Poverty, Violence and Health

Anna Aizer*
Brown University and NBER

October 2009

Two percent of women in the US suffer from intimate partner violence annually, with poor and minority women disproportionately affected. In this paper I provide evidence of an important negative externality associated with violence against women by estimating a negative and causal relationship between violence against pregnant women and the health of their children at birth. To do so I use a unique individual-level dataset that links hospitalization for assault while pregnant with birth outcomes for all California births 1991-2002. To control for selection into violent relationships and establish causality, I exploit variation in the enforcement of laws against domestic violence across jurisdictions and over time for identification. I find that hospitalization for an assault while pregnant reduces birth weight by 100 grams. This finding 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. Moreover, because poor birth outcomes are associated with worse health and lower income as an adult, these results suggest that the higher rates of violence against poor women may contribute to the observed intergenerational persistence of poverty.

Keywords: domestic violence, infant health, birth weight, income gradient in health

* Department of Economics, Brown University, 64 Wateman Street, Providence RI 02912; Aizer@brown.edu.
Funding provided by grant NIH RO3HD051808- 01A2.

I. Introduction

Every year two percent of women in the US 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 independently 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 non-random 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 births 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

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

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 about 100 grams. While this represents a relatively large effect, it is smaller than the effect estimated using only an extensive set of individual controls, suggesting that estimates that do not control for unobservable characteristics of the mother that might be correlated with both violence and newborn health are likely to be upward biased.

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 may also 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

[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, forthcoming; Angelucci, 2009; Bobonis et al, 2009).

and present the results, section IV contains a discussion of 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 US come from the National Violence Against Women (NVAW) survey fielded in 1994. These data reveal an 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 over the age of 18 (Tjaden and Thoennes, 1998), though for pregnant women, the estimate is 87 percent (Goodwin and Breen, 1990). Disadvantaged women face much higher risks 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) and there is evidence that the relationship between women's income and violence is causal, as discussed later. 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 Economic Literature on Domestic Violence

There is a small but growing economics literature on domestic violence. The focus of most of these studies is the relationship between female income, employment and/or earnings and the probability of domestic violence. These studies generally find a negative relationship

between female economic status and violence using a variety of methods included individual fixed effects, quasi-experiments, instrumental variable and structural estimation methods to establish causality (Aizer, forthcoming; Angelucci, 2009; Bobonis, Castro and Gonzalez-brenes, 2009; Bowlus and Seitz ,2005; Farmer and Tiefenthaler, 1997; Tauchen, Witte and Long, 1991.) 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).[3]

C. Previous Medical Literature on Violence and Birth Outcomes

Previous studies yield estimates of the prevalence of domestic violence among pregnant women in the US that range from 0.9% to 20.1% (Gazmararian, et al 1996). A number of studies have found that violence often initiates or escalates during pregnancy (Stewart and Cecutti, 1993; Helton, McFarlane and Anderson, 1987; Amaro, Fried, Cabral and Zuckerman, 1990).[4]

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 multiple pathways by which violence negatively affects pregnancy outcomes. Abuse

[3] Iyengar (2009) is an exception. She finds that mandating arrests in cases of domestic violence reduces reporting.
[4] 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.

resulting in blunt trauma to the maternal abdomen can cause abruptio placentae, fetal fractures, rupture of the maternal uterus, liver, spleen and antepartum hemorrhage. Non-abdominal trauma can also cause uterine contractions, premature rupture of membranes and infection. Finally, abuse may also lead to the exacerbation of chronic illnesses such as hypertension, diabetes or asthma which can negatively affect the fetus (Newberger, et al, 1992).

While the biological pathways linking violence to poor birth outcomes have been established, previous observational studies have not necessarily isolated the impact of violence on birth outcomes separate from other maternal characteristics such as poverty and risk taking behavior (eg, smoking, drinking) that are correlated with both violence and birth outcomes. While some of the observational studies include an extensive set of observable maternal characteristics as controls, none include an identification strategy designed to control for unobserved characteristics. The contribution of this paper is to exploit a source of exogenous variation in violence against women that would control for any potential unobservable characteristics of the mother that might bias results, thereby establishing the first causal estimate of the impact of violence on an important measure of newborn health - birth weight.

The finding that violence during pregnancy negatively affects newborn health has important implications for our understanding of the infant health production function as well as the gradient in health, as discussed below.

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

A large literature shows that those of low socio-economic 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). Multiple hypotheses have been put forth to try to explain observed income and education gradients in health. These 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 with 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).

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 (Aizer, forthcoming; Bobonis et al, 2009). Second, poor women are more likely to live in high crime, violent neighborhoods, thereby increasing their exposure to violence (Ludwig, Duncan and Hirschfield, 2001).

Given the negative causal relationship between income and violence among 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. In the next section I present, in greater detail, the data, estimation methods and results.

