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IFPRI Discussion Paper 00764

April 2008

Marriage Behavior Response to Prime-Age Adult Mortality

Evidence from Malawi

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IFPRI's research, capacity strengthening, and communications work is made possible by its financial contributors and partners. IFPRI gratefully acknowledges the generous unrestricted funding from Australia, Canada, China, Finland, France, Germany, India, Ireland, Italy, Japan, Netherlands, Norway, Philippines, Sweden, Switzerland, United Kingdom, United States, and World Bank.

Published by

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ACKNOWLEDGMENTS

We thank Scott Drimie, Kathleen Beegle, and anonymous referees for useful comments. We are grateful to the Japan Society for the Promotion of Sciences, the Ministry of Education's 21st Century Center for Excellence Project, and the Regional Network on AIDS, Livelihoods and Food Security (RENEWAL) for financial support. Remaining errors are ours.

ABSTRACT

This paper examines the effect of AIDS-related mortality of the prime-age adult population on marriage behavior among women in Malawi. A rise in prime-age adult mortality increases risks associated with the search for a marriage partner in the marriage market. A possible behavioral change in the marriage market in response to an increase in prime-age adult mortality is for marriage to occur earlier to avoid women's exposure to HIV/AIDS risks under the condition that the risks are higher during singlehood. We test this hypothesis using micro data from Malawi, where prime-age adult mortality has drastically increased. In the analysis, we estimate prime-age adult mortality that sample women have observed during the adolescent period by utilizing retrospective information on the death of their siblings.

Empirical analysis shows that excess prime-age adult mortality observed in the local marriage market (district) lowers the marriage age for females and reduces their premarital sexual activities. Since a lower age for first marriage implies less schooling completed, we expect that the average schooling achievement among women would decline. This behavioral change also implies a longer reproduction period during their marriage, which may lead to a higher fertility rate. However, the second implication should be discounted if the reduction of sexual activities also applies to the married population. Lower schooling attainment among women has further implications on human capital formation in the next generation.

Keywords: HIV/AIDS, marriage, sexual behavior, Malawi

1. INTRODUCTION

It has been increasingly recognized that HIV/AIDS has drastically raised mortality rates among prime-age adults. Excessive mortality of prime-age adults can influence various aspects of household behavior, since the loss of prime-age adults decreases the household income and thus human capital investments of the next generation (for examples, see Ainsworth, Beegle, and Koda 2005; Yamauchi, Buthelezi, and Velia 2007). The problem is confined not only in household behavior, but influences perceptions on potential risks in family formation such as finding a marriage partner (for example, see Caldwell et al. 1999). For example, in a society where the AIDS epidemic is prevalent, agents may try to secure a safe partner at an early stage during marriage-partner search. Since marriage decision is key to the way family is structured, current HIV/AIDS mortality risks can potentially have long-term impacts propagating to the next generation.

Earlier studies showed that even with HIV/AIDS epidemics in the society, agents hardly change their sexual behavior despite widespread knowledge and awareness of HIV/AIDS (Lagarde, Emmanual, and Enel 1996; Bloom et al. 2000; Caldwell et al. 1999).[1] These studies highlighted traditional marriage institutions and rituals to explain why Africans do not respond to risks and dangers caused by HIV/AIDS.

However, the above proposition has been questioned recently, given the fact that awareness and knowledge of HIV/AIDS seems to be common in many Sub-Saharan African populations, especially in high HIV prevalence countries (de Walque 2006, using DHS from various countries). In particular, they have an opportunity to discuss the risks of infection and gather information on precautionary measures. For example, according to the 2004 Malawi DHS that is used in our analysis, 98.7 percent of respondents have heard about HIV/AIDS, 83.3 percent know the place to take an HIV test, 70 percent have discussed with their spouses strategies to avoid AIDS, and 65 percent know someone who has AIDS or has died of AIDS.

At the same time, there has been a growing number of descriptive research that examines changing sexual behavior in response to the HIV/AIDS epidemic. Through a focus group discussion in Uganda, Mukiza-Gapere and Ntozi (1995) found that younger generations are more fearful of marriage because they are not sure of the HIV status of their potential partners and many newly married people are dying of AIDS. Ng'weshemi et al. (1996) examined men's sexual behavior in urban Tanzania and found a significant decline in men's extra-marital sexual activities in recent years. Using a longitudinal data from Malawi, Smith and Watkins (2005) and Helleringer and Kohler (2005) found that Malawians are changing their sexual and marriage behavior.

Clark (2004) investigated the link between early marriage and risks of HIV infection among adolescent females by comparing sexually active married women aged 15-24 and sexually active but unmarried women of the same age group. She claimed that married women face a higher risk of infection than unmarried women of the same age group due to (1) a high frequency of sexual activity, (2) a decrease in condom use, and (3) a larger age difference between spouses. Gregson et al. (2002) found that women whose sexual partners are older (large age difference) are more likely to be HIV infected than those whose partners are in similar ages. Bongaarts (2007) pointed out that rising marriage age is associated with a longer period of premarital sex, which increases the infection risks.

Our paper attempts to identify causal effects of AIDS mortality risks on marriage behavior among women, using the 2004 DHS data from Malawi.[2] We hypothesize that an increase in prime-age adult mortality in the marriage market (correlated with the epidemic of HIV/AIDS) leads to a safer behavior among young women in the marriage market by marrying at younger age, shortening the period of

[1] In addition, a number of epidemiological and anthropological studies documented recent trends in rising marriage age and increased instances in premarital sex for young girls in Sub-Saharan Africa without focusing on recent HIV/AIDS epidemics (Zaba et al. 2004; Manda and Meyer 2005; Mensh, Grant, and Blanc 2006).

[2] Unlike many previous studies, this paper uses a nationally representative household survey from Malawi in which the HIV prevalence is high and the excess prime-age adult mortality has increased in recent years.

premarital sexual activities, and securing a young partner.3 These behavioral changes reduce the probability of HIV infection during both singlehood and marriage.

The above changes have further implications to demography and human capital investment of the next generation. First, early marriage means a longer span of the marriage period, particularly during women's reproductive ages. Therefore, the fertility rate is expected to increase. Ceteris paribus, this leads to a reduction in human capital investments in children due to the quality-quantity trade-off (Becker and Lewis 1973).

Second, early marriage can potentially lower educational attainment among women, changing women's bargaining power within the household, which affects intrahousehold resource allocation and welfare outcomes of children (for example, see, Thomas 1990, 1994). Therefore, early marriage among women also adversely affects human capital formation of the next generation.

Verifying our hypothesis is not an easy task, since in many countries, the mortality rate and marriage age are negatively correlated over time. Due to improved nutrition and medical science, the mortality rate has decreased until recently, which partly contributes to a rapid population growth in developing countries. The marriage age, on the other hand, had an upward trend in many countries (Manda and Meyer 2005; Harwood-Lejeune 2000), probably due to the increase in opportunity cost for marriage as women are becoming more educated along with economic development. Until recently, we therefore observed a negative correlation between the marriage age and the mortality rate. Therefore, when looking at correlation, we observe a negative correlation between the mortality rate and marriage age.

We use the following empirical strategy. Using the retrospective death records of respondents' siblings in the 2004 Malawi Demographic and Health Survey, we calculate district-wise (average) prime-age adult mortality rates that each birth cohort has faced, and relate it to marriage behavior for each birth cohort. We take a recent reversal of the mortality-rate trend among prime-age adults as an exogenous change, which, recently, young women have observed before marriage age. We use the district-wise age-specific mortality rate in the 26-to-30-year-old population as the reference for a prime-age adult mortality rate. Then we assume that women age 11-15 observe the reference mortality rate (in the age 26-30 group) to form perceptions on HIV/AIDS risks ahead in their adolescent period.

However, using respondents' siblings to infer the reference prime-age mortality rate in the region requires a caution, since death of older siblings has an impact on marriage behavior of younger siblings. Death of siblings changes intra-family resource allocation, which affects the marriage decision among young women. For example, if an income earner dies, the drop in household income may encourage young women in the household to get married earlier, to join another family.[4] Death of older siblings may also affect the knowledge flow to younger siblings regarding marriage. This effect needs to be controlled in the estimation.

The paper is organized as follows. The next section describes our data set and key demographic characteristics of the sample population, such as prime-age adult mortality rates and first-marriage age in Malawi. We show that mortality rates estimated from the DHS siblings data differ across districts and drastically increase in high HIV prevalence districts. We also observe an upward trend of marriage age when comparing different cohorts, which has been only recently reversed among young women, especially in severely HIV/AIDS-affected regions.

Section 3 sets up a dynamic model that describes the marriage decision in the presence of excess mortality during singlehood. Excess mortality lowers the average marriage age because marriage secures a safe partner, which increases the survival rate among married agents. Section 4 discusses our empirical

3 Due to the data limitation, this paper examines women's behavioral responses. However, our empirical results are applicable to an interpretation of men's behavioral responses. Not only women, but also men seek younger partners, who have a lower probability of being infected, to marry and decide who to marry at a younger age to reduce the risks of HIV infection. Men's preference for younger wives accelerates women's early marriage. We predict the negative correlation between marriage age and the HIV/AIDS epidemic both among men and women.

[4] For instance, Beegle and Krutikova (2007) found that orphaned girls tend to enter marriage at significantly younger ages than non-orphan girls.

strategy. Since we only observe marriage age if the respondent is married, we use tobit and duration models to incorporate the right-censoring issue—distinguishing between complete and incomplete singlehood samples.

We summarize empirical results in Section 5. We found that excess mortality due to AIDS observed in recent years leads to a decrease in women's age for their first marriage. This finding goes against a stylized fact that in many countries, marriage age for women has an upward trend over time. Our results suggest that the recent emergence of the HIV/AIDS epidemic is the main cause. We also found that young women became more conservative in their sexual activity, shortening the premarital sexually active period and hence reducing infection risk. Concluding remarks are mentioned in the final section.

