Social Network Effects in Contraceptive Behavior among Adolescents

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Abstract

Objective: To quantify empirically the role of peer social networks in contraceptive behavior among adolescents.
Method: Using longitudinal data from a nationally representative sample of adolescents, we utilize a multivariate structural model with school-level fixed effects to account for the problems of contextual effects, correlated effects, and peer selection to reduce the potential impact of biases from the estimates of peer influence. Our peer group measures are drawn not only from the nominations of close friends but also from classmates. Contraception use among the peer groups was constructed using the peers' own reports of their contraceptive behavior.
Results: Controlling for parental characteristics and other demographic variables, we find that a 10 percent increase in the proportion of classmates who use contraception increases the likelihood of individual contraception use by approximately 5 percent. We also find evidence that the influence of close friends diminishes after accounting for unobserved environmental confounders.
Conclusion: Our findings support the findings in the literature that peer effects are important determinants of contraception use even after controlling for potential biases in the data. Effective policy aimed at increasing contraception use among adolescents should consider these peer effects.

KEY WORDS: Adolescent Contraception Use; Peer Measurements; Peer Influence.

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INTRODUCTION

The vast majority of pregnancies among adolescents in the United States are unintended [1]. The use of contraception has been identified as a primary factor in reducing the number of unintended pregnancies [2,3]. However, adolescent contraception remains a complex issue for healthcare providers and policy makers because sexual activity often precedes the ability to make responsible decisions related to sex [4]. Although the use of contraception among adolescents has been increasing [5], only 28 percent of sexually active adolescents use any method of contraception, while 62 percent of all age groups use contraceptives [6]. Research suggests that effective use of contraceptives reduces the medical, socio-economic, and health costs associated with adverse outcomes from unprotected sexual intercourse [7,8,9].

Determinants of adolescent contraceptive behavior include factors like demographic characteristics (e.g., age, ethnicity, income), parental characteristics (e.g., parental education, relationship with parents), and other individual characteristics (e.g., attitude toward contraception and pregnancy, age at sexual debut, number of sexual partners). Another proposed determinant of contraception use is the receipt of advice about contraceptive methods from members of one's social network, such as family and friends [2,10]. Considerable research has been devoted to determining the importance of social networks in influencing adolescents' risky health behaviors and outcomes [11 - 16]. In the case of adolescent contraception use, the role of social networks or peer effects, is unclear [17], although there is some evidence to suggest that behavioral choices by adolescents are partly determined by how acceptable their peers believe the behavior to be [18]. For example, individuals' self-reported perception of the amount of

contraception use among members of their social networks has been identified as an important predictor of contraceptive behavior [2,10], and friends and family members are listed as the primary source of contraceptive knowledge [19]. Regardless of the mechanism through which social influences affect adolescent contraception use, from a policy perspective, whether the social network effect operates and, if it does, its size are of interest since peer effects may serve to amplify the effects of interventions [11 – 13]. Therefore, it is important to understand the social processes that influence contraceptive behavior so they can be incorporated in preventive policies.

However, peer effects are difficult to estimate, and causal interpretations must be made with caution since most individuals choose with whom to associate [20]. In other words, estimates that do not account for peer selection cannot identify accurately whether an individual's behavioral choices vary in some way with the behavior of the reference group [21]. Peer selection implies that similarity in behavior can be attributed to the similarity among individuals, whereas peer influence implies that the similarity in behavior is due to the peer behavior itself. Disentangling the peer influence from spurious unobserved factors associated with peer selection is important if we are to predict with any accuracy the success of policies aimed at reducing risky behavior among adolescents. If individuals in a peer group have common underlying characteristics that drive behavior more than peer influence does, policies aimed at taking advantage of peer influence may not have the desired effects.

