FOOD SECURITY RESEARCH PROJECT

CHARACTERISTICS OF INDIVIDUALS AFFLICTED BY AIDS-RELATED MORTALITY IN ZAMBIA

By

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ACKNOWLEDGMENTS

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ABSTRACT

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 and early 1990s generally found a positive correlation between socioeconomic characteristics such as education, income, and wealth and subsequent contraction of HIV. However, as the disease has progressed, the relationship between socioeconomic status and HIV contraction may have changed in many areas, although there is little hard evidence to support this.

Using nationally representative panel data on 18,821 individuals between 15-59 years of age in rural Zambia surveyed in 2001 and 2004, we estimate probit models to determine the *ex ante* socioeconomic characteristics of individuals and households who are subsequently afflicted by prime-age adult mortality. The results of these models are used to report the probabilities of disease-related mortality over a three-year period for a range of individual profiles that differ by gender, level of income, education, months residing away from home, distance to district town, and other individual and household characteristics.

The study highlights 10 major findings: (1) within the three-year period between May 2001 and May 2004, the probabilities of disease-related death for a prime-aged male and female were roughly 0.6% and 1.1%, respectively; (2) 61% 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; (3) single women and men are 2 to 5 times more likely to die of disease-related causes as women and men who are the heads or spouses of their households; (4) females are more likely to die at an earlier age than their male counterparts; (5) relatively wealthy men (defined according to household assets and income) are 1.4 to 1.8 times more likely to die than relatively poor men; (6) relatively wealthy and poor women are equally likely to die of disease-related causes; (7) among relatively poor women, those having some form of formal or informal business income are 15% less likely to die of disease-related causes than those without any form of business income; (8), by contrast, among relatively non-poor women, those with business income were 7% more likely to die than those without business income; (9) educational attainment was largely unrelated to vulnerability to death for men and only weakly so for women; and (10) irrespective of income 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% and 16.3% for men and women experiencing a prior-disease-related death in their household in the past 8 years versus 0.54% and 0.90% for men and women not experiencing a prior prime-aged death. Of the 362 households experiencing prime-age mortality between 2001 and 2004, 15% 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. These results hold many important implications for poverty reduction strategies in areas hard-hit by AIDS, such as most of eastern and southern Africa.

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1.0   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 paper seeks to determine the *ex ante* socioeconomic characteristics of individuals who die between the ages of 15 to 59 years of age (hereafter called "prime age" mortality), using nationally representative panel data on 18,821 individuals surveyed in 2001 and 2004 in rural Zambia. The findings from this study will help policy-makers and development agencies better understand current transmission pathways of HIV/AIDS, which should help in the formulation of AIDS prevention and mitigation strategies.

We estimate several probit models of disease-related mortality of prime-age (PA) individuals in rural Zambia between May 2001 and May 2004, using nationally representative rural household survey data collected by the Government of Zambia. 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.

The study highlights a number of findings: First, we find a strong correlation between PA mortality in our data and HIV-prevalence at nearby sentinel survey sites, supporting other findings that the rising number of disease-related mortality in rural Zambia is indeed related to AIDS (Ngom and Clark 2003). Second, within the three year period between May 2001 and May 2004, the probabilities of disease-related death for a prime-aged male and female were roughly 0.6% and 1.1%, respectively. Women accounted for 61% of the prime-age deaths observed in this nationally-representative rural sample between 2001 and 2004, supporting other findings that women are being disproportionately afflicted by the disease. Third, the marginal probability of dying from disease rises steeply from age 15, peaking between ages 30 and 39 for females, and 45-59 for males. This finding confirms previous findings showing that females are more likely to die at an earlier age than their male counterparts. Fourth, and 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 men are ranked by their households' total incomes and divided into two equal groups, the men in the upper half of the income distribution are found to be 81% more likely to die of disease-related causes than men from relatively poor households (probability of death being 0.85% vs. 0.47% over the 3-year survey interval). When ranked by asset levels, relatively non-poor men are 43% more likely to die of disease-related causes than men in poor households. Fifth, 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% regardless of their households' income or asset levels. Sixth, among relatively poor women, those having some form of formal or informal business income are 15% less likely to die of disease-related causes than those without any form of

business income. This finding suggests that efforts to provide greater income-earning opportunities for poor women may make at least a modest contribution to reducing female prime-age mortality. However, among relatively non-poor women, those with business income were 7% more likely to die than those without any business income. This finding, coupled with the finding that poor and non-poor 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. Seventh, single women and men are 2 to 5 times more likely to die of disease-related causes as women and men who are the heads or spouses of their households. Eighth, men and women living 2 or more months away from home per year are 2 to 10 times more likely to die than men and women living at home throughout the year. Ninth, educational attainment was found to be largely unrelated to the probability of death for both men and women. Tenth, the results show that the prior death of at least one adult in the household is the single most important factor influencing the probability that a prime-aged individual will die due to illness. Irrespective of their 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% and 16.3% for men and women experiencing a prior-disease-related death in their household in the past 8 years versus 0.54% and 0.90% for men and women not experiencing a prior prime-aged death in their households. 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.

The remainder of this paper is organized as follows: Section 2 describes the data, issues related to sample attrition between the 2001 and 2004 surveys, and estimation methods. Estimation results and their interpretation are presented in Section 3. Section 4 discusses the conclusions of the paper and implications for donor and government response.

2.0   DATA AND METHODOLOGY

2.1   Data

The study uses nationally representative longitudinal data on 18,821 prime-age individuals (15-59 years of age) in 6,922 households in 394 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%) were re-interviewed in May 2004. If we exclude attrition caused by enumerators not re-visiting several SEAs in 2004 that were included in the 2001 survey, the re-interview rate rises to 88.7%. And if we exclude attrition caused by adult household members being away from home during the enumeration period and those refusing to be interviewed, the re-interview rate rises to 94.5%.

Table 1 presents the relationship between household attrition, dissolution, and household size in 2001. The findings show that the percentage of households "attriting" is inversely related to household size (column C). While 8.4% of the households sampled in 2001 contained either one or 2 members, these households accounted for over 12% of the cases of attrition and 18% of the cases of household dissolution. In contrast, 65.5% of the sample contained households with 5 or more members and among these households only 47% of attrition due to dissolution is observed. (Columns D and E). In addition, Table 1, column F shows 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 (column G and H). This is because the probability that a household will incur a prime-age adults is positively correlated with the number of adult members in the household.

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[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.

Table 1. Relationship between household size, attrition, dissolution, and prime-age mortality

Household Size	Households in 2001 sample	Households attriting in 2001-2004	Households attriting due to dissolution	Households dissolving as % of 2001 sample	Households dissolving as % of households attriting	Households incurring PA mortality	Households incurring PA mortality as % of reinterviwed household
(A)	(B)	(C)	(D)	(E)[a]	(F)[b]	(G)[c]	(H)[d]
Number	number	number	number	(%)	(%)	number	(%)
1	199	68	30	15.1	44.1	1	0.8
2	385	118	43	11.2	36.4	12	4.5
3	781	196	57	7.3	29.1	27	4.6
4	1021	263	76	7.4	28.9	36	4.7
5	1041	224	48	4.6	21.4	55	6.7
6	924	211	46	5	21.8	46	6.5
7	730	126	32	4.4	25.4	40	6.6
8	606	108	24	4	22.2	44	8.8
9	387	70	11	2.8	15.7	25	7.9
≥10	848	119	23	2.7	19.3	76	10.4
Total	6922	1503	390			362	

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

Notes:
[a]Column E =Column D /Column B
[b]Colum F=Column D/Column C,
[c]36 housheolds incurred more than one prime-age death
[d]Column H=ColumnG/(Columns B-C)

Table 2 presents basic information on the households surveyed, re-interview rates, and prevalence of disease-related mortality over the 2001-2004 period. Of the 5,420 households successfully re-interviewed, 362 of these households (6.3%) had at least one disease-related prime-age (PA) death over the three-year period, (see table 2, column c).[2] Of these 362 households incurring a prime-age disease-related death, 53 of them suffered multiple prime-age deaths, with 45 households experiencing 2 deaths, 6 households experiencing 3 deaths' and 2 households experiencing 4 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, we find that 24% of the deaths due to diseases are estimated to be AIDS related.[3] However, because we did not collect information 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, in this paper we confine our analysis to correlates of prime-age mortality due to disease in general. Of the 419 prime-age deaths recorded in the sample, 21 of them were due to accidents or homicide. Hereafter, to save words, we refer to disease-related prime-age (15-59 years) mortality as "PA mortality."

Of the 398 cases of illness-related PA mortality, 165 (41%) were men and 233 (59%) were female.[4] Of the 18,821 prime-age adults recorded in 2001, 36% had left the sample between 2001 and 2004 for causes other than death, e.g., moving to another location, getting married and starting another household elsewhere. We define non-afflicted individuals as those remaining in the sample and alive at the time of the second interview in May 2004.

