in 2001–04		Male		Female		By WHO classification ^e		One major sign and at least one minor sign		
	Number	Number (%)	Number	Number (%)	Number (%)	Number	AMR ^c	Number	AMR ^c	Number (%)	Number (%)	Number (%)	Number (%)		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)		
Central	714	573 (80.3)	50 (8.7)	27	12.1 (14.4)	26	13.7 (16.1)	10 (18.9)	13 (24.5)	34					
Copperbelt	393	312 (79.4)	16 (5.1)	6	11.2 (14.8)	10	11.2 (14.6)	4 (25.0)	6 (37.5)	36					
Eastern	1331	1126 (84.6)	71 (6.3)	31	12.4 (14.6)	45	15.4 (18.5)	15 (19.7)	27 (35.5)	35					
Luapula	777	619 (79.7)	41 (6.6)	19	9.7 (12.1)	27	12.1 (15.1)	11 (23.9)	22 (47.8)	36					
Lusaka	214	161 (75.2)	15 (9.3)	5	15.7 (19.2)	10	13.3 (16.6)	3 (20.0)	6 (40.0)	36					
Northern	1363	1027 (750.3)	55 (5.4)	27	8.0 (10.3)	29	10.3 (13.1)	14 (25.0)	18 (32.1)	38					
Northwestern	472	324 (68.6)	15 (4.6)	9	6.1 (9.3)	8	6.8 (10.0)	2 (11.8)	3 (17.6)	36					
Southern	872	690 (79.1)	55 (8.0)	25	12.0 (15.1)	36	14.0 (17.3)	15 (24.6)	25 (41.0)	32					
Western	786	588 (74.8)	51 (8.7)	16	12.5 (16.4)	42	12.6 (17.7)	22 (37.9)	31 (53.4)	33					
Total	6922	5420 (78.3)	362 (6.7)	165	11.1 (14.0)	233	12.2 (15.4)	96 (24.4)	151 (38.3)	35					

Source: CSO/MACO/FSRP Post Harvest Survey, 1999/2000, and Supplemental Survey, 2001 and 2004.

Notes: ^aPrime-age is defined as ages 15–59 for both men and women. ^bOf the 21.7 percent not reinterviewed, 0.2 percent were refusals, 10.2 percent moved out of standard enumeration area (SEA), 5.7 percent were recorded as dissolved, and 5.2 percent noncontact. ^cAMR (adult mortality rate) = (Prime-age deaths/1000 prime-age person years). Figures in parentheses are AMR including individuals who joined the household and died between 2001 and 2004 but were not in the first survey. ^dCause of death is defined as HIV/AIDS using lay diagnosis data of the deceased. ^eWHO classification: two major signs (weight loss greater than 10 percent of body weight in a short period of time, chronic diarrhea for more than a month) and at least one minor sign (persistent cough for more than 1 month, itching skin rash, fungal infection of mouth and/or throat, history of herpes zoster, generalized herpes simplex infection, and enlarged lymph nodes).

had left the sample between 2001 and 2004 for causes other than death, such as moving to another location, getting married, and starting another household elsewhere. Excluded from this analysis are 211 prime-age individuals who joined the household after the 2001 survey and died between 2001 and 2004. Strictly speaking, the relevant sample is composed of prime-aged adults who were residents of sampled households in 2001. Including individuals joining sampled households later might overestimate the prevalence of prime-aged mortality, as indicated in Table 2.1, columns d and e (figures in parentheses). Other studies have found that a high proportion of HIV-positive individuals returned to their rural families to receive terminal care after becoming ill (e.g., Kitange, Machibya, and Black 1996).

To test for possible bias in results caused by household attrition, the mean levels of control variables measured in May 2001 were compared for households that were reinterviewed versus those that were lost to attrition. The means of many variables differ statistically between reinterviewed and lost households. For example, households not reinterviewed had slightly younger household heads (43 years vs. 45 years), smaller household sizes with fewer children age 5 and below, fewer boys and girls age 6 to 14, fewer prime-age men and women, and fewer elderly men, slightly smaller landholdings, less farm equipment and animals, and slightly higher rates of chronically ill adults in 2001. This is not surprising given the fact that the households lost to follow-up were smaller to start with in 2001. Systematic differences between those reinterviewed and those not, coupled with a high attrition rate, may cause concern about inference with these data. Also, if the lost households suffered a higher incidence of PA mortality between 2001 and 2004, there would be attrition bias in estimating the ex ante socioeconomic characteristics of individuals who died of AIDS-related causes.⁵ So one should be worried about the possibility of systematic attrition leading to selection bias.

In order to deal with potential attrition bias, the inverse probability weighting (IPW) method is adopted, which assumes that the probability of being reinterviewed as a function of observables information is the same as the probability of being reinterviewed as a function of observables, plus unobservables that are observable only for nonlost observations (see Wooldridge 2002).⁶ In general, the IPW method works well if the observations on observed variables are strong predictors of nonattrition and if the observations on unobserved variables are not strong predictors of nonattrition. Interview-quality variables are used to predict interview; in particular, 59 enumeration teams are used to predict reinterview. Each enumeration team was headed by a supervisor who was authorized to decide how much effort enumerators make to contact designated households after not finding a valid respondent at home after the first visit. The reinterview model is specified as follows:

$$\text{Prob}(R_{kbt} = 1) = f(\text{HIV}_{t-j}, I_{bk,2000}, X_{b,2000}, E_{bt}, P) \quad (2.1)$$

where R_{kbt} is 1 if individual (k) is in a household (b) that is reinterviewed at time t , conditional on being interviewed in the previous survey and 0 otherwise; HIV_{t-j} is the district HIV prevalence rate at the nearest surveillance site in 1999; $I_{bk,2000}$ is a vector of individual characteristics in 2000; $X_{b,2000}$ is a set of household characteristics in the 2001 survey including landholding, productive assets, demographic characteristics (number of children ages 5 and under, number of prime-age men and women), and ownership of various assets; E_{bt} is a set of 59 enumeration team dummies; and P is a set of nine provincial dummies. Note that all of the variables in equation 2.1 are observable even for individuals in households that were not reinterviewed in 2004.

