HIV/AIDS Prevention Knowledge: An Age-Period-Cohort Analysis of Trends in Malawi from 1992 to 2010

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Abstract

This paper explores how individuals update their knowledge of HIV/AIDS over time in Malawi, a high HIV prevalence country in sub-Saharan Africa. HIV knowledge uptake could potentially be operating across periods and birth cohorts. Individuals of all ages may be becoming more informed about HIV at a relatively equal pace from year to year, implying a period effect. Alternatively, individuals may be unlikely to change their beliefs and update their knowledge, but rather, younger birth cohorts may be more likely to accept new knowledge, implying a cohort effect. The goal of this paper is to address whether HIV knowledge is changing over time in Malawi more strongly by period of time or by birth cohort using a cross-classified random effects age-period-cohort (APC) method developed by Yang and Land. I find a slight period effect in awareness of whether condoms and abstinence are effective means of reducing HIV/AIDS risk, meaning that knowledge of effective HIV prevention tactics has increased over time. Contrary to expectations, I do not find a strong cohort trend in increased HIV prevention knowledge, meaning that this increase in knowledge over time is not differentially disseminated or accepted according to the age of an individual at a certain point in time. However, in general, knowledge of HIV prevention tactics increases with age.

Introduction

Reducing the sexual transmission of HIV has remained a strong goal throughout the history of the epidemic, and nowhere more so than in sub-Saharan Africa where the epidemic has affected so many millions of people. The result has been a myriad of prevention methods and officially prescribed recommendations, as well as innumerous programs designed to educate and assist individuals in protecting themselves and their partners against the risk of HIV. In recognition that the journey between the availability of HIV prevention knowledge and safer sexual behavior is not simple or straightforward, this study looks beneath the surface of behavioral interventions by examining how basic knowledge of HIV/AIDS prevention behavior has changed over time in Malawi. Malawi has been heavily affected by the HIV epidemic, with nearly one million people currently living with HIV/AIDS, although steady progress has been made in reducing the scope of the epidemic over time. An estimated 10.6 percent of adults between 15 and 49 years of age are currently HIV positive, down from a peak of 16.4 percent of the adult population in 1999 (UNAIDS 2012a).

When thinking about how knowledge is disseminated, several different scenarios can be envisioned. First, as more information about HIV/AIDS has become available in Malawi, individuals of all ages may become more informed about what HIV is, how the disease is transmitted and how one can prevent or reduce the chances of becoming infected. This is essentially a description of a period effect, in which people of all ages are updating their HIV related knowledge at a relatively equal pace to one another over time. A second scenario that may play out is that as more information about HIV/AIDS has become available, younger people who grow up in this new environment with greater information are more likely to believe the information and take more precautions as they become sexually active. At the same time, older generations may be more reticent to change beliefs and behaviors, especially when these changes in beliefs are tied to culturally defined processes of sexuality and marriage. This describes a cohort effect in which individuals do not change their beliefs, but rather, different birth cohorts develop a different set of beliefs. When thinking about the possible differences in knowledge according to period of time and birth cohort, it is also important to simultaneously control for age since knowledge, in general, most likely also increases with age. Due to the statistical impossibility of simultaneous estimation of the effects of age, period and cohort in a single analysis, this has been a longstanding empirical challenge. However, recent methodological developments by Yang and Land (2006) provide an improved means of simultaneously measuring the relative importance of period versus cohort effects while controlling for age within the same model, a cross-classified random effects models.

Looking at data spanning from 1992 to 2010 in Malawi, I examine whether changes in HIV knowledge over this time period are more attributable to age, period or cohort effects. In reality, age, period and cohort effects are probably all operating to varying degrees and they are all affecting changes in a broad range of topics concerning HIV, including knowledge and knowledge uptake. The general goal of this paper is to address the following questions:

- Is HIV/AIDS prevention knowledge changing over time?

- Are these changes a reflection of the age structure of a population, period effects or cohort effects?

In addition to providing important information about the best age group to focus on in provision of HIV prevention and educational programs, this paper also provides interesting theoretical evidence about how knowledge uptake changes within individuals over the life course, as well as within a society over time. Furthermore, this paper engages a theoretical debate within demography about the relative importance of periods versus cohorts in explanations of social change. Below I discuss in more detail how this paper contributes to HIV research and policy implications, demographic debates of the relative importance of period versus cohort effects, and sociological theories of ideological change and shifts in normative behavior over time.

