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Characteristics Associated with Prime-Age Mortality in Eastern and Southern Africa: Evidence from Zambia and Kenya

by

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CHARACTERISTICS ASSOCIATED WITH PRIME-AGE MORTALITY IN EASTERN AND SOUTHERN AFRICA: EVIDENCE FROM ZAMBIA AND KENYA

by

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September 2009

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EXECUTIVE SUMMARY

Campaigns to prevent the spread of HIV 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. As the disease has progressed, the relationship between socioeconomic status and HIV contraction may have changed, although there is little evidence to support this. An emerging strand of the literature on the AIDS epidemic in Africa posits that poverty is increasingly associated with the spread of the disease. However, this conclusion is somewhat contentious, as other recent studies find mixed evidence of a poverty-AIDS connection.

This study attempts to shed light on these issues by reporting findings from two linked studies on the socioeconomic characteristics of prime-age individuals (defined as ages 15 to 59) dying of disease-related causes in Zambia and Kenya. Longitudinal data from nationwide rural household surveys are analyzed using probit models to determine how the probability of individual mortality is affected by initial socioeconomic characteristics of individuals and their households. The survey periods covered in the two countries examined in this study (Zambia, 2000 to 2004 and Kenya, 1997 to 2004) makes the findings more recent than the studies in the 1980s which led to the generally accepted findings that AIDS-related mortality disproportionately afflicted individuals with relatively high incomes and educational attainment. Moreover, the panel nature of the data in this study provides the means to examine individual and household characteristics prior to mortality, which provides a more accurate picture than cross-sectional studies which measure socioeconomic attributes only after mortality has occurred.

Findings in these two countries point to a more complex burden of mortality than generally understood, with significant variations by gender, age and economic conditions of individuals. In Zambia, there appears to be little correlation between indicators of individual and household wealth and the probability of disease-related mortality. Nor is there a significant relationship between individual educational attainment and mortality, for either poor or non-poor men or women. Being away from home was associated with increased probability of mortality. By contrast, results in Kenya where HIV prevalence is about half that of Zambia are somewhat similar to those found in Zambia. Years of education reduces the probability of mortality for men, especially non-poor men, but not for women. Disease-related mortality rates for poor men and women (5.46 and 5.07 persons per 1000 person years) are higher than for non-poor men and women (3.51 and 3.44 persons per 1000 person years). However, we find that women who had salaried jobs or business activities in the initial survey period were no more or less likely to die than women without such jobs.

An important observation from the results from Kenya and Zambia is that generalizations about whether poverty or wealth is driving disease-related mortality in Africa are not warranted. Much depends on HIV prevalence rates, the stage of the disease in the country in question, and the general health environment. 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, the Zambia results indicate that non-poor male adult mortality rates are 42% higher than those for poor men. Mortality rates in Zambia are virtually the same for poor and non-poor women. Yet in Kenya where HIV prevalence rates during the periods of these surveys were roughly one-half that of Zambia, disease-related adult mortality rates were highest among the poor. This is likely to be because AIDS accounts for a smaller proportion of prime-age mortality in Kenya

compared to Zambia, and therefore that the other leading causes of death in these countries such as gastro-intestinal maladies, tuberculosis, lower respiratory tract infections, cerebrovascular diseases disproportionately affect the poor (Mather, Lopez, and Murray 2006).

However, in Zambia, which ranks in the top seven countries in the world in terms of HIV prevalence rates at 16.5% in 2003, the fact that mortality rates are not clearly positively related to wealth after controlling for other factors leads us to believe that over time it is likely that the disease has spread broadly into all socio-economic groups. In this case, the transmission pathways, including the ones driven both by wealth and by poverty, are likely to be at play. If this were to be true, risk communication messages and programs would need to be assessed in terms of their cost-effectiveness in reaching multiple socio-economic groups, and programs aiming to reduce the incentives to engage in risky behavior would need to consider the myriad reasons for such behavior, not simply the ones driven by poverty. In fact, we find little evidence that prime-age women from relatively poor households who were engaged in some form of business or self employment activity are less likely to die of disease-related causes than poor women who did not have any business/self-employment activity. These results imply that although policy and programmatic efforts to reduce women's economic vulnerability may contribute to other important social and economic objectives, they alone may make only a modest contribution at best to reducing female prime-age mortality. Interventions to augment incomes and livelihoods of both men and women in general might best be accompanied by complementary interventions to reduce the incidence of risky behaviors, including interventions to reduce women's vulnerability to sexual exploitation in the workplace, alcohol consumption especially by men, and increased access to and acceptability of testing and treatment for sexually transmitted diseases.

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ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
AMR	Adult Mortality Rates
ARV	Anti-retroviral treatment
CSO	Central Statistical Office
DHS	Demographic and Heath Surveys
HIV	Human Immunodeficiency Virus
IPW	Inverse Probability Weights
MACO	Ministry of Agriculture and Cooperatives, Zambia
MSU	Michigan State University
NASCOP	National AIDS and STDs Control Programme
PA	Prime age (15-59 years of age)
PHS	Post-Harvest Survey
Pr	predicted probabilities
SEAs	Standard Enumeration Areas
SS	Supplemental Survey
STD	Sexually Transmitted Disease
USAID	United States Agency for International Development

1. INTRODUCTION

Prime-age adult mortality rates in eastern and southern Sub-Saharan Africa have more than doubled since 1980 (UNAIDS 2003). There is overwhelming evidence that the dramatic rise in disease-related adult mortality in this region is a result of the Acquired Immune Deficiency Syndrome (AIDS) epidemic (World Bank 1999; United Nations 2003; UNAIDS 2003).

Campaigns to prevent the spread of the Human Immunodeficiency Virus (HIV) require accurate knowledge of the characteristics of those most likely to contract the disease. Before the spread of AIDS, health studies in Africa were consistent with findings in the rest of the world, i.e., that there were well-established positive links between wealth, education, and health status (Pritchett and Summers 1996; Kuate-Defo 1997; Deaton 2002, 2003; Mesfin and Schooler 2002; Adler and Newman 2002; Fotso and Kuate-Defo 2005). However, 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.[1] These statistical findings reinforced common perceptions that relatively wealthy and mobile men tended to have more sexual partners, and that these partners came from roughly similar social and educational backgrounds. An important implication of this work was the importance of including and perhaps emphasizing these social groups in HIV prevention and educational campaigns.

As the disease has progressed, the relationship between socioeconomic status and HIV contraction may have changed. An emerging strand of the literature on the AIDS epidemic in Africa posits that poverty (possibly itself being fuelled by AIDS) is increasingly associated with the spread of the disease (Fenton 2004; Gillespie and Kadiyala 2005; Nyindo 2005). However, this conclusion is somewhat contentious, as other recent studies find mixed evidence of a poverty-AIDS connection (e.g., Wojciki 2005; Gillespie, Kadiyala, and Greener 2007).

There are at least three compelling reasons why poverty may be increasingly driving the AIDS epidemic in the region. First, the poor are more likely to have biological co-factors that make unprotected sex more risky. Individuals with sexually transmitted diseases (STD) have at least a five-times greater chance per sexual act of contracting HIV with a HIV positive partner than an individual who is free of STDs (Chin 2006). It is likely that STD prevalence is much higher among the poor (Stillwaggon 2005). Moreover, HIV infection appears to proceed more rapidly to AIDS among individuals with weakened immune systems due to, for example, intestinal parasites or poor diets (Stillwaggon 2005). Through their effect on malnutrition and through specific synergies with HIV transmission, parasitic diseases like malaria[2], and bilharzia as well as helminthic and filarial infections can increase the spread of HIV/AIDS (Stillwaggon 2005). Malnutrition promotes viral replication and can

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[1] The multi-country review of empirical studies by the World Bank (1999) remains the authoritative work on this issue, though it is now increasingly dated.

[2] These infections are co-factors of HIV transmission. For instance, malaria stimulates HIV replication and HIV viral loads have been found to be significantly higher in malaria patients (even after treatment) than in HIV positive individuals without malaria, suggesting that malaria could cause faster progression of HIV (Whitworth et al. 2000). A reduction in HIV viral load after malaria treatment indicates that causation is from malaria to higher viral load rather than from a higher viral load to malaria (Hoffman et al. 1999). However, Whitworth et al. (2000) also provide evidence that HIV promotes malaria transmission. They find greater prevalence of malaria and higher parasite loads in HIV-infected people than in HIV-negative ones.

contribute to greater risk of vertical or sexual transmission of HIV (Friis and Michaelsen 1998). The poor are arguably less likely to have balanced diets, purchase nutritional supplements and STD treatments, or live in areas where adequate health facilities are available.