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. 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).

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[2] A small number of recorded deaths were due to violence or accidents; these were excluded from the analysis.
[3] Following WHO algorithm, the major clinical symptoms for which data was collected are: chronic diarrhea for more than one month, prolonged fever (intermittent and constant) for more than one month, and weight loss of more than 10% of body weight. The minor signs were prolonged cough, prolonged difficulty in breathing, prolonged pneumonia, thrush in the mouth and 'rash', which is considered to be an indicator of generalized *pruritic dematitis* if it occurred in combination with two major signs. 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, since the validation of verbal autopsy studies in literature are flawed (the validation sample come from a clinical sample and therefore are not likely to be representative of the population) (Birbeck 2004).
[4] After weighting, women accounted for 61% of PA mortality.

Table 2. Prevalence of prime-age (PA) mortality[a] by province, rural Zambia between 2001 and 2004.

Province	Households interviewed in 2001	Households re-interviewed in 2004[b]	Households from column (b) with at least one prime-age adult death in 2001-2004	Prime-age deaths due to illness				Cause of death		Predicted AIDS-related deaths[e]		Median age of adults dying from diseases between 15-59 years of age
				Male		Female		Disease	Other[d]	by WHO classification[f]	One major sign an at lease one minor sign	
	(a)	(b)	(c)	(d)		(e)		(f)	(g)	(h)	(i)	(j)
	Number	Number(%)	Number(%)	Number	AMR[c]	number	AMR	number		number (%)	number (%)	---Years----
Central	714	573 (80.3)	50 (8.7)	27	14.4	26	16.1	53	3	10 (18.9)	13 (24.5)	34
Copperbelt	393	312 (79.4)	16 (5.1)	6	14.8	10	14.6	16	3	4 (25.0)	6 (37.5)	36
Eastern	1331	1126 (84.6)	71 (6.3)	31	14.6	45	18.5	76	4	15 (19.7)	27 (35.5)	35
Luapula	777	619 (79.7)	41 (6.6)	19	12.1	27	15.1	46	3	11 (23.9)	22 (47.8)	36
Lusaka	214	161 (75.2)	15 (9.3)	5	19.2	10	16.6	15	1	3 (20.0)	6 (40.0)	36
Northern	1363	1027 (75.3)	55 (5.4)	27	10.3	29	13.1	56	3	14 (25.0)	18 (32.1)	38
Northwestern	472	324 (68.6)	15 (4.6)	9	9.3	8	10.0	17	-	2 (11.8)	3 (17.6)	36
Southern	872	690 (79.1)	55 (8.0)	25	15.1	36	17.3	61	3	15 (24.6)	25 (41.0)	32
Western	786	588 (74.8)	51 (8.7)	16	16.4	42	17.7	58	1	22 (37.9)	31 (53.4)	33
Total	6922	5420 (78.3)	362 (6.7)	165	14.0	233	15.4	398	21	96 (24.4)	151 (38.3)	35

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

Notes: [a]Prime-age is defined as ages 15-59 for both men and women. [b]Of the 21.7% not re-interviewed, 0.2% were refusals, 10.2% moved out of SEA, 5.7% recorded as dissolved and 5.2% non contact. [c]AMR (adult mortality rate)=Prime-age deaths/1000 prime-age person years. [d]Other deaths were caused by unexpected causes such as accidents, murder and snake bite, and were excluded from the analysis in Section 4. [e]Cause of death is defined as HIV/AIDS using lay diagnosis data of the deceased (see section 2). [f]WHO classification: 2 major signs (weight loss greater than 10% 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 one month, itching skin rash, fungal infection of mouth and/or throat, history of herpes zoster, generalized herpes simplex infection and enlarged lymph nodes).

Comparison of means between reinterviwed and attrited households

To test for possible bias in results due to household attrition, we compare the mean levels of control variables measured in May 2001 for households that were re-interviewed versus those that attrited. The means of many variables differ statistically between re-interviewed and attrited households (Table 3). For example, households not re-interviewed 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 male and female and elderly males, slightly smaller landholdings, less farm equipment and animals, and slightly higher rates of chronically ill adults in 2001. This is not surprising given the data presented in Table 1 showing that attriting households were smaller to start with in 2001. Systematic differences between attritors and non attritors, coupled with a high attrition rate, may cause concern about inference with this data. Also, if the attrited households suffered a higher incidence of PA mortality between 2001 and 2004, we would have attrition bias when estimating the *ex ante* socioeconomic characteristics of individuals who died of AIDS-related causes.[5] So we should be worried about the possibility of systematic attrition leading to selection bias.

In order to deal with potential attrition bias, we adopt the inverse probability weighting method, which assumes that the probability of being re-interviewed as a function of observables information is the same as the probability of being re-interviewed as a function of observables, plus unobservables that are only observable for non-attrited observations (see Wooldridge 2002).[6] In general the IPW works well if the observations on observed variables are strong predictors of non-attrition and if the observations on unobserved variables are not strong predictors of non-attrition. We use interview quality variables to predict interview, in particular we use 59 enumeration teams to predict re-interview. Each enumeration team was headed by a supervisor who was authorized to decide whether enumerators give up trying to contact designated households.

The re-interview model is specified as follows

$$\text{Prob}(R_{kht} = 1) = f(HIV_{t-j}, I_{hk,2000}, X_{h,2000}, E_{ht}, P) \tag{1}$$

Where R_{kht} is one if individual (k) is in a household (h) that is re-interviewed at time t, conditional on being interviewed in the previous survey, and zero otherwise; HIV_{t-j} is the district HIV-prevalence rate at the nearest surveillance site in 1999; $I_{hk,2000}$ is a vector of individual characteristics in 2000; X_{h2000} 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 males and females), ownership of various assets, monogamous vs. polygamous household; E_{ht} is a set of 59 enumeration teams; and P is a set of 9 provincial

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[5] Available evidence on attrition rates in longitudinal surveys in developing countries range from 5 to 30% for 2 rounds (see Alderman et al. 2001; Thomas, 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 paper. Overviews of sample selection models can be found in Fitzgerald, Gottschalk, and Moffit (1998), Alderman et al. (2001).

Table 3. Household characteristics stratified by attrition status

Household attributes in 2000	Re-Interviewed N=5420		Not re-interviewed N=1502		Difference	
	Mean	Std. dev	Mean	Std. dev	Mean	t-stat
Age of household head (years)	44.71	15.04	42.50	15.04	2.21**	5.72
Mean education of head and spouse	5.78	3.22	5.86	3.68	-0.07	-0.27
Household size (number)	5.91	3.01	5.17	2.63	0.73**	9.58
Children 5 and under (number)	0.93	0.93	0.83	0.91	0.09**	4.08
Boys 6 to 14 (number)	1.47	1.34	1.30	1.21	0.17**	5.31
Girls 6 to 14 (number)	1.57	1.35	1.39	1.22	0.18**	6.08
Prime-age male 15 to 59 (number)	1.26	0.99	1.07	0.87	0.19**	6.71
Prime-age female 15 to 59 (number)	1.33	0.88	1.20	0.78	0.14**	6.52
Elderly Males age 60 and above (number)	0.14	0.35	0.10	0.31	0.04**	4.06
Elderly Females age 60 and above (number)	0.11	0.33	0.10	0.30	0.02+	1.84
Households with at least 1 chronically ill adult (%)	1.27	0.46	1.31	0.50	-0.04	-0.58
Prime-age death between 1996-2000	0.10	0.30	0.10	0.30	0.00	-[a]
Landholding size (ha)	2.80	2.82	2.45	2.69	0.35**	5.44
Land cultivated (ha)	1.49	1.38	1.25	1.20	0.24**	7.19
Total household income ('000 ZMK per household)	1843.12	3961.82	1819.22	3570.83	23.91	1.10
Value of assets ('000 ZMK per household)	900.99	2793.23	549.73	1750.97	351.26**	5.76
Productive assets ('000 ZMK per household)[b]	107.80	399.49	52.77	238.21	55.02**	6.23
Distance to nearest tarred/main road (km)	25.32	35.49	24.93	33.39	0.39	0.58
Distance to nearest district town (km)	34.48	22.57	36.00	23.77	-1.52	-1.78

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004
Notes:
** indicates 1% significance level; *indicates 5% significance level; + indicates 10% significance level.
[a] t cannot be computed because the standard deviations of both groups are 0.
[b]Productive assets are the sum of the value of farm equipment (scotch carts, harrows and ploughs) and livestock.

dummies. All of the variables in (1) are observable even for individuals in households that were not re-interviewed in 2004. Equation (1) is estimated with Probit for attrition between the 2001 and 2004 surveys, obtaining predicted probabilities (Pr_{2001}). Then, we compute the inverse probability ($1/Pr_{2001}$), which we apply to the probit models described in the following section for estimating prime-age (PA) mortality.