Equation 2.1 is estimated with probit for attrition between the 2001 and 2004 surveys, obtaining predicted probabilities (Pr_{2001}). Then, the inverse probability ($1/\text{Pr}_{2001}$) is computed and applied to the probit models, estimating the determinants of prime-age (PA) mortality. Because of space restriction we do not discuss the results from the reinterview models.

Estimation Strategies and Variables

In order to examine the relationship between socioeconomic characteristics and the probability of PA death, all individuals in households interviewed in 2001 were used, and it was determined whether they died between 2001 and 2004. Probit regressions were run for a dichotomous (0/1) dependent variable that equals 1 if the person died of disease-related causes and 0 otherwise. The base model for the analysis is as follows:

$$\text{Prob}(A_{it} = 1) = g(I_{i2000}, X_{b2000}, \text{HIV}_{t-j}, C) \quad (2.2)$$

where A is a binary variable that equals 1 if individual i died between 2001 and 2004, 0 otherwise; I_{i2000} is a set of individual characteristics in 2000; X_{b2000} is a set of household characteristics in 2000; HIV_{t-j} is the lagged district HIV prevalence rate in 1999; and C is a set of community variables including 393 village dummies. Because initial 2000 conditions associated with subsequent mortality are being measured, all of the variables are observable even for individuals in households that were not reinterviewed in 2004 but were contained in the 2001 survey. The vector of individual characteristics includes relationship of the deceased to the person who was household head in 2000, marital status, age, years of education, and months residing away from home. Ages are entered as 5-year age groups up to the age of 59, with ages 15 to 19 as the reference group. Years of schooling are also included

in dummy variable form for lower primary (1 to 3 years), upper primary (3 to 6 years), completed primary (7 years), and secondary and higher schooling (8 years and above), with the reference group being those with no formal schooling. Months away from home are divided into three binary variables: 0, 1, and 2 or more months away during the 2000/01 survey season. Individuals who died in 2001 are excluded in computing months away from home variables because 86 (22 percent of total prime-age deaths) of those who died in 2001 were at home all the time in 2000, suggesting that these individuals were already chronically ill and were more likely to be at home throughout the year.

Household characteristics include landholding size, a dummy variable for prior prime-age death between 1996 and 2000, value of productive assets (farm equipment and farm animals), and ownership of durable assets (housing quality, radio, motor vehicles, and water source).

Community variables include distance of the village from the nearest tarmac road and district town and whether the district is located on a railroad line (proxies for degree of interaction between local residents and extent of contact with outsiders passing through the area). The inclusion of quadratic terms of landholding size, productive assets, and distance of village from the nearest tarmac road and district town are tested for because their marginal effect on the probability of being afflicted may be nonlinear. However, specification tests rejected the nonlinearity hypotheses in all cases, so no quadratic terms are included in the reported model results.⁷

Potential regional differences in factors associated with prime-age adult mortality in terms of wealth and income were also tested for, but there was very limited evidence of this through specification tests, so the pooled national sample is used, which is further stratified by gender and assets and/or income status.⁸

Equation 2.2 is estimated with probit using the inverse probabilities from the reinterview model as weights. We run province and village effect models on the full sample as well as estimate separate models for prime-aged men and women and for individuals in the top versus bottom half of the 2001 assets distribution in order to understand whether the socioeconomic correlates of adult mortality vary by gender and wealth status. Provincial fixed-effects models allow us to examine the effects of variables measured at the district level, such as lagged HIV prevalence rates and indicators of market access (distance to the nearest town, distance to the nearest tarmac road, and district on a railroad line). These models also provide more accurate estimates of probability of death over the 3-year survey interval because the full sample is utilized.⁹ All findings pertaining to probability of mortality are derived from these models. By contrast, the advantage of village-fixed-effects models is that they control for intervillage differences in the attributes of mortality and thus

may provide a more accurate indication of the importance of household-level and individual-level correlates of mortality within communities. Because of space restrictions we report results only from provincial fixed effects.

It is likely that individual participation in nonfarm income activities, having formal or informal business income, months away from home, and prior prime-age death, are likely to be endogenous because they may be related to household's wealth status and individual's educational attainment, which may increase or decrease the likelihood of contracting and dying from AIDS-related cause. Therefore, to check the robustness of our results we run two sets of models, with and without these variables. However, the results on the impact of wealth and education on the likelihood of death from illness were not statistically significant even when we exclude the likely endogenous variables. Therefore, we report the results from the two models side by side but discuss in detail only the findings from the longer models.

Results

Adult Mortality and HIV Prevalence in Zambia

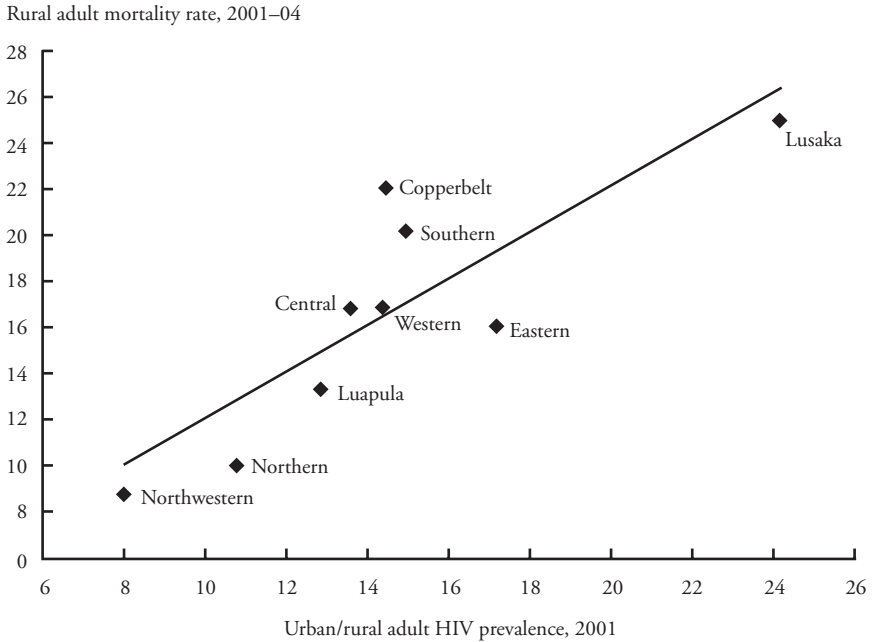
We begin by investigating the correlation between prime-age mortality rates from the Zambia panel household survey data and district HIV prevalence rates from antenatal clinics as reported in Zambia's Demographic Health Survey (CSO, MoH, and Macro International 2003).¹⁰ A strong relationship between prime-age mortality and HIV prevalence rates would suggest that a large proportion of prime-age mortality observed in our household data is indeed from AIDS-related causes.

