NBER WORKING PAPER SERIES

SCHOOLING, WEALTH, RISKY SEXUAL BEHAVIOR, AND HIV/AIDS IN SUB-SAHARAN AFRICA

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Working Paper 24962
http://www.nber.org/papers/w24962

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2018

We thank seminar participants at the Population Association of America 2017 Annual Meeting and Alden Boetsch for many excellent comments. The PopPov Research Network and the Population Reference Bureau provided generous financial support. The findings, interpretations, and conclusions expressed in this paper are those of the authors and do not necessarily represent the views of the aforementioned individuals or agencies, nor those of the National Bureau of Economic Research. The authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

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NBER Working Paper No. 24962
August 2018
JEL No. I12,J13,O15

ABSTRACT

Economic growth and development have improved human health in many regions, while sub-Saharan Africa continues to lag behind. Economic theory and the existing empirical evidence suggest that development may not generate large reductions in the leading cause of adult mortality in the region, HIV/AIDS, and may increase risky sexual behavior. We examine the association between schooling/material standard of living and HIV risk using data from more than 500,000 respondents in 32 sub-Saharan African countries. The results of our descriptive analysis suggest that the rapid increase in primary school completion without improvements in living standards or secondary school completion might not mitigate HIV transmission.

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1 Introduction

Economic growth and development have greatly improved human health and longevity in many regions, while sub-Saharan Africa continues to lag behind (Cutler et al. 2006, World Bank 2006). Economic theory and the existing empirical evidence suggest that economic development may not generate large reductions in the leading cause of adult mortality in the region, HIV/AIDS (WHO 2011), and may increase risky sexual behavior. A standard conceptual framework for evaluating the effects of economic development (or related factors) on risky sexual behavior generates ambiguous predictions (Edlund and Korn 2002, Wilson 2012, Burke et al. 2015). Increases in female schooling and in economic opportunities for women should in theory increase employment opportunities outside of transactional sex, reducing the supply of risky sex. On the other hand, increases in male earnings may increase demand for risky sex through the "income effect".[2] If economic development positively impacts both male and female wages and education, then the sign of the net effect of these changes cannot be determined theoretically without more information. In order to provide additional insight into this relationship, we examine the association between both schooling and material standard of living and risky sexual behavior, the primary driver of the HIV/AIDS pandemic in the region (Oster 2005), using national household surveys from 32 countries in sub-Saharan Africa that include more than a half-million individual respondents.[3] We also use the HIV testing modules from these surveys to examine whether these behavioral associations manifest in epidemiological differences.

[2] Increased male education could also reduce the price of risky sex through a reduction in search costs, again increasing quantity demanded.

[3] A large literature (e.g., Morris and Kretzmar 1997, Halperin and Epstein 2004, Mah and Halperin 2010, and Fox 2014) has identified multiple concurrent partnerships as a key driver of the HIV/AIDS pandemic. Two other key risky sexual behaviors identified in the literature are not using a condom (e.g., Weller and Davis 2002) and engaging in transactional sex (e.g., Baral et al. 2015).

Existing empirical evidence based on quasi-experimental or experimental methods has been limited in geographic scope—focusing on a single country or sub-region of a country and covering only five total countries across all studies.[4] Existing evidence shows that increased human capital investment, particularly for females, and increased economic opportunities for women are linked with reduced HIV risk (de Walque 2007a, Baird et al. 2009, Baird et al. 2011, Baird et al. 2012, Wilson 2012, DeNeve et al. 2015). Little evidence exists for males or large-scale, systematic general equilibrium evidence for either gender.[5,6] For both males and females, national secondary school expansion (DeNeve et al. 2015), nationwide HIV education expansion (de Walque 2007a), and large positive economic shocks (Wilson 2012) reduced HIV risk. Specifically, for females, national increases in female secondary school enrollment (Alsan and Cutler 2013), conditional cash transfers (CCTs) for schooling (Baird et al. 2009, Baird et al. 2011, Baird et al. 2012), and unconditional cash transfers (UCTs) (Baird et al. 2011) reduced HIV risk. Further, negative economic shocks increased (particularly) risky sexual behavior among commercial sex workers (Robinson and Yeh 2011, Robinson and Yeh 2012). In contrast, small UCTs for males increased risky sexual behavior among recipients (Kohler and Thornton 2012).

Most similar to the current study are a number older multi-country descriptive studies. Two descriptive analyses used national household survey data from 2003 and 2004 from five sub-Saharan African countries: Burkina Faso, Cameroon, Ghana, Kenya, and Tanzania. Fortson (2008) analyzed the HIV-education and HIV-wealth gradients in these data and found that adult HIV

[4] Of the studies that follow, four studies use data from Malawi, two studies each use data from Uganda and Kenya, and one study each uses data from Botswana and Zambia.
[5] Several studies (e.g., Higgins et al. 2010, Poulin et al. 2016) have documented and analyzed the relative lack of attention to males in HIV policy and research.
[6] The one exception to the focus on a single country is Burke et al. (2015) that uses data from 21 sub-Saharan African countries to examine the effects of weather shocks on HIV and finds that large negative weather shocks increase HIV risk.

prevalence was positively related to schooling and (in some countries) it was increasing in household wealth. Further, she found an inverted U-shaped relationship between years of schooling and risky sexual behavior in most countries. De Walque (2009) analyzed the HIV-education and risky sexual behavior-education gradients in these data and found that HIV prevalence was not increasing in years of schooling, condom use was increasing in years of schooling, and that multiple partnerships were increasing in years of schooling.[7] Bingenheimer (2010) analyzed data from 15 sub-Saharan African countries and found that men's control over household decision-making, male wealth, and male education, were associated with multiple partnerships. Parkhurst (2010) conducted a cross-country analysis of time trends in HIV prevalence by wealth quintile, yielding mixed findings on the association between wealth and HIV prevalence, including evidence on declining HIV prevalence among wealthier households. Finally, Fox (2012) used national household survey data from 2003 to 2007 from 16 sub-Saharan African countries and found the relationship between wealth and HIV risk to be mixed, particularly between urban and rural areas, but also that HIV risk was associated with higher community-level inequality.[8]

