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Does the number of sex partners affect educational attainment? Evidence from female respondents to the Add Health

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Abstract We use data on young women from the National Longitudinal Study of Adolescent Health to explore the relationship between number of sex partners and educational attainment. Using the average physical development of male schoolmates to generate plausibly exogenous variation in number of sex partners, instrumental variables estimates suggest that number of sex partners is negatively related to educational attainment. This result is consistent with the argument that romantic involvements are time consuming and can impose substantial emotional costs on young women.

Keywords Adolescent sex · Educational attainment · Abstinence

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1 Introduction

In a recent study, Sabia and Rees (2009) found that delaying age at first intercourse sharply increases the probability that females graduate high school and that this effect persisted even after controlling for teen fertility. One interpretation of this result is that early sexual activity impedes human capital accumulation through fostering social and psychological turmoil (Rector and Johnson 2005). In fact, there is evidence that an early sexual debut leads to more frequent sexual encounters (Kahn et al. 2002) and more romantic partners (Sandfort et al. 2008), both of which could, in theory, take time away from academic pursuits and adversely impact psychological wellbeing.

Using a sample of females 22 through 24 years of age drawn from the National Longitudinal Study of Adolescent Health, we explore whether number of lifetime sex partners is related to educational attainment. Ordinary least squares estimates indicate a strong negative relationship between number of sex partners and educational attainment. This relationship, however, could easily be due to difficult-to-measure individual- or family-level characteristics. In an effort to account for the potential influence of such characteristics, we pursue an instrumental variables strategy. Specifically, exogenous variation in the number of sex partners is identified using the physical development of the respondent's male schoolmates. We hypothesize that having schoolmates of the opposite sex who reached puberty quickly should lead to a greater number of lifetime sex partners due to increased availability and desirability of potential sex partners.

Instrumental variables results suggest that number of sex partners is negatively related to number of years of schooling, the probability of high school graduation, and the probability of attending college. The magnitude of the effect is modest (each additional sex partner is associated with an approximately 0.1-year decline in years of schooling attained), but a wide set of sensitivity tests bolster the case for a causal interpretation of these results. Moreover, the negative relationship between number of sex partners and educational attainment remains when we condition on teen fertility and age at first intercourse, and when age at first intercourse is treated as an endogenously determined variable. This pattern of results suggests that, among young women, the frequency of sex partners may play an important role in the formation of human capital.

2 Background

Economists have recently become interested in social interactions and their relationship to educational and labor market outcomes. For instance, Segal (2005) examined the effects of disruptive social behavior on educational and labor market outcomes; Krueger and Schkade (2008) examined the relationship between interactions with friends and occupation choice; and Borghans

et al. Borghans et al. (2008) examined the effect of social interactions as an adolescent on a variety of labor market outcomes. Although these and other studies attempt to explore the influence of interpersonal interactions on outcomes typically studied by economists, there has been comparatively little attention paid to interactions of a romantic nature. Such interactions are arguably as important to teens and young adults as interactions with friends and family.

In fact, there is evidence that the typical US teenager spends a great deal of time thinking about, and in the company of, the opposite sex. For instance, Richards et al. (1998) paged 11th and 12th graders living in Chicago at random intervals and asked them to write down what they were thinking and doing. The results of this study suggest that female 11th and 12th graders were engaged in thinking about "an individual of the opposite sex" approximately 8 h/week and were alone with a male approximately 10 h/week. In contrast, teenagers spend on average less than 6 h/week studying or reading for pleasure (Juster et al. 2004).[1]

Although Richards et al. (1998) noted that being in the company of an individual of the opposite sex was often associated with higher self-esteem and other "positive feelings," they did not attempt to assess the impact of romantic relationships on psychological wellbeing. Using data from the National Longitudinal Study of Adolescent Health, Joyner and Udry (2000) found that becoming involved in short-lived, unstable romantic relationships was associated with an increase in the symptoms of depression, especially among females. Ayduk et al. (2001), Grello et al. (2006), and Davila et al. (2004) focused on the impact of romantic relationships gone sour. Their results, summarized by Collins et al. (2009, p. 641), suggest that, "break-ups, rather than involvement in romantic relationships per se, may explain the frequent reports of elevated depressive symptoms [among adolescents]."

A related vein of research examines the effect of having multiple sex partners on psychological wellbeing and behavior. For instance, Rector et al. (2002) found that having multiple sex partners was associated with a greater likelihood of feeling "very unhappy"; Howard and Wang (2004) found that it was associated with substance use; and Hallfors et al. (2005) found that adolescent females who had multiple sex partners were 10 times more likely to develop the symptoms of major depression than their counterparts who remained sexually abstinent but found no evidence of a similar relationship between having multiple sex partners and depression among male adolescents.

[1] Juster et al. (2004) analyzed data from the Child Development Supplement to the Panel Study of Income Dynamics. They found that, during the 2002–2003 academic year, the average 15–17-year-old spent 4 h 59 min/week studying and an additional 49 min reading. In comparison, Kooreman (2007) found that the average Dutch teenager spent 5.8 h/week reading but did not distinguish between studying and reading for pleasure.

Hallfors et al. (2005) hypothesized that female adolescents were especially susceptible to stress and depression as a result of sexual activity.[2]

As noted above, our interest is in whether lifetime number of sex partners is negatively related to the educational attainment of young women. There are at least three reasons why we might expect to find evidence of such a relationship. First, there is a potential tradeoff between time spent in the pursuit of academic goals and time spent thinking about or in the company of the opposite sex.[3] Second, to the extent that it is a measure of the intensity or frequency of romantic relationships, work by Joyner and Udry (2000) and others suggests that number of sex partners may be negatively related to psychological wellbeing, which in turn may be related to educational outcomes. In fact, Joyner and Udry (2000) found that school performance explained a substantial proportion of the estimated effect of romantic relationships on depression. Finally, having multiple sex partners may increase the risk of teen childbearing, miscarriages, and abortions, all of which could influence schooling decisions.

The remainder of this paper is organized as follows. The next section describes the data and provides a description of the outcome variables used in the analysis below. Section 4 introduces the instruments and empirical models. In Section 5 we present the basic results and then conduct a series of sensitivity and falsification tests. Section 6 concludes.

3 Data and measures

The primary data source for this project is the National Longitudinal Study of Adolescent Health (Add Health), a nationally representative school-based survey conducted by the Carolina Population Center at the University of

[2]Specifically, Hallfors et al. (2005, p. 168) wrote, girls' greater interpersonal sensitivity contributes to higher levels of interpersonal stress during adolescence. Substance use and sexual activity likely contribute to experienced stress. The greater exposure to stress due to risk behavior, and girls' more negative reactivity to interpersonal stressors, may partially account for demonstrated gender differences in depression.

[3]We are not the first to hypothesize that such a tradeoff exists. Freud hypothesized that, if repressed, sexual energy (or libido) could be transformed into creative energy (Gay 1992). In *Think and Grow Rich*, Hill (1937) famously asserted that:

> So strong and impelling is the desire for sexual contact that men freely run the risk of life and reputation to indulge in it. When…redirected along other lines, this motivating force maintains all of its attributes of keenness of imagination, courage, etc., which may be used as powerful creative forces in literature, art, or in any other profession or calling, including, of course, the accumulation of riches.

In a similar vein, Rector and Johnson (2005, p. 20) wrote:

> Human attention and motivation are finite; when greater energy and interest are invested in sexual activity, the drive for academic performance is likely to diminish. Sexually active teens may become preoccupied with the present; long-term academic goals may have diminished importance.