Background

Existing HIV research on the uptake of basic knowledge of HIV in African countries mostly consists of descriptive reports of population level changes in knowledge and beliefs (UNAIDS 2012a; UNAIDS 2012b; World Health Organization 2011). The availability of thorough HIV prevention information in Malawi was limited early in the history of the epidemic, due to financial, social and political barriers. Prior to 1994, public discussion of sexual matters was censored by President Hastings Banda, due to his conservative religious views (AVERT 2012) . It wasn't until after President Banda relinquished control in 1994 that the public was able to openly discuss HIV and the new president acknowledged the scope of the epidemic in Malawi. After an initial adjustment period, the government response to AIDS in Malawi intensified. In 2000 a five-year National Strategic Framework to combat AIDS was implemented, the National AIDS Commission was established in 2001 and the first National AIDS policy was implemented in 2004 (AVERT 2012) . Many international organizations also implemented large HIV prevention programs. For example, the BRIDGE program sponsored by the U.S. Agency for International Development (USAID), was initiated in 2003 and designed to encourage the adoption of HIV prevention behaviors (Limaye et al. 2009) . Since the implementation of these and many other prevention and treatment programs, much progress has been made in terms of general public knowledge, reductions in new incidences of HIV/AIDS and a lower proportion of HIV positive individuals in the population overall (Bowie 2007; Limaye et al. 2009; UNAIDS 2012a) . Increases in basic HIV prevention knowledge have slowed significantly in recent years in Malawi and there is a recognized need for more effective transmission and acceptance of HIV prevention tactics (Bowie 2007; UNAIDS 2012a) .

To my knowledge, there have not been any in-depth, multivariate analyses of long-term time trends in changes in HIV knowledge uptake. Furthermore, there have not been any studies focusing on the relative importance of cohort versus period effects in changing patterns of knowledge uptake. The current study will not only be an interesting addition to research on HIV knowledge acquisition, but could also be interesting to policy makers and HIV program administrators. The policy implications of this may be particularly interesting because of the information it will give in terms of which age groups are most important to consider when focusing on provision of HIV knowledge and prevention programs. For example, if knowledge changes within individuals over time, regardless of birth cohort, then provision of information and HIV education to all age groups is still a relevant and necessary aspect of HIV prevention efforts. However, if knowledge uptake largely changes only among younger birth cohorts who grow up with greater exposure to this new information, then focusing HIV education within younger age groups may be the most cost effective and efficient means of changing uptake of HIV knowledge.

Although the idea of knowledge acquisition may seem to be an entirely transparent and fluid process of those with information, disseminating it to those without information, information of this sort may not be readily accepted in its westernized medicinal articulation in such a different cultural environment. Given that data from the 2010 DHS show that 12 percent of women believe that a healthy looking person cannot have AIDS, (down from 19 percent in 1992), there is clearly a breakdown in either (1) provision of knowledge, (2) belief in knowledge gained or (3) ability to assess the accuracy of competing information given from multiple sources. In either of the last two scenarios, ideational change and the cultural transmission of information is an important element to consider. In this way, the current analysis of changes in knowledge reflects more generalized social processes of changes in ideas and norms. There has been much sociological theory that has focused on how ideational change occurs in society and how normative behavior is transformed over time (Blau 1967; Habermas 1985; Habermas 1996; Lesthaeghe and Surkyn 1988; Schutz 1951; Schutz 1967) . This line of theory provides a means of delving deeper into the elements involved in making behavioral changes. More specifically, in analyzing how knowledge of HIV and HIV prevention tactics change over time, I provide a unique perspective by which to examine broader changes in social patterns of beliefs and accepted knowledge. In addition to providing important practical information about the best age groups to focus HIV prevention and educational programs, this paper also provides interesting theoretical evidence about how knowledge uptake changes within individuals over the life course, as well as within a society over time.

Another way to view this theoretical debate of how social change occurs over time is through the demographic debate of the relative importance of period versus cohort effects in explanations of demographic and social change. Ryder (1965) made a strong argument for the importance of a cohort perspective for analyzing fertility and fertility change over time. He pushed for more focus on cohorts by emphasizing that cohorts are different from each other by the changing context in which they grow up and in which they develop. Specifically, birth cohorts are subject to unique education regimes or policies, peer group socialization and idiosyncratic historical experiences (Ryder 1965). Similar cohort effects have also been articulated and measured for mortality patterns (Hobcraft et al. 1982; Preston and Wang 2006) . However, other literature has argued the importance of period effects and the relative unimportance of cohort effects (Bhrolchain 1992). Bhrolcháin (1992) argues that the emphasis within demography on cohort change, especially in regard to fertility, is unnecessary at best and misleading at worst.

These debates do not necessarily imply that either period or cohort effects are not important, but rather they are arguments as to which of the two is more important for a specific demographic process. Many of these arguments were articulated in the context of limited data and methodological resources due to the identification problem created when attempting to simultaneously model age, period and cohort in a single analysis. Because it is necessary to control for the effect of age in order to accurately estimate the relative contribution of period versus cohort effects, all three elements must be included in an analysis to avoid spurious results (Mason and Winsboro.Hh 1973). The exact linear dependency of the three makes this a longstanding empirical challenge. The arguments described above about choosing between period versus cohort effects center on the scenario in which one must choose one or the other as an empirical focus while relying largely on theoretical justifications for such choices. The ideal would be to have a means of measuring the relative importance of period versus cohort within the same empirical model. Several ways to work around this problem and produce estimates of have been developed in the past, most of which rely on population level occurrence rates of an event or aggregate population-level data (Hobcraft et al. 1982; Mason and Winsboro.Hh 1973; Yang et al. 2004). The most recent methodological development to provide a solution to the identification problem is a cross-classified random effects model (CCREM), or a hierarchical Age-Period-Cohort (HAPC) model by Yang and Land (2006; 2008). Yang and Land (2006; 2008) focus on a solution to the identification problem for application on individual level, repeated cross-sectional data. Using this method I am able to simultaneously estimate period and cohort changes in HIV knowledge in Malawi over time.