2. EMPIRICAL MOTIVATION

2.1. Data

This study uses the 2004 Malawi Demographic and Health Survey (DHS).[5] The DHS surveys, conducted in various developing countries since the middle of 1980, are nationally representative, designed to collect information on marriage, fertility, family planning, reproductive health, child health, and HIV/AIDS. The sample size (respondent women) of the 2004 Malawi DHS is 11,245. Reproductive-age women aged 15-49 are the focus of the survey, while most recent DHS surveys also include husbands' and household questionnaires. The questionnaire also includes a list of female respondents' siblings, and asks whether or not each of these siblings was still alive at the time of the survey. It has additional information on siblings' current age, year of death if deceased, and age at death.

The DHS surveys are unique large databases for researchers who analyze socioeconomic impacts of HIV/AIDS. It includes rich information on marital status, current and past sexual behavior, including premarital and extramarital sexual activities, knowledge and attitude toward HIV/AIDS, and the result of HIV testing for subsample respondents.[6]

For the purpose of our study, the birth-death records of respondents' siblings are particularly important. To examine the changes of marriage behavior arising from the AIDS epidemic, ideally, we can use information on the regional HIV prevalence in different periods. However, since there are not many surveillance sites collecting HIV test results in the country, it is difficult to investigate the regional differences and dynamic changes in the prevalence rate from aggregated statistics. The DHS survey can only provide the current estimates of the HIV prevalence rate. Therefore, our analysis uses prime-age adult mortality as a proxy for the HIV prevalence.7

Our methodology is as follows. Using birth-death records of respondents' siblings, we compute the age-specific mortality rates, the probability of dying between ages X and Y ($X < Y$), that is, the conditional probability of dying at age Y given that he/she lived until age X.[8] We group people by five-year birth cohorts: 1984-88, 1979-83, 1974-78, 1969-73, 1964-68, 1959-63, 1954-58, and 1949-53 to track their age-specific mortality rates.9

2.2. Trends in Adult Mortality

Table 1 reports estimates of the age-specific adult mortality rates by birth cohorts in Malawi, calculated from the death information of all respondents' siblings. To delineate the trend in mortality rates by birth cohorts, the following age-specific adult mortality rates are calculated: mortality rate in ages 16-20, 21-25, 26-30, 31-35, 36-40, 41-45, and 46-50.

The data show that each age-specific adult mortality rate is higher for recent birth cohorts. The mortality rates are drastically higher for the younger cohorts. This tendency is especially pronounced in the mortality of prime-age adults such as those in ages 26-30, 31-35, and 36-40. For example, the mortality rate in ages 26-30 for the 1969-73 birth cohort (ages 31-35 in 2004) is 61.85 per 1,000, which is

[5]The official website of the DHS: http://www.measuredhs.com/start.cfm

[6]The result of HIV testing allows for an in-depth analysis of sociodemographic and behavioral factors of HIV infection (for example, see de Walque 2006 and Gersovitz 2005). In addition, while HIV prevalence rates are usually estimated from surveillance data taken from pregnant women attending antenatal clinics and high-risk populations, DHS can provide nationally representative estimates of HIV infection, which is more accurate than the surveillance method.

7 See Chapoto and Jayne 2006, Mather et al. 2004, Ainsworth, Beegle, and Koda 2005, and Yamano and Jayne 2005, who adopt a similar approach.

[8] Since respondents by definition are alive during the survey period, mortality rate estimates could be downwardly biased if survival probabilities among siblings are positively correlated.

9 For example, the formula of calculating the mortality rate in ages 26-30 is as follows. First, we calculate the number of people living until age 26 by each birth cohorts, then, calculate the number of deaths until age 30 among them. We divide the number of deaths by the total number of living people.

higher than that of other birth cohorts. The level is nearly four times greater than that for the 1949-53 cohort.

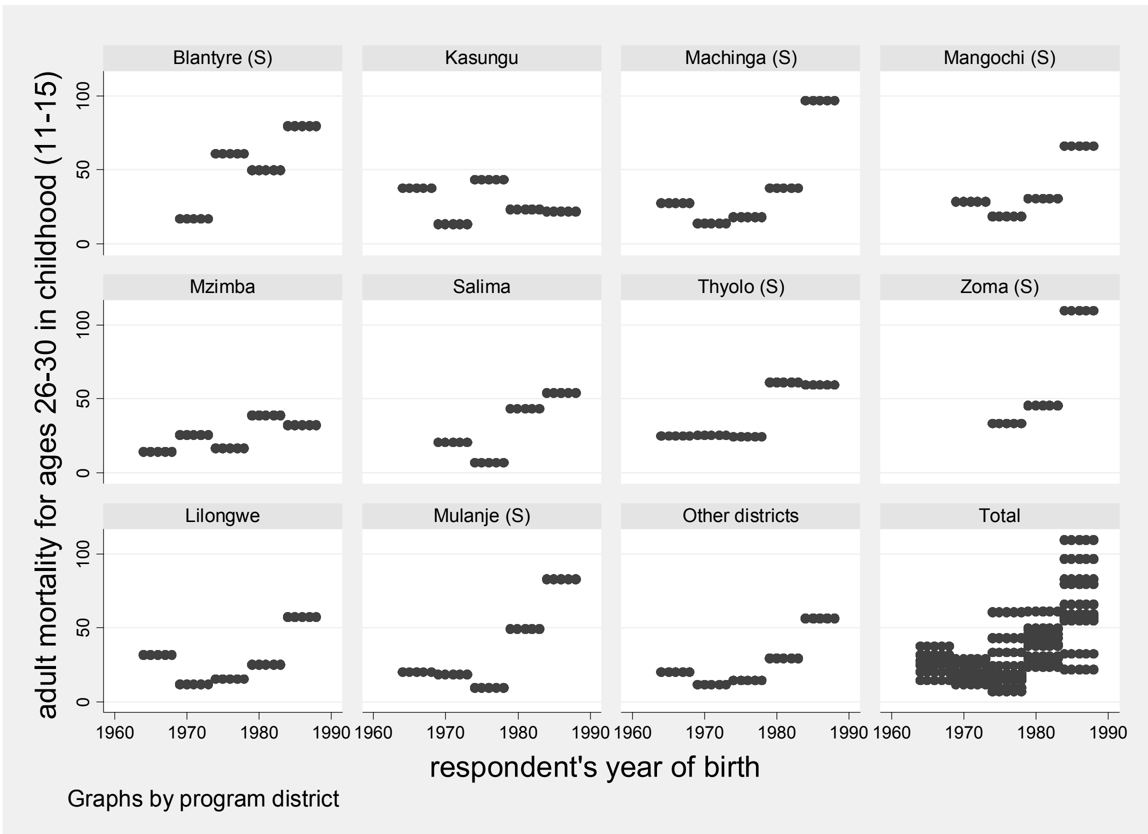
Table 1. Age-specific adult mortality, by birth cohort (all Malawi)

	Probability of death (per 1,000)						
	16-20	**21-25**	**26-30**	**31-35**	**36-40**	**41-45**	**46-50**
All Malawi							
197983	24.55						
	(0.04)						
1974-78	16.16	34.41					
	(0.02)	(0.07)					
1969-73	13.55	29.76	61.85				
	(0.02)	(0.07)	(0.21)				
1964-68	10.98	15.01	37.15	68.92			
	(0.02)	(0.03)	(0.11)	(0.28)			
1959-63	11.62	12.07	20.58	41.37	99.32		
	(0.02)	(0.02)	(0.05)	(0.16)	(0.61)		
1954-58	14.98	9.98	15.36	21.94	66.30	93.43	
	(0.04)	(0.02)	(0.04)	(0.07)	(0.39)	(0.69)	
1949-53	17.21	11.38	17.71	19.84	31.28	51.28	112.11
	(0.07)	(0.04)	(0.07)	(0.08)	(0.17)	(0.37)	(1.26)
Male							
197983	23.48						
	(0.06)						
1974-78	15.59	24.71					
	(0.03)	(0.06)					
1969-73	10.93	23.41	54.26				
	(0.02)	(0.07)	(0.24)				
1964-68	9.46	16.20	29.55	65.25			
	(0.02)	(0.04)	(0.11)	(0.36)			
1959-63	13.22	12.13	25.84	47.08	104.38		
	(0.04)	(0.03)	(0.11)	(0.27)	(0.94)		
1954-58	11.27	12.35	15.38	25.39	65.13	93.25	
	(0.04)	(0.04)	(0.06)	(0.13)	(0.54)	(0.98)	
1949-53	13.45	18.74	19.10	17.70	34.23	61.57	131.21
	(0.06)	(0.11)	(0.11)	(0.10)	(0.27)	(0.68)	(2.27)
Female							
197983	25.62						
	(0.06)						
1974-78	16.75	44.14					
	(0.03)	(0.15)					
1969-73	16.19	36.20	69.65				
	(0.04)	(0.13)	(0.35)				
1964-68	12.46	13.84	44.59	72.60			
	(0.03)	(0.03)	(0.20)	(0.42)			
1959-63	10.03	12.03	15.38	35.81	94.53		
	(0.03)	(0.03)	(0.05)	(0.18)	(0.79)		
1954-58	18.71	7.63	15.37	18.54	67.59	93.82	
	(0.08)	(0.02)	(0.06)	(0.08)	(0.57)	(0.99)	
1949-53	21.16	3.60	16.27	22.06	28.20	40.62	92.74
	(0.13)	(0.01)	(0.09)	(0.14)	(0.21)	(0.37)	(1.33)

Note: Standard errors in parentheses.