III. Data, Empirical Methods and Results

A. Data on Violence during Pregnancy and Birth Outcomes

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 nine months prior to birth with detailed natality data that includes information on birth outcomes from California for the period 1991-2002 (excluding 1998).[5] This measure of violence has a number of 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). However, it suffers three potential drawbacks. First, this measure will only include those assaults so severe as to require hospitalization (seven percent of injured women, according to the NVAW survey). Thus results based on hospitalizations may not be generalizeable to less severe acts of violence. 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 non-random selection into the hospital data. Second, these data will fail to capture women who were assaulted but failed to seek care at the hospital. The fact that virtually all pregnant women in California over this period have health insurance (either private, or one of two public

[5] The state of California did not perform this individual linking of the hospital discharge and natality datasets for 1998.

programs) suggests that the cost of care is not a barrier to seeking care at the hospital, thereby potentially mitigating this potential source of measurement error. However, to further address the issue of access to care and reliance on hospitals, I control for changes in access to primary prenatal care that could affect hospital utilization as measured by the number or primary care clinics per 1000 adult women in each county and year of the analysis, as well as differences in hospital utilization more generally among women in California.

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, we limit this source of measurement error by focusing on pregnant women (Goodwin and Breen, 1990).

Violence and Poverty

Of the more than 5 million births over this period, only 1681 women were admitted to the hospital for an assault while pregnant – roughly 30 per 100,000. The rate is much higher among disadvantaged women. For example, the rate of hospitalization for assault among pregnant mothers on Medicaid (MediCal in California) who are, by definition, at or below 200% of the Federal Poverty Line was 49.2 versus 15.6 for those with private health insurance. The rate of assaults for black mothers is 160 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 38 per 100,000 versus 26 for those with at least a high school degree. That more disadvantaged women have higher rates of hospitalization for assault 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 1998-2002 (see Appendix Table 1).

As for secular changes, female hospitalizations for assault decline over time, consistent with Bureau of Justice Statistics reports of declines in reports of domestic violence (Figure 2). Because there were also 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 an attempt to control for any secular trends in hospitalization more generally. As is evident from Figure 2, assaults are declining over this period even conditional on the general declines in hospital utilization, though both unconditional and conditional measures of violence start to increase again towards the end of the period.

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 (0.149 vs. 0.064), one and a half times more likely to suffer fetal death (0.010 vs 0.006) and twice as likely to suffer any death within the first year of life (0.015 vs 0.008).[7] For purposes of comparison, in columns (3) and (4) of Table 1 are characteristics of pregnant women who suffered unintentional injuries and

[6] Smoking and drinking variables are under-reported 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.

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.[8] 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

To estimate the impact of violence on birth outcomes, I first estimate OLS models of the relationship between admission to the hospital for an assault and birth weight. This is followed by estimates based on a control function approach that accounts for potential selection into violent relationships based on unobservables. As an extension, I present estimates based on propensity score matching. While the propensity score estimates assume all selection is on observable characteristics and thus the results less arguably represent causal effects, they are useful for exploring potential heterogeneity in the effects. For all regressions, the sample is

[8] Among women who have been assaulted, we observe that those who suffered fetal death were more disadvantaged. They were more likely to be poor (have MediCal) and more likely to be black, but they were no more likely to be HS drop outs relative to those who were assaulted but did not suffer fetal death.

limited to mothers with less than 16 years of schooling given that the rate of violence for college graduates is so low (5 per 100,000 or 44 in this sample).

OLS Specification

I present the results of multiple OLS specifications of the relationship between violence during pregnancy, as measured by admission to the hospital for an assault while pregnant, and birth outcomes (birth weight, fetal death and infant death). The specifications vary in the controls included. By comparing results across specifications, we can learn something about the nature of the selection into violent relationships and how it might bias estimates of the relationship between violence and newborn health. The first column of Table 2 includes only the indicator for assault as a regressor. When no other controls are included, it appears as though assault during pregnancy is very much negatively related to birthweight: women who have been assaulted deliver a baby weighing, on average, 252 grams less than those who have not. In column 2 I include a comprehensive set of controls for maternal characteristics including marital status, age, education, health insurance, child gender, and paternal characteristics (age, education and race). I also include a control for changes in hospital utilization more generally, which is the rate of hospitalizations for non-assault injuries among all women (not just pregnant women) of the same race, county and year. Finally, I include four controls that vary at the county-year that may affect birth outcomes directly: the unemployment rate, real per capita income, number of primary care clinics and shelters for victims of domestic violence per 1000 adult women in the county, as well as a quadratic in year and county fixed effects for the 5 largest counties in

California (Los Angeles, San Francisco, San Diego, Alameda and Sacramento).[9] The inclusion of all these controls reduces the coefficient on assault by 42 percent to -146. This is entirely consistent with previous findings in the literature that domestic violence, and violence more generally, is concentrated among those of low SES (see Aizer, forthcoming 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.)

