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Do parental involvement laws deter risky teen sex?

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ABSTRACT

Parental involvement (PI) laws require that physicians notify or obtain consent from a parent(s) of a minor seeking an abortion before performing the procedure. Several studies suggest that PI laws curb risky sexual behavior because teens realize that they would be compelled to discuss a subsequent pregnancy with a parent. We show that prior evidence based on gonorrhea rates overlooked the frequent underreporting of gonorrhea by race and ethnicity, and present new evidence on the effects of PI laws using more current data on the prevalence of gonorrhea and data that are novel to this literature (i.e., chlamydia rates and data disaggregated by year of age). We improve the credibility of our estimates over those in the existing literature using an *event-study* design in addition to standard difference-in-difference-in-differences (DDD) models. Our findings consistently suggest no association between PI laws and rates of sexually transmitted infections or measures of sexual behavior.

1. Introduction

The ongoing and heated debates over federal and state policies that influence access to abortion turn in large part on strongly held normative beliefs. However, the positive evidence on how abortion policies influence risky sexual behavior—particularly among minors—also figures prominently in these discussions. Specifically, over the past three decades, most states have introduced controversial laws that mandate parental involvement (PI) in minors' access to abortion services.[1] Supporters of PI laws contend that these regulations reduce risky sexual behavior among teens because teens realize that they would be compelled to discuss a subsequent pregnancy with a parent.[2] Such predictions implicitly view teens as forward-looking decision makers who are aware of PI laws and take the implied costs of discussing a possible pregnancy with a parent into account when making decisions about risky sex. In contrast, one would expect PI laws to have no meaningful effects on risky sexual behavior if teens are generally unaware of these regulations until they become pregnant or if they can circumvent these restrictions by obtaining an abortion in a neighboring state without a PI law.

Several previous studies have engaged this question empirically by evaluating the effects of PI laws on two proximate measures of sexual risk-taking among teens: self-reports of sexual activity and contraceptive use (Levine, 2001; Argys et al., 2002; Levine, 2003) and the prevalence of the sexually transmitted infection (STI) *Neisseria gonorrhoeae* (Dee and Sen, 2006; Klick and Stratmann, 2008). However, mainly due to methodological differences, these studies provide contradictory evidence on whether PI laws have influenced risky sexual behavior among teens. Drawing on multiple (and updated) sources of data, this study seeks to reconcile the disparate findings in the existing literature and to provide new and comprehensive evidence on the association between PI laws and rates of STIs among teens. More specifically, the evidence presented in this study makes three distinct contributions.

First, we explore the robustness of prior findings and we update evidence on whether PI laws have influenced the prevalence of gonorrhea with 10 years of additional data. We emphasize that previous analyses of gonorrhea rates have not engaged the substantive

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[1] These laws require either notifying a parent or securing the consent of a parent. States began introducing PI laws in 1973, soon after abortion was legalized nationwide. Thirty-seven states currently require PI, up from nine states in 1988 (Merz et al., 1995; Guttmacher Institute, 2013).

[2] As Texas State Representative Phil King, who sponsored the change from a parental notification to a parental consent statute, stated, "I think it will do what [parental notification] intended to do by bringing parents into the decision-making process, and when that happens we'll see a reduction in abortion and in teenage pregnancy" (Associated Press, 2010).

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measurement problems with the data that are available from STI surveillance systems. Second, we analyze an entirely different STI, *Chlamydia trachomatis*, among teens and minors. The prevalence of both chlamydia and gonorrhea among teens is a major public health concern (Hampton, 2008). However, chlamydia has a particular appeal in this context because it is roughly 10 times more common among young adults and teens than gonorrhea. In a population-based screening of young adults ages 18–26, 4.2 percent tested positive for chlamydia compared with 0.43 percent for gonorrhea (Miller et al., 2004). Third, we test whether PI laws are associated with changes in sexual activity, unprotected sex, the number of sexual partners and use of the contraceptive pill with data on a nationally representative sample of high school students from the Youth Risk Behavior Surveillance (YRBS) system. Although these data are limited by the number of participating states and years, they provide useful information on a key mediator. A decrease in sexual activity or an increase in condom use associated with a PI law would be a key link in the causal chain to fewer STIs.

2. Abortion access and risky sexual activity among teens

2.1. Parental involvement laws

After the US Supreme Court in 1973 established the constitutional right to terminate a pregnancy by abortion, several states introduced policies regulating abortion access, such as limitations on public funding, mandatory waiting periods, and parental involvement (PI) laws. Twelve states established enforceable PI laws at some point during the 1980s. Over the past two decades, these state-level abortion restrictions expanded dramatically and, currently, 38 states have an enforceable PI law in effect (Guttmacher Institute, 2013). There were periods in several states during which states were legally enjoined from enforcing a PI law. Furthermore, some state PI laws require parental notification only of a teen's intent to have an abortion, whereas other states mandate parental consent.

2.2. Theoretical considerations

There are at least two competing theories about the behavioral response of adolescents to changes in access to reproductive health services. Standard economic models of sexual behavior generally conceptualize abortion as a form of insurance against an unwanted birth (for example, Levine, 2003; Levine and Staiger, 2004). Policy levers that restrict access to abortion, such as PI laws, are viewed as increases in the effective cost of acquiring an abortion. In this framework, forward-looking minors would react to a PI law by either reducing sexual activity or increasing the use of contraceptives (Levine, 2003). Because condoms and birth control pills are the most widely used contraceptive methods among minors, PI laws could increase the use of either or both methods. A reduction in sexual activity and/or an increase in condom use could yield a reduction in STIs.