North Carolina at Chapel Hill. The first wave of the Add Health (the Wave I core in-home sample) provides detailed health and behavioral information on 20,745 middle and high school students from 1995. Approximately one year later, at Wave II, 14,738 of these students were re-interviewed; approximately 5 years later, at Wave III, 15,170 of the original participants were contacted and interviewed.[4]

Our analysis is focused on a sample of 3,684 females who were between the ages of 22 and 24 at Wave III (2002).[5] In order to be included in this sample, a respondent had to answer questions about their educational attainment and number of sex partners at Wave III. In addition, we restricted our focus to respondents who reported having had intercourse by Wave III. Fully 91% of the female Add Health respondents between the ages of 22 and 24 were sexually active by their Wave III interview.[6]

Three educational attainment measures were constructed from self-reported information in the Add Health data. The first is a continuous measure equal to the number of years of schooling completed; the second is a dichotomous variable equal to 1 if the respondent had reported receiving a high school diploma by the time of the Wave III survey in 2001, and equal to 0 if she dropped out; the third is equal to 1 if the respondent was attending college at the time of the Wave III survey or had completed at least one year of college prior to the survey.

The key independent variable of interest is *Number of Sex Partners.* This variable is constructed using respondents' answers to the following question asked of Wave III participants: "With how many partners have you ever had vaginal intercourse, even if only once?" The typical respondent in our sample reported having had almost six sex partners; approximately a third of the sample reported one to two partners, 37.4% reported 3–6 partners, 21.6% reported 7–14 partners, and 8.2% reported 15 or more partners.[7]

In Tables 1 and 2, we present descriptive statistics for numbers of sex partners by educational attainment. It provides evidence that number of sex partners is negatively related to educational attainment. For respondents who

[4]A sample of 80 high schools and 52 middle schools from the USA was selected with unequal probability. Incorporating systematic sampling methods and implicit stratification into the Add Health study design ensured this sample is representative of US schools with respect to region of country, urbanicity, school size, school type, and ethnicity (see Harris et al. 2003 for more information on the research design).

[5]At Wave III, Add Health respondents were between the ages of 18 and 28. In the interest of keeping our sample homogeneous and old enough to have completed high school and begun college, we focused on individuals between the ages of 22 and 24. However, our main results are robust to examining a larger sample that includes younger females aged 18–21 (see Supplementary Appendix Table 2). Only 5.2% of female Add Health respondents were older than 24 at Wave III.

[6]Nine percent of 22- to 24-year-olds reported having zero sexual partners in their lifetime at the time of the Wave III survey. These individuals are omitted from our sample in order to avoid having to estimate abstinence effect. However, their inclusion does not appreciably change the results presented below. Estimates including virgins are available upon request.

[7]Self-reports of sexual behavior have been found to be relatively accurate, despite the sensitive nature of such subject matter. See, for example, Jaccard and Wan (1995) and Jaccard et al. (2002).

Table 1 Average number of sex partners by school attainment

	Overall (1)	≤10 years (2)	11–12 years (3)	13–14 years (4)	15+ years (5)	No HS diploma (6)	HS diploma (7)	No college (8)	College (9)
Number of sexual partners	5.96 (6.48)	7.41 (7.81)	6.27 (6.96)	6.21 (6.74)	5.28 (5.46)	7.04 (7.66)	5.76 (6.21)	6.35 (6.99)	5.73 (6.15)
N	3,684	164	1,338	881	1,301	578	3,106	1,352	2,332

Note: Standard deviations are in parentheses. The sample is drawn from respondents ages 22–24 at the time of the Wave III survey of the National Longitudinal Study of Adolescent Health. The sample consists of non-virgin females with non-missing information on schooling and total number of sexual partners

Table 2 Distribution of sex partners by school attainment

	Overall (1)	≤10 years (2)	11–12 years (3)	13–14 years (4)	15+ years (5)	No HS diploma (6)	HS diploma (7)	No college (8)	College (9)
1–2 sex partners	0.327 (0.469)	0.226 (0.419)	0.318 (0.466)	0.296 (0.457)	0.371 (0.483)	0.303 (0.460)	0.332 (0.471)	0.308 (0.462)	0.338 (0.473)
3–6 sex partners	0.374 (0.484)	0.427 (0.496)	0.373 (0.484)	0.393 (0.489)	0.357 (0.479)	0.341 (0.474)	0.381 (0.486)	0.376 (0.485)	0.373 (0.484)
7–9 sex partners	0.113 (0.317)	0.091 (0.289)	0.107 (0.309)	0.111 (0.315)	0.124 (0.329)	0.112 (0.316)	0.113 (0.317)	0.108 (0.311)	0.116 (0.320)
10–14 partners	0.103 (0.303)	0.122 (0.328)	0.108 (0.311)	0.110 (0.313)	0.089 (0.285)	0.123 (0.329)	0.099 (0.298)	0.109 (0.312)	0.099 (0.298)
15+ partners	0.082 (0.275)	0.134 (0.342)	0.094 (0.292)	0.090 (0.286)	0.059 (0.236)	0.121 (0.327)	0.075 (0.264)	0.097 (0.296)	0.074 (0.262)
N	3,684	164	1,338	881	1,301	578	3,106	1,352	2,332

Note: Standard deviations are in parentheses. The sample is drawn from respondents ages 22–24 at the time of the Wave III survey of the National Longitudinal Study of Adolescent Health. The sample consists of non-virgin females with non-missing information on schooling and total number of sexual partners

completed 10 years of schooling or less, the average number of lifetime sex partners was 7.41. In contrast, respondents who completed 15 or more years of schooling had, on average, 5.28 sex partners. Those who reported receiving a high school diploma by Wave III had an average of 5.76 sex partners, while the corresponding figure for dropouts was 7.04. Respondents who attended college had an average of 5.73 sex partners, while the corresponding figure for those who did not attend college was 6.35.

4 Estimation strategies

The differences describe in the paragraph above, although statistically significant, could easily be driven by factors such as personal characteristics, family background, or even school structure or size. The first step in our analysis is to test whether the relationship between number of sex partners and educational attainment can be explained by these variables. Specifically, we estimate the following equation using Ordinary Least Squares (OLS):

$$E_i = \beta_0 + \boldsymbol{\beta_1'} \boldsymbol{X_i} + \beta_2 \text{ Number of Sex Partners}_i + \varepsilon_i, \tag{1}$$

where E_i is a measure of educational attainment constructed from answers to the Wave III Add Health survey, and $\boldsymbol{X_i}$ is a vector of controls.

We include a wide set of individual-, family-, and school-level variables in $\boldsymbol{X_i}$. Most are measured at Wave I, including the educational attainment of the parent who answered the parental questionnaire, household income, parents' marital status, the respondent's Peabody Picture Vocabulary Test score (a measure of cognitive ability), measures of religiosity, race, ethnicity, height, weight, class size, whether the respondent attended a public school, percent of students in the respondent's school who were enrolled in college preparatory classes, school size, school type (high school versus junior high/middle school), average age of students in the respondent's school, whether she had an older sibling, and a measure of the respondent's attractiveness as rated by the Add Health interviewer. Controls drawn from the Wave III include age dummies and an indicator for whether the respondent had ever been married.[8]

Although the detailed information available in the Add Health allows us to include a wide variety of "observables" in the vector $\boldsymbol{X_i}$, the estimate of β_2 will be biased if there are unobserved characteristics that are associated with number of sex partners and educational attainment. For example, family background characteristics such as the degree of parental supervision may be associated with both sexual activity as an adolescent and the decision to drop out of school.

[8]Tables 1 and 2 present descriptive statistics for the all the variables used in the analysis.

One method of addressing the issue of family-level unobservables is to restrict the sample to twin sisters and include a vector of family fixed effects in the estimating equation:

$$E_{ij} = \beta_0 + \boldsymbol{\beta_1'} \boldsymbol{X_i} + \beta_2 \text{ Number of Sex Partners}_{ij} + \kappa_j + \varepsilon_{ij}, \quad (2)$$

where j denotes the individual's family and κ_j is the vector of family fixed effects.[9] While this approach controls for the influence of difficult-to-measure differences at the family level, it is also associated with a number of drawbacks.

First, twin sisters may not be exactly alike in terms of personality and experiences, and these unmeasured differences between twins could be correlated with both the number of sex partners chosen and school attainment. For instance, one twin may have discounted the future more than the other or have been more risk adverse. Another drawback to adding family fixed effects to the estimating model is that it involves a large reduction in sample size. As noted by Klepinger et al. (1999, p. 424), this reduction in sample size, coupled with a focus on twins, may "reduce the efficiency of estimates, and may introduce sample selection bias." Finally, if additional time spent in school leads to different preferences with regard to number of sex partners or provides greater exposure to potential partners, then reverse causality could be an issue.