Figure 1 shows the mortality rate for ages 26-30 by both birth year and district to illustrate regional differences in a rising trend in prime-age adult mortality. See, also, Appendix Table A.3 for the data on the district-wide, age-specific mortality rates. In general, we find a recent upward trend in the mortality rate for all regions. However, changes vary by district. Districts in the southern region, such as Blantyre, Machinga, Zomba, and Mulanje districts, saw a more drastic increase in the mortality rate than in the northern or central regions. In contrast, changes in the mortality rate are gradual in Kasungu and Mzimba districts in the northern or central regions. Also, for the whole of Malawi, the variance of adult mortality across districts has increased recently.

Figure 1. Trend in adult mortality, by district



Note: (S) denotes that the district is in the Southern region.

This result is consistent with the regional trend in the HIV/AIDS epidemic. The southern region has the highest HIV prevalence rate of all regions. According to the DHS, the HIV prevalence rates are 17.5, 8.1, and 6.4 percent in the southern, northern, and central regions, respectively.

To see the relationship between the HIV prevalence rate and prime-age adult mortality, Figure 2 shows the trends in both indicators by districts. We use the HIV prevalence rates from surveillance data within the district. The surveillance HIV prevalence rates come from the HIV database at the United States Bureau of the Census.[10] While survey period varies across the surveillance sites, we have the HIV prevalence rate estimates between 1992 and 2001 for most sites. To accommodate missing values and to smooth the trend, we take the three-year average prevalence rates in the following three periods:

[10] See the website of the United States Bureau of the Census HIV/AIDS Surveillance Database at http://www.census.gov/ipc/www/hivaidsd.html. See UNAIDS/WHO (2006) for time series infection estimates of each surveillance site.

1992-94; 1995-97; and 1998-2001. Note that we do not have surveillance sites in Blantyre and Zomba districts to infer their HIV prevalence rates. We use surveillance sites in rural areas except for Lilongwe District.

We use our age 26-30 mortality rate estimates in the above periods to compare with the HIV prevalence rates; that is, for 1992-94, we use the mortality rate from cohorts born between 1959 and 1963.

We find rising trends both in the HIV prevalence and in the mortality rates in most districts.[11] In particular, the correlation seems to be stronger in the southern region. In this region, both the prevalence rates and mortality rates rise sharply. The Pearson correlation coefficient between the prevalence and mortality rates is 0.70 in the southern region (observations = 15), while it is 0.44 in the whole of Malawi (observations = 27).

[11]Another reason for the difficulty in comparing the correlation between HIV prevalence and adult mortality is a long time lag between the infection and the death due to AIDS. Current excess mortality due to AIDS may reflect the HIV prevalence of the past.

Figure 2. HIV prevalence and prime-age adult mortality

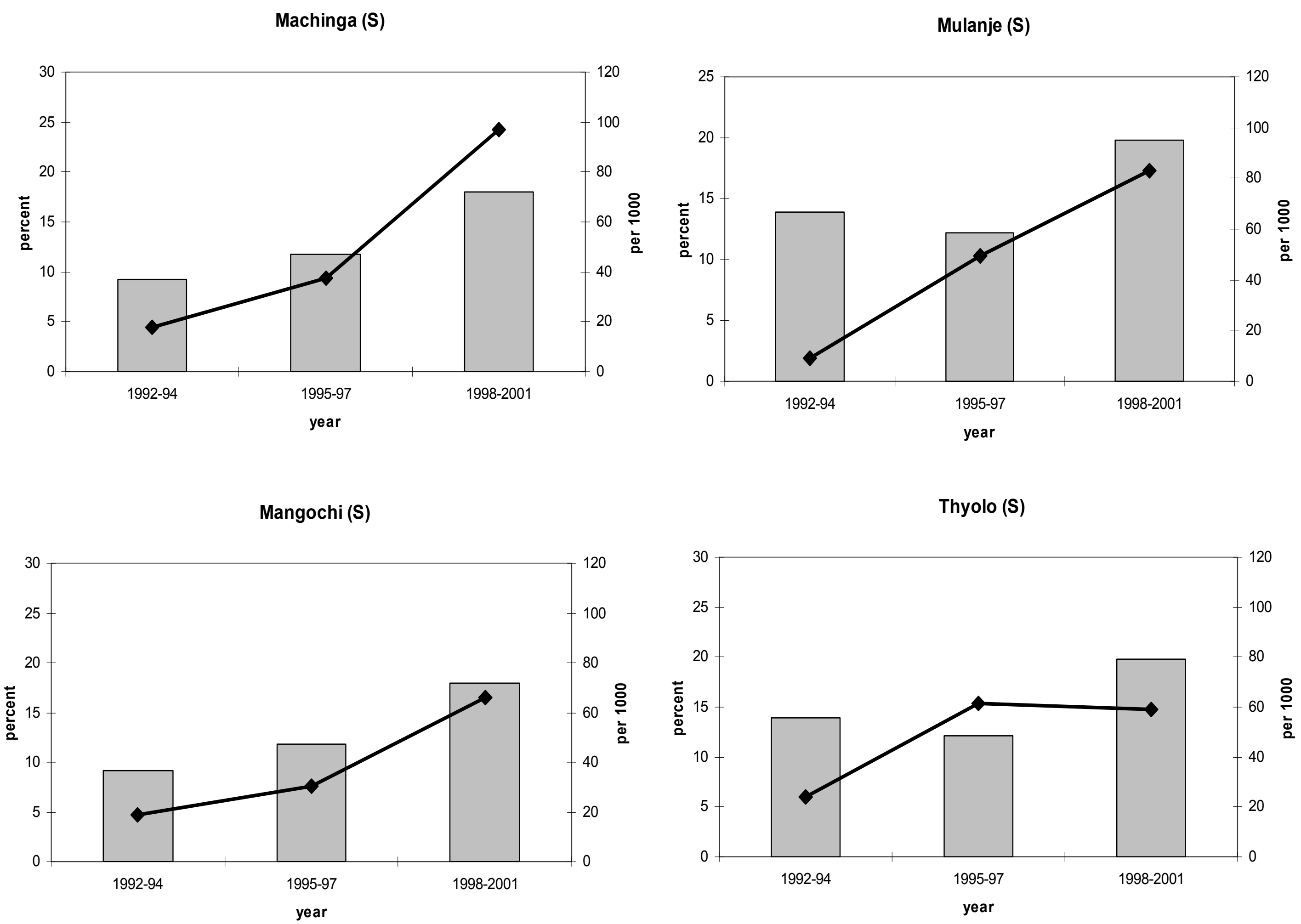
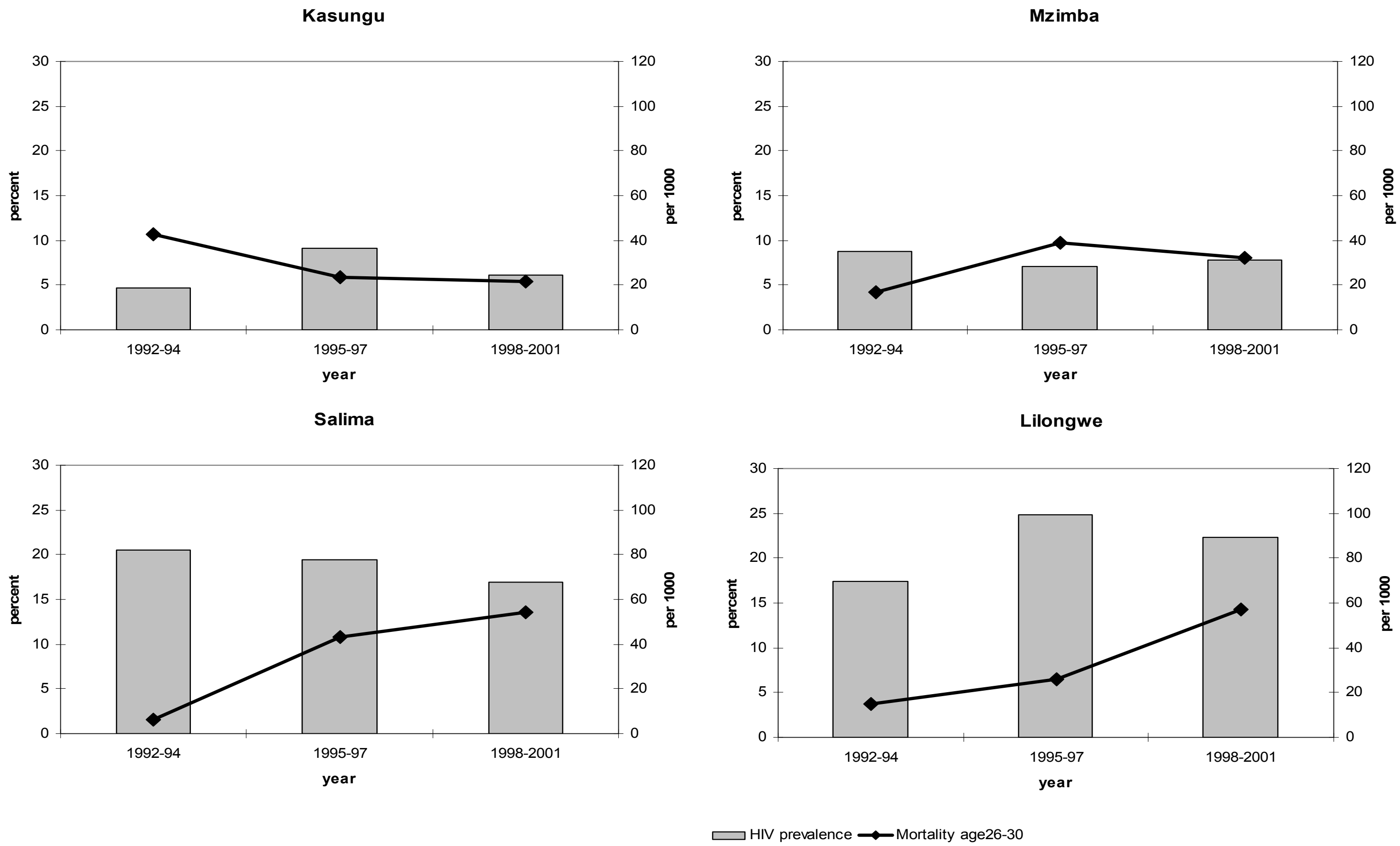


Figure 2. Continued



Source: HIV prevalence rates of surveillance sites are based on the HIV database maintained by the U.S. Bureau of the Census. For more details, see Epidemiological Fact Sheets on HIV/AIDS and Sexually Transmitted Infections: Malawi 2006. Mortality rates between 26 and 30 years old come from our estimates.