Figure 2.1 presents a scatter plot of provincial HIV prevalence and rural adult mortality rates from our provincially representative household data. The strength of these correlations is notable, especially considering that the provincial HIV prevalence rate is not disaggregated by urban/rural classification. The Pearson correlation coefficient of 0.84 suggests that the adult mortality rates observed in our survey data is closely associated with HIV prevalence.

Descriptive Analysis

Table 2.2 presents characteristics of the prime-aged individuals who died in sampled households. The following features are discernible. First, more women die from prime-aged disease (and, most likely, from AIDS) than men. The first row of Table 2.2 reports absolute numbers of prime-aged men and women having died compared to individuals remaining in the sample. After weighting of the results to the national level, results indicate that 61 percent of the illness-related prime-age deaths in Zambia's small- and medium-scale farm sector between 2001 and 2004 were

Figure 2.1 Correlation between provincial adult mortality rates from CSO 2001 and 2004 household survey data and 2001 HIV Prevalence Rates, Zambia



Note: Pearson correlation coefficient is 0.84.

Sources: Adult mortality rates are derived from the 2001 and 2004 household surveys. HIV prevalence rates are from 2001 Sentinel Surveillance Site information published by the Ministry of Health and Zambia Demographic and Health Survey, respectively.

women. These results are also consistent with emerging evidence that a higher proportion of women are dying of AIDS than men in Southern Africa (UNAIDS 2003). Women's mortality rates are expected to be somewhat higher than men's in low-income countries even in the absence of HIV because of maternal-related mortality, but these figures count only illness-related deaths. An important question is whether this 61 percent finding is explained by the physiological differences between men's and women's susceptibility to contracting the disease,¹¹ or whether it also reflects gender differences in the use of ARV therapy. Because the use of ARV therapy was known to be extremely low during the survey period (fewer than 1 percent of all HIV-positive individuals), it is likely that physiological difference is the primary explanation for this finding. In addition, prime-age female mortality is occurring predominantly among single women in the younger age groups. These

Table 2.2 Descriptive statistics among PA^a adults who died from illness in 2001–04 and remaining PA adults in the sample

Attributes	PA adult deaths from illness in 2001–2004		PA adults remaining in the sample	
	Male	Female	Male	Female
Number prime-age adults (unweighted)	165	233	5,735	5,851
Number prime-age adults (weighted)	17,801	27,730	659,478	677,593
Individual characteristics in 2000				
Relationship of deceased to the household head in 2000 (%)				
Head/spouse	55.5	54.6	61.5	76.4
Others (sons and daughters, uncles, etc.)	44.5	45.4	38.5	23.6
Marital status 2000 (%)				
Single	43.5	55.4	38.3	32.5
Married	56.5	44.6	61.7	67.5
Age (years)	35.6	33.5	31.2	32.7
Completed school (%)				
No formal education	7.5	21.9	9.8	22.9
1–3 years	11.6	16.7	10.6	16.1
4–6 years	20.9	22.7	25.4	25.2
7 years and above	60.1	38.7	54.2	35.7
Salaried/wage employment (%)	11.3	3	14.2	4.1
Informal/formal business activities (%)	21.2	13.2	18.5	13.3
Months spent away from home (median)	0.4	0.5	0.4	0.3
Household characteristics				
Female-headed households in 2000 (%)	17.7	32.6	12.3	22.8
Prior death of adults 1996–2003 (% of households) ^b	68.4	65.5	6.0	5.9
Landholding size in 2000 (hectares)	3.4	2.7	3.0	2.9
Draft animals and equipment (000 Zkw)	641.9	588.1	729.2	664.4
Per capita household income quartiles in 2000 (%)				
Poor (bottom 50%)	47.6	56.1	49.0	50.7
Nonpoor (top 50%)	52.4	43.9	51.0	49.3
Community characteristics in 2000				
Distance to the nearest town (km)	31.4	33.1	33.4	34.4
Distance to the nearest tarmac road (km)	23.7	22.9	24.1	24

Source: CSO/MACO/FSRP Post Harvest Survey, 1999/2000, and Supplemental Survey, 2001 and 2004.

Notes: ^aPrime age is defined as ages 15–59 for both men and women. ^bRefers to other adults aged 15 to 59 in household who died up to 8 years before the individual under analysis.

results are consistent with the findings of a five-country study by Mather et al. (2004). Moreover, men and women who died between 2001 and 2004 were somewhat more likely to be better educated.

Attributes of Deceased Prime-Age Individuals

The probabilities of PA death for men and women were roughly 0.6 percent and 1.1 percent, respectively (see Chapoto 2006). However, the probability of death for

relatively nonpoor men was 0.9 percent and 0.6 percent (depending on whether the sample is stratified in terms of 2001 income or asset levels), whereas for relatively poor men, the death probabilities were 0.5 percent and 0.8 percent. There was little variation in probability of death between poor and nonpoor women (Table 2.3).

For both relatively poor and nonpoor women, being married and/or the head or spouse of the household significantly reduces the likelihood of death. Among men, the effects of being married in 2001 on the probability of mortality between 2001 and 2004 are weak but still negative. In the village fixed-effects models, relatively poor men who are heads of households are significantly less likely to die than other poor men.

Other variables that affect the probability of death are whether the individual resided at home throughout the year, whether the household experienced prior prime-age mortality, and education (for nonpoor women mainly). Variables that had little effect or ambiguous effects on the probability of dying included whether the individual was engaged in formal or informal business activities, landholding size of the household, and community indicators of proximity to towns and markets.