A second link between poverty and HIV transmission pertains to hardship and migration. Poverty may force poor and hungry people to engage in survival strategies that put them at risk of infection, as contended by Bryceson and Fonseca (2006) based on their study in Malawi. Transitory or chronic hunger, leading to migration, is likely to increase the risk of HIV infection because of the associated disruption of family and spousal relationships. Endemic unemployment is likely to enhance feelings of social disillusionment, frustration and boredom, which could encourage unsafe sex (Van Donk 2002). Migration alters the composition of urban areas in terms of age and sex, with the majority of migrants being working-age men. This reality encourages other livelihood strategies, including sex in exchange for money, goods, or protection. Because unprotected commercial sex often fetches a higher reward, the use of condoms in these sexual transactions is discouraged (Van Donk 2002).

Third, poverty may also influence knowledge. The poor may have limited access to information about HIV/AIDS and how to protect themselves compared to their non-poor counterparts, and even if they do have such information, they may be less likely to alter their behavior. The choice between buying condoms and basic necessities of life may be a stark one for many poor people (Whiteside 2001). Evidence suggests that there is a correlation between levels of education, fertility and condom use. In Uganda, de Walque (2004) finds that educated individuals have been more responsive to HIV/AIDS information campaigns that condom use is positively associated with schooling levels, and that HIV prevalence is progressively less correlated with education over time.

For these three sets of reasons – (i) biological factors that raise the risk of HIV transmission from sex being more common among the poor, (ii) sex as a livelihood strategy being more common among the poor, and (iii) receptivity to behaviour change being slower among poor and relatively uneducated people – it would be plausible to expect that PA mortality would be increasingly correlated with indicators of poverty over time in areas hard hit by HIV/AIDS.[3]

This study attempts to shed light on these issues by reporting findings from two linked studies on the socioeconomic characteristics of PA individuals (defined as ages 15 to 59) dying of disease-related causes in Zambia and Kenya. Longitudinal data from nationwide rural household surveys are analyzed using probit models to determine how the probability of individual mortality is affected by initial socioeconomic characteristics of individuals and their households.

These studies have two important advantages in uncovering whether AIDS is being increasingly driven by poverty or wealth. First, the use of longitudinal data provides a means to assess the impacts of *initial* characteristics of individuals and households, observed before the impacts of illness and death materialized in these households. A major difficulty with

[3] A fourth likely factor relates to the recent roll-out of anti-retro viral (ARV) therapy in rural areas. Because ARVs are more likely to be used by relatively non-poor individuals, they have a better chance of remaining alive than poor individuals. However, we would not expect the impact of ARV use to figure prominently in the survey data in the countries examined in this study, which cover the period just before the major roll-out of ARVs in the region.

cross-sectional assessments is that, by the time of the survey, many individual and household characteristics will have already changed as a result of the individual's illness or death, which would contribute to misleading inferences about the relationship between mortality and pre-death household characteristics. In cross-sectional data, individuals' and households' incomes and other characteristics prior to suffering the consequences of PA mortality are unobserved.[4] The second important feature of these studies is that they are nationwide rural samples (nationally representative rural samples in the case of Zambia) and hence are less vulnerable to inaccurate generalization than studies based on case studies of specific areas.

The results of this two country analysis will assist policy-makers and development agencies better understand the current socioeconomic dimensions of PA mortality in rural Africa, which should help not only in the formulation of HIV prevention and mitigation strategies, but perhaps more saliently, in understanding the potential importance of poverty reduction strategies in overcoming problems of disease-related PA mortality in the region.

The remainder of this paper is organized as follows: Section II describes the data, examines the correlation between mortality rates as observed in the survey data and regional HIV prevalence rates, the modeling approach used in this analysis, and sample attrition issues. Estimation results and their interpretation are presented in Section III. Section IV discusses the conclusions of the paper and implications for donor and government response.

[4] It would be possible to obtain retrospective information in cross-sectional surveys to understand behavior and household conditions prior to the time that the individual started experiencing the symptoms of AIDS. However, difficulties with obtaining accurate recall over a number of years from respondents makes this approach generally unreliable.

2. DATA AND METHODS

The rural household data sets used in this study were designed in collaboration between the organizations represented by the authors and national statistical agencies. Unlike most national Demographic and Heath Surveys (DHS), these surveys contain detailed information on household assets, livestock and crop production, agricultural and off-farm incomes, as well as socio-demographic information on individual household members, including morbidity and mortality. Also in contrast to DHS surveys, the two surveys in this study are longitudinal, allowing us to identify initial pre-mortality characteristics of directly-affected individuals and households.

The sample in both Zambia and Kenya is composed of PA adults who were residents of sampled households in the initial survey year.[5] The second survey tracked the whereabouts of members recorded in the initial survey. In cases where mortality was the cause of individuals no longer being in the household, the surveys asked a few questions about the circumstances of the death.

2.1. Country Data Sets

2.1.1. Zambia

The Zambia data are drawn from nationally representative longitudinal data on 18,821 PA individuals (15-59 years of age) in 6,922 households in 393 standard enumeration areas (SEAs)[6] in Zambia surveyed in May 2001 and May 2004. The survey was conducted by the Central Statistical Office (CSO) in conjunction with the Ministry of Agriculture and Cooperatives (MACO). The 1999/2000 nationally representative Post Harvest Survey (PHS), which surveyed about 7,500 households, was the base for the Supplemental Survey (SS) of May/June 2001. A follow-up survey of the same 6,922 households contained in the 2001 SS was revisited in May/June 2004 and a total of 5,420 (78.3%) households were re-interviewed. If attrition caused by enumerators not re-visiting several SEAs in 2004 that were included in the 2001 survey is excluded, the re-interview rate rises to 88.7%. 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 re-interview rate rises to 94.5%.

A common feature of the data in the two countries is the substantial mobility of individuals in and out of sample households. Of the 18,821 PA Zambian 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). However, because they are contained in the initial survey, and information about their health and whereabouts were captured in the 2004 survey, they are contained in the analysis. Excluded from the analysis are prime-aged individuals who joined their household after the 2001 survey, of which 211 died prior to the 2004 survey. There

[5] It has been noted in the literature that a sizeable proportion of people incurring AIDS returned to their rural homes to receive terminal care and to die (Kitange, Machibya, and Black 1996). A comparison of adult mortality rates (AMR) indicates that in both Kenya and Zambia, the AMR was higher when individuals who joined the household between the first and second surveys are included in the sample (Table 1). For comparability the multivariate analysis in each country was carried out on the sample of prime-aged individuals contained in the baseline survey.

[6] Standard enumeration areas (SEAs) are the lowest geographic sampling unit in the CSO's sampling framework for its annual PHSs. Each SEA contains roughly 150 to 200 rural households.

were 419 deaths recorded among the original 18,821 PA adults, 398 of which were illness-related. Of these, 165 (41%) were men and 233 (59%) were women.

2.1.2. Kenya

The Kenya analysis utilizes two nationwide surveys of rural households conducted in 1997 and 2004 by the Edgerton University's Tegemeo Institute. The sampling frame for the surveys was prepared in consultation with the Central Bureau of Statistics. The survey is designed to be representative of 24 districts within the eight agriculturally-oriented provinces of the country. These districts were chosen to be representative of the major crop producing provinces of the country. A total of 1,578 households were chosen from the 24 districts but 40 households from two pastoral districts were excluded since they differed considerably from households in other zones and had high rates of attrition. In addition, 38 households whose landholding was larger than 20 acres were excluded from the survey, in order to focus on small-scale households. As a result, this study is based on 5,755 PA individuals (15-59 years) in 1,500 households from the 1997 survey.

Out of these 1,500 households, 1,356 were found and re-interviewed in 2004 (90.4%). The household attrition rate between 1997 and 2004 was 9.6%. Of the 5,755 PA individuals (15-59 years) contained in the original 1997 sample, 50.2% had left the household premises by 2004 survey. As with the Zambia survey, the surveys continued to track these individuals, including their health status. The individuals who could not be relocated after the 1997 survey left the households due to various reasons including: search for employment (25.3%), attending school (1.9%), marriage (35.4%), divorce/separation (1.0%), moving away to start their own households or to live with other relatives (23.5%), and death (8.7%).