Building on the existing literature on peer effects, we extend our analysis by empirically quantifying the role of peer social networks to explain contraceptive behavior among adolescents. Our peer measures, drawn not only from the nomination of close

friends but also from classmates in the same grade, allow us to identify the differences in effects from different compositions of the reference groups. We implement a two-stage least squares modeling approach with school-level fixed effects to minimize the confounding in the peer effect estimates.

In our study, contraceptive behavior refers to the use of contraception during the adolescent's first sexual intercourse. We focus on this measure of contraceptive use for two important reasons: First, nonuse of contraception during one's first sexual intercourse is typical among adolescents [22, 23]. Second, many situational and contextual factors—pressure from a partner, the inability to communicate effectively, the influence of drugs or alcohol, and so on—play significant roles in determining whether contraception is used during the first experience of sexual intercourse [22]. Therefore, this measure is important for policy purposes, especially in identifying strategies to prevent unintended pregnancies [5].

ESTIMATING SOCIAL NETWORKS

A standard linear regression using an average contemporaneous measure by a reference group (e.g., at the school level, by workplace, or by the close friends the individuals identify) as a proxy for social interactions is easy to estimate. However, such measures of peer networks or social interactions have many problems of interpretation [21]. According to Manski (1993), a significant effect of a peer indicator could be open to three different interpretations [21]. While there may be subtle differences among these interpretations, effective policies would vary depending on which is the driving force behind the significant peer effect. The three interpretations Manski (1993) [21] offers are

the endogenous effect, the exogenous (or contextual) effect, and the correlated (or confounding) effect.

The endogenous effect occurs when an individual's behavior responds to the behavior of others in his or her reference group. For example, an individual is more likely to use contraception if there is a high rate of contraception use in the reference group than if there is not because individuals commonly rely on advice about contraceptive methods from those in their social networks [2,10]. The influence comes from the peer behaviors themselves, and their behaviors influence each other. Targeting the individual to change his or her behavior is an effective policy in this case because the behavior has a multiplier effect such that, even if only some of the individuals are part of the intervention, their behavior will influence behavior of their peers.

The exogenous (or contextual) effect occurs when individual behavior responds to the exogenous characteristics of the reference group. For example, if there is a low rate of contraception use among adolescents in a community because of a lack of parental communication about sexual behavior [24], spillover occurs even to the individuals whose parents are talking with them about sexual activity because there is a peer effect on top of any parent effect. Targeting only the adolescent will not get at the root of the problem, nor will it have the multiplier effect since the children of parents who do not have such discussions will continue to engage in sexual activity without contraception, despite the behavior of their peers.

The correlated (or confounding) effect occurs when individuals in the same group behave similarly because they have similar characteristics or they operate in institutions with similar characteristics [15]. For example, children from similar disadvantaged

socioeconomic backgrounds will be drawn to each other and will be likely to initiate sex without contraception because of their similar attributes [24]. As in the exogenous effect, if one of them refrains from sexual engagement without contraception because of an intervention, their doing so is unlikely to impact the others' behavior since some unobserved characteristic is driving them all to a higher propensity to sexual activity without contraception.

Given these three alternative interpretations of a significant peer effect, standard regressions of individual engagement in a particular activity on group means cannot distinguish among the endogenous, the exogenous, and the correlated effects, and the success level of the policy will vary depending on what is driving the peer effect. This identification difficulty, which Manski (1993) coined "the reflection problem" [21], occurs because group behavior, by definition, is the aggregation of individual behavior; that is, group behavior affects individual behavior (and vice versa) because of the simultaneity of choices. Therefore, in devising effective policy, policymakers must purge these biases from peer effect estimates in order to identify whether peer influence is more important than peer selection. The presence of peer influence would imply that "social networks would reinforce or alter norms by providing examples of behavior that may then be considered and copied by others"[10].