2.2 Estimation Strategies and Variables

Model

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

$$\text{Prob}(A_{it} = 1) = g(I_{i2000}X_{h2000}, HIV_{t-j}, C) \qquad (2)$$

where A is a binary variable that equals one if individual *i* died between 2001 and 2004, 0 otherwise, I_{i2000} is a set of individual characteristics in 2000, X_{h2000} 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 we are measuring initial 2000 conditions associated with subsequent mortality, all of the variables are observable even for individuals in households that were not re-interviewed in 2004 but contained in 2001 survey. The vector of individual characteristics include: 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 five-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 (one to three years), upper primary (three to six years), completed primary (seven years), and secondary and higher schooling (eight 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 greater than 2 months away during the 2000/01 survey season. We exclude individuals who died in 2001 in computing months away from home variables because 86 (22% 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, 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, whether the district is located on the line of rail (proxies for degree of interaction between local residents and extent of contact with outsiders passing through the area). We test for the inclusion of quadratic terms of landholding size, productive assets, distance of village from the nearest tarmac road and district town because their marginal effect on the probability of being afflicted may be non linear. However, specification tests rejected the non-linearity hypotheses in all cases so we include no quadratic terms in the reported model results. We also tested for potential regional differences in factors associated with prime-age adult mortality, but we found very limited evidence of this through

specification tests, so we use the pooled national sample stratified by gender and income status.

Equation (2) is estimated with Probit using the inverse probabilities from the re-interview model as weights. We chose to run these models separately for prime-aged men and women, and for individuals in the top vs. bottom half of the 2001 income and assets distribution in order to understand whether the socioeconomic correlates of adult mortality vary by gender and/or assets/income. As a robustness check to examine the impact of initial poverty levels on the correlates of prime-age mortality, we report marginal probabilities for models stratified by income and value of assets side by side (see Tables 6 and 7). We present in Appendix Tables 2 and 3 village- and province- fixed effects models (stratified by gender but pooled across income and asset groups) with household income and value of assets dummies as explanatory variables. The results indicate that neither household income nor assets were statistically related to individuals' probability of death.

3.0   DESCRIPTIVE RESULTS

3.1 Adult Mortality and HIV Prevalence in Zambia

We start by investigating the correlation between prime-age mortality rates from our 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).[7] 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 due to AIDS-related causes.

Figure 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

Figure 1. Correlation between Provincial adult mortality rates from CSO 2001 and 2004 household survey data and 2001 HIV + Prevalence Rates, Zambia
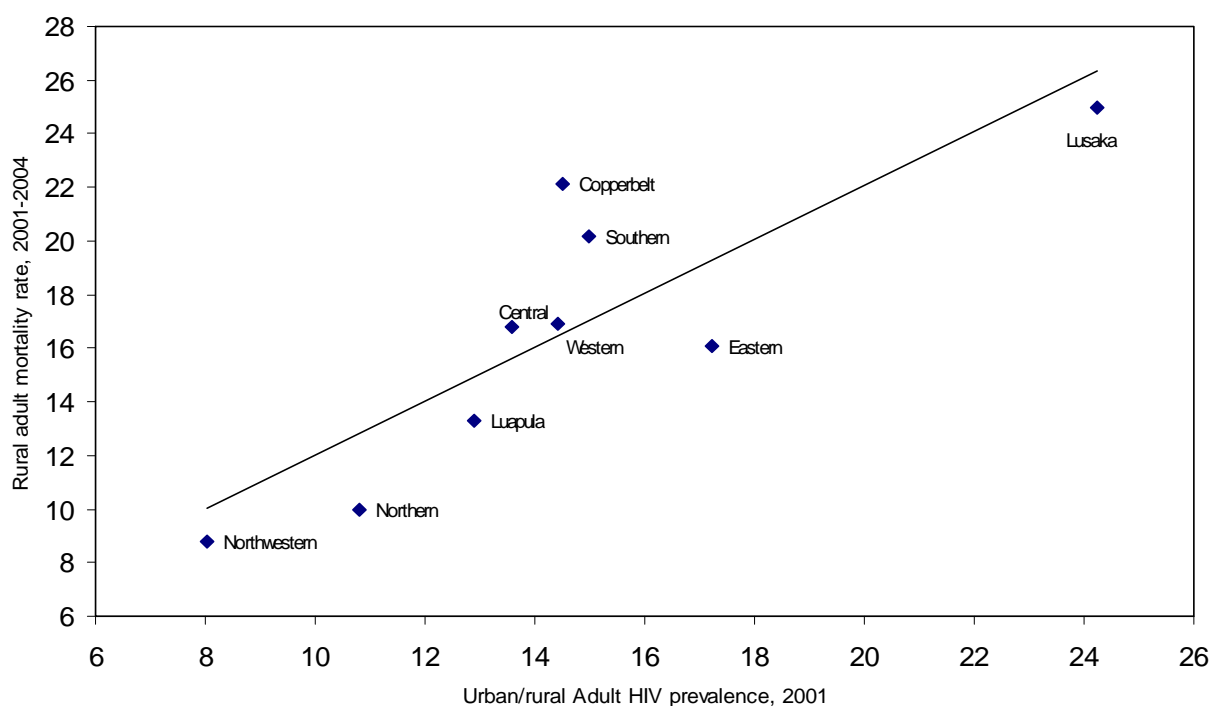
Notes: Pearson correlation coefficient is 0.84.
Sources: Adult mortality rates derived from the 2001 and 2004 household surveys. HIV+ prevalence rates are from 2001 Sentinel Surveillance Site information published by CSO, MoH, and Macro International 2003.

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[7] National estimates of HIV prevalence in sub-Saharan Africa are almost exclusively based upon 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.

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.

3.2 Descriptive Analysis

Table 4 presents characteristics of the prime-aged individuals 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 4 reports absolute numbers of prime-aged men and women having died compared to individuals remaining in the sample. After weighting the results to the national level, results indicate that 61% of the illness-related prime-age deaths in Zambia's small- and medium-scale farm sector between 2001 and 2004 were 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% finding is explained by the physiological differences between men and women's susceptibility to contracting the disease,[8] 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 (less than 1% of all HIV-positive individuals), it is likely that physiological difference is the primary explanation for this finding.

We also observe that prime-age female mortality is occurring predominantly among single women in the younger age groups. These 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 (Table 4). Men displaying at least one major and one minor sign of AIDS-related death (according to the World Health Organization) were more likely to have at least a Grade 7 education compared to healthy prime-age men. Of the males who died displaying at least one major and one minor sign of AIDS, 69.6% had at least seven years of education. Among men in the upper half of the income distribution who were estimated to have died of AIDS-related causes, 81.1% of them had at least a Grade 7 education, compared to 61.7% of healthy prime-age men in the sample.

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[8] 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).

Table 4. Descriptive statistics among prime-age[a] adults who died due to illness in 2001-2004, and remaining prime-age adults in the sample

Attributes	PA adult deaths' due to illness in 2001 –2004		PA adults remaining in the sample	
	Male	Female	Male	Female
Number prime-age adults (unweighted)	165	233	5735	5851
Number prime-age adults (weighted)	17801	27730	659478	677593
Individual Characteristics in 2000				
Relationship of deceased to the HH 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 in 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 Schooling (%)				
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 HH in 2000 (%)	17.7	32.6	12.3	22.8
Prior death of adults between 1996-2003 (% of HH)[b]	68.4	65.5	6	5.9
Landholding size in 2000 (Hectares)	3.4	2.7	3	2.9
Draft animals and equipment (000' ZMK per HH)	641.9	588.1	729.2	664.4
Per Capita Household income quartiles in 2000 (%)				
Poor (bottom 50%)	47.6	56.1	49	50.7
Non-poor (top 50%)	52.4	43.9	51	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: [a]Prime-age is defined as ages 15-59 for both men and women. [b]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.

4.0   RESULTS

4.1   Determinants of Re-interview

We first discuss results of the re-interview model. The results indicate that individuals in attrited households differ from non-attrited households in terms of their 2000 values of observed variables. The 2000 individual and households characteristics are jointly significant as the determinants of re-interview. As indicated earlier, the probability of being re-interviewed is inversely related to household size. Table 5 shows that single or previously married individuals were less likely to be re-interviewed than married individuals. However, other factors constant, the results also show that prime-age male members were 4.7% more likely to remain in the households between the first and second survey compared to females. This may be because in most parts of Zambia which are patrilineal, females are more likely to leave their parents' home when they marry compared to men who may marry and still live with their parents. Older individuals (age 30 and above) were more likely to be contained in the panel compared to younger members (age 29 and below). Generally, there exists a stronger positive association with reinterview as age increases. Also, individuals with salary and wage income, and who spend more time away from home in 2000 were less likely to be contained in both surveys. This is an indication that individuals with these characteristics are more mobile and less likely to be in households re-interviewed.   In contrast, individuals who had formal or informal business income were more likely to be contained in both surveys. Although the coefficients on years of education are not significant even at the 10% level of significance, it would appear that the marginal probability of remaining in the sample decreases as an individual's years of education increases. This suggests that individuals with more years of education are more likely to be contained only in the first survey and may have moved elsewhere for better prospects.