In order to address the potential sources of endogeneity outlined above, we pursue an instrumental variables strategy. If Z_i is a vector of instruments correlated with the number of sex partners but uncorrelated with the error term of Eq. 1, and number of sex partners is given by:

$$\text{Number of Sex Partners}_i = \gamma_0 + \boldsymbol{\gamma_1'} \boldsymbol{X_i} + \boldsymbol{\gamma_2'} \boldsymbol{Z_i} + \varepsilon_{i,} \quad (3)$$

then β_2 can be obtained using two-stage least squares (2SLS) estimation. 2SLS estimation will produce a consistent estimate of the effect of number of sex partners on educational attainment provided that appropriate instruments can be found. We utilize three instruments related to the timing of the biological onset of puberty.

We begin by following the approach of Sabia and Rees (2011). Specifically, we use two measures of the respondent's own pubertal physical development as instruments. The first of these is the respondent's physical development score on a five-point physical development scale. At Wave I, after a series of questions with regard to breast development and body curves, female Add Health participants were asked, "[h]ow advanced is your physical development

[9] Although there is evidence that economic conditions impact sexual activity (Arkes and Klerman 2009), this specification will capture characteristics of the community common to siblings such as local economic conditions.

compared to other girls your age?" Possible responses were: "I look younger than most" = 1; "I look younger than some" = 2; "I look about average" = 3; "I look older than some" = 4; and "I look older than most" = 5.

The second instrument is the respondent's age of menarche. There is evidence to suggest that age of menarche is related to age at first intercourse (Sabia and Rees 2009; Averett et al. 2002; Phinney et al. 1990; Soefer et al. 1985; Zabin et al. 1986) and the dating behavior of adolescent females (Phinney et al. 1990; Presser 1978), but there is little reason to believe that it should directly affect educational attainment. In fact, several studies have assumed that physical development, as measured by age of menarche, is exogenous to educational attainment conditional on factors such body weight, height, and physical attractiveness (Sabia and Rees 2009; Klepinger et al. 1995, 1999; Ribar 1994; Field and Ambrus 2008).

However, a potential criticism of the above instruments is that the timing of the respondent's own physical development may be correlated with unmeasured components of physical or mental health, which in turn could affect educational attainment.[10] Therefore, our final instrument does not measure the respondent's *own* physical development, but rather how physically developed the respondent's male schoolmates were at Wave I. After a series of questions with regard to facial hair growth, underarm hair growth, and the deepening of their voice, males who participated in the Add Health were asked, "[h]ow advanced is your physical development compared to other boys your age?" Again, the possible responses were: "I look younger than most" = 1; "I look younger than some" = 2; "I look about average" = 3; "I look older than some" = 4; and "I look older than most" = 5. These responses were used to calculate a mean physical development score for the males in each respondent's school, which can be thought of as measuring the number of potential partners or their desirability.

We hypothesize that the mean physical development score will be positively related to number of sex partners. Although male Add Health respondents were asked to assess their physical maturity relative to "other boys your age," we are careful to control for school characteristics that could be related to educational attainment, including the average age of students, whether the school was public or private, whether it was a high school or junior high school, average class size, school size, and percentage of students enrolled in college preparatory classes. We find little evidence that the mean male physical development score is related to school characteristics (see Supplementary Appendix Table 3); thus we believe that with the inclusion of the above

[10]The early onset of sexual maturation may be associated with obesity or being overweight (Adair and Gordon-Larsen 2001; Anderson et al. 2001), and late onset of sexual maturation may be associated with bulimia or being extremely underweight (Striegel-Moore et al. 2001). It is also possible that early maturation may be associated with greater self-esteem and better mental health (Booth 1990; Prieto and Robbins 1975).

controls, the remaining variation in the mean physical development score can be thought of as essentially random.[11]

In order to test the exogeneity of the instruments, we take a number of tacks. First, we include them as regressors in Eq. 1 and observe whether, after controlling for number of sex partners, they are individually or jointly significant predictors of educational attainment. In addition, we use a Hansen test of overidentifying restrictions as a more formal method of investigating whether the instruments are correlated with the residuals of Eq. 1. We also conduct a wide set of robustness tests, testing the sensitivity of our results to instrument choice. Finally, to ensure that the instruments are not capturing physical or mental health, we explore the sensitivity of our results to adding an extensive set of controls for weight, depression, and self-esteem.

5 Results

Regression results are presented in Tables 3–11. They are based on unweighted data and the reported standard errors are corrected for clustering at the school level. Our focus is on the estimates of β_2, the coefficient of *Number of Sex Partners*. The estimated coefficients of the control variables are not shown but are available upon request.

5.1 OLS estimates

Table 3 presents OLS estimates of the relationship between number of sex partners and educational attainment. Panel I shows results for the full sample of 22- to 24-year-old females. Conditional on observables, we find that each

[11] Many studies have examined the correlates and causes of age at menarche, but only a relative handful have examined the correlates of male pubertal development. From these studies we know that there is substantial regional variation in age at menarche (Saar et al. 1988; Boldsen and Mascie-Taylor 1992; Rimpela and Rimpela 1993; Parent et al. 2003; Juul et al. 2006). There is also evidence, albeit weaker, of regional variation in male pubertal development (Juul et al. 2006, 2007). Regional variation in both male and female pubertal development could be due to socioeconomic differences, genetic factors, or environmental conditions such as light, temperature, altitude, and contaminants (Zacharias and Wurtman 1969; Parent et al. 2003; Monosson et al. 1999; Golub et al. 2004; Matchock et al. 2004). Field and Ambrus (2008, p. 895) have argued persuasively that most of the observed variation in age at menarche is genetic in nature and therefore can be thought of as random. Presumably, genetic-based variation in male pubertal development can also be thought of as random, and it is difficult to believe that factors such as light, temperature, altitude, and contaminants are related systematically to both number of sex partners and educational attainment. However, if the school-level variation in male physical development is a reflection of regional differences in socioeconomic status, and if socioeconomic status in turn affects both number of partners and educational attainment, this would bias our 2SLS estimates. In an effort to address this potential problem, we experiment with controlling for the social economic status of the respondent's schoolmates. The results are reported in column (5) of Table 8.

Table 3 OLS estimates of relationship between number of sex partners and females' school attainment

	Years of schooling (1)	High school (2)	College (3)
Panel I: Ages 22–24			
Number of sex partners	−0.035***	−0.005***	−0.005***
	(0.006)	(0.001)	(0.001)
	[3,684]	[3,684]	[3,684]
Panel II: Age 22			
Number of sex partners	−0.045***	−0.006***	−0.008***
	(0.010)	(0.002)	(0.002)
	[1,287]	[1,287]	[1,287]
Panel III: Age 23			
Number of sex partners	−0.016***	−0.005**	−0.004***
	(0.005)	(0.002)	(0.002)
	[1,302]	[1,302]	[1,302]
Panel IV: Age 24			
Number of sex partners	−0.026***	−0.003	−0.004**
	(0.008)	(0.002)	(0.002)
	[1,095]	[1,095]	[1,095]

Notes: Standard errors corrected for clustering at the school level are in parentheses. Estimates are from unweighted OLS regressions based on data from Waves I and III of the National Longitudinal Study of Adolescent Health. The sample includes respondents ages 22–24 at the time of the Wave III survey who have had at least one sexual partner in their lifetime and have non-missing information on educational attainment. All models include the full set of controls

***Statistically significant at the 1% level; **at the 5% level; *at the 10% level

additional sex partner is associated with 0.035 fewer years of schooling (column 1), a 0.005 lower probability of receiving a high school diploma (column 2), and a 0.005 lower probability of attending college (column 3).[12]

The specification in Panel I includes a set of age dummies. In Panels II–IV, we estimate separate regressions by age. The results indicate that the negative relationship between number of sex partners and educational attainment exists across the age distribution, although the estimated effects are slightly larger for respondents who were 22 years of age at Wave III.