To aid in understanding the magnitude of the impact of these variables on death probabilities, the provincial-fixed effects model results reported in Table 2.3 were used to compute estimated probabilities of dying over the 3-year period for 20 different individual “profiles.” These simulations are reported in Table 2.4 and discussed in the remainder of this chapter.

Relationship of Deceased to Head of Household

Single and relatively young women are much more likely to die than married women. Individual profiles 1 and 2 in Table 2.4 are identical in every respect except for their marital status. According to the probit model results, women fitting the “profile 2” category have a 1.09 percent likelihood of dying over a 3-year period, compared to 0.45 percent for women fitting the “profile 1” category. With other attributes constant, single women are about 2.4 times more likely to die of disease-related causes than married women. Married men are also less likely to die from disease-related causes than single men. As seen in profiles 12 and 13 in Table 2.4, single men with the specified characteristics are 59 percent more likely to die than married men with otherwise similar characteristics.

Age Groups

Age is one of the more important determinants of death from illness as shown by the marginal probabilities in Table 2.3 (where the 15- to 19-year-old age group dummy is omitted). The marginal probability of dying from disease rises steeply

Table 2.3 Probit models^a of PA mortality in 2001–04 by gender and wealth status (provincial–fixed effects models) corrected for attrition

	Deceased prime-age adult (= 1, 0 otherwise)							
	Asset poor (bottom 50%)				Asset nonpoor (top 50%)			
	Male		Female		Male		Female	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Individual characteristics in 2000								
Head/spouse (= 1)	-0.004 (1.00)	-0.004 (1.10)	-0.007 (1.16)	-0.005 (0.94)	0.003 (0.46)	0.003 (0.50)	-0.007* (0.98)	-0.006* (1.05)
Currently married (= 1)	-0.009 (1.80)	-0.005 (1.35)	-0.007 (2.37)	-0.005 (2.41)	0.004 (1.03)	0.005 (0.94)	-0.003 (1.86)	0.001 (1.92)
Never married (= 1)	-0.009 (1.70)	-0.005 (1.18)	-0.007 (1.38)	-0.005 (1.11)	0.004 (0.43)	0.005 (0.55)	-0.003 (0.34)	0.001 (0.12)
Age groups in 2000 (= 1)								
Age 20–24	0.017* (2.09)	0.011* (2.01)	0.009 (1.09)	0.008 (1.08)	0.003 (0.52)	0.002 (0.36)	0.008 (1.07)	0.007 (1.01)
Age 25–29	0.030** (2.74)	0.022** (2.50)	0.015 (1.51)	0.016 (1.80)	0.043** (3.68)	0.042** (3.64)	0.038** (3.23)	0.041** (3.75)
Age 30–34	0.027* (2.28)	0.015* (1.94)	0.041** (2.95)	0.042** (3.22)	0.037** (2.75)	0.032* (2.47)	0.029* (2.02)	0.032* (2.29)
Age 35–39	0.036** (2.60)	0.028** (2.44)	0.025* (2.10)	0.024* (2.21)	0.042** (2.84)	0.040** (2.76)	0.060** (2.98)	0.063** (3.35)
Age 40–44	0.090** (3.59)	0.080** (3.59)	0.023 (1.84)	0.027* (2.20)	0.044** (2.97)	0.046** (2.91)	0.038* (2.35)	0.041** (2.74)
Age 45–49	0.067** (3.14)	0.077** (3.16)	0.031* (1.98)	0.031* (2.08)	0.073** (3.81)	0.068** (3.65)	0.001 (0.10)	0.004 (0.36)
Age 50–54	0.097** (3.78)	0.067** (3.74)	0.003 (0.28)	0.004 (0.38)	0.101** (3.54)	0.096** (3.47)	0.029 (1.75)	0.033* (2.06)
Age 55–59	0.108** (3.81)	0.100** (3.90)	0.021 (1.50)	0.023 (1.70)	0.079** (3.76)	0.078** (3.70)	0.031 (1.65)	0.031 (1.78)
Years of education in 2000 (= 1)								
1–3 years	0.005 (0.83)	0.003 (0.57)	0.009 (1.45)	0.008 (1.33)	0.034* (2.14)	0.032* (2.12)	-0.009 (1.76)	-0.009* (2.08)

4–6 years	0.003 (0.55)	0.001 (0.26)	0.003 (0.52)	0.002 (0.33)	0.022* (2.03)	0.021* (2.05)	-0.010* (2.03)	-0.009* (2.03)
7 years	0.017** (2.60)	0.012** (2.21)	-0.003 (0.49)	-0.003 (0.54)	0.012 (1.32)	0.011 (1.29)	-0.007 (1.21)	-0.007 (1.40)
8 years and above	0.006 (1.07)	0.003 (0.77)	0.014 (1.65)	0.013 (1.58)	0.010 (1.27)	0.008 (1.06)	-0.009 (1.91)	-0.010** (2.58)
Salary wage income in 2000 (= 1)	-	0.008* (2.27)	-	-0.008 (1.44)	-	0.002 (0.56)	-	-0.009 (1.41)
Business activity in 2000 (= 1) ^b	-	0.002 (1.13)	-	-0.002 (0.47)	-	-0.002 (0.64)	-	0.002 (0.42)
Resided in home throughout the year in 2000 (= 1) ^b	-	0.002 (3.85)	-	-0.002 (4.44)	-	-0.002 (2.65)	-	0.002 (6.02)
One month spent away from home in 2000 (= 1)	-	-0.002 (0.90)	-	-0.012* (2.37)	-	-0.007 (1.12)	-	-0.012** (2.99)
Household characteristics in 2000								
Polygamous household (= 1)	-0.006 (1.91)	-0.005* (2.25)	-0.001 (0.11)	-0.001 (0.17)	0.002 (0.35)	0.001 (0.26)	0.002 (0.39)	0.003 (0.59)
Prior PA death in 1996–2003 ^c (= 1)	-	0.140** (11.77)	-	0.169** (14.37)	-	0.079** (10.43)	-	0.111** (9.96)
ln[Landholding size (hectares)]	-0.000 (0.19)	-0.000 (0.17)	-0.001 (0.34)	-0.001 (0.48)	-0.003 (1.48)	-0.003 (1.49)	-0.005* (2.42)	-0.005** (2.70)
Community characteristics								
District HIV prevalence rate in 1999	-0.000 (0.48)	-0.000 (0.37)	0.000 (0.45)	0.000 (0.51)	0.001 (0.66)	0.001 (0.72)	0.002* (2.29)	0.002* (2.57)
District on the line of rail (= 1)	-0.000 (0.07)	-0.001 (0.36)	-0.005 (0.83)	-0.004 (0.79)	0.001 (0.17)	0.000 (0.05)	-0.006 (1.21)	-0.008 (1.72)
Distance to the nearest tarmac road (km)	-0.000 (0.39)	-0.000 (0.13)	-0.000 (0.00)	0.000 (0.03)	0.000 (0.50)	0.000 (0.53)	0.000 (0.41)	0.000 (0.47)
Distance to the district town/boma (km)	0.000 (0.55)	0.000 (0.44)	0.000 (0.24)	0.000 (0.21)	0.000 (0.79)	0.000 (0.66)	0.000 (1.63)	0.000* (1.97)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Predicted probability of dying from disease-related causes ^d	0.006	0.005	0.013	0.012	0.009	0.009	0.012	0.011
Number of observations	3,596	3,596	3,977	3,977	3,812	3,812	3,711	3,711