This paper makes progress toward identifying the role of peer networks in adolescent contraception use on two fronts. First, we adopt a framework—namely, two-stage least squares regression with school-level fixed effects—that not only models contraception usage but also accounts for the reflection problem in order to deal with the potential bias from peer selection and omitted variables. We also include other

confounding factors identified in earlier literature [1] in order to purge potential bias from omitted variables associated with contraception use. Second, the compositions of our reference groups are based on two distinct measures: one reference group comes from the individual's nomination of his or her closest friends, while another consists of those who are in the same school and grade (hereafter, "grade-level peers"). These peer measures are not based on individuals' self-reports, which are subject to biases [25], but are drawn from the responses of the peers themselves. We hypothesize that the influence of close (nominated) friends will decline under our preferred specification, whereas the more exogenous grade-level peers will continue to exert a significant influence.

METHODS

Data

We utilize data from Wave I (1994) of the National Longitudinal Study of Adolescent Health (Add Health). Add Health consists of data on adolescents in 132 schools in the U.S. in grades 7 to 12. The schools are representative of U.S. schools with regard to region, urbanicity, school size, school type, and race/ethnicity. Parents were also interviewed in Wave I of the data-gathering component, and this part of the survey is key to how we deal with the problem of unobserved correlated variables that may bias the estimate of the peer effect. A primary advantage of the data set is that Add Health asked respondents to nominate their five closest male and five closest female friends. Since these friends were also part of the survey, we were able to construct peer measures of contraception use from the responses of the friends themselves.

The average number of nominated friends per individual is 2.54, and approximately 85 percent of the friends are from the same school as the respondent.

Therefore, the sample of nominated peers used in our analysis consists of 1,602 *sexually active adolescents*, with at least one nominated friend interviewed in Add Health. This sample size reflects the fact that not all of the individuals' nominated peers were part of the Add Health survey. The sample size of our grade-level peer analysis consists of 7,019 individuals. Table 1 reports descriptive statistics from the first wave of the data.

[Insert Table 1 here]

3.1 Measures of Adolescent Contraception Use

The dependent variable of our analysis is a dichotomous indicator of contraception use during the respondents' first experience of sexual intercourse. The respondents were asked, "Did you or your partner use any method of birth control the first time you had sexual intercourse?" The use indicator was set equal to 1 if the adolescent responded positively to this question and 0 otherwise.

3.2 Measures of Peer Contraception Use

We constructed different measures of peer contraception use for each reference group. For the nominated friends we created a variable pertaining to the percentage of friends who used contraception during their first sexual intercourse. The contraception use measure for grade-level peers was the percentage of students (excluding the respondent) in the respondent's grade and school who used contraception during their sexual debut.

3.3 Parental Measures and Demographics

Add Health's parent survey allowed us to control for a number of parental characteristics that are relevant to predicting adolescents' use of contraception, including maternal attitude toward sex, as well as socio-demographic variables like parental

education, family income, and whether the adolescent lives with both biological parents. Maternal attitude toward sexual behavior is measured by whether the mother approves of the adolescent's having sex at his or her current age with a romantic partner and whether the mother discusses contraception with the adolescent. One of the risk factors for nonuse of contraception is the lack of a significant relationship with parents or lack of mutual attachment [24]. Therefore, we also control for whether the adolescent is satisfied with the relationship he or she has with his or her parents. In addition, parental measures, such as whether the parents chose their residence because of the school district and the age of the adolescent when the family first moved into the residence were accounted for in the analysis. These controls can account for the endogenous sorting of households across neighborhoods that, if unaccounted for, may bias the estimate of peer influence. In other words, while an adolescent who attends the local public school does not have a choice over the composition of his or her schoolmates/classmates, the parents do have some discretion over which schools their children attend.

Among other controls are socio-demographic factors previously identified as important factors in contraceptive use: age, race/ethnicity, gender, country of birth (US or not US), the importance of religion, the presence or absence of siblings, the Picture Vocabulary Test (PVT) score as an indicator of the adolescents' verbal and test-taking ability [1], age at sexual debut, number of sexual partners, history of pregnancy, and popularity [1,26]. Popularity was assessed as the percentage of students in the adolescent's school whom the adolescent nominated as friends. We also control for the adolescent's attitude toward contraception and his or her attitude toward pregnancy, two variables that are considered significant predictors of contraception use [1,27,28].