Naively interpreted, the results in Table 3 suggest that having multiple sex partners leads to lower human capital acquisition. However, because the association between sex partners and educational attainment may be driven by family-level unobservables, we next turn to a model that compares differences in educational attainment between twin sisters.

[12]Using a single-equation probit model to estimate effects on high school completion and college attendance produced similar results. Each additional sex partner is associated with a 0.004 increase in the probability of high school diploma receipt (standard error = 0.001; $p = 0.00$) and a 0.006 increase in the probability of college attendance (standard error = 0.001; $p = 0.00$).

Table 4 Family fixed estimates of relationship between number of sex partners and schooling for sample of twin sisters

	Years of schooling		High school		College	
	OLS (1)	FE (2)	OLS (3)	FE (4)	OLS (3)	FE (4)
Number of sex partners	−0.036	−0.004	−0.019**	−0.016**	−0.003	0.010
	(0.044)	(0.044)	(0.009)	(0.008)	(0.011)	(0.012)
	[143]	[143]	[143]	[143]	[143]	[143]

Notes: Sample sizes are in brackets. Standard errors in OLS models are corrected for clustering at the family level. Estimates are from unweighted OLS and family fixed effects regressions based on a sample of twin sisters from Waves I and III of the National Longitudinal Study of Adolescent Health. The sample includes respondents ages 22–24 at the time of the Wave III survey who have had at least one sexual partner in their lifetime and have non-missing information on educational attainment. OLS models include the controls in Tables 1 and 2. Family fixed effects models include controls for PPVT score, bodyweight, marital status, and attractiveness

***Statistically significant at the 1% level; **at 5% the level; *at the 10% level

5.2 Twin sisters

Table 4 presents estimates of Eq. 2 based on a sample of 143 twins.[13] The sample includes both monozygotic and dizygotic twins, and twins of unknown zygoticity. If two twins reported the same number of sex partners, the pair was not included in the analysis. For purposes of comparison, Table 4 also presents OLS estimates based on the twins sample.

Estimates of Eq. 2 provide some evidence that the negative effect of having multiple sex partners is not fully explained by family-level unobservables (Table 4). Specifically, we find that each additional sex partner is associated with a 1.6 percentage-point decline in the probability of graduating high school, an estimate that is statistically equivalent to that produced by OLS. However, there is little evidence that number of sex partners is related to years of schooling completed or the probability of college graduation.

It is tempting to view the negative estimated relationship between number of sex partners and the probability of high school graduation in Table 4 as casual in nature. However, there is reason to treat it with care. As noted, estimates based on twin data could reflect reverse causality, or could reflect the fact that we have only a small sample of twins with which to work. The next section presents 2SLS estimates of the relationship between number of sex partners and educational attainment. Provided that we have valid instruments with sufficient power, 2SLS estimates will allow us to avoid these problems.

[13]The sample includes 70 twin pairs and one set of triplets. Because Eq. 2 includes family fixed effects, there are only four controls in the vector X_i: the respondent's attractiveness as assessed by the Add Health interviewer, bodyweight, PPVT score, and marital status at Wave III.

Table 5 Estimated relationship between the instruments, sexual partner variables, and schooling

	Instrument relevance	Instrument exogeneity		
	Number partners (1)	Years of schooling (2)	High school (3)	College (4)
Average male physical development score in female's school	2.64*** (0.732)	−0.286 (0.257)	−0.006 (0.038)	−0.095 (0.061)
Own physical development index	0.651*** (0.117)	−0.033 (0.031)	−0.009 (0.008)	−0.002 (0.006)
Age of menarche	−0.022 (0.066)	0.004 (0.017)	0.001 (0.003)	0.0005 (0.005)
F-stat on all instruments	F = 13.3	F = 0.94	F = 0.47	F = 0.88
p-value on joint significance test	$p = 0.00$	$p = 0.42$	$p = 0.70$	$p = 0.45$
Number of sex partners		−0.034*** (0.006)	−0.005*** (0.001)	−0.005*** (0.001)
N	3,578	3,578	3,578	3,578

Notes: Standard errors corrected for clustering at the school level are in parentheses. Estimates are from unweighted OLS regressions based on data from Waves I and III of the National Longitudinal Study of Adolescent Health. The sample includes respondents ages 22–24 at Wave III who have had at least one sexual partner in their lifetime and have non-missing information on educational attainment and each of the instruments. All models include the full set of controls in Tables 1 and 2 along with average age of students in the female's school, and indicators for whether the female's school is a junior high school, high school, or comprehensive school

*** Statistically significant at the 1% level; **at the 5% level; *at the 10% level

5.3 Baseline IV estimates

Table 5 provides evidence with regard to the relevance and exogeneity of the instruments. The first column of Table 5 shows estimates of Eq. 3. The respondent's own physical development score is positively related to number of sex partners; a one-point increase in this score is associated with 0.65 more sex partners. The mean physical development score of males in the respondent's school is also positively related to number of sex partners. Specifically, a one-point increase in the mean score is associated with 2.6 additional sex partners. The estimated coefficient of *Age of Menarche*, however, is not significantly related to number of sex partners.[14] Jointly, the instruments are significant predictors of number of sex partners, with an F-statistic of 13.3, meeting the standard for instrument relevance suggested by Staiger and Stock (1997). In columns (2)–(4), we present estimates of Eq. 1 that include the instruments as explanatory variables along with the number of sex partners. The instruments are never individually or jointly significant predictors of education,

[14]If the own physical development index is dropped as an instrument, the coefficient of age of menarche becomes positive, but is not significant at the 5% level.

Table 6 2SLS estimates of effect of number of sex partners on females' school attainment

	Years of schooling		High school		College	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (3)	2SLS (4)
Number of sex partners	−0.035***	−0.101**	−0.005***	−0.015*	−0.005***	−0.017**
	(0.006)	(0.042)	(0.001)	(0.009)	(0.001)	(0.008)
	[3,578]	[3,578]	[3,578]	[3,578]	[3,578]	[3,578]
F-stat on instruments (first-stage)		F = 13.3		F = 13.3		F = 13.3
Hansen J-stat on overidentification test		J = 0.283		J = 0.356		J = 1.90
p-value on overid test		$p = 0.87$		$p = 0.84$		$p = 0.39$

Notes: Sample sizes are in brackets. Standard errors corrected for clustering at the school level are in parentheses. Estimates are from unweighted OLS and 2SLS regressions based on data from Waves I and III of the National Longitudinal Study of Adolescent Health. The sample includes respondents ages 22–24 at Wave III who have had at least one sexual partner in their lifetime and have non-missing information on educational attainment and each of the instruments. All models include the full set of controls in Tables 1 and 2 along with average age of students in the female's school, and indicators for whether the female's school is a junior high school, high school, or comprehensive school

***Statistically significant at the 1% level; **at 5% the level; *at the 10% level

suggesting that they do not proxy for unmeasured determinants of educational attainment.

Table 6 presents the second-stage estimates as well as OLS estimates for the sample used in the 2SLS analysis. They show that an additional sex partner reduces years of schooling by 0.035, reduces the probability of high school graduation by 0.015, and reduces the probability of college attendance by 0.017. Although these estimates are larger than the corresponding OLS estimates, Hausman tests fail to reject equivalence. In all three specifications, overidentification tests indicate that the instruments are valid.

Because the effect of sex partners on educational attainment may be nonlinear, we created three new outcome variables: *Three or More Partners*, equal to 1 if the respondent reported having three or more partners, and equal to 0 otherwise; *Seven or More Partners*, equal to 1 if the respondent reported having seven or more partners, and equal to 0 otherwise; and *Fifteen or More Partners*, equal to 1 if the respondent reported having 15 or more partners, and equal to 0 otherwise.