A competing theory of teen reproductive behavior argues that teens give little consideration to the costs of an unwanted pregnancy when deciding to have sex (Paton, 2006). Under this model, changes in laws that alter the price of accessing abortion services have little effect on sexual activity. It is only after an act of unprotected intercourse or contraceptive failure, when faced with an unwanted pregnancy or with the possibility of one, that teens consider the cost of their behavior. Under this assumption, the introduction of a PI law would not cause a change in teens' sexual behavior. Evidence consistent with this model would be a lack of change in rates of STIs. However, such a null result could also indicate that PI laws induced greater use of the pill or other hormonal contraception, reducing the risk of pregnancy but without necessarily altering exposure to STIs.

PI laws might also have limited or no effects when information about the abortion restrictions in a state is not readily available to teens. For example, some studies suggest that teens are largely unaware of their state's PI laws (Stone and Waszak, 1992; Blum et al., 1987). PI laws could also have limited relevance because a substantial proportion of teens appear to discuss their pregnancies with a parent in the absence of these regulations. Specifically, Henshaw and Kost (1992) found that 61 percent of minors seeking an abortion in states without PI laws had already told their parents about the procedure. The ability of teens to obtain abortions in nearby states or use the judicial bypass procedure can also be expected to limit the behavioral consequences of PI laws (Cartoff and Klerman, 1986; Blum et al., 1990; Henshaw, 1995; Joyce et al., 2010).

2.3. Prior empirical evidence

These theoretical and practical considerations suggest that the question of whether PI laws have behavioral consequences is, ultimately, an empirical one. Numerous studies evaluated the association between PI laws and abortion and birth rates among teens (Kane and Staiger, 1996; Levine, 2003; Joyce et al., 2006; Colman et al., 2008). However, a link between PI laws and changes in the rates of abortions, births, or pregnancies does not correspond exactly to how PI laws may influence STI prevalence (Ohsfeldt and Gohmann, 1994; Levine, 2003; Colman et al., 2008). If PI laws induce minors to reduce their risk of an unwanted pregnancy, this can be achieved by increasing the use of hormonal contraceptives or switching to a more effective hormonal method. A reduction in STIs, on the other hand, requires that minors either reduce sexual activity or the number (or riskiness) of partners or increase the use of condoms. Thus, a negative association between PI laws and pregnancies or births or abortions would not imply that PI laws reduce the risk of STIs. The relationship between PI laws and the risk of STIs can be determined only by evaluating the effect directly on the prevalence of STIs or STI-related risky behavior such as consistency of condom use.

More direct evidence on this question has come from a study that focuses on the variation in rates of gonorrhea among youth (Klick and Stratmann, 2008), hereafter KS, examined 1981–1998 state-year gonorrhea rates, by race and ethnicity, among all females younger than 20. The study concluded that PI laws led to substantive reductions in gonorrhea rates: 12 percent among white females younger than 20, and 21 percent among Hispanic females younger than 20 but no change among black non-Hispanics. These inferences are based on population-weighted DD specifications that also condition on linear state trends and the prevalence rate among women older than 20, as a way of controlling for general trends in the rate among women younger than 20 in the state (KS, 2008, Table 2). DDD specifications that condition on state-year, state-age, and year-age fixed effects (KS, 2008, Table 3) provide mixed evidence in support of these DD results. Another substantive (and previously unrecognized) source of concern with these inferences is that they are based on the race- and ethnicity-specific gonorrhea rates reported by Centers for Disease Control and Prevention (CDC). As discussed in more detail below, these data have a surprisingly large rate of underreporting. A third concern is that the estimated effects reported by KS are extremely large. Sixty-one percent of minors involve parents or guardians in their decision to have an abortion (Henshaw and Kost, 1992). In a separate survey, 60 percent of minors also report their parents or guardians were aware that they were accessing sexual health services (Jones et al., 2005). Thus, less than half of all minors would have an incentive to change their behavior in response to a PI law. This implies that the 20 percent decline in rates of gonorrhea among Hispanics, as reported by KS, resulted from a 50 percent decline among the subpopulation of Hispanic minors who would not have involved their parents. If effect sizes this large are unrealistic, then it raises questions of statistical power to detect more realistic responses, an issue we return to below.[3]

3. Replication of methods applied by Klick and Stratmann (2008)

We assess the sensitivity of KS's findings to the reporting error in CDC's race-specific data in three steps. First, we explore the extent of underreporting in the CDC's race-specific data in detail, then we estimate KS's model separately for White non-Hispanics, Black non-Hispanics, and Hispanics after removing from the data all observations with a zero rate of gonorrhea that are clearly not true zeros.[4] Second, we estimate the KS model for White non-Hispanics in states in which at least 85 percent of the female population under 20 was white according to the 1990 census.[5] Finally, we evaluate whether the race-specific findings by KS hold up for the sample of all women, and compare the estimates among all women for the period covered by KS (1981–1998) to the estimate based on 10 years of additional data (1999–2008).

3.1. The limitations of STI reporting by race and ethnicity

As suggested earlier, a particularly salient limitation of the CDC system is the large number of cases for which race and ethnicity are unknown or misreported. This inconsistent reporting is unfortunate because racial and ethnic differences in the prevalence of gonorrhea and chlamydia are profound. Data from the National Longitudinal Study of Adolescent Health indicate that 12.5 percent of blacks, 1.9 percent of whites, and 5.9 percent of Hispanics ages 18–25 were infected with chlamydia in 2001–2002. Differences in the prevalence of gonorrhea by race/ethnicity are even greater (Miller et al., 2004).

If the percentage of unknown cases reported to the CDC by race and ethnicity were relatively modest and stable over time, then race-specific analyses by KS would be more justifiable. However, in the 10 most populous states, which generally have the largest proportion of racial and ethnic subgroups, the percentage of cases of gonorrhea with unknown race is typically between 30 and 40 percent with substantial year-to-year fluctuations. The pattern for chlamydia is similar if not worse than with gonorrhea. As examples, consider Michigan, Pennsylvania and Georgia—states with a PI law and with the second, third, and fourth largest Hispanic population, respectively. Reported cases among Hispanics in these states are zero or close to zero throughout the period, while cases with unknown race fluctuate wildly. In Michigan, for instance, there are zero reported cases of gonorrhea among Hispanics between 1981 and 1992, and only between 40 and 70 in the later years. New York is another notable example. The number of reported cases of gonorrhea among Hispanic women is close to 0 throughout the study period which makes no sense given the size of the Hispanic population in New York (see Colman et al., 2013).