The Add Health questionnaire asked the respondents to rate on a five-point Likert scale seven items about contraceptives in order to measure their attitude toward birth control: too much of a hassle to use, too expensive to buy, takes too much planning, too hard to get a partner to use with you, interferes with sexual enjoyment, using it is morally wrong, and your friends might think you were looking for sex if you used contraceptives. We constructed a scale from these items by averaging the responses, with higher values indicating a more positive attitude toward contraception (Cronbach's alpha= 0.8577). We used five survey items, each with five response options (strongly agree, agree, neither agree nor disagree, disagree and strongly disagree), to assess the adolescents' perceptions of the consequences of pregnancy. These five responses were averaged into a single index for attitude toward pregnancy, with higher values indicating a more positive attitude toward pregnancy (Cronbach's alpha=0.7820).

Empirical Model

We estimate a model of peer effects, where contraception use by adolescent *i* at school *s* during time *t*, Y_{ist} (a dichotomous indicator) is given by

$$Y_{ist} = \beta_0 + \beta_1 F_{ist} + \beta_2 X_{ist} + \beta_3 P_{ist} + \beta_4 S_{ist} + \varepsilon_{ist} \ , \quad (1)$$

where F_{ist} refers to our peer contraception use measure, pertaining to either the adolescent's nomination of close friends or their classmates; X_{ist} is a vector of personal or demographic characteristics; P_{ist} is a vector of parent and family characteristics; and S_{ist} is a vector of school dummy variables that controls for unobserved school type (school-level fixed effects) or confounding (environmental) factors that are common to all individuals in the same school. The presence of such (often unmeasured) shared surroundings (see page 6 for an example of such an environmental confounder) can lead

to erroneously implicating peer effects in individual outcomes when none may be present. School-level fixed effects will pick up characteristics that are common to all individuals within the same school because of the shared environment or conditions.

We are primarily interested in the endogenous effect β_1, which indicates the extent of peer influence on an individual's decision to use contraception. If β_1 is estimated to be positive, then any policy intervention that alters the contraceptive behavior of the individual within a reference group or social network would have an effect on the contraceptive behavior of non-treated adolescents who are in the same social network [21]. The estimated coefficient of β_1 would be biased if we did not control for the correlated effects and the contextual effects. Estimating our models with S_{ist}, the school-level fixed effects, potentially mitigates the correlated or confounding effects; that is, it allows us to account for the possibility that "observed peer effects are not a result of identification processes but rather reflect some unspecified parallel event or confound" [15].

A two-stage least squares regression is also necessary in this empirical analysis because of the reflection problem, which arises because peer behavior affects individual behavior and vice versa. For example, if individuals *i* and *j* are friends, this approach allows us to avoid the difficulty of separating individual *i*'s effect on individual *j* from individual *j*'s effect on individual *i*. Manski (1993) [21] demonstrated that most estimates of β_1 are not identified without utilizing instrumental variables or other similar methodologies because the fundamental assumption of the consistency of least-squares estimation in order to give β_1 a causal interpretation is violated. There is something in the error term, ε, that is correlated with both F and Y so that $E(\varepsilon|F) \neq 0$. The instrumental

variable estimator (IV) provides a consistent estimator under the assumption that the instruments (z) are variables correlated with the regressor, F, that satisfy E(ε|z)=0 [29]. It is possible to obtain the instrumental variable estimator through the two-stage least squares (2SLS) method, which is just a two-stage model that deals with accurately capturing the component of the peer variable we want (stage 1) and then puts that cleaned-up peer variable into the contraception regression (stage 2).