Table 1 shows illness-related PA adult mortality rates estimated from each country study, as well as HIV prevalence rates from secondary sources. Rural PA adult mortality rates are highest in Zambia for both poor and non-poor males and females compared to Kenya. The PA mortality among poor (non-poor) PA men and women is 6.49 (10.75) and 9.25 (10.81) in Zambia compared to 5.46 (3.51) and 5.07 (3.44) in Kenya respectively. Among countries with the highest female and male PA adult mortality rates in the 15-49 year age range, Zambia is ranked eleventh and Kenya seventh in terms of the total number people currently living with HIV or AIDS. HIV prevalence rates in 2003, which roughly coincide with the time period covered in these household surveys, were estimated at 16.5% in Zambia and 6.7% in Kenya (United Nations 2003).[7]

[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. However, the antenatal clinic data are subject to various selection biases related to convenience sampling (sites may not always be randomly chosen), location of antenatal clinics (most are in urban areas), lower fertility rates among women with HIV infection, and other socio-demographic factors (e.g., age distribution of those attending antenatal clinics, level of education, socioeconomic status) (Rehle and Shisana 2003). Moreover, there are insufficient data on the relative importance of these factors in different regions and countries, not to mention that such factors may vary over time. In spite of the limitations of antenatal HIV prevalence data, they remain the most comprehensive information on HIV prevalence in nearly every Sub-Saharan African country.

Table 1. Survey-based Estimates of Prime-age Mortality and HIV Prevalence Rates: Zambia and Kenya

Country	Households in sample survey	Households with at least one illness-related prime-age death	Survey interval	Prime-age (15-59 year) adult mortality rate[a]				National Adult HIV Prevalence
				Poor (bottom 50% ranked by household wealth)		Non-poor (top 50% ranked by household wealth)		
	n	n (%)	Years	Male	female	male	female	(%)
Zambia	5342	542 (10.1%)	3 years (2001-2004)	6.49	10.75	9.25	10.81	16.5[b]
Kenya	1422	83 (5.8%)	7 years (1997-2004)	5.46	5.07	3.51	3.44	6.7[c]

Sources: Zambia: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Surveys, 2001 and 2004. Kenya: Tegemeo Institute (Nairobi)/Michigan State University Agricultural Monitoring and Policy Analysis Household Surveys in 1997, 2000, 2002, and 2004.

Notes: [a](PA adults / 1000 person-years). Figures in parentheses include prime-aged individuals who joined their households between the first and second surveys, of which some died after joining the household. [b]Based on DHS 2001. [c]Based on NASCOP (2001).

2.2. Relationship between Adult Mortality Rates and HIV Prevalence Rates

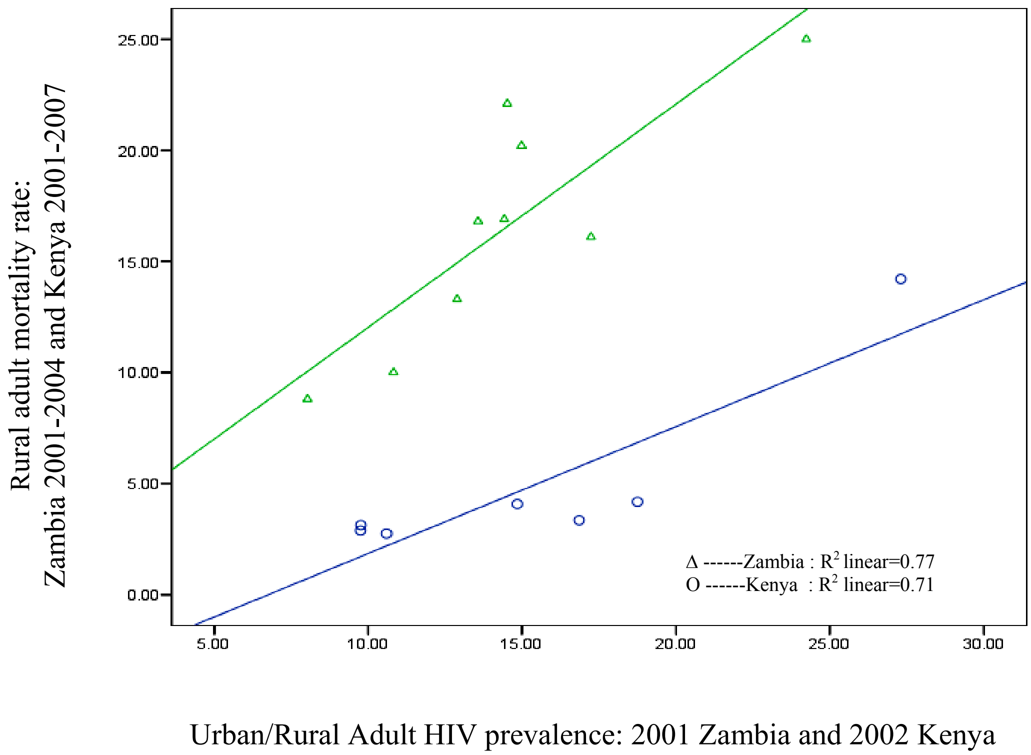
We begin by investigating the correlation between PA mortality rates from the panel household survey data and district HIV prevalence rates from antenatal clinics. A strong relationship between PA mortality and HIV prevalence rates would suggest that a large proportion of PA mortality observed in our 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 in Zambia and Kenya. 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 coefficients of 0.84 and 0.88 for Zambia and Kenya, respectively, suggest that the adult mortality rates observed in the survey data are closely associated with HIV-prevalence.

It is possible that some of the increase in adult mortality across Sub-Saharan Africa is due to recent increases in various opportunistic diseases, such as tuberculosis, which are more likely to occur when adults have a compromised immune system. Those diseases can confound any simple diagnosis as to the cause of illness or death, and are important killers in the absence of AIDS. Malaria, by contrast, is primarily fatal to infants and very young children, not PA adults (WHO 2003).[8] However, recent evidence suggests that HIV-positive adults may be subject to more severe and more life-threatening attacks of malaria (Grimwade et al. 2004; Eline et al. 2005; Laith, Patnaik, and Kublin 2006). Thus, in the absence of widely available diagnostic services in the countries of study, the cause of PA adult mortality in this study should be interpreted within the context of a broader complex disease burden.

[8] The WHO report notes that 90% of malaria deaths are among children under five.

Figure 1. Correlation between Provincial Adult Mortality Rates from Household Survey Data and HIV + Prevalence Rates in Zambia and Kenya



2.3. Model and Estimation Strategies

To examine the relationship between socioeconomic characteristics and the probability of PA death, Probit regressions were run for a dichotomous (0/1) dependent variable, taking a value of 1 if the person died of disease-related causes, zero otherwise. We start with a flexible model specification of the following type:

$$\text{Prob}(A_{it} = 1) = g(I_{i0}, X_{h0}, C) \tag{1}$$

where *A* is a binary variable that equals one if individual *i* died of disease-related causes between the two surveys, zero otherwise. I_{i0} is a set of individual characteristics in the baseline survey, X_{h0} is a set of household characteristics in the base period, and C is a set of community conditions influencing individual health outcomes. These individual, household and community characteristics are drawn from the initial survey to determine the baseline attributes of PA individuals who died between the first and second survey. Households incurring a death in the year of the initial surveys are excluded from the analysis because their baseline values are already likely to be affected by morbidity. The variables contained in each of these categories are as follows:

- *Individual characteristics:* Individual characteristics include the relationship of the PA adult to the household head, age, years of education, months residing at home, and whether the adult had a formal job or was engaged in informal business- or labor-related activities. Because these variables are for the baseline period, they represent individual characteristics before mortality. The age variable is entered as five-year age group dummies, up to the age of 59, with the 15-19 years age group as the reference category. This specification is better able to detect potential non-linearities between age and probability of mortality than linear or quadratic specifications. Education is entered as a continuous variable. A specification test rejected the inclusion of a quadratic term in years of education. Dummy variables are included for whether the individual had a formal job or was engaged in informal business- or labor-related activities during the initial survey period. Months away from home are divided into three binary variables: 0, 1, and 2 or more months away during the initial survey season.[9]

- *Household characteristics:* The vector of household characteristics includes: hectares of land owned and value of assets (productive assets and farm animals).

- *Community characteristics:* Community variables differed somewhat by country due to different information being collected in the surveys. For Kenya, the community variables were distance to the nearest tarmac road and distance to the nearest fertilizer store, which act as proxies for the extent of interaction among local residents and contact with people from other areas. Whilst, the Zambia models included the distance of the village from the nearest tarmac road and district town and a binary variable whether the district is located on the line of rail.