Turning to household characteristics, results in Table 5 show that individuals in households experiencing adult death between 1996 and 2000 were less likely to be re-interviewed compared to individuals in households experiencing no death during the same period. Landholding size, production assets are positively associated with reinterview. Individuals in households with many children were more likely to be re-interviewed.

The lagged HIV prevalence variable is negatively associated with re-interview and statistically significant at the 10% level of significance. This may suggest that AIDS exacerbates attrition in standard household surveys. Households suffering from adult mortality due to AIDS may have moved away or dissolved, although the lagged HIV prevalence rate may be picking up the effects of other spatial factors correlated with district-level attrition rates, such as migration and mobility. Other community characteristics such as distance of household to the nearest tarmac road or to the district town appear to reduce the probability of being re-interviewed although this effect is statistically insignificant at 10%. This may be because enumerators may be less likely to attempt to re-visit households in remote or relatively inaccessible locations. The enumeration team dummies are also jointly significant; suggesting that differences in enumeration team effort could be a strong predictor of re-interview. In any case, the results in Table 5 suggest the importance of controlling for attrition, as is done in the remainder of the analysis.

Table 5. Individual-level re-interview model (Probit[a])

Attributes	1=Individuals contained in 2001 and 2001 Surveys, 0=individuals contained only in 2001		
	dy/dx	z	P>z
Individual characteristics in 2000			
Gender(1=male, 0=female)	0.047	6.69	0.000
Never married (1=, 0 otherwise)	-0.172	-14.28	0.000
Previously married (1=, 0 otherwise)	-0.139	-9.13	0.000
Age group (=1, 0 otherwise)			
Age 20-24	-0.076	-5.92	0.000
Age 25-29	-0.021	-1.42	0.155
Age 30-34	0.021	1.36	0.173
Age 35-39	0.037	2.02	0.043
Age 40-44	0.090	4.70	0.000
Age 45-49	0.103	4.56	0.000
Age 50-54	0.134	6.64	0.000
Age 55-59	0.124	5.38	0.000
Years of education (=1, 0 otherwise)			
1-3 years	0.023	1.48	0.139
4-6 years	0.020	1.53	0.125
7 years	0.000	-0.02	0.985
8 years and above	-0.007	-0.42	0.673
Salary wage income (=1, 0 otherwise)	-0.044	-3.15	0.002
Formal/Informal business activity (=1, 0 otherwise)	0.033	2.50	0.012
Months away from home (number)	-0.013	-4.51	0.000
Household characteristics in 2000			
Polygamous household in 2000 (=1, 0 otherwise)	0.007	0.35	0.727
Children 5 years and under (number)	0.010	1.77	0.077
Children ages 6 to 11 (number)	0.002	0.81	0.420
Prior PA adults death in HH from diseases in 1996-2000	-0.038	-2.25	0.024
Landholding size (Ha)	0.002	1.01	0.312
Draft animals and farm equipment (ZMK)	0.002	2.31	0.021
Community characteristics			
District HIV prevalence rate in 1999	-0.003	-1.23	0.218
District on the line of rail (=1 , 0 otherwise)	-0.030	-1.16	0.244
Distance to the nearest tarmac road (km)	-0.000	-0.09	0.927
Distance to the district Town/Boma (km)	-0.000	-0.82	0.410
Enumeration team dummies included[b]	Yes		
Joint test for individual characteristics $(X^2)^c$	1477.83	[0.000]	
Joint test for household characteristics $(X^2)^c$	20.38	[0.002]	
Joint test for community variables (X^2)	4.99	[0.288]	
Joint test for team effects $(X^2)^c$	1074.45	[0.000]	
Predicted probability of positive outcomes at $\bar{x}$	0.81		
Number of prime-age adults	18817		

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

Notes: Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for individuals. [a]Estimated coefficients are marginal changes in probability. [b]Enumeration teams are included but not reported in the table. [c]Joint test for individual and household characteristics, and enumeration team effects are significant at 1% significance level.

4.2   Attributes of Deceased Prime-Age Individuals

This section presents results from probit models estimated to determine the attributes of deceased prime-age individuals in rural Zambia. Two sets of models were run: provincial- and village-fixed effects. Provincial fixed effects models allow us to examine the effects of variables measured at the district level, e.g., lagged HIV prevalence rates, and indicators of market access (distance to the nearest town, distance to the nearest tarmac road, and district on the line of rail). These models also provide more accurate estimates of probability of death over the three-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 inter-village 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. Both sets of results are reported so that the reader can examine the robustness of these findings.

The bottom row of Table 6 reports the probability of death over the 2001-2004 period for men and women. The probabilities of PA death for men and women were roughly 0.6% and 1.1%, respectively. However, the probability of death for relatively non-poor men was 0.85% and 0.70% (depending on whether the sample is stratified in terms of 2001 income or asset levels), whereas for relatively poor men, the death probabilities were 0.47% and 0.49%. There was little variation in probability of death between poor and non-poor women.

Table 6 and 7 presents the province-level and village-level probit model results for some initial individual and household characteristics in 2001 that greatly affected the probability of dying. For both relatively poor and non-poor 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 on mortality 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 non-poor women mainly). Variables that had little effect or ambiguous effects on the probability of dying included whether the individual resided in a polygamous household, 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, we used the model results reported in Table 6 to compute estimated probabilities of dying over the 3-year period for 20 different individual "profiles." These simulations are reported in Table 8 and discussed in remainder of this section.

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[9] By contrast, when estimating models with village dummies, the estimation program automatically drops those cases where no variation in the dependent variable exists, which restricts the sample somewhat. Of the 392 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.

Table 6. Probit Models[a] of prime-age mortality in 2001-2004 by gender and poverty status, with province dummy variables (Province-fixed effects models).