The key to implementing the IV technique is finding instruments that have two properties: they affect (cause variation in) the variable whose effect we want to know about (in our case, the peer measure), and they have no direct effect on the outcome measure (Y_{ist} in eq 1); that is, they are independent of the latent factors that drive that outcome. We propose five variables for our instrument: (i) the percentage of peers who have discussions about contraception use with their mothers, (ii) the percentage of peers whose mothers approve of their having sex with a romantic partner, (iii) the percentage of peers who have at least one parent with a college degree, (iv) the percentage of peers who live with both biological parents, and (v) the percentage of peers who are satisfied with the relationships they have with their parents. These peer-level variables directly affect peer behavior, but they do not predict individual behavior. The intuition behind the instruments is that, while individuals who have mothers who discuss contraception with them are more likely to use contraception during intercourse [24], the percentage of an individual's friends who have such "discussing mothers" will directly affect only the friends, not the individual. Similar intuition applies to the other instruments. Combined with the school-level fixed effects, the IV or 2SLS procedure enables us to obtain unbiased peer effect estimates. We also undertake a test to verify the validity of our

instruments. Figure 1 contains a diagram outlining how our empirical model identifies the peer effect and solves the reflection problem by using personal and family demographic controls, school-level fixed effects, and instrumental variables.

[Insert Figure 1 here]

RESULTS

We begin by presenting OLS results for the effects of peer contraception use on individual contraception use. Least-square estimates of coefficients in linear probability models are consistent estimates if standard errors are adjusted for the presence of heteroskedasticity [30]. We report standard error estimates that are robust to any form of heteroskedasticity. Linear probability also converges to normal when samples are large [31]. Table 2 presents our OLS results using Wave I (1994) data for the nominated and grade-level peers.

[Insert Table 2 here]

The results indicate a positive and statistically significant association between peer contraception use and individual contraception use. A 10 percent increase in the percent of close friends who use contraception during first intercourse increases the likelihood of an individual's contraceptive use by 0.8 percent (coefficient = 0.079, p-value = 0.000), and a 10 percent increase in contraception use among grade-level peers is associated with an almost 2 percent increase in individual contraception use (coefficient = 0.182, p-value = 0.000). We also find that males are more likely to use contraception than females are in their first intercourse experience. The effect of age at first experience of sex has the expected positive sign, as older initiators are more likely to use protection. As expected, the number of sexual partners increases the likelihood of contraception use.

There are some racial differences in the results, with Whites and Blacks more likely than other racial groups to use contraception during first intercourse. Attitude toward contraception is positively correlated with contraception use, whereas a more positive attitude toward pregnancy is inversely related to contraception use. Among the parent-level characteristics, maternal discussions about contraception have the greatest positive effect on contraceptive behavior in the grade-level peer model.

Since these peer estimates cannot be interpreted to signify causality (because of the reasons outlined in Section 2), we pursue an IV estimation strategy to identify the causal effect of peer behavior on individual behavior. Our IV results are reported in Table 3; since the other control variables exhibit similar effects, we report the coefficients of only our main variable of interest. We also implemented an over-identification test by computing Hansen's J statistic [32] to check the validity of our instruments. The Hansen's J statistic is a test of the joint null hypothesis that the excluded instruments are valid instruments, that is, they are uncorrelated with the error term and correctly excluded from the estimated equation. The test fails to reject their validity, so all five of the instruments pass the test under all model specifications.

[Insert Table 3 here]

Our results show that the effects of nominated peers are no longer statistically significant, whereas the size of the grade-level peer estimates is magnified under the IV specifications. This result indicates that, after correcting for the reflection problem, social network effects become more important for our exogenous peer group. While this result is consistent with the peer effects literature that utilizes similar methodologies [12], these IV models were estimated without controls for school-level unobservable factors or

environmental confounders (correlated effects) that could simultaneously affect individual and peer outcomes and bias the estimated coefficients. Our IV estimates with school-level fixed effects shows smaller coefficients than the IV estimates without school-level fixed effects. Peer participation in contraception use continues to be statistically significant for the grade-level peers, suggesting that, holding everything else constant, a 10 percent increase in contraception use among an individual's classmates results in an approximately 5 percent increase in the likelihood of individual contraception use (coefficient = 0.466, p-value < 0.05). The effect of nominated peers continues to be statistically insignificant, a result consistent with our hypothesis that, if peer selection is important, the peer effects will be lower or non-existent under the IV fixed effects specification. Since the grade-level peer measures are not driven by selective peer sorting [12], these coefficients should capture true peer influence. Other factors remain important with no statistically significant difference in interpretations or relative importance.

