Poverty, Violence, and Health

The Impact of Domestic Violence During Pregnancy on Newborn Health

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A B S T R A C T

Two percent of women in the United States suffer from intimate partner violence annually, with poor and minority women disproportionately affected. I provide evidence of an important negative externality associated with domestic violence by estimating a negative and causal relationship between violence during pregnancy and newborn health, exploiting variation in the enforcement of laws against domestic violence for identification. I find that hospitalization for an assault while pregnant reduces birth weight by 163 grams. This sheds new light on the infant health production process as well as observed income gradients in health given that poor mothers are disproportionately affected by violence.

I. Introduction

Every year 2 percent of women in the United States are the victims of domestic violence, with poor and minority women disproportionately affected (Tjaden and Thonnes 1998). Existing empirical research has generally found that women who suffer domestic violence experience a host of negative outcomes including, but not limited to, reductions in earnings and poor health.[1] In this paper I estimate external costs associated with domestic violence not previously considered or quantified in most calculations of the costs of domestic violence: the children of women who are the victims of violence while pregnant suffer worse health at birth. There are two main barriers to estimating a causal relationship between violence and newborn health. The first is that women in violent relationships are more likely to be minority, poor, less educated and engage in risky behavior—all factors indepen-

1. The CDC has estimated these direct costs at $5.8 billion annually (CDC 2003).

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dently associated with poor birth outcomes and this can potentially lead to omitted variable bias. Second, previous studies in the medical literature are based on relatively small samples and individual reports of abuse which are prone to nonrandom underreporting.

To overcome these barriers, I follow two strategies. First, I use a new individual-level dataset linking data on hospital admissions for assault during pregnancy with birth outcomes for all births in California during the period 1991–2002. These data represent an improvement over survey data because they do not rely on self-reports of violence, are consistently collected over a long period of time, and include the universe of all pregnant women in California (half a million annually). While the classification captures all assaults, not just those perpetrated by domestic partners, previous work has found that 87 percent of all violence against pregnant women is perpetrated by intimates (Goodwin and Breen 1990). Second, to overcome omitted variable bias and establish causality, I exploit differences across jurisdictions and over time in the severity with which the justice system treats perpetrators of domestic violence. In California over this period the criminal penalties for domestic violence varied across counties (jurisdictions) and over time. As criminal sanctions increase, I find that domestic violence declines, consistent with existing work on the deterrent effect of criminal sanctions (Levitt 1996).

Using these policy changes to identify the effect of violence, I find that being assaulted while pregnant has a negative impact on newborn health as measured by birth weight. Specifically, I find that being admitted to the hospital for an assault decreases birth weight by 163 grams, on average, with larger effects if it occurs early in the pregnancy.

In addition to providing evidence of externalities associated with domestic violence not previously quantified, the results have two additional implications. The first is that the higher levels of violence observed among poor women can explain, in part, observed infant gradients in health.[2] Second, given the importance of birth outcomes in determining adult education and income (Black, Devereux and Salvanes 2007), these results suggest that the higher levels of violence experienced by poor women also may help contribute to the intergenerational transmission of economic status.

The rest of the paper is organized as follows: in Section II, I survey the existing literature on the causes and consequences of domestic violence and discuss implications for our understanding of the gradient in health, in Section III, I describe the data and empirical methods and present the results, Section IV is the conclusion and Section V discusses the analysis and offers suggestions for future research.

II. Background on Domestic Violence

A. Prevalence and Risk Factors

Most estimates of domestic violence in the United States come from the National Violence Against Women (NVAW) survey fielded in 1994. These data reveal an

2. This follows from the fact that previous work has established a negative and causal impact of income on the probability of domestic violence, as discussed later (Aizer 2010; Angelucci 2009; Bobonis et al. 2009).

annual incidence of 2 percent, a lifetime incidence of 25 percent and suggest that intimate partners are responsible for three fourths of all violence against women older than 18 (Tjaden and Thoennes 1998). A number of studies have found that violence often initiates or escalates during pregnancy (Stewart and Cecutti 1993; Amaro, Fried, Cabral, and Zuckerman 1990).[3] Previous studies yield estimates of the prevalence of domestic violence among pregnant women in the United States that range from 0.9 percent to 20.1 percent (Gazmararian, et al. 1996).

Disadvantaged women are at higher risk of abuse. Women with income below $10,000 annually report rates of domestic violence that are five times greater than those with annual income greater than $30,000 (BJS 1994). In addition, black women are at significantly greater risk of violence and conditional on violence are subject to more severe attacks (Rennison and Welchans 2000). Also at greater risk are young women between the ages of 20 and 34, corresponding to the peak child-bearing years.

B. Previous Medical Literature on Violence and Birth Outcomes

Medical studies have documented a strong negative correlation between domestic abuse during pregnancy and birth outcomes controlling for observable patient characteristics (Murphy el al. 2001; Silverman et al. 2006; Valladeras 2002). Moreover, medical research has identified both direct and indirect pathways by which violence negatively affects pregnancy outcomes. Direct effects from blunt trauma to the maternal abdomen include abruptio placentae, fetal fractures, rupture of the maternal uterus, liver, spleen and antepartum hemorrhage. Indirect effects of violence include (1) the exacerbation of chronic illnesses such as hypertension, diabetes or asthma, which can negatively affect the fetus, (2) elevated stress, (3) inadequate access to prenatal care, (4) behavioral risks such as smoking, and (5) inadequate maternal nutrition (Newberger, et al. 1992).