The inclusion of quadratic terms of landholding size, productive assets, 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 non-linear. However, specification tests rejected the non-linearity hypotheses in all cases so only linear terms of these variables are used in regressions.[10] Probit models are run separately for prime-aged men and women, and for individuals in the top versus bottom half of the initial assets distribution to understand whether the socioeconomic correlates of adult mortality vary by gender and wealth status. However, some variables such as individual participation in non-farm income activities, having formal or informal business income, and months away from home are arguably endogenous because they may be related to household wealth status and individual education level which also may increase or decrease the likelihood of contracting and dying from AIDS-related cause. Nevertheless, these individual level variables correlation with PA mortality are the core of this analysis hence, we include them in the analysis.

2.4. Accounting for Possible Attrition Bias

In studies using longitudinal data such as this one, treatment of attrition is particularly important. Adult mortality may contribute to household dissolution, which causes attrition and may lead to under-reporting of mortality rates and biased measurement of the socio-economic characteristics of the deceased as well as impacts of mortality (Hosegood et al. 2004).

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[9] Individuals who died in the year of the first survey are excluded in computing months away from home variables because these individuals were already chronically ill and were more likely to be at home throughout the year. For example, in Zambia, 86 (22% of total prime-age deaths) of those who died in 2001 were at home all the time in 2000, whilst in Kenya nine (5.1% of total prime-age deaths) of those who died in 1997 were at home all the time in 1997.

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

An examination of the relationship between household attrition, dissolution, and household size in Zambia and Kenya survey data shows that the percentage of households attriting is inversely related to household size. 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 PA adult death. This is because the probability that a household will incur a PA adult death is positively correlated with the number of adult members in the household. Also, in both countries we find that households not re-interviewed had slightly younger household heads, smaller household sizes with fewer children age five and below, fewer boys and girls age 6 to 14, fewer PA males and females and elderly males, slightly smaller landholdings, and less farm equipment and animals. These differences indicate that attriting households are generally at an earlier stage in their household life-cycle. Such households tend to be more mobile and transitory, which would make them more likely to attrit in longitudinal surveys. However, we also find that attriting households had slightly higher rates of chronically ill adults in the first survey, suggesting that attrition due to mortality-related household dissolution could be a problem.

Systematic differences between attritors and non attritors, coupled with not insignificant attrition rates, may cause concern about inferences. To deal with potential attrition bias, we use the inverse probability weighting (IPW) method (see Fitzgerald, Gottshalk, and Moffitt 1998; Wooldridge 2002). We construct enumerator quality variables to predict re-interview. Each enumeration team was headed by a supervisor who was authorized to decide when enumerators give up trying to contact designated households. The re-interview model is specified as follows:

$$\text{Prob}(R_{kht} = 1) = f(HIV_{t-j}, I_{hk,0}, X_{h,0}, E_{ht}, P) \qquad (2)$$

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 lagged HIV-prevalence rate; I_{hk0} is a vector of individual characteristics in the initial survey; $X_{h,0}$ is a set of household characteristics in the initial survey including landholding size, productive assets, demographic characteristics (number of children ages 5 and under, number of PA males and females), ownership of various assets; E_{ht} is a set of enumeration team dummies; and P is a set of provincial dummies. Note that all of the variables in (1) are observable even for individuals in households that were not re-interviewed.

Equation (2) is estimated with Probit for attrition between the two surveys, obtaining predicted probabilities (Pr). Then, the inverse probability (1/Pr) is computed, and applied to the probit models described in the following section for estimating PA mortality. Fortunately, the use of IPW to control for possible attrition bias has little effect on the magnitudes of the estimated impact of mortality suggesting that attrition bias is not a major problem in Zambia and Kenya.

3. EMPIRICAL RESULTS

3.1. Descriptive Analysis

Basic characteristics of PA adults who remained alive versus those who died from disease-related causes over the survey interval are summarized in Table 2. The following observations are noteworthy:

- *First*, in absolute numbers, more women died in their prime-age than men in Zambia (233 vs. 165), whilst in Kenya the number of male PA deaths is slightly higher than females (90 vs. 86). However, in Kenya the ratio of female to male mortality has risen over time from roughly 1:1 in the late 1990s, to 1.6:1 in the 2002-2004 period (Kirimi 2008). Adult mortality rates computed from the survey data in Zambia are substantially higher for women than for men (Table 1). The finding that women account for the majority of disease-related PA deaths in these data is consistent with estimates by UNAIDS that women account for 60% of the AIDS-related deaths in Sub-Saharan Africa (UNAIDS 2003).

- *Second*, in both Zambia and Kenya, the mean age at death was lower for women than for men, three years younger.

- *Third*, the proportion of adults who were heads or spouses of household heads during the initial survey is lower among those who died than those remaining alive. Sons and daughters of the household head accounted for a relatively small share of the total PA adults in the sample, but incurred a disproportionately high share of the total disease-related deaths. Still, head or spouses accounted for over 50% of the disease-related PA mortality in each country.

- *Fourth*, the figures in Table 2 show an unclear pattern between educational attainment and mortality. Among women, there appears to be little difference in the years of education between surviving and deceased adults. By contrast, a slightly higher proportion of men with no education died than those with some education. Yet in Zambia's case, 60% of the men who died came from the highest education group (over eight years). These bivariate results indicate potential non-linearities between education and mortality.

- *Fifth*, a higher percentage of men who died in Kenya and Zambia between the survey periods were engaged in informal businesses, 27.8 and 21.2% respectively, compared to only 18.0 and 18.5% for the rest of the male sample. Whilst, unlike in Zambia, Kenyan women who died were also more likely to have been engaged in informal businesses during the initial survey. Overall between the two countries, no distinct patterns emerge in the relationship between wage employment, business activity, and probability of mortality.

Table 2. Descriptive Statistics among Prime-age Adults Who Died Due to Illness and Remaining Prime-age Adults in Kenya and Zambia Samples

Correlates	Kenya (1997-2004)				Zambia (2001-2004)			
	PA adult deaths due to illness		PA adults remaining in the sample		PA adult deaths due to illness		PA adults remaining in the sample	
	Male	Female	Male	Female	Male	Female	Male	Female
Number of observations	90	86	2787	2792	165	233	5735	5851
Age (mean)	38.7	35.5	29.3	30.2	35.6	33.5	31.2	32.7
Head/spouse (%)	58.9	47.7	68.8	52.3	55.5	54.6	61.5	76.4
Education (years)	7.2	6.3	7.9	6.8	6.6	4.7	6.4	4.8
Years of Education (=1) (%)								
No education	12.2	20.9	7.2	14.9	7.5	21.9	9.8	22.9
1-6 years	30.0	34.9	33.3	37.4	11.6	16.7	10.6	16.1
7 years	32.2	20.9	22.4	20.9	20.9	22.7	25.4	25.2
8 years or more	25.6	23.3	37.2	26.8	60.1	38.7	54.2	35.7
Salary/wage income (=1)	17.8	7.0	19.0	5.5	11.3	3	14.2	4.1
Business activity (=1)	27.8	23.3	18.0	15.6	21.2	13.2	18.5	13.3
Income (expenditure) terciles (%)[b]								
Lowest	36.7	43.0	25.2	29.8	32.3	41.5	31.6	34.8
Middle	28.9	24.4	31.7	31.9	39.6	28.8	33.6	33.1
Highest	34.4	32.6	43.1	38.3	28.1	29.7	34.8	32.1
Assets value terciles (%)								
Lowest	32.2	32.5	27.4	29.3	38.4	38.9	31.6	34.1
Middle	35.6	38.4	33.7	34.0	35.4	31.0	33.7	33.6
Highest	32.2	29.1	38.9	36.7	26.2	30.1	34.7	32.3

Source: Kenya: Tegemeo Institute (Nairobi)/Michigan State University Agricultural Monitoring and Policy Analysis Household Surveys in 1997, 2000, 2002, and 2004; Zambia: 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] Income terciles are reported for Kenya and Zambia.

3.2. Probit Regression Results

This section presents results from probit models to identify the attributes of deceased PA individuals in rural Zambia and Kenya. The reported coefficient estimates are marginal effects. To facilitate comparison between the two countries, we report predicted adult mortality rates (number of deaths per 1000 person years) between the time of the baseline and follow-up survey.

Results are reported in two tables. Table 3 reports model results in each country for the full sample and for prime-aged men and women separately. Table 4 reports model results after stratifying the sample both by gender and by initial household wealth groups. It is possible that the relationship between initial individual and household conditions and probability of death may differ between asset-poor and non-poor households and between men and women within each wealth group. The probit model results in Table 4 allow us to empirically examine these issues.