Despite the importance of HIV as a public health emergency in sub-Saharan Africa, contemporary micro-econometric evidence is missing about the association between both

[7] Methodological differences likely explain the (partly) divergent HIV-education gradient results across countries. Fortson (2008) primarily reported regression results using pooled samples of females and males, estimated separately by country. De Walque (2009) primarily reported regression results estimated separately for females and for males, estimated separately by country and pooled across countries. In addition, the main regression specifications in Fortson (2008) did not simultaneously control for educational attainment and for household wealth, whereas the main regression specifications in de Walque (2009) simultaneously controled for educational attainment and for household poverty (i.e. an indicator variable for earth floor, instrumented by ownership of other household consumer durables). Fortson (2008) allowed for non-linearities in the HIV-education gradient and de Walque (2009) restricted the gradient to be linear.

[8] A final approach has been systematic reviews. In a review of articles from 6 countries, Hargreaves and Glynn (2002) found evidence that HIV prevalence was correlated with educational attainment, although they concluded that the relationship may be changing over time.

schooling and material standard of living and risky sexual behavior (and HIV prevalence) in many sub-Saharan African countries. To fill this evidence gap, we update prior analyses and use more recent Demographic and Health Surveys (DHS) from 32 countries to study the relationship between schooling/household material standard of living and risky sexual behavior. The DHS include information on prior schooling attainment of adults, as well as household consumer durables. These household consumer durables are reliable measures of real material standard of living in this setting, and we use them separately and combine them into a measures of socioeconomic status (Young 2012). The data also include individual-level HIV test results and survey responses about recent sexual behavior, such as coital frequency, unprotected sex, and multiple partnerships. We regress these sexual behavior measures (and HIV status) on each of the socioeconomic status (SES) measures, while controlling for several key covariates such as ethnicity and region-country fixed effects. We allow our estimates to vary by gender of the respondent, and allow for non-monotonic relationships between risky sexual behavior/HIV risk and schooling/household consumer durables ownership.

Our analysis yields insight into how education and material standard of living both relate to behaviors that increase the likelihood of someone contracting HIV and the likelihood of being HIV positive. First, in general, reported risky sexual behavior is lower among people with more education and higher material standards of living. One notable exception is the likelihood of multiple partners for males that is both associated with higher education in males and with material standard of living. Second, when separating material standard of living into its component consumer durables, vehicle ownership typically is associated with increased risky behavior. Third, the relationship between these same measures of education and material standard of living and HIV status is more complicated. Across both genders, education and the likelihood of being HIV

positive has an inverted-U shaped pattern: primary school completion increases the likelihood of being HIV positive and secondary school completion decreases the likelihood. Therefore, in expectation those who have completed secondary school have the lowest likelihood of being HIV positive, followed by those who have not completed primary school, and those with exactly primary school completion having the highest likelihood of being HIV positive. Women in households with higher material standard of living are less likely to be HIV positive, although the magnitude of the gradient is relatively small. Men in higher material standard of living households are also less likely to be HIV positive and the magnitude of the gradient is approximately one-fifth of that for women. Taken together these results demonstrate a complex relationship between HIV and economic development, and provide descriptive evidence that reductions in HIV transmission may not directly follow from economic development more broadly, despite the role that education can play in reducing risky sexual behavior.

These findings add to several existing bodies of knowledge. They expand on the existing literature on material standard of living and risky sexual behavior in sub-Saharan Africa by providing precise estimates of the pooled association from standardized household surveys from the majority countries in this region (see previous work in de Walque 2007a, Dinkelman et al. 2007, Fortson 2008, Baird et al. 2009, de Walque 2009, Baird et al. 2011, Baird et al. 2012, Kohler and Thornton 2012, Wilson 2012, Alsan and Cutler 2013, DeNeve et al. 2015, Duflo et al. 2015). In addition, the results document that risky sexual behavior is an important mechanism underlying the negative association between material standard of living and HIV/AIDS found in several studies in this setting (e.g., Durevall and Lindskog 2012, Poulin et al. 2016). The findings contribute to a broad literature on schooling and health behavior (Cutler and Lleras-Muney 2010) and expand on the literature documenting a link between female schooling and HIV risk (de

Walque 2007a, Alsan and Cutler 2013, Duflo et al. 2015), by highlighting the role that male schooling may play as well. Our findings on the association between particular household consumer durables and risky sexual behavior builds on the existing economic evidence on the role of television and electrical power in the process determining sexual behavior (Jensen and Oster 2009, La Fererra et al. 2012, Wilson 2012, and Burlando 2015).

The rest of the paper is organized as follows. Section 2 provides a brief two-part conceptual framework. Section 3 discusses the statistical methods. Section 4 describes the data. Section 5 presents the results. Section 6 concludes.

2 Conceptual Framework

Our estimates will be the sum of a number of potentially competing effects. Instead of a formal model, we provide intuitive pathways below—first related to schooling, then to material standard of living.

2.1 Schooling and sexual behavior

One mechanism linking schooling and risky sexual behavior is exposure to HIV prevention education in schools. Because HIV prevention education is often embedded in formal schooling, those individuals who have attended more school are likely to have been exposed to more HIV prevention education (De Walque 2007a). More generally, increased schooling may increase an individual's ability to learn about and correctly implement HIV prevention strategies (Alsan and Cutler 2013, Aguero and Bharadwaj 2014) and contraceptive strategies (Rosenzweig and Schultz 1989).