C. Poverty and Violence: Implications for the Gradient in Health

A large literature shows that those of low socioeconomic status are characterized by worse health than their better-off counterparts and that differences in health often originate in childhood and even earlier, in the newborn period (see Case, Paxson, and Lubotsky 2002; Deaton 2002; Cutler, Deaton, and Lleras-Muney 2006 and references therein). Explanations of the gradient include differences in access to medical care, health behaviors (such as smoking and drinking), time preferences, and social status\stress. In the case of newborn health, which has been linked to parental economic status, there is empirical evidence of multiple mechanisms: more educated women are less likely to smoke, more likely to initiate prenatal care early, and have fewer children in whom they invest more (Currie and Moretti 2003).

3. Psychologists have offered one possible explanation for the increase in violence during pregnancy: sexual jealousy inspired by the uncertainty of paternity. In an interview of 258 men convicted of spouse abuse, Burch and Gallup (2004) found that the frequency and severity of abuse directed toward pregnant partners was double that directed toward partners who were not pregnant and that sexual jealousy was also greater for men with pregnant partners.

But it is also the case that income is protective against violence and this may represent an additional mechanism linking income and health. Poor women are exposed to greater violence for multiple reasons. First, they are subject to greater levels of intimate partner violence. In a household bargaining model that incorporates violence, the lower a woman's income, the worse her bargaining power and the greater the level of intimate partner violence. A number of empirical studies have shown that as a woman's income increases (either absolutely or in relative terms), domestic violence against her declines (Aizer 2010; Angelucci 2009; Bobonis, Castro, and Gonzalez-Brenes 2009; Bowlus and Seitz 2005; Farmer and Tiefenthaler 1997.) Second, poor women are more likely to live in high crime, violent neighborhoods, increasing their exposure to violence (Ludwig, Duncan, and Hirschfield 2001).[4]

Given the negative causal relationship between income and violence against women established in the literature, the results presented here linking assaults during pregnancy with worse newborn health suggests that violence may be another mechanism behind the gradient in infant health.

III. Data, Empirical Methods and Results

A. Data on Violence During Pregnancy and Birth Outcomes

1. Description of Data

To estimate the impact of violence on birth outcomes I use a unique dataset that links individual-level data on maternal hospitalizations in the year prior to birth with detailed natality data that includes information on birth outcomes from California for the period 1991–2002 (excluding 1998, for which linked data don't exist). This measure of violence has three advantages over individual survey data. It's collected consistently over a long period of time, is not subject to self-reporting bias, and is based on a large and representative sample (the universe of births in California). It also suffers three potential drawbacks. First, it will only include those assaults so severe as to require hospitalization (7 percent of injured women, according to the NVAW survey). However, the reliance on severe injury is also an advantage because there is less discretion in utilization (in contrast to emergency room or doctor visits), reducing the potential for nonrandom selection into the hospital data. Second, these data will fail to capture women who were assaulted but failed to seek care at the hospital. Since nearly all pregnant women in California over this period have health insurance, the cost of care should not be a barrier, thereby mitigating this potential source of measurement error. However, I also control for changes in access to primary prenatal care that could affect hospital utilization (the number or primary care clinics per 1,000 adult women in each county and year), as well as changes/differ-

4. A second related strand of literature seeks to estimate the impact of policy changes related to criminal sanctions, ease of divorce and provision of public resources for victims on the prevalence of domestic violence. This literature, with some exceptions, generally finds that increasing sanctions and resources reduces domestic violence as does reducing barriers to divorce (see Aizer and Dal Bo 2009; Dugan, Nagin and Rosenfeld 1999; Stevenson and Wolfers 2006). Iyengar (2009) is an exception. She finds that mandating arrests in cases of domestic violence reduces reporting.

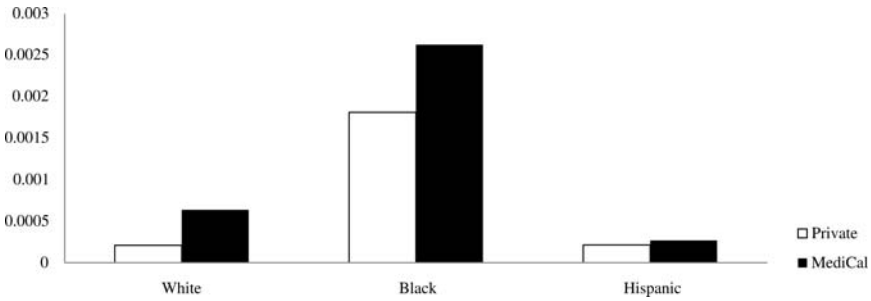

Figure 1
Racial Differences in Assault Rates All Pregnant Women 1991–2002

ences in hospital utilization more generally among women in California over this period.

A third drawback of these data is that one cannot distinguish between domestic and random violence. This could, potentially, reduce our ability to explain assault based on variation in criminal sanctions against domestic violence. However, given that 87 percent of pregnant women who suffer violence do so at the hands of an intimate partner, this source of measurement error is limited (Goodwin and Breen 1990).

