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Trends and Socioeconomic Gradients in Adult Mortality around the Developing World

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Abstract

The authors combine data from 84 Demographic and Health Surveys from 46 countries to analyze trends and socioeconomic differences in adult mortality, calculating mortality based on the sibling mortality reports collected from female respondents aged 15–49. The analysis yields four main findings. First, adult mortality is different from child mortality: while under-5 mortality shows a definite improving trend over time, adult mortality does not, especially in Sub-Saharan Africa. The second main finding is the increase in adult mortality in Sub-Saharan African countries. The increase is dramatic among those most affected by the HIV/AIDS pandemic. Mortality rates in the highest HIV-prevalence countries of southern Africa exceed those in countries that experienced episodes of civil war. Third, even in Sub-Saharan countries where HIV-prevalence is not as high, mortality rates appear to be at best stagnating, and even increasing in several cases. Finally, the main socioeconomic dimension along which mortality appears to differ in the aggregate is gender. Adult mortality rates in Sub-Saharan Africa have risen substantially higher for men than for women—especially so in the high HIV-prevalence countries. On the whole, the data do not show large gaps by urban/rural residence or by school attainment.

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Trends and Socioeconomic Gradients in Adult Mortality around the Developing World

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1) Introduction

In developed countries, premature mortality is negatively associated with income and education (Deaton and Paxson 2003; Lleras-Muney 2005). The same gradient is expected in developing countries, although, given the lack of vital registration systems it has been less easy to demonstrate. What has generally been shown is that the poor are more likely to experience poor health and less likely to have access to health services (Filmer 2005, Gwatkin, Wagstaff and Yazbeck, 2005). Additional information is available over a wide range of socioeconomic differences in health, nutrition and population including indicators on child mortality, malnutrition, fertility, immunization coverage, treatment of diarrhea and acute respiratory infections, antenatal care visits and delivery attendance, use of modern contraception as well as knowledge of HIV/AIDS prevention (Gwatkin, Rutstein, Johnson, Suliman, Wagstaff, and Amouzou. 2007). However adult mortality is not included among the indicators reported. Since adult mortality is the most objective measure of adult health (as opposed to self-reported health status or diseases), analyzing the socioeconomic gradient in premature adult mortality adds to the knowledge about the disparities in health in developing countries.

Bicego (1997), Timaeus and Jasseh (2004), Gakidou and King (2006) and Obermeyer, Rajaratnam, Park, Gakidou, Hogan, Lopez and Murray (2010) have analyzed adult mortality using various data sources (including the Demographic and Health Surveys—DHS—that we use in this study) and have gradually improved the methods for doing so, but they have limited their analysis on overall trends and on differences by gender and by age.

Part of our analysis looks at the extent of adult mortality in countries affected by conflicts and as such generalizes earlier analyses of the distribution and consequences of excess adult mortality in Cambodia (de Walque 2005, de Walque 2006) and Rwanda (de Walque and Verwimp, 2010). The HIV/AIDS epidemic is another important factor contributing to adult mortality, especially in Sub-Saharan Africa. Contrary to conflicts and famines, its impact is spread over a long period. Bicego (1997) and Timaeus and Jasseh (2004) have attempted to see if by looking at mortality by birth cohort and by period the impact of the HIV/AIDS epidemic could be detected in mortality trends. Using more recent data sets, we document large increases in adult mortality in countries heavily affected by HIV/AIDS, especially in southern Africa.

We extend this literature in several ways. First, we assess the correlation of mortality to national income and how that has changed over time. Second, we update the analysis of mortality changes in the era of HIV/AIDS. Third, we go beyond "extreme mortality" events and assess how adult mortality changes as a result of conflicts more generally. And last, by using the socioeconomic characteristics of the female respondent as a proxy for the socioeconomic background of her siblings, we analyze how these trends and variations in adult mortality differ with socioeconomic status, including an analysis of the variation over time in the gradient.

2) Data

We derive estimates of adult mortality from an analysis of Demographic and Health Survey (DHS) data from 46 countries, 33 of which are from Sub-Saharan Africa and 13 of which are from countries in other regions (Annex Table). Several of the countries have been surveyed more than once and we base our estimates on the total of 84 surveys that have been carried out (59 in Sub-Saharan Africa, 25 elsewhere). The countries covered by DHS in Sub-Saharan Africa represent almost 90 percent of the region's population. Outside of Sub-Saharan Africa the DHS surveys we use cover a far smaller share of the population—even if this is restricted to countries whose GDP per capita never exceeds $10,000: overall about 14 percent of the population is covered by these countries, although this increases to 29 percent if China and India are excluded (countries for which we cannot calculate adult mortality using the DHS). It is therefore important to keep in mind that the sample of non-Sub-Saharan African countries we have cannot be thought of as "representative" of the rest of the world, or even the rest of the developing world.

DHS data are attractive for two main reasons. First, these are surveys that have been carried out systematically using similar protocols and questionnaires.[1] No other collection of nationally representative datasets this large has such a degree of cross-country comparability. Second, the surveys include a "sibling mortality" module from which we can derive mortality

[1] DHS data collection and cleaning are typically carried out in a partnership between MeasureDHS and a local implementing partner with funding from USAID. By monitoring quality at all stages, MeasureDHS ensures that the protocols meet quality standards, resulting in extremely reliable data. More information in the DHS is available at http://www.measuredhs.com.

estimates.[2] Originally intended to be used to estimate maternal mortality, these modules record the survival status of all main female respondents' siblings, and include the current age if alive, and record the year of death, and age at death, in the event that a sibling has died. Subject to various assumptions and adjustments (described in more detail below) the responses can be extrapolated to form an estimate of national-level mortality.

2.1) Estimating mortality based on sibling reports

At one level using sibling reports to estimate adult mortality is straightforward. The nationally representative DHS identifies all women aged 15-49 as respondents.[3] These women list all of their siblings born to the same biological mother, the birth dates of those siblings, report on the survival status of those siblings, and on the age and date at death if relevant. For any timeframe, therefore, we can establish which siblings were alive at the beginning of the timeframe, and whether or not they died during that timeframe. The number of deaths during the timeframe, divided by the population at risk at the beginning of the timeframe, determines the timeframe-specific mortality rate. To be more concrete, consider the timeframe of 1995-1999. We establish the population at risk at the beginning of 1995 (P_{1995}), calculate the number of deaths between 1995 and 1999 ($D_{1995,1999}$), and estimate mortality as ($M_{1995,1999}$) the ratio between the two. The generic form of this relationship is given in equation (1)

$$M_{t,t+5} = \frac{D_{t,t+5}}{P_t} \qquad \textbf{(1)}$$

where *t* is the beginning of the timeframe of interest. We are able to cover the periods 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999, and 2000-2004 using these data. Not all surveys provide information on all the periods as we require that the full period be captured by the survey for it to be included (that is, a survey conducted in 1997 will not contribute to the estimate of mortality in the 1995-1999 or 2000-2004 periods).

[2] Not all DHS surveys include the sibling mortality module. We restrict ourselves in this analysis to those that do.
[3] In some countries this is all ever-married women.

The population at risk needs to be more specifically defined, and we do this by specifying the age range of interest:

$$M_{t,t+5}^{a,a+n} = \frac{D_{t,t+5}^{a,a+n}}{P_t^{a,a+n}} \tag{2}$$

where *a* is the beginning age of the age group of interest, and *a+n* is the ending age. For much of the analysis we consider the population at risk aged 15-54 (which we refer to, for expository purposes, as "adult mortality"). When disaggregating the data, we use 10 year age rages so, concretely, we consider siblings aged 15-24 years old at risk at the beginning of time *t*, and then siblings 25-34, 35-44, and 45-54 years old in turn.

Estimates based on equation (2) have a number of potential biases. First, there is a possibility of double-counting if a sibling is reported twice in the survey. This could occur if the households of two siblings were randomly selected to be in the study sample (and each reports about the same set of siblings), or it could occur if two siblings live in the same household (and, again, each reports about the same set of siblings). We cannot investigate the first situation as the data are anonymous and it would be very hard to establish sibling status across households. Nevertheless, we believe the chances that siblings would emerge in randomly selected households are quite small. For the second situation we identify households with more than one sister who responded to the questionnaire, and then drop all but one randomly selected sister from the analysis.[4]

A second potential bias would emerge since sets of sisters with lower mortality are more likely to appear in the sample—which would lead to underestimating mortality. The bias could be exacerbated (or somewhat offset) if mortality were correlated with the number of sisters. If the correlation were positive then respondents with a large number of siblings would be more

[4] Since the DHS do not fully characterize relationships between household members, but only relationship to household head, we implement a series of steps to characterize two members as sisters. Sisters are defined as: (a) two women who are both daughters of the household head, or both sisters of the household head; (b) women in the same household who report the exact same structure of siblings (sex, years since birth, years since death); (c) women in the same household who report a structure of siblings that is "fuzzily" the same (the sex, years since birth, and years since death of death are extremely similar). We implement (c) to allow for some misreporting.

likely to have had those siblings die, and bias in the mortality estimates would be reduced; if the correlation were negative then mortality estimates would be biased even further downwards. We account for this potential correlation by following the methodology proposed by Gakidou and King (2006) and weight each sibling observation by the inverse of the number of surviving female siblings at the time of the survey (including the respondent).[5] Specifically, each observation contributes $1/s_i$ in the calculation of D and P in equation (2), where s_i is the number of surviving female siblings in a family. As illustrated with the solid points in Figure 1 for the 1990-1994 period and the population aged 15-59, the general effect of this adjustment is to increase the estimate of adult mortality.[6]

A third potential bias could emerge if all of the sisters in a family die and therefore none appear in the survey. Excluding such families would tend to bias mortality estimates downward since high mortality sets of siblings would be excluded from the estimation sample. We again followed the approach suggested by Gakidou and King (2006) and estimated the number of "missing" siblings who have died. The approach consists of estimating the relationship between the number of siblings who have died and the total number of surviving children in each family, and then projecting out of sample to a case where there are zero surviving children. This approach is data intensive in that it requires a substantial number of observations to reliably estimate a relationship between the number of survivors and the number of children who have died. Moreover, it requires imposing strong assumptions about the functional form of the relationship between those two quantities. Our experience, illustrated with the hollow points in Figure 1 for the 1990-1994 period for the population aged 15-54, the effect is quite small at most (relatively lower) mortality levels and only meaningful in the case of very large mortality events. Indeed, the points on the right of the graph are data from Rwanda—in the midst of a genocide at that point. While feasible to implement this approach for the adult population as a whole, our experience was that this adjustment became very unstable when considering more narrow age

[5] Note that we also weight each sibling observation by the survey weight associated with the responding sibling assigned on the basis of the original sampling strategy. Therefore, each sibling observation is weighted by the survey weight divided by the number of surviving female siblings.

[6] Appendix 1 provides a simulation of how various approaches to weighting affect the results and reduce the biases, particularly when mortality and the number of siblings are correlated. In addition, it shows how including the respondent herself in the mortality calculations is an important part of removing bias in the estimation of mortality.

ranges, especially when disaggregating the data further by gender, education or residence.[7] We chose therefore to not implement this adjustment in the analysis for this paper, with the understanding that our estimates for the very high mortality events are likely to be somewhat biased downwards.

A last potential source of bias has to do with the recall nature of the data. Respondents are asked to remember the date at which one (or more) of their siblings died, and relate the siblings' age at that date. Both of those pieces of information are subject to recall error (as discussed in Obermeyer and others 2010). To assess whether there is any systematic recall bias, we use the fact that many countries have several rounds of data and, therefore, some of the sibling mortality rates from earlier periods can be derived from more than one round of the survey.[8] If the estimated sibling mortality rates were systematically lower or higher the more recent the survey, then this would suggest a problem. Figure 2 illustrates the mortality rates among siblings for the 1975-1979 (top panel) and 1980-1984 (lower panel). The left column shows the sibling mortality estimate based on the first DHS survey conducted after the relevant period (where recall bias should be smallest) and the subsequent DHS survey. The right column compares the first survey to the third survey (if it exists). While in most cases the mortality estimates are not identical, it is hard to discern any systematic pattern.[9] Multivariate analysis confirms this result: a regression of the adult mortality rate on dummy variables for survey round, controlling for country fixed effects and period dummies, yields coefficients that are small and not even close to statistically significant at conventional levels for second and third round estimates of a mortality rate.[10]

The mortality estimates we generate based on this approach are derived from the sibling history reports of 850,000 respondent women ages 15-49 (473,000 of which are from Sub-Saharan Africa). These respondents generate almost 5 million adult mortality reports, that is,

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[7] Indeed, in these smaller sample cells, the size of the adjustment depended almost exclusively on the functional form specified for the estimation of the relationship between the number of surviving and dead siblings.
[8] For this discussion, we focus on the mortality of siblings only, and do not include the respondent on the grounds that the reporting on their status is correct (that is, they are alive).
[9] This is consistent with Obermeyer and others (2010) who find only small, and inconsistent, recall effects.
[10] The regression is: $M^{15,54}_{t,t+5} = \alpha_1 + \alpha_2 * R_2 + \alpha_3 * R_3 + \alpha_4 * R_4 + \mathbf{P} + \mathbf{Z} + \boldsymbol{\varepsilon}^{15,54}_{t,t+5}$ where R_2, R_3, and R_4 are dummy variables for survey round, and **P** is a set of period dummy variables (that is, a dummy variable equal to 1 if the mortality estimate is for the period 1980-84, another dummy variable equal to 1 if the mortality estimate is for 1985-89, and so on), and **Z** is a set of country fixed effects. The coefficients on α_2, α_3, and α_4 are -0.0025, -0.0001, and -0.0059 respectively with corresponding p-values of 0.255, 0.977, and 0.504.

reports of sibling survival status for siblings who survived until age 15 (2.8 million of these are for Sub-Saharan Africa). Of these, 2.9 million are reports on women (including respondents) and 2.1 are reports on men (corresponding figures for Sub-Saharan Africa are 1.6 million and 1.2 million).[11]

2.2) Determining socioeconomic characteristics

The DHS include a large number of variables that could be used to characterize respondents' socioeconomic status. However for the task at hand, we face two challenges. First, the data we have describe the socioeconomic characteristics of the respondent, and not necessarily their sibling whose mortality we are analyzing. Second, the data collected pertain to the time of the survey, and not necessarily to the timeframe for which we are estimating mortality.

We address the second of these potential problems by focusing on relatively stable indicators of socioeconomic status. We address the first by using information about the respondents to proxy the socioeconomic status of their siblings. We limit our analysis to two variables: urban/rural residence and educational attainment. It is impossible using the DHS to conclusively determine the extent to which these variables are correlated across siblings. Two sets of facts give us confidence that the approach is legitimate. First, some DHS datasets include a variable that indicates whether a respondent lived in a rural or urban area as a child. It is very likely that siblings would share the same residential location in childhood. We find that the results we get are extremely similar whether we use the current or childhood residential location (a discussion we return to below). Second, Conley and Glauber (2005) indicate that in the United States the correlation in the educational outcomes of siblings is 0.576. Dahan and Gaviria (2001) report that this correlation is substantially higher in a sample of 16 countries in Latin America, suggesting that using the educational status of a sibling as a proxy might work even better for developing countries. We also investigated the extent to which the variation in schooling attainment is primarily within or between households in the DHS surveys included in

[11] Appendix 2 describes two datasets we have created for this project and which are freely accessible to analysts who wish to use them for their own work. The first dataset includes mortality estimates for all subgroups at the level of each DHS survey that was carried out (that is, for each country and each survey). The second dataset includes mortality estimates for all subgroups at the level of each country (that is, after we have averaged multiple country- and period-specific mortality rates).

our analysis. Among 15 to 19 year olds, the intra-household correlation of the years of schooling attained ranges from 0.70 to 0.95 across these surveys, with a mean of 0.86. This suggests a very high degree of correlation among siblings in school attainment.