Schooling may affect risky sexual behavior in other ways. First, schooling and pregnancy are often mutually exclusive because girls often drop out of school when they are pregnant (Black

et al. 2008, Baird et al. 2009, Baird et al. 2011, Baird et al. 2012, Duflo et al. 2015). Increased schooling may increase earnings and health knowledge more broadly, leading to increased life expectancy and a higher opportunity cost of risky sexual behavior (Oster 2012). Possible simultaneity of schooling and sexual behavior decisions means that factors such as tastes, relative prices, and income may jointly determine these outcomes. The association that we find will be the sum of all possible relationships.

Additionally, schooling can increase material standard of living, which can also independently relate to risky sexual behavior. We address this relationship in the next section.

In summary, available theories hypothesize that the association between schooling and risky sexual behavior may be positive, negative, possibly non-monotonic, and heterogeneous by gender.

2.2 Material standard of living and sexual behavior

At least three main causal mechanisms link material standard of living and risky sexual behavior. First, material standard of living (e.g., income) affects demand for (Dinkelman et al. 2007, Kohler and Thornton 2012, Wilson 2012) and supply of risky sex (Dinkelman et al. 2007, Baird et al. 2009, Robinson and Yeh 2011, Baird et al. 2012, Robinson and Yeh 2012, Wilson 2012). Second, one particular consumer durable, television, appears to affect sex through a mechanism other than wealth (Jensen and Oster 2009, La Ferrera et al. 2012, Burlando 2014), possibly because it affects leisure activities or exposes individuals to social values, public information campaigns, or advertising. Third, another durable, vehicles, may be associated with asymmetric information about sexual behavior outside of the household and increase the ease of having multiple partners.

Causality may operate in the opposite direction for respondents engaged in transactional sex, with increased risky sexual behavior causing higher material standard of living. This may

occur through an earnings premium for particularly risky sexual behavior (Gertler et al. 2005, Arunchalam and Shah 2013) and through a quantity effect on revenue. In addition, other factors such as government expenditures on public services may simultaneously determine material standard of living and risky sexual behavior. As with the schooling and sexual behavior analysis, the association that we find will be the net association through all these possible mechanisms.

On the whole, available theories hypothesize that the association between consumer durables ownership and risky sexual behavior may be positive, negative, and heterogeneous by gender.

3 Statistical Methods

We estimate the association between schooling/material standard of living and risky sexual behavior using multivariate ordinary least squares (OLS) regressions. Our primary regression specification is:

$$SEX_{irc} = \gamma + \beta SES_{irc} + X'_{irc}\Omega + \mu_{rc} + v_{irc} \qquad (1)$$

where SEX_{irc} is the sexual behavior of respondent i in region r in country c and SES_{irc} is the level of schooling or household material standard of living of the same respondent. X'_{irc} is a vector of individual-level controls including indicator variables for each of the survey ethnic groups and religious groups to address concerns about unobservable differences in social norms (e.g., polygamy) associated with ethnicity/religious affiliation that may be correlated with SES, as well as indicator variables for age in years, married, urban residence, and interview month. We include country-region fixed effects, μ_{rc}, to address additional concerns about unobservable

heterogeneity across countries and across regions within countries.[9] The error term, ν_{irc}, is an idiosyncratic error term.[10] We estimate separate regressions for females and for males, allowing all of the parameters in Equation (1) to vary by gender of the respondent.

The coefficient of interest, β, measures the correlation between either education or material standard of living (SES_{irc}) and sexual behavior (SEX_{irc}), net of the covariates in X'_{irc} and country-region fixed effects. Our measures of sexual behavior are sex in the last week and three measures of risky sexual behavior.

4 Data

Data are the Demographic and Health Surveys (DHS) for the 32 available sub-Saharan African countries. The DHS are standardized, national household surveys conducted in low- and-middle income countries that ask questions about demographic and socioeconomic behaviors and outcomes. For each of the 32 countries, we use the most recent standard DHS with information on risky sexual behavior that was available at the end of 2015.[11]

4.1 Sexual behavior and HIV Status

The DHS include detailed information on each respondent's sexual behavior with (up to) the last three sexual partners in the twelve months preceding the survey date and information on the total number of sexual partners in the twelve months preceding the survey date.[12] We use this

[9] This a sub-national fixed effect, e.g. the Northern region of Ghana.
[10] We estimate heteroskedastic robust standard errors.
[11] The countries and survey years are: Benin 2011, Burkina Faso 2010, Burundi 2010, Cameroon 2011, Comoros 2012, Congo 2011, Congo Democratic Republic 2013, Cote d'Ivoire 2011, Ethiopia 2011, Gabon 2012, Ghana 2014, Guinea 2012, Kenya 2014, Lesotho 2009, Liberia 2013, Madagascar 2008, Malawi 2010, Mali 2012, Mozambique 2011, Namibia 2013, Niger 2012, Nigeria 2013, Rwanda 2014, Sao Tome and Principe 2008, Senegal 2010, Sierra Leone 2013, Swaziland 2006, Tanzania 2010, Togo 2013, Uganda 2011, Zambia 2013, and Zimbabwe 2010.
[12] Behavioral outcomes (even self-reported) may be more accurate measures of HIV risk than biomarkers (Corno and de Paula 2016). The relatively low HIV transmission rate per HIV discordant unprotected coital act can lead to a large difference between latent HIV risk and actual HIV status.

information to construct an indicator variable for sex in the past week (i.e. a measure of coital frequency), as well as three measures of particularly risky sexual behaviors in the twelve months preceding the survey date. First, we construct an indicator variable equal to one if the respondent did not use a condom at last sex in the past 12 months and zero otherwise. Second, we construct an indicator variable equal to one if the respondent reported having two or more sexual partners in the past 12 months and zero otherwise. Third, we construct an indicator variable equal to one if the (male) respondent reported exchanging money for sex in the past 12 months and zero otherwise.[13]