Table 3. Probit Models of Prime-age Mortality, Full Sample and Disaggregated by Gender in Kenya and Zambia

Attributes	Dependent Variable: Deceased prime-age adult (=1, 0 otherwise)					
	---------------Kenya---------------			---------------Zambia---------------		
	Full Sample	Male	Female	Full Sample	Male	Female
	A	B	C	D	E	F
***Ex ante* Individual Characteristics**						
Gender(1=male, 0=female)	-0.002	-	-	-0.010**		
	(0.40)	-	-	(4.39)		
Head/spouse (1=, 0 *otherwise*)	-0.018*	-0.009	-0.023**	-0.024**	-	-0.030**
	(2.55)	(0.68)	(3.54)	(7.56)	(4.83)	(6.38)
Age groups (=1)						
Age 20-24	0.018+	0.010	0.023+	0.014**	0.012	0.017*
	(1.80)	(0.80)	(1.72)	(2.85)	(1.83)	(2.24)
Age 25-29	0.053**	0.042*	0.067**	0.048**	0.048*	0.047**
	(3.35)	(2.36)	(2.85)	(6.65)	(4.80)	(4.48)
Age 30-34	0.059**	0.057*	0.062**	0.061**	0.049*	0.070**
	(3.37)	(2.42)	(2.77)	(6.81)	(4.06)	(5.07)
Age 35-39	0.060**	0.050*	0.083**	0.071**	0.061*	0.073**
	(3.10)	(2.30)	(2.66)	(6.75)	(4.72)	(4.83)
Age 40-44	0.157**	0.198**	0.117**	0.088**	0.100*	0.078**
	(4.55)	(3.51)	(3.66)	(6.65)	(5.41)	(4.69)
Age 45-49	0.097**	0.093**	0.096**	0.085**	0.114*	0.067**
	(3.80)	(2.72)	(2.80)	(5.98)	(5.01)	(3.78)
Age 50-54	0.144**	0.214**	0.079*	0.094**	0.159*	0.051**
	(3.62)	(2.98)	(2.44)	(6.93)	(6.98)	(3.40)
Age 55-59	0.159**	0.169**	0.164**	0.124**	0.172*	0.088**
	(4.53)	(3.24)	(3.99)	(8.45)	(7.17)	(4.84)
Years of schooling	-0.00099	-0.0022+	0.00017	0.00012	0.0003	-0.00047
	(1.07)	(1.81)	(0.16)	(0.29)	(0.73)	(0.72)
Salary wage income (=1)	-0.011	-0.018+	0.006	-0.001	0.003	-0.013
	(1.29)	(1.91)	(0.43)	(0.21)	(0.66)	(1.48)
Business activity (=1)	-0.00029	-0.005	0.007	-0.000	-0.001	0.001
	(0.04)	(0.66)	(0.64)	(0.07)	(0.16)	(0.19)
Months spent away from home						
Resided at home throughout the year(=1)	-0.00047	-0.015	0.019+	-0.042**	-	-0.060**
	(0.05)	(1.33)	(1.89)	(8.48)	(5.27)	(7.57)
One month spent away from home (=1)	0.252*	0.251+	-[a]	-0.016**	-0.009	-0.022**
	(1.99)	(1.81)	-	(3.86)	(1.47)	(3.82)
Ex ante household characteristics						
Polygamous household in 2000(=1)	-0.011	-0.006	-0.012	-0.002	-0.004	-0.002
	(1.49)	(0.47)	(1.38)	(0.53)	(0.64)	(0.31)
Log Landholding size	-0.003	-0.00015	-0.002	-0.004*	-0.002	-0.005*
	(0.92)	(0.04)	(0.67)	(2.34)	(0.97)	(2.37)
Value of assets terciles						
Lowest	0.006	0.004	0.008	0.001	0.004	-0.003
	(0.77)	(0.49)	(0.73)	(0.23)	(1.20)	(0.55)
Highest	-0.008	0.001	-0.016+	-0.003	-0.005	-0.002
	(1.12)	(0.07)	(1.89)	(0.99)	(1.17)	(0.39)

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Community characteristics						
District on the line of rail (=1)	-	-	-	-0.003	-0.001	-0.005
	-	-	-	(1.04)	(0.39)	(1.12)
Distance to the nearest tarmac road (‘00 km)	-0.083*	-0.096+	-0.100	-0.0026	-	-0.0031
	(2.18)	(1.76)	(1.38)	(0.61)	(0.44)	(0.50)
Distance to the district town (‘00 km)	-0.017	-0.055	0.015	0.0004	-.0017	-.0002
	(0.57)	(1.53)	(0.40)	(0.06)	(0.25)	(0.02)
Predicted adult mortality rates	3.86	3.57	3.53	7.14	5.83	8.49
Percent correctly predicted	76%	66%	73%	77%	74%	77%
Observations	5755	2877	2878	15124	7410	7714

Source: Kenya: Tegemeo Institute (Nairobi)/Michigan State University Agricultural Monitoring and Policy Analysis Household Surveys in 1997, 2000, 2002 and 2004; Zambia: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004 Notes: ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for individuals. Estimated coefficients are marginal changes in probability. aVariable not included because there is no variation n the dependent variable.

Table 4. Probit Models of Prime-age Mortality by Gender and Assets Poverty in Kenya and Zambia

Attributes	Dependent Variable: Deceased prime-age adult (=1, 0 otherwise)							
	Kenya				Zambia			
	Assets poor		Assets non-poor		Assets poor		Assets non-poor	
	Male (A)	Female (B)	Male (C)	Female (D)	Male (E)	Female (F)	Male (G)	Female (H)
***Ex ante* Individual Characteristics**								
Head/spouse (1=, 0 *otherwise*)	-0.011	-	-4.61e-	-0.005	-	-	-	-
	(0.71)	(3.48)	(0.00)	(1.45)	(3.56)	(3.94)	(3.03)	(5.63)
Age groups (=1)								
Age 20-24	-0.020	0.020	0.037*	0.042*	0.022	0.015	0.004	0.016
	(1.08)	(0.94)	(2.50)	(2.56)	(1.91)	(1.54)	(0.52)	(1.63)
Age 25-29	0.044+	0.078+	0.041*	0.104**	0.053**	0.032*	0.041**	0.056**
	(1.66)	(1.94)	(2.16)	(3.48)	(3.53)	(2.54)	(3.30)	(3.98)
Age 30-34	0.095*	0.055	0.030	0.128**	0.065**	0.065**	0.034**	0.066**
	(2.25)	(1.54)	(1.16)	(3.60)	(3.25)	(4.01)	(2.58)	(3.56)
Age 35-39	0.074*	0.047	[d]	0.206**	0.093**	0.049**	0.032*	0.092**
	(2.26)	(1.36)		(3.61)	(4.07)	(2.99)	(2.42)	(4.10)
Age 40-44	0.180**	0.113*	0.216**	0.188**	0.174**	0.071**	0.038**	0.078**
	(2.70)	(2.26)	(3.06)	(3.78)	(4.84)	(3.40)	(2.79)	(3.78)
Age 45-49	0.083*	0.251**	0.089*	0.019	0.155**	0.066**	0.070**	0.053*
	(2.14)	(3.39)	(1.97)	(0.93)	(3.94)	(3.18)	(3.46)	(2.42)
Age 50-54	0.250**	0.141*	0.139*	0.076*	0.198**	0.025	0.118**	0.079**
	(2.57)	(2.20)	(2.61)	(2.33)	(5.27)	(1.48)	(4.05)	(3.41)
Age 55-59	0.099+	0.207**	0.223**	0.218**	0.255**	0.091**	0.093**	0.071**
	(1.91)	(2.68)	(3.07)	(3.83)	(5.57)	(4.00)	(3.80)	(2.85)
Years of schooling	-0.0003	0.0007	-0.003*	-0.0001	0.0006	0.0004	0.00003	-0.0013
	(0.21)	(0.32)	(2.30)	(0.20)	(0.91)	(0.50)	(0.06)	(1.80)
Salary wage income (=1)	-0.026+	0.034	-0.09	-0.003	0.008	-0.014	-0.001	-0.009
	(1.82)	(0.94)	(1.55)	(0.46)	(1.20)	(1.48)	(0.17)	(0.73)
Self employment activity (=1)	-0.008	0.010	-0.004	0.004	0.005	-0.001	-0.006	0.002
	(0.76)	(0.51)	(0.58)	(0.53)	(0.85)	(0.17)	(1.05)	(0.25)
Months away from home								