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). The same pattern emerges: a large positive relationship between assault and death that declines by roughly half once controls are included.[10] However, because of the infrequency of these outcomes, the estimates are imprecise.[11]

We conclude based on this that women in violent relationship are disadvantaged and that observable measures of this disadvantage explain a substantial portion of the negative relationship between violence and birth outcomes that we observe. The concern, of course, is that there may be other unobserved characteristics of women in violent relationships that might also, independently, negatively affect birth outcomes which are biasing these estimates. Our control function estimates, presented in the next section, are designed to address this concern.

[9] 62 percent of all assaults occur in these five counties. The results are unchanged when I include an individual fixed effect for each of the 58 counties in California in OLS regressions. However, the control approach which relies on maximum likelihood estimation precludes inclusion of all 58 fixed effects.

[10] Similar estimates/marginal effects were obtained from probit regressions, but were also imprecise.

[11] The probability of fetal death or infant death is twice as high in women who have been assaulted, but the occurrence of a death is still infrequent: out of 1625 women who were assaulted, only 12 suffered a fetal death and 10 an infant death.

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:

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

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

Equation 1A is the equation of interest and equation 1B describes selection into violent relationships. In equation 1A, 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 linear time trend.[12] 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 (eq 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. The vectors X, C and Year are the same as in equation 1A. However, in equation 1B, Z_{cry-1} is a vector of variables not included in 1A that affect violence against women but do not otherwise independently affect birth weight. [13] In this case we use variation across local jurisdictions and

[12] The same controls included in the OLS specifications presented in the previous section.
[13] It is possible to identify simply off of the form of the control function (a probit), but this is not preferable and we do not pursue that here.

over time in the strictness of local criminal enforcement against domestic violence as the source of exogenous variation in the probability of assault, 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). Once we calculate the selection term, it is included in equation 1A as the term λ and we can generate consistent estimates of β_2 with estimation of the following:

$$BW_{icry} = \beta_1 X_{icry} + \beta_2 V_{icry} + \beta_3 C_{cy} + \beta_4 Year_y + \beta_5 \lambda + \upsilon_{icry} \qquad (1C)$$

In this regression, the significance of λ indicates the presence of selection.

As noted, for identification we use variation across local jurisdictions and over time in two measures of the strictness of local criminal enforcement against domestic 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) prosecutors as well as the local police. Local police and prosecutors in California have wide discretion over arrest criteria and prosecution, conditional on arrest, for intimate partner assault. For example, local police vary in terms of the threshold for arrest in cases of domestic violence, with some counties, at one extreme, mandating arrest in all cases of domestic violence. Prosecutor offices vary in terms of whether they have separate offices/prosecutors who specialize in domestic violence, the amount of training prosecutors receive in domestic violence and the presence of advocates assigned to women bringing charges.

Data on police and prosecutorial policies, per se, are not available on a consistent basis.[14] Instead, I proxy for enforcement policies with two measures. The first 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. The second measure captures the severity of punishment conditional on arrest. It is constructed as the proportion of all men arrested for domestic violence who are sentenced to jail for each race in each county and year – for the previous year.

If either the deterrent or incapacitation effects of arrest and incarceration are strong (Levitt, 1996), the proportion of reports of violence that result in arrest and the proportion of arrested offenders who go to jail in the previous year may serve as instruments for the level of domestic violence witnessed in the current year. Specifically, as the arrest and incarceration rates in the previous period increase, violence in the current period should decline. However, there is no reason to believe that either the arrest or incarceration rate in the previous year should affect newborn health directly.

Table 3 contains coefficient estimates from probit (column 1) and OLS (columns 2 and 3) regressions of the determinant of violence (the first stage or equation 1B). Marginal effects are presented in bold below the coefficient estimates in the probit regression and are similar to the OLS results. Increases in the percentage of men who go to jail conditional on arrest for domestic violence and arrests conditional on 911 calls in the previous year significantly decrease the probability that a pregnant woman will be admitted to the hospital for an assault in the next year. Over this period, the incarceration rate for those arrested for domestic violence increased from

[14] Data on such policies are only available for the 7 largest counties in California and only up until 1996.

20 percent to 74 percent and arrests conditional on 911 calls increased from 13 to 20 percent.[15] Increases of this magnitude lead to a small but significant decline in the probability of assault in the next period (chi-squared statistic of 11.08, p-value=0.0039 in the probit and F statistics of 18.29 and 17.50, p-values=0.0000, in the OLS regressions). The observed increase in the average strictness of enforcement over this period led to a four percent decline in the probability of assault, or 16 percent of the decline witnessed over this period.