Data and Methods

The cross-classified random effects APC model specified by Yang and Land (2006; 2008) requires multiple cross-sectional surveys with large sample sizes, distributed across multiple birth cohorts. Demographic and Health Surveys (DHS) gather information about population, health, nutrition, HIV and other topics in developing countries all over the world. DHS data are repeated, cross-sectional surveys that are designed to be representative of the population in each country. I focus on DHS surveys in Malawi because Malawi is one of only a handful of sub-Saharan African countries with the adequate number of repeated waves of DHS, as required for HAPC models. DHS surveys were conducted in Malawi in 1992, 1996, 2000, 2004 and 2010, sampling from adults between 15 and 54 years of age. The data were merged between all five DHS Malawi waves to yield a single sample representing five distinct periods of time, spanning across 18 years. Synthetic birth cohorts were constructed from the combined cross-sectional data, ranging from 1937 to 1995. The total sample size is 72,807 for all five combined waves of DHS Malawi data.

Each DHS Malawi wave asked a varying set of questions about HIV/AIDS knowledge. The most consistent questions across waves serve as the outcomes in the current analysis.[1] Respondents were asked, "What can a person do to avoid getting AIDS?" followed by a set of choices from which respondents could select all that apply. Among these choices were abstain

[1] Several other questions about HIV/AIDS knowledge were repeated across DHS Malawi waves, although some inconsistency in the way the questions were asked exist, requiring additional examination and treatment before valid comparisons across waves should be attempted. I hope to include some of these additional questions as outcomes in future drafts of the paper. Some of the additional variables are as follows: (1) Is it possible for a healthy looking person to have the AIDS virus, (2) Can AIDS be transmitted from mother to child, and (3) Is it possible to get the AIDS virus from mosquito or other insect bites?

from sex and use condoms, which serve as the two dichotomous measures of HIV prevention knowledge used as outcomes in this analysis. This question was asked in exactly the same form across all surveys used in this analysis. If respondents answered “no” to the previous question, “Have you ever heard of an illness called AIDS?” they are not asked the other questions about HIV/AIDS knowledge. This restriction is greatest in the first DHS Malawi survey in 1992, but even in this year approximately 96 percent of respondents still answered yes, only reducing the overall 1992 sample size by four percent. The overall sample size for outcomes in the current analysis using the five year combined DHS Malawi data is still 99 percent of the whole DHS sample.

In addition to these outcomes, several other important control variables are included in the analysis. There is wide variation in both reports of HIV prevention knowledge and HIV status between men and women, rural and urban locations and between regions in Malawi (UNAIDS 2012a). A dummy variable for whether the respondent is male or female is included, as well as a dummy for rural versus urban residence. A categorical variable is included for region of the country, as either north, south or central. Finally, because education level may be directly related to knowledge acquisition, a categorical variable for level of education is also included in the analysis, specifying whether a respondent has no education, some primary school, has completed primary school, some secondary school, has completed secondary school, or has education beyond secondary school.

In order to implement CCREM’s in the estimation of age, period and cohort effects on outcomes of interest, several important adjustments must be made to the measures of age, period and cohort in order to overcome the identification problem created by simultaneous estimation of the three (Yang and Land 2006; Yang and Land 2008). When age, period and cohort are measured in the same time intervals, there is an exact linear dependency between these three elements (period – age = birth cohort). However, by using repeated cross-sectional data, the identification problem is broken after construction of synthetic birth cohorts across multiple periods of observation. Because individuals born in any given year are distributed across several different survey years, variation exists between periods of observation and birth cohorts in merged, repeated cross-sectional data. Table 1 illustrates the distribution of individuals from the same birth cohort, across different periods of observation. Birth cohorts are then grouped into five-year intervals so that the respondent’s age can no longer be exactly determined by their year of birth. Grouping those born within five years of one another is theoretically justifiable because those who are born in close time proximity to one another still experience similar life events at the same periods of historical time. The first and last birth cohorts include births across a slightly wider range of years in order to ensure adequate sample size within each birth cohort, as well as to ensure that each birth cohort is distributed between at least two periods of observation. The "1940" birth cohort includes births from 1937 to 1944, the "1985" birth cohort includes births from 1985 to 1995, while the remaining birth cohorts represent five-year intervals in the years between (i.e. 1945-1949, 1950-1954, …, 1980-1984). Also, the 2004 DHS survey was actually implemented over a two-year time span, with some respondents interviewed in 2004 and others in 2005. I take advantage of this additional variation in period of observation by estimating period effects for both 2004 and 2005, increasing the total number of periods of observation to six in total. Age is modeled as a quadratic in order to transform its relationship to period and cohort into one that is non-linear, as suggested in previous studies addressing the APC identification problem (Mason and Winsboro.Hh 1973; Yang and Land 2006) . Age is also centered on the grand mean (28.3 years) for ease of interpretation, as well as to reduce the association between age and age squared.