2. Violence and Poverty

Of the more than five million births over this period, only 1,657 women were admitted to the hospital for an assault while pregnant, a rate of 31 per 100,000. The rate is much higher among disadvantaged women. The rate for pregnant mothers on Medicaid (MediCal) who are, by definition, at or below 200 percent of the Federal Poverty Line was 49.5 versus 16.3 for those with private health insurance. The rate of assaults for black mothers is 157 per 100,000 versus 19 for whites and 20 for Hispanics and these differences across race do not just reflect income differences. If we stratify by insurance status, our proxy for income, we still observe large differences by race (Figure 1). We also observe important differences by level of maternal education. Mothers without a high school degree are hospitalized for assault at a rate of 39 per 100,000 versus 26 for those with at least a high school degree.[5]

Over time, the rate of female hospitalizations for assault among women of child bearing age (age 19–34) has declined (Figure 2), consistent with trends reported by Bureau of Justice Statistics. In an attempt to control for secular declines in hospital utilization more generally over this period, I also present the ratio of admissions for assaults to admissions for car crashes in the figure. Defined this way, assaults are still declining over this period.

5. This is consistent with national data on domestic violence collected by the Bureau of Justice Statistics as well as survey data from California for the period 1998s–2002 (see Appendix Table 1).

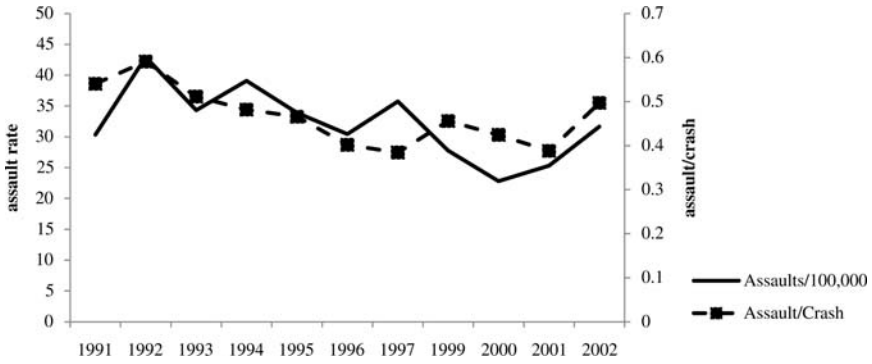

Figure 2
Trends in Hospitalization for Assault Among All Women 19–34

Sample means for these data presented in Table 1, Columns 1 and 2, illustrate in a purely descriptive manner how women who are admitted to the hospital for an assault are more disadvantaged and suffer worse birth outcomes. They are younger, poorer, less educated and more likely to be black. They are more likely to engage in risky behavior such as using drugs and smoking which may independently affect birth outcomes.[6] Those who have been assaulted are more than two times as likely to have low birth weight (LBW) births (0.151 vs. 0.064), nearly three times more likely to suffer fetal death (0.022 vs. 0.006) and to suffer any death within the first year of life (0.028 vs. 0.007).[7] For purposes of comparison, in Columns 3 and 4 of Table 1 are characteristics of pregnant women who suffered unintentional injuries and car crashes, respectively. These women suffer worse birth outcomes than women with no injuries (Column 1), but better than those who have been assaulted (Column 2). In addition, they are not as disadvantaged as victims of assault, consistent with negative selection into violent relationships.

It should be noted that while these data represent the universe of California births (and fetal death), they exclude women who miscarried or aborted earlier in their pregnancies. How this might bias the estimate depends on from what part of the distribution we believe these women are drawn. One might reasonably argue that these women suffer (or expect to suffer) the most extreme violence and the worst birth outcomes, suggesting that estimates that exclude these women will be biased downward.

B. Empirical Estimation Strategy and Results

I present estimates from OLS regressions of newborn health (weight, fetal death, infant death) on hospitalization for an assault while pregnant. I also explore whether

6. Smoking and drinking variables are underreported and measured with considerable error in the California natality data because, unlike most states, California only requires reporting if the behavior resulted in a complication.
7. Any death within the first year of life includes fetal death.

Table 1
Birth Outcomes and Maternal/Paternal Characteristics

	(1) No assault/ Injury/Crash	(2) Assault	(3) Unintentional Injury	(4) Car Crash
Birth outcomes				
Birth weight (grams)	3364	3061	3253	3282
LBW	0.064	0.151	0.101	0.080
Fetal Death	0.006	0.022	0.005	0.004
Death within first year of life (includes fetal)	0.007	0.028	0.011	0.008
Pregnancy				
Drug use	0.001	0.007	0.004	0.001
Tobacco	0.020	0.073	0.046	0.037
Bleeding	0.005	0.007	0.006	0.010
Maternal Characteristics				
Teenage	0.12	0.23	0.13	0.16
Over 35 years old	0.10	0.06	0.10	0.08
$<$High school	0.34	0.44	0.31	0.28
High school	0.30	0.37	0.35	0.38
Some college	0.19	0.14	0.21	0.22
College	0.17	0.03	0.12	0.12
Medicaid	0.43	0.70	0.52	0.48
Black	0.08	0.41	0.19	0.17
White	0.91	0.58	0.81	0.82
Hispanic	0.53	0.36	0.39	0.43
Paternal Characteristics				
Black	0.08	0.38	0.18	0.18
Hispanic	0.54	0.46	0.44	0.45
White	0.36	0.58	0.35	0.35
$<$High school	0.30	0.28	0.22	0.21
High school	0.30	0.38	0.38	0.38
Some college	0.16	0.10	0.15	0.17
College grad	0.17	0.03	0.12	0.13
Observations	5,386,662	1,657	3,709	5,400