2SLS estimates using these new second-stage outcomes appear in Table 7 and suggest that having three or more sex partners is associated with approximately the same decrease in educational attainment as having seven or more sex partners. In other words, the effect of having multiple sex partners appears to "kick in" quickly. There is also evidence that having 15 or more partners is associated with a larger decrease in educational attainment than having seven or more partners. However, we should emphasize that the coefficients of *Fifteen or More Partners* are imprecisely estimated. In fact, they are so

Table 7 2SLS estimates of effect of multiple sex partners on females' school attainment

	Years of schooling (1)	High school (2)	College (3)
Panel I: ≥3 partners			
Three or more sex partners	−1.58**	−0.262	−0.242*
	(0.730)	(0.163)	(0.145)
	[3,578]	[3,578]	[3,578]
F-stat on instruments (first-stage)	F = 15.4	F = 15.4	F = 15.4
Hansen J-stat on overid test	J = 0.959	J = 0.290	J = 2.51
p-value on overid test	$p = 0.62$	$p = 0.87$	$p = 0.29$
Panel I: ≥7 partners			
Seven or more sex partners	−1.34**	−0.186	−0.245**
	(0.528)	(0.114)	(0.120)
	[3,578]	[3,578]	[3,578]
F-stat on instruments (first-stage)	F = 25.8	F = 25.8	F = 25.8
Hansen J-stat on overid test	J = 0.047	J = 0.617	J = 1.23
p-value on overid test	$p = 0.98$	$p = 0.73$	$p = 0.54$
Panel I: ≥15 partners			
Fifteen or more sex partners	−2.92**	−0.503	−0.419*
	(1.38)	(0.320)	(0.254)
	[3,578]	[3,578]	[3,578]
F-stat on instruments (first-stage)	F = 7.0	F = 7.0	F = 7.0
Hansen J-stat on overid test	J = 1.52	J = 0.182	J = 2.93
p-value on overid test	$p = 0.49$	$p = 0.91$	$p = 0.23$

Notes: Sample sizes are in brackets. Standard errors corrected for clustering at the school level are in parentheses. Estimates are from unweighted OLS regressions based on data from Waves I and III of the National Longitudinal Study of Adolescent Health. The sample includes respondents ages 22–24 at Wave III who have had at least one sexual partner in their lifetime and have non-missing information on educational attainment and each of the instruments. All models include the full set of controls in Tables 1 and 2 along with average age of students in the female's school, and indicators for whether the female's school is a junior high school, high school, or comprehensive school

***Statistically significant at the 1% level; **at the 5% level; *at the 10% level

imprecise that we cannot reject the hypothesis that they are equal to the coefficient of *Seven or More Partners*.[15]

5.4 Robustness checks on validity of instruments

Next, we explore the sensitively of our results to including additional controls in the vector X_i. These controls are intended to address the possibility that pubertal development is correlated with factors other than number of sex

[15]IV probit estimates of the effect of multiple sex partners on high school completion and college attendance produce similar results. We also experimented with splitting the sample based on race and ethnicity. The 2SLS estimate indicated a positive relationship between number of partners and the educational attainment of black females. However, because the first-stage F-statistics on the instruments were considerably below 10 when black females were examined separately, we are reluctant to infer too much from this estimate. Finally, we also experimented with examining the relationship between number of sex partners and male educational attainment. 2SLS estimates, while imprecise and statistically insignificant, were positive.

partners that could impact educational attainment. Column (1) of Table 8 presents results from the baseline 2SLS model. First, studies have shown that early onset of sexual maturation may be associated with obesity or being overweight (Adair and Gordon-Larsen 2001; Anderson et al. 2001), and that late onset of sexual maturation may be associated with bulimia or being extremely underweight (Striegel-Moore et al. 2001). In order to ensure that the respondent's physical development score is uncorrelated with the error term of Eq. 1, the variable *Weight* was replaced by the following controls: whether the respondent made herself vomit to lose weight or keep from gaining weight, whether the respondent was severely underweight, whether the respondent was underweight, whether the respondent was overweight, and whether the respondent was obese.[16] The results of this exercise, presented in column (2) of Table 8, are similar to those in Table 6.

While all specifications control for the marital status of the respondent's parent who filled out the Add Health questionnaire, some studies have suggested that pubertal timing could be related to the absence of biological father or presence of a stepfather in the household, (Ellis and Garber 2000; Boegeart 2005). In column (3), we include a control for whether the biological father was absent from the household and whether the mother remarried. The 2SLS estimate from this specification is similar to that obtained without these additional controls.

The timing of puberty could also affect the self-esteem of the adolescent, which, in turn, could have long-run effects on schooling (Booth 1990; Prieto and Robbins 1975). In column (4), we show 2SLS estimates controlling for the respondent's score on the Rosenberg Self-Esteem Scale at Wave I (when questions used to construct the puberty scales were asked). The estimated effect of number of sex partners remains is unchanged when this additional control is added to X_i.

Finally, peer choice represents another possible route through which puberty could, in theory, affect educational attainment. Students who develop earlier may choose different peer groups, which, in turn, could affect schooling choices. At Wave I, when physical development was measured, respondents to the Add Health survey were asked, "Of your 3 best friends, how many: Smoke at least 1 cigarette a day? Drink alcohol at least once a month? Use marijuana at least once a month?" Column (5) of Table 8 shows the 2SLS estimate controlling for the answers to these questions as well as average family income of the students in the respondent's school, the proportion of their parents who had not received at least a high school education, and the

[16]The bulimia indicator was based on responses to the Wave III Adolescent Health survey. The weight indicators were based on the respondent's Body Mass Index at the time of the Wave I survey and CDC charts available at: http://www.cdc.gov/growthcharts/.

Table 8 Robustness of 2SLS estimates to added controls

	Main model (1)	Use controls for BMI, bulimia (2)	(2) + control for stepfather (3)	(3) + controls for baseline self-esteem (4)	(4) + peer effects & school-level SES (5)
Panel I: Years of schooling					
Number of sex partners	−0.101**	−0.110**	−0.105**	−0.107**	−0.127**
	(0.042)	(0.044)	(0.044)	(0.043)	(0.055)
	[3,578]	[3,578]	[3,578]	[3,578]	[3,578]
F-stat on instruments	F = 13.3	F = 13.6	F = 12.8	F = 12.8	F = 9.2
Hansen J-stat on overid test	J = 0.283	J = 0.094	J = 0.051	J = 0.045	J = 2.31
p-value on overid test	$p = 0.87$	$p = 0.95$	$p = 0.97$	$p = 0.98$	$p = 0.32$
Panel II: High school					
Number of sex partners	−0.015*	−0.016*	−0.016*	−0.017*	−0.019*
	(0.009)	(0.009)	(0.009)	(0.009)	(0.011)
	[3,578]	[3,578]	[3,578]	[3,578]	[3,578]
F-stat on instruments	F = 13.3	F = 13.6	F = 12.8	F = 12.8	F = 9.2
Hansen J-stat on overid test	J = 0.356	J = 0.539	J = 0.628	J = 0.750	J = 0.007
p-value on overid test	$p = 0.84$	$p = 0.76$	$p = 0.73$	$p = 0.69$	$p = 0.99$
Panel III: College					
Number of sex partners	−0.017**	−0.019**	−0.018*	−0.020**	−0.015*
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)
	[3,578]	[3,578]	[3,578]	[3,578]	[3,578]
F-stat on instruments	F = 13.3	F = 13.6	F = 12.8	F = 12.8	F = 10.6
Hansen J-stat on overid test	J = 1.90	J = 1.27	J = 1.03	J = 1.00	J = 1.16
p-value on overid test	$p = 0.39$	$p = 0.53$	$p = 0.60$	$p = 0.61$	$p = 0.56$

Notes: Sample sizes are in brackets. Standard errors corrected for clustering at the school level are in parentheses. Estimates are from unweighted 2SLS regressions based on data from Waves I and III of the National Longitudinal Study of Adolescent Health. The sample includes respondents ages 22–24 at Wave III who have had at least one sexual partner in their lifetime and have non-missing information on educational attainment and each of the instruments. All models include the full set of controls listed in Tables 1 and 2. Model (1) includes the following instruments: (i) the number of county-level family planning clinics per 10,000 women; and (ii) the presence of a contraceptive-inclusive HIV education program as measured by the presence of a state HIV education mandate coupled with school-level provision of (or referral to) family planning services. Model (2) replaces the continuous variable *Weight* by the variables *Severely Underweight, Underweight, Overweight, Obese*, and *Bulimia*. Model (3) includes a control for whether the respondent's biological father does not reside in the household and the mother has had multiple marriage or marriage-like relationships in the previous 18 years. Model (4) includes a control for the continuous RSE Scale. Model (5) adds controls for the number of best friends of the respondent at Wave I who engaged in binge drinking, cigarette consumption, and marijuana use, as well as school-level average household income, share of never-married parents, and share of parents who are high school graduates

***Statistically significant at the 1% level; **at the 5% level; *at the 10% level

proportion of their parents who were never married.[17] Again, it is similar to that presented in Table 6.[18]

Taken together, the results in Table 8 suggest that the negative impact on educational attainment of having multiple partners is robust to adding controls for being overweight, being underweight, bulimia, self esteem, and peer behavior.