3) Results

3.1) Aggregate trends in adult mortality

Figure 3 summarizes the aggregate trends in under-5 (solid lines) and adult mortality (dashed lines) for countries from the Sub-Saharan African region and countries from other regions.[12,13] Under-5 mortality (which are obtained from the World Bank's World Development Indicators database) is shown for two sets of countries.[14] First "all" countries for which under-5 mortality data are available and for which GDP per capita never exceeds $10,000 (in real 2000 dollars) during the periods under consideration; and second, restricting the set of countries to those for which we also have adult mortality data (referred to as "overlapping" countries). A comparison of adult mortality trends to under-5 mortality trends in overlapping countries provides comparison of these two mortality trends in the same set of countries.

Comparing under-5 mortality between the full and "overlapping" samples suggests that our DHS sample is fairly representative of the regions as a whole: indeed, the levels and trends in these mortality estimates are very similar. This is consistent with the fact that the countries surveyed in Sub-Saharan Africa cover a high share of the population in that region. It also suggests that while the countries outside of Sub-Saharan Africa are not "representative" of developing countries, they do have similar levels and trends of under-5 mortality.

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[12] When there are multiple estimates of adult mortality for the same country and same period (based on different rounds of the DHS) the estimates are averaged, weighting each estimate by the inverse of the variance of the estimate so that more precise estimates are given more weight.
[13] These regional averages are population weighted, where the weights are the total population at the beginning of the period in question.
[14] Under-5 mortality for each period is the average of the rate reported for the beginning and end of the period. So, for example, under-5 mortality for 2000-04 is estimated as the average of the WDI reported mortality rates for 2000 and 2005.

Figure 3 confirms that under-5 mortality rates have been steadily declining in the developing world—both within and outside of Sub-Saharan Africa. In the former, the overall rate declined from about 200 deaths per thousand births in 1975-79 to 152 deaths per thousand births in 2000-04 (203 to 165 focusing on only the overlapping countries). In the non Sub-Saharan African countries, the rate fell from 106 per 1000 births in 1975-79 to 48 in 2000-04 (in overlapping countries the decline was from 127 to 53). Part of the decline can be attributed to increases in national incomes. Table 1 reports results of a regression of the log of under-5 mortality in each country and for each period on the log of GDP per capita for that country in that period, and dummy variables for period. The coefficients on GDP per capita suggest a statistically significant and large effect: a 10 percent increase in GDP per capita is associated with on the order of 3 to 5 percent decrease in mortality.

However, income alone does not explain the decline in under-5 mortality. Figure 4 illustrates the change, over time, in the relationship between national income and mortality. The top left panel (panel A) shows, for Sub-Saharan African countries, (log) mortality on the vertical axis plotted against (log) GDP per capita on the horizontal axis. Round dots show the points for 1975-79 while Xs show the points for 2000-04. The solid line shows the fitted line for the early period and the dashed line shows the fitted line for the late period. The lines are sloped downward, showing that mortality declines with income. From the early to the late period, the whole line has shifted down: at any given level of income mortality has fallen. Panel (B) shows the fitted lines for all period starting with 1975-79 and ending with 2000-04. Clearly the shift has been incremental and progressive. Panels (C) and (D) show the same relationships for countries in other regions—which show greater mortality declines from each period to the next when compared to Sub-Saharan Africa.

Table 1 captures these changes statistically by showing significant and steadily increasing (in absolute value) coefficients on the dummy variables for period. In Sub-Saharan African countries the coefficient reaches -0.448 in the full sample, and -0.325 in the overlapping sample, for the 2000-04 period (the reference period is 1975-79). These correspond to declines of 36 and 28 percent respectively.[15] For the non-Sub-Saharan African sample of countries, the coefficients

[15] Since these are dummy variables in a semi-log specification, the percentage change is not simply given by the coefficient on the dummy variable α, but rather by $\exp(\alpha)-1$ (Halvorsen and Palmquist 1980).

reach -1.162 and -0.778, which correspond to declines of 69 and 54 percent respectively. These results are another way of restating the finding by Preston (1975, 1980) that, conditional on incomes, under-5 mortality rates have declined over time—thanks to improvements in public health and health technologies.

Adult mortality (defined here as mortality of those aged 15 to 54) does not follow the same pattern. As is clear from Figure 3, adult mortality outside of Sub-Saharan Africa has remained fairly constant over the entire period from 1975 to 2004—with a slight increase in the most recent period. The estimates suggest that for each person "at risk" (that is, a 15-54 year old who is alive at the beginning of each of the 5 year periods) the probability of death is between 1 and 1.6 percent. In stark contrast, while adult mortality remained steady at around 2 percent prior to the mid-1980s in the Sub-Saharan African countries, it has increased steadily ever since—to 3 percent in 1990-94 and to over 4 percent by 2000-04.

Outside of Sub-Saharan Africa, adult mortality is responsive to national income. Indeed the coefficient on GDP per capita in the results reported in Table 1, while smaller than that for under-5 mortality, is statistically significant in the adult mortality models. The models suggest that a 10 percent increase in GDP per capita is associated with a 2.6 percent decline in adult mortality outside of Sub-Saharan Africa. In Sub-Saharan Africa the association between GDP per capita and adult mortality is not statistically significantly different from zero.

Figure 4 dramatically illustrates how the trends are different. In countries outside of Sub-Saharan Africa adult mortality and national income are related, and the relationship has barely shifted between 1975-79 and 2000-04. By contrast, adult mortality has shifted upward in Sub-Saharan Africa. The coefficients on period reported in Table 1 for Sub-Saharan Africa become progressively larger. By 1990-94 adult mortality (conditional on GDP per capita) is statistically significantly higher than in 1975-79, with a coefficient of 0.251 (a 28 percent increase). After steady increases, the coefficient reaches 0.742 in 2000-04 (a 110 percent increase). Figure 4 reveals a more startling trend: the relationship between national income and adult mortality has become upward sloping: that is, it is the higher income Sub-Saharan African countries in which adult mortality tends to be highest. The shift coincides with the start and the spread of the HIV epidemic. This reversal of the gradient might be driven by the fact that the countries in southern Africa with the highest HIV prevalence are also among the richest in SSA.

The HIV/AIDS pandemic is certainly a major underlying factor for these changes. The bottom panel of Figure 3 separates out the Sub-Saharan African countries into those in which the prevalence of HIV was above 5 percent in 2001 and those where it was below 5 percent (according to UNAIDS 2010). The effects of high levels of HIV on adult mortality are readily apparent, with the average adult mortality rate almost tripling between 1985-89 and 2000-04 (from a probability of around 1.7 percent to almost 5 percent) in the high prevalence Sub-Saharan African countries. Importantly, however, mortality increased somewhat as well in the lower prevalence Sub-Saharan countries as well, from around 1.6 percent in 1985-89 to over 2 percent in 2000-04—a point we return to below.

3.2) Country-specific trends in adult mortality

The aggregated results presented so far mask a substantial amount of heterogeneity across countries, and may be driven by a few large countries (note that while the figures presented here aggregate using population weights, the regression analyses are not weighted). Figure 5 shows the trends in adult mortality for each country in our study. Countries are grouped by region, although we separate out two groups of countries (regardless of region): those in which there has been an episode of civil or international conflict, and those in which that episode resulted in a period of genocide. (Note that the vertical scales in these graphs differs from graph to graph: while this downplays differences across groups of countries, for example the countries where mortality is surging versus those where it has remained relatively stable, it allows the maximum amount of information to be visible in each graph.)

Panel (A) of Figure 5 shows countries in the southern region of Sub-Saharan Africa. The increases in adult mortality are (with the exception of Madagascar) very steep. In the 1980-84 period, the 5-year probability of death was less than 2 percent in all these countries. By 1995-99, for the six countries with data, the probabilities range from 2.3 percent (Lesotho) to 5.5 percent (Zambia). For the four countries with data for 2000-04, the 5-year probability of death ranges from 3.8 (Lesotho) to 7.8 percent (Swaziland). These increases are unparalleled in other countries in our sample, and consistent with the high HIV prevalence in these Sub-Saharan African countries.[16]

Panels (B) through (E) show the trends for other Sub-Saharan African countries. All show an increase in mortality that starts in the late-1980s or the early 1990s. While the increase is perhaps not surprising in those countries with high HIV prevalence (for example Kenya and Tanzania where HIV prevalence in 2001 was 8.4 and 7.1 percent respectively) it is more puzzling for those countries with low HIV prevalence. In 2001 HIV prevalence was less than 2 percent in Benin, Guinea, Mali, Mauritania, and Niger while adult mortality rates increased in all these countries after 1985-89. For example the probability of death in Benin increased from 1.4 to 2.0 percent between 1985-89 and 2000-04. Over the same timeframe mortality increased from 1.8 to 2.7 percent in Guinea, and 1.7 to 2.1 in Mali. In none of these countries, however, does the 5-year probability of death exceed 3 percent.

Consistent with the aggregate results, mortality rates outside of Sub-Saharan Africa have remained relatively low and constant over the study period (panels F and G) and in several cases they have fallen (Bolivia, Jordan, Morocco, Nepal, Yemen). Haiti stands out as an exception with high mortality among these countries—although the rate remains consistently high from 1975-79 to 2000-04 at just under 3 percent probability of death. In the other sample countries mortality never exceeds 2 percent (except for Nepal prior to 1985-89).

We separate out two particular groups of countries. Panel (H) shows trends for countries in Sub-Saharan Africa that have had an episode of civil or international conflict. Panel (I) shows the trends for two countries in which there was an episode of genocide. In the latter, the mortality effects of genocide are readily apparent. In Cambodia the 5-year death probability was 14 percent in 1975-79, and in Rwanda it reached 15 percent in 1990-94 (and is estimated at 8 percent in 1995-99).[17] The effects of conflict are apparent in the other countries—mortality rates are noticeably higher than in the non-southern countries in Sub-Saharan Africa—but spikes in mortality are harder to discern than in the genocide countries. Uganda illustrates the situation with mortality continuing to increase after the end of the conflict in 1986—a result likely related

[16] With the exception of Madagascar, all these countries had an HIV prevalence rate of over 5 percent in 2001.
[17] Recall that these are likely somewhat underestimated as these figures do not adjust for entire sets of siblings dying.

to the increase in HIV prevalence (which was 7.0 percent in 2001). In general, whereas the 5-year probability of death is typically less than 3 percent in other Sub-Saharan African countries (outside of the southern region), it reaches around 4 percent in several of the conflict countries.

One startling comparison that these estimates reveal is that in the countries in which HIV is widespread, namely in the southern African countries in our sample, mortality rates are higher those in countries that experience conflict. The exceptions are countries where conflict escalates into genocide—although these appear as dramatic peaks in mortality which subsequently reverts to non-conflict levels. By contrast, elevated levels of mortality in the high-HIV prevalence countries are sustained and, to-date, increasing.

3.3) Demographic and socioeconomic gaps in adult mortality

Age

We first being to disaggregate our results by disaggregating the association between GDP per capita, period, and adult mortality by the age of the adult at risk. These results, reported in Table 2, are generally in line with those for the whole group of 15-54 year olds. In countries outside of Sub-Saharan Africa the association between mortality and GDP per capita is statistically significantly negative for all age groups—with the estimate of the elasticity ranging from -.214 to -.74. Moreover, in these countries there are no systematic shifts in mortality for any of the age groups: Coefficients on the period dummy variables in the regressions are typically negative (meaning mortality is lower in the later periods than the earlier ones) although these associations are virtually always not significantly different from zero.

In Sub-Saharan Africa, by contrast, the negative association between GDP per capita and mortality is not statistically significantly different from zero for ages 25-34 (although the point estimate remains negative). At ages above 35, when HIV/AIDS mortality tends to be highest, the negative association disappears (that is, it is close to zero and statistically insignificant).

The patterns in the coefficients on the period dummy variables show that the largest jumps in mortality occurred among 25-34 and 35-44 year olds in the 1990-94 period. The magnitude of the jumps result in mortality being 23 and 56 percent higher, respectively, than corresponding mortality rates in 1975-79 (the reference category). In the subsequent period, 1995-99, the younger age group (ages 15-24) also experiences a sharp increase in mortality (leaving it 25 percent higher than in 1975-79). Nevertheless, mortality increases over the entire period through 2000-04 remain highest for the older (25-34, 35-44, and 45-54) age groups, corresponding well to the HIV/AIDS mortality profile given the median of 9 years between HIV infection and death in the absence of treatment.[18]

Gender, Residence and Education

We next turn to differences disaggregated by the three socio-demographic dimensions that we extract from the data: gender, urban or rural residence, and education. Ideally one would like to analyze the three dimensions simultaneously, but our experience suggested that interacting residence and education led to very small cell sizes which resulted in unstable estimates. This is perhaps unsurprising since urban residence is correlated with higher education. We therefore proceed in two steps, first addressing gender and residence, and subsequently focusing on gender and education. In assessing these results, it is important to keep in mind that residential status and education potentially capture a range of other attributes (including each other) and the results should be interpreted as descriptive and not causal.[19]

Gender and residence

Table 3 reports the results from regressions of adult mortality on gender and residence. We explore differences along these dimensions by expanding the model reported in Table 1 by introducing variables for being male (models 1 and 8), for urban residence (models 2 and 9), and

[18] The pattern of coefficients on period dummies emerges clearly in models restricted to Sub-Saharan African countries with high HIV prevalence in 2001. On the other hand, the coefficients are all statistically insignificant when the sample is restricted to countries with low HIV prevalence. (These results are not shown here, but available from the authors on request).

[19] In the datasets we analyze the correlation between ever attending school and urban residence among adults 15-49 ranges from 0.04 to 0.52, with a mean of 0.22.

for urban residence as a child (models 3 and 10).[20] We then estimate a model with gender and residence interacted—with and without country fixed effects. The fixed effects specification allows us to isolate that part of the variation that is within-country, and ensure that the results are not simply being driven by differences across countries (and, potentially, the differential timing of surveys across countries).[21]

In Sub-Saharan Africa, being male is associated with 20 percent higher adult mortality. Urban residence is negatively associated with mortality. When we use current residence the association is statistically significant; when we use residence as a child the association is not significant. In both cases the magnitude of the coefficient is small (implying between about 3 and 6 percent lower mortality in urban areas). Outside of Sub-Saharan Africa the coefficients have similar signs—and in the case of gender a similar magnitude. However urban residence is associated with substantially lower mortality in these countries (on the order of 16 percent lower).

