



AIDS education, condom demand, and the sexual activity of American youth

Carol Horton Tremblay^{a,*} and Davina C. Ling^b

^a*Department of Economics, Oregon State University, Corvallis, USA*

^b*Department of Economics, California State University, Fullerton, USA*

Summary

This paper examines the effects of AIDS education at school and at home on the sexual behavior of American youth. Multinomial logit equations of the probabilities of abstinence, sexual intercourse with a condom, and intercourse without a condom are estimated using data from the Youth Risk Behavior Supplement of the 1992 National Health Interview Survey. We find no significant effects of AIDS education on the probability of abstinence, but we do find that AIDS education significantly raises the likelihood of condom-protected relative to unprotected intercourse. These results indicate that risk-altering and risk-revealing AIDS education dominate any utility-altering effects favoring intercourse over abstinence. We also find that young women are influenced by AIDS education to a greater extent than young men. Overall, our results suggest that educating young people about AIDS does not promote sex and encourages safer sex, reducing the likelihood of HIV transmission and lowering the subsequent social costs. Copyright © 2005 John Wiley & Sons, Ltd.

Keywords sex education; AIDS; condom; abstinence; sexual activity

Introduction

Acquired immune deficiency syndrome (AIDS) is the fourth leading cause of mortality in the world and has claimed approximately 20 million lives since it was first identified in 1981 [1]. About 38 million people are living with human immunodeficiency virus (HIV), and nearly half of all new HIV cases are young people aged 15–24 [1]. The Joint United Nations Programme on HIV/AIDS recommends funding for school-based AIDS education as part of their efforts to contain the AIDS epidemic [1].

In addition to the profound private direct and indirect costs of the disease, appreciable costs are borne by society. For example, in the United

States, Medicaid serves about 55% of people living with AIDS, with expenditures estimated at \$8.5 billion for fiscal year 2003 [2]. The estimated number of American AIDS cases through 2002 is 886,575, including 35,460 youth aged 15–24 [3]. According to the Centers for Disease Control and Prevention [4], 'the challenges of addressing disparities in care, preventing secondary transmission, and meeting the social and medical needs of persons living with HIV or AIDS are especially critical for youth, considering their long-term needs'. In fact, the CDC specifies in its *HIV Prevention Strategic Plan* [4] that the adolescent population is one of five priority populations that are targeted for HIV prevention interventions.

AIDS education programs in schools may be an effective strategy for inhibiting irresponsible sexual

*Correspondence to: Department of Economics, Oregon State University, Ballard Extension Hall 303, Corvallis, OR 97331-3612, USA. E-mail: ctremblay@oregonstate.edu

behavior among adolescents, thereby deterring the incidence of AIDS, other sexually transmitted diseases, and pregnancy. The CDC currently supports 107 state, large city and non-governmental organizations in their efforts to provide school-based HIV prevention programs [4]. Evidence from the public health literature suggests that AIDS education programs may discourage unprotected intercourse [5–8]. Related research in the economics literature has been less promising. Although Evans *et al.* [9] find that sex education reduces teen pregnancy, Oettinger [10] finds that sex education in the 1970s prompted earlier sexual activity and pregnancy in teenage women. Further, estimates obtained by Philipson and Posner [11,12] reveal that AIDS education expenditures may actually reduce the average knowledge about AIDS held by a state's citizenry.

This paper attempts to bridge the economics and health literatures by analyzing the direct effects of school- and home-based AIDS education on adolescent sexual behavior. We draw from the economic theory of health behavior by using an expected utility-maximization model that depends upon the perceived probability of disease acquisition. AIDS education enters the choice process by altering the risks, revealing the risks, or affecting the utility of condom use or sexual activity [10]. We use this economic framework to derive multinomial logit equations of the probability of abstinence, the probability of condom-protected sexual intercourse and the probability of sexual intercourse without condom protection. In addition, we draw from the existing health literature and use micro-data with information on individuals' sexual behavior, AIDS education background, and demographic variables: the Youth Risk Behavior Supplement of the 1992 National Health Interview Survey [13].

We find that exposure to AIDS information at school and at home does not significantly affect the abstinence–intercourse choice but does significantly increase the incidence of condom-protected relative to unprotected intercourse. This indicates that any utility-altering AIDS education that conveys social approval of intercourse is dominated by risk-altering and risk-revealing information. AIDS education, therefore, can be a useful policy tool for impeding the spread of AIDS.

The paper follows the standard structure. We develop the theoretical model in the next section and discuss the empirical model and data in the following section. The results follow in the penulti-

mate section and the paper concludes with final remarks regarding public policy in the last section.

Theoretical framework

In this section, we attempt to provide the theoretical basis for linking AIDS education to sexual outcomes. We show that the relationship varies with individual preferences and with the type of AIDS education (risk-altering, risk-revealing, and utility-altering). First, we discuss the decision of whether to abstain or to engage in intercourse, conditioned on the optimal condom protection option, the effect of individual preference rankings on the intercourse decision, and the signs of the impacts of risk-altering, risk-revealing, and utility-altering AIDS education on the probability of intercourse. Second, we develop the analytics of the optimal condom use choice, and we derive the anticipated signs of the effects of alternative forms of AIDS education on the probability of condom use. Finally, we combine the sign expectations for the probability of intercourse conditioned on optimal condom status, and for the probability that the optimal condom status choice is condom use rather than non-use, to predict the signs of the effects of alternative types of AIDS education on the unconditional probabilities of condom-protected sex, unprotected sex, and abstinence. These sign predictions apply directly to the empirical multinomial logit model used in the estimation.

The conditional abstinence–intercourse decision

The conceptual model of sexual decision making in this work is adapted from the model of sexual activity and pregnancy proposed by Oettinger [10]. As in his work, we define sexual activity narrowly as intercourse and do not include other forms of sexual behavior. Our theoretical model abstracts from the complexities of other sexually transmitted diseases, pregnancy and interdependent utility between partners.

An individual will engage in sexual intercourse if the expected utility of intercourse exceeds the utility of abstinence (V). Condom use affects the expected utility of sexual activity, and it is assumed that the individual evaluates expected utility at optimal condom status k^* . The determination of k^* as either c if using a condom is optimal, or as nc if

not using a condom is optimal, is discussed below. For present purposes, the expected utility of intercourse is conditioned on optimal condom status.

Benefits and costs accrue at the time of the sexual act, but also over future periods. For example, immediate benefits might include sexual gratification and relationship enhancement, immediate costs might include the cost of a condom and the psychic costs of societal or parental disapproval, while long-term costs would include medical costs, deterioration of quality of life, and loss of life if the individual becomes infected. The term $U(a|k^*)$ is defined as the net utility of sex in the present period plus the present value of expected future net utility. Net utility varies across disease states a , where $a = h$ if the individual acquires HIV from an incident of intercourse and $a = nh$ if the individual is not infected by HIV.

A young person does not know the HIV outcome of an act of intercourse with certainty and will utilize his or her perceptions about the probability of HIV transmission, given optimal condom status, $P(h|k^*)$, to formulate the expected value of the utility of intercourse. An individual will engage in sexual intercourse if the expected utility of sexual activity outweighs the utility of abstinence:

$$\begin{aligned} P(h|k^*) \cdot U(h|k^*) + [1 - P(h|k^*)] \cdot U(nh|k^*) &> V \\ P(h|k^*) < [U(nh|k^*) - V] / [U(nh|k^*) - U(h|k^*)] \\ P(h|k^*) < Z(k^*) \end{aligned} \quad (1)$$

where $Z(k^*) \equiv [U(nh|k^*) - V] / [U(nh|k^*) - U(h|k^*)]$. Assuming that well outcomes are preferred to disease outcomes, the difference $U(nh|k^*) - U(h|k^*)$ is positive, and the sign of $Z(k^*)$ depends upon the preference orderings of the individual. If the utility of abstinence exceeds the utility of intercourse without infection (that is, $V > U(nh|k^*)$), then the value of $Z(k^*)$ will be negative. Because the probability of infection must lie between zero and one, the inequality will not hold, and the individual will choose to abstain. On the other hand, if the net utility of intercourse dominates abstinence for an individual (that is, $V < U(nh|k^*)$), the right-hand side of (1) is positive. Inequality (1) may or may not hold depending on the individual's relative strength of preferences and the perceived probability of disease transmission. The probability of engaging in sexual activity for individuals with this utility ranking is given by $\Pr(sa = 1|k^*) = \Pr[P(h|k^*) < Z(k^*)]$, where $sa = 1$ if the individual chooses sexual activity, and $sa = 0$ if he or she chooses abstinence. This probability is the value of the cumulative distribution

function (CDF) of $P(h|k^*)$ evaluated at $Z(k^*)$, $\int_0^{Z(k^*)} dF[P(h|k^*)] = F[Z(k^*)]$. Changes in the perceived probability of infection shift the CDF, whereas changes in the utility of abstinence relative to sexual activity affect the value of Z , which is represented graphically as a movement along the CDF.