An alternative method of exploring the validity of our instruments is to examine the sensitivity of the 2SLS estimates to various exclusion restrictions. Table 9 presents such an exploration. Column (1) of Table 9 reproduces the baseline results for years of schooling first presented in Table 6. In column (2), we drop age of menarche and the respondent's physical development score as instruments, relying on the mean physical development score of males in the respondent's school to identify exogenous variation in number of sex partners. The estimated coefficient of *Number of Sex Partners* is still negative and statistically significant, albeit slightly less precise.

In column (3), WE experiment with an alternative method of measuring the physical development of males in the respondent's school. Male Add Health respondents were asked at Wave I:

1. How much hair is under your arms now? The possible responses were: "I have no hair at all" = 1; "I have a little hair" = 2; "I have some hair, but not a lot; it has spread out since it first started growing and is thicker" = 3; "I have a lot of hair that is thick" = 4; and "I have a whole lot of hair that is very thick, as much hair as a grown man" = 5.
2. How thick is the hair on your face? The possible responses were: "I have a few scattered hairs, but the growth is not thick" = 1; "The hair is somewhat thick, but you can still see a lot of skin under it" = 2; "The hair is thick; you can't see much skin under it" = 3; and "The hair is very thick, like a grown man's facial hair" = 4.
3. Is your voice lower now than it was when you were in grade school? The possible responses were: "No, it is about the same as when you were in grade school" = 1; "Yes, it is a little lower than when you were in grade school" = 2; "Yes, it is somewhat lower than when you were in grade school" = 3; "Yes, it is a lot lower than when you were in grade school" = 4; and "Yes, it is a whole lot lower than when you were in grade school; it is as low as an adult man's voice" = 5.

[17]The answers to the peer substance use questions were dichotomized. Specifically, $\mathbf{X}_i$ was augmented by: an indicator equal to 1 if the respondent reported having 1 friend who smoked, and equal to 0 otherwise; an indicator equal to 1 if the respondent reported having 2 friends who smoked, and equal to 0 otherwise; an indicator equal to 1 if the respondent reported having 3 friends who smoked, and equal to 0 otherwise; an indicator equal to 1 if the respondent reported having 1 friend who drank, and equal to 0 otherwise; and so forth.

[18]We also experimented with using peer characteristics measured at Wave II, but the results were qualitatively similar to those reported in Table 6.

Table 9 Sensitivity of 2SLS estimates of effect of number of sex partners on years of schooling to instrument choice

	Main model	IV: Average male phys. develop index only	IV: Average male hair index only	IV: Average male phys. develop + avg. hair index	IV: Own physical develop index only	IV: Own breast and curves index only	IV: Own phys. develop index + breast-curves index	IV: All indexes	IV: All indexes + policy instruments
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Number of sex partners	−0.101**	−0.138*	−0.092	−0.137*	−0.085*	−0.080	−0.075*	−0.074*	−0.078*
	(0.042)	(0.081)	(0.143)	(0.081)	(0.047)	(0.076)	(0.045)	(0.041)	(0.042)
	[3,578]	[3,578]	[3,578]	[3,066]	[3,558]	[3,558]	[3,558]	[3,553]	[3,049]
F-stat on instruments	F = 13.3	F = 12.8	F = 6.1	F = 6.4	F = 10.9	F = 17.8	F = 18.6	F = 11.0	F = 12.4
Hansen J-stat (overid)	J = 0.283	–	–	J = 0.157	–	–	J = 0.392	J = 1.46	J = 5.79
p-value on overid test	$p = 0.87$	–	–	$p = 0.69$	–	–	$p = 0.53$	$p = 0.69$	$p = 0.33$

Notes: Sample sizes are in brackets. Standard errors corrected for clustering at the school level are in parentheses. Estimates are from unweighted 2SLS regressions based on data from Waves I and III of the National Longitudinal Study of Adolescent Health. The sample includes respondents ages 22–24 at Wave III who have had at least one sexual partner in their lifetime and have non-missing information on educational attainment and each of the instruments. All models include the full set of controls listed in Tables 1 and 2

***Statistically significant at the 1% level; **at the 5% level; *at the 10% level

The answers to these three questions were summed to create an alternative 14-point physical development scale for males, and the mean score on this scale by school was calculated. Using this alternative method of measuring the physical development of males in the respondent's school, 2SLS produces an estimate of the effect of number of sex partners on years of school equal to −0.09, although it is less precisely estimated than the estimate in column (2) presumably because the new instrument has less power than the one it replaced (F-stat = 6.1). When both physical development scores for males in the school are used as instruments, the results are similar to those presented in Table 6.[19]

In columns (5)–(7), we drop the male physical development measures as instruments and focus on the respondent's physical development. When the respondent's physical development score is the sole instrument, we continue to find evidence of a negative sex partner effect that is comparable magnitude to that obtained when using the male physical development measures as instruments. However, one potential concern with regard to relying solely on the respondent's own physical development score as a source of exogenous variation in number of sex partners is that it could reflect the respondent's sense of perceived self-worth, personal maturity, or modesty, each of which could, in theory, be related to school attainment. Thus, we next examine an alternative, arguably more "objective," measure of female puberty onset. Female Add Health respondents were asked:

1. As a girl grows up her breasts develop and get bigger. Which sentence best describes you? The possible responses were: "My breasts are about the same size as when I was in grade school" = 1; "My breasts are a little bigger than when I was in grade school" = 2; "My breasts are somewhat bigger than when I was in grade school" = 3; "My breasts are a lot bigger than when I was in grade school" = 4; and "My breasts are a whole lot bigger than when I was in grade school, they are as developed as a grown woman's breasts" = 5.
2. As a girl grows up her body becomes more curved. Which sentence best describes you? The possible responses were: "My body is about as curvy as when I was in grade school" = 1; "My body is a little more curvy than when I was in grade school" = 2; "My body is somewhat more curvy than when I was in grade school" = 3; "My body is a lot more curvy than when I was in grade school" = 4; and "My body is a whole lot more curvy than when I was in grade school" = 5.

The answers to the above questions were summed to create an alternative 10-point physical development scale. Because the possible responses refer to the respondent's physical development in "grade school," we include controls

[19]We also experimented with controlling for cognitive ability of the respondent's male schoolmates to ensure that self-reported puberty measured were not reflecting unmeasured school-differences in knowledge or ability. When we added the mean Peabody Picture Vocabulary Test (PPVT) score of the respondent's male schoolmates and the male as an additional control in X_i, 2SLS are qualitatively similar to those reported in Table 6.

for age of the respondent at Wave I as well as for their grade in school at Wave I. The results suggest that using either this or the original measure of the respondent's physical development as an instrument produces comparable 2SLS estimates. In column (7) we include both the alternative and the original physical development scores as instruments. The results suggest that an additional sex partner is associated with a 0.075 decrease in years of schooling. In column (8), we include all four physical development scales. The results suggest that an additional sex partner is associated with a 0.075 decrease in years of schooling.