3.2. Sensitivity of KS's race-specific estimates to underreporting and model specification

Findings from our replication exercise are presented in Table 1. For each racial group we show coefficients on the PI law from models with and without state-specific trends as well as estimates weighted by race-specific female population younger than 20 and unweighted estimates. Results from KS's preferred specification—presented in columns (1), (3), and (5) in panel A—indicate a statistically significant negative association between PI laws and rates of gonorrhea among white non-Hispanic and Hispanic women younger than 20. Specifically, they found that PI laws were associated with a decline of 9.5 cases of gonorrhea per 100,000 among white non-Hispanics and a decline of 12.0 cases per 100,000 among Hispanics (KS, 2008, Table 2). However, the findings are sensitive to the inclusion of state-specific trends as controls and to weighting. For instance, none of the estimates from models that do not control for state-specific trends, or control for state-specific trends but are not weighted by the size of the population are statistically significant (panels B–D, columns (1), (3) and (5)).

As noted above, the remaining results in Table 1 explore the robustness of these findings to problems in the race-specific data. For example, we drop cells with zero cases of gonorrhea for Hispanics and Blacks in columns (2) and (4) respectively. In column (6) we include only whites from predominantly white states (the 17 states where at least 85 percent of the women under 20 were white). Interestingly, the estimate for Hispanics falls almost in half and is statistically insignificant when these "zero" cells are omitted from the specification preferred by KS (i.e., panel A). Similarly, the coefficient for whites (i.e., column (6)) becomes statistically insignificant (and has the opposite sign) when we limit the sample to states where misreporting is less pronounced (i.e., states with high concentrations of whites). None of the other estimates in columns (2), (4) and (6) of panels B–D provide evidence of an association between PI laws and rates of gonorrhea. In fact, the evidence from these unweighted regressions implies that population weighting exacerbates the measurement error as states with the largest minority population have the greatest proportion of unknowns. For instance, the coefficient on PI laws in the weighted regression of Hispanics changes from negative to positive when unweighted (column 2, panels A and C). In columns (8) we analyze rates of gonorrhea from 1981 to 1998 among all women for which there are relatively few unknowns and in column (9) we extend the sample to include data through 2008. There is no association with PI laws in any specification.[6]

[3] Changing the behavior of 50 percent of minors exposed to the law seems extremely large based on the recent literature on emergency contraception (EC). Free provision of EC would lower the cost of unprotected sex and thus be expected to increase the incidence of STIs. In a review of 11 randomized studies of EC, researchers reported no change in STIs or unintended pregnancy among women who were provided free courses of emergency contraception (Polis et al., 2007). Although different from PI laws, the lack of an association between the provision of EC and risky sex underscores the difficulty of changing sexual behavior.

[4] Cells with values greater than zero are not necessarily credible, either. There is extensive underreporting by race, especially for Hispanics as is evident in New York (see Colman et al., 2013, Fig. 2), but there is no objective way to eliminate cells with too few cases to be credible.

[5] These states are: Idaho, Indiana, Iowa, Kentucky, Maine, Minnesota, Nebraska, New Hampshire, North Dakota, Oregon, South Dakota, Montana, Utah, Vermont, West Virginia, Wisconsin and Wyoming.

[6] Our coding of PI laws differs in some states from that of Klick and Stratmann (2008). In addition, we make no distinction between laws that require parental consent from those that require parental notification. Nor do we compare the impact of laws that were enjoined from those that were enforced. We re-estimated the model in column (8) using our coding through 1998 and the results did not differ significantly that that of KS. The coefficient was (−21.31) with a standard error of (12.87) in KS preferred specification. Additional results are available upon request.

Table 1
Replication of model by Klick and Stratmann (2008): sensitivity to missing data, weighting & state trends.

	1	2	3	4	5	6	7	8	9
	Hispanics		Blacks		Whites		All cases		
	All	w/o 0's	All	w/o 0's	All	17 states	17 states	All states	All states, 1981–1998, Author's coding
Panel A: estimates from models with state-specific trends, weighted									
PI law	−12.048**	−7.116	−40.723	−52.503	−9.541*	5.74	11.601	−14.377	−4.79
	(5.648)	(8.086)	(69.777)	(67.884)	(5.309)	(6.295)	(14.179)	(13.554)	[10.87]
R^2	0.938	0.938	0.947	0.944	0.962	0.957	0.97	0.962	0.96
Panel B: estimates from models without state-specific trends, weighted									
PI law	−4.905	−13.46	−36.61	−51.928	−0.816	9.911**	24.336**	0.398	−13.07
	(6.350)	(8.569)	(57.081)	(58.382)	(4.814)	(4.410)	(10.383)	(11.930)	[11.24]
R^2	0.92	0.912	0.938	0.929	0.945	0.942	0.959	0.948	0.94
Sample size	911	601	912	802	912	286	286	912	1423
Mean dep. var.	66.49	73.75	1080	1167	84.12	71.77	158.5	288.6	245.4
Panel C: estimates from models with state-specific trends, unweighted									
PI law	−8.499	6.358	−56.475	−88.754	−5.322	−1.079	−5.143	0.472	0.11
	(6.690)	(11.952)	(66.487)	(58.132)	(4.472)	(5.765)	(13.592)	(12.582)	[9.87]
R^2	0.809	0.82	0.927	0.928	0.906	0.945	0.958	0.961	0.95
Panel D: estimates from models without state-specific trends, unweighted									
PI law	−0.574	−2.59	−23.678	−64.509	−1.619	9.255	13.812	−3.635	−8.14
	(6.438)	(8.614)	(38.088)	(44.563)	(5.206)	(6.283)	(10.627)	(11.442)	[18.53]
R^2	0.784	0.782	0.917	0.913	0.839	0.92	0.944	0.947	0.93
Sample size	911	601	912	802	912	286	286	912	1423
Mean dep. var.	56.82	86.13	1006.00	1144.00	89.46	64.01	114.60	287.20	242.832