DISCUSSION

In this paper, we estimated models of adolescent contraception use to identify the role of social networks or peer groups in the propensity to use contraception during the first experience of sexual intercourse. We used a two-stage least squares with school-level fixed effects methodology to purge potential biases from the estimates of peer effects. Our estimation strategy allowed us to account for the contextual effects, correlated effects, and the reflection problem, all of which are present in efforts to measure social influence empirically.

Our findings indicate that grade-level peer effects are important determinants of contraception use that could be used as a policy tool to increase contraception usage rates among adolescents. Specifically, our results suggest that a 10 percent increase in the proportion of classmates who use contraception will increase the likelihood of contraception use by any one individual by approximately five percentage points. These findings suggest that public health interventions at the school level may be more cost-effective than previous estimates have suggested since health-promoting behavior in one person may spread to others. We also found evidence that the influence of close friends diminishes under our preferred specification, supporting the hypothesis that peer selection is non-random. Another significant finding was the importance of controlling for unobserved environmental confounders, confirming a correlation between those factors and the peer measures. Estimates that do not control for such environmental factors resulted in larger estimated effects of peer influence even when the bi-directionality of the peer effects was accounted for. In sum, family attributes and the prevalence of contraception use in one's school environment are significant determinants of an adolescent's propensity to use contraception.

This work lends evidence in support of existing literature that documents the impact of social networks on contraception, but it also improves on the accuracy of the estimated magnitudes of these effects and expands on how those effects vary across different peer group compositions. Most of the previous studies did not conduct their analyses based on different measures of the peer group but focused instead on perceived peer measures [2,10], which may have resulted in biased estimates of the role of social networks in contraception use.

Compared to previous studies, our estimates appear to be conservative, probably because of our inclusion of school-level fixed effects in our two-stage least squares models since school-level fixed effects could be capturing environmental factors related to contraception usage. For example, in communities where the social and economic costs attached to nonmarital pregnancy are low, the perceived benefits of contraception use are also low, thus reducing the likelihood of contraception use [33]. These perceptions may also be a reflection of growing up in an environment in which the early adoption of "adult" behavior provides benefits and few immediate costs [34]. Therefore, consistent with the previous literature, our results suggest that environmental interventions can increase the use of contraceptive behavior by increasing access to different methods of contraception, raising awareness about safe sex practices, and increasing the availability of family planning centers or clinics. Our results also indicate that policy interventions at the school level may be effective since grade-level peer influence may amplify their effects.

While we are able to address some of the issues surrounding the estimation of peer effects, the study has some limitations. Even though our measure of the dependent variable is relevant to policy, the influence of peer networks may vary with different measures of contraceptive behaviors. For example, consistency in the use of contraception in subsequent sexual activities after debut may also be influenced by social networks. Another limitation of the study is its use of cross-sectional data. Although our empirical methodology minimized the impact of potential biases in estimates of peer effects, we could not fully account for individual unobserved heterogeneity in our analysis. In addition, our data set is drawn from a survey that was conducted fifteen years

ago, potentially limiting the policy implications derived from our results. However, this data set has very strong measures of social networks, parental influence, and environmental confounders, and it seems unlikely that the overall effect of peers, parents, and the school environment have shifted dramatically in the last fifteen years.