AIDS education may influence an individual's ultimate decision regarding sexual activity by revealing or altering the probability of transmission and by affecting the relative utility of abstinence. The expected signs of the impacts of these types of AIDS education on the probability of engaging in intercourse given the optimal condom choice, $\Pr(sa = 1|k^*)$, are listed in Table 1. Individuals who rank abstinence above intercourse (formally, $V > U(nh|k^*)$) will abstain regardless of the value of the perceived probability of infection, $P(h|k^*)$, and will therefore be unaffected by risk-revealing or risk-altering information. An individual preferring intercourse (without disease) to abstinence ($U(nh|k^*) > V$) who becomes aware of the risk of HIV infection such that $P(h|k^*)$ increases will be less likely to engage in intercourse (risk-revealing Case 1). The true CDF lies to the right of the perceived CDF, and for a given value of $Z(k^*)$, corresponds to a reduction in the probability of sexual activity. Of course, a student might overpredict the probability of infection prior to AIDS schooling in which case $P(h|k^*)$ would decline with AIDS education, and the individual would be more inclined to engage in sexual activity (Case 2). Risk-altering AIDS education also enters the choice process by affecting the perceived probability of infection. Learning safer intercourse methods, for example, moves the CDF of $P(h|k^*)$ to the left, and the conditional probability of sexual activity increases for those who rank intercourse above abstinence.

Critics of AIDS education argue that it encourages young people to engage in intercourse by conveying social approval of sexual activity. In the context of the framework here, the argument presumes that AIDS education is utility-altering such that the utility of intercourse increases relative to the utility of abstinence (Case 1) and generates a higher predicted probability of sex. This would occur for individuals preferring intercourse to abstinence (that is, $U(nh|k^*) > V$). The value of $Z(k^*)$ increases and the conditional probability of engaging in intercourse, $\Pr(sa = 1|k^*)$, increases as well. When the utility of abstinence exceeds the net utility of intercourse (that is, $V > U(nh|k^*)$) the probability of inter-

Table 1. Predicted effects of types of AIDS education

Utility ordering	Impact on (1)	Type of AIDS education				
		Risk-altering ^a (2)	Utility-altering ^b		Risk-revealing ^c	
			Case 1 (3)	Case 2 (4)	Case 1 (5)	Case 2 (6)
$U(nh k^*) > V$	$\Pr(sa = 1 k^*)$	+	+	0 or -	-	+
	$\Pr(sa = 1, k^* = c)$	+	+	0	+	-
	$\Pr(sa = 1, k^* = nc)$?	+	0 or -	-	+
	$\Pr(sa = 0)$?	-	0 or +	?	?
$V > U(nh k^*)$	$\Pr(sa = 1 k^*)$	0	0 or +	0	0	0
	$\Pr(sa = 1, k^* = c)$	+	0 or +	0 or -	?	?
	$\Pr(sa = 1, k^* = nc)$	-	0 or +	0 or -	-	+
	$\Pr(sa = 0)$	0	0 or -	0	?	?
All	$\Pr(k^* = c)$	+	0	0	+	-
Overall	$\Pr(sa = 1, k^* = c)$	+	+	0 or -	?	?
	$\Pr(sa = 1, k^* = nc)$?	+	0 or -	-	+
	$\Pr(sa = 0)$?	-	0 or +	?	?

^aRisk-altering AIDS education reduces the probability of HIV infection given optimal condom use choice k^* .
^bCase 1 utility-altering AIDS education increases $U(nh|k^*)$ relative to V ; case 2 utility-altering AIDS education decreases $U(nh|k^*)$ relative to V .
^cCase 1 risk-revealing AIDS education increases the perceived probability of HIV infection given k^* ; case 2 risk-revealing AIDS education decreases $\Pr(h|k^*)$.

course may or may not be influenced by Case 1 utility-altering AIDS education. If the utility of intercourse rises sufficiently to surpass the utility of abstinence, $Z(k^*)$ will become positive and generate a positive probability of sexual activity. If not, the conditional probability of sexual activity ($\Pr(sa = 1|k^*)$) will be unchanged. Utility-altering AIDS education can also occur if the curriculum enhances the utility associated with abstinence, perhaps by stressing it as a reasonable alternative to intercourse (Case 2). If so, persons preferring abstinence to intercourse will continue to abstain. The probability of engaging in intercourse for those preferring intercourse to abstinence will decrease if the utility of abstinence becomes large enough to overwhelm the utility of intercourse.

The condom decision

For our purposes, the term ‘condom’ refers to the male latex condom. For a female or a homosexual

receptive partner, ‘condom use’ refers to the use of a condom by the insertive partner. A sexually active person will choose to use a condom if the expected utility of condom use exceeds the expected utility without a condom:

$$P(h|c) \cdot U(h|c) + [1 - P(h|c)] \cdot U(nh|c) > P(h|nc) \cdot U(h|nc) + [1 - P(h|nc)] \cdot U(nh|nc)$$

Assuming that the disutility of HIV infection ($U(nh) - U(h)$) is the same when a condom is used as when a condom is not used (that is, $U(nh|c) - U(h|c) = U(nh|nc) - U(h|nc)$) and rearranging terms yields

$$P(h|c) - P(h|nc) < [U(nh|c) - U(nh|nc)] / [U(nh) - U(h)]$$

$$P(h|c) - P(h|nc) < Z(c) \tag{2}$$

where $Z(c) \equiv [U(nh|c) - U(nh|nc)] / [U(nh) - U(h)]$. The left-hand side of the inequality is the difference in transmission probabilities for intercourse with a condom and without a condom.

Given that HIV transmission is impeded by condom use (in other terms, $P(h|c) < P(h|nc)$), and exploiting the fact that $P(h|c)$ and $P(h|nc)$ must lie between 0 and 1, the difference in the perceived probabilities of HIV transmission, $P(h|c) - P(h|nc)$, must lie between -1 and 0 . Unlike the case of the intercourse decision, we assume that preference orderings are constant across individuals for the condom decision. Specifically, we assume that intercourse is more pleasurable without the encumbrance of a condom (implying that $U(nh|nc) > U(nh|c)$), and $Z(c)$ lies between -1 and 0 for all young people. The probability that using a condom is optimal, $\Pr(k^* = c)$, is the probability that $(P(h|c) - P(h|nc)) < Z(c)$ or $\int_{-1}^{Z(c)} dF[P(h|c) - P(h|nc)] = F[Z(c)]$. This probability will vary across perceived probabilities of infection with and without a condom and across values of the utility of intercourse with and without a condom.

Risk-altering, risk-revealing, and utility-altering AIDS education can affect the optimal condom decision as well as the intercourse decision. Because of the assumption that the utility of intercourse with a condom ranks below the utility of intercourse without a condom, alternative preference orderings need not be considered in predicting the direction of the effects of the forms of AIDS schooling on optimal condom use. Anticipated signs on the impact of alternative forms of AIDS education on the probability of condom use, $\Pr(k^* = c)$, are listed in Table 1.