Notes: Estimates in columns (1), (3) and (5) of panels A and B replicate the results in Klick and Stratmann (2008, Table 2). The dependent variable is the gonorrhea rate among women less than 20, by state and year. The independent variables include an indicator of PI laws, the gonorrhea rate among women ages greater than or equal to 20, and state and year fixed effects. Models 2 and 4 exclude all cells with zero reported cases of gonorrhea. Model 6 includes the 17 states in which at least 85 percent of women less than 20 years of age were white in 1990. Models 7 and 8 include all women and model 9 includes all women and covers the years 1981–2008. The coefficients presented in the table are the coefficients on the indicator of PI laws. The four panels, A–D, show estimates from models weighted (by population of women less than 20 years of age) and unweighted, with and without state-specific trends. The standard errors have been adjusted for clustering at the state level.

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

3.3. Statistical power

The comparative results in Table 1 demonstrate the sensitivity of the estimate reported by KS both to the previously undiagnosed misreporting of race-specific STI data and to model specification choices (i.e., conditioning on linear state trends and the use of weighting).

However, it is important to note that the alternative results presented in Table 1 are in general not estimated with sufficient statistical precision to clearly reject the large KS estimates. For example, KS report a point estimate of −12.0 in the rate of gonorrhea among Hispanics, a decline of 18.1 percent evaluated at the mean of 66.49 (Table 1, panel A, column 1). When state-year cells with zero reported Hispanic cases are omitted (Table 1, panel A, column 2), the confidence interval for the resulting impact estimate (−14.75) includes that reported by KS. However, it should be noted that the results that correct for misreporting of race-specific STI data do have sufficient statistical power to reject the KS estimate for the impact of PI laws on white teens. Specifically, the 95-percent confidence interval for the point estimate based only on data where a clear majority of teens are white (Table 1, panel A, column 7) does not include the large point estimate reported by KS (column 5). In addition, KS contrast gonorrhea rates of all women less than 20 years of age to all women 20 years and older which further diminishes power since a relatively small proportion of women in the younger age group are affected. In results that follow, we likely increase statistical power by: (1) narrowing the analysis to the age group most likely affected by the law (15–19 year-olds), (2) analyzing all minors and women, which eliminates the measurement error associated with race and ethnicity, (3) extending the series to 2008, and (4) analyzing the association between PI laws and chlamydia, a much more prevalent STI.

4. Data and methods employed in current study

4.1. Data and samples

We use reported female cases of gonorrhea from 1981 to 2008 in all 50 states and the District of Columbia (hereafter 51 states) as maintained by CDC. For chlamydia we use data from 1996 to 1999 in 48 states and all 51 states from 2000 to 2008. Data released by the CDC are only available in five-year age groups. The CDC data enable us to evaluate the association between PI laws and the rates of STIs among teens ages 15–19 using the rate of STIs among young adults ages 20–24 as the comparison group. However, 18- and 19-year-olds are unaffected by PI statutes. Including them in the treatment group might obscure effects of the law on minors. Thus, we have also obtained an unbalanced panel of cases of gonorrhea and chlamydia for teens by single year of age from 21 states beginning in 1990. With this subsample, we compare changes in STIs among minors ages 15–17 relative to older teens ages 18 and 19. Isolating minors should increase power and comparing their change in STI rates with older teens rather than with young adults is likely to improve the credibility of the counterfactual.[7]

[7] A possible limitation of using rates of STIs among 18- and 19-year-olds is that minors who delay sex in response to a PI law might take more risks as 18-year-olds. Put differently, the law might simply delay risky behavior, which would contaminate

We use the national Youth Risk Behavior Surveillance System (YRBS) to analyze changes in sexual behavior among teens associated with PI laws. The YRBS is a probability multi-stage survey of youth administered biennially starting in 1991 in classrooms to students enrolled in grades 9–12 in public and private schools. We analyze five dichotomous outcomes: (1) whether the teen ever had sex; (2) whether the teen had sex in the last three months; (3) whether the teen had sex in the last three months and did not use contraception; (4) whether the teen was using the contraceptive pill at last intercourse and (5) whether the teen had sex in the last three months and did not use a condom. The latter is a measure of whether the teen was at risk for an STI. An affirmative answer to each question is coded as 1. In none of the questions do we condition on having sex because PI laws could, in theory, deter minors from engaging in sexual activity. Because the YRBS did not survey every state in each year, we present some results for the states that participated at least 8 times, in addition to the full-sample results.

Population by state, year, age, gender, and race is from the Surveillance Epidemiological and End Results (SEER) of the National Cancer Institute (NCI). Information about the status of PI comes from three sources: Merz et al. (1995); "Who Decides? The Status of Women's Reproductive Rights in the United States" by NARAL Pro-Choice America Foundation (NARAL, 2011), and "State Policies in Brief: Parental Involvement in Minors' Abortions" by the Guttmacher Institute (2013). For a more detailed description of our data sources please see Colman et al. (2013).

4.2. Statistical methods

4.2.1. Difference-in-difference-in-differences analysis

In Fig. 1 we show the rates of gonorrhea and chlamydia by five-year age groups based on the data obtained from the CDC. As shown in the figure, rates of gonorrhea and chlamydia among teens ages 15–19 and young adults ages 20–24 far exceed rates among the other age groups and follow similar trajectories over the study period. PI laws apply only to minors younger than 18 and should have little impact on the behavior of young women ages 20–24. The latter, therefore, becomes a natural comparison group.