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Resided at home all year(=1)	-0.018	0.018	-0.008	0.011*	-	-	-0.012*	-
	(1.05)	(1.02)	(0.77)	(2.26)	(3.55)	(4.48)	(2.49)	(5.77)
One month spent away	0.395*	d	d	d	-0.003	-0.012*	-0.006	-
from home (=1)	(2.13)	-	-	-	(0.78)	(2.26)	(1.07)	(3.11)
Ex ante household characteristics								
Polygamous household in 2000(=1)	0.009	-0.009	-0.011	-0.004	-0.015*	-0.005	0.009	0.001
	(0.39)	(0.57)	(1.20)	(0.86)	(2.05)	(0.55)	(1.02)	(0.13)
Log Landholding size	0.009	0.02	-0.0002	-0.0007	-0.002	-0.001	-0.003	-
	(1.11)	(0.32)	(0.08)	(0.41)	(0.64)	(0.51)	(1.40)	(2.85)
Community characteristics								
District on the line of rail (=1)	-	-	-	-	0.005	-0.002	-0.004	-0.005
	-	-	-	-	(0.70)	(0.22)	(0.97)	(0.91)
Distance to the tarmac road ('00 km)	-0.001	-0.001	-0.091	0.0025	0.00078	-0.0028	-0.0002	-0.0017
	(1.58)	(1.56)	(1.49)	(0.10)	(0.12)	(0.41)	(0.32)	(0.18)
Distance to the district town('00 km)	-	0.03	-0.028		-0.011	-0.0072	0.0068	0.012
	(1.71)	(0.45)	(0.85)	(0.03)	(1.02)	(0.62)	(0.78)	(0.91)
Predicted adult mortality rates	4.08	5.50	2.06	1.16	4.86	7.47	7.31	7.78
Percent correctly predicted	56%	79%	52%	38%	75%	70%	62%	72%
Observations	1412	1466	1465	1412	3379	3795	4031	3919

Source: Kenya: Tegemeo Institute (Nairobi)/Michigan State University Agricultural Monitoring and Policy Analysis Household Surveys in 1997, 2000, 2002 and 2004; Zambia: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004. Notes: Absolute ** 1% level of significance, * 5% level of significance and + 10% level of significance. Numbers in parentheses are absolute z-scores, calculated using heteroskedasticity robust standard errors clustered for individuals. Estimated coefficients are marginal changes in probability. d variable dropped due to insufficient observations.

Table 5. Simulations of the Predicted Adult Mortality Rates Based on Specific Individual and Household Attributes

Individual Profile	Gender	Relationship to head[a]	Assets poverty status	Age group	Years of schooling[b]	Months away from home per year	Salary wage income	Formal/ Informal business activity	Predicted adult mortality rates	
									Zambia %	Kenya %
1	Female	Head	low	25-29	25^{th} pctile	0	No	No	5.01	3.00
2	Female	Non-head	low	25-29	25^{th} pctile	0	No	No	13.78	14.09
3	Male	Head	low	25-29	25^{th} pctile	0	No	No	2.21	5.27
4	Male	Non-head	low	25-29	25^{th} pctile	0	No	No	7.13	7.83
5	Male	Head	High	45-49	90^{th} pctile	0	No	No	7.65	3.72
6	Male	Non-head	High	45-49	90^{th} pctile	0	No	No	19.51	3.71
7[c]	Male	Non-head	High	45-49	90^{th} pctile	≥2	Yes	No	38.01	2.81
8	Male	Non-head	High	45-49	90^{th} pctile	0	Yes	No	18.79	1.69
9	Female	Non-head	Low	20-24	10^{th} pctile	0	No	Yes	8.43	7.38
10	Female	Non-head	Low	20-24	10^{th} pctile	≥2	No	Yes	29.12	4.27

Source: Zambia: CSO/MACO/FSRP Post Harvest Survey 1999/2000 and Supplemental Survey, 2001 and 2004; Kenya: Tegemeo Institute (Nairobi)/Michigan State University Agricultural Monitoring and Policy Analysis Household Surveys in 1997, 2000, 2002 and 2004. Notes: [a]Simulation outcomes based on regression model in Table 4. [b]Years of schooling: Zambia- 10^{th} percentile=0, 25^{th} percentile =3 90^{th} percentile = 9, and Kenya :10^{th} percentile=0, 25^{th} percentile =6, 90^{th} percentile=11, [c] Months away 2 or greater, else at home throughout the year.

3.2.1. Attributes of Deceased Prime-age Adults

Overall, the average predicted mortality rates of a PA adult during the survey periods is higher in Zambia (7.14%) compared to Kenya (3.86%). These mortality rates are presented in Table 3. Mortality rates for PA males are significantly lower than that of females in Zambia (5.83% versus 8.49%), whilst in Kenya the predicted mortality rates for PA adults are almost equal over the seven year survey period at 3.53% for men and 3.57% for females (Table 3, second from the bottom row).

Gender and Position of the Deceased Individual in Household: The regression results in Table 3 columns A, D, and G support our earlier finding that married household heads and spouses are much less likely to die than unmarried adults in both countries. When stratified by gender the results are significant for both male and females in Zambia and only for women in Kenya (results statistically significant at 1% level). When stratifying the sample by gender and wealth status (Table 4), we find that in both poor and non-poor households, women heads and spouses of the household head are significantly less likely to die than other women in both countries. Male heads of poor households also face a lower likelihood of mortality than other men in Zambia. In Kenya, male household heads face the same probability of mortality as other non-head men, regardless of their households' initial wealth status.

In order to understand the relative magnitude of the different factors affecting death probabilities (which have different units and are, therefore, not directly comparable), we use the model results in Table 4 to compute estimated adult mortality rates over the various survey periods for ten different individual profiles. These predicted mortality rates are reported in Table 5. The findings in Table 5 can be explained as follows, using profiles 1 and 2 in the first two rows as an example. Individuals 1 and 2 are identical in every respect except for their household position. According to the simulation model results, the predicted mortality rates for women fitting the profile 2 category (those who are neither the household head nor spouse of the head) are 13.78% and 14.09%, compared to 5.01% and 3.00% for women fitting the profile 1 category (head or spouse) in Zambia and Kenya respectively. Other attributes constant, non-heads/spouses women are about 2.8 and 4.7 times more likely to die of disease-related causes than women who are heads/spouses of their households, with the highest difference recorded in Kenya.

Unlike in Kenya, men who are heads/spouses of their households in Zambia are also somewhat less likely to die from disease-related causes than men who are not heads or spouses. Comparing profiles 3 and 4 in Table 5, the predicted mortality rates for men who are not the heads of their household (holding other attributes constant) are 3.23 and 1.49 times higher in Zambia and Kenya, respectively, than for men who are the heads of their households. We get similar results when we compare individual profiles 5 and 6, which compare two relatively well educated and high income men. In Zambia, the head of household's predicted mortality rate (mortality per 1000 person years) is 7.65 compared to 19.51 for the man who is not a household head.

Gender and Lifecycle: There are gender differences in the likelihood of death within age groups between the two countries. For example, the probability of death is relatively low for women aged 20-24, but then rises steadily with age and peaks at the 40-44 age range. After that, the probability of mortality declines somewhat before peaking again at the 55-59 age group range (the last reported age range in the definition of prime-age). Among men in

Zambia, mortality rates rise fairly steadily with age, whilst in Kenya it peaks among 40-44 year old men, declines after that, and peaks again in the 50-54 age group (Table 3).

When stratifying mortality impacts by gender and wealth, the story becomes more complex (Table 4). In both Kenya and Zambia, the predicted probability of dying from disease for women residing in relatively non-poor households rises from age 15, peaks first between ages 35 and 39, declines after this but again rises in the 55-59 age range. However, among women in relatively poor families, the probability of mortality does not peak until the 45-49 year age range. For women under 30 years of age, mortality rates are higher for those in non-poor households than in poor households.

Education: 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), the results in Table 4 show a much weaker and mixed relationship between educational attainment and the probability of mortality from disease across the three countries. Results in Table 4 show that years of education significantly lower the probability of PA mortality of non-poor men in Kenya. These findings are somewhat consistent with de Walque (2004), who found that over time, susceptibility to HIV/AIDS in Uganda declined for relatively well-educated people more so than for poorly educated people, as information regarding precautionary measures spread. This could mainly be due to the fact that non-poor men and women are able to process public health messages and that education and relative wealth empowered them to translate their knowledge into practice. However, educational attainment appears to have no strong impact on the probability of mortality for any of the other gender/wealth categories. While the literature that addresses socioeconomic determinants of health (Link and Phelan 1995; Deaton 2002) indicates that differences across individuals in educational and economic resources will maintain a gradient in health whenever there exists a mechanism or technology that more economically better-off and knowledgeable people can access to improve their health, this does not appear to have occurred yet in Zambia or Kenya except among non-poor men. While we cannot conclude that the HIV/AIDS pandemic is the reason why we fail to see the typical positive relationship between an individual's education and health status, this would certainly be a leading hypothesis. The fact that education is weakly correlated with the probability of death in Zambia (where prevalence rates are relatively high) is also consistent with this hypothesis.