The control function estimates that account for unobservables that may be correlated with assault and birth weight suggest that the true causal effect of assault during pregnancy is to reduce birth weight by 100 grams (Table 4). The effect is significant, both statistically and economically, but smaller than the effect obtained via OLS regression with a full set of controls (-146 grams) suggesting that some negative selection on unobservables exists despite the comprehensive set of controls included. Moreover, the coefficient on λ is significantly different from zero (z statistic=3.30, p-value=0.001), consistent with negative selection into violent relationships based on unobservables.

Accounting for Selection: Propensity Score Matching Estimates

In this section I compare birth outcomes of women who were assaulted with women who were not based on propensity score matching methods. For this analysis, the sample consists of all women who were assaulted, referred to as the treated births, (n=1,637), each of whom is individually matched based on propensity scores methods with a woman who was not assaulted,

[15] Over this period, the number of arrests for domestic violence actually increased even though violence declined, suggesting that the increase in the incarceration rate does not reflect a shift in policy towards prosecuting only the most serious offenses, but rather reflects an increase in prosecution and enforcement across the board.

referred to as comparison births. For the matching, I estimate the probability of assault (propensity score) based on all control variables included in the probit regression plus some higher order terms and match women who have been assaulted with the comparison birth with the most similar propensity score.

For observations with similar propensity scores, the distribution of the covariates should be the same across the treatment and comparison groups (Rosenbaum and Rubin, 1983). To assess this, I examine mean differences (and significance levels) for all covariates (maternal, paternal and offspring characteristics) in Table 5. Before propensity score matching, differences are large and statistically significant for all maternal and paternal characteristics (first and second panels of Table 5).[16] After propensity score matching, the differences decline considerably and lose significance for all covariates, suggesting that the covariates are balanced.

To generate the propensity score estimate, I average the within-pair difference in birthweight between treatment and comparison births. The estimates derived from propensity score matching methods suggest that women who were assaulted while pregnant deliver babies who weigh 129 grams fewer than similar women who have not been assaulted (Table 6). This estimate lies halfway between the OLS and control function estimates and the 95 percent confidence interval for this estimate [-172, -87] spans both. When I weight the observations by propensity score, the estimated effect is larger (203 gram difference). This reflects the fact that women most likely to be assaulted (ie, have the highest propensity score) are weighted more heavily and the estimated impact of assault is much greater for women with higher propensity

[16] I compute differences in the probability of having each of the maternal and paternal characteristics (age, poverty, race, education, age) between those who have and have not been assaulted. I do this for the entire sample (first or top panel) and then for a sample that consists of all women who have been assaulted (n=1637) and a random sample of 1637 women who have not been assaulted and the differences are just as large and still highly significant. I perform this second comparison to show that the reduction in significant differences when propensity score matching techniques are used is not the result of reduced sample size.

scores. For example, the impact of assault on birth weight among those with the lowest propensity scores (defined as the bottom quartile) is -44, increasing to -209 for those with highest propensity scores (top quartile). It can be argued that an estimate that reflects the impact of violence on newborn health for those most likely to be the victim of violence is more useful than one that gives equal weight to women at very low risk of abuse. Though the propensity score matching estimates are limited by the fact that they assume selection on observables, they are useful in underscoring potential heterogeneity in the effect of assault on birth weight.

To summarize, there are five main findings. First, poor, less educated and minority women are more likely to be admitted to the hospital for an assault while pregnant (even conditional on their higher reliance on the hospital for medical care), consistent with much higher rates of violence suffered by women of low socio-economic status. Second, increasing criminal penalties for domestic violence reduces the number of pregnant women assaulted so severely as to require hospitalization. Third, estimates of the impact of domestic violence on birth outcomes that do not control for potential selection into violent relationships based on unobservables likely lead to estimates that are biased upward. Fourth, once we control for potential bias in a control function framework, we find that severe violence reduces birth weight by 100 grams, suggesting large external costs associated with violence against pregnant women. Fifth, propensity score matching estimates suggest heterogeneity in the effects of assault, with the most disadvantaged women who are most likely to be assaulted suffering the worse birth outcomes as a result of assault.

IV. Conclusions

Across countries, within countries, and over time, research has found that wealthier individuals are also healthier and that this relationship begins in childhood, with the children of poor parents being in worse health than those of their wealthier counterparts. A number of hypotheses have been put forth to explain this relationship, referred to as the gradient in health. These include differences in the ability of the poor to access health care, 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, in its severe form, is estimated to reduce birthweight by 100 grams. Moreover, given the importance of birthweight in determining adult education and income, these results suggest that the higher levels of violence experienced by poor women may also contribute to the intergenerational persistence of poverty. These results imply that efforts to reduce health disparities should also 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.

References

Aizer, Anna "The Gender Wage Gap and Domestic Violence" forthcoming, *American Economic Review.*

Aizer, Anna and Pedro Dal Bo (2009). "Love, Hate and Murder: Commitment Devices in Violent Relationships." *Journal of Public Economics.* 93(3-4).