Notes: (S) denotes the southern region. Except Lilongwe, the HIV prevalence rates come from rural surveillance sites. The HIV prevalence rates of Lilongwe are from urban sites.

2.3. Age at First Marriage and Premarital Sexual Activities

Figures 3 and 4 present the Kaplan-Meier estimates of the single proportion by birth cohorts and districts. While there does not seem to be drastic structural changes in the timing of marriage among birth cohorts, in general, there is a gradual shift toward marriage at the latter age, especially the decline in marriage age in a recent birth cohort (Figure 3). This result is consistent with the findings in Manda and Meyer (2005), who analyzed the timing of marriage using the data from the 2000 Malawi DHS. Although the distributions are slightly different by districts, there does not seem to be any differences in timing of marriage across districts (Figure 4).

Table 2 shows regional differences in the marriage timing and premarital sexual behaviors by birth cohorts, especially for the younger cohorts. The upper portion of the table shows the proportion of those who were ever married by age 17 and age 19.[12] The data suggest that the proportion of married by both age 17 and 19 is higher for younger cohorts. This tendency seems to be remarkable in the southern region, especially in districts where the HIV epidemic has spread, such as Blantyre, Machinga, Thyolo, and Mulamje).

The lower portion of Table 2 describes premarital sexual activities. The left side shows the proportion of women who experienced sex before their marriage, and the right side shows the average years between the first sex experience and marriage by birth cohorts by districts. The data show regional differences in premarital sexual activities. More unmarried women in the southern region are sexually active than those in the northern and central regions. Also, the interval between the first sex experience and marriage is longer in the southern region. The trends in premarital sexual activities by the birth cohorts seem to be an inversed U shape in many districts. Until recently, before the HIV/AIDS epidemic emerged, the share of women with premarital sex tended to increase. However, as the epidemic has spread in the general population, people are more cautious about sexual activities. Such a trend is pronounced in the interval years between the first sex experience and marriage. Especially in the southern region, the interval becomes shorter for younger cohorts than older ones in all districts except for Zomba.

12 Age 17 is the median age at the time of first marriage; age 19 is the 75th percentile of women ever married in our sample.

Figure 3. Kaplan-Meier plot of the probability of not marrying, by birth cohort

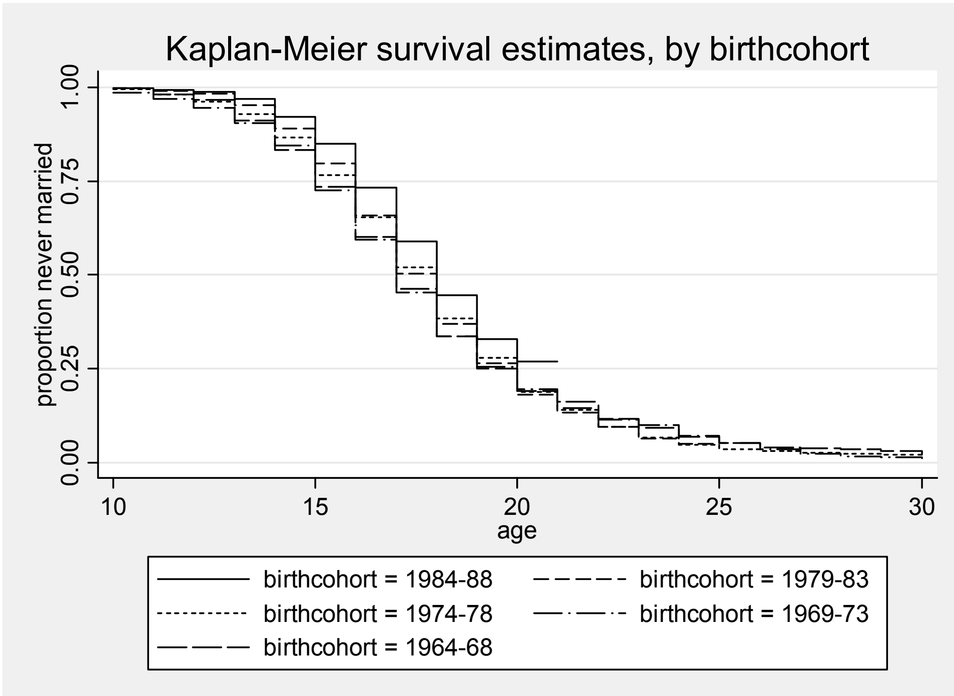
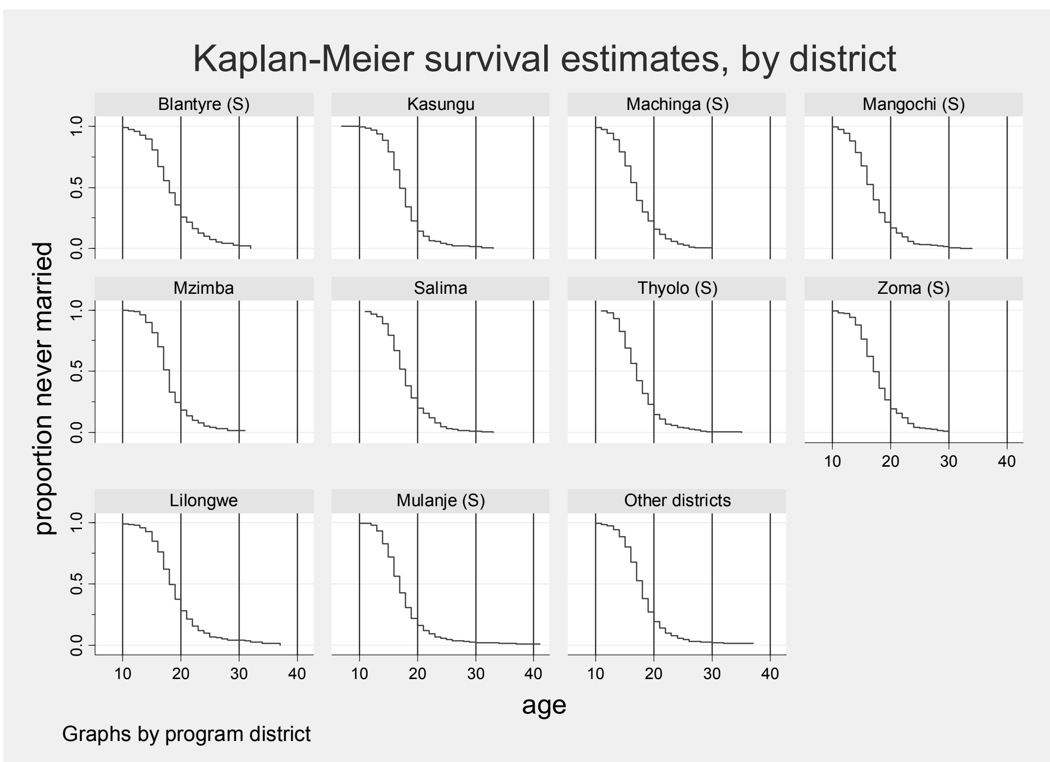


Figure 4. Kaplan-Meier estimates of the probability of not marrying, by district



Note: (S) denotes the southern region.

Table 2. Trends in the timing of marriage and premarital activities, by birth cohort and district

	Birth cohort							
	1979-83	1974-78	1969-73	1964-68	1979-83	1974-78	1969-73	1964-68
	Age at first marriage							
	Proportion of married by age 17				**Proportion of married by age 19**			
Southern region								
Blantyre	0.47	0.41	0.45	0.54	0.66	0.65	0.65	0.73
Machinga	0.59	0.64	0.55	0.69	0.81	0.75	0.72	0.82
Mangochi	0.63	0.64	0.62	0.52	0.77	0.83	0.76	0.74
Thyolo	0.66	0.51	0.56	0.68	0.81	0.74	0.77	0.84
Zomba	0.46	0.47	0.55	0.66	0.74	0.72	0.78	0.76
Mulanje	0.61	0.58	0.58	0.61	0.81	0.77	0.80	0.72
North/Central region								
Kasungu	0.56	0.54	0.53	0.55	0.81	0.79	0.79	0.80
Mzimba	0.53	0.51	0.59	0.53	0.76	0.79	0.82	0.81
Salima	0.53	0.47	0.61	0.46	0.72	0.69	0.84	0.69
Lilongwe	0.34	0.40	0.54	0.51	0.60	0.62	0.75	0.74
Other districts	0.50	0.46	0.54	0.49	0.77	0.73	0.73	0.73
All Malawi	0.50	0.48	0.55	0.54	0.73	0.72	0.74	0.75
	Premarital sexual activities							
	Proportion of women premarital sex				**Years between first sex and marriage**			
Southern region								
Blantyre	0.51	0.45	0.43	0.35	1.74	2.07	2.21	1.69
Machinga	0.30	0.38	0.31	0.33	0.83	1.58	1.72	1.09
Mangochi	0.31	0.27	0.28	0.27	0.79	0.76	0.98	2.12
Thyolo	0.56	0.61	0.57	0.58	1.63	2.12	2.19	2.21
Zomba	0.58	0.60	0.42	0.42	1.98	1.78	1.60	1.86
Mulanje	0.45	0.42	0.44	0.35	1.19	1.38	1.77	1.81
North/Central region								
Kasungu	0.28	0.25	0.26	0.20	0.47	0.43	0.79	0.58
Mzimba	0.26	0.21	0.11	0.19	0.90	0.78	0.41	0.44
Salima	0.27	0.37	0.24	0.24	0.59	1.23	0.91	1.07
Lilongwe	0.31	0.34	0.31	0.29	0.95	1.71	1.16	1.57
Other districts	0.36	0.35	0.30	0.31	0.98	1.22	1.27	1.51
All Malawi	0.37	0.37	0.33	0.32	1.07	1.32	1.34	1.43

3. THEORETICAL HYPOTHESES

3.1. A Simple Model

Our model is based on a search framework in which single agents look for their marriage partners. As discussed in Yamauchi (2007), if the AIDS-related mortality shock decreases the survival probability (discount factor) for the single but does not affect equally that for the married, this gap in survival probability (or discount factor in dynamic optimization) increases the incentive to marry.