	Deceased Prime-age Adult (=1, 0 otherwise)							
	Poor (bottom 50%)				Non-Poor (Top 50%)			
	Male		Female		Male		Female	
	Income Poor	Assets Poor	Income Poor	Assets Poor	Income non-poor	Assets non-poor	Income non-poor	Assets non-poor
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Individual Characteristics in 2000								
Head/spouse (1=, 0 otherwise)	-0.000	-0.004	-0.014**	-0.004	-0.003	-0.001	-0.003	-0.013**
	(0.08)	(1.18)	(2.72)	(0.91)	(1.26)	(0.37)	(0.60)	(2.65)
Currently married (1=, 0 otherwise)	-0.009	-0.005	-0.007	-0.009*	-0.005	-0.006	-0.010*	-0.008
	(1.72)	(1.38)	(1.55)	(2.43)	(1.48)	(0.98)	(2.18)	(1.61)
Never married (1=, 0 otherwise)	-0.003	-0.003	-0.004	-0.004	-0.002	0.003	-0.001	-0.001
	(0.56)	(0.84)	(0.95)	(0.93)	(0.35)	(0.38)	(0.11)	(0.19)
Age groups in 2000 (=1, 0 otherwise)								
Age 20-24	0.013	0.011	0.006	0.008	0.002	0.002	0.015*	0.011
	(1.88)	(1.82)	(0.93)	(1.19)	(0.49)	(0.49)	(2.29)	(1.81)
Age 25-29	0.041**	0.022**	0.034**	0.015	0.020**	0.034**	0.022**	0.040**
	(3.81)	(2.62)	(3.77)	(1.89)	(3.06)	(3.66)	(2.59)	(4.30)
Age 30-34	0.028**	0.015	0.045**	0.040**	0.010	0.026**	0.034**	0.036**
	(2.46)	(1.92)	(3.51)	(3.42)	(1.82)	(2.71)	(2.94)	(2.73)
Age 35-39	0.029*	0.029**	0.029*	0.019*	0.039**	0.030**	0.053**	0.074**
	(2.47)	(2.61)	(2.36)	(2.08)	(3.70)	(2.68)	(3.59)	(4.14)
Age 40-44	0.072**	0.087**	0.049**	0.025*	0.049**	0.030*	0.023	0.052**
	(3.55)	(3.78)	(3.30)	(2.10)	(4.09)	(2.55)	(1.93)	(3.51)
Age 45-49	0.063**	0.075**	0.027*	0.021	0.066**	0.071**	0.020	0.019
	(3.20)	(3.24)	(2.19)	(1.74)	(4.33)	(3.99)	(1.39)	(1.55)
Age 50-54	0.084**	0.073**	0.018	0.003	0.082**	0.096**	0.023	0.042**
	(3.85)	(3.61)	(1.48)	(0.38)	(4.46)	(3.82)	(1.67)	(2.68)
Age 55-59	0.052**	0.111**	0.053**	0.023	0.125**	0.075**	0.011	0.038*
	(2.88)	(4.16)	(3.07)	(1.91)	(5.97)	(3.80)	(0.94)	(2.18)
Years of Education in 2000 (=1, 0 otherwise)								
1-3 years	0.004	0.003	-0.000	0.006	0.025*	0.018	-0.003	-0.009*
	(0.60)	(0.58)	(0.07)	(1.21)	(2.13)	(1.85)	(0.63)	(2.57)
4-6 years	0.004	0.002	-0.005	-0.001	0.013	0.013	-0.004	-0.008*
	(0.85)	(0.40)	(1.21)	(0.23)	(1.82)	(1.80)	(0.89)	(2.30)
7 years	0.007	0.012*	-0.005	-0.004	0.013	0.006	-0.005	-0.007
	(1.37)	(2.35)	(1.04)	(0.87)	(1.96)	(0.96)	(1.02)	(1.78)
8 years and above	0.005	0.003	0.003	0.008	0.005	0.004	-0.005	-0.009**
	(0.93)	(0.73)	(0.46)	(1.26)	(1.03)	(0.77)	(0.93)	(2.77)
Salary wage income in 2000 (=1, 0 otherwise)	0.007	0.009*	-0.007	-0.008	0.005*	0.001	-0.010*	-0.007
	(1.13)	(2.55)	(0.89)	(1.44)	(2.15)	(0.21)	(2.33)	(1.61)
Business activity in 2000 (=1, 0 otherwise)[b]	0.004	0.002	-0.002	-0.001	-0.001	-0.002	0.001	0.001
	(0.98)	(1.30)	(0.34)	(0.33)	(0.47)	(0.64)	(0.15)	(0.19)
Resided at home throughout the year in 2000	-0.015**	-0.013**	-0.032**	-0.030**	-0.013**	-0.012**	-0.040**	-0.043**
	(2.77)	(3.62)	(4.24)	(4.43)	(4.07)	(2.88)	(6.75)	(6.31)
One month spent away from home in 2000	-0.004	-0.003	-0.010	-0.010*	-0.003	-0.004	-0.011**	-0.010**
	(0.93)	(1.11)	(1.92)	(2.42)	(0.92)	(0.70)	(3.47)	(2.88)
Household Characteristics in 2000								
Polygamous household (=1, 0 otherwise)	-0.003	-0.005*	-0.001	0.001	-0.002	0.002	0.000	0.001
	(0.88)	(2.26)	(0.15)	(0.25)	(0.97)	(0.44)	(0.03)	(0.30)
Prior prime-age death in household in 1996 -2003[c]	0.109**	0.153**	0.166**	0.170**	0.115**	0.082**	0.133**	0.113**
	(10.28)	(12.97)	(16.30)	(15.29)	(12.08)	(10.90)	(12.60)	(11.04)
ln(Landholding size (hectares)	0.000	-0.000	-0.002	-0.001	-0.002*	-0.002	-0.003	-0.005**
	(0.06)	(0.21)	(1.06)	(0.35)	(2.05)	(1.53)	(1.47)	(3.00)
Community characteristics								
District HIV prevalence rate in 1999	0.001	0.000	0.001	0.000	-0.000	0.000	0.001	0.002**
	(1.78)	(0.12)	(1.44)	(0.04)	(0.40)	(0.88)	(1.73)	(2.71)
District on the line of rail (=1 , 0 otherwise	-0.001	-0.001	-0.007	-0.002	-0.000	-0.001	-0.004	-0.007
	(0.48)	(0.50)	(1.45)	(0.33)	(0.22)	(0.48)	(0.90)	(1.84)
Distance to the nearest tarmac road (km)	0.000	-0.000	-0.000	0.000	0.000	0.000	0.000	0.000
	(0.37)	(0.26)	(0.14)	(0.06)	(0.52)	(0.48)	(0.79)	(0.62)
Distance to the district Town/Boma (km)	0.000	0.000	-0.000	-0.000	-0.000	0.000	0.000*	0.000
	(1.26)	(0.06)	(0.07)	(0.28)	(1.34)	(0.62)	(1.99)	(1.64)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	3634	3596	3855	3977	3774	3812	3779	3711
Predicted Probability of dying from disease-related causes[d]	0.0047	0.0049	0.012	0.010	0.0085	0.0070	0.011	0.010

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004.
Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. ** indicates 1% significance level; * indicates 5% significance level. [b]Formal or informal business activities. [c]refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis. [d]The probability of dying from disease related causes, setting all explanatory variables at their mean values.

Table 7. Probit Models[a] of prime-age mortality in 2001-2004 by gender and poverty status, with village dummy variables (village-fixed effects models)

	Deceased Prime-age Adult (=1, 0 otherwise)							
	Poor (bottom 50%)				Non-Poor (Top 50%)			
	Male		Female		Male		Female	
	Income Poor	Assets Poor	Income Poor	Assets Poor	Income non-poor	Assets non-poor	Income non-poor	Assets non-poor
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Head/spouse (1=, 0 otherwise)	-0.019*	-0.011*	-0.028**	-0.004	-0.005	-0.004	-0.011	-0.035**
	(2.50)	(2.23)	(2.80)	(0.48)	(0.85)	(0.41)	(1.07)	(3.05)
Currently married (1=, 0 otherwise)	-0.002	-0.010	-0.009	-0.014	-0.015*	-0.006	-0.017	-0.021
	(0.24)	(1.91)	(1.21)	(1.77)	(2.15)	(0.35)	(1.62)	(1.81)
Never married (1=, 0 otherwise)	-0.001	-0.007	-0.009	0.000	-0.009	0.011	0.007	-0.003
	(0.10)	(1.22)	(1.07)	(0.00)	(0.96)	(0.71)	(0.64)	(0.23)
Age groups in 2000 (=1, 0 otherwise)								
Age 20-24	0.064**	0.036**	0.006	0.002	0.001	-0.000	0.027*	0.041**
	(3.64)	(3.54)	(0.53)	(0.27)	(0.14)	(0.04)	(2.20)	(2.67)
Age 25-29	0.210**	0.148**	0.044**	0.013	0.039**	0.071**	0.040*	0.100**
	(5.64)	(4.46)	(2.89)	(0.95)	(3.48)	(3.41)	(2.11)	(4.05)
Age 30-34	0.157**	0.072**	0.080**	0.082**	0.005	0.049**	0.096**	0.118**
	(3.63)	(2.94)	(3.27)	(3.42)	(0.60)	(2.92)	(3.00)	(3.49)
Age 35-39	0.156**	0.206**	0.036	0.039*	0.042**	0.040*	0.162**	0.195**
	(3.12)	(4.21)	(1.74)	(2.07)	(2.68)	(1.97)	(4.13)	(4.21)
Age 40-44	0.442**	0.535**	0.087**	0.036	0.129**	0.088*	0.067*	0.131**
	(4.87)	(6.15)	(3.04)	(1.70)	(3.46)	(2.40)	(2.34)	(3.39)
Age 45-49	0.460**	0.392**	0.054*	0.063*	0.170**	0.198**	0.067	0.091*
	(5.49)	(4.38)	(2.10)	(2.47)	(4.82)	(4.16)	(1.84)	(2.39)
Age 50-54	0.404**	0.267**	0.016	-0.009	0.154**	0.244**	0.060	0.231**
	(4.71)	(4.57)	(0.75)	(0.63)	(3.73)	(4.22)	(1.67)	(3.58)
Age 55-59	0.340**	0.597**	0.079**	0.057*	0.226**	0.160**	0.020	0.090*
	(4.32)	(5.46)	(2.65)	(2.08)	(5.44)	(3.91)	(0.81)	(2.22)
Years of Education in 2000 (=1, 0 otherwise)								
1-3 years	0.004	0.010	-0.009	0.002	0.033	0.035	-0.011	-0.018**
	(0.40)	(1.21)	(1.14)	(0.16)	(1.65)	(1.64)	(1.10)	(2.62)
4-6 years	0.003	0.006	-0.016*	-0.010	0.009	0.024	-0.011	-0.014
	(0.37)	(0.84)	(2.26)	(1.34)	(1.03)	(1.42)	(1.21)	(1.88)
7 years	0.008	0.028*	-0.016*	-0.011	0.015	0.011	-0.020*	-0.016
	(0.78)	(2.28)	(2.19)	(1.25)	(1.46)	(0.81)	(2.21)	(1.88)
8 years and above	-0.005	0.004	-0.009	0.002	0.002	0.010	-0.025*	-0.023**
	(0.69)	(0.66)	(1.11)	(0.16)	(0.26)	(0.80)	(2.47)	(3.24)
Salary wage income in 2000 (=1, 0 otherwise)	0.034**	0.017**	-0.008	-0.012	0.022**	0.004	-0.016	-0.017
	(3.08)	(3.27)	(0.56)	(1.41)	(3.18)	(0.41)	(1.51)	(1.78)
Business activity in 2000 (=1, 0 otherwise)[b]	0.018*	0.006	-0.006	-0.009	0.000	-0.010	-0.007	0.002
	(2.26)	(1.65)	(0.95)	(1.27)	(0.00)	(1.64)	(0.78)	(0.16)
Resided at home throughout the year in 2000	-0.019*	-0.011*	-0.076**	-0.064**	-0.036**	-0.039**	-0.115**	-0.088**
	(2.23)	(2.12)	(4.26)	(4.28)	(3.73)	(3.05)	(5.75)	(5.02)
One month spent away from home in 2000	-0.005	0.003	-0.017*	-0.018*	-0.004	-0.003	-0.021**	-0.019**
	(0.90)	(0.57)	(1.97)	(2.33)	(0.84)	(0.25)	(3.64)	(3.02)
Polygamous household in 2000(=1, 0 otherwise)	-0.003	-0.002	-0.003	-0.002	-0.005	-0.001	0.002	0.007
	(0.37)	(0.42)	(0.27)	(0.19)	(1.37)	(0.13)	(0.18)	(0.59)
Prior prime-age death in household in 1996 -2003[c]	0.414**	0.396**	0.398**	0.375**	0.279**	0.203**	0.313**	0.286**
	(9.94)	(9.77)	(14.75)	(13.19)	(10.34)	(9.28)	(9.76)	(9.90)
ln(Landholding size (hectares) in 2000)	0.002	0.001	-0.004	0.001	-0.003	-0.005	-0.004	-0.008*
	(0.77)	(1.01)	(1.09)	(0.19)	(1.54)	(1.45)	(0.98)	(2.05)
Protected water source (=1, 0 otherwise)	0.011	0.000			0.017	0.029*	-0.004	-0.004
	(0.48)	(0.03)			(1.92)	(2.08)	(0.17)	(0.23)
Superior roofing material (=1, 0 otherwise)	-0.092**	-0.011	-0.061**	-0.011	-0.008	-0.003	0.021*	0.017*
	(3.89)	(1.60)	(2.92)	(0.79)	(1.71)	(0.23)	(2.05)	(1.99)
Superior floor material (=1, 0 otherwise)	-0.003	0.003	0.017**	0.016	0.022*	-0.002	-0.032**	-0.015
	(0.44)	(0.87)	(3.09)	(1.83)	(2.56)	(0.15)	(2.72)	(1.26)
Standard door frame and door	0.012*	0.004	0.006	0.000	0.004	0.001	0.005	0.000
	(2.55)	(1.40)	(0.70)	(0.05)	(0.73)	(0.16)	(0.51)	(0.00)
Superior wall material (=1, 0 otherwise)	0.010*	-0.003	-0.004	0.009	-0.002	0.008	-0.013	-0.012
	(2.23)	(0.74)	(0.46)	(1.18)	(0.35)	(0.94)	(1.19)	(1.18)
Village dummies included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	1017	1018	1505	1454	1175	1315	1404	1450