Columns 4-7 and 11-14 report the results from the model with gender and urban residence interacted. Both within and outside of Sub-Saharan Africa, urban and rural women have substantially and statistically significant lower mortality than men—with urban women having the lowest mortality rate. The gap is especially large for urban women outside of Sub-Saharan Africa. For example, in Sub-Saharan Africa rural and urban women have mortality rates that are 13 and 21 percent lower than rural males; in countries outside of Sub-Saharan Africa they are 11 and 32 percent lower than those for rural males. When we use residence as a child to identify location, the differential between rural and urban women is reduced in Sub-Saharan Africa. The general pattern of results, however, is not affected. Given that residence as a child is only available for a subset of countries, we restrict the remainder of the discussion to current residence.[22]

[20] As discussed above, childhood residence is only available for some of the datasets.
[21] Note that these models include (log) GDP per capita, age-group dummy variables, and period dummies. For compactness these are not reported in the table but are available from the authors on request. The coefficients on these variables are qualitatively similar to those reported in Table 1.
[22] The results are consistent with mortality being most closely associated with current residential status, and childhood residence being a noisy measure of current residence. In such a situation, the lower coefficient on childhood residence than current residence is consistent with attenuation bias imparted by measurement error.

The relationship between mortality, gender and location are not much affected by the inclusion of country fixed effects. This suggests, in particular, that the results are not being driven by systematic differences across countries in the rate of urbanization.

But even this disaggregation masks significant trends over time. The top panels of Table 4 repeat the models from columns 5 and 12 of Table 3 for Sub-Saharan African countries (panel A) and countries in other regions (panel B) but disaggregate across time periods; the bottom panels repeat the same models but separate out the Sub-Saharan African countries between those with higher HIV prevalence (panel C) and those with lower HIV prevalence (panel D). As before, higher and lower prevalence are defined as above and below prevalence of 5 percent in 2001. Figure 6 illustrates the coefficient estimates by showing predicted adult mortality at two points in time, 1980-84 and 2000-04, for the various subgroups.[23]

In countries outside of Sub-Saharan Africa, mortality levels for men diminished slightly over time. Among women reductions were largest among rural women—although the fact that urban women started with a lower mortality level to begin with results in them being the group with the lowest mortality rate in the latest period we observe (2000-04). In this period, urban women outside of Sub-Saharan Africa have a mortality rate that is 34 percent lower than that for rural men.

Within Sub-Saharan Africa mortality rates have clearly increased in all countries—dramatically so in the higher HIV prevalence countries. This is clearly the main result to emerge from these estimates. But the trend in gender gaps is interesting as well. In the high prevalence HIV countries, mortality increased among both men and women and in rural and urban areas. The increase was largest for men: while mortality rates were roughly equal across genders in the early period, women's mortality was around 20 percent less than that of men's by the late period. The patterns are similar in the lower HIV prevalence countries—but the magnitudes are substantially smaller. The gender gap is similar in percentage terms—although it is only urban women who have a statistically significant lower mortality rate in the most recent period.

[23] Predicted probabilities are based on mean predictions setting each of the gender and location dummy variables to 1 in turn with the other dummies set to 0, and other variables in the model at their actual values. Since the models are semi-log the reported predictions include an adjustment based on the mean squared error of the regressions (see Duam 1983).

Figure 7 disaggregates the analysis further by reporting predicted mortality rates by age groups, namely for 15-24, 25-34 and 35-44 year olds.[24] In countries outside of Sub-Saharan Africa declines in mortality are largest in the younger and older of these three groups—with especially large proportionate reductions among the youngest group. In the Sub-Saharan African countries the increases in mortality are evident across all age groups.

In the high HIV prevalence countries mortality increases are especially large in the older age group (ages 35-44), particularly for men. Mortality rates among both rural and urban men ages 35-44 in 2000-04 are 60 to 70 percent higher than those of women of the same age. But Figure 7 also points to a disturbing emerging phenomenon—namely excess mortality among women in the youngest group. In 1980-85 mortality rates among women were lower for women than for men among 15-24 year olds; in 2000-04 they were substantially higher. For example, the adult mortality rate among rural women aged 15-24 was 30 percent higher than that among rural men of the same age. This finding is consistent with the gender/age profile of the HIV/AIDS epidemic in Sub-Saharan Africa in which HIV prevalence picks up at younger ages among women than men.

In the low HIV prevalence countries the patterns for the two older groups are similar—but the magnitudes are quite a bit smaller. Mortality increased over time, with male mortality outpacing female mortality. Among the youngest group there is no evidence that mortality is increasing faster for women than for men.

Figure 8 illustrates these overall patterns with age-specific mortality trends for rural areas of four specific countries: Swaziland and Zimbabwe with high HIV prevalence (with 2001 prevalence estimated at 23.6 and 23.7 respectively) and in Benin and Nigeria which are classified as low HIV prevalence (with 2001 prevalence estimated at 1.4 and 3.8 respectively). The figures make clear the increase in mortality in the high HIV prevalence countries. Mortality increases in among males in the older group are astounding in Swaziland and Zimbabwe, from less than 5 percent in 1980-84 to over 15 percent in 2000-04. Mortality rates among the other groups increased substantially starting around 1990-94 with the increase accelerating after 1995-99.

[24] These predicted values are based on age-specific regressions with the same structure as those in Table 4. The regression results are not reported here but are available from the authors.

Mortality among women 15-24 begins to exceed that of men of the same age only in the most recent period—and by a large margin in Swaziland.

Overall mortality levels are substantially lower in Benin and Nigeria (note that the scales of the vertical axes are different). Mortality fell in both countries in the earliest periods (from 1975-79 to 1980-84) and stagnated thereafter. In Nigeria mortality appears to be slowly increasing after 1990 especially for men 35-44 and women 25-34. As in the high HIV prevalence countries, the mortality of the youngest women appears to exceed that of the youngest men in 2000-04. It is unclear whether this is related to HIV/AIDS or other factors.

Gender and education

We continue our investigation of the socioeconomic correlates of adult mortality by turning to gender and education. We use dichotomous categories to capture the level of education attained: completed primary or more on the one hand and less than completed primary school on the other hand. We also explored using three education categories: no education, at least some primary education and at least some secondary education. Since the qualitative findings were unaffected, and the models (especially the interactive models) become more complicated to interpret, we report only the more parsimonious specification.[25] It is important to keep in mind that the level of education considered is that of the respondent sister, which serves as proxy for the education background of her siblings.

In Sub-Saharan Africa, women have lower mortality than men, and this is especially true for more educated women (Table 5). Women with less than primary schooling have a mortality rate that is 13 percent lower than that among men, women with primary schooling or more have a mortality rate that is 26 percent lower than that among men. Outside of Africa more educated individuals are substantially less likely to die. Men with primary schooling or more have mortality that is about 13 percent lower than those without primary schooling. As in the earlier models, women have overall lower mortality, and mortality for women with primary schooling or more is 30 percent lower than that among women with less than primary schooling.

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[25] These results are available from the authors upon request.

In Table 6, we disaggregate the analysis by re-running the analysis for each of the 5 year periods separately. Figure 9 again illustrates the results for two of the time periods (1980-84 and 2000-04) by showing the predicted mortality rates. In Sub-Saharan Africa the education gradient in mortality has sharpened over time in the higher HIV-prevalence countries—particularly for men. In the earlier periods male mortality was similar across education groups, but in the latest period (2000-04) the gradient had become statistically significant and sizeable. In the higher HIV-prevalence countries male adult mortality was 17 percent lower among those with primary schooling than among those without. In these countries the education gradient among women is not statistically significant (and is small). In the lower HIV-prevalence countries it is only women with more education that have statistically significantly lower mortality rates—a finding that is consistent in both the earlier as well as the later periods. Outside of Sub-Saharan Africa, the mortality rates of adults have fallen, especially among those with more schooling. By 2000-04, mortality was 23 percent lower among men with at least primary schooling than among men without primary schooling, and was 36 percent lower among women with at least primary schooling than among women without primary schooling.

Figure 10 further disaggregates the results by showing predicted mortality rates for separate age groups (ages 15-24, 25-34 and 35-44). In countries outside of Sub-Saharan Africa mortality rate reductions were sharpest for the more educated in the youngest group, and among more educated women 35-44 years old. In high HIV-prevalence countries in Sub-Saharan Africa the negative association between higher education and lower mortality in the later period is *only* evident within the youngest cohort of 15-24 year olds. In the earlier period (1980-84) there was no education gradient in mortality for this group. This is consistent with the discussion in Case and Paxson (2011) who argue that younger more educated women are beginning to change behaviors in such a way as to protect against HIV (for example by delaying initial sexual activity and by marrying earlier). It is also consistent with de Walque (2007) who shows that in 1999/2000 there was a negative gradient between education and HIV prevalence among young women in rural Uganda. For the middle-aged cohort (those ages 25-34) there is no perceptible education gradient in mortality—for either men or women. In the older age group (ages 35-44) the results are somewhat different. In the later periods there is a positive association between education and mortality, especially among women. This is consistent with earlier findings on the positive association between HIV infection and education among women and none among men (Fortson 2008). However, it is puzzling why this gradient in mortality manifests in the 1980-84 period as well.

Socioeconomic mortality gaps in countries experiencing conflict and genocide

We turn last to countries that have experienced an episode of heightened violence and conflict. As discussed above in the context of overall trends in these countries (Panels H and I of Figure 5) the experiences appear quite different across these countries—and the mortality "event" in question is potentially muted by longer-run trends. We focus here are four cases which illustrate a variety of profiles. First is the Democratic Republic of Congo (DRC) which, since the late 1990s (i.e. in the 1995-00 and 2000-04 periods) has been experiencing a civil war and episodic violence; second is Ethiopia where factional violence flared in the late 1980s, and a border war with neighboring Eritrea lasted from 1998 to 2000; third is Rwanda which suffered ethnic violence—which escalated into internationally recognized genocide—in 1994; last is Sierra Leone in which a civil war ran from 1991 to 2001.

Figure 11 shows the mortality trends in these countries by gender and location (left panels), and by gender and education (right panels).[26] In each case the conflict in question is apparent in the mortality rates—although not all socioeconomic groups experience the same mortality shocks. The clearest case is, perhaps unsurprisingly, Rwanda (notice the different scale for the vertical axis for Rwanda). In that country the mortality spike in the 1990-94 and 1995-00 periods is sharp. While mortality increased for both men and women, in both urban and rural areas, and among those with both more and less schooling—it was particularly pronounced for men, especially urban and more educated men (this case is discussed in greater detail in de Walque and Verwimp 2009).[27]

In DRC mortality among rural men and among men with less than primary schooling has increased steadily since the mid-1990s—more than doubling from about 2 percent to over 4 percent in 2000-04. The mortality increases among other groups have been somewhat more

[26] Figures for all countries and for subgroups (that is gender, location, education and their interactions) are available at http://go.worldbank.org/RIIWM53VS0.

[27] The mortality spike during the Cambodian genocide of the late 1970s is similarly concentrated on urban and educated men as documented by de Walque (2005).

muted, but are apparent for all groups with urban and more educated women being the most "protected". In Ethiopia there has been a big difference in male/female mortality over the entire period we are able to analyze—with mortality among adult men typically about a third higher than that of women. During the factional violence period of the mid- to late-1980s mortality increased for men, especially in urban areas and for those with more schooling—and only regained parity with their rural and less educated counterparts by the late 1990s. Urban and more educated women also experienced mortality "spikes" in the mid- to late-1980s, although these were somewhat smaller. Adult mortality among rural and among less education women did not appear to be affected in the same way. Last, the decade-long civil war in Sierra Leone shows up in adult mortality increases for all groups. The increase is especially acute for urban and more educated men in the 1990-94 and 1995-99 periods, and noticeable among women from all groups over the same period. Among rural and among less educated men there seems to be a longer run increasing mortality trend that starts in 1985-89 and peaks in 1995-99.

Clearly, episodes of conflict and violence are country-specific, and perhaps less amenable to the types of broader generalizations we make above. But these four cases do suggest that while mortality events precipitated by civil conflicts tend to affect all groups—men and women, urban and rural, more and less educated—they often appear to affect men, and in particular urban and more educated men to a greater extent than the other groups.

4) Conclusions

In this paper we combine data from 84 DHS datasets from 46 countries (59 and 33 of which are from Sub-Saharan Africa) to analyze trends and socioeconomic differences in adult mortality. We calculate mortality based on the sibling mortality reports collected from about 850,000 female respondents aged 15-49. In total, the estimates are based on mortality histories of almost 5 million individuals. In the analysis, we use age and gender of each individual, and proxy for urban residence and education attainment with that of the respondent.

The analysis yields four main findings. First, adult mortality is different from child mortality. This is perhaps obvious to most readers, but bears stating since under-5 mortality is often used—perhaps implicitly—as a measure of "population health". Several key features of the data suggest that this is not legitimate. A first feature is that while under-5 mortality shows a definite improving trend over time, adult mortality does not. Second, the cross-sectional association between under-5 mortality and national income is quite a bit stronger than that for adult mortality. Third, while under-5 mortality has fallen over time conditional on national income, this is not the case for adult mortality. Indeed, in Sub-Saharan Africa the trend is the opposite, with adult mortality rising at any given level of income. In countries outside of Sub-Saharan Africa the relationship between adult mortality and national income has remained the same.

The second main finding is this increase in mortality in Sub-Saharan African countries. The increase is dramatic among those most affected by the HIV/AIDS pandemic. Mortality rates in the most affected countries of southern Africa (for example Swaziland, Zimbabwe, Zambia, Namibia) exceed those in countries that experienced episodes of civil war. Excess mortality during episodes of genocide is readily apparent in these data—with aggregate adult mortality rates approaching 15 percent (i.e. that among those at the beginning of a 5-year period before the genocide, probability of death was 15 over that 5-year period). But mortality rates decline at the end of these "extreme mortality events" whereas the adult mortality in the high HIV-prevalence countries shows no sign of slowing over the period we cover (through to 2000-04).

The third main finding is that even in Sub-Saharan countries where HIV-prevalence is not as high, mortality rates appear to be at best stagnating, and even increasing in several cases. It is unlikely that this finding is driven by the data or methods we use—in many countries outside of Sub-Saharan Africa adult mortality rates have fallen, in some cases dramatically so. It is unclear whether this finding is simply because even low HIV rates are translating into higher mortality in these countries, or because of some other underlying cause.

The fourth main finding is that the main socioeconomic dimension along which mortality appears to differ in the aggregate is gender. Adult mortality rates in Sub-Saharan Africa have risen substantially higher for men than for women—especially so in the high HIV-prevalence countries. On the whole, the data do not show large gaps by urban/rural residence or by school attainment. To the extent that there are some differences, the data suggest that urban women, and more educated women in Sub-Saharan Africa had smaller increases in mortality and among the various groups studied have the lowest overall mortality rate in both high and low HIV-prevalence countries. On the other hand, men with less than primary education have the largest increase in mortality. In high HIV-prevalence countries these men have mortality rates that are substantially higher than men with more education, and than women.