A possible extension of the study is an investigation of the effect of changes in social network composition on contraceptive behavior using longitudinal data. Future studies could also investigate the role of sexual partners on contraception use, how relationship abuse may affect contraceptive use, whether peer effects influence the contraceptive method chosen, and which age groups are at highest risk of peer influence.

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Table 1: Descriptive statistics for wave I (1994)

Variable	N	Mean	SD	Min	Max
Demographic Characteristics					
Age	7019	15.964	1.414	11	20
Male	7019	0.508	0.5	0	1
White	7019	0.572	0.495	0	1
Black	7019	0.294	0.456	0	1
Hispanic	7019	0.175	0.38	0	1
Religious	7019	0.499	0.5	0	1
Born in USA	7019	0.76	0.427	0	1
Has siblings	7019	0.757	0.429	0	1
Verbal ability (PVT score)	7019	97.106	13.747	9	135
Age at first sex	7019	14.916	2.162	8	20
Prior pregnancy	7019	0.095	0.294	0	1
Attitudes toward contraception	7019	3.822	0.796	1	5
Attitudes toward pregnancy	7019	2.426	0.852	1	5
No. of sexual partners	7019	11.642	8.187	1	20
Popularity	7019	0.002	0.006	0	0.156
Chose location because of school	7019	0.356	0.479	0	1
Child age when moved	7019	9.689	5.968	0	19
Mother or father has college	7019	0.269	0.443	0	1
Log of pretax income	7019	3.479	0.978	-4.605	6.907
Lives with both biological parents	7019	0.401	0.49	0	1
Satisfied w/relationship w/parents	7019	0.838	0.369	0	1
Parents talked about contraception	7019	0.578	0.494	0	1
Parents approve sex with romantic	7019	0.134	0.341	0	1
Dependent Variable					
Contraceptive use	7019	0.644	0.479	0	1
Social Network Characteristics					
Friends: contraceptive use	1602	0.647	0.425	0	1
Friends: Mother or father has college	1602	0.284	0.38	0	1
Friends: Lives with both biological parents	1602	0.489	0.409	0	1
Friends: Satisfied w/relationship w/parents	1602	0.866	0.279	0	1
Friends: Parents talked about contraception	1602	0.589	0.404	0	1
Friends: Parents approve sex with romantic	1602	0.128	0.269	0	1
Grade: contraceptive use	7019	0.64	0.153	0	1
Grade: Mother or father has college	7019	0.307	0.169	0	1
Grade: Lives with both biological parents	7019	0.481	0.141	0	1
Grade: Satisfied w/relationship w/parents	7019	0.868	0.079	0	1
Grade: Parents talked about contraception	7019	0.515	0.129	0	1
Grade: Parents approve sex with romantic	7019	0.123	0.078	0	1

Table 2: Determinants of Contraception Use at First Sexual Intercourse (OLS)

Variables	Friends		Grade-Level Peers	
	Coefficient	Std. Error	Coefficient	Std. Error
Contraceptive use	0.079***	(0.028)	0.182***	(0.038)
Male	0.051**	(0.025)	0.036***	(0.012)
Age	-0.030***	(0.011)	-0.024***	(0.005)
White	0.042	(0.036)	0.035*	(0.018)
Black	0.072*	(0.042)	0.075***	(0.021)
Hispanic	-0.071*	(0.036)	-0.020	(0.017)
Religious	0.020	(0.024)	0.013	(0.011)
Born in USA	0.029	(0.033)	0.014	(0.016)
Has siblings	-0.023	(0.029)	-0.009	(0.014)
Verbal ability (PVT score)	0.001	(0.001)	0.001	(0.000)
Age at first sex	0.031***	(0.007)	0.032***	(0.003)
Prior pregnancy	-0.093**	(0.047)	-0.047**	(0.021)
Attitudes toward contraception	0.100***	(0.016)	0.112***	(0.008)
Attitudes toward pregnancy	-0.026*	(0.015)	-0.016**	(0.007)
No. of sexual partners	0.003*	(0.001)	0.002***	(0.001)
Popularity	1.919	(1.172)	0.679	(0.855)
Child age when moved	0.000	(0.002)	-0.000	(0.001)
Chose location because of school	0.018	(0.025)	-0.001	(0.012)
Mother or father has college	0.029	(0.027)	0.018	(0.013)
Log of pretax income	-0.009	(0.013)	0.008	(0.006)
Lives with both biological parents	-0.009	(0.027)	0.018	(0.013)
Satisfied w/relationship w/parents	0.052	(0.034)	0.019	(0.016)
Parents talked about contraception	0.035	(0.024)	0.029**	(0.012)
Parents approve sex with romantic	0.061*	(0.035)	0.028*	(0.017)
Observations	1602		7019	
Adjusted R-squared	0.085		0.074	