Risk-altering AIDS education can reduce $P(h|c)$ by teaching how to use and store condoms more effectively, for example, and can reduce $P(h|nc)$ by teaching other safer sex techniques such as avoiding partners with genital ulcers. Assuming that the perceived probability of HIV transmission decreases to a greater extent for condom use than for non-use, the left-hand side of (2) becomes more negative, inequality (2) is more likely to be satisfied, the CDF of $P(h|c) - P(h|nc)$ moves to the left, and the probability of condom use increases.

Along the same lines, AIDS education that reveals that condom use reduces the risk of HIV infection when previously unknown to the individual will lower the difference in HIV acquisition probabilities, move the CDF to the left, and increase the expected probability of condom use. Alternatively, a student may find that $P(h|nc)$ is actually lower than he or she expected, which will

increase the left-hand side of (2) and decrease the condom use probability.

If AIDS education alters the utility of intercourse relative to abstinence, but does not affect the value of condom-protected relative to unprotected intercourse (specifically, $U(nh|c) - U(nh|nc)$), utility-altering AIDS education will have no influence on the probability that the optimal condom status is usage, $\Pr(k^* = c)$. Consequently, the unconditional probabilities of sex with a condom ($\Pr(sa = 1, k^* = c)$) and sex without a condom ($\Pr(sa = 1, k^* = nc)$), will share the same expected signs as $\Pr(sa = 1 | k^* = c)$.

Unconditional probabilities

The probability of sexual intercourse conditioned on optimal condom status, $\Pr(sa = 1 | k^*)$, and the probability that use is the optimal condom protection choice, $\Pr(k^* = c)$, can be used to construct unconditional probability functions corresponding to the multinomial logit model:

$$\begin{aligned} \Pr(sa = 1, k^* = c) & \\ &= \text{the probability of condom-protected} \\ &\quad \text{intercourse} \\ &= \Pr(sa = 1 | k^* = c) \Pr(k^* = c) \end{aligned}$$

$$\begin{aligned} \Pr(sa = 1, k^* = nc) & \\ &= \text{the probability of intercourse without} \\ &\quad \text{condom protection} \\ &= \Pr(sa = 1 | k^* = nc) [1 - \Pr(k^* = c)] \end{aligned}$$

$$\begin{aligned} \Pr(sa = 0) & \\ &= \text{the probability of abstinence} \\ &= 1 - \Pr(sa = 1, k^* = c) - \Pr(sa = 1, k^* = nc) \end{aligned}$$

The sign expectations for the impacts of the alternative forms of AIDS education on the probability of condom use and the probability of sexual activity conditioned on optimal condom protection choice, can be used to infer sign expectations for the unconditional probabilities of interest. For example, risk-altering AIDS education raises the probability of sexual activity conditional on optimal condom status for individuals preferring intercourse to abstinence, and raises the probability of condom use. With both

components expected to increase, the anticipated direction of change for the joint probability of sexual activity and condom use, $\Pr(sa = 1, k^* = c)$, is positive. The sign of the impact on the probability of sexual activity without condom use, $\Pr(sa = 1, k^* = nc)$, is ambiguous. Although the probability of intercourse conditioned on condom status increases, the probability that the optimal condom choice is non-use, $\Pr(k^* = nc) = 1 - \Pr(k^* = c)$, declines. Risk-altering AIDS education will also have an uncertain effect on the probability of abstinence; the probability of condom-protected sex increases, but the probability of unprotected sex may increase or decrease. For those who rank the utility of abstinence more highly than the utility of intercourse, the conditional probability of sexual activity is unaffected, but the probability of condom use increases. Thus, the joint probability of sex with a condom is expected to rise.

Table 1 shows that these expectations are often indeterminate. The empirical work in the next section may or may not be able to isolate the importance of a particular type of AIDS education. Nevertheless, the results will provide an estimate of the net effect of all forms of AIDS education on the sexual behavior of youth and will shed light on the effectiveness of AIDS education as a policy instrument for combating the spread of AIDS.

Empirical methods and data

The equations for abstinence, intercourse with a condom, and intercourse without a condom are estimated jointly by multinomial logit analysis. If a person had not engaged in intercourse in the 3-month period prior to the interview, the abstinence choice category is assigned. Alternatively, an individual is designated as choosing intercourse with a condom if he or she had engaged in intercourse in the 3-month pre-interview interval and used a condom at the most recent incidence of intercourse. The reference category is intercourse without a condom, the least desirable state from a disease prevention perspective.

The primary data set is the 14–22 year-old subset of the 1992 National Health Interview Survey-Youth Risk Behavior Supplement [13]. The YRBS follows a complex multistage sample design representative of the civilian non-institu-

tional population of the United States. We employ sampling weights, calculated as the inverse of the probability of sample inclusion, and utilize stratum and primary sampling unit (PSU) identifiers to account for unmeasured commonalities among persons within each particular data cluster (with the exception of the one ‘unadjusted’ model). Variable abbreviations, definitions, and weighted summary statistics for 6615 individuals are displayed in Table 2. As the frequencies show, approximately 50% abstained from intercourse for 3-months prior to the interview, 22% had engaged in intercourse with a condom, and 28% had engaged in intercourse but did not use a condom.

AIDS education will have a greater impact on sexual behavior, the more limited the individual’s prior information set. For example, Oettinger [10] finds that sex education is less influential for older teens and for teens with older siblings than for teens without the benefit of additional information from siblings and life experience. If education regarding AIDS is provided in the home by parents, perhaps AIDS education at school will have little or no additional impact. If this is the case, and if most parents convey such information, public provision of AIDS information at school is not socially optimal. On the other hand, AIDS education at school and at home might be mutually reinforcing. To explore these possibilities, AIDS education is represented by a set of three dummy variables: AIDS education at school but not at home (SCHOOL), AIDS education at home but not at school (HOME), and AIDS education at both school and home (BOTH). About 19% of the young people had been taught about AIDS in school but not at home, 9% had talked about AIDS with an adult family member at home but had not received any information at school about AIDS, 64% had received information at school and at home, and 8% received no information from school or home. Thus, failing to provide AIDS instruction at school would have left about 27% of the young people in the sample to their own resources to obtain any information about AIDS.

The net utility of intercourse with a condom and without a condom and the risk of disease transmission may vary by race, Hispanic origin, gender, marital status, urban residence status, geographic division, education level, age, AIDS prevalence in the state of residence, and income. There are higher rates of AIDS prevalence among

Table 2. Variable definitions and weighted sample statistics

Variable name	Definition	Mean (std dev.)
<i>Dependent variable</i>		
Y	= 0 if the individual abstained from intercourse for at least 3 months prior to the interview	0.499
	= 1 if the individual had intercourse in the last 3 months and a condom was used at most recent intercourse	0.218
	= 2 if the individual had intercourse in the last 3 months but no condom was used at most recent intercourse (reference category)	0.284
<i>Independent variables</i>		
SCHOOL	= 1 if previously taught about AIDS or HIV infection in school but not at home	0.193
HOME	= 1 if discussed AIDS or HIV with a parent or other adult in the family but never received AIDS instruction at school	0.086
BOTH	= 1 if previously taught about AIDS or HIV in school and discussed it with adults at home	0.643
RACE	= 1 if individual is African American	0.141
HISP	= 1 if individual is of Spanish origin	0.125
FEM	= 1 if individual is female	0.494
NEVMAR	= 1 if individual has never been married	0.887
CCITY	= 1 if individual lives in a central city	0.311
INCOME	= family income approximated by the mid-point of the reported income interval (1992 dollars)	30,308.04 (42,512.76)
ED	= years of education completed by individual	10.555 (3.851)
PREV	= accumulated cases of AIDS in the state of residence per thousand residents, 1992	0.889 (2.411)
AGE	= age at time of interview in years	17.650 (3.522)
	AGE for young men sample	17.566 (2.399)
	AGE for young women sample	17.738 (2.416)
Number of states ^a = 48		
Number of observations = 6615		

^aState data are matched to the individual's state of residence for 48 states. There are no individuals residing in Nebraska or North Dakota in the sample.