If the search for a marriage partner involves some risks of HIV infection, an increase in the AIDS-related mortality rate increases the search cost, for example, using condoms and acquiring more information on partners. Since the incentive to continue the search decreases, agents may delay their starting age for sexual activity as well as decide to marry earlier. Together with a decrease in survival probability, this factor decreases the expected value of continuing the search, which increases the probability of marriage.

However, if a partner search does not involve sexual contact, an increase in prime-age adult mortality does not affect marriage behavior. Moreover, common risk aversion in the face of increased adult mortality due to the high HIV/AIDS prevalence can deter women from using sexual contact as the prime incentive to secure a marriage partner. If so, prime-age adult mortality does not necessarily change marriage behavior among young women. Our main hypothesis critically depends on whether adult mortality increases the partner search cost.

The fundamental assumption in this section is that agents know how AIDS affects mortality risks and how marriage can function to reduce the risk. First, it is controversial to assume perfect information on the AIDS effect on mortality risks in the context of Sub-Saharan Africa since some communities think the cause of death is more spiritual. In this case, we will find any effect of increased mortality on marriage behavior in our empirical analysis. Our intention in this section is to lay out behavioral foundations for testing our empirical hypothesis in the next sections.

We introduce a simple model to describe the effects of the AIDS epidemic on the marriage decision. The stationary dynamic problem is summarized in the Bellman equation,

$$V(v) = \max_{\text{marry, single}} \left\{ V_M(v), V_S \right\},$$

where $V_M(v)$ and V_S are the values of marriage and singlehood, respectively, given the marriage value $v \sim F(v)$. Given that marriage is assumed to be a permanent decision,[13] the value of marriage is written as

$$V_M(v) = (1-\alpha)W + v + \beta^* V_M(v),$$

where W is wage income. After marriage, the couple only get $(1 - \alpha)$ of wage income. The value of singlehood does not depend on v:

$$V_S = W - c + \beta EV(v')$$

where c is search cost, which can increase due to the AIDS epidemic (for example, due to HIV infection risks, agents use condoms and need better information on partners). Under the condition that $\beta_0 > \beta^* > \beta$, where β_0 is the non-AIDS survival probability, the gap in the survival probability between marriage and singlehood gives an incentive to get married earlier to protect one's human capital.

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[13] It is not hard to include separation (divorce) probability, although we simplify this aspect. We also ignore polygamy in this section as we focus on the women's decision.

The marriage decision is given as the following optimization,

$$V(v) = \max_{\text{marry, single}} \left\{ \frac{1}{1-\beta^*} \left[(1-\alpha)W + v \right], W - c + \beta EV(v') \right\}.$$

The threshold point for spouse value v^* (v above, which implies marriage) is

$$v^* = m^* \left[\beta EV(v') - c \right] + (\alpha - \beta^*)W ,$$

where $m^* = 1 - \beta^*$. The agent chooses to marry with a partner of v greater than v^*. Determinants of v^* will affect marriage age.

3.2. Our Hypotheses

In the above model, whether the agent has an incentive to marry earlier or later depends on (changes in) survival probabilities in marriage and singlehood. If an increase in adult mortality decreases the survival rate β (among singles) and increases the search cost c (through sexual activities during singlehood), these factors will decrease v^*, which increases the probability of getting married. On the other hand, an increase in the survival probability in marriage, β^*, increases the incentive to marry. If β^* is smaller than β (that is, singlehood is safer than marriage), then agents have an incentive to delay marriage.

Although we have not explicitly incorporated sexual activity, for example, delaying first sex during singlehood in the model, it is feasible that the agent takes an action to control exposure to HIV/AIDS risks. In singlehood, the agent can make a risk-avoiding investment, z (delaying first sex), with per-period cost p, which increases $\beta(z)$. We interpret z as an action to limit exposure to HIV/AIDS risks. It is easy to show that z^* increases as $EV(v')$ increases and decreases as p increases. Thus, a search without sexual activities increases the survival probability in singlehood.

Combining implications on the marriage age and sexual activities during singlehood, we conclude that the total effect of increased adult mortality on first sex is ambiguous. Marriage age is expected to decrease, which lowers the age for first sex ceteris paribus. However, we are also predicting less sexual activities during singlehood, which increases the age for first sex ceteris paribus.

In the next sections, we test the above hypotheses using individual-level data from Malawi.

4. EMPIRICAL STRATEGY

This section discusses our empirical strategy. To construct reference mortality rates for a respondent woman, we use district-level average mortality rates for ages 26-30 when the respondent was of age 11-15. It is assumed that women of age 11-15 decide the timing of their marriage based on the observed mortality rates in adults aged 26-30 in the same district. For example, the mortality rate of aged 26-30 in the birth cohort of 1939-43 is used in the analysis of marriage behavior of the 1949-53 birth cohort.[14]

The second assumption is that the district is taken as the marriage market. According to our data, most postmarriage mobility is within a district. More than half of married women remains within the same village. This observation implies that the spouse search is also likely to be bound within the district.

The adult mortality has only recently increased particularly in the southern region. Although cross-sectional variations across districts may reflect regional characteristics, dynamic changes observed in recent years are mainly attributed to the HIV/AIDS shocks, which recently hit prime-age adults in the country (see discussion above).

Siblings' deaths also change intrahousehold resource allocation, which influences marriage behavior among young women. Therefore, we have to control for this intrahousehold resource allocation effect when estimating the effect of district-level aggregate mortality on marriage behavior. To do so, we include two variables on deceased siblings: (1) the proportion of siblings who died before the respondent turned 15 years old, and (2) the proportion of adult siblings who died before the respondent reached the age of 15. Because child mortality is strongly correlated with income level, the former indicates living standards of the respondent's family. The latter indicator is more related to HIV/AIDS within the household as the age range of siblings is in prime age.

We estimate the following equation:

$$y^*_{ijkc} = \alpha + \beta m_{kc} + \gamma d_{ijkc} + x_{ijkc}\delta + \mu_i + \phi_c + \eta_{jk} + \varepsilon_{ijkc},$$

where y^*_{ijkc} is marriage decision (for example, marriage age) for woman *I* of cohort *c* in cluster *j* and district *k*, m_{kc} is the district-level age 26-30 mortality at the time the respondent woman *I* was of age 11-15, x_{ijkc} is a set of variables including the proportion of deceased own siblings (of age 26-30 when the respondent was of age 11-15), μ_I is individual fixed effect, ϕ_c is cohort (birth year) fixed effect, η_{jk} is location fixed effect (district or cluster), and ε_{ijkc} is error term.

In the analyses, y^*_{ijkc} includes (1) first-marriage age, (2) age at first sex, and (3) the interval between first sex and first marriage. The interval between first sex and first marriage defines the age at the first marriage minus the age at the first sex, meaning a period of exposure to premarital sexual activities. For characteristics of the household during childhood, we include information on the type of place during childhood (such as city, town, and countryside), the number of siblings, and birth order in all analyses. We also control for ethnicity and religion, and include age fixed effects (dummies) in all regressions.

We hypothesize that an increase in prime-adult mortality due to AIDS motivates younger generations to abstain from risky sexual behaviors. In severe epidemic societies, people would hasten the timing of marriage, delay their first intercourse, and reduce the period of premarital sexual activities. Thus, we expect that the coefficients on district-level mortality would be negative for the marriage age and the period of premarital sexual activities, on the other hand, positive for the age of first intercourse. However, the relationship between the age at first sex and prime-age adult mortality is ambiguous. If one assumes that all girls engaged in premarital sex, then it is positive. However, if they become more

[14] The above assumption may be arbitrary. However, if we expand the age range of adult mortality rates, then more data are required for the calculation of mortality rates in the past. Since the data set has only eight cohorts, expanding the age range for adult mortality will result in a smaller number of cohorts of women that we can study.

conservative and abstain from premarital sex altogether, then the age at first sex is the same as the age at first marriage. In this case, the relationship would be negative. Therefore, using the interval is a better measure in examining whether younger generations are changing their premarital sexual behavior in response to the HIV/AIDS epidemic, since this incorporates the possibility of abstinence.

In the analysis of marriage age, we only observe marriage age if the respondent is married. For single women, we still do not know what age they will get married. This is the same in the analysis of age at first sex. This problem is similar to the distinction between complete and incomplete tenure, in which we only know years of tenure when a worker has already quit his/her job. To solve this right-censored problem in our estimation, we use a tobit model to separate samples of complete and incomplete singlehood, taking into account that a single may get married at an older age than their current age.