The DDD model for evaluating the association between PI laws and rates of STIs among teens is presented in Eq. (1):

$$R_{\text{sta}} = \beta \text{PI}_{\text{sta}} + (\lambda_{\text{s}} \times \text{Teen}_{\text{a}}) + (\tau_{\text{t}} \times \lambda_{\text{s}}) + (\tau_{\text{t}} \times \text{Teen}_{\text{a}}) + e_{\text{sta}} \quad (1)$$

where R_{sta} is the rate of STIs by state, year, and age group (15–19 vs. 20–24); the rate for both chlamydia and gonorrhea is defined as the number of female cases per 100,000 female population of the same age. PI_{sta} is a dichotomous indicator that equals one for the years and states in which teens ages 15–19 are exposed to a PI law and zero otherwise. Teen_{a} is a dichotomous indicator that equals one if the outcome refers to teens ages 15–19 and zero for young adults ages 20–24. State and year fixed effects are represented by λ_{s} and τ_{t}, respectively.[8] Thus, the coefficient, β, identifies effect of PI laws on teens relative to the young adults in the same state-year cell (i.e., conditional on $\tau_{\text{t}} \times \lambda_{\text{s}}$) and conditional on the unobserved determinants unique to each state-age interaction ($\lambda_{\text{s}} \times \text{Teen}_{\text{a}}$) and each year-age interaction ($\tau_{\text{t}} \times \text{Teen}$). We estimate this specification using data from all state, year, age cells. We also estimate Eq. (1) by comparing rates of STIs among minors ages 15–17 to rates among older teens ages 18 and 19. Only minors are covered by PI laws. Provided there are no spillover effects from minors to older teens, analyzing changes in STI among 15–17 year olds may improve our ability to detect a link with PI laws.

4.2.2. Event-study design

We complement our canonical DDD methodology with an event-study approach that allows for an unrestricted examination of the differences in the rates of STIs between the treatment and comparison groups in the years before and after the enactment of a law. This approach allows us to assess the possibly dynamic treatment effects of PI laws. Critically, it also provides ad hoc evidence on the identifying assumptions in this specification. Specifically, if there were substantial differences in STI trends between teens and young adults *before* a PI law, it would suggest that we have not adequately controlled for the unobserved determinants varying within states over time that are unique to the younger age group bound by PI laws.

The event-study approach is represented by the following equation:

$$R_{\text{sta}} = \sum_{k=-6}^{k=6} \beta_k \times \text{PI}^1_{\text{sa}}(t - T_{\text{t}}* = k + 1) + (\lambda_{\text{s}} \times \text{Teen}_{\text{a}}) + (\tau_{\text{t}} \times \lambda_{\text{s}}) + (\tau_{\text{t}} \times \text{Teen}_{\text{a}}) + e_{\text{sta}} \quad (2)$$

The notation in Eq. (2) is similar to that of Eq. (1) with the following modifications. The variable PI_{sa} is one for teens in states that ever passed a PI law. Let T^* be the year the law went into effect and let k vary from 1 to 6 or more and from −1 to less than or equal to −6. The year before the law goes into effect in a given state is normalized to zero. The indicator function creates the leads and lags for that state and age group. For example, if a PI law goes into effect in 1990, $k = 0$ for 1989 and thus the indicator function is zero; $k = 1$ for 1990 and the indicator function is one. For each state with a law there is a maximum of 12 parameters since any period 6 or more years before or after the law is captured by a single coefficient. In this specification, coefficients, β_k, estimate the DDD for the periods before and after implementation of each state's PI law. If the state, year and age interactions effectively control for trends, then plots of β_k should fluctuate around zero in years before the law.

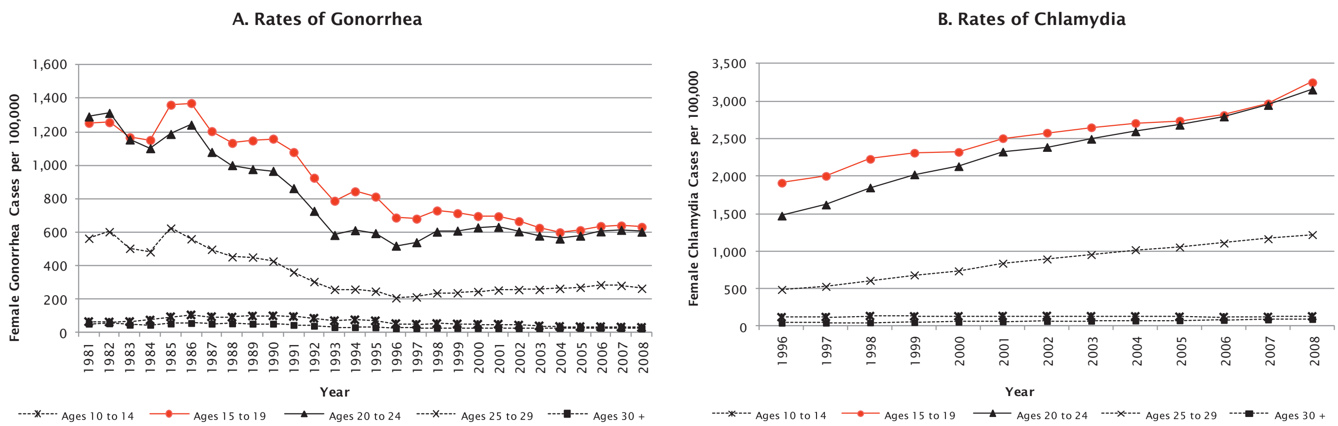
5. Estimated impact of PI laws on rates of gonorrhea, chlamydia, and sexual activity

The DDD estimates based on Eq. (1) for gonorrhea and chlamydia are presented in Table 2, panels A and B, respectively. We show results that contrast two age grouping: teens vs. young adults (column 1–4) and then minors with older teens (columns 5–8). We also compare results from two samples of states: states that enforced a PI law (columns 1, 2, 5 and 6) and then all states (columns 3, 4, 7 and 8). Estimates for gonorrhea consistently indicate that PI laws had statistically insignificant effects on gonorrhea rates (panel A). In the models based on the 5-year age groups the point estimates are particularly imprecise. In contrast, results for minors imply fairly tight bounds. For example, model (8) in Table 2 implies a 95-percent lower confidence limit of approximately 41 cases per 100,000 minors (i.e., under 6 percent relative to the sample mean).