Amaro H, Fried LE, Cabral H, Zuckerman B. (1990). "Violence during pregnancy and substance abuse." *American Journal of Public Health*. 80:575–9.

Angelucci, Manuela (2008). "Love on the Rocks: Domestic Violence and Alcohol Abuse in Rural Mexico." *The B.E. Journal of Economic Analysis & Policy*, 8(1).

Black, Sandra, Devereux, Paul and Kjell Salvanes (2007) "From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes" *Quarterly Journal of Economics.*122(1):409-439.

Bobonis, Gustavo J. Castro, Roberto and Melissa González-Brenes. (2009) "Public Transfers and Domestic Violence: The Roles of Private Information and Spousal Control." Mimeo University of Toronto.

Burch, Rebecca, and Gordon Gallop (2004) "Pregnancy as a Stimulus for Domestic Violence." *Journal of Family Violence.* 2(21).

Bureau of Justice Statistics (1994). "Domestic Violence: Violence Between Intimates, Selected Findings." NCJ-149259.

Case, Anne, Lubotsky, Darren and Christina Paxson (2002) "Economic Status and Health in Childhood: The Origins of the Gradient," *American Economic Review*. 92(5):1308-1334.

Currie, Janet and Enrico Moretti (2003) " Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings" *Quarterly Journal of Economics*.118(4):1495-1532.

Cutler, David, Deaton, Angus and Adriana Lleras-Muney (2006) "The Determinants of Mortality" *Journal of Economic Perspectives*. 20 (3): 91-120.

CDC - National Center for Injury Prevention and Control. *Costs of Intimate Partner Violence Against Women in the United States.* Atlanta (GA): Centers for Disease Control and Prevention; 2003.

Deaton, Angus (2002) "Policy Implications of the Gradient of Health and Wealth" *Health Affairs.* 21:13-30.

Dugan, Laura, Daniel Nagin and Richard Rosenfeld (1999). "Explaining the Decline in Intimate Partner Homicide; The Effect of Changing Domesticity, Women's Status and Domestic Violence Resources." *Homicide Studies*. 3(3).

Edleson, Jeffrey (1995) "Mothers and Children: Understanding the Links between Woman Battering and Child Abuse" Minnesota Center Against Violence and Abuse.

Ellsberg, Mary, Heise, Lori, Pena, Rodolfo, Agurto, Sonia and Anna Winkvist (2001). "Researching Domestic Violence Against Women: Methodological and Ethical Considerations." *Studies in Family Planning*, 32(1).

Farmer, Amy and Jill Tiefenthaler, (1997) "An Economic Analysis of Domestic Violence," *Review of Social Economy*. 55(3): 337-358.

Goodwin, Thomas and Michael Breen (1990). "Pregnancy Outcome and Fetomaternal Hemorrhage After Noncatastrophic Trauma" *American Journal of Obstetrics and Gynecology*. 162 (3).

Heckkman, James (1979). "Sample Selection as a Specification Error" *Econometrica*. 47(1):153-161.

Iyengar, Radha (2009) "Does the Certainty of Arrest Reduce Domestic Violence? Evidence from Mandatory and Recommended Arrest Laws" *Journal of Public Economics* 93: 85–98

Lee, Lung-Fei (1982) "Some Approaches to Correction of Selectivity Bias." *Review of Economic Studies*. 49(3):355-372.

Levitt, Steven (1996). "The Effect of Prison Population Size on Crime Rates: Evidence from Prison Overcrowding Litigation." *The Quarterly Journal of Economics* 111(2): 319-351

Ludwig, Jens, Duncan, Greg and Paul Hirschfield (2001) "Urban Poverty and Juvenile Crime: Evidence from a Randomized Housing-Mobility Experiment." *Quarterly Journal of Economics*. 116(2): 655-679.

Murphy, Claire, Schei, Berit, Myhr, Terri and Janice Du Mont (2001). "Abuse: a risk factor for low birth weight? a systematic review and meta-analysis." *Canadian Medical Association Journal*,164(11):1567-1572

Newberger, Eli, Barkan, Susan, Lieberman, Ellice, McCormick, Mari, Kersti, Yllo, Gary, Lisa and Susan Schechter (1992) "Abuse of Pregnant Women and Adverse birth Outcome Current Knowledge and Implications for Practice." JAMA. 267 (17).

Perry, B.D. (1997). "Incubated in terror: Neurodevelopmental factors in the cycle of violence." Children, Youth and Violence: The Search for Solutions (J. Osofsky, Ed.). New York: Guilford Press.

Rennison, Callie Marie and Sarah Welchans (2000). "Intimate partner Violence." US Department of Justice, Bureau of Justice Statistics. NCJ 178247.