I then implement a hierarchical age-period-cohort logistic model using SAS PROC GLIMMIX. Age estimates are fixed effects and periods and birth cohorts are estimated as random effects. Fixed effects estimations of periods and cohorts are also possible, while using a quadratic function of age and five-year birth cohorts to correct for the APC identification problem. However, this would limit the estimation of period and cohort effects to being fixed and may result in collinearity and downwardly biased standard errors (Yang and Land 2008). To adjust for the probability that some of the effects are not fixed, but rather, vary randomly according to period of time and birth cohort, Yang and Land (2006;2008) suggest the use of a hierarchical or multilevel mixed-effects cross classified regression model (Raudenbush and Bryk 2002; Snijders and Bosker 1999). This specification basically assumes that individuals are nested within their birth cohort, as well as their period of observation. Individual level data comprise the level one observations in the hierarchical model, and the cohorts and periods make up the level two observations. Periods and cohorts are cross-classified, meaning that neither are nested within the other but rather, they represent two different level two variables (for more details see Raudenbush and Bryk 2002, and Snijders and Bosker 1999). This specification allows the level-1 intercepts to vary randomly by cohort and period, but not the level-1 slopes. The specification of variability in knowledge of abstinence/ condom use as a means of preventing the transmission of HIV/AIDS is as follows:

Level-1 model:

$$Knowledge_{ijk} = \beta_{0jk} + \beta_1 Age_{ijk} + \beta_2 Age_{ijk}^2 + \boldsymbol{\beta_x X_{ijk}} + e_{ijk}$$
$$\text{with } e_{ijk} \sim N(0, \sigma^2) \qquad (1)$$

Level-2 model:

$$\beta_{0jk} = \gamma_0 + u_{0j} + v_{0k}$$
$$\text{with } u_{0j} \sim N(0, \tau_u), v_{0k} \sim N(0, \tau_v) \qquad (2)$$

Combined model:

$$Knowledge_{ijk} = \gamma_0 + \beta_1 Age_{ijk} + \beta_2 Age_{ijk}^2 + \boldsymbol{\beta_x X_{ijk}} + u_{0j} + v_{0k} + e_{ijk} \qquad (3)$$

where $Knowledge_{ijk}$ is knowledge of abstinence or condom use as a means of reducing HIV/AIDS risk for the *i*th participant for $i = 1, \ldots, n_{jk}$ individuals in the *j*th period of observation for $j = 1, \ldots, J$ periods and the *k*th birth cohort for $k = 1, \ldots, K$ cohort, modeled as a function of age, age-squared and a vector of other control variables, $\boldsymbol{\beta_x X_{ijk}}$, including respondent's gender, type and region of residence, and the respondent's education level. β_{0jk} is the intercept, or the mean individual knowledge for a respondent surveyed in year *j* and belonging to birth cohort *k*. β_1, β_2 and $\boldsymbol{\beta_x}$ are the level-1 fixed effects and e_{ijk} is the random individual effect which is assumed to be normally distributed, with mean zero and within-cell variance σ^2. The model intercept, or grand mean of the outcome is γ_0**.** The residual random effect of period *j*, averaged over all birth cohorts is u_{0j}, which is assumed normally distributed with mean zero and variance τ_u. The residual random effect of cohort *k*, averaged over all periods of observation is v_{0k}, which is assumed normally distributed with mean zero and variance τ_v.

Results

Descriptive statistics are shown in table 2. There are a total of ten birth cohorts and six periods of observation used in this analysis. The remaining descriptive statistics are for the aggregate across all periods and years of birth. In the sample, 69 percent of respondents said that a person can abstain from sex in order to avoid getting the AIDS virus and 59 percent said that a person can use condoms in order to avoid getting the AIDS virus. The mean age of the sample is 28.3 years, varying between 15 and 54 years of age. The sample is 24 percent male and 80 percent of the sample comes from rural Malawi. Approximately 47 percent of the sample comes from the southern part of Malawi, 35 percent from the central area and 18 percent from the north. Educational attainment is widely distributed, with 19 percent having no education, 54 having some primary school education, only 10 percent completing primary school and 5 percent completing secondary school.