All estimates for chlamydia are statistically indistinguishable from zero regardless of which age group we compare. Estimates for teens ages 15–19 are positive in models that only include states that enforced a PI law during our study period (Table 2, panel B; columns 1, 2 and 5, 6). They become negative when all available states are included, but are relatively small when contrasted with the mean rate for teens. The findings are similar for models based on the data by single year of age. The DDD estimates based on the

the comparison group. The use of young people ages 20–24 as a comparison group provides a check against that source of contamination.

[8] All age, state and year main effects are redundant when the full set of interactions are included.



Source: Authors' calculation based on data on reported to the National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (NCHHSTP), Centers for Disease Control and Prevention (CDC).

Fig. 1. Female gonorrhea and chlamydia rates, by age group and year; 1981–2008.

7 states with a change in the laws between 1997 and 2007 are positive and rather large, whereas the ones based on 21 states are negative and much smaller in magnitude. None of the estimates is statistically significant.

The event-study results for both STIs strengthen the case for the null findings from the DDD analysis. In Fig. 2 we plot the unweighted estimates of β based on Eq. (2), which allows the DDD estimates to vary for each pre- and post-implementation year. Estimates of β range from −41 to 8.8 during the pre-implementation years and from −71 to −17 during the post-law years for gonorrhea. The estimates are small relative to the standard errors, but even in the first two years after implementation of a law, in which the confidence intervals are much tighter, we observe no association between rates of gonorrhea and PI laws. For chlamydia, the estimate in the year of implementation is negative but relatively small in magnitude (−24). Estimates for all subsequent years are positive and not significant. Furthermore, while none of the coefficients for the five pre-law years are statistically significant, their magnitude and pattern is close to the coefficients for the post-law years.

Estimates from the YRBS for each outcome and samples of states are shown in Table 3. The estimated coefficients for age and race

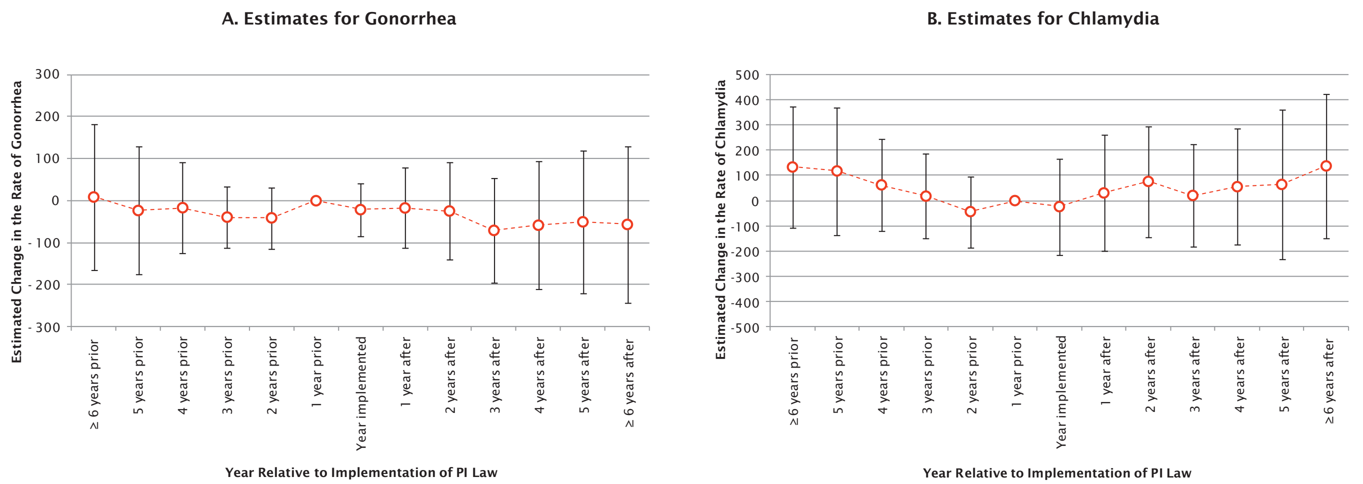
Table 2
DDD estimates of the association between PI laws and rates of gonorrhea.

	15–19 vs. 20–24				15–17 vs. 18 and 19			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Panel A: results for rates of gonorrhea								
PI law	−28.51	−24.46	−33.78	−30.69	23.38	19.35	10.54	−0.45
	(40.21)	(41.40)	(44.88)	(41.43)	(19.75)	(27.56)	(21.01)	(20.52)
R^2	0.96	0.95	0.95	0.96	0.84	0.82	0.87	0.85
Number of states	30	30	51	51	8	8	21	21
Mean dependent variable	920.65	1006.37	794.54	848.82	883.74	872.76	695.07	707.45
Years	1981–2008	1981–2008	1981–2008	1981–2008	1986–2009	1986–2009	1986–2009	1986–2009
Weighted	No	Yes	No	Yes	No	Yes	No	Yes
States with change in law during study period	Yes	Yes	No	No	Yes	Yes	No	No
Sample size	1672	1672	2846	2846	640	640	1470	1470
Panel B: results for rates of chlamydia								
PI law	51.92	79.18	−35.81	−46.96	160.51	163.24	−26.1	−18.94
	(99.52)	(72.17)	(82.10)	(70.13)	(226.99)	(177.41)	(106.63)	(101.98)
R^2	0.97	0.98	0.98	0.98	0.69	0.67	0.72	0.69
Number of states	9	9	51	51	7	7	21	21
Mean dependent variable	2230.20	2456.88	2349.35	2454.12	2603.01	2621.51	2444.14	2480.07
Years	1996–2008	1996–2008	1996–2008	1996–2008	1990–2009	1990–2009	1990–2009	1990–2009
Weighted	No	Yes	No	Yes	No	Yes	No	Yes
States with change in law during study period	Yes	Yes	No	No	Yes	Yes	No	No
Sample size	234	234	1326	1326	530	530	1430	1430