Rosenbaum, P and Donal Rubin (1983). "The Central Role of the Propensity Score in Observational Studies for Causal Effects," *Biometrika*, 70:41-55.

Silverman, Jay, Decker, Michele, Reed, Elizabeth and Anita Raj (2006). "Intimate Partner Violence Victimization Prior to and During Pregnancy among Women Residing in the 26 US States: Associations with Maternal and Neonatal Health." *American Journal of Obstetrics and Gynecology*. Vol 195.

Stevenson, Betsey and Justin Wolfers,(2006) "Bargaining in the Shadow of the Law: Divorce Laws and Family Distress" *Quarterly Journal of Economics*, 121 (1): 267-288.

Stewart DE, Cecutti A (1993) "Physical Abuse in Pregnancy." *Canadian Medical Association Journal*. Vol 149.

Tjaden, Patricia and Nancy Thoennes (1998). "The Prevalence, Incidence and Consequences of Violence Against Women: Findings from the National Violence Against Women Survey." Washington DC: US Department of Justice, OJP. Report No: NCJ 172837.

Valladares, Eliette, Ellsberg, Mary, Peña, Rodolfo, Högberg, Ulf and Lars Persson (2002). "Physical partner abuse during pregnancy: a risk factor for low birth weight in Nicaragua." *Obstetrics & Gynecology*. 100 (4):700-705.

Table 1: Birth Outcomes and Maternal/Paternal Characteristics

	(1) **No assault/Inury/Crash**	(2) **Assault**	(3) **Unintentional Injury**	(4) **Car Crash**
Birth outcomes				
LBW	0.064	0.149	0.101	0.080
Fetal Death	0.006	0.010	0.005	0.004
Death within first year of life (includes fetal)	0.008	0.015	0.011	0.008
Pregnancy				
Drug use	0.001	0.009	0.004	0.001
Tobacco	0.020	0.081	0.046	0.037
Bleeding	0.005	0.009	0.006	0.010
Maternal Characteristics				
Teenage	0.12	0.22	0.13	0.16
Over 35 years old	0.10	0.05	0.10	0.08
<HS	0.34	0.44	0.31	0.28
HS	0.30	0.37	0.35	0.38
Some college	0.19	0.14	0.21	0.22
College	0.17	0.05	0.12	0.12
Medicaid	0.43	0.70	0.52	0.48
Black	0.08	0.43	0.19	0.17
White	0.91	0.56	0.81	0.82
Hispanic	0.53	0.34	0.39	0.43
Paternal Characteristics				
Black	0.08	0.40	0.18	0.18
Hispanic	0.54	0.45	0.44	0.45
White	0.36	0.14	0.35	0.35
<HS	0.30	0.28	0.22	0.21
HS	0.30	0.39	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	5397529	1681	3699	5270

Table 2: Prenatal Assaults and Birth Outcomes - OLS Regressions

	Birthweight		Fetal Death		Infant Death		Any Death	
	No controls	Full Controls	No Controls	Full Controls	No Controls	Full Controls	No Controls	Full Controls
Prenatal assault	-251.658	-146.015	0.001	0.001	0.004	0.002	0.005	0.003
	[14.93]	[9.18]	[0.66]	[0.43]	[1.96]	[1.17]	[1.81]	[1.11]
MediCal		-18.766		0		0		0
		[29.22]		[0.69]		[5.87]		[3.69]
Black		-168.088		0.005		0.001		0.006
		[42.53]		[11.39]		[1.84]		[10.20]
White		40.885		0.001		-0.001		0.001
		[11.65]		[3.61]		[2.30]		[1.45]
Hispanic		-2.645		0		-0.001		-0.001
		[2.86]		[2.39]		[10.96]		[8.28]
Single		-21.152		-0.011		0.001		-0.01
		[29.83]		[130.32]		[10.39]		[96.98]
Over 35 years ols		-16.531		0.005		0		0.005
		[14.14]		[25.56]		[2.49]		[24.19]
Teen mother		-98.12		0.001		0.001		0.002
		[123.02]		[13.58]		[6.72]		[14.97]
< HS		-14.881		0.001		0.001		0.002
		[15.57]		[6.84]		[9.48]		[10.83]
HS		-12.202		0.001		0		0.001
		[14.92]		[7.46]		[4.99]		[8.97]
Male		106.177		0		0.001		0.001
		[194.59]		[2.49]		[13.50]		[9.30]
Twin birth		-994.129		0.013		0.004		0.017
		[459.29]		[30.13]		[16.11]		[34.31]
Father black		18.406		0.004		0		0.004
		[6.86]		[10.43]		[1.86]		[9.59]
Father white		70.043		0		0		-0.001
		[32.04]		[0.91]		[2.44]		[2.16]
Father hispanic		36.71		0		-0.001		0
		[16.66]		[0.89]		[3.03]		[1.04]
Father <HS		-26.81		0.003		0.001		0.004
		[20.81]		[18.02]		[8.17]		[19.74]
Father HS		-28.408		0.002		0.001		0.003
		[24.41]		[14.45]		[8.95]		[16.99]
Father some college		-8.624		0.001		0		0.001
		[7.19]		[6.22]		[2.86]		[6.84]
Father information missing		-78.704		0.004		0.002		0.006
		[50.02]		[18.92]		[12.91]		[22.94]
County unemployment rate		117.219		0.014		0.001		0.015
		[9.86]		[8.80]		[1.15]		[8.15]
County per capita income (real)		29.474		0		-0.001		-0.001
		[26.34]		[0.40]		[6.24]		[3.60]
# shelters per 100,000 adult women		-0.405		0		0		0
		[1.29]		[0.14]		[0.91]		[0.65]
Number of clinincs per 1000 women		0.33		0		0		0
		[3.18]		[2.05]		[0.27]		[1.16]
Observations	4486227	4486227	4486752	4486752	4486752	4486752	4486752	4486752
R-squared	0	0.09	0	0	0	0	0	0