One group for which the higher mortality among men does not hold is among young women (ages 15-24) especially those with less education. For this group, mortality rates are higher than all other groups of the same age. This is consistent with the age profile of HIV/AIDS, but is also consistent with findings by others that younger more educated women appear to be engaging in more "protective" behaviors as knowledge about HIV and AIDS is disseminated.

Last, perhaps unsurprisingly, countries that have experienced conflict or episodes of internationally recognized genocide, display heterogeneous patterns in the time trends and socioeconomic patterns in mortality. The experience from several countries suggests that male mortality is typically more responsive to these events—and in several cases it is urban or more educated males for whom mortality increases most. At the same time, it is important to recognize that increased mortality during these episodes of conflict is not restricted to men—in all cases women's mortality is affected as well.

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Appendix 1: Weighting in the Measurement of Mortality when using sibling reports

This appendix reports on a simulation we carried out to illustrate how the measurement of mortality using sibling histories works in practice, and how weighting adjusts for the potential bias induced by the correlation between mortality and the number of sisters (which would affect the probability of being sampled). The simulation proceeded as follows:

1. Create sibling sets
    - Generate 900 sets of sisters; 300 of these are sibsets of two sisters; 300 are sibsets of three sisters; and 300 are sibsets of four sisters.[28]
    - We restrict our simulation to the situation where there is at least one sister who has survived (and can therefore potentially be sampled).
    - For the remaining sisters we assign mortality probabilities by sibset size—with various iterations which imply differing degrees of correlations between mortality and the number of sisters.
    - Based on these probabilities, we randomly assign these remaining sisters to "survived" or "died" status.
2. Create a "population" of survivors
    - We use the data generated in (1) to create a population of individuals who have survived, with their associated sister sibsets and the survival status of these sisters.
3. Repeatedly (300 times)
    - sample a subset of 15 of these individuals
    - drop "duplicates" (that is, "sisters" who are reporting on the same sibset)
    - estimate the mortality rate based on this sample
4. Report
    - the "true" mortality rate based on the full set of individuals defined in (1)
    - the mean mortality rates across the 300 sample replications estimated based on:
        - all individuals (respondents and their siblings) identified in the sampling, unweighted
        - all individuals (respondents and their siblings) identified in the sampling, weighted by the inverse of the number of survivors
        - siblings (that is, non-respondents only) identified in the sampling, unweighted
        - siblings (that is, non-respondents only) identified in the sampling, weighted by the inverse of the number of survivors

The results of this exercise are reported in the Appendix 1 Table. The top of each column shows the mortality rate assigned to the additional siblings (that is, the siblings additional to the "respondent" whom we assume has survived), depending on the number of siblings in the sibset. So, for example, the first column of results states that the mortality rate for the additional sibling is 0.9 for sibsets of size 2, 0.6 for sibsets of size 3, and 0.2 for sibsets of size 4—as sibset size increases the mortality probability decreases in this model. In the last column of results, the mortality rate is 0.1 for sibsets of size 2, 0.6 for sibsets of size 3, and 0.467 for sibsets of size 4. The table was constructed by varying the mortality probability of additional siblings in sibsets of 2 between 0.9 and 0.1 (corresponding to each column), fixing the mortality probability of additional siblings in sibsets of 3 at 0.6, and then adjusting the mortality probability of the additional siblings in sibsets of 4 to ensure that the overall true mortality probability equals 0.3.

[28] Since only women are surveyed about their siblings, it is only the probability of sisters' survival that is potentially affected by the correlation between it is the survival status and sibset size. The simulation is only models the estimation of sisters' mortality.

Row **A** reports the overall "true" mortality probability as generated by the random generation of the data (the theoretical value of this is 0.3). Row **B** reports the overall "true" correlation between an individual's mortality and the size of their sibset. These correlations run from negative in the columns on the left of the table, to positive in the columns on the right.

Row **C** of the Table illustrates how simply calculating the mortality rate based on a sample of respondents who have survived without adjustment leads to an underestimate of mortality. In these parameterizations, the mortality estimates are between 66 and 79 percent of the actual—an underestimate of between 44 and 31 percent. The results in this row also illustrate how the underestimate is largest when there is a negative correlation between sibset size and mortality. The intuition is that survivors in larger sibsets are more likely to be selected into the sample, and therefore their lower mortality rate affects the overall estimate.

Adjusting for this unequal sampling probability, by using the inverse of the number of surviving siblings as weights in the various calculations, corrects for this bias (row **D**). Indeed, in the example of the Table, the mortality estimates are never less than 96 percent of the actual mortality in the samples. Moreover, there is no discernable association between the bias and the correlation between mortality and sibset size.

Rows **E** and **F** show that dropping the sampled respondent from the calculation of mortality (on the grounds that she is by definition alive and therefore contributes no information) does not adequately adjust for the various biases—except in exceptional cases. Estimates in row **E** which do not use any form of weights are frequently too high—suggesting that ignoring the survival of the respondent biases mortality estimates upwards. The exception is the case where there is no correlation between sibset size and mortality—the case which Trussel and Rodriguez (1990) demonstrate that the various biases cancel each other out.[29] Row **F** shows that weighting by one divided by the number of surviving siblings exacerbates the upwards bias that would be induced by ignoring the survival of the respondent. These mortality estimates are almost 50 percent higher than the actual ones. (Using these weights does, however, appear to remove the bias induced by the correlation between mortality and sibset size).

The simulations reported in Appendix 1 Table do not, of course, reflect the wide variety of situations that are possible. But the findings they reflect are consistent with various other simulations we carried out. For example, increasing the number of sibsets substantially (from 900 to 9000) barely affects the results. Carrying out a similar exercise where the overall mortality rate is higher than 0.3 (e.g. 0.4 or 0.5) also yielded consistent results.

[29] More precisely, Trussel and Rodriguez (1990) show that the biases cancel each other out in calculations where all surviving siblings are potentially sampled, that is, not dropping duplicates.

Appendix 1 Table: Results of simulations of mortality estimation based on sibling reports, without and with weights, with and without including the respondent, at various degrees of correlation between sibset size and mortality.

Correlation between sibset size and mortality:	← Negative	----------	----------	----------	----------	----------	----------	----------	Positive →
Mortality rate assigned to additional siblings when									
Sibset size is equal to 2	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
Sibset size is equal to 3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Sibset size is equal to 4	0.2	0.233	0.267	0.3	0.333	0.367	0.4	0.433	0.467
(A) Actual mortality in "population"	**0.303**	**0.301**	**0.299**	**0.300**	**0.301**	**0.304**	**0.304**	**0.302**	**0.301**
(B) Correlation between mortality and sibset size in "population"	**-0.271**	**-0.208**	**-0.145**	**-0.084**	**-0.036**	**0.023**	**0.090**	**0.152**	**0.214**
(C) Estimated mortality (including respondent in survival calcs) - unweighted	**0.200**	**0.209**	**0.206**	**0.211**	**0.227**	**0.234**	**0.227**	**0.231**	**0.237**
Ratio to actual	*0.66*	*0.69*	*0.69*	*0.70*	*0.75*	*0.77*	*0.75*	*0.76*	*0.79*
(D) Estimated mortality (including respondent in survival calcs) - weighted	**0.297**	**0.300**	**0.288**	**0.288**	**0.301**	**0.301**	**0.295**	**0.291**	**0.295**
Ratio to actual	*0.98*	*1.00*	*0.96*	*0.96*	*1.00*	*0.99*	*0.97*	*0.96*	*0.98*
(E) Estimated mortality (excluding respondent in survival calcs) - unweighted	**0.287**	**0.300**	**0.297**	**0.304**	**0.329**	**0.341**	**0.332**	**0.339**	**0.349**
Ratio to actual	*0.95*	*0.99*	*0.99*	*1.02*	*1.09*	*1.12*	*1.09*	*1.12*	*1.16*
(F) Estimated mortality (excluding respondent in survival calcs) - weighted	**0.449**	**0.451**	**0.433**	**0.433**	**0.453**	**0.452**	**0.444**	**0.436**	**0.441**
Ratio to actual	*1.48*	*1.50*	*1.45*	*1.45*	*1.50*	*1.49*	*1.46*	*1.44*	*1.47*

Note: Number of sibsets=900; number of individuals=2700; number of survivors sampled in each replication=15; number of replications=300

Appendix 2: Public-use database with estimates of adult mortality

In the course of carrying out this study, we created two databases of adult mortality estimates based on the original DHS datasets, both of which are publicly available for analysts who wish to carry out their own analysis of the data. The databases are available at http://go.worldbank.org/RIIWM53VS0.

The first database (**survey_mortality.dta**) reports adult mortality estimates derived from each survey that was carried out.

The second database (**country_mortality.dta)** reports the same adult mortality estimates but averages the estimates for the same country and period from different rounds of the DHS. The weights used to average across survey rounds are the inverse of the variance of each estimate, so that more precise estimates are given more weight. This second database only includes the "adjusted" mortality estimates (the ones we use in our analysis) but also includes the national level social and economic indicators that we use in the analysis. Note that this database includes countries for which we do not have adult mortality estimates, but for which we have under-5 mortality.

The naming conventions for the adult mortality-related are as follows. Variables are named:

GGG_MC_AAAA

GGG refers to the population subgroup. The values it can take, and the corresponding definitions are in the following table:

All	All
Fem	Female
Mal	Male
Rur	Rural
Urb	Urban
Rurm	Rural/Male
Urbm	Urban/Male
Rurf	Rural/Female
Urbf	Urban/Female
Noed	No education
Pri	Some or completed primary only
Sec	At least some secondary education
Noedm	No education/Male
Prim	Some or completed primary only/Male
Secm	At least some secondary education/Male
Noedf	No education/Female
Prif	Some or completed primary only/Female

Secf	At least some secondary education/Female
Rch	Rural as child
Uch	Urban as child
Rchm	Rural as child/Male
Uchm	Urban as child/Male
Rchf	Rural as child/Female
Uchf	Urban as child/Female
Edltp	Less than primary schooling
Edpom	Primary or more schooling
Edltpm	Less than primary schooling/Male
Edpomm	Primary or more schooling/Male
Edltpf	Less than primary schooling/Female
Edpomf	Primary or more schooling/Female
Edltpu	Less than primary schooling/Urban
Edpomu	Primary or more schooling/Urban
Edltpr	Less than primary schooling/Rural
Edpomr	Primary or more schooling/Rural
Edltpmu	Less than primary schooling/Male/Urban
Edpommu	Primary or more schooling/Male/Urban
Edltpmr	Less than primary schooling/Male/Rural
Edpommr	Primary or more schooling/Male/Rural
Edltpfu	Less than primary schooling/Female/Urban
Edpomfu	Primary or more schooling/Female/Urban
Edltpfr	Less than primary schooling/Female/Rural
Edpomfr	Primary or more schooling/Female/Rural

M refers to whether the variable is the number of observations used to calculate the estimate (in which case **M** takes on the value “n”) or whether it is a mortality estimate (in which case **M** takes on the value “m”).

C refers to whether the variable is for the unadjusted mortality rate calculation (in which case **C** takes on the value “u”) or whether it adjusts for the number of surviving female siblings (in which case **C** takes on the value “a”).

AAAA refers to the age group that the mortality estimate is calculated for. It takes on the values:
1554 Ages 15-54
1524 Ages 15-24
2534 Ages 25-34
3544 Ages 35-44
4554 Ages 45-54

Other variables that are in the databases are:

period	Period for which mortality rate is calculated (takes on the values 1975-79, 1980-84 … 2000-04)
svycountry	Name of country for DHS countries
ccode3	Country code
u5mr	Under-5 mortality (from World Development Indicators)
cname	Country name
gdppc	GDP per capita (constant 2000 US$) (from World Development Indicators)
gdppcppp	GDP per capita PPP (constant 2005 intl $) (from World Development Indicators)
pop	Population (from World Development Indicators)
hivprev2001	HIV prevalence in 2001 (from UNAIDS 2010)
region	Region

Figure 1: Alternative approaches to estimating the adult mortality rate 1990-1994

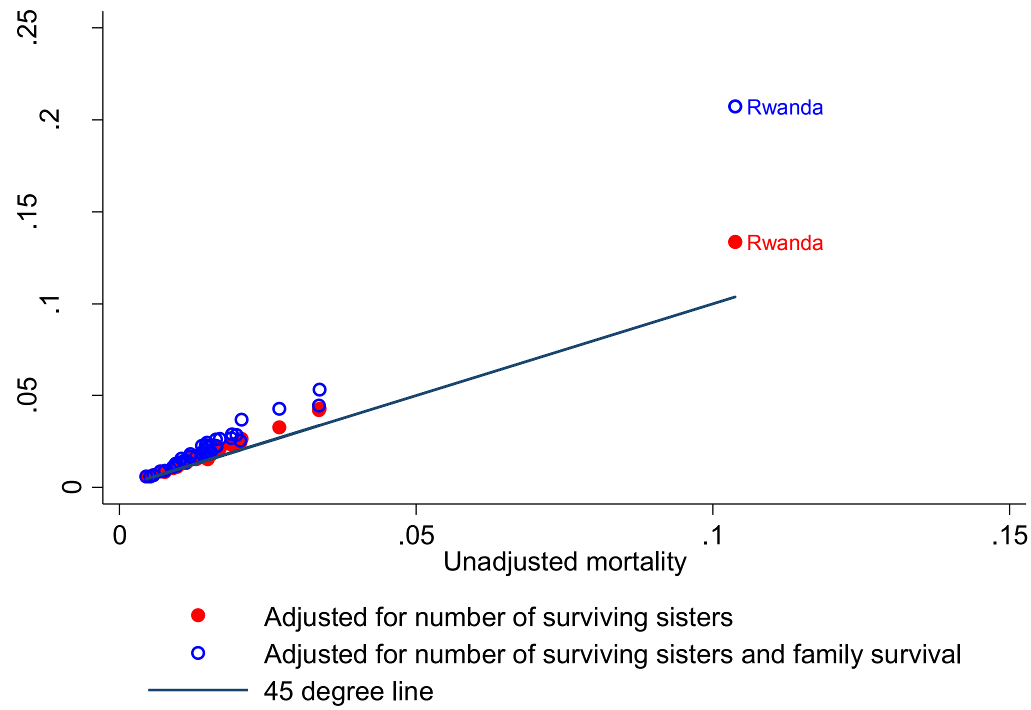
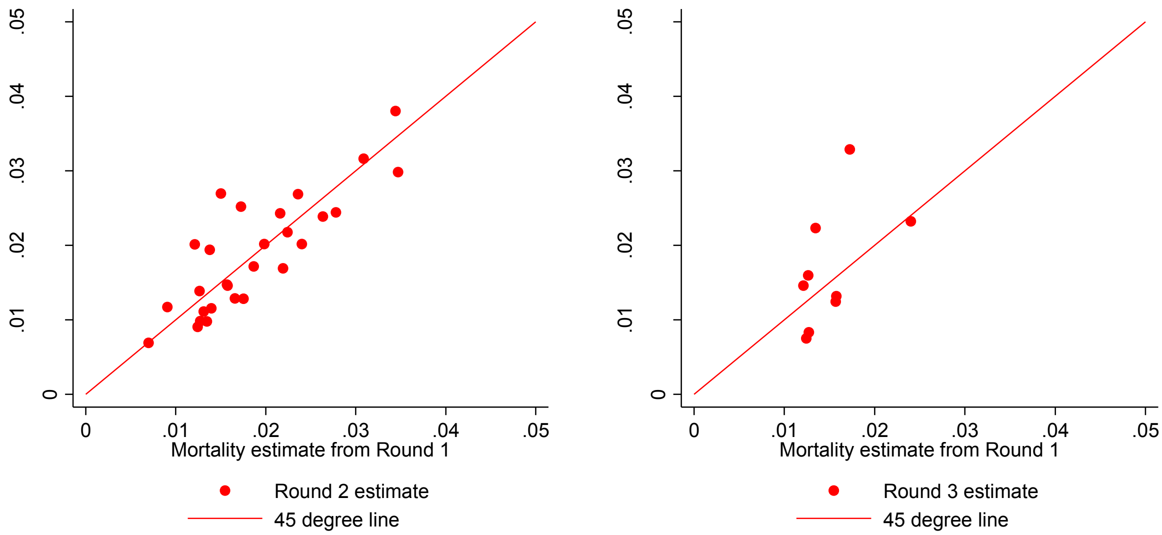