The results of the CCREMs for the two outcomes are reported in table 3. The overall significance of period and cohort effects is demonstrated through the variance components. For both outcomes, there are weak period trends in increased HIV knowledge, net of cohort and age effects, although these trends are not quite statistically significant (p-value = 0.057 for both outcomes). Contrary to expectations, knowledge of neither abstinence nor condom use as a prevention method shows an overall significant cohort trend in knowledge (p-value = 0.157 and 0.071, respectively), net of period and age effects. Knowledge of both abstinence and condom use as an HIV/AIDS prevention method increases significantly with age while controlling for period and cohort effects.

The random effects from table 3 are transformed into predicted probabilities in figure 1 and figure 2, holding all other variables at their means. Figure 1 shows the trends in age, period and cohort effects on knowledge of abstinence as a means of protecting against HIV/AIDS. The plot for change in knowledge according to birth cohort shows little variation. The predicted probability of knowing that abstinence is an effective means of preventing HIV/AIDS is around 69 to 72 percent for all birth cohorts between 1940 and 1985. The period trend in knowledge of abstinence as a means of HIV/AIDS prevention is quite different, showing an increase in knowledge from 1992 to 2010. Most notably, there was a huge increase in awareness between the years 1996 and 2000, changing from around 27 percent of adults in 1996 knowing that abstinence is an effective means of avoiding HIV/AIDS, to almost 70 percent of adults in 2000. The increase in abstinence as a prevention method after the year 2000 continued to be steady but modest, reaching a high of about 80 percent of adults in 2010 being aware of abstinence as an effective means of avoiding HIV/AIDS. There is also a steady increase with age in awareness of abstinence as a way to avoid getting HIV/AIDS. Around 68 percent of 15 year olds in Malawi know that abstinence can help a person avoid getting HIV/AIDS, which steadily increases to around 77 percent of 54 year olds being aware of abstinence as an effective prevention strategy.

Figure 2 graphs the trends in age, period and cohort effects on knowledge of condom use as an effective means of avoiding HIV/AIDS. Similar to the results for knowledge of abstinence as a prevention method, trends in knowledge of condom use as a prevention method across birth cohorts show little variation. The predicted probability of knowing that condoms reduce HIV/AIDS risk wavers between 58 to 64 percent across birth cohorts, with a slight decrease in the youngest birth cohort. The period trend in knowledge of condoms as a means of HIV/AIDS prevention increases significantly over time from only approximately 15 percent of the sample being aware of the benefits of condoms in 1992 and nearly 75 percent having knowledge of condoms as an effective means of preventing HIV/AIDS risk by the year 2010. There is again a large jump between 1996 and 2000, from 29 percent awareness to almost 60 percent awareness of the benefits of condoms. There is also a steady but quite modest increase in knowledge of condoms as a prevention tactic over age, moving from 59 percent awareness among 15 year olds and approximately 63 percent awareness by the age of 54 in Malawi.

Discussion and Conclusion

Knowledge of both abstinence and condom use as a means of avoiding HIV/AIDS has predominantly increased in Malawi through period effects, meaning that HIV prevention knowledge has increased over time in Malawi, regardless of age and birth cohort. I expected to find period effects of HIV knowledge in Malawi, but I also expected to find equal, if not stronger, cohort effects on knowledge acquisition and uptake. This did not hold true in the data, with little evidence of trends in HIV prevention knowledge according to birth cohort. Although individuals did, in general, know more as they got older, this increase with age in prevention knowledge did not differ according to year of birth.

There were large increases in period effects on knowledge of abstinence and condom use as a means of avoiding HIV/AIDS in the late 1990's. This is consistent with the time frame during which prevention knowledge became available and began to be widely disseminated within Malawi (AVERT 2012). The overall level of awareness in abstinence versus condom use as a means of avoiding HIV/AIDS differed slightly, with abstinence being cited as a means of avoiding HIV/AIDS about 15 percent more often in 1992 and about 5 percent more often by 2010. This result is not entirely surprising. In Malawi there is a fair amount of skepticism, uncertainty and misconception about the effectiveness of condoms (Bowie 2007). Because of this, we would expect the acceptance of condoms to lag slightly behind acceptance of other means of preventing HIV.

In many ways, the overall results found in this analysis are quite encouraging. I expected to find a large cohort effect in increased prevention knowledge largely because of the Malawian context in which individuals are updating knowledge based on western medical information, which may not be in line with this very different cultural context. The cultural context would imply that updating beliefs about HIV to western medical standards would be done reluctantly, if at all, for older cohorts whereas younger individuals who were exposed to these ideas from a younger age might be more open to accepting new beliefs about the disease. Any resistance on the part of individuals in Malawi to change their beliefs about disease and illness would have been reflected in weaker period effects relative to cohort effects. The fact that birth cohort trends in HIV risk prevention knowledge were not found indicates that regardless of age when HIV prevention information became available on a large scale to the general population in Malawi, Malawians received the information in a way that was accepted and embraced by a large part of the population. Ultimately, this is a success on the part of organizations seeking to communicate information that will benefit the recipients and decrease the spread of HIV.