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004.
Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. **indicates 1% significance level; * indicates 5% significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.

4.2.1 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 8 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% likelihood of dying over a 3-year period, compared to 0.45% for women fitting the "profile 1" category. 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. Comparing profiles 12 and 13 in Table 8, we find that single men with the specified characteristics are 59% more likely to die than married men with otherwise similar characteristics.

4.2.2 Age groups

Age is one of the more important determinants of death due to illness as shown by the marginal probabilities in tables 6 and 7 (where the 15-19 year old age group dummy is omitted). The marginal probability of dying from disease rises steeply 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 females 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 low-income families, the probability of mortality peaks in the 30-34 year age range. The predicted probability of disease-related mortality for a relatively poor woman in the 30-34 year age range is roughly twice as high as a poor woman in the 20-24 year age range. The probability of mortality for a relatively non-poor woman in the 30-34 year age range is only 1.3 times higher than non-poor woman in the 20-24 year age range.

4.3 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; Hargreaves, and Glynn 2002; Gregson, Waddell, and Chandiwana 2001; Glynn et al. 2004), our results show a much weaker relationship between educational attainment and the probability of mortality from disease. We find no statistically significant relationship for either low- or high-income men. 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 non-poor women. The results for non-poor women do not show a clear relationship between educational attainment and probability of dying. One apparent implication of this finding is that both well educated and poorly educated men and women should continue to be targeted for HIV/AIDS education campaigns.

Our findings 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 is shown in Table 8 by comparing profiles 13 vs.16, which are identical in all respects except for assets and/or income. Non-poor 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 (non-poor men have a probability of mortality over a three-year period of 2.09% compared to 1.58% 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, since 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 6, 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% regardless of their households' income or asset levels. This may vary somewhat according to age group. For example, comparing profiles 7 vs. 9, we find 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 three year period of 1.25% compared to 0.66% for women in the top half of the assets distribution. If we change the age group of profiles 7 and 9 from 20-25 to 35-39 and all other characteristics kept the same, we get the opposite result where women in the bottom half of the asset distribution have a probability of mortality over a three year period of 2.2 % compared to 3.2% for women in the top half of the assets distribution. This finding highlights the sensitive of the relationship between poverty and probability of death to age group.

We also find that women from relatively poor households who have some form of formal/informal business income are less likely to die of disease-related causes than poor women who did not have any formal/informal business activity (profiles 9 vs.10). This finding seem to support Epstein (2002, 2003) who contends that female members in poorer household 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 prime-age mortality.

However, Epstein's argument is contradicted by our finding that women from relatively non-poor households having some formal/informal business income are 10% more likely to die of disease related causes than women with similar characteristics not having business income. This may suggest that non-poor 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.

Table 8. 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	
										Income	Assets
1	Female	Married	low	25-29	4-6 years	0	No	No	N	0.59%	0.45%
2	Female	Single	low	25-29	4-6 years	0	No	No	N	2.17%	1.09%
3	Male	Married	low	25-29	4-6 years	0	No	No	N	0.66%	0.01%
4	Male	Single	low	25-29	4-6 years	0	No	No	N	1.50%	0.34%
5	Female	Married	High	20-24	4-6 years	0	Yes	No	N	0.05%	0.03%
6	Female	Single	High	20-24	4-6 years	0	Yes	No	N	0.20%	0.28%
7	Female	Single	High	20-24	1-3 years	0	No	No	N	0.95%	0.66%
8	Female	Single	High	20-24	1-3 years	0	No	Yes	N	1.41%	0.73%
9	Female	Single	Low	20-24	1-3 years	0	No	No	N	1.33%	1.25%
10	Female	Single	Low	20-24	1-3 years	0	No	Yes	N	0.82%	1.11%
11	Female	Single	Low	20-24	1-3 years	≥2	No	Yes	N	3.45%	4.69%
12	Male	Married	High	45-49	≥8 years	0	No	No	N	0.44%	0.90%
13	Male	Single	High	45-49	≥8 years	0	No	No	N	1.93%	2.09%
14	Male	Single	High	45-49	≥8 years	≥2	Yes	No	N	11.02%	8.65%
15	Male	Single	High	45-49	≥8 years	0	Yes	No	N	3.71%	3.78%
16	Male	Single	Low	45-49	≥8 years	0	No	No	N	1.14%	1.58%
17	Male	Married	High	45-49	≥8 years	0	No	No	N	0.44%	0.90%
18	Male	Married	High	45-49	≥8 years	0	No	No	Y	14.9%	12.8%
19	Female	Married	High	35-39	≥8 years	0	No	No	N	1.29%	0.72%
20	Female	Married	High	35-39	≥8 years	0	No	No	Y	18.8%	12.2%

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

[a]Simulation outcomes based on regression models in Table 6. For purposes of the simulation, married men and women are simulated as being heads and spouses of their households.

The results show that irrespective of poverty status males and women living 2 or more months away from home per year in 2001/2001 period are more likely to die of disease-related causes between 2002 and 2004 compared to men and women of the same characteristics but spent all the time at home. For example, comparing profiles 14 vs. 15, non-poor men who spend 2 and more months away from home in 2000/01 have a probability of mortality over a three year period of 8.7%, whilst males 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 3.8%. In contrast, comparing profiles 10 vs. 11, we find that poor women living 2 and more months away from home are 4 times more likely to die of disease related deaths than women of the same characteristics but resided at home through out 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 due to illness.[10] Irrespective of income 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 8 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% and 12.2%. 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 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. We also find in Table 6 that 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 non-poor groups. This is perhaps not surprising considering that HIV prevalence rates are derived from blood tests of women (not men) who visit antenatal clinics in peri-urban and urban areas who are more likely to be non-poor than most women contained in this sample.