Note: drug use, tobacco and bleeding only indicated if a complicating factor in California.

the relationship between newborn health and assault varies by when during the pregnancy the assault occurred. This is followed by estimates based on (1) a control function approach that accounts for potential selection into violent relationships based on unobservables, and (2) matching estimates. For all analyses, the sample is limited to mothers with less than 16 years of schooling given that the rate of violence for college graduates is so low (five per 100,000 or 44 in this sample).

1. OLS Results

The OLS specifications vary in the controls included. The first column of Table 2 includes only the indicator for assault as a regressor: women who have been assaulted deliver a baby weighing, on average, 283 grams less than those who have not. However, adding just two controls for MediCal (a proxy for low income) and race reduces the estimate by one-third to -191 (Column 2). This is consistent with previous findings in the literature that domestic violence, and violence more generally, is concentrated among those of low SES (see Aizer 2010 for a review of the literature) as well as evidence that poor mothers have worse birth outcomes (Case, Lubotsky, and Paxson 2002; Currie and Moretti 2003.)

Adding a more comprehensive set of controls further reduces the estimate only slightly. Including controls for characteristics of the mother (marital status, age, education), child (gender), father (age, education and race), and the county*year (the rate of hospitalizations for nonassault injuries among all women, the unemployment rate, real per capita income, number of primary care clinics and shelters for victims of domestic violence per 1,000 adult women in the county), and a quadratic in year and county fixed effects for the five largest counties in California (where 62 percent of all assaults occur), reduces the coefficient only slightly (− 188, Column 3). Finally in Column 4, I include year and County FE for all 58 counties in California and the estimate is unchanged.

The remaining columns of Table 2 contain OLS estimates of the impact of violence on additional measures of newborn health: fetal death, infant death, and any death (either infant or fetal). All coefficients are multiplied by 100. Prenatal assault is associated with a 1.2 percent increase in the probability of fetal death. The impact on infant mortality is much smaller and imprecise. Even though women who have been assaulted are twice as likely to suffer fetal death, fetal death is still uncommon, with only 37 fetal deaths among those assaulted.

To examine whether the impact of assault declines with gestational age, we regress birth weight on four separate indicators: assault in the first, second, or third trimester, and assault prior to conception, which occurs, on average, 45 days before conception in these data. For 400 women the exact timing of the assault could not be determined due to missing information, so the sample does change.[8] Among the 1,200 for whom we can date the assault, half were assaulted in the third trimester, one-quarter in the second, and one-quarter in the first.

As we did in the previous analysis, we present estimates with no controls, a parsimonious set of controls, and a full set of controls, which in this case also includes gestation at birth to control for positive selection into the third trimester (that is, by definition, those assaulted in the third trimester made it to the third trimester, which is positively related to birth weight). Without controls, assault in the first trimester is associated with a reduction in birth weight of 271 grams, assault in the second trimester 308 grams, assault in the third, 199 grams and assault prior to conception 221 grams (Table 3, Column 1). However, as with the previous anal-

8. Women were identified as pregnant in one of two ways: (1) with information on DOB, gestation and date of admission to hospital or (2) if gestation/date of admission were missing, but an additional diagnosis of "pregnant" when admitted to the hospital for an assault.

Table 2
Prenatal Assaults and Birth Outcomes

	Birth Weight (Grams)				Fetal Death (×100)		Infant Death (×100)		Any Death (×100)	
	No controls		Full Controls		No Controls	Full Controls	No Controls	Full Controls	No Controls	Full Controls
Prenatal assault	−283.019	−191.277	−188.463	−187.286	1.311	1.278	0.402	0.252	1.713	1.53
	[15.64]	[10.67]	[10.69]	[10.63]	[3.81]	[3.73]	[2.01]	[1.26]	[4.32]	[3.87]
MediCal		−45.427	−18.76	−17.322		0.012		0.032		0.044
		[75.67]	[29.21]	[26.82]		[1.38]		[5.69]		[4.18]
Black		−229.06	−168.061	−163.987		0.521		0.07		0.591
		[59.93]	[42.52]	[41.47]		[11.55]		[2.04]		[10.45]
Hispanic		−31.125	−2.652	−0.643		−0.027		−0.086		−0.113
		[47.59]	[2.86]	[0.69]		[2.31]		[10.49]		[7.93]
White		41.528	40.877	43.383		0.132		−0.06		0.072
		[11.48]	[11.65]	[12.35]		[3.54]		[2.08]		[1.53]
Single			−21.15	−22.666		−1.176		0.071		−1.105
			[29.85]	[30.56]		[123.78]		[10.61]		[95.34]
Over 35 years old			−16.528	−16.255		0.453		0.022		0.475
			[14.14]	[13.91]		[25.54]		[2.56]		[24.19]
Teen mother			−98.111	−98.061		0.158		0.05		0.208
			[123.01]	[122.84]		[14.80]		[6.51]		[15.84]
< High school			−14.875	−15.147		0.087		0.075		0.162
			[15.57]	[15.85]		[6.82]		[9.42]		[10.78]
High school			−12.199	−12.236		0.082		0.031		0.113
			[14.92]	[14.96]		[7.55]		[4.88]		[9.00]
Male			106.181	106.155		0.018		0.061		0.079
			[194.59]	[194.62]		[2.48]		[13.50]		[9.29]
Twin birth			−994.164	−994.031		1.298		0.404		1.701
			[459.30]	[459.30]		[30.17]		[16.11]		[34.34]
Father black			18.419	20.522		0.378		0.05		0.427
			[6.87]	[7.65]		[10.62]		[1.95]		[9.79]
Father white			70.038	71.479		−0.035		−0.046		−0.081
			[32.04]	[32.69]		[1.25]		[2.31]		[2.37]