References

AVERT. 2012. "HIV & AIDS In Malawi." *Averting HIV and AIDS, International HIV & AIDS Charity* 2013(March 10):http://www.avert.org/aids-malawi.htm.

Bhrolchain, M.N. 1992. "Period Paramount? A Critique of the Cohort Approach to Fertility." *Population and Development Review* 18(4):pp. 599-629.

Blau, P.M. 1967. *Exchange and Power in Social Life*. 2nd ed. New York, NY: Wiley and Sons.

Bowie, C. 2007. "Policy Review - The Malawi HIV Prevention Policy." *College of Medicine University of Malawi, Center for Reproductive Health Division of Community Health* :http://www.medcol.mw/commhealth/publications/HIV%20Prevention%20Brochure%20a.pdf.

Habermas, J. 1996. "Civil Society, Public Opinion, and Communicative Power." Pp. 359-387 in *Between Facts and Norms: Controbutions to a Discourse Theory of Law and Democracy*Anonymous . Malden, MA: Polity Press.

-. 1985. "Remarks on the Concept of Communicative Action." Pp. 151-173 in *Social Action*, edited by G. Seebass and R. Tuomela. Boston, MA: D. Reidel Publishing Company.

Hobcraft, J., J. Menken, and S. Preston. 1982. "Age, Period, and Cohort Effects in Demography: A Review." *Population Index* 48(1):pp. 4-43.

Lesthaeghe, R. and J. Surkyn. 1988. "Cultural Dynamics and Economic Theories of Fertility Change." *Population and Development Review* 14(1):pp. 1-45.

Limaye, R., R.N. Rimal, J. Brown, G. Mkandawire, K. Bose, T. Kakhobwe, M. Boulay, L. Aslan, R. Sikka, A.D. Suka, P. Nakoma, and J. Suzi. 2009. "Promoting HIV Prevention Behaviors in Malawi through the BRIDGE Project: Trends in Exposure and Outcomes from 2003 to 2009." *John Hopkins Bloomberg Center for Public Health Center for Communication Programs* Baltimore, MD, USA.(http://www.jhuccp.org/sites/all/files/Malawi%20Bridge%20I%20Research%20Report.pdf).

Mason, K.O. and Winsboro.Hh. 1973. "Some Methodological Issues in Cohort Analysis of Archival Data." *American Sociological Review* 38(2).

Preston, S.H. and H. Wang. 2006. "Sex Mortality Differences in the United States: The Role of Cohort Smoking Patterns." *Demography* 43(4):pp. 631-646.

Raudenbush, S.W. and A.S. Bryk. 2002. *Hierarchical Linear Models: Applications and Data Analysis Methods*. 2nd ed. Thousand Oaks, CA: Sage.

Ryder, N.B. 1965. "The Cohort as a Concept in the Study of Social-Change." *American Sociological Review* 30(6):843-861.

Schutz, A. 1967. *The Phenomenology of the Social World*. Evanston, IL: Northwestern University Press.

-. 1951. "Choosing Among Projects of Action." *Philosophy and Phenomenological Research* 12:161-184.

Snijders, T. and R. Bosker. 1999. *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*. Thousand Oaks, CA: Sage.

UNAIDS. 2012a. "2012 Global AIDS Response Progress Report: Malawi Country Report for 2010 and 2011." *UNAIDS Country Progress Report* http://www.unaids.org/en/regionscountries/countries/malawi/.

-. 2012b. "UNAIDS Report on the Global AIDS Epidemic." New York: World Health Organization and UNAIDS. Available online at http://www.unaids.org.

World Health Organization. 2011. "HIV in the WHO African Region: Progress towards achieving universal access to priority health sector interventions, 2011 update." *World*

Health Organization Report Available online at http://www.afro.who.int/en/clusters-a-programmes/dpc/acquired-immune-deficiency-syndrome/aids-publications.html.

Yang, Y., W.J.J. Fu, and K.C. Land. 2004. "A methodological comparison of age-period-cohort models: The intrinsic estimator and conventional generalized linear models." *Sociological Methodology, 2004, Vol 34* 34.

Yang, Y. and K.C. Land. 2008. "Age-period-cohort analysis of repeated cross-section surveys - Fixed or random effects?" *Sociological Methods & Research* 36(3):297-326.

-. 2006. "A mixed models approach to the age-period-cohort analysis of repeated cross-section surveys, with an application to data on trends in verbal test scores." *Sociological Methodology* 36:75-97.