African-Americans and in central cities, and Ahituv *et al.* [14] have shown that AIDS prevalence positively correlates with condom use. Thus, higher rates of condom use are expected for African-Americans and urban residents to the extent that their partners share these characteristics. Regarding marital status, unmarried individuals are at a greater risk of infection and are thus more likely to use a condom. The anticipated sign on the never-married dummy variable is therefore positive. AIDS prevalence (PREV) in the state of residence is measured by the number of accumulated cases through 1992 per 1000 residents [15]. To capture the possible effects of regional attitudes toward sexual activity and condom use, a set of dummy variables are derived for the individual's residential location from the nine geographic division categories of the US Census Bureau.

Under-reporting of condom use by women, which results in a negative coefficient on the female dummy variable in pooled samples of females and males, has been noted in the literature by Ahituv *et al.* [14], for example. Further, if homosexuals use condoms more frequently than heterosexuals, the expected parameter sign on the female dummy variable would also be negative. Because HIV infection is more prevalent among homosexuals than heterosexuals, homosexuals have a greater incentive to use condoms.

Ahituv *et al.* [14] and Santelli *et al.* [16] find that condom use is negatively related to age. If teens become infected, they have more to lose in terms of years of life and good health than adults. Further, the young tend to have more sporadic, short-lived relationships, which lend themselves to using condoms rather than the pill for birth

control, and condoms may be more accessible to the young than other contraceptive methods. Of course, age is tied to sexual maturity, which is expected to be negatively related to abstinence. We include AGE as a regressor, measured as years of age at the time of the interview.

The mean age of young women in the sample exceeds the mean age for young men (see Table 2). The coefficient on the female dummy variable would partially include the impact of age on sexual activity and bias the coefficient estimates on FEM. To avoid this potential bias, we include an interaction term between the female dummy variable and the age variable, FEMAGE, as a control variable in the model.

As discussed above, older teens and teens with older siblings possess more information and are less likely to be influenced by sex education. This suggests that in addition to AGE, education level should be included as a control variable. Although years of education is correlated with age in the sample (Pearson correlation coefficient = 0.79), we include ED, the number of grades completed by the individual, as a regressor. A number of studies show a positive link between education and healthy outcomes, and the acquisition of AIDS instruction at school likely correlates with education level. Omission of ED potentially biases the coefficient estimate on SCHOOL. Education is tied to higher expected earnings and a greater opportunity cost of pregnancy and disease acquisition. Educated individuals would be more likely to abstain and less likely to engage in unprotected intercourse.

Income may affect sexual decisions in a number of ways. Assuming that health is a normal good, the rich would be less likely to have sex without a condom than the poor. Income also controls for unobservable social factors linked to social class.^a Suppose that members of the upper class are more inclined to discuss AIDS with their children and that condom use is more popular among upper-class youth than lower-class youth. Without a control variable for social class, the model would generate a spurious positive coefficient estimate on HOME. Income serves as a proxy for social class, which enables unbiased estimation of the HOME parameter.

The income variable is constructed from the categorical family income variable for each individual in the YRBS. There are 25 categories representing a range of values for family income; the mid-point of the range is used to approximate

income. The data are top-coded at \$50,000. For individuals with family incomes exceeding \$50,000, the 1992 national income distribution is used to approximate the median family income [17]. Income is deflated by city cost-of-living indices [18]. The appropriate income measure relevant to the sexual decision-making process is the income of the couple, rather than the income of the family of the individual in the survey. Unfortunately, information about the partner is unavailable. To the extent that sexual partners have similar income levels, and that the standard-of-living for each family member is commensurate with family income, the couples' budget constraint will be correlated with the family budget constraint and family income will serve as a fair proxy.

In summary, the model contains the following set of regressors: SCHOOL, HOME, BOTH, RACE, HISP, NEVMAR, CCITY, FEM, FEMAGE, AGE, ED, INCOME, PREV, and a set of geographic division variables. In the next section, we estimate the model for five samples: the total sample, young men, young women, children (aged 14–17), and adults (18–22). We also explore an alternative model that accounts for religion and family background variables and conduct specification tests.

Empirical results

Table 3 displays the abstinence and condom-protected intercourse parameter estimates for the multinomial logit model. The reference category is intercourse without a condom. Thus, positive coefficients indicate socially desirable effects from a disease containment perspective. Applying sampling weights and adjusting the standard errors to account for stratified and clustered sampling yields 'adjusted' estimates for abstinence and intercourse with a condom that are listed in columns (1) and (2). The sampling weights are calculated as the inverse of the probability of sample inclusion. Complex health survey sample designs including stratified and clustered sampling are discussed by Korn and Graubard [19]. For readers preferring standard multinomial logit estimates, 'Unadjusted' parameters appear in columns (3) and (4). Below, we find significant heteroscedasticity for all samples. Consequently, we use the Huber/White/sandwich heteroscedasticity-robust variance estimator to generate the standard errors and *t*-ratios for the adjusted multinomial logit regressions.

Table 3. Multinomial logit parameter estimates^a

Variable name	Adjusted		Unadjusted	
	Abstinence (1)	Intercourse with condom (2)	Abstinence (3)	Intercourse with condom (4)
SCHOOL	0.042(0.22)	0.147(0.77)	0.106(0.70)	0.246(1.44)
HOME	0.122(0.59)	0.229(1.08)	0.109(0.64)	0.300(1.61)
BOTH	0.055(0.32)	0.391(2.44) ^c	0.109(0.79)	0.455(2.96) ^b
INCOME	5.31e-06(2.45) ^c	-1.60e-06(0.61)	5.84e-06(3.39) ^b	-1.29e-06(0.67)
RACE	-0.490(3.51) ^b	0.369(2.86) ^b	-0.516(4.65) ^b	0.363(3.33) ^b
HISP	0.173(1.20)	-0.068(0.50)	0.125(1.21)	-0.111(0.95)
FEM	-0.355(0.56)	-1.675(2.51) ^c	-0.306(0.53)	-1.708(2.66) ^b
FEMAGE	-0.011(0.30)	0.057(1.60)	-0.011(0.36)	0.054(1.57)
ED	0.025(0.74)	0.004(0.11)	0.007(0.27)	0.009(0.34)
AGE	-0.467(13.38) ^b	-0.189(5.28) ^b	-0.444(14.47) ^b	-0.193(6.03) ^b
NEVMAR	1.768(15.30) ^b	1.158(8.01) ^b	1.733(13.86) ^b	1.154(9.36) ^b
CCITY	0.023(0.74)	0.112(1.14)	0.060(0.75)	0.103(1.20)
PREV	0.098(1.21)	0.050(0.56)	0.068(0.97)	0.062(0.85)
χ^2, F		$F = 26.70^b$		$\chi^2 = 1877.79^b$
N		6156		6156

^a Parentheses contain absolute values of *t*-ratios. A constant term and a set of geographic division dummy variables are included in each model.

^b Significant at 1%.

^c Significant at 5%.

Intercourse with condom estimates on BOTH in (2) and (4) are significant at 5%. This implies that combined school and home AIDS education significantly raises the natural logarithm of the probability of sex with a condom relative to the natural logarithm of the probability of sex without a condom (in other words, the 'log-odds' of sex with a condom relative to sex without a condom). The remaining adjusted and unadjusted parameter estimates on the AIDS education variables are all positive, indicating that AIDS education increases the log-odds of abstinence, and the log-odds of condom-protected intercourse, relative to unprotected intercourse. The adjusted parameter estimates tend to be lower in absolute value than the corresponding unadjusted estimates. In the remainder of the paper, only adjusted estimates are discussed.