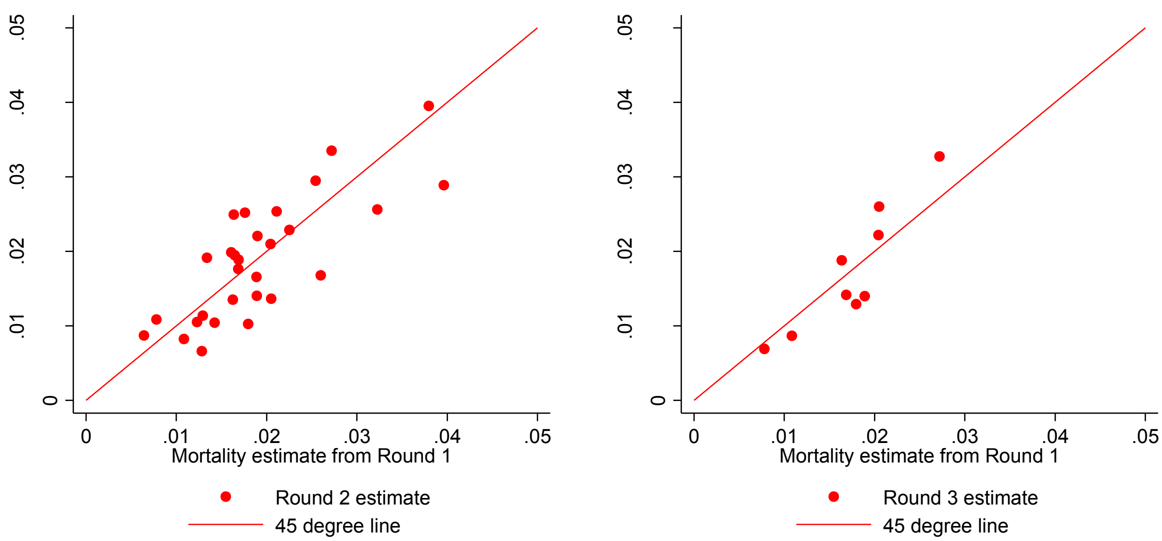
Figure 2: Repeated estimation of sibling mortality using different rounds of the survey: Is there a systematic recall bias?

Comparing first and second rounds of DHS	**Comparing first and third rounds of DHS**

Estimate of sibling adult mortality between 1975 and 1979



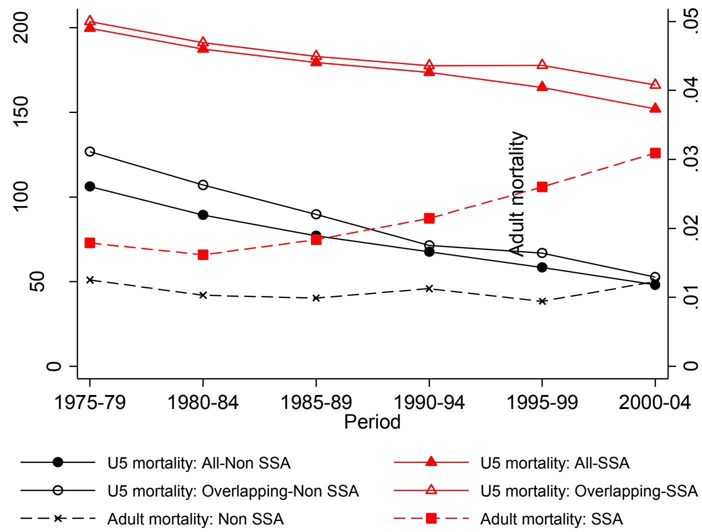
Estimate of sibling adult mortality between 1980 and 1984



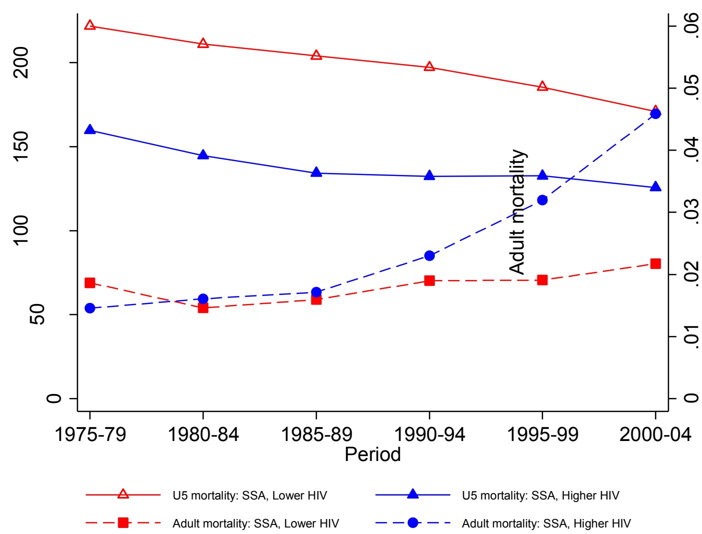
Note: 1975-79 graphs exclude Cambodia where mortality estimate using the first round of DHS is 0.165 and the second round of DHS is 0.166.

Figure 3: Trends in under-5 and adult mortality

(A) Overall



(B) Within Sub-Saharan Africa



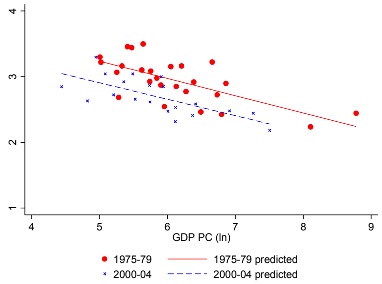
Note: "All" refers to full sample; "Overlapping" refers to countries/years that are also in the adult mortality database.

Figure 4: Relationship between mortality and GDP per capita over time

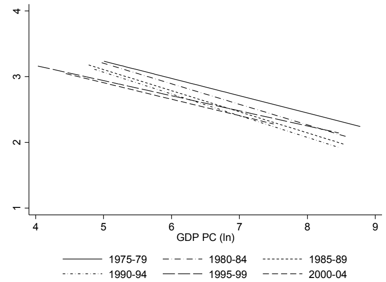
	Sub-Saharan African countries		Countries in other regions	
	1975-79 versus 2000-04	All 5-year periods	1975-79 versus 2000-04	All 5-year periods

Child mortality

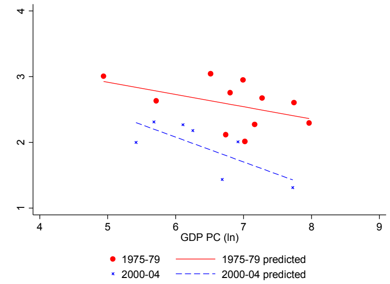
(A)



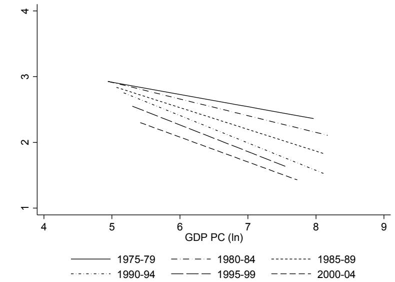
(B)



(C)

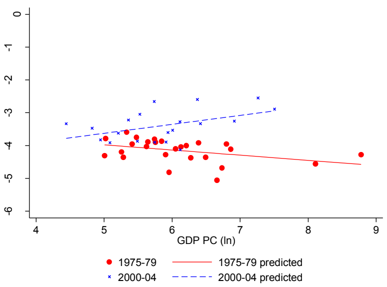


(D)

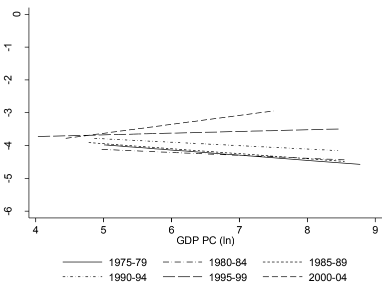


Adult mortality

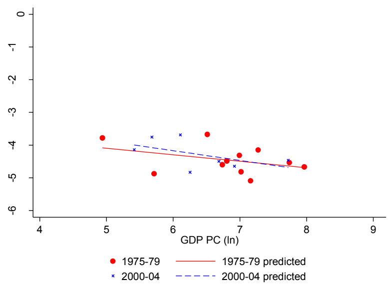
(E)



(F)



(G)



(H)

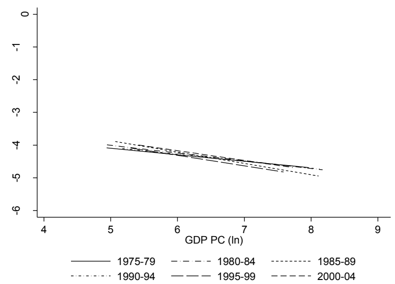
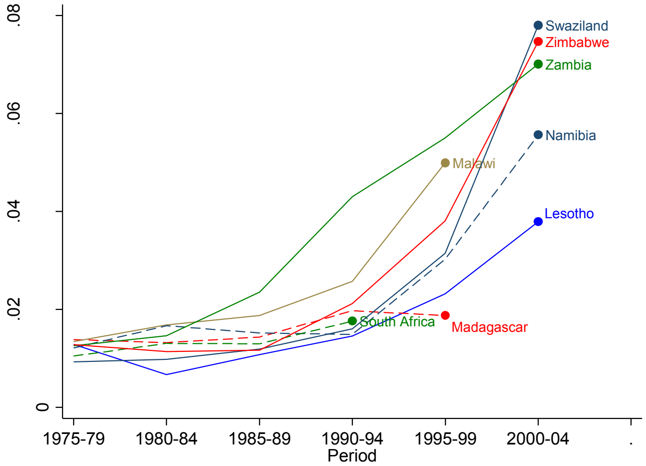
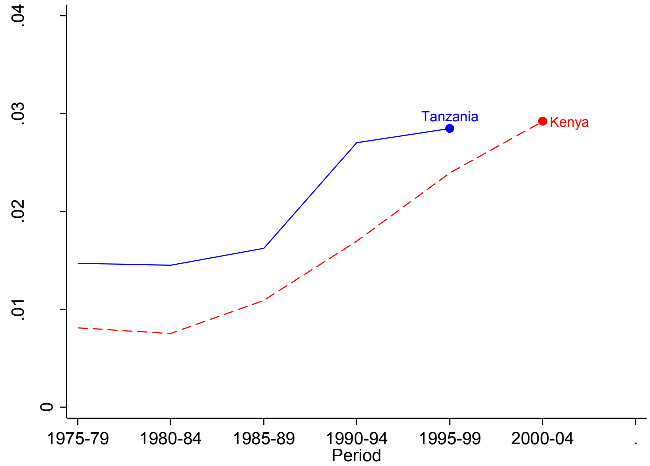


Figure 5: Country-specific trends in adult mortality

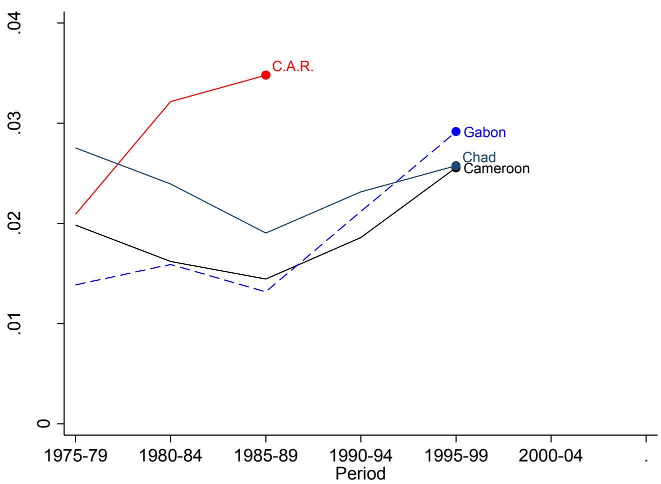
(A) Sub-Saharan Africa: Southern



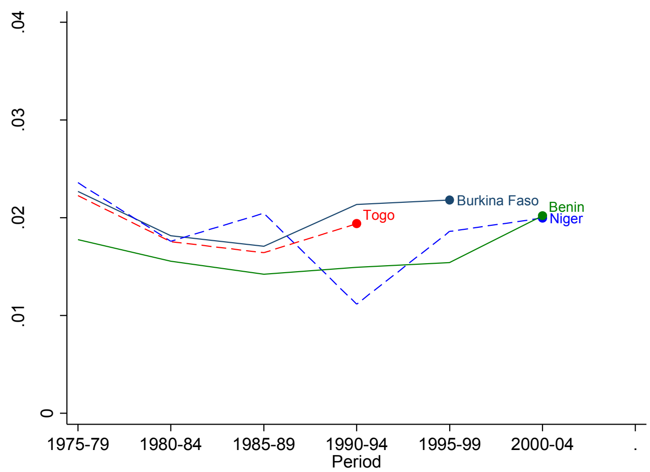
(B) Sub-Saharan Africa: Eastern



(C) Sub-Saharan Africa: Central and Western (1)



(D) Sub-Saharan Africa: Central and Western (2)



(E) Sub-Saharan Africa: Central and Western (3)