One major concern with these data are possible measurement errors associated with self-reported risky sexual behavior. Gersovitz et al. (1998) demonstrated that in these type of "knowledge, attitudes, and practice surveys" males may over-report their risky sexual behavior and/or females may under report their risky sexual behavior. That is, differences by gender in reported risky sexual behavior in these surveys may be too large to be explained by a small subset of females with high frequency sexual activity. If self-reported behavior is uniformly overstated by a particular gender, ethnic group, or in a particular region, our extensive fixed effects will control for that. If this measurement error is uncorrelated with schooling and with household living standards, then it likely will reduce the precision of our estimates. As a complementary biomarker and a proxy for unprotected sex, we also construct an indicator variable for pregnant at any point in the twelve months preceding the survey date, which may help overcome possible underreporting, if any, of risky sexual behavior by females.[14,15]

[13] The asymmetry by gender in measures of risky sexual behavior results from the DHS only asking males about exchanging money for sex. Swaziland does not ask any respondents about exchanging money for sex.
[14] This does not address concerns about relative over-reporting by males.
[15] One concern about the risky behavior results for females and males is that these behaviors may not be particularly risky for married and older individuals. Using data from six sub-Saharan African countries, De Walque (2007b) demonstrates that two-thirds of HIV-infected couples are sero-discordant (i.e. only one individual is HIV positive)

In addition to these survey responses, we use biomarker data on HIV status for the subset of individuals who were sampled and consented to the DHS HIV testing module in the subset of DHS countries that implemented the HIV testing module.[16] We construct an indicator variable equal to one if the respondent's blood test was HIV positive and zero if the respondent's blood test was HIV negative.

Panel A of Table 1 presents descriptive statistics for these variables. Approximately one-third of the sample reported sex in the past week. More than one-half of the sample had not used a condom at last sex in the past 12 months. Although 2% of females reported multiple partnerships in the past twelve months, 16% of males reported multiple partnerships in the past twelve months.[17] Three percent of males reported exchanging money for sex. Six percent of females were HIV positive and 4% of males were HIV positive.

4.2 Socioeconomic and demographic variables

The household module of the DHS asks respondents to report household ownership of basic consumer durables—improved floor, refrigerator, television, radio, car, motorcycle, and bicycle. Since Young (2012) finds that these consumer durables data are accurate measures of consumption in sub-Saharan African countries, we follow Bollen et al. (2002), Case et al. (2004), Fortson

and in approximately one-third of these it is the female that is HIV positive. This indicates that unprotected sex within marriage is still quite risky. Nonetheless, we provide additional evidence that our results reflect truly risky behavior. We re-estimated Equation (1) using just unmarried individuals (and then just unmarried, younger individuals) and found patterns for the signs and statistical significance of the coefficient estimates nearly identical to those in Tables 3 and 4, with small-to-medium changes in magnitudes. These findings indicate that our results reflect differences in particularly risky behaviors.

[16] Not all sub-Saharan African DHS countries for which we have sexual behavior data implemented a HIV testing module. For those that implemented a HIV testing module, a subset of DHS respondents were asked to participate in the module. Approximately 80 percent of those asked agreed to participate.
In our full sample of 32 countries, the following 23 countries provide data from DHS HIV testing modules that can be linked to the main DHS data: Burkina Faso 2010, Burundi 2010, Cameroon 2011, Congo Democratic Republic 2013, Cote d'Ivoire 2011, Ethiopia 2011, Gabon 2012, Ghana 2014, Guinea 2012, Lesotho 2009, Liberia 2013, Malawi 2010, Mali 2012, Namibia 2013, Niger 2012, Rwanda 2014, Sao Tome and Principe 2008, Senegal 2010, Sierra Leone 2013, Swaziland 2006, Togo 2013, Zambia 2013, and Zimbabwe 2010.

[17] Polygamy does not appear to be driving this result. Among unmarried males, 14% report multiple partnerships in the past 12 months.

(2008), and Wilson (2016) and construct a measure from 0 to 7 that counts whether a household owns at least one of each category, where 0 indicates the household has none of the items and 7 that the household owns at least one of each item.[18] We also construct separate indicator variables for ownership of an improved floor, refrigerator, television, radio, car, motorcycle, and bicycle. The DHS further asks respondents their highest level of schooling attained. From this response we construct two schooling indicator variables: at least primary school completion (i.e. 7 or more years of schooling) and at least secondary school completion (i.e. 11 or more years of schooling). Individuals who complete secondary school (or more) will have a value of 1 for both of these variables. Panel B of Table 1 contains the descriptive statistics for schooling, total household consumer durables ownership, and several other key sociodemographic characteristics.

5 Results

We first estimate the relationship between schooling and sexual behavior and then estimate the relationship between consumer durables ownership and sexual behavior. We posit a number of potential mechanisms that could underlie these relationships. Finally, we test whether the relationships hold when considering HIV status instead of risky sexual behavior.

5.1 Schooling and sexual behavior

Table 2 presents the main regression results on the association between schooling and risky sexual behavior, estimations of Equation 1with a dependent variables as noted at the top of each column. The dependent variable in Column 1 is an indicator variable for sex in the past week. Columns 2-4 report regressions with risky sexual behaviors as measured over the 12 months preceding the

[18] We examine the robustness of our results to an alternative measure of consumer durables ownership, the DHS wealth index, in Section 5.2. One reason not to use the wealth index in our primary specification is that it is constructed separately by country and may be difficult to compare directly across countries.

interview date: indicator variables for not using a condom at last sex, multiple partnerships, and money paid for sex. The final column provides estimates for pregnancy in the past 12 months, an outcome of unprotected sex measured for females only.