Results are presented separately for young men and for young women in Table 4. For young men, none of the parameter estimates on the AIDS education variables significantly influence sexual behavior. At the same time, SCHOOL, HOME, and BOTH significantly affect the log-odds of sex with a condom relative to sex without a condom for young women (at 5% for HOME and BOTH, and 10% for SCHOOL). The greater responsive-

ness to information by young women relative to young men may result from differences in initial knowledge or in risk aversion. Risk-revealing information about transmission probabilities and the greater probability of male-to-female than female-to-male HIV transmission, may lead women to increase sex with a condom relative to sex without a condom. Females also bear the cost of possible pregnancy to a greater extent than males and may not experience the same degree of disutility from condom use. In this case, $U(nh|c) - U(nh|nc)$ would be greater for women than men and the threshold equations (2) for condom use would be more likely satisfied for women than men.

We also segment the sample by age group into two categories: 'children' (aged 14–17) and 'adults' (aged 18–22). In Table 5, we show the results for each age group. The younger subsample has positive parameter estimates on the AIDS education variables in the abstinence equation, while the adult subsample has insignificant estimates, one even negative. In contrast, children have smaller coefficient estimates and *t*-ratios than the adults in the intercourse with condom equation. As for the total sample, the 18–22 year-olds are significantly influenced by the combination of school and home

Table 4. Multinomial logit parameter estimates by gender^a

Variable name	Young men		Young women	
	Abstinence (1)	Intercourse with condom (2)	Abstinence (3)	Intercourse with condom (4)
SCHOOL	0.029(0.12)	-0.207(0.81)	-0.087(0.31)	0.618(1.96) ^d
HOME	-0.014(0.05)	-0.208(0.66)	0.176(0.60)	0.617(2.07) ^c
BOTH	0.005(0.02)	0.224(0.95)	0.040(0.16)	0.604(2.32) ^c
INCOME	4.71e-06 (1.68) ^d	-1.62e-06(0.50)	5.53e-06(1.94) ^c	-1.85e-06(0.5)
RACE	-0.813(3.73) ^b	0.238(1.32)	-0.200(1.09)	0.435(2.30) ^c
HISP	0.004(0.03)	0.144(0.76)	0.367(2.13) ^c	-0.432(1.82) ^d
NEVMAR	1.702(10.86) ^b	1.481(6.90) ^b	1.865(12.49) ^b	0.989(5.72) ^b
CCITY	0.184(1.11)	0.213(1.45)	-0.118(0.83)	0.064(0.46)
ED	0.03(0.65)	0.038(0.82)	0.024(0.54)	-0.033(0.63)
AGE	-0.473(11.58) ^b	-0.214(5.02) ^b	-0.484(12.19) ^b	-0.108(2.25) ^c
PREV	-0.062(0.49)	-0.042(0.37)	0.226(1.92) ^d	0.124(0.94)
<i>F</i>		13.61 ^b		17.85 ^b
<i>N</i>		2964		3192

^a Parentheses contain absolute values of *t*-ratios. A constant term and a set of geographic division dummy variables are included in each model.

^b Significant at 1%.

^c Significant at 5%.

^d Significant at 10%.

Table 5. Multinomial logit parameter estimates by age group^a

Variable name	Children (14-17)		Adults (18-22)	
	Abstinence (1)	Intercourse with condom (2)	Abstinence (3)	Intercourse with condom (4)
SCHOOL	0.472(1.21)	0.122(0.29)	-0.044(1.20)	0.198(0.91)
HOME	0.478(1.09)	-0.220(0.45)	0.002(0.01)	0.359(1.53)
BOTH	0.577(1.56)	0.396(1.02)	0.085(0.44)	0.445(2.46) ^c
INCOME	16.1e-06(3.91) ^b	4.67e-06(0.9)	-5.62e-08(0.02)	-3.00e-06(0.99)
RACE	-0.465(2.05) ^c	0.419(1.88)	-0.485(2.75) ^b	0.336(2.05) ^c
HISP	0.128(0.65)	0.091(0.42)	0.358(2.28) ^c	-0.154(0.91)
NEVMAR	0.787(2.61) ^b	1.055(2.75) ^b	3.121(12.11) ^b	1.107(6.88) ^b
CCITY	-0.286(1.75) ^d	-0.106(0.60)	0.144(1.13)	0.166(1.41)
ED	-0.042(0.55)	-0.049(0.55)	0.085(2.40) ^c	0.018(0.48)
AGE	-0.737(6.51) ^b	-0.252(2.15) ^c	-0.242(3.83) ^b	-0.133(2.22) ^c
PREV	0.303(2.26) ^c	0.158(0.89)	-0.052(0.45)	-0.032(0.32)
<i>F</i>		7.42 ^b		9.53 ^b
<i>N</i>		2931		3225

^a Parentheses contain absolute values of *t*-ratios. A constant term and a set of geographic division dummy variables are included in each model.

^b Significant at 1%.

^c Significant at 5%.

^d Significant at 10%.

AIDS instruction to engage in condom-protected sex relative to unprotected sex. It appears that the less physically mature young people are more responsive regarding the abstinence decision while

the more mature young people are more responsive regarding the condom use decision. Maturity likely lowers the utility of abstinence relative to the utility of intercourse and the difference may be too

large to outweigh any changes in the perceived probability of HIV infection attributable to risk-revealing AIDS education.

Returning to Table 3, adjusted and unadjusted coefficient estimates on the control variables for the total sample indicate that the log-odds of abstinence relative to intercourse without a condom is significantly lower for African-Americans, for individuals presently or previously married, for those who are older in the 14–22 age group, and for those with lower incomes. The log-odds of choosing intercourse with a condom over intercourse without a condom is significantly greater for African-Americans, males, never-married individuals, and those who are younger.

Parameter estimates on the control variables are in accord with previous literature [14,16] with the following exceptions. The insignificance of the education parameter estimates is inconsistent with the literature on health and education, but these parameters do correspond to the finding that the propensity to use birth control pills relative to condoms increases with education [20]. In the abstinence equation, the significant positive coefficient on income is consistent with studies showing a negative relationship between economic opportunity and pregnancy [21,22]. In terms of the theoretical model, income may confer advantages in expected years of life and in expected future quality of life, resulting in a greater divergence between expected lifetime utility with AIDS and without AIDS. This reasoning, however, is not consistent with the insignificant coefficient on income in the equation for condom-protected intercourse. Perhaps those individuals who choose to engage in intercourse and have higher incomes are better able to afford alternative birth control methods or abortion than those who choose intercourse and have lower incomes.

The results in Table 4 allow differences in slope coefficients and error variances for males and females and may shed light on gender differences in sexual decision making. For the most part, the signs of the significant parameter estimates on the control variables in the subsamples of young men and young women mirror those of the pooled sample. Race, however, is no longer significantly related to the log-odds of condom-protected intercourse for young men or to the log-odds of abstinence for young women. Although the HISP coefficient estimates are insignificant for the total sample, the results indicate that the log-odds of abstinence are significantly higher for Hispanic

women than non-Hispanic women, and that the log-odds of sex with a condom, relative to without, is significantly lower for Hispanic women at 10%. Perhaps, on average, Hispanic women are more likely to adhere to religious mores favoring abstinence and prohibiting birth control. The prevalence of AIDS in the state of residence significantly increases the log-odds of abstinence for young women but only at 10%.

Estimates for the children subsample exhibit a positive and significant impact of prevalence on the log-odds of abstinence at the 5% level (see Table 5). In addition, this is the only group for whom abstinence is affected by central city residence (at 10%). The unexpected negative sign may indicate lenient attitudes in central cities. In addition, the PREV variable may in part account for the higher risk of disease acquisition in cities. Although income is significantly related to the log-odds of abstinence for children, it is insignificant for the adult subsample. On the other hand, the significant result for Hispanic heritage in the abstinence equation reappears in the adult subsample. The subsample of 18–22 year-olds is the only sample for which education significantly affects the log-odds of abstinence. Perhaps there is not enough variability in education levels for the 14–17 year-olds. It is interesting that even within each age group, years of age significantly reduce the log-odds of abstinence and the log-odds of sex with a condom. As might be expected, physical development appears to play an important role.