The married (complete singlehood) and the single (incomplete singlehood) form the following likelihood:

$$\sum_i \ln F\left(y_{ijkc}^* > y_{ijkc} \mid X_{ijkc}\right) + \sum_i \ln f(y_{ijkc}^* \mid X_{ijkc}),$$

where $F\left(y_{ijkc}^* > y_{ijkc} \mid X_{ijkc}\right)$ is the probability of not observing marriage age y^* but the current age y (that is, unobserved marriage age is larger than the current age) and $f(y_{ijkc}^* \mid X_{ijkc})$ is the probability of observing marriage age y^*. The same framework applies to analysis of the interval between the first sex and marriage age, since we can only compute this variable when the respondent is married. Likewise, we employ a tobit model to the analysis of age at first sex to take care of virgin females.

We assume that m_{kc} is uncorrelated with μ_I as m_{kc} is an aggregate factor at the district level differentiated by cohort groups and is unlikely to be correlated with individual unobserved characteristics, under the assumptions that μ_I is distributed similarly in each district or cluster and uncorrelated with cohort given birth-year fixed effects.

To check the above assumption, we also include the educational level to proxy the woman's (and her family's) income level. It is plausible that the mortality shock affects poor (and uneducated) households more adversely than well-off (and educated) households, and/or simply, poverty influences marriage behavior. Since we are controlling for birth-year fixed effects and village fixed effects in our framework, the inclusion of educational level means that we compare educated and uneducated women (and families) within the same cohort-village group.

This perspective also provides an interesting insight on the difference in the speed of adjustment in response to the local mortality change. We hypothesize that the more educated can identify changes in the mortality rate quicker, and be in a position to modify their marriage behavior faster than the uneducated. This conjecture has been verified in some studies that examined social learning and learning by doing in different contexts (for example, Foster and Rosenzweig 1995; Yamauchi 2004).

5. EMPIRICAL RESULTS

Table 3 shows estimation results, correcting for the right-censored problem. We analyzed the first-marriage age, age at first sex, and the years between first intercourse and first marriage. For single women in our sample, we use the current age for the lower bounds to correct for potential bias due to the right-censored problem.

Table 3. Impact of adult mortality on marriage (Tobit)

	Age at first marriage		Interval between first sex and marriage		Age at first sex	
	(1)	(2)	(3)	(4)	(5)	(6)
District adult mortality in childhood	-0.008	-0.007	-0.036	-0.033	-0.004	-0.003
	(2.53)**	(2.23)**	(6.90)***	(6.58)***	(1.48)	(1.37)
Number of siblings	0.033	0.023	0.001	-0.003	0.036	0.025
	(1.99)**	(1.41)	(0.04)	(0.11)	(2.76)***	(1.92)*
Birth order	-0.014	-0.017	-0.017	-0.023	-0.029	-0.029
	(0.77)	(0.96)	(0.55)	(0.77)	(2.00)**	(2.06)**
Proportion of deceased infant/child siblings	-0.927	-0.689	-1.310	-1.027	-0.625	-0.586
	(5.39)***	(3.99)***	(4.50)***	(3.53)***	(4.54)***	(4.25)***
Proportion of deceased adult siblings	-1.095	-0.861	-1.396	-1.119	-0.723	-0.476
	(2.92)***	(2.34)**	(2.18)**	(1.79)*	(2.41)**	(1.61)
Childhood place (= town)	-0.463	-0.234	-0.703	-0.361	0.008	0.015
	(2.27)**	(1.14)	(2.09)**	(1.07)	(0.05)	(0.09)
Childhood place (= countryside)	-1.113	-0.504	-1.514	-0.602	-0.460	-0.287
	(5.98)***	(2.66)***	(4.95)***	(1.93)*	(3.15)***	(1.93)*
District fixed effects	Yes		Yes		Yes	
Village (cluster) fixed effects		Yes		Yes		Yes
Observations	9,161	9,161	8,527	8,527	9,141	9,141
Uncensored observations	7,723	7,723	7,106	7,106	8,294	8,294
Censored observations	1,438	1,438	1,421	1,421	847	847

Notes: Absolute t-statistics are in parentheses. * Significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent. Also control for a constant term, women's age (birth year), ethnicity and religion.

The results of marriage age are shown in Columns 1 and 2, those of the interval between first sex and marriage are shown in the following two columns, and those of age at first sex are presented in the last two columns. Columns 1, 3, and 5 show the results with controlling for district fixed effects. We found that district-level adult mortality rate significantly reduces age at first marriage (Column 1). These findings indicate that women who faced higher adult mortality in the neighborhood during their adolescent period are more likely to get married at a younger age. Marriage is still customary in Malawi; therefore it is not common to refuse marriage. One possible interpretation is that women tend to get married younger in an area experiencing high HIV prevalence in order to find a safe spouse. At the same time, the negative correlation between women's marriage age and prime-age adult mortality may be interpreted in that men choose younger women to marry because younger women, especially virgins, have a lower probability of being HIV positive.

Column 3 shows that the HIV epidemic has a significant effect on reducing premarital sexual behavior. Women who faced higher adult mortality during their adolescent time are likely to shorten the interval between first sexual intercourse and first marriage. However, we do not find any significant correlation between the age of first intercourse and mortality rates during their adolescent period (Column 5). This is because first marriage is frequently interdependent with first intercourse. On the one hand, the HIV/AIDS epidemic motivates unmarried women to delay or avoid premarital sexual activities; on the other hand, early marriage as a risk-mitigate strategy causes them to be sexually active at an earlier age. By balancing out both effects, the empirical result in age at first sex becomes ambiguous. Combined with our previous result, this finding means that women take two strategies: reducing premarital sexual activities and marrying at a younger age.

In addition to the regional mortality effect, the proportion of deceased siblings is an important factor affecting the timing of marriage. Death of siblings significantly decreases the first-marriage age and shortens the difference between first intercourse and first marriage. There are two reasons for this negative effect. First, the death of siblings may cause a reduction in household income, which encourages young women to get married to secure their livelihood elsewhere. Second, young women can learn from siblings' death within the household that HIV/AIDS epidemic is a significant problem among the population from which they choose their spouses. Both factors decrease first marriage age.

The right-censoring problem causes an upward bias in parameter estimates of our interest. Ignoring the incomplete singlehood sample (especially young women), we lose information from a group of women who may marry later. Since mortality rate estimates are cohort-specific in our analysis, a substantial proportion of the recent cohort would be dropped from our sample. Therefore, the negative impact of mortality on marriage behavior may be underestimated without the sample of younger women (recent cohort).

The above results, although corrected for the right-censoring problem, may be biased due to a correlation between village-specific and individual-specific fixed unobservables and explanatory variables in the equation. However, since our mortality measure is of the district-level, potential bias would be small.

To check the robustness, Columns 2, 4, and 6 show results with village fixed effects. Results are quite similar to those with district fixed effects. The coefficient estimates on adult mortality are significant and negative in the analyses of marriage age and the interval between first sex and marriage, but insignificant in the analysis of age at first sex.

Table 4 includes interaction terms between the district-level adult mortality rates and the birth cohorts of women. The base category of birth cohort is women who were born between 1984 and 1988 (the youngest cohort). In this group, district-level adult mortality significantly decreases first-marriage age. The interactions are insignificant in most cases, implying that there are no significant differences with the base (youngest) cohort.

Interestingly, we observe some cohort-specific heterogeneity in the age difference between first sex and first marriage. The negative effect of adult mortality is significant only in the base group of the most recent cohort. The effect seems to be much smaller, not different from zero, among older cohorts.

As discussed, we check the robustness of the above results by including the highest level of education attained. Since in most cases there is only one respondent in the sample household, individual characteristics also represent household condition. Although, ideally, we would like to include income measures for each respondent as of her childhood or adolescent period, the data do not have such retrospective information. We think that education attainment can capture the income level, if we control cohort effect (or trend) in education attainment. Table 5 includes dummy variables representing primary, secondary, and higher education attained in the right-censoring controlled tobit model.[15]

[15] Changes in labor market conditions (such as returns to schooling) affect the incentive to invest in child schooling, which influences women's marriage behavior. Given the possibility that schooling and marriage decisions are interrelated, it is important to control completed schooling levels in the analysis. However, we assume that schooling is exogenously determined.

Table 4. Impact of adult mortality on marriage, controlling for village fixed effects (with interaction between district adult mortality and birth cohort)

	(1)	(2)
	Tobit	Tobit
	Age at first marriage	Interval between first sex and marriage
District adult mortality in childhood	-0.010	-0.046
	(2.70)***	(7.88)***
Cohort (1979-83)*adult mortality	0.001	0.041
	(0.13)	(3.91)***
Cohort (1974-78)*adult mortality	0.010	0.034
	(1.41)	(2.96)***
Cohort (1969-73)*adult mortality	0.020	0.063
	(1.33)	(2.44)**
Cohort (1964-68)*adult mortality	0.011	0.052
	(0.66)	(1.78)*
Number of siblings	0.023	-0.001
	(1.40)	(0.05)
Birth order	-0.016	-0.021
	(0.91)	(0.71)
Proportion of deceased infant/child siblings	-0.686	-1.036
	(3.98)***	(3.57)***
Proportion of deceased adult siblings	-0.854	-1.141
	(2.32)**	(1.82)*
Childhood place (= town)	-0.228	-0.332
	(1.11)	(0.98)
Childhood place (= countryside)	-0.503	-0.601
	(2.65)***	(1.93)*
Observations	9,161	8,527
Uncensored observations	7,723	7,106
Censored observations	1,438	1,421

Notes: Absolute t-statistics are in parentheses. * Significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent. Include a constant term and dummy variables for village, women's age (birth-year), ethnicity, and religion.