Table 1. DHS Malawi Data by Birth Cohort and Period

Birth Cohort (J)	Survey Year/Period (K) 1992	1996	2000	2004	2010
1937	1	0	0	0	0
1938	10	0	0	0	0
1939	16	0	0	0	0
1940	28	0	0	0	0
1941	14	5	0	0	0
1942	29	25	0	0	0
1943	73	26	0	0	0
1944	69	17	0	0	0
1945	81	20	3	0	0
1946	94	32	29	0	0
1947	93	64	42	0	0
1948	109	76	35	0	0
1949	135	81	43	1	0
1950	122	81	67	25	0
1951	90	68	190	24	0
1952	166	107	270	49	0
1953	135	72	199	37	0
1954	130	107	234	46	0
1955	109	74	219	143	7
1956	139	99	206	196	54
1957	144	85	191	171	59
1958	164	138	311	220	107
1959	125	94	198	213	66
1960	188	122	402	230	193
1961	129	80	242	150	295
1962	245	154	402	265	491
1963	153	116	291	222	429
1964	285	219	453	369	528
1965	185	104	348	211	372
1966	207	149	323	304	393
1967	201	107	308	173	340

(continued)

Birth Cohort (J)	Survey Year/Period (K) 1992	1996	2000	2004	2010
1968	271	186	453	342	580
1969	241	145	316	379	456
1970	243	182	552	364	649
1971	243	163	445	318	485
1972	258	203	580	446	719
1973	209	181	537	357	642
1974	235	215	622	487	733
1975	229	243	754	478	851
1976	228	239	609	563	746
1977	174	230	714	504	723
1978	0	228	630	536	903
1979	0	207	770	676	858
1980	0	270	866	632	1047
1981	0	190	676	556	846
1982	0	0	860	766	1218
1983	0	0	644	674	1095
1984	0	0	740	786	1126
1985	0	0	538	615	1154
1986	0	0	0	738	1068
1987	0	0	0	533	1081
1988	0	0	0	607	1162
1989	0	0	0	547	1082
1990	0	0	0	6	1195
1991	0	0	0	0	1061
1992	0	0	0	0	1293
1993	0	0	0	0	1316
1994	0	0	0	0	1690
1995	0	0	0	0	1082
N	6000	5204	16312	14959	30195
Total N	72670				

Table 2. Descriptive Statistics - DHS Malawi Combined Cross-Sectional Data, 1992-2010

	n	Mean / %	SD	Min	Max
Outcomes:					
What can a person do to avoid getting AIDS?					
Abstain from sex	72,071	0.69	0.46	0	1
Use condoms	72,099	0.59	0.49	0	1
Independent Variables:					
Age	72,807	28.31	9.68	15	54
Male	72,807	0.24	0.43	0	1
Group Variables:					
Period - Survey year	6			1992	2010
Cohort - 5 year birth cohorts	10			1940	1985
Categorical Variables:					
Type of Residence	72,807				
Rural		0.80			
Urban		0.20			
Region	72,807				
North		0.18			
Central		0.35			
South		0.47			
Education	72,807				
No education		0.19			
Incomplete primary		0.54			
Complete primary		0.10			
Incomplete secondary		0.11			
Complete secondary		0.05			
Higher		0.01			

Table 3. HAPC-CCREMs of HIV Prevention Knowledge in Malawi, DHS 1992-2010

What can a person do to avoid getting AIDS?	Abstain			Use Condoms		
Fixed Effects	Coefficient	SE	p-value	Coefficient	SE	p-value
Intercept	-0.096	0.465	0.845	-0.777	0.439	0.137
Age (centered)	0.012	0.002	<.0001	0.005	0.002	0.034
Age-squared (centered)	0.000	0.000	0.190	-0.001	0.000	<.0001
Male	0.353	0.023	<.0001	0.469	0.021	<.0001
Rural (urban)	-0.091	0.025	0.000	-0.085	0.024	0.000
Region (north)						
Central	0.085	0.025	0.001	-0.014	0.024	0.563
South	0.459	0.025	<.0001	0.649	0.023	<.0001
Education (no education)						
Some primary	0.324	0.024	<.0001	0.405	0.023	<.0001
All primary	0.573	0.036	<.0001	0.582	0.034	<.0001
Some secondary	0.708	0.037	<.0001	0.691	0.035	<.0001
All secondary	0.737	0.049	<.0001	0.587	0.044	<.0001
Higher	0.887	0.102	<.0001	0.589	0.087	<.0001
Random Effects	Estimate	SE	p-value	Estimate	SE	p-value
Period						
1992	-1.385	0.464	0.003	-1.729	0.438	<.0001
1996	-1.489	0.464	0.001	-0.863	0.438	0.049
2000	0.311	0.464	0.503	0.427	0.437	0.328
2004	0.740	0.464	0.111	0.502	0.437	0.251
2005	0.927	0.465	0.046	0.548	0.438	0.211
2010	0.896	0.464	0.053	1.115	0.437	0.011
Cohort						
1940	-0.045	0.043	0.298	-0.001	0.075	0.990
1945	0.013	0.040	0.749	0.031	0.065	0.635
1950	-0.015	0.036	0.683	-0.062	0.053	0.244
1955	0.010	0.033	0.755	-0.067	0.046	0.142
1960	0.006	0.029	0.823	-0.065	0.039	0.096
1965	0.016	0.028	0.577	-0.025	0.038	0.508
1970	0.036	0.026	0.177	0.000	0.037	0.995
1975	0.048	0.026	0.067	0.078	0.038	0.043
1980	-0.010	0.028	0.716	0.147	0.042	0.001
1985	-0.059	0.033	0.077	-0.035	0.052	0.492