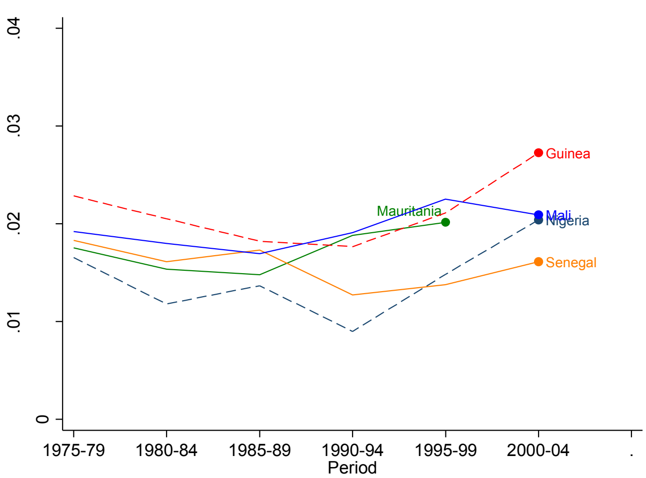
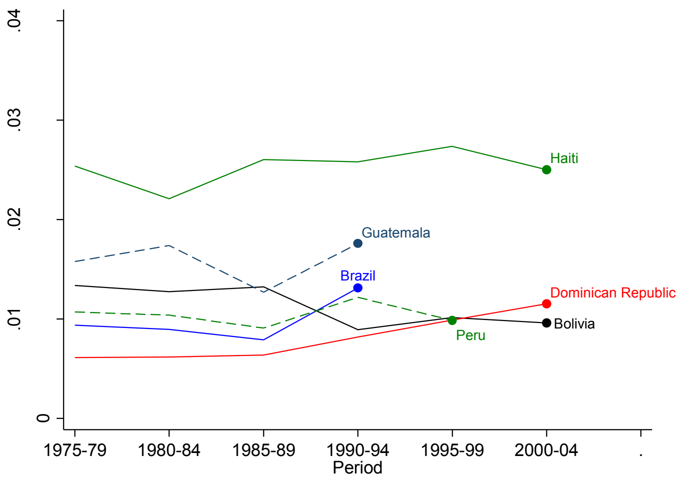
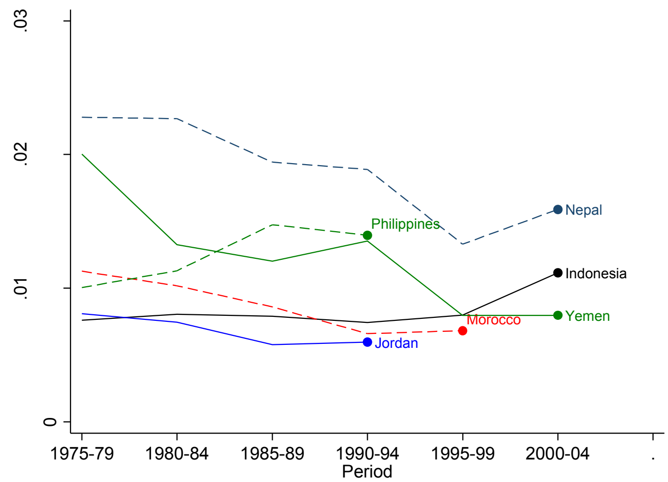


Figure 5 continued: Country-specific trends in adult mortality

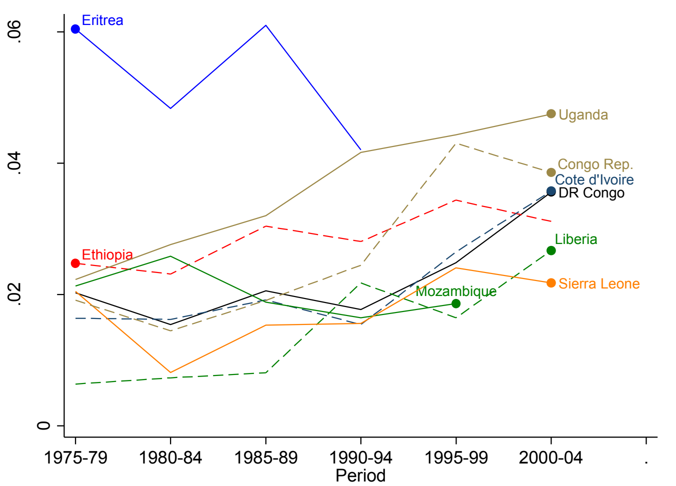
(F) Non Sub-Saharan Africa: Latin America and Caribbean



(G) Non Sub-Saharan Africa: Asia, North Africa, and Middle East



(H) Countries with episodes of civil or international conflict



(I) Countries with episode of genocide

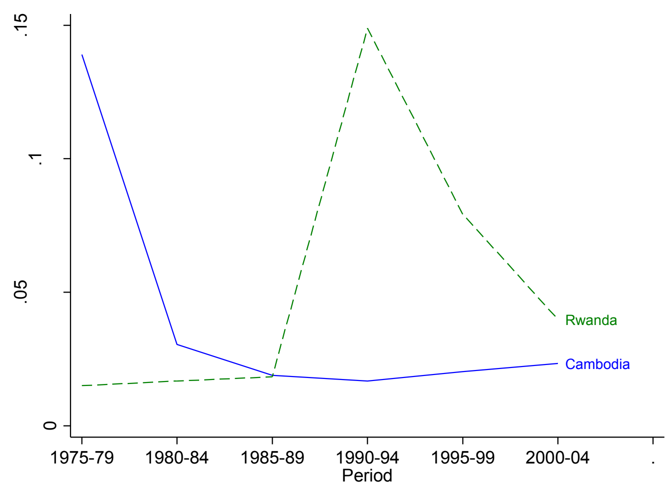
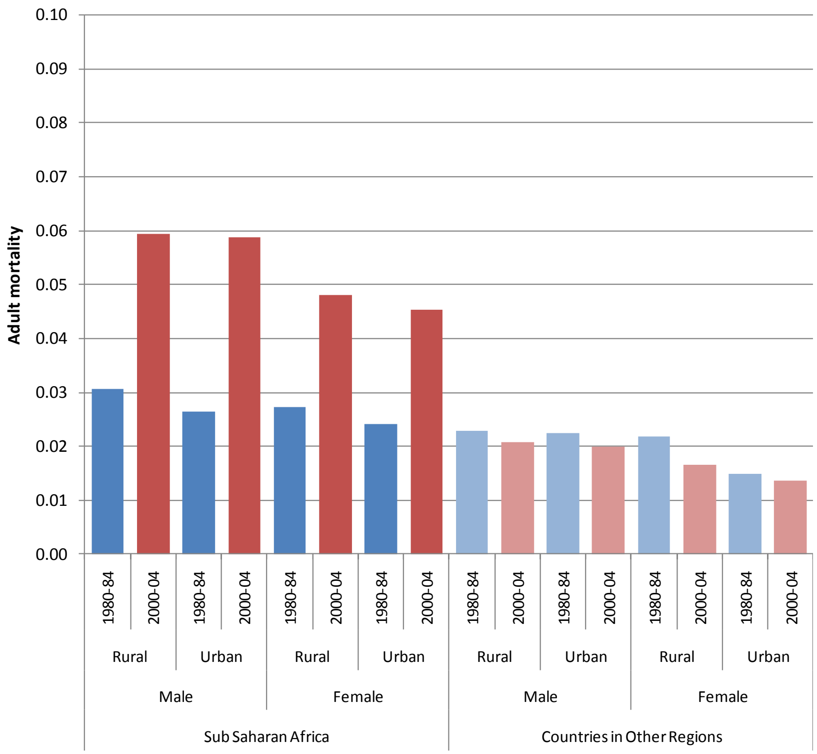
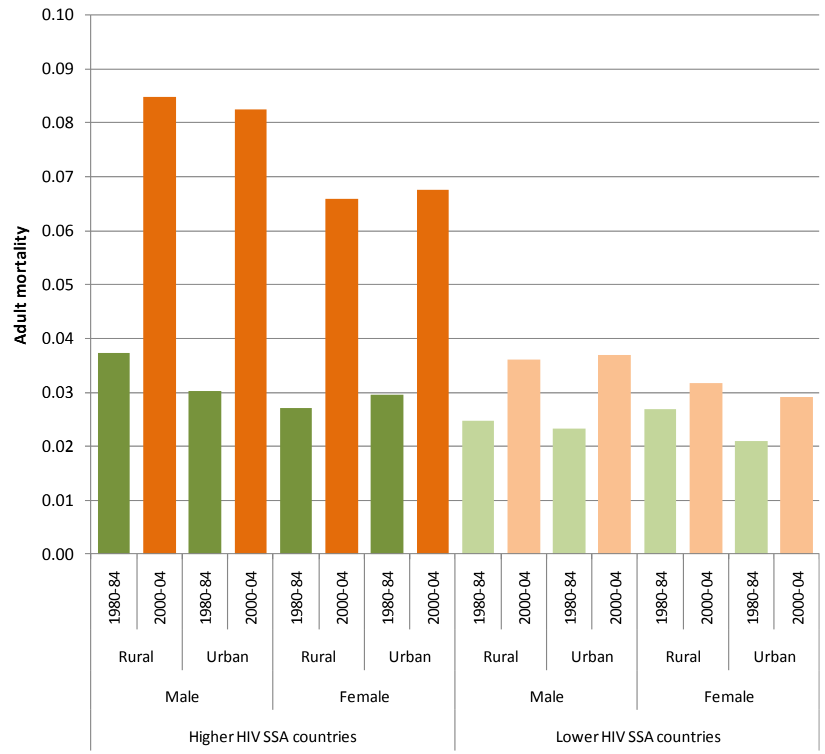


Figure 6: Predicted adult mortality by year, gender, and location

Sub Saharan African countries and countries in other regions



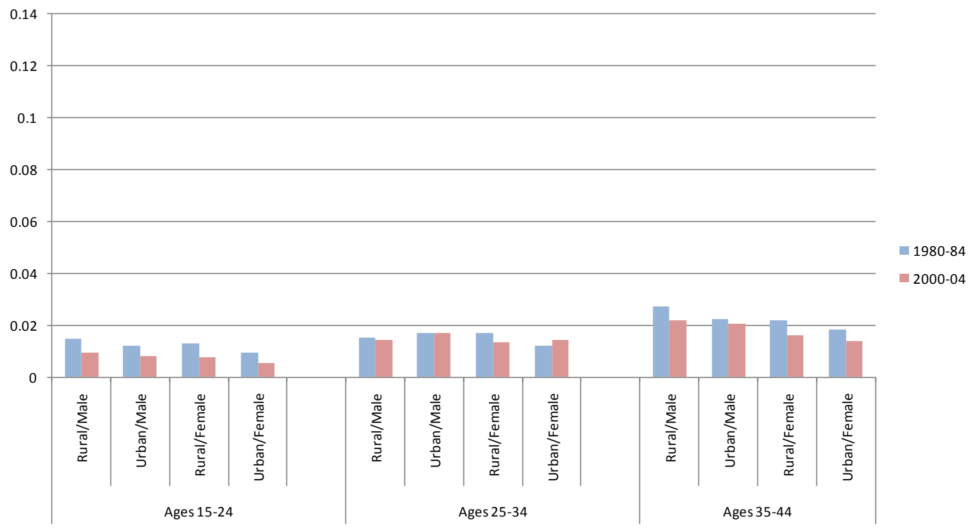
Sub Saharan African countries with higher and lower HIV prevalence



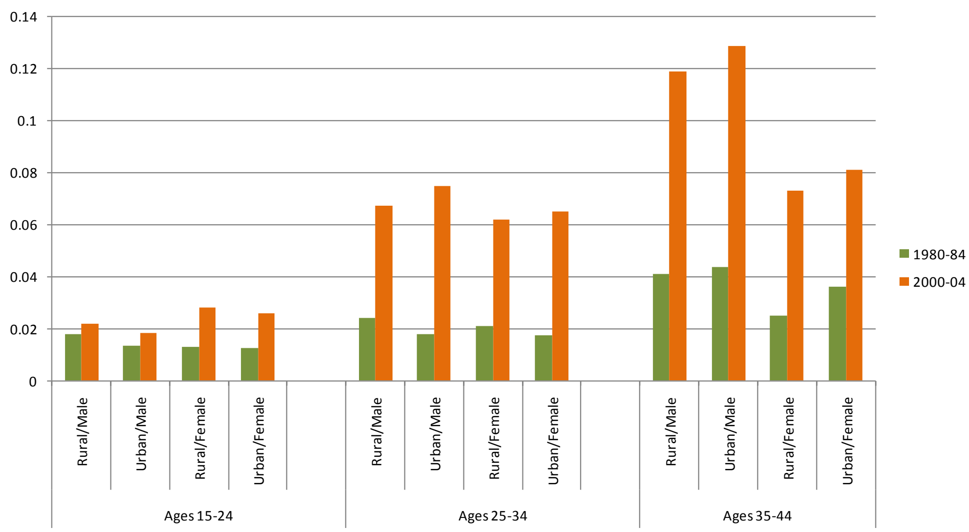
Note: Based on estimates reported in Table 4

Figure 7: Predicted adult mortality by year, gender, and location—by age group

Non sub-Saharan African countries



Sub-Saharan countries with higher HIV prevalence



Sub-Saharan countries with lower HIV prevalence

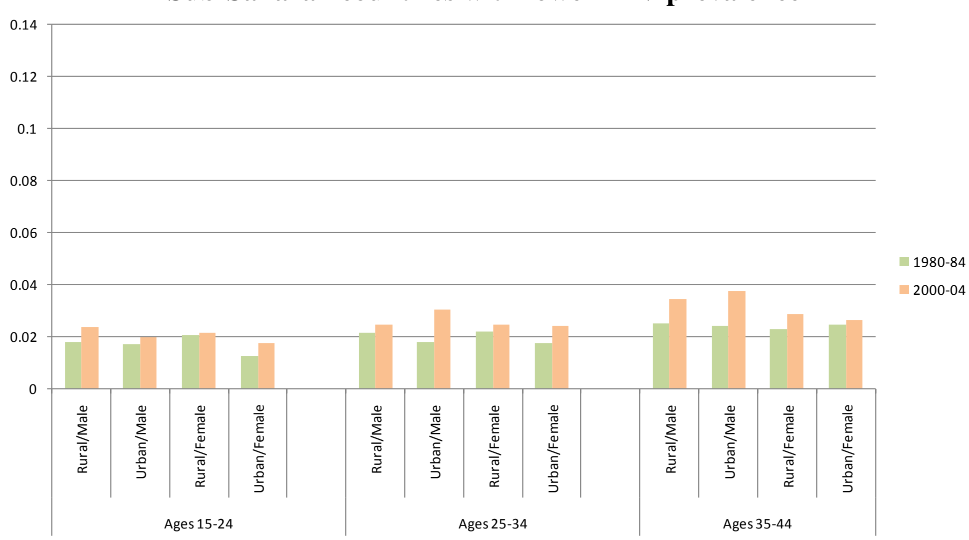


Figure 8: Trends in age- and gender-specific mortality rates in rural areas of four sub-Saharan African countries.