The first two columns show the results of age at first marriage. These show that district-level mortality has a significant impact on the timing of marriage, even after controlling for educational level. The coefficients on dummy variables for primary, secondary, and higher education are significant and positive, meaning that educated women tend to marry later than uneducated women. The magnitude of the coefficient on higher education is larger than that on primary education. To test whether the impact of adult mortality on the timing of marriage differs by educational levels, Column 2 adds the interaction terms between district adult mortality and dummy variables for educational levels. The coefficient on adult mortality is still significant and negative. The coefficients on dummies for secondary and higher education are very similar to those of Column 1, although that on primary education becomes insignificant. The coefficient on the interaction term between adult mortality and primary education is significant and positive, suggesting that for women who have completed only primary school, the mortality effect is weakened. For others, the mortality effect remains robust.

Table 5. Impact of adult mortality on marriage, controlling for respondents' education and village fixed effects

	(1)	(2)	(3)	(4)
	Tobit	Tobit	Tobit	Tobit
	Age at first marriage		Interval between first sex and marriage	
District adult mortality in childhood	-0.0053	-0.015	-0.0293	-0.0668
	(1.79)*	(2.87)***	(5.89)***	(7.41)***
Highest education (reference = no education)				
Primary education	0.5821	0.2112	-0.1587	-0.9118
	(6.50)***	(1.28)	(1.02)	(3.17)***
Secondary education	3.5993	3.6652	3.2789	-0.0199
	(26.63)***	(14.82)***	(14.22)***	(0.05)
Higher education	6.9723	6.778	6.2455	-2.2777
	(14.06)***	(6.41)***	(7.64)***	(1.28)
Primary education * adult mortality		0.0128		0.0303
		(2.60)***		(3.55)***
Secondary education * adult mortality		0.001		0.0955
		(0.17)		(8.79)***
Higher education * adult mortality		0.0075		0.2669
		(0.24)		(5.33)***
Number of siblings	0.0074	0.0068	-0.0129	-0.0064
	(0.47)	(0.43)	(0.47)	(0.24)
Birth order	-0.0196	-0.019	-0.0266	-0.0273
	(1.16)	(1.12)	(0.90)	(0.93)
Proportion of deceased infant/child siblings	-0.3614	-0.3556	-0.6674	-0.6588
	(2.20)**	(2.17)**	(2.34)**	(2.32)**
Proportion of deceased adult siblings	-0.5779	-0.5889	-0.7957	-0.6712
	(1.64)	(1.67)*	(1.30)	(1.10)
Childhood place (= town)	-0.2635	-0.2578	-0.3865	-0.3046
	(1.34)	(1.32)	(1.17)	(0.92)
Childhood place (= countryside)	-0.0523	-0.0524	-0.1332	-0.0617
	(0.29)	(0.29)	(0.43)	(0.20)
Observations	9,161	8,527	8,527	8,527
Uncensored observations	7,723	7,106	7,106	7,106
Censored observations	1,438	1,421	1,421	1,421

Notes: Absolute t-statistics are in parentheses. * Significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent. Include a constant term and dummy variables for village, women's age (birth-year), ethnicity, and religion.

Similar results are obtained from the results on the interval between first sex and marriage. The coefficients on adult mortality are significant and negative. Women who attained primary school have a shorter interval between first intercourse and marriage than uneducated women. In Column 4, we found that the mortality effect is weak among educated women. They have a longer period of singlehood after the first sex.

To check the robustness of the above tobit results, we employ a duration (survival) analysis of marriage decision. Table 6 shows the results of the proportional hazard model with time-variant explanatory variables. The measure of survival duration is the number of years until marriage. We use the district-level mortality rate in ages 26-30 in t-5 (years) for potential decisionmaking at t (t = 1,2,3,…. T). This is a time-variant, district-level prime-age adult mortality rate. Other explanatory variables are the same as in the tobit model. Since in the general setup we treat "marriage" as an exit state, a hazard ratio that is greater than one means it is more likely to enter marriage, that is, she has a shorter duration until marriage.

All the estimates are shown as hazard ratios, and absolute z values are reported in parentheses. The mortality rate of age 26-30 is significant and the hazard ratio is greater than unity, implying that women who faced higher district-level prime-age mortality during childhood married earlier in their life (Column 1). In Column 2, we interacted birth-cohort indicators with the district-level adult mortality. The results are similar to those obtained in the tobit model in Table 4. The youngest cohort (baseline cohort) changes the timing of their marriage in response to an increase in adult mortality in the region.

Column 3 includes women's educational levels and Column 4 adds its interaction with the district-level adult mortality. The results are very similar to those in Table 5 (tobit model). Even after controlling for women's education, the impact of adult mortality is still significant. The probability of marriage decreases with the educational level of women. The interactions between adult mortality and women's education are significant for primary and higher education, but its odds ratios are approximately equal to 1. This suggests that the impact of adult mortality on marriage age is not different largely by educational level. Women who faced higher district-level adult mortality tend to hasten their marriage regardless of their educational levels. In Table 6, therefore, we confirmed our key empirical results in survival analysis too.

Table 6. Impact of adult mortality on a timing of marriage, a duration analysis

	Conditional hazard: Marriage			
	(1)	**(2)**	**(3)**	**(4)**
District adult mortality in childhood	1.049	1.062	1.05	1.049
	(59.32)***	(27.48)***	(59.77)***	(39.60)***
Cohort (1979-83)*adult mortality		0.995		
		(2.31)**		
Cohort (1974-78)*adult mortality		0.993		
		(2.98)***		
Cohort (1969-73)*adult mortality		0.979		
		(8.35)***		
Cohort (1964-68)*adult mortality		0.944		
		(11.27)***		
Highest education (reference = no education)				
Primary education			0.94	0.86
			(2.45)**	(3.22)***
Secondary education			0.38	0.37
			(17.99)***	(9.59)***
Higher education			0.24	0.54
			(6.38)***	(1.35)
Primary education * adult mortality				1.00
				(1.72)*
Secondary education * adult mortality				1.00
				(0.40)
Higher education * adult mortality				0.98
				(1.83)*
Number of siblings	0.996	0.996	1.004	1.004
	(0.72)	(0.90)	(0.71)	(0.76)
Birth order	1.002	1.002	1.002	1.002
	(0.34)	(0.42)	(0.42)	(0.40)
Proportion of deceased infant/child siblings	1.219	1.203	1.085	1.085
	(3.89)***	(3.76)***	(1.61)	(1.61)

Table 6. Continued

	Conditional hazard: Marriage			
	(1)	(2)	(3)	(4)
Proportion of deceased adult siblings	1.146	1.105	1.095	1.097
	(1.06)	(0.77)	(0.76)	(0.77)
Childhood place (= town)	1.218	1.147	1.162	1.162
	(2.31)**	(1.73)*	(1.89)*	(1.89)*
Childhood place (= countryside)	1.369	1.321	1.075	1.073
	(3.94)***	(3.84)***	(0.97)	(0.95)
Observations	134,477	134,477	134,477	134,477

Notes: Odds ratio shown. Robust t-statistics are in parentheses. * Significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent. All regressions include dummy variables for district, women's age (birth-year), ethnicity, and religion.

6. CONCLUSION

This paper showed that excess mortality arising from AIDS observed in recent years decreased women's age for their first marriage in Malawi. This finding goes against a stylized fact that in many countries, marriage age for women has been rising over time globally. The recent emergence of the HIV/AIDS epidemic reversed this trend in Malawi and likely in other countries in Sub-Saharan Africa. Young women also became more conservative in their sexual activity, delaying the age of first intercourse (thus shortening the premarital sexually active period).

The findings have some implications on human capital formation among women and for the next generations. First, early marriage means less schooling among young women, which may weaken their bargaining power in the household and consequently have negative outcomes on children. Second, a longer period of marriage may also imply an increase in fertility, which also has a negative outcome on child schooling through so-called quantity-quality trade-offs. Therefore, it is possible that AIDS-related excess mortality has negative effects on human capital formation among women and the next generations through changes in women's marriage behavior. The detailed investigation of the impact of women's early marriage on human capital formation is an issue to be tackled in the future.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1. HIV prevalence in Malawi

	Male	Female	Total
		(percent)	
All Malawi	10.2	13.2	11.7
Urban	16.6	18.1	17.3
Rural	8.8	12.4	10.6
Region			
Northern	5.8	10.3	8.1
Central	6.2	6.6	6.4
Southern	15.1	19.7	17.5
Age			
15-19	0.4	3.7	2.1
20-24	3.8	12.9	9.2
25-29	9.8	16.3	12.9
30-34	20.3	16.3	18.3
35-39	15.3	18.7	16.9
40-44	19.4	18.6	19.0
45-49	11.0	11.7	11.4
Education			
No education	11.3	13.0	12.4
Primary	8.9	12.8	10.9
Secondary	13.5	15.9	14.4
Higher	6.2	6.3	6.3
Household wealth			
Poorest	4.3	10.8	8.0
Poorer	5.0	10.2	7.7
Middle	11.7	12.5	12.1
Richer	11.9	14.7	13.3
Richest	15.0	18.0	16.4

Table A.2. HIV prevalence, by women's characteristics

	HIV prevalence rate
	(percent)
Current marriage status	
Widowed	37.4
Divorced	26.5
Remarriage (more than once married)	22.9
Age difference between spouses (husband older 10 more)	19.1
Sexual behavior	
Had sex before marriage	18.3
More than one sexual partner	43.7
Nonmarital sexual intercourse	22.6
All women	13.1