Notes: All estimates are based on a model presented in Eq. (1). The dependent variable is the age-specific female cases of gonorrhea per 100,000 age-specific female population in panel A, and the age-specific female cases of chlamydia per 100,000 age-specific female population in panel B. The coefficients presented in the table are the coefficients on the PI law indicator (β). Standard errors adjusted clustering at the state level are in parentheses. Models 1, 2, 5, and 6 include only states that enacted a PI law during our study period. Models 3 and 4 include all 50 states and Washington, DC.; models 7 and 8 include all 21 states for which we have data by single year of age. Estimates from models 1–4 are based on a balanced panel of states and years.

Data on rates of gonorrhea are missing for 1983 in Indiana, Georgia, and Idaho, and for 1984 in Tennessee.

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.



Note: The coefficients shown in the figures are estimates of $_k$ from Equation (2). The dependent variable is the age- specific female cases of gonorrhea per 100,000 age- specific female population in Figure 2A, and the age- specific female cases of chlamydia per 100,000 age- specific female population in Figure 2B. Standard errors are adjusted for a general form of heteroskedasticity.

Fig. 2. DDD estimates and 95% confidence intervals of the association between PI laws and rates of gonorrhea and chlamydia among female teens (15–19) relative to young adults (20–24) each year pre and post implementation of a PI law.

Table 3
Association between PI laws and sexual activity among high school students ages 15–17; YRBS 1991–2009.

	Ever have sex		Unprotected sex		Sex last 3 months		At risk for STDs		Pill used	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
PI law	0.045*	0.017	0.016	0.008	0.032	0.009	0.007	−0.003	0.005	0.001
	(0.021)	(0.018)	(0.012)	(0.009)	(0.02)	(0.016)	(0.017)	(0.013)	(0.007)	(0.007)
R^2	0.101	0.098	0.024	0.025	0.071	0.072	0.035	0.04	0.020	0.027
Number of states	14	47	14	47	14	47	14	47	14	47
Mean dependent variable	0.445	0.445	0.088	0.086	0.316	0.317	0.124	0.128	0.050	0.056
Sample size	75,693	110,937	73,451	107,611	75,537	110,606	74.692	109.418	73451	107611

Notes: Coefficients are from a linear probably model of the form $R_{ist} = \beta PI_{st} + X\alpha + \tau_t + \lambda_s + e_{ist}$ where R_{ist} is the 1 if the individual report one of the outcomes and zero otherwise. X is matrix of controls for age and race, sex. The model includes state and year fixed effects. Standard errors are adjusted for the sampling design with Stata's survey regression procedure and corrected for clustering at the state level. There are two samples for each outcome. The first includes the 14 states with at least 8 years of data and the second includes all states with data. Each model includes indicators for age, race/ethnicity, state and year.

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

conform to the prior literature. For example, risky sexual behavior increases with age and is more prevalent among black and Hispanic minors relative to whites (Santelli et al., 2004). The last two columns show estimates of the association between PI laws and the contraceptive pill. Although not a risky behavior per se, an increase in pill use in response to a PI law would be associated with a decrease in abortions and pregnancies, but no change in STI's, all else constant. Estimates of the effect of PI laws are all positive and relatively small in magnitude, suggesting that there is little evidence that PI laws are associated with a reduction in risky sexual behavior. Nor are PI laws associated with pill use. Moreover, coefficients from the sample of 14 states that participated in the YRBS for at least 8 years differ very little from those based on all available states. Although we cluster the standard errors by states, the small number of states and highly unbalanced panel may render the adjustment less effective. In results not shown, we aggregate the data to the state level and re-estimate the models. Aggregation eliminates the intra-class correlation among individuals in the same state. We then estimate regressions with the aggregate data adjusted for first-order autocorrelation. The coefficients on the PI laws are always positive and thus counter to the hypothesis that PI laws encourage risky sex, but none are statistically significant (results available upon request).

6. Conclusion and implications

Currently, laws in 38 states require that physicians notify or obtain consent from a parent or parents of a minor before performing an abortion. Advocates of these laws argue that they reduce risky sexual behavior among teens. However, prior evidence on this question has been mixed. This study examined this issue using multiple and updated sources of data. We found little evidence that PI laws were associated with changes in rates of gonorrhea or chlamydia among teens ages 15–19 and minors ages 15–17. Similarly, we uncovered no association between PI laws and direct measures of sexual activity in a subset of states that participated in the YRBS. Our findings are at odds with a previous study that reported a decrease in rates of gonorrhea among white non-Hispanic and Hispanic women younger than 20 in the wake of a PI statute (KS, 2008). However, race is poorly reported in the CDC data as the most populous and diverse states have the greatest percentage of cases with unknown race and ethnicity. In an effort to reconcile the conflicting findings, we estimated the same model as KS but for all women instead of by race. We found little evidence to support their conclusion that PI laws are negatively related to rates of gonorrhea.