Robust t statistics in brackets

Note: Additional controls include indicators for the 5 largest counties in California and a quadratic time trend.

Any death is the summation of fetal death and infant death.

Table 3 Determinants of Assault

	Probit	OLS	OLS-FE
Lagged Incarceration Rate	-0.006	-0.0000321	-0.0000319
	-0.0000488		
	[1.42]	[4.50]	[4.48]
Lagged Arrest Rate	-0.007	-0.0000243	-0.0000233
	-0.0000587		
	[2.75]	[5.64]	[5.49]
MediCal	0.174	0.0002122	0.0002124
	[9.77]	[9.42]	[9.39]
Black	0.064	0.0008015	0.0008152
	[0.69]	[4.98]	[5.05]
White	-0.191	-0.0001911	-0.0001735
	[2.19]	[1.56]	[1.41]
Hispanic	-0.2	-0.0002137	-0.0002103
	[6.87]	[6.14]	[6.01]
Single	0.153	0.0002222	0.0002181
	[8.71]	[8.07]	[7.94]
Over 35 years ols	-0.064	-0.0000557	-0.0000557
	[1.96]	[2.01]	[2.00]
Teen mother	0.007	0.000009	0.0000089
	[0.34]	[0.28]	[0.27]
< HS	0.102	0.000148	0.000149
	[3.83]	[4.46]	[4.48]
HS	0.046	0.000071	0.0000711
	[1.96]	[2.89]	[2.90]
Male	0.013	0.000015	0.000015
	[0.88]	[0.83]	[0.83]
Twin birth	0.008	0.000025	0.0000246
	[0.17]	[0.38]	[0.37]
Father black	0.136	0.0003413	0.0003417
	[2.08]	[2.93]	[2.93]
Father white	-0.114	-0.0000617	-0.000061
	[1.84]	[0.89]	[0.88]
Father hispanic	-0.017	0.0000005	0.0000023
	[0.27]	[0.01]	[0.03]
Father <HS	0.171	0.0001014	0.000103
	[3.56]	[2.95]	[2.99]
Father HS	0.176	0.0001147	0.0001145
	[3.88]	[4.19]	[4.18]
Father some college	0.067	0.0000048	0.000005
	[1.42]	[0.19]	[0.19]
Father information missing	0.358	0.0004948	0.0004931
	[7.26]	[8.34]	[8.32]
County unemployment rate	0.307	0.0003075	0.0014679
	[0.99]	[0.92]	[1.89]
County per capita income (real)	-0.017	0.0000002	-0.0001258
	[0.51]	[0.01]	[1.56]
# shelters per 100,000 adult women	0.001	0.0000048	0.0000092
	[0.05]	[0.48]	[0.80]
Number of clinincs per 1000 women	-0.001	-0.000009	-0.0000081
	[0.19]	[0.89]	[0.80]
Observations	4473679	4473679	4473679
R-squared		0	0
Robust z statistics in brackets			
Chi squared statistic	11.08 (p=.0039)		
F statistic		18.29 (p=.0000)	17.50 (p=.0000)

Notes: dependent variable isi an indicator for whether the mother was admitted to the hospital for an assault while pregnant
Lagged Incarceration Rate is the share of men arrest for domestic violence who spent any time in jail;
Lagged Arrest Rate is the ratio of arrests for domestic violance to the number of 911 calls reporting domestic violence.
Additional controls in columns 1 and 2 include indicators for the 5 largest counties in California
and a quadratic time trend; column 3 includes fixed effects for all 58 counties and a quadratic time trend
Marginal effects in bold below probit coefficient estimates in column (1).