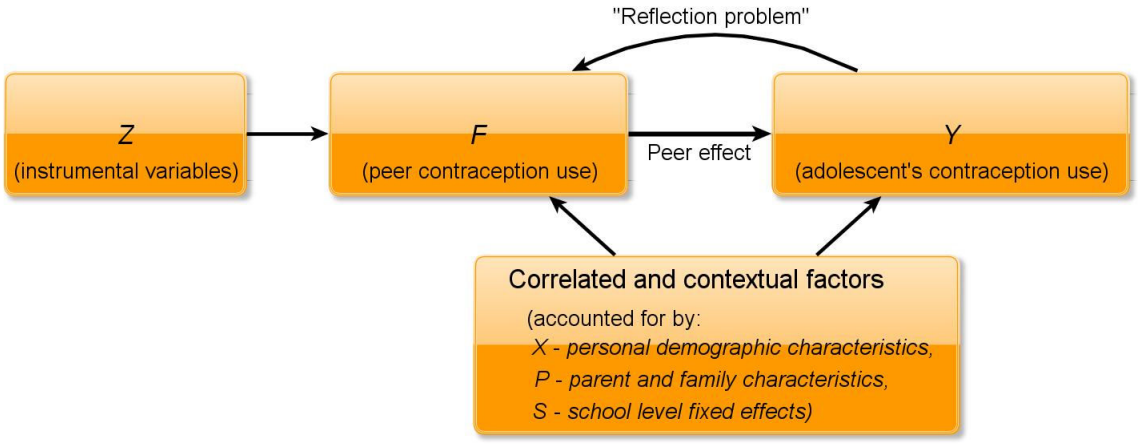
Note: Standard errors in parentheses. Significance is defined as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Determinants of Contraception Use at First Sexual Intercourse (2SLS)

Variable	Friends				Grade-Level Peers			
	IV	Std.Err	IV, FE	Std.Err	IV	Std.Err	IV, FE	Std.Err
Contraceptive use	0.147	(0.219)	0.139	(0.233)	0.522***	(0.140)	0.466**	(0.214)
Observations	1602		1602		7019		7019	
Adjusted R-squared	0.082		0.014		0.063		0.019	
Hansen's J-Statistic: Overid test (p-value)	0.963		0.780		0.195		0.931	

Note: Standard errors in parentheses. Significance is defined as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 1. Diagram outlining the empirical approach to identifying peer effect.



Note: In order to identify peer effect in contraception use, it is necessary to separate it from several other effects that can also cause correlation between peer contraception use and adolescent's contraception use. First, contraception use among peers in a social network is an equilibrium outcome and is therefore endogenous. This phenomenon is called the "reflection problem" (Manski 1993) [21]. Second, adolescents may choose friends with similar characteristics that are also correlated with the contraception use, and there may be omitted variables that are correlated with both own and peer contraception use (correlated effects). Third, there may be contextual effects where adolescent's behavior responds to the exogenous characteristics of the peer group. Our empirical model identifies peer effect and solves the reflection problem with the use of personal demographic and family controls, school level fixed effects and instrumental variables.