Source: CSO/MACO/FSRP Post Harvest Survey, 1999/2000, and Supplemental Survey, 2001 and 2004.

Notes: ^aAbsolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. ^{**} indicates 1 percent significance level; ^{*} indicates 5 percent significance level.

^bFormal or informal business activities. ^cRefers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis. ^dThe probability of dying from disease related causes, setting all explanatory variables at their mean values.

Table 2.4 Simulations^a of the probability of mortality based on specific individual and household attributes

Individual profile	Gender	Marital status	Income group	Age group	Education	Months away from home per year	Salary wage income	Formal/informal business income	Prior death of adult in household, 1996–2004	Predicted P of mortality in 3-year period	
										Assets (%)	Income (%)
1	Female	Married	Low	25–29	4–6 years	0	No	No	No	0.45	0.59
2	Female	Single	Low	25–29	4–6 years	0	No	No	No	1.09	2.17
3	Male	Married	Low	25–29	4–6 years	0	No	No	No	0.01	0.66
4	Male	Single	Low	25–29	4–6 years	0	No	No	No	0.34	1.50
5	Female	Married	High	20–24	4–6 years	0	Yes	No	No	0.03	0.05
6	Female	Single	High	20–24	4–6 years	0	Yes	No	No	0.28	0.20
7	Female	Single	High	20–24	1–3 years	0	No	No	No	0.66	0.95
8	Female	Single	High	20–24	1–3 years	0	No	Yes	No	0.73	1.41
9	Female	Single	Low	20–24	1–3 years	0	No	No	No	1.25	1.33
10	Female	Single	Low	20–24	1–3 years	0	No	Yes	No	1.11	0.82
11	Female	Single	Low	20–24	1–3 years	≥2	No	Yes	No	4.69	3.45
12	Male	Married	High	45–49	≥8 years	0	No	No	No	0.90	0.44
13	Male	Single	High	45–49	≥8 years	0	No	No	No	2.09	1.93
14	Male	Single	High	45–49	≥8 years	≥2	Yes	No	No	7.76	8.67
15	Male	Single	High	45–49	≥8 years	0	Yes	No	No	3.61	2.69
16	Male	Single	Low	45–49	≥8 years	0	No	No	No	1.58	1.14
17	Male	Married	High	45–49	≥8 years	0	No	No	No	0.90	0.44
18	Male	Married	High	45–49	≥8 years	0	No	No	Yes	12.8	14.9
19	Female	Married	High	35–39	≥8 years	0	No	No	No	0.72	1.29
20	Female	Married	High	35–39	≥8 years	0	No	No	Yes	12.2	18.8

Source: CSO/MACO/FSRP Post Harvest Survey, 1999/2000, and Supplemental Survey, 2001 and 2004.

^aSimulation outcomes based on regression models in Table 2.3. For purposes of the simulation, married men and women are simulated as being heads and spouses of their households.

from age 15, peaking between ages 30 and 39 for poor females and 45 to 59 years of age for men, regardless of their poverty status. This finding confirms previous findings showing that women are more likely to die at an earlier age than their male counterparts. The predicted probability of dying from diseases for women residing in relatively high-asset households rises from age 15, peaks between ages 50 and 54, and then declines. However, among women in relatively poor families, the probability of mortality peaks in the 30- to 34-year age range. The predicted probability of disease-related mortality for a relatively poor woman in the 30- to 34-year age range is roughly twice as high as for a poor woman in the 20- to 24-year age range. The probability of mortality for a relatively nonpoor woman in the 30- to 34-year age range is only 1.3 times higher than a nonpoor woman in the 20- to 24-year age range.

Education, Mobility, Income, and Household Wealth Indicators

Unlike earlier studies in Sub-Saharan Africa that generally found a positive correlation between education and HIV-related deaths (e.g., Ainsworth and Semali 1998; Gregson, Waddell, and Chandiwana 2001; Hargreaves and Glynn 2002), the results in Table 2.4 show a much weaker relationship between educational attainment and the probability of mortality from disease. There is no statistically significant relationship for men in households with either low or high income and/or assets even after exclusion of all potentially endogenous variables as discussed earlier. This appears to be in contrast to earlier findings showing that highly educated men were the most likely to die of disease-related death (Ainsworth and Semali 1998). Among women, the findings generally indicate a negative relationship between educational attainment and the probability of disease-related death, especially for relatively nonpoor women. These findings are consistent with de Walque (2004), who found that over time, susceptibility to HIV/AIDS in Uganda declined for relatively well-educated people more than for poorly educated people, as information regarding precautionary measures spread. One apparent implication of this finding is that well-educated and (especially) poorly educated men and women should continue to be targeted for HIV/AIDS education campaigns.