Table 6 shows estimated marginal effects of each AIDS education variable on the probability of each outcome that are derived from the coefficients in Tables 3–5. The absolute values of the *t*-ratios for the marginal effects are calculated using the delta method [23, pp. 357–358]. The estimates for the total sample and for each gender subset show that AIDS education does not significantly affect the probability of abstinence, but significantly increases the probability of intercourse with a condom when taught at school and at home. The estimated impact of AIDS education at school and at home on intercourse with a condom is 6.3 percentage points, which comprises about one-fifth of the young people who had sex without a condom (30% of the sample).

Males are not significantly influenced by AIDS education regarding sex with a condom. For females, studying AIDS at both home and school significantly raises the probability of condom-protected sex by 9.3 percentage points, and those

Table 6. Estimated marginal effects for the multinomial logit model^a

Choice and variable name	Total sample (1)	Young men (2)	Young women (3)	Age 14–17 (4)	Age 18–22 (5)
Abstinence					
SCHOOL	-0.007 (0.18)	0.035 (0.69)	-0.088 (1.43)	0.101 (1.41)	-0.031 (0.73)
HOME	0.002 (0.04)	0.024 (0.41)	-0.026 (0.40)	0.139 ^d (1.67)	-0.039 (0.85)
BOTH	-0.032 (0.85)	-0.029 (0.61)	-0.046 (0.83)	0.094 (1.48)	-0.064 (1.60)
Intercourse with condom					
SCHOOL	0.022 (0.72)	-0.043 (1.06)	0.125 ^c (2.14)	-0.028 (0.48)	0.045 (1.15)
HOME	0.028 (0.79)	-0.037 (0.79)	0.096 ^d (1.72)	-0.089 (1.54)	0.077 ^d (1.65)
BOTH	0.063 ^b (2.61)	0.042 (1.11)	0.093 ^b (2.64)	0.020 (0.36)	0.095 ^b (3.17)
Intercourse without condom					
SCHOOL	-0.015 (0.46)	0.008 (0.21)	-0.037 (0.70)	-0.073 (0.94)	-0.015 (0.35)
HOME	-0.030 (0.88)	0.013 (0.27)	-0.070 (1.39)	-0.051 (0.58)	-0.037 (0.84)
BOTH	-0.032 (1.06)	-0.013 (0.37)	-0.047 (0.94)	-0.115 (1.41)	-0.031 (0.80)

^aThe absolute values of the *t*-ratios in parentheses are based on variances estimated by the delta method.

^bSignificant at 1%.

^cSignificant at 5%.

^dSignificant at 10%.

with exclusively school-based AIDS education are significantly more likely to have intercourse with a condom by 12.5 percentage points. Young women who have only home-based AIDS instruction are 9.6 percentage points more likely to have condom-protected intercourse than other young women although the significance level is only 10%. The gender differences in the impacts of AIDS education may result from less initial information for females relative to males, greater risk aversion for females, newly revealed pregnancy costs, or lower disutility from condom use for females than males.

The marginal effects in the abstinence equation are positive for those aged 14–17, significantly so at 10% for AIDS information conveyed at home. Young adults (aged 18–22) respond significantly to AIDS education in the sex with condom equation. The estimated marginal effect of BOTH predicts a 9.4 percentage point increase in the probability of sex with a condom for this group. The marginal effect of HOME implies that home discussion about AIDS raises the likelihood of condom-

protected sex by 7.7 percentage points (significant at 10%).

None of the marginal effects indicate a significant relationship between AIDS education and the probability of intercourse without a condom. Nevertheless, the signs of the marginal effects of SCHOOL, HOME, and BOTH are negative for the total sample and the young women, children, and adult subsamples. This provides weak evidence that AIDS information reduces the probability of unprotected intercourse, with the exception of young men.

In summary, we find insignificant effects for abstinence, positive and significant effects for condom-protected sex for the total sample, young women and young adults, and negative insignificant effects for unprotected sex. These findings are consistent with the overall predictions in Table 1 for risk-altering AIDS education and for Case 1 risk-revealing AIDS education (that is, increasing the perceived probability of HIV infection). It does not appear that AIDS education increases the

utility of intercourse relative to abstinence. If this Case 1 utility-altering AIDS education is present, it is overcome by risk-revealing and risk-altering instruction. For adolescents aged 14–17, we find weak evidence of Case 2 utility-altering AIDS education, where the utility of abstinence relative to intercourse rises. The abstinence–intercourse decision appears to be more responsive to AIDS information for the 14–17 year-olds, whereas the condom decision is more responsive to AIDS education for the 18–22 year-olds. The sexual behavior of young men is never significantly affected by AIDS instruction in our results. This may indicate that none of the forces in Table 1 are in play or that two or more forces are offsetting. In addition, the utility differences between condom use and non-use, and between intercourse and abstinence, may be sufficiently large to render marginal changes in perceived transmission probabilities or utility levels ineffective for changing sexual choices of young men (see Equations (1) and (2)).

Religion and family background

Religion and family background may play important roles in influencing a young person's valuation of alternative intercourse/condom choices. A number of studies report a relationship between religiosity, defined in various ways, and the sexual behavior of adolescents. Religious male and female adolescents are more likely to delay first intercourse according to Rostosky *et al.* [24] and Hardy and Rafelli [25]. This finding stands for the subgroup, religious African-American adolescent females, who are also more likely to use condoms than their less religious counterparts [26]. Viewing religion as important positively relates to intent to use condoms for sexually experienced never-married men aged 15–19 [27].

In our sample, the religion of a particular individual is not known. As a proxy, we use state-level data on religion matched to each individual's state of residence. We define two variables representing religion: CATH, the percentage of the state's population who are Catholic adherents [28] and FUND, the percentage of the state's population who are fundamentalist adherents [28,29]. Family influences on attitudes are additionally represented by the highest education level of the responsible adult family members (EDPAR) and a dummy variable indicating

residence with both parents (BOTHPAR). The regressors FUND, CATH, EDPAR, and BOTHPAR are added to the model and estimates are obtained for the five samples. These estimates are not shown here but are available from the authors on request. Results for the AIDS education variables are consistent with the results above. For example, the BOTH parameter estimate in the sex with condom equation remains significant at 5% for the total and adult samples.

Regarding the religion variables, the signs of the parameter estimates indicate that FUND and CATH positively relate to the log-odds of abstinence and the log-odds of intercourse with a condom for all five samples. A striking difference in the results arises by age. Both FUND and CATH bear significant coefficient estimates for those aged 14–17 in the abstinence and sex with condom equations. In contrast, the religion variables are not significant in the equations for the 18–22 year-olds. For the total, male, and female samples, the coefficients on FUND are not significant with the exception of the abstinence equation for females if one is willing to accept a 10% level of significance. Catholic representation, however, significantly increases the log-odds of abstinence at 5%, and the log-odds of sex with a condom at 10%, for the total sample. For young men, the coefficients on CATH are significant in the abstinence equation and in the sex with condom equation, whereas young women are not significantly influenced by the Catholic presence in the state. Young women are significantly affected by parental education achievement, however. As for the other samples, parental education significantly raises the log-odds of abstinence. Living with both parents significantly raises the log-odds of abstinence for young men, for adults and for children at conventional levels, and for the total sample at 10%. The log-odds of intercourse with a condom relative to intercourse without a condom is significantly affected by parental education for the total sample, for young men, and for adults, but is not significantly affected by living with both parents for any of the samples.

We also consider a discrete demand model that adds the price of condoms to the regressors in the first model (without religion and family variables). Condom price serves as own-price in the sex with condom equation, and as the price of a substitute good in the abstinence and sex without condom equations. The price variable is instrumented from location variables, and its coefficient estimate is

never significant. The weak results for the price variable may arise from weak instruments and lack of individual-level price data. (Estimation results and an appendix on the methods for constructing the price instrument are available from the authors on request.)