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[10] Respondents in the 2001 survey were asked about prior deaths in the household back to 1996, which respondents in the 2004 survey were asked about deaths experienced in the household since the 2001 survey. We computed a binary variable equaling one if the household experienced a death across this 1996-2004 period.

5.0   CONCLUSION

This study has identified important *ex ante* socio-economic 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 policy-makers 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., 15-59 year) woman would die of a disease was roughly 1.0% over the three year period, while the comparable probability for men was 0.6%. Just over 60% 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.

For both asset-poor and non-poor women, the probability was roughly 1.0% whilst for asset-poor and non-poor men the probabilities were 0.5 and 0.7/0.8%. 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 relationship between 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 might expect 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 relatively poor women who have some form of formal/informal business income are less likely to die of disease-related death than women with same characteristics and no formal/informal business activity. This finding suggests that efforts to provide greater income-earning opportunities for poor women may make at least a modest contribution to reducing female prime-age mortality. This relationship does not hold, however, for relatively non-poor females. And 47.2% (45.0) of the women dying of disease-related causes over the three year survey period came from households in the top half of the asset (income) distribution. These findings 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.

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 non poor households are 3.7 and 4.5 times more likely to suffer a disease-related death compared to married women and men who are the heads or spouses of their households. Irrespective of gender, individuals who spend several months or more away from home are 2 to 10 times more likely to die of disease-related causes in succeeding years. 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 the use of condoms, other forms of safe sex, and prevention interventions.

Educational attainment 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 non-poor women. This finding suggests that education is an empowerment tool for women and helps reduce mortality of females and should be encouraged in rural Zambia. Also, HIV/AIDS education campaigns should still target both 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 income 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% and 16.3% for men and women experiencing a prior-disease-related death in their household in the past 8 years versus 0.54% and 0.90% for men and women not experiencing a prior prime-aged death. Of the 362 households experiencing prime-age mortality between 2001 and 2004, 15% 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 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 point in 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 socio-economic factors associated with the disease is likely to help considerably in designing appropriate risk messages and prevention strategies.

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Appendix 1. Descriptive statistics of variables used in the analysis

Variable	Mean	Std Dev	Min	Max	Value of variable at xth percentile		
					25th	50th	75th
Gender (1=male, 0 otherwise)	0.49	0.50	0	1			
Head/spouse (=1 , 0 otherwise)	0.57	0.50	0	1	-	-	-
Marital status (=1, 0 otherwise)							
Currently married	0.56	0.50	0	1	-	-	-
Never married	0.36	0.48	0	1			
Previously married	0.08	0.28	0	1			
Age groups in 2000 (=1, 0 otherwise)							
Age 15-19	0.23	0.42	0	1			
Age 20-24	0.18	0.38	0	1	-	-	-
Age 25-29	0.15	0.35	0	1	-	-	-
Age 30-34	0.11	0.31	0	1	-	-	-
Age 35-39	0.09	0.29	0	1	-	-	-
Age 40-44					-	-	-
Age 45-49	0.08	0.28	0	1	-	-	-
Age 50-54	0.06	0.24	0	1	-	-	-
Age 55-59	0.06	0.23	0	1	-	-	-
Years of education (=1, 0 otherwise)							
None	0.15	0.35	0	1			
1-3 years	0.12	0.32	0	1	-	-	-
4-6 years	0.25	0.43	0	1	-	-	-
7 years	0.24	0.43	0	1	-	-	-
8 years and above	0.24	0.43	0	1	-	-	-
Salary wage income in 2000 (=1, 0 otherwise)	0.09	0.29	0	1	-	-	-
Formal/Informal business activity (=1, 0 otherwise)	0.14	0.35	0	1	-	-	-
Months spent away from home in 2000							
Resided all months at home	0.87	0.33	0	1	-	-	-
Spent one month away	0.04	0.19	0	1	-	-	-
Spent two or more months away	0.09	0.28	0	1	-	-	-
Polygamous household in 2000 (=1, 0 otherwise)	0.13	0.34	0.00	1.00	-	-	-
Prior death of head/spouse in 1996-2004 (=1, 0 otherwise)[a]	0.07	0.25	0.00	1.00	-	-	-
Land holdings (hectares) in 2000	3.39	3.30	0.03	20.00	1.13	2.25	4.50
Productive assets ('000 ZMK) in 2000[b]	814	2502	0.00	42000	7	50	314
District HIV prevalence rate in 1999	15.88	3.25	10.8	31.0	13.34	15.90	17.20
District on the line of rail (=1, 0 otherwise)	0.36	0.48	0.00	1.000	-	-	-
Distance to the nearest tarmac road (km)	23.41	33.23	0.00	188.90	3.60	10.40	27.50
Distance to the district Town/Boma (km)	33.83	22.48	0.30	104.40	15.40	28.80	46.50

Source: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004
Notes: -[a]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.
-[b]Productive assets are the sum of the value of farm equipment (scotch carts, harrows and ploughs) and livestock.

Appendix 2. Probit model results[a] of prime-age mortality between 2001-2004 by gender (village-fixed effects)

	Pooled Sample		Male		Female	
		Corrected for attrition		Corrected for attrition		Corrected for attrition
	(1)	(2)	(3)	(4)	(5)	(6)
Gender(1=male, 0=female)	-0.006**	-0.007**				
	(3.09)	(3.63)				
Head/spouse (1=, 0 otherwise)	-0.010**	-0.011**	-0.008	-0.009	-0.019**	-0.020*
	(3.18)	(3.44)	(1.21)	(1.59)	(2.58)	(2.51)
Currently married (1=, 0 otherwise)	-0.007*	-0.007*	-0.016	-0.014	-0.016*	-0.018*
	(2.28)	(2.21)	(1.86)	(1.78)	(2.48)	(2.55)
Never married (1=, 0 otherwise)	-0.002	-0.002	-0.004	-0.004	-0.001	-0.003
	(0.43)	(0.60)	(0.49)	(0.39)	(0.11)	(0.41)
Age groups in 2000 (=1)						
Age 20-24	0.011**	0.011**	0.016*	0.013	0.015	0.018*
	(2.83)	(2.75)	(1.98)	(1.73)	(1.91)	(2.01)
Age 25-29	0.038**	0.042**	0.076**	0.083**	0.041**	0.046**
	(6.35)	(6.46)	(4.78)	(5.20)	(3.50)	(3.48)
Age 30-34	0.039**	0.046**	0.043**	0.048**	0.081**	0.095**
	(5.72)	(5.92)	(3.14)	(3.34)	(4.66)	(4.66)
Age 35-39	0.054**	0.065**	0.079**	0.092**	0.078**	0.091**
	(6.17)	(6.49)	(3.94)	(4.33)	(4.14)	(4.21)
Age 40-44	0.063**	0.077**	0.175**	0.202**	0.065**	0.077**
	(5.88)	(6.02)	(5.42)	(5.73)	(3.63)	(3.66)
Age 45-49	0.054**	0.062**	0.183**	0.209**	0.051**	0.055*
	(4.62)	(4.51)	(5.38)	(5.57)	(2.67)	(2.52)
Age 50-54	0.063**	0.072**	0.193**	0.214**	0.033*	0.037*
	(5.55)	(5.63)	(5.58)	(5.85)	(2.02)	(2.05)
Age 55-59	0.077**	0.094**	0.239**	0.285**	0.051**	0.066**
	(6.18)	(6.39)	(6.20)	(6.80)	(2.92)	(3.06)
Years of Education in 2000 (=1)						
1-3 years	-0.001	0.001	0.011	0.018	-0.007	-0.006
	(0.22)	(0.29)	(1.23)	(1.63)	(1.21)	(0.85)
4-6 years	-0.001	-0.000	0.010	0.016	-0.011*	-0.011
	(0.46)	(0.08)	(1.22)	(1.68)	(2.08)	(1.65)
7 years	0.000	0.002	0.010	0.017	-0.011	-0.012
	(0.06)	(0.44)	(1.24)	(1.88)	(1.90)	(1.81)
8 years and above	-0.002	-0.001	0.001	0.004	-0.010	-0.010
	(0.64)	(0.34)	(0.09)	(0.57)	(1.58)	(1.33)
Salary wage income in 2000 (=1)	0.001	0.002	0.011*	0.015*	-0.013	-0.012
	(0.19)	(0.68)	(2.09)	(2.51)	(1.44)	(1.14)
Business activity in 2000 (=1)[b]	-0.001	-0.001	0.002	0.003	-0.005	-0.004
	(0.43)	(0.30)	(0.53)	(0.73)	(0.97)	(0.71)
Resided at home throughout the year in 2000	-0.043**	-0.038**	-0.032**	-0.028**	-0.100**	-0.097**
	(9.32)	(8.05)	(4.80)	(4.45)	(8.10)	(7.47)
One month spent away from home in 2000	-0.011**	-0.012**	-0.006	-0.005	-0.020**	-0.024**
	(4.25)	(3.96)	(0.94)	(0.65)	(4.03)	(4.27)
Polygamous household in 2000(=1)	-0.002	-0.002	-0.005	-0.005	0.002	0.003
	(0.48)	(0.46)	(0.82)	(0.86)	(0.29)	(0.40)
Prior PA death in household in 1996 -2003[c]	0.185**	0.164**	0.276**	0.228**	0.274**	0.260**
	(26.72)	(23.80)	(15.16)	(13.57)	(17.60)	(15.92)
Ln(Landholding size (hectares) in 2000)	-0.003*	-0.002	-0.002	-0.001	-0.005	-0.005
	(2.19)	(1.68)	(0.92)	(0.53)	(1.87)	(1.68)
Protected water source (=1, 0 otherwise)	0.000	0.001	0.019	0.025*	-0.009	-0.012
	(0.08)	(0.15)	(1.66)	(2.14)	(0.78)	(0.97)
Superior roofing material (=1, 0 otherwise)	-0.001	-0.001	-0.010	-0.010	0.005	0.005
	(0.31)	(0.34)	(1.37)	(1.26)	(0.78)	(0.61)
Superior floor material (=1, 0 otherwise)	-0.000	0.001	0.003	0.005	-0.007	-0.007
	(0.06)	(0.20)	(0.46)	(0.63)	(0.97)	(0.86)
Standard door frame and door	0.002	0.002	0.006	0.005	0.002	0.004
	(0.61)	(0.70)	(1.20)	(1.08)	(0.31)	(0.60)
Superior wall material (=1, 0 otherwise)	0.002	0.002	0.008	0.008	-0.003	-0.002
	(0.59)	(0.61)	(1.41)	(1.32)	(0.48)	(0.27)
Quartiles of value of household assets Mid-Low	0.003	0.004	0.004	0.003	0.003	0.007
	(1.07)	(1.35)	(0.68)	(0.57)	(0.58)	(1.05)
Mid-High	0.002	0.003	0.001	-0.000	0.006	0.009
	(0.84)	(0.87)	(0.16)	(0.07)	(0.94)	(1.16)
Highest	0.001	0.002	-0.002	-0.001	0.003	0.009
	(0.16)	(0.58)	(0.26)	(0.14)	(0.45)	(0.97)
Village dummies included	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	9806	9804	2866	2866	3498	3497