Our findings have important public health implications. Given the alarmingly high rate of STIs among teens, decreasing risky sexual behavior and thereby reducing the spread of STIs among young individuals remains a vital policy objective. Our results suggest that PI laws do not induce minors to change sexual behaviors that might lower the incidence of STIs. Results from the YRBS, although limited by the sample, suggest more proximate measures of sexual behavior are also unaffected. One interpretation is that the constraints implied by PI laws influence minors when making decisions regarding sexual activity (e.g., the use of hormonal contraceptives, though we find no such evidence). Another explanation for the lack of association is that the law does not affect a sufficiently large portion of minors so as to be detectable at the population level. Upwards of 60 percent of minors discuss their decision to obtain an abortion with their parent(s) in states without a PI law, and thus are unlikely to be affected by a PI requirement. In addition, a substantial proportion of minors obtain an abortion via a court bypass procedure (Blum et al., 1990; Joyce, 2010). This suggests that a relatively small proportion of minors even potentially view the law as increasing the cost of an abortion. In sum, the findings suggest that states look beyond PI laws in seeking to curb risky sexual activity and the rate of STIs among teens.

References

Argys, L.M., Averett, S.L., Rees, D.I., 2002. The impact of government policies and neighborhood characteristics on teenage sexual activity and contraceptive use. American Journal of Public Health 92 (11), 1173–1178.

Associated Press, 2010. Parental consent urged for abortions: proposal would require girls under 18 to get approval. In: As Printed in the Houston Chronicle, February 18, 2005, Available at http://www.chron.com/disp/story.mpl/metropolitan/3045585.html (accessed 05.09.10).

Blum, R., Resnick, M., Stark, T., 1987. The impact of a parental notification law on adolescent abortion decision-making. American Journal of Public Health 77, 619–620.

Blum, R., Resnick, M., Stark, T., 1990. Factors associated with the use of court bypass by minors to obtain abortions. Family Planning Perspectives 22 (4), 158–160.

Cartoff, V.G., Klerman, L.V., 1986. Parental consent for abortion: impact of the Massachusetts law. American Journal of Public Health 76 (4), 397–400.

Colman, S., Dee, T., Joyce, T., 2013. Do parental involvement laws deter risky teen sex? In: National Bureau of Economic Research Working Paper Number 18810. http://www.nber.org/papers/w18810 (accessed 28.05.13).

Colman, S., Joyce, T., Kaestner, R., 2008. Misclassification bias and the estimated effect of parental involvement laws on adolescents' reproductive outcomes. American Journal of Public Health 98 (10), 1881–1885.

Dee, Thomas S., Sen, Bisakha, 2006. Do parental involvement laws promote safe sex among female teens? In: Working Paper.

Guttmacher Institute, 2013. State Policies in Brief: Parental Involvement in Minors' Abortions. Guttmacher Institute, New York.

Hampton, T., 2008. Researchers seek ways to stem STDs. Journal of the American Medical Association 299 (16), 1888–1889.

Henshaw, S.K., 1995. The impact of requirements for parental consent on minors' abortions in Mississippi. Family Planning Perspectives 27 (3), 120–122.

Henshaw, S.K., Kost, K., 1992. Parental involvement in minors' abortion decision. Family Planning Perspectives 24 (5), 196–207, 213.

Jones, R., Purcell, A., Singh, S., Finer, L.B., 2005. Adolescents' reports of parental knowledge of adolescents' use of sexual health services and their reactions to mandated parental notification for prescription contraception. Journal of the American Medical Association 293 (3), 340–348.

Joyce, T., Kaestner, R., Colman, S., 2006. Changes in abortions and births and the Texas parental notification law. New England Journal of Medicine 354 (10), 1031–1038.

Joyce, T.J., Tan, R., Zhang, Y., 2010. Changes in birth rates of young women following access to the pill and abortion in the early 1970s, Unpublished manuscript. Retrieved July 5, 2013, from the Princeton University Web site: http://paa2012.princeton.edu/papers/120255

Kane, T., Staiger, D., 1996. Teen motherhood and abortion access. The Quarterly Journal of Economics 111 (2), 467–506.

Klick, J., Stratmann, T., 2008. Abortion access and risky sex among teens: parental involvement laws and sexually transmitted diseases. Journal of Law, Economics, and Organization 24 (1), 2–21.

Levine, P.B., 2001. The sexual activity and birth-control use of American teenagers. In: Gruber, J. (Ed.), Risky Behavior Among Youth: An Economic Analysis. University of Chicago Press, Chicago and London.

Levine, P.B., 2003. Parental involvement laws and fertility behavior. Journal of Health Economics 22 (5), 861–878.

Levine, P.B., Staiger, D., 2004. Abortion policy and fertility outcomes: the eastern European experience. Journal of Law and Economics 47, 223–243.

Merz, J.F., Jackson, C.A., Klerman, J.A., 1995. A Review of abortion policy: legality, medicaid funding, and parental involvement 1967–1994. Women's Rights Law Reporter 17, 1–61.

Miller, W.C., Ford, C.A., Morris, M., Handcock, M.S., Schmitz, J.L., Hobbs, M.M., Cohen, M.S., Harris, K.M., Udry, J.R., 2004. Prevalence of chlamydial and gonococcal infections among young adults in the United States. Journal of the American Medical Association 29 (7), 2229–2236.

NARAL Pro-Choice America Foundation, 2011. Who Decides? The Status of Women's Reproductive Rights in the United States, 20th ed. NARAL, Washington, DC.

Ohsfeldt, R., Gohmann, S., 1994. Do parental involvement laws reduce adolescent abortion rates? Contemporary Economic Policy 12, 65–76.

Paton, D., 2006. Random behavior or rational choice? Family planning, teenage pregnancy and sexually transmitted infections. Sex Education 6 (3), 281–308.

Polis, C.B., Grimes, D.A., Schaffer, K., Blanchard, K., Glasier, A., Harper, C., 2007. Advance provision of emergency contraception for pregnancy prevention. Cochrane Database of Systematic Reviews (2), http://dx.doi.org/10.1002/14651858.CD005497.pub2, Art. No.: CD005497.

Santelli, J., et al., 2004. Can changes in sexual behaviors among high school students explain the decline in teen pregnancy rates in the 1990s? Journal of Adolescent Health 25 (2), 80–90.

Stone, R., Waszak, C., 1992. Adolescent knowledge and attitudes about abortion. Family Planning Perspectives 24, 52–57.