The independent variables of interest measure two important schooling milestones: primary school and secondary school completion. The omitted category, or referent group, is individuals who have not completed primary school. In most countries in this study, primary school completion lasts 6 to 8 years with an additional 4 to 6 years of secondary school. These categories are not mutually exclusive. Therefore, the expected value for someone who completed secondary school relative to someone who did not complete primary school would be the sum of the coefficients on the two education regressors. The coefficient on secondary school completion shows the incremental change in association for someone who completed secondary school relative to someone who only completed primary school.

Panel A reports regression results for all females. On the whole, these estimates suggest that a higher level of schooling is associated with decreased risky sexual behavior, Columns 1, 2, and 5. For example, the point estimate on primary school completion in Column 2, -0.040 (p-value<0.01), suggests that females who complete primary school are 4 percentage points less likely to have had unprotected sex in the last twelve months. Said another way, they are approximately 11% more likely to have used a condom with their partner at last sex relative to the sample mean of 37%. As stated above, one concern is that education teaches respondents the "correct" response to these questions, and their responses do not reflect behavioral differences. In Column 5 we test for associations between education and pregnancy and find a similarly sized coefficient as for the association between education and not using a condom at last sex. One exception to this pattern of

higher education leading to less risky behavior is for multiple partnerships, Column 3, where the estimated association with schooling is a fairly precisely estimated zero.

Panel B reports regression results for males. These estimates largely suggest that a higher level of schooling is associated with decreased risky sexual behavior, Columns 1, 2, and 4. For example, the point estimate on primary school completion in Column 4, -0.004 (p-value<0.01), suggests that males who complete primary school are approximately 0.4 percentage points, or approximately 10% relative to the sample mean of 3.4%, less likely to pay money for sex. Two exceptions to this pattern of higher education being associated with less risky sexual behavior are (i) the fairly precisely estimated "zero" relationship between primary school completion and coital frequency as proxied by sex in the past week (Column 1), and (ii) an increased likelihood of multiple partnerships associated with primary school completion (Column 3).

5.2 Material standard of living and sexual behavior

Table 3 presents the main regressions results on the association between household consumer durables ownership and risky sexual behavior, using the same dependent variables as in Table 2. Recall that in this context, consumer durables ownership is a proxy for material standard of living. Panel A reports regression results for all females. First, from Column 1, more consumer durables are associated with more sex. Second, female risky sexual behavior (aside from coital frequency) is negatively associated with more household consumer durables ownership, but the magnitude of this effect is not particularly large. For example, the point estimate on total consumer durables in Column 3, -0.001 (p-value<0.01), suggests that a one unit increase in the total household consumer durables owned is associated with an approximately 0.1 percentage points, or 5%, reduction in the likelihood of multiple partners.

Panel B reports regression results for all males. The results for males are roughly similar to those for females. The main exception is that consumer durables ownership for males is associated with increased likelihood of multiple partners.

As a robustness check, Panels C and D repeat the analysis using the DHS wealth index in place of total consumer durables. The results are very similar to those in Panels A and B.

Therefore, even though schooling and consumer durables are positively correlated, their relationships with sexual behaviors are not always the same. In the next section, we explore this relationship.

5.3 Mechanisms

We now turn toward exploring the mechanisms possibly linking schooling/living standards and risky sexual behavior. First, we examine the effects of regressing the measures of risky sexual behavior on both schooling and household consumer durables ownership in the same regression. This will illuminate whether the relationships above are separate pathways or if household living standards are a mechanism by which schooling is linked to risky sexual behavior. If the relationships shown above are simply measuring the same mechanism in different ways, then the coefficient estimates on schooling should be greatly attenuated in a regression where we also control for consumer durables ownership.

Table 4 reports the results of this exercise. The coefficient estimates on schooling and on consumer durables owned are very similar to those in Tables 2 and 3, respectively, where they appeared separately, consistent with independent mechanisms linking these two variables to risky sexual behavior. Therefore, schooling relates to sexual behavior independent of the correlation with material standard of living and material standard of living relates to sexual behavior independent of the correlation with schooling.

In addition to the material standard of living channel, another possible link between schooling and risky sexual behavior is information. Table 5 explores this mechanism by re-estimating the risky behavior-schooling regressions while controlling for respondents' knowledge about HIV prevention techniques. In particular, we control for whether the respondent reported knowing that being faithful reduces HIV risk and for whether the respondent reported knowing that condom use reduces HIV risk.[19,20] The coefficient estimates on educational attainment are virtually identical to those in Table 2, suggesting that knowledge about HIV prevention techniques is not the mechanism linking schooling and risky sexual behavior.

Table 6 examines the role of particular consumer durables, by relaxing the parametric restriction that each consumer durable owned has an equal association with risky sexual behavior. We include indicator variables for each of the consumer durables, instead of using the sum as the regressor. The results suggest that having an improved floor or a refrigerator are strong predictors of reduced risky sexual behavior (columns 1, 2, and 5), with the exceptions of multiple partners (column 3). These are the two most expensive, non-mobile consumer durables. The transportation consumer durables are often associated with increased risky sexual behavior, particularly for males (Panel B, columns 1, 2, and 3), perhaps reflecting an ease of engaging in sex away from the primary residence. The two entertainment consumer durables (i.e. television and radio) are often associated with increased coital frequency (column 1), but reduced likelihood of the particularly risky sexual behaviors, perhaps reflecting broadcast information campaigns or portrayed norms.

[19] Eighty-five percent of female respondents and eighty-eight percent of male respondents report knowing that being faithful reduces HIV risk. Seventy-four percent of female respondents and eighty-two percent of male respondents report knowing that condom use reduces HIV risk.