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

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. ** 1% significance level; * indicates 5% significance level [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.

Appendix 3. Probit models[a] of prime-age mortality in 2001-2004 by gender (province fixed effects)

	Pooled Sample		Male		Female	
		Corrected for attrition		Corrected for attrition		Corrected for attrition
	(1)	(2)	(3)	(4)	(5)	(6)
Gender(1=male, 0=female)	-0.004**	-0.006**				
	(2.85)	(3.39)				
Head/spouse (1=, 0 otherwise)	-0.007**	-0.008**	-0.001	-0.002	-0.009*	-0.010*
	(2.67)	(3.02)	(0.43)	(0.78)	(2.55)	(2.53)
Currently married (1=, 0 otherwise)	-0.006*	-0.006*	-0.007	-0.007	-0.009**	-0.010**
	(2.48)	(2.57)	(1.78)	(1.80)	(2.70)	(2.81)
Never married (1=, 0 otherwise)	-0.002	-0.002	-0.001	-0.001	-0.002	-0.003
	(0.53)	(0.60)	(0.20)	(0.15)	(0.54)	(0.74)
Age groups in 2000 (=1)						
Age 20-24	0.008*	0.009*	0.007	0.007	0.009*	0.011*
	(2.57)	(2.55)	(1.86)	(1.73)	(2.05)	(2.12)
Age 25-29	0.027**	0.031**	0.028**	0.031**	0.026**	0.030**
	(5.83)	(6.06)	(4.00)	(4.25)	(4.03)	(4.17)
Age 30-34	0.027**	0.033**	0.018**	0.021**	0.036**	0.043**
	(5.07)	(5.31)	(2.72)	(2.89)	(4.14)	(4.21)
Age 35-39	0.034**	0.041**	0.030**	0.035**	0.037**	0.044**
	(5.35)	(5.76)	(3.69)	(3.93)	(3.88)	(4.08)
Age 40-44	0.039**	0.048**	0.054**	0.064**	0.030**	0.037**
	(5.02)	(5.26)	(4.48)	(4.77)	(3.27)	(3.46)
Age 45-49	0.036**	0.041**	0.065**	0.076**	0.022*	0.024*
	(4.25)	(4.22)	(4.70)	(4.84)	(2.26)	(2.19)
Age 50-54	0.041**	0.046**	0.079**	0.090**	0.017*	0.020*
	(5.20)	(5.34)	(5.28)	(5.45)	(2.02)	(2.09)
Age 55-59	0.047**	0.057**	0.084**	0.099**	0.025**	0.031**
	(5.62)	(5.97)	(5.70)	(5.98)	(2.59)	(2.87)
Years of Education in 2000 (=1)						
1-3 years	0.001	0.002	0.006	0.011	-0.002	-0.001
	(0.21)	(0.61)	(1.45)	(1.93)	(0.60)	(0.39)
4-6 years	-0.001	-0.000	0.005	0.008	-0.005	-0.005
	(0.34)	(0.02)	(1.32)	(1.79)	(1.70)	(1.42)
7 years	0.000	0.002	0.007	0.011*	-0.005	-0.005
	(0.14)	(0.54)	(1.68)	(2.37)	(1.61)	(1.45)
8 years and above	-0.001	-0.000	0.002	0.004	-0.003	-0.002
	(0.28)	(0.06)	(0.72)	(1.17)	(0.78)	(0.54)
Salary wage income in 2000 (=1)	-0.000	0.001	0.004	0.006	-0.008*	-0.009
	(0.10)	(0.42)	(1.52)	(1.86)	(2.04)	(1.86)
Business activity in 2000 (=1)[b]	-0.001	-0.000	0.000	0.000	-0.001	-0.001
	(0.41)	(0.20)	(0.05)	(0.18)	(0.51)	(0.24)
Resided at home throughout the year in 2000	-0.028**	-0.025**	-0.016**	-0.014**	-0.038**	-0.036**
	(8.90)	(7.58)	(5.32)	(4.43)	(7.97)	(7.03)
One month spent away from home in 2000	-0.008**	-0.009**	-0.004	-0.004	-0.010**	-0.012**
	(3.75)	(3.45)	(1.57)	(1.12)	(3.42)	(3.55)
Polygamous household in 2000(=1)	-0.001	-0.001	-0.003	-0.003	0.001	0.001
	(0.60)	(0.62)	(1.42)	(1.32)	(0.29)	(0.24)
Prior PA death in household in 1996 -2003[c]	0.156**	0.137**	0.143**	0.117**	0.164**	0.153**
	(31.26)	(28.15)	(18.43)	(16.89)	(21.40)	(19.77)
ln(Landholding size (hectares) in 2000)	-0.002**	-0.002*	-0.001	-0.001	-0.003*	-0.003*
	(2.67)	(2.36)	(1.01)	(0.84)	(2.14)	(2.02)
Quartiles of value of household assets Mid-Low	0.002	0.002	0.002	0.002	0.000	0.002
	(0.81)	(1.08)	(0.99)	(0.85)	(0.13)	(0.67)
Mid-High	0.001	0.001	0.000	0.000	0.002	0.004
	(0.58)	(0.61)	(0.18)	(0.01)	(0.80)	(1.12)
Highest	-0.000	0.000	-0.002	-0.002	0.002	0.004
	(0.20)	(0.15)	(0.75)	(0.68)	(0.42)	(0.87)
District HIV prevalence rate in 1999	0.001	0.001	0.000	0.000	0.001**	0.001*
	(1.86)	(1.60)	(0.22)	(0.61)	(2.72)	(2.13)
District on the line of rail (=1 , 0 otherwise	-0.003	-0.003	-0.000	-0.001	-0.005	-0.005
	(1.23)	(1.23)	(0.15)	(0.39)	(1.51)	(1.45)
Distance to the nearest tarmac road (km)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.59)	(0.61)	(0.44)	(0.40)	(0.43)	(0.49)
Distance to the district Town/Boma (km)	0.000	0.000	-0.000	0.000	0.000	0.000
	(0.68)	(1.00)	(0.07)	(0.23)	(1.02)	(1.19)
Provincial dummies included	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	15126	15120	7411	7408	7715	7712

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

Notes: [a]Absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for households. ** indicates 1% significance level; * indicates 5% significance level. [b]Formal or informal business activities. [c]Refers to other adults ages 15 to 59 in household who died up to 8 years before the individual under analysis.