The results are somewhat consistent with findings in the 1980s and early 1990s indicating that prime-age mortality is more likely to affect men in the upper income brackets. This can be seen in Table 2.4 by comparing profiles 13 and 16, which are identical in all respects except for assets and/or income. Nonpoor men with the attributes shown in profile 13 are 1.3 times more likely to die of disease-related deaths compared to men in the bottom half of the assets distribution (nonpoor men have a probability of mortality over a 3-year period of 2.09 percent compared to 1.58 percent for men in the bottom half of the assets distribution). Although

poverty might be expected to raise the probability of infection of sexually transmitted diseases and HIV because men with low incomes may be less able to afford condoms or STD treatment, our findings indicate that the influence of high economic and social status tends to predominate for men. As shown in Table 2.3, women in the lower and upper half of the asset distribution are equally likely to die of disease-related causes, with the probability of mortality over the 3-year period being roughly 1.0 percent regardless of their households' income or asset levels. This may vary somewhat according to age group. For example, comparison of profiles 7 and 9 shows that women in the bottom half of the asset distribution (with the particular characteristics specified for these profiles) have a probability of mortality over a 3-year period of 1.25 percent compared to 0.66 percent for women in the top half of the assets distribution. If the age group of profiles 7 and 9 is changed from 20–25 to 35–39 and all other characteristics are kept the same, the opposite result is obtained: women in the bottom half of the asset distribution have a probability of mortality over a 3-year period of 2.2 percent compared to 3.2 percent for women in the top half of the assets distribution. This finding highlights the sensitivity to age group of the relationship between poverty and probability of death.

Women from relatively poor households who have some form of formal or informal business income are less likely to die of disease-related causes than poor women who did not have any formal or informal business activity (profiles 9 vs. 10). This finding seems to support Epstein (2002, 2003), who contends that female members in poorer households with few employment opportunities are more likely to engage in riskier sexual activities for economic reasons, exposing themselves to HIV infection.

So efforts to provide greater income-earning opportunities for poor women may make at least a modest contribution to reducing female PA mortality. However, Epstein's argument is contradicted by our finding that women from relatively nonpoor households having some formal or informal business income are 10 percent more likely to die of disease-related causes than women with similar characteristics not having business income. Nonpoor women with businesses are more likely to spend more time away from home and have more social interactions than poor women with and without businesses. Other things equal, working women with their own income sources may be less vulnerable (along the lines of Epstein's argument), but working may also involve being outside the village or working away from home more, which may in turn increase certain risk factors. Recent research demonstrates that relative economic disadvantage is found to significantly increase the likelihood of a variety of unsafe sexual behaviors and experiences in KwaZulu-Natal Province, South Africa (Hallman and Grant 2004). However, the findings from rural Zambia provide mixed evidence, which calls into question the view that poverty leading

to risky behavior is the major pathway through which the disease is spread, although this may certainly be one of many pathways. Among rural prime-aged Zambian women, there appears to be no clear relationship between income and asset levels, access to business income, and probability of dying.

The results show that irrespective of poverty status, men and women living 2 months or more away from home per year in the 2000/01 period are more likely to die of disease-related causes between 2002 and 2004 than men and women of the same characteristics who spent all the time at home. For example, comparison of profiles 14 and 15 shows that nonpoor men who spend 2 months or more away from home in 2000/01 have a probability of mortality over a 3-year period of 7.8 percent, whereas men of the same characteristics who spend all their time at home and did not die in 2001 had a probability of mortality over the same period of 3.6 percent. In contrast, comparison of profiles 10 and 11 showed that poor women living 2 months or more away from home are four times more likely to die of disease-related deaths than women of the same characteristics who resided at home throughout the year.

Finally, the probit results show that the prior death of at least one adult in the household over the past 8 years is the single most important factor influencing the probability that a prime-aged individual will die as a result of illness.¹² Irrespective of income or assets status, men and women experiencing a prior death of a prime-age person in their household are 14 to 16 times more likely to die of disease-related causes than the average prime-age individual. This is shown by comparing Table 2.4 profiles 17 and 18 for men and profiles 19 and 20 for women. The probability that men and women with the profiles shown in rows 18 and 20 would die over a 3-year period is 12.8 percent and 12.2 percent, respectively. In this way, AIDS differs from other kinds of diseases (e.g., malaria) that do not appreciably raise the likelihood of subsequent death in the family after one member contracts the disease. To the extent that the death of two prime-age members from the same household within a few years of each other causes extreme hardships on remaining members, especially for children, the implication of this finding is that special programs to target and support AIDS-afflicted households are likely to become an important component of poverty reduction strategies, especially in areas hard hit by AIDS, such as most of eastern and southern Africa.

Household variables that appeared to be largely unrelated to the probability of an individual dying from disease include several indicators of rural wealth such as landholding size and livestock assets. As reported in Table 2.3, indicators of market access, such as the village's distance to the nearest tarmac road or district town, were largely unrelated to the probability of an individual dying from disease. This indicates that the disease has moved far into the interior of rural Zambia, such that

proximity to towns and highways that initially were the main locations where the disease was transmitted no longer has a significant bearing on the probability of death. District-level HIV prevalence rates are correlated strongly only with the probability of death among women in the nonpoor groups. This is perhaps not surprising because HIV prevalence rates are derived from blood tests of women (not men) who visit antenatal clinics in periurban and urban areas, who are more likely to be nonpoor than most women contained in this sample.

Conclusion

This study has identified important ex ante socioeconomic conditions of individuals and households in rural Zambia who die between the ages of 15 and 59 years of disease-related causes, using nationally representative panel data on 18,821 individuals surveyed in 2001 and 2004 in rural Zambia. The findings of the study can help policymakers and development agencies better understand current transmission pathways of HIV/AIDS, which should help in the formulation of up-to-date AIDS prevention and mitigation strategies.

Overall, the probability that a prime-aged (i.e., 15- to 59-year-old) woman would die of disease-related causes was roughly 1.0 percent over the 3-year period, whereas the comparable probability for men was 0.6 percent. Just over 60 percent of the prime-age deaths observed in this nationally representative rural sample were women, supporting other findings that women are being disproportionately afflicted by the disease.