Father Hispanic			36.707	39.251		0.024		−0.057		−0.032
			[16.66]	[17.80]		[0.85]		[2.82]		[0.94]
Father <High school			−26.803	−28.032		0.316		0.076		0.392
			[20.81]	[21.73]		[18.44]		[7.93]		[19.99]
Father High school			−28.4	−29.322		0.227		0.072		0.299
			[24.41]	[25.18]		[14.90]		[8.65]		[17.25]
Father some college			−8.618	−9.368		0.099		0.022		0.121
			[7.19]	[7.81]		[6.41]		[2.70]		[6.94]
Father information missing			−78.674	−79.917		0.416		0.168		0.584
			[50.00]	[50.70]		[20.08]		[12.55]		[23.73]
County unemployment rate			117.238	121.5		0.552		−0.169		0.383
			[9.88]	[3.23]		[1.09]		[0.58]		[0.65]
County per capita income (real)			29.476	1.94		0.062		0.026		0.088
			[26.40]	[0.61]		[1.52]		[1.05]		[1.85]
Domestic violence shelters per 100,000 adult women			−0.407	−0.622		−0.014		0.004		−0.01
			[1.30]	[0.98]		[1.75]		[0.68]		[1.00]
Number of clinics per 1000 women			0.33	0.229		−0.001		0		−0.001
			[3.18]	[3.54]		[2.25]		[0.30]		[1.84]
Observations	4,486,227	4,486,227	4,486,227	4,486,227	4,486,752	4,486,752	4,486,752	4,486,752	4,486,752	4,486,752
R-squared	0	0.02	0.09	0.09	0	0	0	0	0	0
FE for 5 largest counties	N	N	Y		N		N		N	
Quadratic trend in year of birth	N	N	Y		N		N		N	
FE for all 58 counties	N	N	N	Y	N	Y	N	Y	N	Y
FE for year of birth	N	N	N	Y	N	Y	N	Y	N	Y

Robust *t* statistics in brackets

Table 3
Impact of Prenatal Assault on Birth Weight—Does Timing Matter?

	Birth Weight (Grams)		
	No Controls	Parsimonious Controls	Full Controls
Assault in first trimester	−270.608	−163.434	−166.171
	[6.06]	[3.89]	[4.00]
Assault in second trimester	−308.035	−104.91	−118.4
	[8.18]	[3.47]	[3.98]
Assault in third trimester	−198.599	−101.37	−96.605
	[8.19]	[4.52]	[4.42]
Assault prior to conception	−220.934	−57.461	−61.52
	[5.12]	[1.64]	[1.79]
Gestation		16.328	15.471
		[473.07]	[448.29]
MediCal		−38.846	−24.183
		[71.27]	[41.97]
Black		−150.097	−114.884
		[44.25]	[32.53]
White		29.35	29.447
		[9.10]	[9.32]
Hispanic		−16.182	4.663
		[27.91]	[5.59]
Single			−21.52
			[32.43]
Over 35 years old			30.503
			[30.25]
Teen mother			−92.743
			[129.49]
< High school			−4.422
			[5.21]
High school			−7.833
			[10.88]
Male			121.978
			[249.25]
Twin birth			−638.967
			[366.61]
Father black			32.661
			[13.69]
Father white			70.419
			[35.71]

(continued)

Table 3 *(continued)*

	Birth Weight (Grams)		
	No Controls	Parsimonious Controls	Full Controls
Father Hispanic			41.729
			[20.98]
Father < High school			−18.829
			[16.54]
Father High school			−20.691
			[20.24]
Father some college			−7.382
			[7.01]
Father information missing			−47.994
			[34.02]
County unemployment rate			75.57
			[2.20]
County per capita income (real)			−3.908
			[1.38]
Domestic violence shelters per 100,000 adult women			−0.868
			[1.48]
Number of clinincs per 1000 women			0.203
			[2.70]
Observations	4,486,227	4,221,202	4,221,202
R-squared	0	0.27	0.31

Robust *t* statistics in brackets
Note: also included are year and county fixed effects

ysis, including only a parsimonious set of controls (MediCal, race, and gestation at birth) reduces the coefficients on all the assault measures significantly (Table 3, Column 2), and including a full set of controls has very little marginal effect beyond the parsimonious set of controls (Table 3, Column 3).