Comparing the models with and without the price variable, the parameter estimates for the AIDS education variables are the same to the second or third decimal place for all five samples. The same coefficients are significant in the model with price as in the model without price: BOTH in the condom equation for the total sample, young women, and young adults, and SCHOOL, HOME, and BOTH in the condom equation for young women. Thus, there appears to be little omitted variable bias in the coefficient estimates on the key variables when price is excluded as in our original model. For the remainder of this work, we use the original model. We now turn to specification testing.

Specification tests

In this subsection, we conduct hypothesis tests for heteroscedasticity, endogeneity of the AIDS education variables, and the validity of the independence of irrelevant alternatives (IIA) assumption. As discussed above, we find evidence of heteroscedasticity in the model for all samples. We use a regression-based test for heteroscedasticity in multinomial logit estimation derived by Pagan and Vella [30]. The estimated test statistic is the t -ratio on the constant term in an ordinary least squares regression based on the scores. The form of heteroscedasticity tested is $\text{var}(\text{error}) = [\exp(c'z)]^2$, where z is the vector of variables suspected of causing heteroscedasticity and c' is a conformable vector of parameter estimates on z , as in Greene [23, p. 829]. We use only one variable for z , INCOME, as income is often a source of heteroscedasticity in regressions. The Pagan–Vella test yields t -statistics of 16.75 for the total sample, 8.47 for young men, 14.84 for young women, 19.00 for adults, and 12.54 for children. The null hypothesis of homoscedasticity is therefore rejected in all samples. We do not know if other regressors or combinations of regressors contribute to heteroscedasticity and if so, what form that heteroscedasticity might take. Thus, we use the Huber/White/sandwich variance estimator to obtain t -ratios in the multinomial logit results [31, pp. 4, 29].

Second, AIDS education may be endogenous to sexual choices. For example, parents with relatively permissive attitudes may move to a neighborhood because of the philosophy of the school, or they may play an active role in instituting an AIDS education program in the school. If so, young people who attend schools with AIDS education programs may be more likely to engage in intercourse because of parental influence, not because of information conveyed by AIDS education itself, resulting in inconsistent parameter estimates. Further, AIDS education programs may be more readily implemented in communities in which AIDS is prevalent. The youth in these communities may be more prone to unprotected intercourse, in which case parameter estimates on the AIDS education variables would be biased. Rosenzweig and Wolpin [32] offer a similar argument for potential bias in estimates used in the evaluation of public health and family planning programs.

The endogeneity of the AIDS education variables is explored by conducting a Hausman-type test [33, pp. 132–134, 139–147]. Unlike the usual Hausman test, the Hausman-type test cannot produce invalid test statistics (that is, negative χ^2 values) and can accommodate clustered data. The set of instruments for the AIDS education variables includes the following institutional and education supply-side variables: a dummy variable for state-required AIDS/HIV education in the schools [34], the number of teachers in the state, a state-by-state index of public school teacher costs, and average school district revenues from all public and private sources by state [35–37]. These variables are matched to the individuals in the total sample by state of residence to estimate the first stage of the model. The sample contains residents of 48 states. (Nebraska and North Dakota are not represented in the YRBS data set.) One could make an argument against orthogonality of the instruments. Migration in pursuit of, and parental control over, particular AIDS education policies, supply of teachers, cost of teachers, and school revenues is considerably less likely to occur at the state level than at the local school district level, however. The instruments are jointly significant in the first-stage model at better than 1% for all samples. The null hypothesis of exogeneity (or more accurately the null hypothesis of no specification errors) is accepted for all samples.

A Hausman-type test can also be used to test for the independence of irrelevant alternatives, IIA [33, pp. 128–135]. If the two intercourse alternatives, with a condom and without a condom, are closer substitutes than abstinence and either intercourse option, for example, the IIA is violated and the multinomial logit model is invalid. The Hausman-type tests for the validity of the IIA do not reject IIA at conventional levels of significance for any of the samples.

The analyses of alternative models and specification issues support the original findings in the tables. We find no significant impact of AIDS education on the abstinence–intercourse decision. We also find that AIDS instruction, particularly in association with family discussion about AIDS, increases the incidence of condom-protected intercourse. Together these results imply that AIDS education can impede the spread of HIV/AIDS, saving lives and averting treatment costs. Additional social benefits accrue from inhibiting the spread of other sexually transmitted diseases, curbing teen pregnancy, and preventing the transmission of HIV and other STDs to future partners and their partners *ad infinitum*, further saving lives, welfare expenditures, and medical costs.

Conclusion

The results of this study reveal that school-based AIDS education in combination with home-based AIDS education promotes responsible sexual behavior by young Americans. AIDS education does not significantly discourage abstinence but does significantly encourage condom-protected intercourse relative to unprotected intercourse. For all samples except young men, the marginal effects of AIDS education variables on the probability of intercourse without condom protection have negative signs. AIDS education does not significantly affect the sexual choices of young men, but does significantly increase the likelihood of condom-protected intercourse for young women. AIDS education affects abstinence decisions to a greater extent for adolescents aged 14–17, but affects condom decisions to a greater extent for adults 18–22. Overall, it appears that the effects of risk-revealing and risk-altering AIDS education dominate any utility-altering effects. In other words, concerns that AIDS instruction signals social approval of intercourse for young people

and encourages intercourse are not consistent with the insignificant marginal effects of AIDS education on abstinence for all samples.

Our study could be extended in a number of ways. The sexual behavior of young people is difficult to model theoretically, and we invoke a number of simplifying constraints which could be relaxed to yield a more comprehensive analysis. Most importantly, incorporating the utility and risk of pregnancy, including the impact of contraception on risk, would better represent the sexual decision-making process of an individual. A more complete model would also account for sexually transmitted diseases other than HIV. In addition, we rely on individual expected utility maximization, while in reality the couple makes the choices. A joint expected utility maximization model or bargaining model would allow for interdependent utility functions and lend insight into decisions made by sexual partners.

Variable measurement might be improved upon. The threshold equations generate a discrete demand model, and a condom price variable is desirable. The condom price that an individual pays or would pay is the preferred measure, but our measure was instrumented and state-based. Obtaining accurate price data would have to be done at the micro-level and might be problematic because of free and reduced-price condoms at some schools and clinics. Second, the religion of the individual, rather than the fraction of state population Catholic or the fraction Fundamentalist, would yield more precise parameter estimates and could accommodate additional religious groups. The parameters on CATH and FUND broadly encompass neighborhood effects. Peer and neighborhood effects are better measured at the local level, however, and might have an effect on sexual behavior.

We were unable to reconcile two findings regarding differences in behavior for young men and young women. The marginal effects of AIDS education variables on the probability of intercourse with a condom are significant for women, but the AIDS education variables are not significant for men regarding any of the sexual behavior outcomes. Nonetheless, men appear to be more responsive to the Catholic representation in the state than women. Catholic prevalence significantly increases the probability of abstinence for men but not for women. It would be interesting to explore these gender differences, particularly with individual religion data. Modeling potential

gender differences in abstinence–intercourse preferences, in the utility of condom use relative to non-use, and in the impacts of religious precepts regarding premarital sex, abortion and birth control on these preferences, may resolve this apparent anomaly.

Finally, the dummy variable SCHOOL, for example, equals 1 if the individual was previously taught about AIDS or HIV infection at school but not at home. This variable encompasses in-depth, long-term programs taught by experts as well as 15-minute open discussions in home room classes. Philosophy varies across schools and across teachers as well. Abstinence-only programs will likely have a different impact than traditional sex education classes. Abstinence-only sex education programs focus on abstinence until marriage and exclude any issues inconsistent with that ideal, such as contraception, sexually transmitted disease, and condom protection. Similarly, HOME stands for a multitude of communication styles and approaches varying by parental time investments, methods of discussion, accuracy of information, and values conveyed. It would be useful for policymakers to disaggregate these variables into specific attributes of the education received by the individual. As a first step, separating abstinence-only programs from traditional programs and examining the effects on sexual behavior would inform the current debate on funding allocation for AIDS education.