Consistent with findings in the 1980s and early 1990s, we find that men in the upper half of the assets distribution are more likely to die of disease-related causes than men residing in poor households. In contrast, women in the lower half of income/assets distribution are equally likely to die of disease-related causes as women residing in the upper half of assets/income distribution. An emerging strand of the social science literature on HIV/AIDS in Africa stresses the relationships among poverty, risky sexual behavior, and subsequent contraction of the disease. It has been argued that single women unable to sustain themselves through wage labor or agriculture are more likely to resort to transactional sex for survival. If this is an important social pathway contributing to the spread of the disease in Africa, then we expected to find a relationship over time between household- and individual-level indicators of poverty, especially for single women, and subsequent chronic illness and death. We find that, regardless of the initial poverty status of their households, women who have some form of formal or informal business income are about as likely to die of disease-related death as women with no formal or informal business activity, after controlling for other socioeconomic characteris-

tics. This finding suggests that efforts to provide greater income-earning opportunities for poor women may make a modest contribution at best to reducing female prime-age mortality. These findings also suggest that the social factors driving the spread of AIDS are considerably more complex than simply poverty-based explanations, although poverty may certainly contribute to risky behavior and poor health, which are important pathways by which the disease is spread.

By contrast, there are several other socioeconomic variables that do have a major influence on probability of mortality. Single women and men in poor households are twice as likely to die of disease-related causes as poor women and men who are the heads or spouses of their households. Single women and men in relatively nonpoor households are 3.7 and 4.5 times more likely to suffer a disease-related death compared to married nonpoor women and men who are the heads or spouses of their households. Individuals who spend 2 months or more away from home are 2 to 10 times more likely to die of disease-related causes in succeeding years than individuals with similar socioeconomic attributes who reside at home all year. Mobility is thus a significant risk factor. It is possible that the creation of business opportunities that involve men and women spending more time away from home for extended periods may exacerbate the AIDS problem in rural Zambia and negate the positive effects of greater financial independence for women, unless progress is made in public health and educational campaigns to promote the use of condoms, other forms of safe sex, and prevention interventions.

Years of formal education was found to be largely unrelated to vulnerability to death for men. For women, the evidence is not robust, but the data tend to show that educational attainment reduces somewhat women's vulnerability to disease-related death, especially for nonpoor women. This result may indicate that public health information is indeed working for the more educated strata of rural Zambian society because earlier studies in the region found that HIV rates were much higher for relatively well-educated men and women (Ainsworth and Semali 1998). This finding suggests that education coupled with public health campaigns may be an important empowerment tool for women and may help to reduce the risk of HIV contraction among women. Also, HIV/AIDS education campaigns should still target both the literate and illiterate because men of any education level have roughly the same risk of contracting HIV.

Most importantly, the prior death of a prime-aged person in the household substantially increases the probability of another prime-aged member dying. Irrespective of poverty status, prime-aged men and women experiencing a prior death in their household are 23.0 and 18.1 times more likely to die of disease-related causes than men and women in households with no prime-age deaths in the past 8 years. The predicted probability of death was 12.4 percent and 16.3 percent for

men and women experiencing a prior disease-related death in their household in the past 8 years versus 0.54 percent and 0.90 percent for men and women not experiencing a prior prime-aged death. Of the 362 households experiencing prime-age mortality between 2001 and 2004, 15 percent of them suffered multiple prime-age deaths. In this way, AIDS differs from other kinds of diseases (e.g., malaria), which does not appreciably raise the likelihood of subsequent death in the family after one member contracts the disease. To the extent that the death of two prime-age members from the same household within a few years of each other causes extreme hardships on remaining members, especially for children, the implication of this finding is that programs and strategies to support the care and education of orphans and children in AIDS-afflicted households may need to become a critical component of poverty reduction strategies in areas hard hit by AIDS, such as most of eastern and southern Africa. More research is necessary to understand the longer-term impacts of the disease on household behavior and welfare and to develop programs that can mitigate the adverse consequences. At this time, the research community still knows very little about the cost-effectiveness of alternative ways of mitigating the impacts of AIDS, but a solid understanding of the socioeconomic factors associated with the disease is likely to help considerably in designing appropriate risk messages and prevention strategies.

Notes

This research has been funded through the USAID/Zambia Mission and USAID/Global Bureau, Office of Agriculture and Food Security, and the Africa Bureau Office of Sustainable Development. This chapter draws from Chapoto's Ph.D. dissertation (see Chapoto 2006).

1. "Standard enumeration areas" (SEAs) are the lowest geographic sampling unit in the Central Statistical Office's sampling framework for its annual Post Harvest Surveys. Each SEA contains roughly 150 to 200 rural households.

2. This includes only households with individuals in both the first and second surveys. A small number of recorded deaths were the result of violence or accidents; these were excluded from the analysis.

3. A review of literature on verbal autopsies and lay diagnoses shows that there is no "ideal" method of measuring AIDS-specific mortality in a Zambian population-based sample. Therefore, we cannot get a "gold standard" diagnosis on a true population basis because the validation of verbal autopsy studies in literature are flawed (the validation samples come from a clinical sample and therefore are not likely to be representative of the population) (G. Birbeck, Michigan State University, personal communication, November 2004).

4. After weighting, women accounted for 61 percent of PA mortality.

5. Available evidence on attrition rates in longitudinal surveys in developing countries range from 5 to 30 percent for two rounds (see Alderman et al. 2001; Duncan, Frankenberg, and Smith 2001; Yamano and Jayne 2004). For a discussion of IPW, see Wooldridge (2002).

6. The literature addressing the detection and correction of selection bias is extensive, and a complete review of this literature is beyond the scope of this chapter. Overviews of sample selection models can be found in Fitzgerald, Gottschalk, and Moffit (1998) and Alderman et al. (2001).

7. In addition to the linear terms, the quadratic terms of landholding size, productive assets, and distance of village from the nearest tarmac road and district town are added to the models, and a test of joint significance is done in order to determine whether to include the quadratic term in addition to the linear term.