Interesting, some coefficients fall more than others once controls are included so that a clear pattern emerges: the earlier the assault, the greater the reduction in birth weight. Including a full set of controls, first trimester assault reduces birth weight by 166 grams, second trimester by 118 grams and third trimester by 97 (Table 3, Column 3). Assault prior to conception is still negatively correlated with birth weight, though with a full set of controls, the effect is much smaller (61 grams), which is roughly one-third the effect of assault in the first trimester and it is only significant at the 10 percent level.[9] There are two ways to interpret this last result.

9. Interestingly, the coefficient on assault prior to conception falls the most (72 percent) once controls are included, consistent with the greatest negative selection on this variable.

The first is that this captures negative selection into violence that is not otherwise captured with our extensive set of controls. Accordingly, the impact of violence in the first trimester, for example, would be closer to 100 grams, once we correct for selection. The second interpretation is that this effect captures the indirect effects of violence on birth outcomes as discussed by Newberger (1992). These indirect effects include exacerbation of chronic illnesses such as hypertension, diabetes or asthma, stress, inadequate access to prenatal care, behavioral risks such as smoking, and inadequate maternal nutrition. In contrast, the larger impact of violence during the first trimester captures both the indirect effects and the direct effect of blunt trauma to the abdomen while pregnant.

2. Accounting for Selection on Unobservables: Control Function Approach

Control function methods enable one to estimate a relationship between assaults and birth weight that controls not only for observable characteristics of the woman but unobservables as well. This approach involves the computation of a "correction" or "control" for selection into violent relationships based on a two-step procedure (Heckman 1979; Lee 1982). We can formalize the control function approach by dividing the problem into two parts:

$$(1a) \quad BW_{icry} = \beta_1 X_{icry} + \beta_2 V_{icry} + \beta_3 C_{cy} + \beta_4 Year_y + \beta_5 County_c + \varepsilon_{icry}$$

$$(1b) \quad V^*_{icry} = \gamma_1 X_{icry} + \gamma_2 C_{cy} + \gamma_3 Year_y + \gamma_4 County_y + \gamma_5 Z_{cry-1} + \mu_{icry}$$

Equation 1a is the equation of interest and Equation 1b describes selection into violent relationships. In Equation 1a, the outcome is birth weight (*BW*), *X* is a vector of individual characteristics of the mother, father and offspring, *V* an indicator for whether the mother was admitted to the hospital for an assault while pregnant, *C* is a vector of controls that vary at the county-year and *Year* is a vector of year dummies and County a vector of county dummies.[10] Identification in Equation 1a is hindered by the fact that the mean of the error term is not zero due its correlation with *V* (violence). The solution requires dividing the error term in Equation 1a into a component due to selection and a new random error term (with mean zero.) We can estimate the former based on estimates of the selection equation (Equation 1b). In the selection Equation V^* is a latent index of underlying violence where $V=1$ if $V^*>0$ and $V=0$ if $V^*<=0$. In Equation 1b, $Z_{cry-1}$is a vector of variables not included in Equation 1a that affect violence against women but do not otherwise independently affect birth weight. In this case we use variation across local jurisdictions and over time in the strictness of local criminal enforcement against domestic violence as the source of exogenous variation, as discussed in greater detail below. Equation 1b is estimated via a probit regression and the resulting estimates of γ are used to construct the selection component (an inverse Mill's ratio) to be included in Equation 1a to generate consistent estimates of β_2

As noted, for identification we use variation across local jurisdictions and over time in a measure of the strictness of local criminal enforcement against domestic

10. These are the same controls included in the OLS specifications presented previously.

violence as the source of exogenous variation in the probability of assault (Z_{cry-1} in Equation 1b). In California, as elsewhere, laws regarding the prosecution of domestic violence are determined at the state level. However, enforcement falls to the local (county) police and prosecutors. Local police in California have wide discretion over arrest criteria for intimate partner assault, with some counties, at one extreme, mandating arrest in all reported cases of domestic violence.

Data on police policies, per se, are not available on a consistent basis.[11] Instead, I proxy for enforcement policies with a measure, which is the probability of arrest conditional on reports of violence against women. It is constructed as the ratio of arrests for domestic violence to the number of 911 calls to the police reporting domestic violence in the previous year. This measure is defined by county and year because the racial breakdown on calls to the police is not available.

If either the deterrent or incapacitation effects of arrest are strong (Levitt 1996), the proportion of reports of violence that result in arrest *in the previous year* may serve as an instrument for the level of domestic violence witnessed in the current year. Specifically, as the arrest rate in the previous period increases, violence in the current period should decline and there is no reason to believe that the arrest rate in the previous year should affect newborn health directly.[12]

Table 4 contains coefficient estimates from probit (Column 1) regressions of the determinant of violence (the first stage or Equation 1b). Marginal effects are presented in bold below the coefficient estimate in the probit regression. An increase in the percentage of men who are arrested conditional on 911 calls in the previous year significantly decreases the probability that a pregnant woman will be admitted to the hospital for an assault in the next year. To interpret the size of the effect, consider that 20 percent of calls, on average result in an arrest, and if this were to increase to 100 percent, admissions to the hospital for an assault would decline by 13.3 percent. As a falsification test, we estimate the impact of the ratio of male arrests to reports of domestic violence in the year after the assault on the probability of assault. The point estimate is positive and insignificant (0.0041, *t*-statistic 1.02).