Finally, we augment the vector $\mathbf{Z}_i$ with two policy instruments based on the work of Sabia and Rees (2008): the per-capita number of county-level family planning clinics per 10,000 population, and the presence of a contraceptive-inclusive HIV education program in the respondent's school. We hypothesize that these measures capture some portion of the cost of becoming sexually active, and that as this cost rises adolescents will be more likely to remain abstinent. The results are presented in the last column of Table 9. They suggest that adding these instruments to the vector $\mathbf{Z}_i$ has little impact on the estimated effect of number of sex partners on years of schooling.[20]

5.5 Timing of number of partners

An important limitation to the variable *Number of Sex Partners* is that we do not observe when the relationships took place. This raises the possibility that some could have occurred *after* a respondent's schooling was completed. We explore this issue in Table 10.

At Wave III respondents were asked about their number of sex partners in the last 12 months. Panel I of Table 10 presents 2SLS estimates, subtracting number of sex partners in the past year from the respondent's lifetime total. The results are similar to those presented in presented in Table 6: number of sex partners is negatively related to all three measures of educational attainment. This pattern of results suggests that romantic relationships that occurred just prior to Wave III interview are not driving our results.

As another check on this point, we examine whether our key instrument—the physical development of the respondent's male schoolmates—affects primarily the respondent's number of sex partners while she is in school. The mean physical development score of males should have little effect on the respondent's sex partners in the year prior to the Wave III survey or on the number of sex partners of those respondents who become sexually active at age 19 or later, when they are no longer attending high school. In Panel II of Table 10, we present estimates of the relationship between the mean physical development score of males in the respondent's school and number of sex partners. First, in column (1) we show that male physical development

[20] Supplementary Appendix Table 4 presents the robustness checks for the outcomes high school graduation and college attendance.

Table 10 Robustness checks on timing of sex partners and relevance of male PDI

	Panel I: Subtract prior year's sex partners (2SLS)		
	Years of schooling	High school	College
Number of sex partners - number of partners in last year	−0.109***	−0.016*	−0.019**
	(0.042)	(0.009)	(0.009)
F-stat on instruments	F = 14.3	F = 14.3	F = 14.3
Hansen J-stat on overid test	J = 0.178	J = 0.746	J = 1.61
p-value on overid test	$p = 0.91$	$p = 0.69$	$p = 0.45$
	[3,560]	[3,560]	[3,560]
	Panel II: Effect of male PDI on sex partners (first-stage)		
	Number of sex partners - number of partners in last year	Number of partners in last year	Number of sex partners for those with age at first sex > 18
Average male physical develop Score in female's school	2.91***	−0.154	−0.267
	(0.729)	(0.107)	(0.724)
	[3,560]	[3,560]	[685]
	Panel III: Age at first sex ≤ 18 (2SLS)		
	Years of schooling	High school	College
Number of sex partners - number of partners in last year	−0.100**	−0.019**	−0.016
	(0.041)	(0.009)	(0.010)
F-stat on instruments	F = 10.2	F = 10.2	F = 10.2
Hansen J-stat on overid test	J = 0.135	J = 0.586	J = 0.372
p-value on overid test	$p = 0.94$	$p = 0.75$	$p = 0.83$
	[2,879]	[2,879]	[2,879]

Notes: Sample sizes are in brackets. Standard errors corrected for clustering at the school level are in parentheses. Estimates are from unweighted 2SLS regressions based on data from Waves I and III of the National Longitudinal Study of Adolescent Health. The sample includes respondents ages 22–24 at Wave III who have had at least one sexual partner in their lifetime and have non-missing information on educational attainment and each of the instruments. All models include the full set of controls listed in Tables 1 and 2

***Statistically significant at the 1% level; **at the 5% level; *at the 10% level

score is a strong predictor of the respondent's number of sex partners prior to the year of the Wave III survey. However, in column (2), we find when we examine the respondent's sex partners in the year prior to the Wave III survey, the estimated coefficient of the mean physical development score is small, negative and statistically insignificant, consistent with the hypothesis that this instrument is related to total lifetime partners through decisions made during adolescence as opposed to young adulthood.

In column (3) of Panel II, we present estimates of the relationship between total lifetime sex partners and the mean physical development score of males in the respondent's school, restricting the sample to respondents whose age at first intercourse was greater than 18. We would not expect the mean physical development score of male schoolmates to be related to number of sex partners for respondents who became sexually active near of after high school graduation, and in fact the results provide little evidence of such a relationship.

Finally, in Panel III of Table 10, we restrict our sample to respondents whose age at first intercourse was less than 18 and examine the relationship between lifetime number of sex partners (minus sex partners in the last year) and educational attainment. The results again indicate a negative relationship between number of sex partners and educational attainment. For instance, an additional sex partner is associated with a decrease of 0.019 in the probability of high school graduation, an estimate that is slightly larger in absolute magnitude than that presented in Table 6.

5.6 Proxy for teen childbearing, STDs, or age at first intercourse?

The findings presented thus far provide strong evidence that an increase in the number of sex partners negatively impacts the educational attainment of young women. We next explore why this relationship might exist.

One possibility is that having multiple sex partners increases the frequency of sexual intercourse, increasing the likelihood of teenage childbearing, which, in turn, affects school attainment. A number of studies have shown that having an out-of-wedlock child early in life negatively impacts educational attainment (Ribar 1994; Klepinger et al. 1999; Ribar 1999; Grogger and Bronars 1994; Hoffman et al. 1993).[21] This finding raises the possibility that number of sex partners is related to educational attainment through fertility. Thus, we explore whether the multiple partner effect persists after controlling for teen childbearing. Column (1) of Table 11 presents the baseline specification.[22] In column (2), we add a control for whether the respondent had a child when she was a teenager. The results suggest that the multiple partner effect persists even after controlling for teen fertility.

Another possibility is that number of sex partners proxies for teen pregnancy, which would include abortions or miscarriages, both of which could, in theory, affect educational attainment. In column (3), we control for whether the respondent reported a miscarriage or an abortion; controlling for these factors alone has little impact on the estimated effect of number of sex partners on school attainment. When abortions, miscarriages and teenage childbearing are included simultaneously as right-hand-side variables, the estimated effect of number of sex partners falls by 18–27% (column 4). In column (5), we control for whether the respondent reported having been diagnosed with a sexually transmitted infection in the year prior to being interviewed.[23] Our

[21] In contrast, Hotz et al. (1997, 2005) find that much of the adverse effects of teen childbearing can be explained by selection.

[22] Note that the sample size is slightly different because we require all respondents to have provided information on their age at first intercourse.

[23] Our measure of STDs is dichotomous, created from respondents' answers to the following question:

In the past 12 months, have you been told by a doctor or nurse that you had the following sexually transmitted diseases: Chlamydia, gonorrhea, trichomoniasis, genital herpes, genital warts, human papilloma virus, bacterial vaginosis, pelvic inflammatory disease, cervicitis, HIV/AIDS, urethritis, vaginitis, or other sexually transmitted infections?

Table 11 Examining whether multiple partner effect is explained by teen childbearing miscarriage, abortion, STDs, or age at first intercourse

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel I: Years of schooling								
Number of sex partners	−0.105**	−0.090**	−0.094**	−0.079*	−0.110**	−0.102*	–	−0.117*
	(0.043)	(0.040)	(0.046)	(0.045)	(0.046)	(0.057)		(0.061)
1st-stage F-stat on instruments	F = 13.1	F = 12.6	F = 12.4	F = 12.0	F = 11.8	F = 9.0		F = 13.1
Age at first intercourse	–	–	–	–	–	Includes dummies	0.132**	−0.025
							(0.063)	(0.097)
1st-stage F-stat on instruments							F = 57.0	F = 57.0
Teen childbearing		−0.998***		−0.888***				
		(0.111)		(0.142)				
Miscarriage			−0.510***	−0.497***				
			(0.132)	(0.121)				
Abortion			0.072	0.032				
			(0.164)	(0.159)				
Sexually transmitted disease					0.227			
					(0.177)			
J-stat overid test	J = 0.324	J = 1.17	J = 0.417	J = 0.965	J = 0.350	J = 0.807	J = 3.18	J = 0.286
p-value overid test	*p* = 0.86	*p* = 0.56	*p* = 0.81	*p* = 0.62	*p* = 0.84	*p* = 0.67	*p* = 0.20	*p* = 0.59
N	3,567	3,567	3,567	3,567	3,567	3,567	3,567	3,567
Panel II: High school								
Number of sex partners	−0.016*	−0.014	−0.014	−0.011	−0.017*	−0.012	–	−0.011
	(0.009)	(0.009)	(0.043)	(0.010)	(0.010)	(0.011)		(0.012)
1st-stage F-stat on instruments	F = 13.1	F = 12.7	F = 12.4	F = 12.0	F = 11.8	F = 9.0		F = 13.1
Age at first intercourse	–	–	–	–	–	Includes dummies	0.026	0.010
							(0.018)	(0.023)
1st-stage F-stat on instruments							F = 57.0	F = 57.0
Teen childbearing		−0.129***		−0.185***				
		(0.023)		(0.034)				
Miscarriage			−0.065**	−0.062**				
			(0.032)	(0.031)				
Abortion			0.014	0.005				
			(0.043)	(0.041)				