[20] A few DHS also ask respondents whether they know that abstaining from sex is an HIV prevention technique, but this question was not asked in most of the countries in our sample.

5.4 Schooling, consumer durables, and HIV status

Does the evidence on the association between more schooling and lower levels of risky sexual behavior translate into lower likelihood of being HIV positive? Table 7 provides evidence on this question by presenting regression estimates of β for a version of Equation 1 with an indicator variable for being HIV positive as the outcome variable. Column 1 examines the association with primary and secondary school completion, without controlling for household consumer durables ownership. Column 2presents the association with household consumer durables ownership, without controlling for educational attainment. Column 3 presents the multivariate association with both sets of variables. Results for females appear in Panel A, and Panel B presents results for males.

The coefficient estimates from Columns 1 and 2 are remarkably similar to those in Column 3—simultaneously including the measures of schooling and of household living standards does not substantially effect the estimates for either set of variables. Therefore, as with risky sexual behavior, the education and material standards of living appear to have separate relationships with HIV status.

We find mixed evidence on the association between education/material standard of living and HIV status. Because of the similarity in the estimates, we focus our discussion on the specification that includes both schooling and material standard of living, Column 3, but the discussion holds for the previous columns as well. Primary school completion is associated with increased likelihood of being HIV positive (p-value<0.01), whereas secondary school completion is associated with reduced likelihood of being HIV positive (p-value<0.01). We reject that the two schooling coefficients sum to 0 in Panel A, therefore females with secondary schooling have a lower likelihood of being HIV positive than those without a primary school education

(Prob>F=0.000). In contrast, males who have completed secondary school have the same likelihood of being HIV positive as those with less than primary school completion as we fail to reject that the education coefficients sum to 0 in Panel B (Prob>F=0.369). Among females (Panel A), the likelihood of being HIV positive is slowly declining in material standard of living, with a 0.5 percentage point reduction in the likelihood of being HIV positive with a one unit increase in total consumer durables owned (p-value<0.01). Among males (Panel B), the likelihood of being HIV positive is also slowly declining in household living standards, with a 0.1 percentage point reduction in the likelihood of being HIV positive with a one unit increase in total consumer durables owned (p-value<0.01).

When considering all results together, while the increased educational attainment and material standard of living increases that occurred in sub-Saharan Africa over the past 20 years mostly reduce risky sexual behavior, the non-linear association between education and HIV indicates that reductions in HIV transmission will not be a natural by-product of development.

6 Conclusion

This paper examines the association between schooling/material standard of living and risky sexual behavior in sub-Saharan Africa. We assembled national household surveys for 32 countries in this region and used multivariate regression analysis to estimate the association between schooling/material standard of living and risky sexual behavior. Our results suggest that schooling and household consumer durables ownership largely are associated with reduced risky sexual behavior, for females and for males. An important exception to this finding is that educational attainment for males is associated with increased likelihood of multiple partnerships. We also examine whether this behavioral association translates into health outcomes by examining the

association between schooling/material standards of living and HIV status. Our results suggest that for secondary school completion for females and material standards of living for males and females are associated with reduced likelihood of being HIV positive. In contrast, primary school completion for females and males is associated with an increased likelihood of being HIV positive.

For both genders, the likelihood of being HIV positive peaks with primary school completion. Secondary school completion is associated with a lower likelihood of being HIV positive. For females those who have completed secondary school have the lowest likelihood of being HIV positive. For males the likelihood of being HIV positive is statistically indistinguishable for those with less than primary schooling and those who have completed secondary school. Further, household material standard of living is associated with reduced likelihood of being HIV positive. The education and living standard results remain when both are included in a regression.

The findings point toward several policy recommendations and directions for future research. Since male educational attainment is associated with increased likelihood of condom use and decreased likelihood of exchanging money for sex, additional male educational attainment, in addition to existing efforts to promote female educational attainment, should be considered a risk reduction policy. Implementing transfer and social protection policies that aim to increase household material standard of living may be an effective method for reducing risky sexual behavior, particularly for females and particularly if these policies focus on promoting consumer durables ownership other than vehicles. However, our analysis raises concerns about the role of primary school completion in determining multiple partnerships for males and HIV prevalence for females and males. Future research should build on our descriptive analysis by providing quasi-experimental evidence on the effects of male educational attainment and household income transfers on risky sexual behavior and HIV incidence.

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Table 1: Descriptive Statistics by Gender

Sample:	Females	Males
	(1)	(2)
Panel A: Sexual behavior and HIV/AIDS		
Sex in past week	0.34	0.35
	(0.47)	(0.48)
No condom at last sex in past 12 months	0.63	0.57
	(0.48)	(0.49)
Multiple partners in past 12 months	0.02	0.16
	(0.14)	(0.37)
Money for sex in past 12 months		0.03
		(0.18)
Pregnant in past 12 months	0.26	
	(0.44)	
HIV positive	0.06	0.04
	(0.24)	(0.20)
Panel B: Socioeconomic and demographic variables		
Primary school completion	0.39	0.51
	(0.49)	(0.50)
Secondary school completion	0.14	0.22
	(0.34)	(0.41)
Total household consumer durables	2.09	2.16
	(1.60)	(1.59)
Age	28.55	30.71
	(9.48)	(11.68)
Married	0.54	0.46
	(0.50)	(0.50)
Urban	0.36	0.37
	(0.48)	(0.48)
Observations	434,471	206,183

Notes: Data come from 32 Demographic and Health Surveys. Entries are sample means. Standard deviations are in parentheses. For "HIV positive", sample sizes are 130,092 for females and 110,075 for males. For "money", sample size is 202,027 for males. "Total household consumer durables" is the sum of indicator variables for improved floor, refrigerator, television, radio, car, motorcycle, and bicycle.