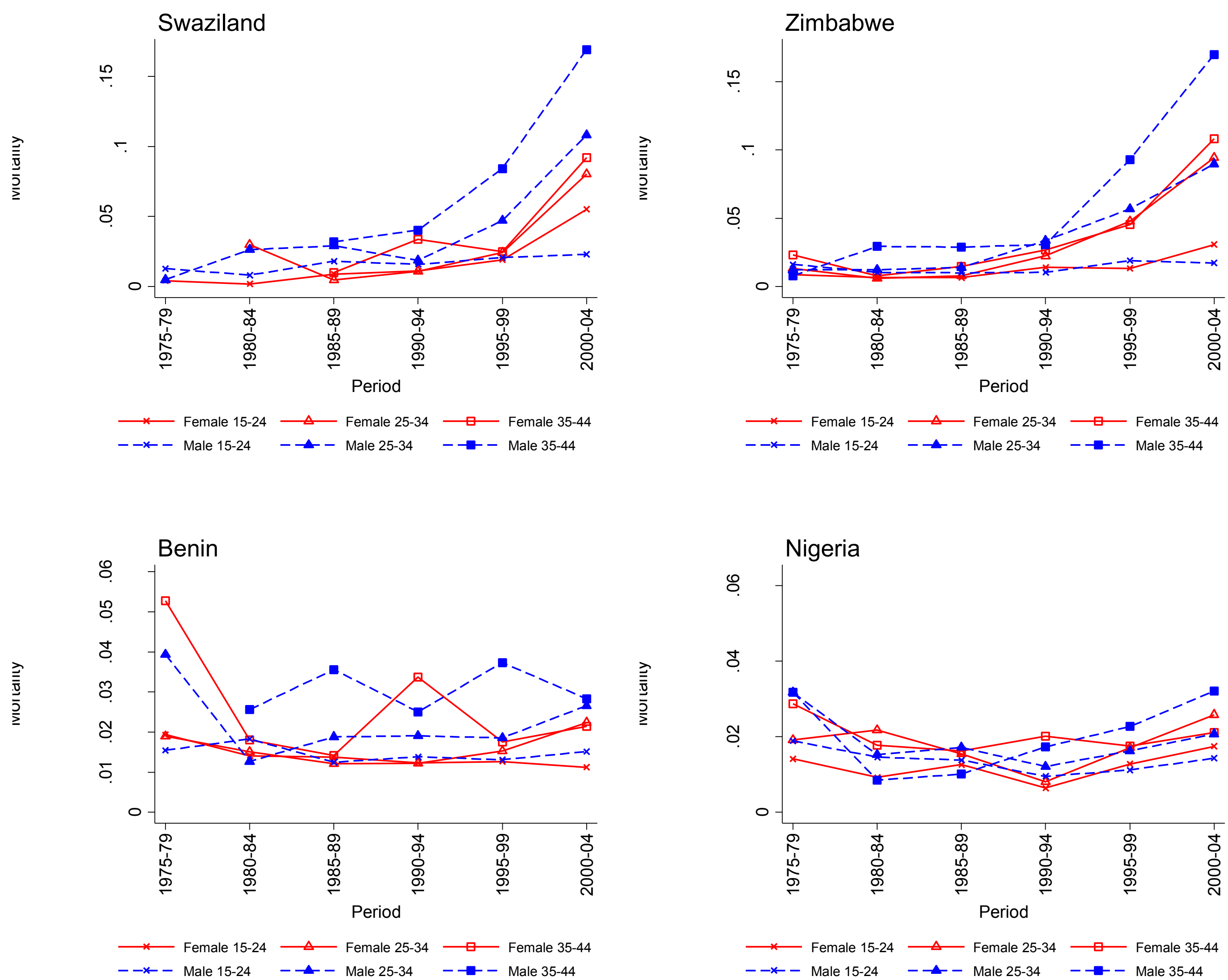
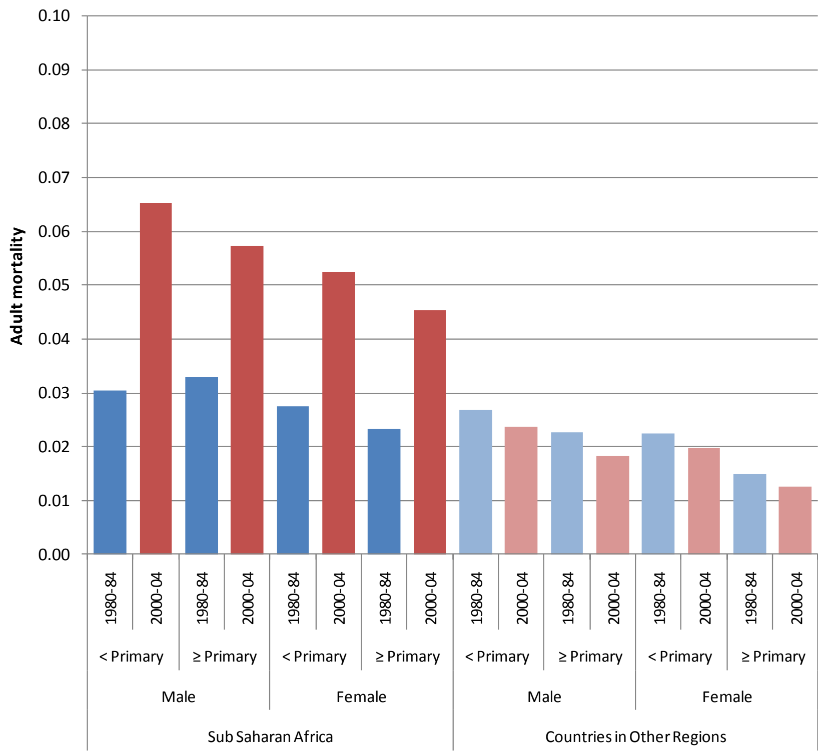
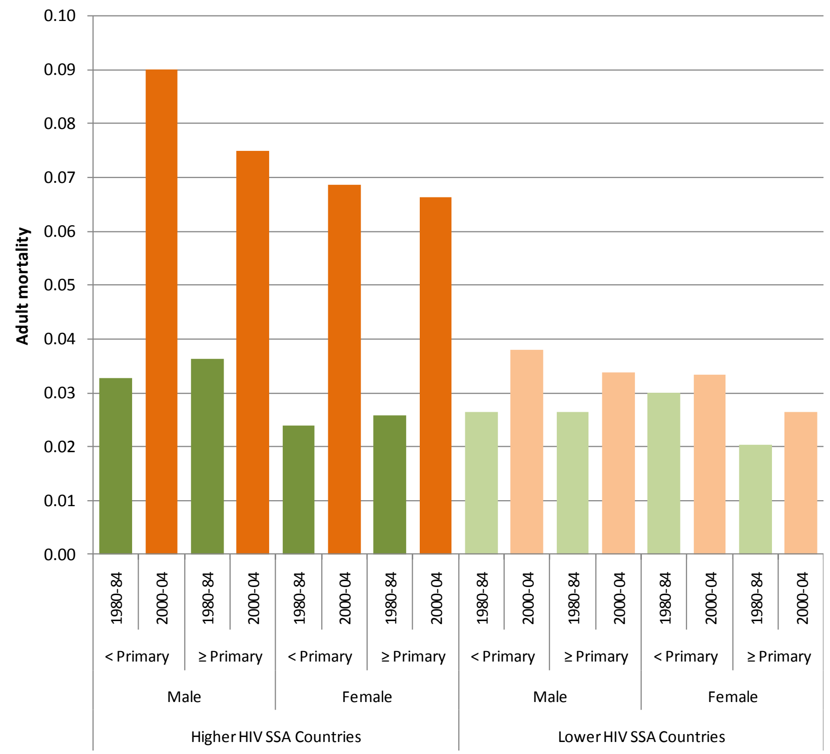


Figure 9: Predicted adult mortality by year, gender, and education

Sub Saharan African countries and countries in other regions



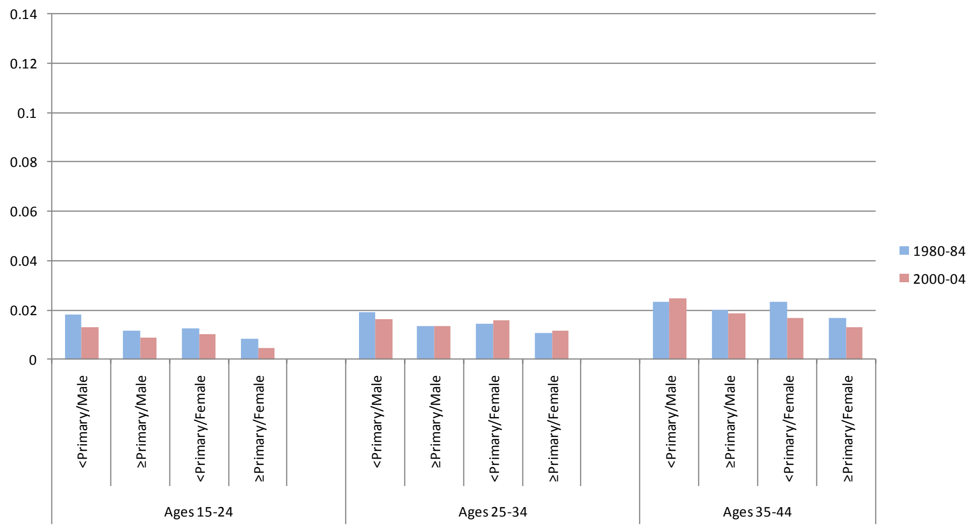
Sub Saharan African countries with higher and lower HIV prevalence



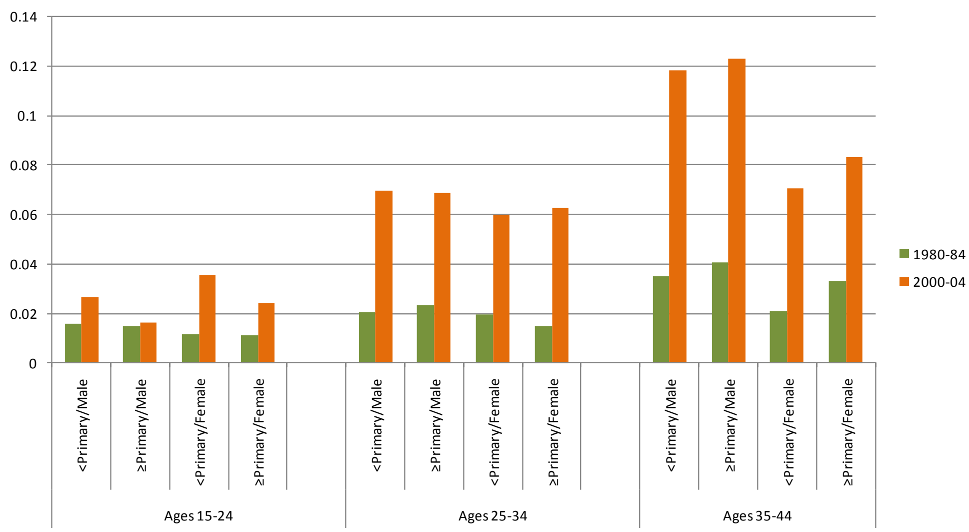
Note: Based on estimates reported in Table 6

Figure 10: Predicted adult mortality by year, gender, and education—by age group

Non sub-Saharan African countries



Sub-Saharan countries with higher HIV prevalence



Sub-Saharan countries with lower HIV prevalence

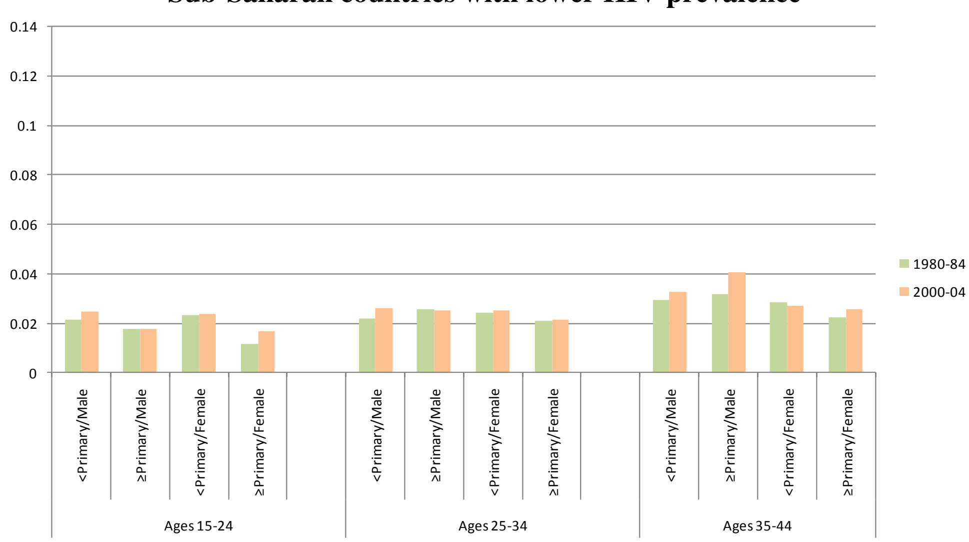


Figure 11: Trends in mortality rates in rural areas of four sub-Saharan African countries experiencing conflict