Sexually transmitted disease					0.047 (0.033)			
J-stat overid test	J = 0.154	J = 0.119	J = 0.277	J = 0.148	J = 0.270	J = 0.210	J = 0.970	J = 0.295
p-value overid test	*p* = 0.70	*p* = 0.94	*p* = 0.87	*p* = 0.93	*p* = 0.87	*p* = 0.90	*p* = 0.62	*p* = 0.86
N	3,567	3,567	3,567	3,567	3,567	3,567	3,567	3,567
Panel III: College								
Number of sex partners	−0.018** (0.009)	−0.015* (0.008)	−0.016* (0.009)	−0.014 (0.009)	−0.019** (0.009)	−0.024* (0.014)	–	−0.027* (0.015)
1st-stage F-stat on instruments	F = 13.1	F = 12.7	F = 12.4	F = 12.0	F = 11.8	F = 9.0		F = 13.1
Age at first intercourse	–	–				Includes dummies	0.016 (0.014)	−0.021 (0.027)
1st-stage F-stat on instruments							F = 57.0	F = 57.0
Teen childbearing	–	−0.192*** (0.023)		−0.163*** (0.032)		–	–	–
Miscarriage			−0.087*** (0.026)	−0.085*** (0.024)				
Abortion			0.026 (0.040)	0.020 (0.040)				
Sexually transmitted disease					0.032 (0.041)			
J-stat overid test	J = 1.44	J = 3.70	J = 2.16	J = 2.95	J = 2.16	J = 2.93	J = 3.64	J = 2.16
p-value overid test	*p* = 0.23	*p* = 0.16	*p* = 0.34	*p* = 0.23	*p* = 0.34	*p* = 0.23	*p* = 0.16	*p* = 0.34
N	3,567	3,567	3,567	3,567	3,567	3,567	3,567	3,567

Notes: Sample sizes are in brackets. Standard errors corrected for clustering at the school level are in parentheses. Estimates are from unweighted 2SLS regressions based on data from Waves I and III of the National Longitudinal Study of Adolescent Health. The sample includes respondents ages 22–24 at Wave III who have had at least one sexual partner in their lifetime and have non-missing information on educational attainment and each of the instruments. All models include the full set of controls in Tables 1 and 2 along with average age of students in the female's school, and indicators for whether the female's school is a junior high school, high school, or comprehensive school

***Statistically significant at the 1% level; **at 5% the level; *at the 10% level

results suggest that the effect of number of sex partners on school attainment does not operate through sexually transmitted diseases.

Still another possibility is that number of sex partners proxies for age at first intercourse. Previous authors have found that age at first intercourse has an effect on educational attainment (Billy et al. 1988; Dorius et al. 1993; Rector and Johnson 2005; Sabia 2007a, b; Schvaneveldt et al. 2001; Upchurch and McCarthy 1990; Sabia and Rees 2009), and there is evidence that it is associated with having multiple partners (Sandfort et al. 2008).

In columns (6)–(8) of Table 11, we explore whether the effects of number of sex partners and the timing of first intercourse can be distinguished. Specifically, we pursue two empirical strategies. The first is to add controls for the timing of first intercourse to the vector $\mathbf{X}_i$.[24] The second strategy is to treat both number of sex partners and timing of first intercourse as endogenously determined. This strategy is made possible by the fact that we have more than one instrument at our disposal.

In column (6), we include a set of dummy variables for age at first intercourse as additional controls. Controlling for age at first intercourse, number of sex partners is still negatively related to years of schooling. This suggests that number of sex partners is not simply capturing the timing of first sex.

In columns (7) and (8), we present 2SLS estimates of the effect of age at first intercourse on years of schooling in which age at first intercourse is instrumented by age of menarche, the respondent's physical development score, and the mean physical development score of males in the respondent's school.[25] Our results are consistent with those of Sabia and Rees (2009): delaying age at first intercourse is positively related to school attainment. However, when we instrument for both age at first intercourse and number of sex partners, the estimated coefficient of *Age at First Intercourse* changes sign and loses statistical significance, while the estimated coefficient of *Number of Sex Partners* retains its magnitude and significance. This pattern of results suggests that frequency of sex partners, as distinct from timing of first intercourse, may play a role in the formation of human capital, and implies that losing one's virginity early in life only adversely affects schooling to the extent that it is associated with more sex partners. It is consistent with research by Arcidiacono et al. (2007, p. 29) showing that first intercourse involves a fixed cost such as crossing a "moral or psychological barrier," but that once this barrier is crossed adolescents rarely revert to abstinence.

[24] Add Health respondents were asked the following question at Wave III: "How old were you the first time you had vaginal intercourse?"

[25] Supplementary Appendix Table 5 shows the first-stage results. Sabia and Rees (2009) used age of menarche to instrument for age at first intercourse. Although age of menarche is a strong predictor of age at first intercourse, it does not provide much predictive power for number of sex partners. Similarly, the mean male physical development index is a strong predictor of number of sex partners, but does not have as much predictive power for age at first intercourse.

6 Conclusion

This study is the first in the literature to attempt to isolate the causal effect of number of sex partners on school attainment. Using both family fixed effects models on a sample of twin sisters and an instrumental variables approach, we find consistent evidence that higher numbers of sex partners have modest adverse schooling effects for young women. Instrumental variables estimates are robust across instrument choice and a wide set of robustness checks. Moreover, the multiple partner effect persists after controlling for teen fertility and age at first intercourse, as well as when age at first intercourse is treated as an endogenously determined variable. These results suggest that the frequency of sex partners during youth, rather than the timing of first intercourse, is an important determinant of educational attainment for females.

Advocates of both comprehensive and abstinence-only sex education programs agree that teenagers should be taught to limit their number of sex partners. For instance, a leading member of the American Psychological Association Committee on Psychology and AIDS concluded, after a review of the research in this area:

We have found that comprehensive sexuality education programs, those that provide information, encourage abstinence, promote condom use for those who are sexually active, [and] encourage fewer sexual partners… are the most effective in keeping sexually active adolescents disease free. (APA Committee on Psychology and AIDS 2005)

On the other side of the sex education debate, the Heritage Foundation argues that,

Any new monies devoted to preventing pregnancy should be directed not to amply funded contraception programs, but to abstinence education programs that teach teens to delay sexual activity, reveal the harm caused by casual sex with multiple partners, and help young people to prepare for fidelity, intimacy, and healthy marriage (Pardue et al. 2004).

Our findings suggest that there may be common ground upon which proponents of abstinence-only and contraceptive-based sex education could build. If sex education courses are taught in such a way as to effectively encourage monogamy and sex partner limitation, there could be human capital benefits for females. However, it is important to underscore that our instrumental variables estimates should be interpreted as local average treatment effects (Imbens and Angrist 1994). A successful sex education program that reduced number of sex partners may have a different impact on educational attainment depending on whose sex decisions were affected.

A next step for research in this area might be to examine the time and psychological costs of adolescent relationship dissolutions. In particular, it would be interesting to explore if the effect of breaking up differs by gender or whether the couple were having intercourse. Such an analysis would take us a step closer to understanding why number of sex partners is negatively related to female educational attainment.

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