Occupation and Business Opportunities: Salary/wage employment: In terms of the mortality risks associated with individuals engaging in formal wage and/or salary employment, the estimation results again show an inconclusive relationship between having a salaried job (a clear indicator of high income and status) in the initial baseline period and the probability of subsequent disease-related death. Among all other gender groups in Zambia and Kenya, individuals with salaried jobs do not seem to have mortality risks that are significantly different from those who did not have such jobs, except among men in Kenya, who faced slightly lower mortality risks.

With regard to informal business activity, we again see no discernable relationship between having an informal business in the initial survey year and subsequent disease-related mortality.

Months Lived Away from Home: The results in Zambia show that irrespective of poverty status, men and women living two or more months away from home per year in the past are more likely to die of disease-related causes compared to men and women of the same characteristics but who spent all the time at home. For example, non-poor women and men who were away from home for two or more months of the year before the initial survey period in 2001 raised the probability of mortality by 4.3 and 1.2 percentage points, respectively. For poor women and men, residing away from home for two or more months was associated with a 3.6 and 1.7 percentage point increase in the probability of subsequent mortality. To gain an understanding of how this affects adult mortality rates, we computed predicted mortality rates for non-poor men who spent two or more months away from home in the initial survey and find that they were 2.02 and 1.66 times more likely to die compared to males with the same characteristics who spent all their time at home in Zambia and Kenya respectively (profiles 7 vs. 8 in Table 5). Comparing profiles 9 and 10, poor women in Zambia living two or more months away from home were 3.5 times more likely to die of disease-related causes than women of the same characteristics but who resided at home throughout the year.

In Kenya, there was a smaller and usually insignificant relationship between months away from home and mortality except for non-poor women and poor men. In these cases, we observe a greater probability of mortality for women residing at home and for men spending one month away from home compared to those spending two or more months away in the year before the initial survey.

Household Wealth Status: In each country, sampled households are ranked by wealth (value of productive assets, not including land) in the baseline survey and divided into three wealth terciles. Categorical variables for the poorest and wealthiest terciles were entered into the probit regressions and reported in Table 3. This approach of computing dummy variables for various percentiles of the wealth distribution allows greater flexibility in uncovering possible non-linear relationships between wealth status and mortality. The use of linear and even quadratic terms requires more restrictive assumptions about functional form.

Results in Table 3 show the relationship between individual wealth status and probability of mortality after holding other model variables constant. Individuals in the relatively non-poor wealth group are significantly less likely to die of disease-related causes among men in Kenya. Among men and women in both Zambia and Kenya, there are no significant differences in the probability of mortality among different wealth groups.

Wealth variables are not entered into the probit estimations reported in Table 4 because these models are already stratified by wealth status. The last several rows of Table 4 report the adult mortality rates due to disease-related causes computed from the survey data for the various wealth/gender groups. In Kenya, observed mortality rates are higher for both poor men and poor women than they are for non-poor men and women. Whilst, in Zambia, mortality rates are roughly the same for poor and non-poor women. However, non-poor Zambian men are 45% more likely to die than poor Zambian men (adult mortality rates of 9.25 vs. 6.49%, respectively). This result is consistent with the earlier World Bank studies reporting a strong positive connection between male mortality due to AIDS and wealth. However, the fact that we do not see this relationship in Kenya (assuming it was there earlier) suggests that the earlier strong positive relationships observed between individual educational attainment, income, and probability of disease-related mortality appear to be weakening with time.

Landholding Size: The amount of land controlled by the household is one of the major determinants of variations in household wealth observed in Sub-Saharan Africa (Jayne et al. 2003). In Tables 3 and 4, we find several statistically significant inverse relationships between household landholding size and the probability of mortality in Zambia. Other factors constant, women in households with three hectares of land had predicted mortality rates that were roughly 18% lower than women in households with only one hectare. Men with larger landholding sizes were also less likely to die than men with less land, but this relationship was not statistically significant. In Kenya, for all sub-groups analyzed in Tables 3 and 4, landholding size bears no statistically significant relationship to the probability of mortality. Because land is one of the primary assets and indicators of wealth in rural Africa, the lack of negative correlation between landholding size and probability of mortality (the evidence actually indicates a positive correlation in Zambia) casts doubt on contentions that adult mortality (AIDS related or otherwise) is being driven by poverty.

4. CONCLUSIONS

This study is motivated by the need to better understand the relationship between poverty and disease-related mortality in countries with high HIV prevalence rates. AIDS is reputedly the single largest cause of disease-related death in Zambia and Kenya (Ngom and Clark 2003). Greater empirical clarity about the socioeconomic correlates of disease-related adult mortality can assist policy-makers and development agencies in the formulation of HIV prevention and mitigation strategies, and perhaps more importantly, to understand the potential importance of poverty reduction strategies in effectively overcoming the problems of AIDS in the region

The survey periods covered in the two countries examined in this study (Zambia, 2000 to 2004 and Kenya, 1997 to 2004) makes the findings more recent than the studies in the 1980s which led to the generally accepted findings that AIDS-related mortality disproportionately afflicted individuals with relatively high incomes and educational attainment (World Bank 1999). Moreover, the panel nature of the data in this study provides the means to examine individual and household characteristics prior to mortality, which provides a more accurate picture than cross-sectional studies which measure socioeconomic attributes only after mortality has occurred.

Findings in these two countries point to a more complex burden of mortality than generally understood, with significant variations by gender, age, and economic conditions of individuals. In Zambia, there appears to be little correlation between indicators of individual and household wealth and the probability of disease-related mortality. Nor is there a significant relationship between individual educational attainment and mortality, for either poor or non-poor men or women. Being away from home was associated with increased probability of mortality. By contrast, in Kenya where HIV prevalence is about half that of Zambia results are somewhat similar to those found in Zambia. Years of education reduces the probability of mortality for men, especially non-poor men, but not for women. Disease-related mortality rates for poor men and women (5.46 and 5.07 persons per 1000 person years) are higher than for non-poor men and women (3.51 and 3.44 persons per 1000 person years). However, we find that women who had salaried jobs or business activities in the initial survey period were no more or less likely to die than women without such jobs.

An important observation from these two countries is that generalizations about whether poverty or wealth is driving disease-related mortality in Africa are not warranted. Much depends on HIV prevalence rates, the stage of the disease in the country in question, and the general health environment. 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, the Zambia results indicate that non-poor male adult mortality rates are 42% higher than those for poor men. Mortality rates in Zambia are virtually the same for poor and non-poor women. Yet in Kenya where HIV prevalence rates during the periods of these surveys were roughly one-half that of Zambia, disease-related adult mortality rates were highest among the poor. This is likely to be because AIDS accounts for a smaller proportion of PA mortality in Kenya compared to Zambia, and therefore, that the other leading causes of death in these countries such as gastro-intestinal maladies, tuberculosis, lower respiratory tract infections, and cerebrovascular diseases disproportionately affect the poor (Mather, Lopez, and Murray 2006).

However, in Zambia, which ranks in the top seven countries in the world in terms of HIV prevalence rates at 16.5% in 2003, the fact that mortality rates are not clearly positively related to wealth after controlling for other factors leads us to believe that over time it is likely that the disease has spread broadly into all socio-economic groups. In this case, the transmission pathways, including the ones driven both by wealth and by poverty, are likely to be at play. If this were to be true, risk communication messages and programs would need to be assessed in terms of their cost-effectiveness in reaching multiple socio-economic groups, and programs aiming to reduce the incentives to engage in risky behavior would need to consider the myriad reasons for such behavior, not simply the ones driven by poverty. In fact, we find little evidence that PA women from relatively poor households who were engaged in some form of business or self employment activity are less likely to die of disease-related causes than poor women who did not have any business/self-employment activity. These results imply that although policy and programmatic efforts to reduce women's economic vulnerability may contribute to other important social and economic objectives, they alone may make only a modest contribution at best to reducing female PA mortality. Interventions to augment incomes and livelihoods of both men and women in general might best be accompanied by complementary interventions to reduce the incidence of risky behaviors, including interventions to reduce women's vulnerability to sexual exploitation in the workplace, alcohol consumption especially by men, and increased access to and acceptability of testing and treatment for sexually transmitted diseases.

REFERENCES

Ainsworth, M. and I. Semali. 1998. Who Is Most Likely to Die of AIDS? Socio- Economic Correlates of Adult Deaths in Kagera Region, Tanzania. In *Confronting AIDS: Evidence for Developing World,* ed. M. Ainsworth, L. Fransen, and M. Over. Brussels: European Commission.