Table A.3. Age-specific adult mortality, by birth cohort by district

	Probability of death (per 1,000)						
	16-20	**21-25**	**26-30**	**31-35**	**36-40**	**41-45**	**46-50**
Blantyre							
197983	31.65						
	(0.26)						
1974-78	31.98	50.66					
	(0.27)	(0.55)					
1969-73	12.12	36.81	79.62				
	(0.07)	(0.40)	(1.32)				
1964-68	11.19	11.32	49.62	96.39			
	(0.07)	(0.07)	(0.70)	(1.99)			
1959-63	35.97	14.93	60.61	32.26	191.67		
	(0.59)	(0.16)	(1.34)	(0.53)	(8.52)		
1954-58	15.87	16.13	16.39	25.00	102.56	114.29	
	(0.18)	(0.19)	(0.19)	(0.37)	(3.21)	(4.01)	
1949-53	18.18	18.52	0.00	37.74	39.22	61.22	86.96
	(0.33)	(0.35)	(0.00)	(1.03)	(1.11)	(2.23)	(3.96)
Kasungu							
197983	12.86						
	(0.06)						
1974-78	7.51	18.15					
	(0.03)	(0.10)					
1969-73	16.98	23.03	21.61				
	(0.10)	(0.15)	(0.14)				
1964-68	12.72	5.15	23.32	53.05			
	(0.07)	(0.02)	(0.18)	(0.65)			
1959-63	12.61	8.51	42.92	44.84	56.34		
	(0.09)	(0.05)	(0.60)	(0.65)	(0.94)		
1954-58	18.75	31.83	13.16	20.00	34.01	49.30	
	(0.20)	(0.46)	(0.12)	(0.23)	(0.53)	(0.95)	
1949-53	24.10	12.35	37.50	25.97	13.33	40.54	98.59
	(0.42)	(0.15)	(0.83)	(0.48)	(0.18)	(0.97)	(3.87)
Machinga							
197983	22.15						
	(0.14)						
1974-78	17.79	43.48					
	(0.10)	(0.39)					
1969-73	11.63	51.76	96.77				
	(0.06)	(0.59)	(1.58)				
1964-68	9.90	20.00	37.41	98.94			
	(0.06)	(0.16)	(0.43)	(1.95)			
1959-63	8.73	8.81	17.78	49.77	119.05		
	(0.05)	(0.06)	(0.16)	(0.77)	(3.02)		
1954-58	13.33	6.76	13.61	13.79	69.93	142.86	
	(0.13)	(0.05)	(0.13)	(0.14)	(1.60)	(5.06)	
1949-53	13.33	13.51	27.40	14.08	42.86	89.55	65.57
	(0.18)	(0.18)	(0.54)	(0.20)	(1.08)	(3.43)	(2.22)

Table A.3. Continued

	Probability of death (per 1,000)						
	16-20	**21-25**	**26-30**	**31-35**	**36-40**	**41-45**	**46-50**
Mangochi							
197983	28.83						
	(0.21)						
1974-78	21.74	35.19					
	(0.14)	(0.29)					
1969-73	9.93	12.53	65.99				
	(0.05)	(0.07)	(0.88)				
1964-68	20.29	29.59	30.49	62.89			
	(0.16)	(0.28)	(0.30)	(0.91)			
1959-63	0.00	13.76	18.60	56.87	65.33		
	(0.00)	(0.11)	(0.17)	(0.96)	(1.22)		
1954-58	27.59	7.09	28.57	7.35	96.30	90.16	
	(0.39)	(0.05)	(0.41)	(0.05)	(2.71)	(2.57)	
1949-53	47.62	0.00	0.00	37.50	25.97	40.00	111.11
	(1.16)	(0.00)	(0.00)	(0.83)	(0.48)	(0.94)	(4.63)

	Probability of death (per 1,000)						
	16-20	**21-25**	**26-30**	**31-35**	**36-40**	**41-45**	**46-50**
Mzimba							
197983	12.12						
	(0.05)						
1974-78	8.03	22.65					
	(0.03)	(0.14)					
1969-73	6.74	13.57	32.11				
	(0.03)	(0.08)	(0.28)				
1964-68	2.53	15.23	38.66	50.94			
	(0.01)	(0.10)	(0.39)	(0.61)			
1959-63	8.26	0.00	16.67	38.14	61.67		
	(0.05)	(0.00)	(0.14)	(0.49)	(1.05)		
1954-58	12.35	18.75	25.48	26.14	26.85	89.66	
	(0.11)	(0.20)	(0.33)	(0.35)	(0.37)	(2.34)	
1949-53	0.00	27.78	14.29	0.00	28.99	14.93	75.76
	(0.00)	(0.55)	(0.21)	(0.00)	(0.60)	(0.22)	(2.67)
Salima							
197983	23.30						
	(0.16)						
1974-78	15.30	25.24					
	(0.08)	(0.18)					
1969-73	2.87	43.23	54.22				
	(0.01)	(0.49)	(0.71)				
1964-68	14.04	10.68	43.17	63.91			
	(0.10)	(0.07)	(0.55)	(1.02)			
1959-63	12.58	6.37	6.41	51.61	102.04		
	(0.11)	(0.04)	(0.04)	(0.97)	(2.84)		
1954-58	0.00	10.10	20.41	31.25	32.26	133.33	
	(0.00)	(0.10)	(0.30)	(0.57)	(0.61)	(5.51)	
1949-53	0.00	0.00	0.00	26.32	54.05	28.57	147.06
	(0.00)	(0.00)	(0.00)	(0.70)	(2.12)	(0.83)	(10.47)

Table A.3. Continued

	Probability of death (per 1,000)						
	16-20	21-25	26-30	31-35	36-40	41-45	46-50
Thyolo							
197983	38.59						
	(0.31)						
1974-78	24.39	50.00					
	(0.16)	(0.47)					
1969-73	12.12	30.67	59.07				
	(0.06)	(0.25)	(0.68)				
1964-68	4.83	9.71	61.27	104.44			
	(0.02)	(0.05)	(0.78)	(1.82)			
1959-63	15.56	15.81	24.10	45.27	129.31		
	(0.12)	(0.13)	(0.24)	(0.63)	(3.27)		
1954-58	18.52	0.00	25.16	6.45	116.88	110.29	
	(0.20)	(0.00)	(0.32)	(0.04)	(3.43)	(3.33)	
1949-53	0.00	57.47	24.39	0.00	25.00	102.56	157.14
	(0.00)	(1.52)	(0.43)	(0.00)	(0.45)	(3.93)	(8.11)
Zomba							
197983	27.20						
	(0.18)						
1974-78	9.65	34.09					
	(0.04)	(0.26)					
1969-73	15.70	43.28	109.52				
	(0.09)	(0.44)	(1.87)				
1964-68	0.00	19.11	45.45	102.04			
	(0.00)	(0.15)	(0.57)	(2.01)			
1959-63	16.00	16.26	33.06	59.83	140.91		
	(0.13)	(0.13)	(0.39)	(0.99)	(3.85)		
1954-58	6.37	6.41	0.00	32.26	66.67	135.71	
	(0.04)	(0.04)	(0.00)	(0.47)	(1.45)	(4.55)	
1949-53	35.71	12.35	0.00	25.00	76.92	69.44	104.48
	(0.75)	(0.15)	(0.00)	(0.45)	(2.51)	(2.24)	(4.36)
Lilongwe							
197983	15.75						
	(0.09)						
1974-78	12.47	27.37					
	(0.06)	(0.21)					
1969-73	18.07	33.74	57.14				
	(0.13)	(0.35)	(0.79)				
1964-68	12.55	16.95	25.86	26.55			
	(0.09)	(0.14)	(0.28)	(0.29)			
1959-63	21.43	14.60	14.81	52.63	55.56		
	(0.27)	(0.15)	(0.16)	(1.08)	(1.20)		
1954-58	33.33	0.00	11.49	34.88	48.19	12.66	
	(0.65)	(0.00)	(0.13)	(0.72)	(1.19)	(0.16)	
1949-53	30.77	0.00	31.75	0.00	32.79	16.95	51.72
	(0.68)	(0.00)	(0.72)	(0.00)	(0.77)	(0.29)	(1.59)

Table A.3. Continued

	Probability of death (per 1,000)						
	16-20	21-25	26-30	31-35	36-40	41-45	46-50
Mulanje							
197983	29.96						
	(0.23)						
1974-78	20.18	71.16					
	(0.12)	(0.85)					
1969-73	4.82	36.32	82.91				
	(0.02)	(0.35)	(1.25)				
1964-68	8.45	22.73	49.42	103.98			
	(0.04)	(0.18)	(0.61)	(1.96)			
1959-63	8.89	17.94	9.13	50.69	126.21		
	(0.06)	(0.16)	(0.06)	(0.80)	(3.34)		
1954-58	11.98	12.12	18.40	25.00	76.92	159.72	
	(0.10)	(0.10)	(0.20)	(0.32)	(1.78)	(5.80)	
1949-53	19.23	0.00	19.61	0.00	30.00	92.78	159.09
	(0.26)	(0.00)	(0.27)	(0.00)	(0.53)	(3.01)	(7.38)
Other district							
197983	25.61						
	(0.08)						
1974-78	15.60	28.82					
	(0.04)	(0.09)					
1969-73	18.26	25.14	56.21				
	(0.06)	(0.09)	(0.31)				
1964-68	14.30	13.25	29.41	52.70			
	(0.04)	(0.04)	(0.13)	(0.32)			
1959-63	9.19	12.99	14.10	27.65	92.16		
	(0.03)	(0.05)	(0.05)	(0.14)	(0.92)		
1954-58	13.93	7.06	11.38	23.02	61.86	67.50	
	(0.06)	(0.02)	(0.05)	(0.13)	(0.61)	(0.72)	
1949-53	12.05	4.88	19.61	27.50	23.14	36.84	120.22
	(0.07)	(0.02)	(0.14)	(0.23)	(0.18)	(0.37)	(2.32)

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