Table 2: Educational Attainment and Risky Sexual Behavior

Dependent variable:	Sex in past week	No condom at last sex in past 12 months	Multiple partners in past 12 months	Money for sex in past 12 months	Pregnant in past 12 months
	(1)	(2)	(3)	(4)	(5)
Panel A: Females					
Primary school completion	-0.013***	-0.040***	0.000		-0.049***
	(0.002)	(0.002)	(0.001)		(0.002)
Secondary school completion	-0.016***	-0.053***	0.000		-0.050***
	(0.002)	(0.002)	(0.001)		(0.002)
Observations	434,471	434,471	434,471		434,471
Panel B: Males					
Primary school completion	0.001	-0.035***	0.011***	-0.004***	
	(0.002)	(0.002)	(0.002)	(0.001)	
Secondary school completion	-0.022***	-0.052***	0.001	-0.008***	
	(0.003)	(0.003)	(0.002)	(0.001)	
Observations	206,183	206,183	206,183	202,027	

Notes: Data come from 32 Demographic and Health Surveys (DHS). "Primary school completion" is an indicator variable equal to one if the respondent completed at least 7 years of schooling and zero otherwise. "Secondary school completion" is an indicator variable equal to one if the respondent completed at least 11 years of schooling and zero otherwise. All specifications include the full set of indicator variables for age, urban, married, interview month, ethnicity, religion, and country-specific region. Parameters estimated using ordinary least squares (OLS) regression. Robust standard errors are in parentheses.

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.

Table 3: Household Consumer Durables Ownership and Risky Sexual Behavior

Dependent variable:	Sex in past week	No condom at last sex in past 12 months	Multiple partners in past 12 months	Money for sex in past 12 months	Pregnant in past 12 months
	(1)	(2)	(3)	(4)	(5)
Panel A: Females, consumer durables					
Total consumer durables	0.004***	-0.009***	-0.001***		-0.018***
	(0.000)	(0.000)	(0.000)		(0.000)
Observations	431,368	431,368	431,368		431,368
Panel B: Males, consumer durables					
Total consumer durables	0.001	-0.013***	0.008***	-0.001***	
	(0.001)	(0.001)	(0.001)	0.000	
Observations	204,599	204,599	204,599	200,470	
Panel C: Females, wealth index					
Wealth index	0.002***	-0.013***	0.000		-0.026***
	(0.001)	(0.001)	(0.000)		(0.001)
Observations	431,368	431,368	431,368		431,368
Panel D: Males, wealth index					
Wealth index	-0.005***	-0.020***	0.007***	-0.001***	
	(0.001)	(0.001)	(0.001)	0.000	
Observations	204,599	204,599	204,599	200,470	

Notes: Data come from 32 Demographic and Health Surveys (DHS). "Total household consumer durables" is the sum of indicator variables for improved floor, refrigerator, television, radio, car, motorcycle, and bicycle. "Wealth index" is the DHS wealth index. All specifications include the full set of indicator variables for age, urban, married, interview month, ethnicity, religion, and country-specific region. Parameters estimated using ordinary least squares (OLS) regression. Robust standard errors are in parentheses.
*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.

Table 4: Educational Attainment, Household Consumer Durables Ownership, and Risky Sexual Behavior

Dependent variable:	Sex in past week	No condom at last sex in past 12 months	Multiple partners in past 12 months	Money for sex in past 12 months	Pregnant in past 12 months
	(1)	(2)	(3)	(4)	(5)
Panel A: Females					
Primary school completion	-0.016***	-0.037***	0.001		-0.042***
	(0.002)	(0.002)	(0.001)		(0.002)
Secondary school completion	-0.020***	-0.050***	0.001		-0.041***
	(0.002)	(0.002)	(0.001)		(0.002)
Total consumer durables	0.007***	-0.004***	-0.001***		-0.013***
	(0.001)	0.000	0.000		(0.000)
Observations	431,368	431,368	431,368		431,368
Panel B: Males					
Primary school completion	0.000	-0.032***	0.007***	-0.004***	
	(0.002)	(0.002)	(0.002)	(0.001)	
Secondary school completion	-0.023***	-0.048***	-0.004	-0.008***	
	(0.003)	(0.003)	(0.002)	(0.001)	
Total consumer durables	0.002***	-0.007***	0.008***	-0.001*	
	(0.001)	(0.001)	(0.001)	0.000	
Observations	204,599	204,599	204,599	200,470	

Notes: Data come from 32 Demographic and Health Surveys (DHS). "Primary school completion" is an indicator variable equal to one if the respondent completed at least 7 years of schooling and zero otherwise. "Secondary school completion" is an indicator variable equal to one if the respondent completed at least 11 years of schooling and zero otherwise. "Total household consumer durables" is the sum of indicator variables for improved floor, refrigerator, television, radio, car, motorcycle, and bicycle. All specifications include the full set of indicator variables for age, urban, married, interview month, ethnicity, religion, and country-specific region. Parameters estimated using ordinary least squares (OLS) regression. Robust standard errors are in parentheses.

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.