The control function estimates that account for unobservables that may be correlated with assault and birth weight suggest that the effect of assault during pregnancy is to reduce birth weight by 163 grams (Table 4, Column 2). The effect is significant, both statistically and economically, and slightly smaller than the effect obtained via OLS regression suggesting very little negative selection on unobservables given the comprehensive set of controls included.[13] It should be noted that when the control function estimation is repeated without the instrument in the first

11. Data on such policies are only available for the seven largest counties in California and only up until 1996.

12. Potential (upward) bias in an estimate of the impact of the lagged arrest rate on hospitalization for assault could arise if, for example, women in counties with ineffective public servants are less likely to report domestic violence and less likely to seek care in hospitals. However, the inclusion of county fixed effects would eliminate this bias if the effectiveness of the public servants is constant over time.

13. For the control function estimation, the sample includes all women who were assaulted and a 25 percent random sample of those who were not assaulted. I limit the sample this way so that the model converges. The average characteristics of the sample do not change at all and the OLS estimates are the same. I was unable to produce control function estimates based on trimester of assault because the first stage is too weak.

Table 4
Impact of Prenatal Assault on Birth Weight—Control Function Estimation

	Prenatal Assault	Birth Weight (Grams)
Prenatal assault		−163.272
		[4.00]
Lagged ratio or arrests for DV/reports	−0.006	
	[2.58]	
	−0.00005	
MediCal	0.169	−17.298
	[9.49]	[19.3]
Black	0.108	−160.530
	[1.17]	[28.99]
White	−0.144	44.093
	[1.66]	[8.83]
Hispanic	−0.189	0.301
	[6.64]	[0.23]
Single	0.185	−21.879
	[8.96]	[20.94]
Over 35 years old	−0.027	−15.634
	[0.91]	[10.62]
Teen mother	0.032	−97.961
	[1.69]	[84.84]
< High school	0.108	−13.996
	[4.22]	[10.5]
High school	0.057	−11.955
	[2.58]	[10.46]
Male	0.021	107.079
	[1.51]	[138.4]
Twin birth	−0.154	−992.961
	[2.78]	[379.89]
Father black	0.158	16.696
	[2.45]	[4.45]
Father white	−0.098	70.065
	[1.59]	[21.97]
Father Hispanic	0.001	37.888
	[0.02]	[11.79]
Father < High school	0.331	−30.689
	[7.07]	[16.7]
Father High school	0.336	−29.863
	[7.73]	[17.96]
Father some college	0.237	−10.527
	[5.35]	[6.11]

(continued)

Table 4 *(continued)*

	Prenatal Assault	Birth Weight (Grams)
Father information missing	0.532	−80.484
	[11.38]	[36.48]
County unemployment rate	0.42	185.087
	[0.40]	[3.46]
County per capita income (real)	0.025	−3.323
	[0.31]	[0.73]
Domestic violence shelters per 100,000 adult women	−0.022	−1.095
	[1.07]	[1.09]
Number of clinincs per 1000 women	0.001	0.898
	[1.29]	[2.44]
Observations	5,346,821	1,122,729

Robust z statistics in brackets
Notes: the variable "Lagged ratio or arrests for DV/reports" refers to the ratio of arrests for domestic violence to 911 calls reporting domestic violence in the previous year. It is designed to capture the seriousness or severeity of police response to domestic violence.
Sample includes all women who have been assaulted and a 25% random sample of those who have not. Also included are year and county fixed effects.
Marginal effect in bold below coefficient and z statistic.

stage, the results are nearly the same (-161 grams). As such, it's likely that the main difference between the OLS regression with the full set of controls and the control function estimates derives from the nonlinearity of the first stage in the control function approach.

3. Accounting for Selection: Matching Estimates

As a final strategy, I compare birth outcomes of women who were assaulted with women who were not based on matching methods. For this analysis, the sample consists of all women who were assaulted (n = 1,657), each of whom is individually matched with a woman who was not assaulted. Because of the size of the data, it was possible to exactly match 1,542 of the women based on *all* of the following: marital status, race (white, black, Hispanic), insurance (MediCal, private), education (< High School, High School, more than High School), age (teen, 19–34, 35 +), county, year of birth, paternal race, paternal education and whether paternal information was missing.

For this matched sample, the birth weight of those born to mothers who have been assaulted while pregnant is 159 grams lower than matched mothers who have not been assaulted (confidence interval −206 to −113), an estimate that is lower than both the −187 grams obtained from the OLS regressions with a full set of controls and the estimate of −163 from the control function specification (Table 5). When we stratify by maternal characteristics, there are some differences by income, marital status and education, but they are generally small (Table 5, Columns 2–7). However, differences by race are larger, with blacks experiencing a reduction in

Table 5
Impact of Prenatal Assault on Birth Weight—Matching Estimation

		by Maternal Characteristic								
	Overall	MediCal	Private	Single	Married	< High school	≥ High school	Black	Hispanic	White
Difference (assaulted-not assaulted)	−159	−163	−150	−141	−176	−146	−170	−116	−227	−186
95 percent CI	[−206 −113]	[−217 −110]	[−241 −59]	[−204 −77]	[−243 −109]	[−211 −81]	[−236 −104]	[−194 −39]	[−299 −157]	[−244 −128]