Gender and location

Gender and education

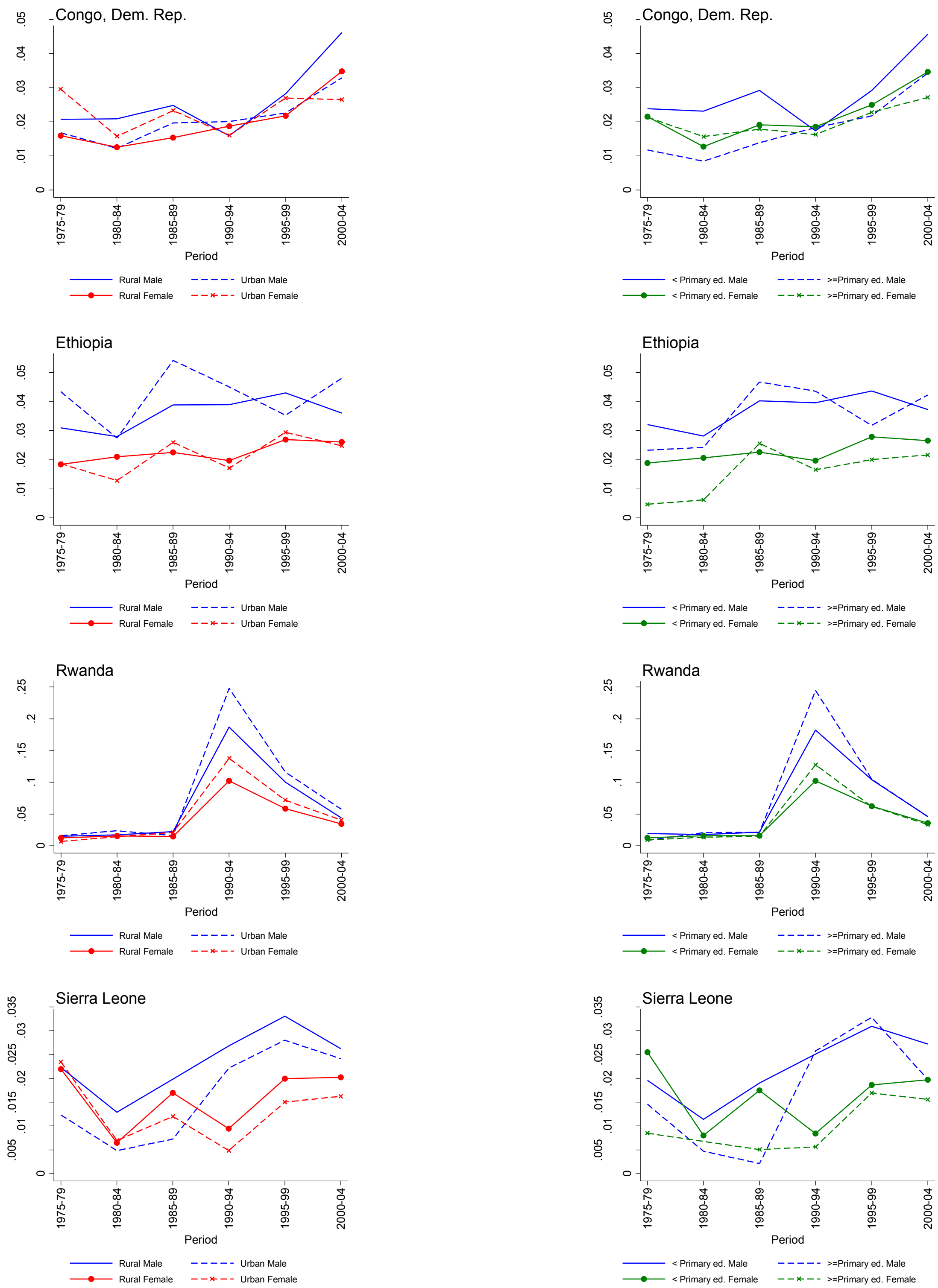


Table 1: Mortality as a function of per capita income and period

	Sub-Saharan African countries			Countries in other regions		
	Child Mortality (ln) #	Child Mortality (ln) ##	Adult Mortality (ln)	Child Mortality (ln) #	Child Mortality (ln) ##	Adult Mortality (ln)
GDP pc (ln)	-0.395	-0.288	-0.053	-0.449	-0.317	-0.263
	(0.021)**	(0.021)**	(0.036)	(0.022)**	(0.049)**	(0.065)**
1980-84	-0.192	-0.087	-0.067	-0.410	-0.114	0.027
	(0.068)**	(0.063)	(0.108)	(0.076)**	(0.128)	(0.170)
1985-89	-0.289	-0.189	0.051	-0.627	-0.319	-0.047
	(0.064)**	(0.062)**	(0.107)	(0.071)**	(0.127)*	(0.170)
1990-94	-0.334	-0.237	0.251	-0.800	-0.512	0.006
	(0.064)**	(0.062)**	(0.107)*	(0.066)**	(0.125)**	(0.166)
1995-99	-0.407	-0.278	0.502	-1.014	-0.614	-0.099
	(0.063)**	(0.063)**	(0.109)**	(0.064)**	(0.135)**	(0.180)
2000-04	-0.448	-0.325	0.742	-1.162	-0.778	0.058
	(0.063)**	(0.070)**	(0.120)**	(0.064)**	(0.146)**	(0.194)
Obs.	329	166	166	589	61	61
R-squared	0.58	0.56	0.34	0.63	0.58	0.25

Note: Standard errors in parentheses. * significant at 5%; ** significant at 1%. # indicates full sample; ## indicates sample of countries/years countries that are also in the adult mortality database ("overlapping" countries).

Table 2: Mortality as a function of per capita income and period, by age group

	Sub-Saharan African countries				Countries in other regions			
	Ages 15-24	Ages 25-34	Ages 35-44	Ages 45-54	Ages 15-24	Ages 25-34	Ages 35-44	Ages 45-54
GDP pc (ln)	-0.132	-0.045	0.054	0.026	-0.258	-0.274	-0.243	-0.214
	(0.037)**	(0.042)	(0.051)	(0.064)	(0.081)**	(0.083)**	(0.073)**	(0.106)*
1980-84	-0.100	-0.000	0.120	0.130	-0.180	-0.135	-0.194	0.639
	(0.102)	(0.117)	(0.146)	(0.232)	(0.195)	(0.199)	(0.175)	(0.252)*
1985-89	-0.014	0.048	0.173	0.112	-0.335	-0.335	-0.270	0.179
	(0.103)	(0.118)	(0.146)	(0.230)	(0.195)	(0.199)	(0.175)	(0.252)
1990-94	0.107	0.207	0.444	0.266	-0.335	-0.330	-0.171	0.282
	(0.104)	(0.120)	(0.148)**	(0.231)	(0.195)	(0.199)	(0.176)	(0.254)
1995-99	0.221	0.507	0.628	0.651	-0.463	-0.399	-0.255	0.345
	(0.108)*	(0.124)**	(0.153)**	(0.235)**	(0.219)*	(0.223)	(0.197)	(0.285)
2000-04	0.360	0.725	0.852	0.849	-0.479	-0.234	-0.119	0.604
	(0.120)**	(0.137)**	(0.169)**	(0.249)**	(0.237)*	(0.242)	(0.213)	(0.308)
Observations	180	179	175	147	68	68	68	66
R-squared	0.23	0.25	0.19	0.18	0.35	0.34	0.37	0.38

Note: Standard errors in parentheses. * significant at 5%; ** significant at 1%.

Table 3: Correlates of adult mortality (ln): gender and residence

	Sub-Saharan African countries							Countries in other regions						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Male(a)	0.186 (0.034)**							0.159 (0.050)**						
Urban(b)		-0.067 (0.033)*							-0.167 (0.050)**					
Urban as child(c)			-0.028 (0.040)							-0.180 (0.055)**				
Rural, Female(d)				-0.144 (0.038)**	-0.142 (0.034)**						-0.117 (0.059)*	-0.115 (0.051)*		
Urban, Male(d)				-0.017 (0.038)	-0.019 (0.035)						-0.067 (0.058)	-0.049 (0.050)		
Urban, Female(d)				-0.242 (0.038)**	-0.246 (0.035)**						-0.393 (0.058)**	-0.387 (0.050)**		
Rural as child, Female(d)						-0.124 (0.044)**	-0.122 (0.040)**						-0.131 (0.065)*	-0.129 (0.058)*
Urban as child, Male(d)						-0.025 (0.045)	-0.023 (0.041)						-0.093 (0.065)	-0.083 (0.058)
Urban as child, Female(d)						-0.172 (0.045)**	-0.165 (0.041)**						-0.367 (0.066)**	-0.365 (0.058)**
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	No	Yes	No	Yes	No	No	No	No	Yes	No	Yes
Observations	1312	1303	999	2485	2485	1899	1899	529	528	461	1023	1023	890	890
R-squared	0.32	0.36	0.30	0.32	0.44	0.27	0.41	0.43	0.42	0.41	0.34	0.51	0.33	0.49

Note: Standard errors in parentheses. * significant at 5%; ** significant at 1%. Models include the log of GDP per capita. Left out categories are: (a) Female; (b) Rural; (c) Rural as Child; (d) Rural [as child], Male.

Table 4: Correlates of adult mortality (ln) by period: gender and location

	(A) Sub Saharan African countries						(B) Countries in other regions					
	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Rural, Female[(a)]	0.007	-0.118	-0.236	-0.103	-0.175	-0.210	0.085	-0.049	-0.127	-0.176	-0.220	-0.230
	(0.090)	(0.085)	(0.078)**	(0.072)	(0.057)**	(0.061)**	(0.126)	(0.121)	(0.108)	(0.097)	(0.104)*	(0.126)
Urban, Male[(a)]	-0.064	-0.145	-0.170	0.140	0.080	-0.008	0.053	-0.016	-0.230	-0.046	0.050	-0.045
	(0.090)	(0.087)	(0.079)*	(0.073)	(0.057)	(0.061)	(0.123)	(0.117)	(0.108)*	(0.096)	(0.104)	(0.126)
Urban, Female[(a)]	-0.139	-0.235	-0.385	-0.216	-0.191	-0.268	-0.185	-0.427	-0.526	-0.330	-0.406	-0.422
	(0.093)	(0.087)**	(0.079)**	(0.073)**	(0.057)**	(0.061)**	(0.125)	(0.119)**	(0.108)**	(0.096)**	(0.104)**	(0.126)**
Age dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	336	405	476	486	462	320	169	187	204	207	144	112
R-squared	0.39	0.39	0.45	0.56	0.65	0.75	0.72	0.52	0.55	0.58	0.66	0.68

	(C) Sub Saharan African countries Higher HIV prevalence						(D) Sub Saharan African countries Lower HIV prevalence					
	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Rural, Female[(a)]	-0.056	-0.325	-0.364	-0.272	-0.254	-0.252	0.101	0.082	-0.047	0.103	-0.087	-0.129
	(0.133)	(0.127)*	(0.118)**	(0.104)*	(0.069)**	(0.088)**	(0.124)	(0.110)	(0.103)	(0.098)	(0.088)	(0.072)
Urban, Male[(a)]	0.140	-0.215	-0.120	0.142	0.096	-0.029	-0.257	-0.067	-0.226	0.116	0.075	0.019
	(0.133)	(0.131)	(0.119)	(0.104)	(0.069)	(0.088)	(0.126)*	(0.111)	(0.103)*	(0.099)	(0.088)	(0.072)
Urban, Female[(a)]	-0.172	-0.237	-0.491	-0.268	-0.119	-0.226	-0.099	-0.169	-0.350	-0.152	-0.234	-0.218
	(0.135)	(0.132)	(0.120)**	(0.106)*	(0.069)	(0.088)*	(0.132)	(0.111)	(0.102)**	(0.099)	(0.088)**	(0.072)**
Age dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	157	188	222	212	207	128	159	192	226	245	223	160
R-squared	0.38	0.46	0.46	0.53	0.73	0.81	0.35	0.42	0.50	0.65	0.66	0.71

Note: Models include the log of GDP per capita. Standard errors in parentheses. * significant at 5%; ** significant at 1%. Left out categories is: (a) Rural, Male.

Table 5: Correlates of adult mortality (ln): gender and education.

	Sub-Saharan African countries		Countries in other regions	
	(1)	(2)	(3)	(4)
Primary or more schooling, Male [(a)]	-0.022	-0.023	-0.137	-0.134
	(0.042)	(0.039)	(0.066)*	(0.059)*
Less than primary schooling, Female[(a)]	-0.134	-0.135	-0.125	-0.121
	(0.041)**	(0.037)**	(0.065)	(0.058)*
Primary or more schooling, Female [(a)]	-0.299	-0.301	-0.520	-0.522
	(0.042)**	(0.039)**	(0.066)**	(0.059)**
Period dummies	Yes	Yes	Yes	Yes
Age dummies	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	Yes
Observations	2407	2407	1007	1007
R-squared	0.31	0.43	0.31	0.45

Note: Standard errors in parentheses. * significant at 5%; ** significant at 1%. Left out category is: (a) Less than primary schooling, Male.

Table 6: Correlates of adult mortality (ln) by period: gender and education

	(A) Sub Saharan African countries						(B) Countries in other regions					
	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
>=Prim. school, Male[a]	0.102	0.078	-0.088	-0.020	-0.004	-0.130	-0.189	-0.169	-0.109	-0.028	-0.116	-0.263
	(0.125)	(0.096)	(0.087)	(0.080)	(0.061)	(0.070)	(0.135)	(0.152)	(0.134)	(0.119)	(0.117)	(0.119)*
<Prim. school, Female[a]	-0.013	-0.101	-0.131	-0.161	-0.185	-0.220	-0.183	-0.177	0.074	-0.098	-0.239	-0.186
	(0.117)	(0.088)	(0.083)	(0.078)*	(0.061)**	(0.070)**	(0.135)	(0.150)	(0.132)	(0.118)	(0.115)*	(0.118)
>=Prim. school, Fem[a]	-0.212	-0.265	-0.382	-0.306	-0.206	-0.366	-0.405	-0.587	-0.571	-0.435	-0.505	-0.631
	(0.129)	(0.095)**	(0.087)**	(0.079)**	(0.062)**	(0.070)**	(0.138)**	(0.155)**	(0.134)**	(0.120)**	(0.116)**	(0.119)**
Age dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	318	384	456	479	451	319	163	188	202	203	141	110
R-squared	0.33	0.41	0.42	0.55	0.62	0.72	0.69	0.44	0.46	0.49	0.64	0.75

	(C) Sub Saharan African countries Higher HIV prevalence						(D) Sub Saharan African countries Lower HIV prevalence					
	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
>=Prim. school, Male[a]	0.262	0.099	0.196	-0.002	0.113	-0.184	-0.028	-0.002	-0.419	-0.051	-0.095	-0.114
	(0.165)	(0.124)	(0.118)	(0.111)	(0.076)	(0.085)*	(0.172)	(0.147)	(0.133)**	(0.109)	(0.091)	(0.106)
<Prim. school, Female[a]	-0.200	-0.315	-0.253	-0.401	-0.210	-0.272	0.161	0.124	-0.004	0.111	-0.141	-0.129
	(0.162)	(0.119)**	(0.116)*	(0.111)**	(0.075)**	(0.085)**	(0.153)	(0.126)	(0.119)	(0.106)	(0.090)	(0.105)
>=Prim. school, Fem[a]	-0.178	-0.241	-0.426	-0.406	-0.141	-0.305	-0.083	-0.260	-0.337	-0.198	-0.191	-0.362
	(0.171)	(0.123)	(0.118)**	(0.111)**	(0.075)	(0.085)**	(0.175)	(0.144)	(0.133)*	(0.108)	(0.093)*	(0.105)**
Age dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	155	188	221	214	205	128	144	172	209	237	214	159
R-squared	0.34	0.51	0.47	0.50	0.68	0.82	0.36	0.37	0.45	0.67	0.66	0.57

Note: Models include the log of GDP per capita. Standard errors in parentheses. * significant at 5%; ** significant at 1%. Left out categories is: (a) Rural, Male.

Annex Table

Sub-Saharan African countries			Countries in other regions	
Country	Survey years	HIV Prevalence in 2001	Country name	
Benin	1996; 2006	1.4	Bolivia	1993; 2003; 2008
Burkina Faso	1999; 2003	2.1	Brazil	1996
CAR	1994	8.9	Cambodia	2000; 2005
Cameroon	1998; 2004	5.5	Dominican Republic	2000; 2007
Chad	1998; 2004	3.2	Guatemala	1995
Congo Rep	2005	3.8	Haiti	2001; 2005
Cote d'Ivoire	1994; 2005	6.5	Indonesia	1994; 1997; 2002; 2007
DR Congo	2007	-	Jordan	1997
Eritrea	1995	1.2	Morocco	1992; 2003
Ethiopia	2000; 2005	-	Nepal	1996; 2006
Gabon	2000	5.3	Peru	1996; 2000
Guinea	1999; 2005	1.7	Philippines	1993; 1998
Kenya	1998; 2003; 2008	8.4	Yemen	1991
Lesotho	2004; 2009	24.5		
Liberia	2007	3.1		
Madagascar	1997; 2003	0.2		
Malawi	1992; 2000; 2004	13.8		
Mali	1995; 2001; 2006	1.6		
Mauritania	2000	0.6		
Mozambique	2003	9.4		
Namibia	1992; 2000; 2006	16.1		
Niger	1992; 2006	1.0		
Nigeria	2008	3.8		
Rwanda	2000; 2005	3.7		
Senegal	1992; 2005	0.6		
Sierra Leone	2008	1.1		
South Africa	1998	17.1		
Swaziland	2006	23.6		
Tanzania	1996; 2004	7.1		
Togo	1998	3.6		
Uganda	1995; 2000; 2006	7.0		
Zambia	1996; 2001; 2006	14.3		
Zimbabwe	1994; 1999; 2005	23.7		