(continued on next page)

Table 3. *continued*

Variance Components	Variance	SE	p-value	Variance	SE	p-value
Period (τ_u)	1.289	0.816	0.057	1.143	0.724	0.057
Cohort (τ_v)	0.002	0.002	0.157	0.007	0.005	0.071
Model Fit						
-2LPL	330,977.4			322,834.6		
Chi-squared (df)	72,386.6	(1.00)		72,324.8	(1.00)	
N	72,071			72,099		

Notes: reference groups are in parenthesis; two-tailed test.

Fig. 1 Predicted Probability for Knowledge of Abstinence as AIDS Risk Reducing Behavior

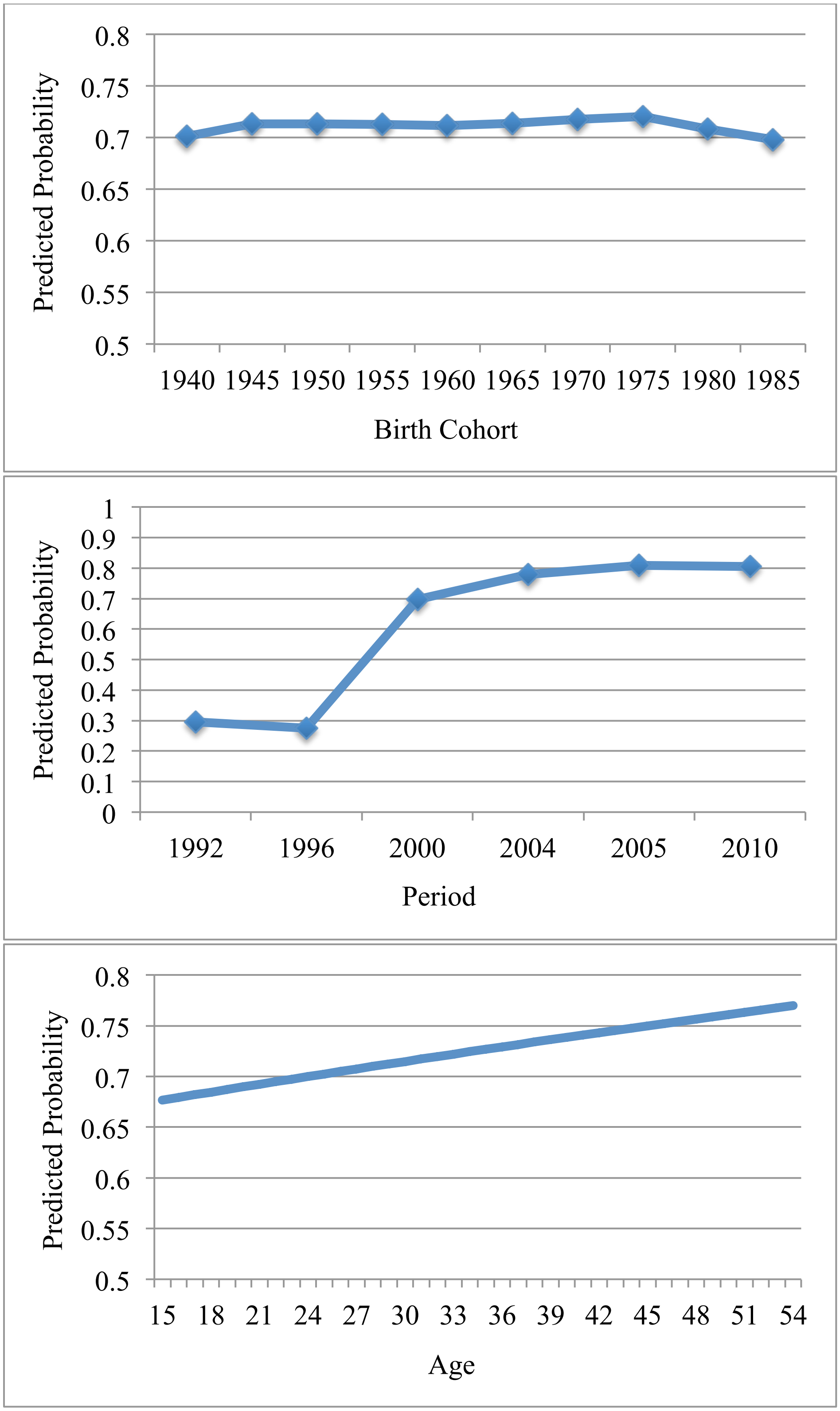

Fig. 2 Predicted Probability for Knowledge of Condom Use as AIDS Risk Reducing Behavior