8. In order to test for regional wealth and/or income differences, we rank household wealth distribution (value of productive assets such as farm equipment and livestock) into terciles and then run two sets of models having two wealth dummies (top and bottom wealth distribution with the middle group as the reference), eight provincial dummies, and interaction terms of wealth distribution dummies and provincial dummies and other household and community variables in the second model. The joint test of significance of wealth and provincial dummies was rejected even at a 20 percent level of significance. A similar approach is done with household income (sum of value of productive assets, gross value of crop output, formal/informal business income, and nonfarm income), but the test for joint significance showed no regional difference by income status as well.

9. By contrast, when estimating models with village dummies, the estimation program automatically drops those households where no within-village variation in the dependent variable exists, which restricts the sample somewhat. Of the 393 villages in the sample, 118 villages experienced no prime-age disease-related mortality among their households. Estimating probability of mortality from such models will generate upwardly biased probabilities because of the many cases dropped of individuals residing in villages where there were no recorded disease-related deaths over the survey interval.

10. National estimates of HIV prevalence in Sub-Saharan Africa are almost exclusively based on surveys of antenatal clinics, the majority of which are located in urban areas. The Zambia Demographic Health Survey figures are derived from blood sample testing of a randomly selected national sample of PA adults.

11. Because of women's greater surface area where infected blood can be exchanged during sexual activity, the risk of HIV transmission from an infected male to a susceptible female is 2-4 times higher than the risk of HIV transmission from an infected female to a susceptible male (Chin 2003, drawing from Gray et al. 2001 based on findings from Rakai, Uganda).

12. Respondents in the 2001 survey were asked about prior deaths in the household back to 1996, whereas respondents in the 2004 survey were asked about deaths experienced in the household since the 2001 survey. A binary variable equaling 1 if the household experienced a death between 1996 and 2004 is then computed.

References

- Ainsworth, M., and I. Semali. 1998. Who is most likely to die of AIDS? Socioeconomic correlates of adult deaths in Kagera Region, Tanzania. In *Confronting AIDS: Evidence for developing world*, eds. M. Ainsworth, L. Fransen, and M. Over. Brussels: European Commission.
- Alderman, H., J. Behrman, H.-P. Kohler, J. Maluccio, and S. Watkins. 2001. Attrition in longitudinal household survey data: Some tests for three developing country samples. *Demographic Research* 5: 78-124.

- Central Statistical Office, Ministry of Health, and Macro International. 2003. *Zambia Demographic Health Survey (ZDHS), 2001/2002*. Lusaka, Zambia.
- Chapoto, A. 2006. *The impact of AIDS-related prime-age mortality on rural farm households: Panel survey evidence from Zambia*. Ph.D. dissertation, Michigan State University, East Lansing, Michigan.
- Chin, J. 2003. *Understanding the epidemiology and transmission dynamics of the HIV/AIDS pandemic*. School of Public Health, University of California/Berkeley. Paper presented at USAID, Washington, D.C., October 2003.
- De Walque, D. 2004. *How does the impact of an HIV/AIDS information campaign vary with educational attainment? Evidence from rural Uganda*. Policy Research Working Paper Series 3289. Washington, D.C.: World Bank.
- Duncan, T., E. Frankenberg, and J. P. Smith. 2001. Lost but not forgotten: Attrition and follow-up in the Indonesia Family Life Survey. *Journal of Human Resources* 36: 556–592.
- Epstein, H. 2002. The hidden cause of AIDS. *New York Times Review of Books* 49 (8), May 9, 2002.
- . 2003. AIDS in South Africa: The invisible cure. *New York Times Review of Books* 50 (12), July 17, 2003.
- Fitzgerld, J., P. Gottschalk, and R. Moffitt. 1998. An analysis of sample attrition in panel data. The Michigan Panel Study on Income Dynamics. *Journal of Human Resources* 33: 251–299.
- Gray, R. H., M. J. Wawer, R. Brookmeyer, N. K. Sewankambo, D. Serwadda, F. Wabwire-Mangen, T. Lutalo, X. Li, T. VanCott, T. C. Quinn, and the Rakai Project Team. 2001. Probability of HIV-1 transmission per coital act in monogamous, heterosexual, HIV-1 discordant couples in Rakai, Uganda. *Lancet* 357: 1149–1153.
- Gregson, S., H. Waddell, and S. Chandiwana. 2001. School education and HIV control in Sub-Saharan Africa: From discord to harmony? *Journal of International Development* 13: 467–485.
- Hallman, K., and M. Grant. 2004. *Poverty, educational attainment, and livelihoods: How well do young people fare in KwaZulu Natal, South Africa?* Horizons Research Summary. Washington, D.C.: Population Council.
- Hargreaves, J. R., and J. Glynn. 2002. Educational attainments and HIV-1 infection in developing countries: A systematic review. *Tropical Medicine and International Health* 7 (6): 489–498.
- Kitange, H. M., H. Machibya, and J. Black. 1996. Outlook for survivors in Sub-Saharan Africa: Adult mortality in Tanzania (abstract). *British Medical Journal* 312: 216–220.
- Mather, D., C. Donovan, T. S. Jayne, M. Weber, E. Mazhangara, L. Bailey, K. Yoo, T. Yamano, and E. Mghenyi. 2004. *A cross-country analysis of household responses to adult mortality in rural sub Saharan Africa: Implications for HIV/AIDS mitigation and rural development policies*. Michigan State University International Development Working Paper, IDWP 82. East Lansing, Michigan.

- Megill, D. J. 2004. *Recommendations on sample design for post harvest surveys in Zambia based on the 2000 census*. Working Paper 10. Lusaka, Zambia: Food Security Research Project/Zambia.
- UNAIDS. 2003. *AIDS epidemic update*. Geneva, Switzerland: WHO.
- Wooldridge, J. M. 2002. Inverse probability weighted M-estimators for sample selection, attrition and stratification. *Portuguese Economic Journal* 1: 117–139.
- Yamano, T., and T. S. Jayne. 2004. Measuring the impacts of working-age adult mortality on small-scale farm households in Kenya, *World Development* 32 (1): 91–119.