Note: of 1657 women who had been assaulted, 1542 matched with pregnant women who had not been assaulted on all the following characteristics: maternal race (white, black, Hispanic), maternal age (teen, 19–34, 35+) marital status (single, married), maternal education (<High school, High school, Some College), insurance (private, public), paternal race (white, black , Hispanic), paternal education (<High school, High school, Some College, College+), and paternal information missing, county and year of birth

birth weight of 116 grams and Hispanics experiencing a reduction in birth weight nearly twice as great (227 grams). Given that in the absence of assault, blacks have lower birth weight on average and Hispanic higher birth weight, one possible explanation could be that the impact of assault on birth weight varies along the birth weight distribution, with larger effects at the high end (Hispanics) and smaller effects at the low end (blacks). Another explanation could be that Hispanics have a higher threshold for seeking care at a hospital due, potentially, to immigration issues, and thus conditional on admittance, their assaults tend to be more severe, leading to worse outcomes. The fact that Hispanics are admitted for an assault at rates similar to whites despite their lower income and education would be consistent with the latter interpretation.

IV. Conclusions

There are three main findings. First, poor, less educated, and minority women are more likely to be admitted to the hospital for an assault while pregnant. Second, increasing the probability of arrest for domestic violence reduces the number of pregnant women hospitalized because of an assault. Third, even controlling for negative selection into violent relationships, severe violence in pregnancy reduces birth weight by 163 grams, with larger effect if the violence occurs earlier in the pregnancy. These effects are similar to the estimated impact of smoking during pregnancy on birth weight and suggest large external costs associated with violence against pregnant women.

Given the similarity between the size of the impact of violence on birth weight and the size of the impact of smoking on birth weight, to quantify the costs of violence, I rely on the estimate of the costs of smoking during pregnancy produced by the U. S. Treasury Office (1998). This calculation considers only the increased costs of complicated deliveries, medical care of low-weight births in their first year of life and throughout adolescence, and the increased costs due to developmental difficulties. Inference based on the U. S. Treasury estimate suggests that domestic violence during pregnancy costs $13.3 million annually, though it should be considered a lower bound since it does not include the costs of fetal death, costs incurred after age 18, or costs to the mother.[14]

V. Discussion

Across countries, within countries, and over time, research has found that wealthier individuals are also healthier and that this relationship begins in childhood. A number of hypotheses have been put forth to explain this relationship,

14. The U. S. Treasury estimate of the cost of smoking is $4 billion annually (U.S. Treasury 1998). Assuming that 10 percent of pregnant women smoke and that 0.03 percent of pregnant women are admitted to the hospital for an assault, and that the costs associated with a reduction in birth weight due to smoking and a reduction in birth weight due to violence are the same, the estimate of the cost of violence is $13.3 million.

referred to as the gradient in health. These include differences in the ability of the poor to access healthcare, their greater participation in unhealthy behavior, and differences in time preferences. In this paper I provide new evidence that violence may be another potential mechanism: poor people are exposed to greater violence and violence reduces health. This relationship starts as early as birth as poor pregnant women are disproportionately exposed to violence which reduces newborn health. Moreover, given the importance of birth weight in determining adult education and income, these results suggest that the higher levels of violence experienced by poor women also may contribute to the intergenerational persistence of poverty. These results imply that efforts to reduce health disparities also should include a focus on reductions in exposure to violence and that these efforts are likely to have lasting intergenerational effects as well.

However, the analysis presented here is limited by the fact that it relies on severe acts of violence that are very infrequent. As such I am unable to identify many pregnant women in these data who are the victims of violence and likely suffer negative birth outcomes. Moreover, these data preclude one from estimating how much of the gradient in health may be attributable to violence because this measure of violence fails to capture the less severe acts of violence that typically afflict a much larger share of the poor. Nevertheless, the results presented here represent the first causal estimates of the impact of violence on newborn health and are highly suggestive that violence may explain some of the observed gradient in newborn health, an important indicator of future adult health and economic status. More research is needed to quantify the role that less severe but more frequent violence plays in perpetuating the gradient in health as well as the intergenerational persistence of poverty.

Appendix Table A1

Probability of Violence and Average Income by Race, Education, Age and Marital Status—Survey Data from the California Women's Health Survey 1997–2002

	Violence	Average Income
All	0.053	$29,881
White	0.043	$32,237
Black	0.072	$26,909
Hispanic	0.068	$25,837
Asian	0.035	$34,862
Other race	0.065	$17,281
< High school	0.072	$24,862
High school	0.063	$23,905
Some College	0.058	$27,354
College	0.029	$39,749
< 25 years old	0.092	$19,306

(continued)

Appendix Table A1 *(continued)*

	Violence	Average Income
25–30 years old	0.082	$28,767
31–39 years old	0.062	$29,798
40–49 years old	0.038	$33,174
50–64 years old	0.015	$33,705
Single	0.093	$21,098
Separated/Divorced	0.100	$28,973
Cohabit	0.090	$27,564
Married	0.035	$32,315

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