Table 5: Educational Attainment, HIV Prevention Knowledge, and Risky Sexual Behavior

Dependent variable:	Sex in past week	No condom at last sex in past 12 months	Multiple partners in past 12 months	Money for sex in past 12 months	Pregnant in past 12 months
	(1)	(2)	(3)	(4)	(5)
Panel A: Females					
Primary school completion	-0.016***	-0.043***	-0.001		-0.049***
	(0.002)	(0.002)	(0.001)		(0.002)
Secondary school completion	-0.017***	-0.054***	0.000		-0.049***
	(0.002)	(0.002)	(0.001)		(0.002)
HIV knowledge controls					
Knows being faithful reduces HIV risk	YES	YES	YES		YES
Knows using condom reduces HIV risk	YES	YES	YES		YES
Observations	398,834	398,834	398,834		398,834
Panel B: Males					
Primary school completion	-0.003	-0.039***	0.008***	-0.004***	
	(0.002)	(0.002)	(0.002)	(0.001)	
Secondary school completion	-0.023***	-0.052***	-0.001	-0.008***	
	(0.003)	(0.003)	(0.002)	(0.001)	
HIV knowledge controls					
Knows being faithful reduces HIV risk	YES	YES	YES	YES	
Knows using condom reduces HIV risk	YES	YES	YES	YES	
Observations	200,653	200,653	200,653	196,532	

Notes: Data come from 32 Demographic and Health Surveys (DHS). "Primary school completion" is an indicator variable equal to one if the respondent completed at least 7 years of schooling and zero otherwise. "Secondary school completion" is an indicator variable equal to one if the respondent completed at least 11 years of schooling and zero otherwise. "Knows being faithful reduces HIV risk is an indicator variable equal to one if the respondent identified being faithful as a HIV prevention strategy" and zero otherwise. "Knows using condom reduces HIV risk" is an indicator variable equal to one if the respondent identified using a condom as a HIV prevention strategy and zero otherwise. All specifications include the full set of indicator variables for age, urban, married, interview month, ethnicity, religion, and country-specific region. Parameters estimated using ordinary least squares (OLS) regression. Robust standard errors are in parentheses.

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level

Table 6: Heterogeneity in Association Between Consumer Durables Ownership and Risky Sexual Behavior

Dependent variable:	Sex in past week	No condom at last sex in past 12 months	Multiple partners in past 12 months	Money for sex in past 12 months	Pregnant in past 12 months
	(1)	(2)	(3)	(4)	(5)
Panel A: Females					
Floor	-0.012***	-0.020***	0.001***		-0.031***
	(0.002)	(0.002)	(0.001)		(0.002)
Refrigerator	-0.024***	-0.052***	-0.001		-0.029***
	(0.002)	(0.002)	(0.001)		(0.002)
Television	0.000	-0.013***	-0.002***		-0.027***
	(0.002)	(0.002)	(0.001)		(0.002)
Radio	0.026***	0.008***	-0.001*		-0.013***
	(0.001)	(0.001)	0.000		(0.001)
Car	-0.002	-0.013***	-0.002**		-0.020***
	(0.003)	(0.003)	(0.001)		(0.003)
Motorcycle	0.021***	0.014***	-0.001		0.006***
	(0.002)	(0.002)	(0.001)		(0.002)
Bicycle	0.014***	0.005***	-0.001**		-0.005***
	(0.002)	(0.002)	0.000		(0.002)
Observations	431,368	431,368	431,368		431,368
Panel B: Males					
Floor	-0.018***	-0.030***	0.005**	-0.002	
	(0.002)	(0.002)	(0.002)	(0.001)	
Refrigerator	-0.010***	-0.031***	-0.009***	-0.002	
	(0.003)	(0.003)	(0.003)	(0.001)	
Television	0.004	-0.013***	0.004	-0.003**	
	(0.003)	(0.003)	(0.002)	(0.001)	
Radio	0.004**	-0.007***	0.005***	0.000	
	(0.002)	(0.002)	(0.002)	(0.001)	
Car	0.003	-0.010***	0.016***	0.002	
	(0.004)	(0.004)	(0.004)	(0.002)	
Motorcycle	0.026***	0.008***	0.052***	0.000	
	(0.003)	(0.003)	(0.003)	(0.001)	
Bicycle	0.005**	0.002	0.000	-0.002**	
	(0.002)	(0.002)	(0.002)	(0.001)	
Observations	204,599	204,599	204,599	200,470	

Notes: Data come from 32 Demographic and Health Surveys (DHS). "Floor", "refrigerator", "television", "radio", "car", "motorcycle", and "bicycle" are indicator variables equal to one if the respondent's household owns that durable and zero otherwise. All specifications include the full set of indicator variables for age, urban, married, interview month, ethnicity, religion, and country-specific region. Parameters estimated using ordinary least squares (OLS) regression. Robust standard errors are in parentheses.

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.

Table 7: Educational Attainment, Household Consumer Durables Ownership, and HIV Status

Dependent variable:	HIV positive		
	(1)	(2)	(3)
Panel A: Females			
Primary school completion	0.008***		0.011***
	(0.002)		(0.002)
Secondary school completion	-0.035***		-0.032***
	(0.003)		(0.003)
Total consumer durables		-0.005***	-0.005***
		(0.001)	(0.001)
P>F(Primary + Secondary = 0)	0.000		0.000
Observations	130,092	129,247	129,247
Panel B: Males			
Primary school completion	0.008***		0.008***
	(0.002)		(0.002)
Secondary school completion	-0.010***		-0.009***
	(0.002)		(0.002)
Total consumer durables		-0.001***	-0.001***
		(0.001)	(0.001)
P>F(Primary + Secondary = 0)	0.369		0.970
Observations	110,075	109,284	109,284

Notes: Data come from 32 Demographic and Health Surveys (DHS). "Primary school completion" is an indicator variable equal to one if the respondent completed at least 7 years of schooling and zero otherwise. "Secondary school completion" is an indicator variable equal to one if the respondent completed at least 11 years of schooling and zero otherwise. "Total household consumer durables" is the sum of indicator variables for improved floor, refrigerator, television, radio, car, motorcycle, and bicycle. All specifications include the full set of indicator variables for age, urban, married, interview month, ethnicity, religion, and country-specific region. Parameters estimated using ordinary least squares (OLS) regression. Robust standard errors are in parentheses.

*** Significant at the 1 percent level, ** Significant at the 5 percent level, * Significant at the 10 percent level.