At present, a growing pool of public funds is supporting abstinence-only sex education. Federal funding for abstinence-only programs totaled \$50 million in fiscal year 2000 [38]. The Bush administration has requested \$273 million for fiscal year 2005, double the fiscal year 2004 allocation [39]. The evidence here indicates that denying access to academic information about AIDS may generate avoidable medical costs and loss of life. Thus, government subsidies for abstinence-only sex education programs may be counterproductive.

Acknowledgements

The authors would like to thank two anonymous referees, Duane E. Leigh, Darius Lakdawalla, James F. Ragan Jr, Victor J. Tremblay, Glen Whitman, and participants at the 2001 Southern Economic Association and 2002 American Economic Association meetings for helpful comments, Ke Yang and Hyungho Youn for research assistance, and the Oregon State University

College of Liberal Arts for financial support. The usual caveat applies.

Note

- a. The authors thank an anonymous referee for contributing this insight.

References

1. UNAIDS. *Joint United Nations Programme on HIV/AIDS*. UNAIDS 2004 Report on the Global AIDS Epidemic. Website. <http://www.unaids.org> [02 August 2004].
2. US Department of Health and Human Services, Center for Medicaid and State Operations. *Medicaid and Acquired Immune Deficiency Syndrome (AIDS) and Human Immunodeficiency Virus (HIV) Infection*. January 2004, Website. <http://www.cms.hhs.gov/hiv/hivfs.asp> [02 August 2004].
3. US Department of Health and Human Services, Centers for Disease Control and Prevention. *HIV/AIDS Surveillance Report*. 2003, Website. <http://www.cdc.gov/hiv> [02 August 2004].
4. US Department of Health and Human Services, Centers for Disease Control and Prevention. *HIV Prevention in the Third Decade*, 05 August 2004 update, Website. <http://www.cdc.gov/hiv> [23 August 2004].
5. Haignere CS, Gold R, McDanel H. Adolescent abstinence and condom use: are we sure we are really teaching what is safe? *Health Educ Behav* 1999; **26**: 43–54.
6. Collins C. *Do as i say*. Monograph, University of California, San Francisco Center for AIDS Prevention Studies, December 1997.
7. Holtgrave DR, Qualls NL, Curran JW *et al*. An overview of the effectiveness and efficiency of HIV prevention programs. *Public Health Rep* 1995; **110**: 134–146.
8. Kirby D, Short L, Collins J *et al*. School-based programs to reduce sexual risk behaviors: a review of effectiveness. *Public Health Rep* 1994; **109**: 339–360.
9. Evans WM, Oates WE, Schwab RM. Measuring peer group effects: a study of teenage behavior. *J Polit Econ* 1992; **100**: 966–991.
10. Oettinger GS. The effects of sex education on teen sexual activity and teen pregnancy. *J Polit Econ* 1999; **107**: 606–644.
11. Philipson TJ, Posner RA. *Private Choices and Public Health: The AIDS Epidemic in an Economic Perspective*. Harvard University Press: Cambridge, MA, 1993.
12. Philipson TJ, Posner RA. Public spending on AIDS education: an economic analysis. *J Law Econ* 1994; **37**: 17–38.

13. US Department of Health and Human Services. *National Health Interview Survey, 1992: Youth Risk Behavior Supplement*. US Department of Health and Human Services: Hyattsville, MD, 1993 (producer); Inter-University Consortium for Political and Social Research: Ann Arbor, MI, 1994 (distributor).
14. Ahituv AV, Hotz J, Philipson T. The responsiveness of the demand for condoms to the local prevalence of AIDS. *J Hum Resour* 1996; **31**: 869–897.
15. US Department of Health and Human Services, National Center for Health Statistics. *Health, United States, 1992*. Public Health Service: Hyattsville, MD, 1993.
16. Santelli JS, Warren CW, Lorry R *et al*. The use of condoms with other contraceptive methods among young men and women. *Fam Plann Perspect* 1997; **29**: 261–267.
17. US Bureau of the Census. *Current Population Reports, Series P60-184, Money Income of Households, Families, and Persons in the United States: 1992*. US Government Printing Office: Washington, DC, 1993.
18. BTA Economic Research Institute. *The 1995 Geographic Reference Report*. BTA Economic Research Institute: Redmond, WA, 1994.
19. Korn E, Graubard BI. *Analysis of Health Surveys*. Wiley: New York, 1999.
20. Piccinino LJ, Mosher WD. Trends in contraceptive use in the United States: 1982–1995. *Fam Plann Perspect* 1998; **30**: 4–10, 46.
21. Olsen RJ, Farkas G. The effect of economic opportunity and family background on adolescent cohabitation and childbearing among low-income blacks. *J Labor Econ* 1990; **8**: 341–362.
22. Duncan GJ, Hoffman SD. Welfare benefits, economic opportunities, and out-of-wedlock births among black teenage girls. *Demography* 1990; **27**: 519–535.
23. Greene WG. *Econometric Analysis*. Prentice-Hall: Upper Saddle River, NJ, 2000.
24. Rostosky SS, Regnerus MD, Wright ML. Coital debut: the role of religiosity and sex attitudes in the ADD health survey. *J Sex Res* 2003; **40**: 358–367.
25. Hardy SA, Rafelli M. Adolescent religiosity and sexuality: an investigation of reciprocal influences. *J Adolesc* 2003; **26**: 731–739.
26. McCree DH, Wingood GM, DiClemente R *et al*. Religiosity and risky sexual behavior in African-American adolescent females. *J Adolesc Health* 2003; **33**: 2–8.
27. Pleck JH, Sonenstein FL, Ku LC. Contraceptive attitudes and intention to use condoms in sexually experienced and inexperienced adolescent males. *J Fam Issues* 1990; **11**: 294–312.
28. Bradley MB, Green NM Jr, Jones DE *et al*. *Churches and Church Membership in the United States 1990*. Glenmary Research Center: Atlanta, 1992; 12–36.
29. Smith TW. Classifying protestant denominations. *Rev Religious Res* 1990; **31**: 225–245 (unpublished appendix).
30. Pagan A, Vella F. Diagnostic tests for models based on individual data: a survey. *J Appl Econometrics* 1989; **4**(Suppl): S29–S59.
31. STATA. *STATA Survey Data Reference Manual Release 8*. Stata Press: College Station, TX, 2003.
32. Rosenzweig MR, Wolpin KI. Evaluating the effects of optimally distributed public programs: child health and family planning interventions. *Am Econ Rev* 1986; **76**: 470–482.
33. STATA. *STATA Base Reference Manual, vol. 4 (S-Z Release 8)*. Stata Press: College Station, TX, 2003.
34. NARAL. *Sexuality Education in America: A State-by-State Review* (revised edn). NARAL: Washington, DC, 1995.
35. US Department of Education, National Center for Education Statistics. *Public School Teacher Cost Differences Across the United States: An Analysis to Develop a Teacher Cost Index (TCI)*. US Government Printing Office: Washington, DC, 1995.
36. US Department of Education, National Center for Education Statistics. Table 65 – Public elementary and secondary teachers, by level and state: Fall 1991 to Fall 1996. *Digest of Education Statistics*. 1997, Website. <http://nces.ed.gov/pubs/digest97/d97t065.html> [13 May 2002].
37. US Department of Education, National Center for Education Statistics. *Inequalities in Public School District Revenues, NCES 98-210*. US Government Printing Office: Washington, DC, 1998.
38. US Department of Health and Human Services, Office of Budget. *Budget in Brief, Fiscal Year 2000*: 23. Website. www.hhs.gov/budget/docbudget.htm [01 September 2004].
39. US Department of Health and Human Services, Office of Budget. *Budget in Brief, Fiscal Year 2005*: 4. Website. www.hhs.gov/budget/docbudget.htm [01 September 2004].