Adler, N.E. and K. Newman. 2002. Socioeconomic Disparities in Health: Pathways and Policies. *Health Affairs* 21.2: 60-76.

Bryceson, D.F. and J. Fonseca. 2006. Risking Death for Survival: Peasant Responses to Hunger and HIV/AIDS in Malawi. *World Development* 34.9: 1654-66.

Chin, James. 2006. The AIDS Pandemic: The Collision of Epidemiology with Political Correctness. Abingdon, U.K.: Radcliffe Publishing.

Deaton, A. 2002. Policy Implications of the Gradient of Health and Wealth. *Health Affairs* 21.2: 13-30.

Deaton, A. 2003. Health, Inequality, and Economic Development. *Journal of Economic Literature* 41.1: 113-58.

Demographic Health Survey (DHS). 2001/2002. Lusaka, Zambia: Government of Zambia.

De Walque, Damien. 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.: The World Bank.

Korenromp, Eline L., Brian G. Williams, Sake J. de Vlas, Eleanor Gouws, Charles F. Gilks, Peter D. Ghys, and Bernard L. Nahlen. 2005. Malaria Attributable to the HIV-1 Epidemic, Sub-Saharan Africa. *Emerging Infectious Diseases* 11.9: September.

Fotso, J. and B. Kuate-Defo. 2005. Measuring Socioeconomic Status in Health Research in Developing Countries: Should We Be Focusing on Household, Communities or Both? *Social Indicators Research* 72.2: 189-237.

Fenton L. 2004. Preventing HIV/AIDS through Poverty Reduction: The Only Sustainable Solution? *Lancet* 364: 1186-87.

Fitzgerald, J., P. Gottshalk, and R. Moffitt. 1998. An Analysis of Sample Attrition in Panel Data. The Michigan Panel Study on Income Dynamics. *Journal of Human Resources* 33.2: 251-99.

Friis, H. and K. Michaelsen. 1998. Micronutrients and HIV Infection: A Review. *European Journal of Clinical Nutrition* 52: 157-63.

Gillespie, S.R. and S. Kadiyala. 2005. *HIV/AIDS and Food and Nutrition Security: From Evidence to Action*. IFPRI Food Policy Review No. 7. Washington, D.C.: IFPRI.

Gillespie, S.R., S. Kadiyala, and R. Greener. 2007. Is Poverty or Wealth Driving HIV Transmission? *AIDS*. 21, Supplement 7: S5-16.

Glynn R. J., M. Carael, A. Buve, S. Anagonou, L. Zekeng, M. Kahindo, and R. Musonda. 2004. Does Increased General Schooling Protect against HIV Infection? A Study in Four African Cities. *Tropical Medicine and International Health* 9.1: 4-14.

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: 467-85.

Grimwade, K., N. French, D. Mbatha, D. Zungu, M. Dedicoat, and C. Gilks. 2004. HIV Infection as a Cofactor for Severe Falciparum Malaria in Adults Living in a Region of Unstable Malaria Transmission in South Africa. *AIDS* 18.3: 547-54.

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: 489-98.

Hoffman, I.F., C.S. Jere, T.E. Taylor, P. Munthali, J.R. Dyer, J.J. Wirima, S.J. Rogerson, N. Kumwenda, J.J. Eron, S.A. Fiscus, H. Chakraborty, T.E. Taha, M.S. Cohen, and M.E. Molyneux. 1999. The Effect of Plasmodium Falciparum Malaria on HIV-1 RNA Blood Plasma Concentration. *AIDS* 13.4: 487-94.

Hosegood, V., N. McGrath, K. Herbst, and I. Timaeus. 2004. The Impact of AIDS Mortality on Household Dissolution and Migration in Rural South Africa. *AIDS* 18.11: 1585-90.

Laith, J. Abu-Raddad, Padmaja Patnaik, and James G. Kublin. 2006. Dual Infection with HIV and Malaria Fuels the Spread of Both Diseases in Sub-Saharan Africa. *Science* 8.December: 1603-06.

Kaute-Defo, B.K. 1997. Effects of Socioeconomic Disadvantage and Women's Status on Women's Health in Cameroon. *Social Science and Medicine* 44.7: 1023-42.

Jayne, T.S., T. Yamano, M.T. Weber, D. Tschirley, R. Benfica, A. Chapoto, and B. Zulu. 2003. Smallholder Income and Land Distribution in Africa: Implications for Poverty Reduction Strategies. *Food Policy* 28: 253-75.

Kirimi, L., W. 2008. Essays on Disease-Related Working-Age Adult Mortality: Evidence from Rural Kenya. Unpublished Ph.D. Dissertation. Michigan State University.

Mather, C., A. Lopez, and C.J.L. Murray. 2006. The Burden of Disease and Mortality by Condition: Data, Methods, and Results for 2001. In *Burden of Disease and Risk Factors,* ed. A.D. Lopez, C.D. Mather, M. Ezzati, T. Jamison, and C.J. L. Murray. Washington D.C.: The World Bank.

Kitange H.M., H. Machibya, and J. Black. 1996. Outlook for Survivors in Sub-Saharan Africa: Adult Mortality in Tanzania. *British Medicine Journal* PubMed Abstract 312: 216-20.

Link, Bruce G. and Jo C. Phelan. 1995. Social Conditions as Fundamental Causes of Disease. *Journal of Health and Social Behavior* Extra Issue: 80-94.

Mesfin, S.M. and C. Schooler. 2002. Causal Connections between Socio-Economic Status and Health: Reciprocal Effects and Mediating Mechanisms. *Journal of Health and Social Behavior* 43.1: 22-41.

NASCOP. 2001. (National AIDS and STDs Control Programme). *Estimating National HIV Prevalence in Kenya from Sentinel Surveillance Data*. Nairobi, Kenya: NASCOP.

Ngom, Pierre and Samuel Clark. 2003. *Adult Mortality in the Era of HIV/AIDS: Sub Saharan Africa.* Workshop on HIV/AIDS and Adult Mortality in Developing Countries, Population Division, 8-13 September, Deptartment of Economic and Social Affairs, New York: United Nations Secretariat.

Nyindo, M. 2005. Complementary Factors Contributing to the Rapid Spread of HIV-I in Sub-Saharan Africa: A Review. *East African Medical Journal* 82.1: 40-46. Available: http://www.ajol.info/viewarticle.php?id=21657.

Pritchett, L. and L. Summers. 1996. Wealthier is Healthier. *Journal of Human Resources* 31.4: 841–68.

Rehle, T.M. and O. Shisana. 2003. Epidemiological and Demographic HIV/AIDS Projections: South Africa. *African Journal of AIDS Research* 2.1: 1-8.

Stillwaggon, Eileen. 2006. The Ecology of Poverty: Nutrition, Parasites, and Vulnerability to AIDS. In *AIDS, Poverty, and Hunger: Challenges and Responses*. (Highlights of the International Conference on HIV/AIDS and Food and Nutrition Security, Durban, South Africa, 14-16 April 2005), ed. S. Gillespie. Washington D.C.: International Food Policy Research Institute.

UNAIDS. 2003. *AIDS Epidemic Update.* Geneva, Switzerland: UNAIDS.

United Nations. 2003. *The Impact of HIV/AIDS on Mortality.* Population Division. New York: United Nations Secretariat.

Van Donk, Mirjam. 2002. HIV/AIDS and Urban Poverty in South Africa. Paper prepared for the South African Cities Network. downloadable at: http://www.isandla.org.za/papers/AIDS%20and%20urban%20poverty%20in%20South%20Africa.pdf

Whiteside, A. 2001. Aids and Poverty: The Links. *AIDS Analysis Africa* 12.2: 1-5.

Whitworth, J., D. Morgan, M. Quigley, A. Smith, B. Mayanja, H. Eotu, N. Omoding, M. Okongo, S. Malamba, and A. Ojwiya. 2000. Effect of HIV-1 and Increasing Immunosuppression on Malaria Parasitaemia and Clinical Episodes in Adults in Rural Uganda: A Cohort Study. *Lancet* 356.9235: 1051-56.

WHO. 2003. *The World Health Report 2003: Shaping the Future*. Geneva: World Health Organization.

Wojcicki, J.M. 2005. Socioeconomic Status as a Risk Factor for HIV Infection in Women in East, Central, and Southern Africa: A Systematic Review. *Journal of Biosocial Science.* 37: 1-36.

Wooldridge, J.W. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

World Bank. 1999. *Confronting AIDS: Public Priorities in a Global Epidemic*. Revised Edition. New York: Oxford University Press.

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