Table 4 Impact of Prenatal Assault on Birthweight - Control Function Estimation

Prenatal assault	-99.02
	[4.27]
MediCal	-18.631
	[29.52]
Black	-169.548
	[43.33]
White	40.375
	[11.45]
Hispanic	-2.747
	[2.98]
Single	-20.649
	[29.19]
Over 35 years ols	-16.544
	[15.89]
Teen mother	-98.144
	[120.22]
< HS	-15.015
	[15.93]
HS	-12.305
	[15.23]
Male	106.198
	[194.09]
Twin birth	-994.136
	[538.30]
Father black	18.899
	[7.14]
Father white	69.953
	[31.10]
Father hispanic	36.708
	[16.21]
Father <HS	-27.037
	[20.84]
Father HS	-28.532
	[24.30]
Father some college	-8.73
	[7.17]
Father information missing	-78.595
	[50.43]
County unemployment rate	105.776
	[8.86]
County per capita income (real)	28.305
	[25.33]
# shelters per 100,000 adult women	-0.217
	[0.65]
Number of clinincs per 1000 women	1.529
	[5.72]
Observations	4473154

Absolute value of z statistics in brackets
Note: marginal effects shown

Table 5: Covariate Balance for Propensity Score Matching Analysis

	Maternal Characteristics							Offspring Characteristics		Paternal Characteristics						
Full Sample	**MediCal**	**Black**	**White**	**Single**	**Over 35**	**Teenager**	**<HS**	**Male**	**Twin**	**Black**	**White**	**Hispanic**	**< HS**	**HS**	**Some Coll**	**Missing**
Assaulted (n=1637)	0.712	0.417	0.576	0.51	0.048	0.223	0.46	0.521	0.026	0.388	0.138	0.46	0.295	0.392	0.094	0.194
Not assaulted (n=4,485,115)	0.502	0.085	0.909	0.264	0.077	0.145	0.415	0.51	0.022	0.089	0.281	0.615	0.353	0.337	0.155	0.078
Difference (assaulted-not assaulted)	0.21	0.332	-0.333	0.246	-0.029	0.078	0.045	0.011	0.004	0.299	-0.143	-0.155	-0.058	0.055	-0.061	0.116
t statistic of difference	18.77**	27.26**	27.23**	19.90**	5.44**	7.54**	3.68**	0.88	1.1	24.85**	16.73**	12.56**	5.16**	4.53**	8.48**	11.88**
All Assaults and Random Sample of Non-Assaults																
Assaulted (n=1637)	0.71	0.42	0.58	0.51	0.049	0.223	0.461	0.521	0.027	0.388	0.139	0.46	0.295	0.391	0.093	0.194
Not assaulted (n=1636)	0.504	0.078	0.915	0.277	0.073	0.153	0.428	0.508	0.02	0.084	0.276	0.629	0.373	0.326	0.157	0.074
Difference (assaulted-not assaulted)	0.208	0.34	-0.339	0.233	-0.024	0.07	0.033	0.013	0.007	0.304	-0.137	-0.169	-0.078	0.065	-0.064	0.12
t statistic of difference	12.49**	24.49**	24.17**	14.03**	2.94**	5.17**	1.9*	0.77	1.27	21.89**	9.85**	9.86**	4.76**	3.91**	5.52**	10.26**
Propensity Score Matching Sample																
Assaulted (n=1637)	0.71	0.418	0.576	0.509	0.048	0.223	0.46	0.521	0.027	0.388	0.138	0.46	0.295	0.392	0.093	0.194
Not assaulted (n=1636)	0.718	0.415	0.579	0.51	0.048	0.223	0.448	0.508	0.024	0.388	0.136	0.458	0.285	0.401	0.09	0.199
Difference (assaulted-not assaulted)	-0.006	0.003	-0.003	-0.001	0	0	0.012	0.013	0.003	0	0.002	0.002	0.01	-0.009	0.003	-0.005
t statistic of difference	0.35	0.15	0.18	0.05	0.03	0.02	0.7	0.75	0.54	0.03	0.15	0.1	0.62	0.53	0.32	0.37

* significant at 5 %
** significant at 1 %

Table 6: Propensity Matching Estimates of Impact of Prenatal Assault on Birthweight

	Unweighted	Weight by PScore	Low PScore	High PScore
Prenatal assault	-129	-203	-44	-209
95 % CI	[-172, -87]	[-246, -160]	[40, -129]	[-293, -126]
Observations (pairs)	1636	1636	409	410

Note: Low Propensity Score defined as bottom quartile; High Propensity Score defined as top quartile.
Low and high propensity score estimates (columns 3 and 4) are not weighted.

Appendix Table 1 Probability of Violence and Average Income by Race, Education, Age and Marital Status - Survey Data from the California Women's Health Survey 1997-2002

	Pr. 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
<HS	0.072	$ 24,862
HS	0.063	$ 23,905
Some College	0.058	$ 27,354
College	0.029	$ 39,749
<25 years old	0.092	$ 19,306
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

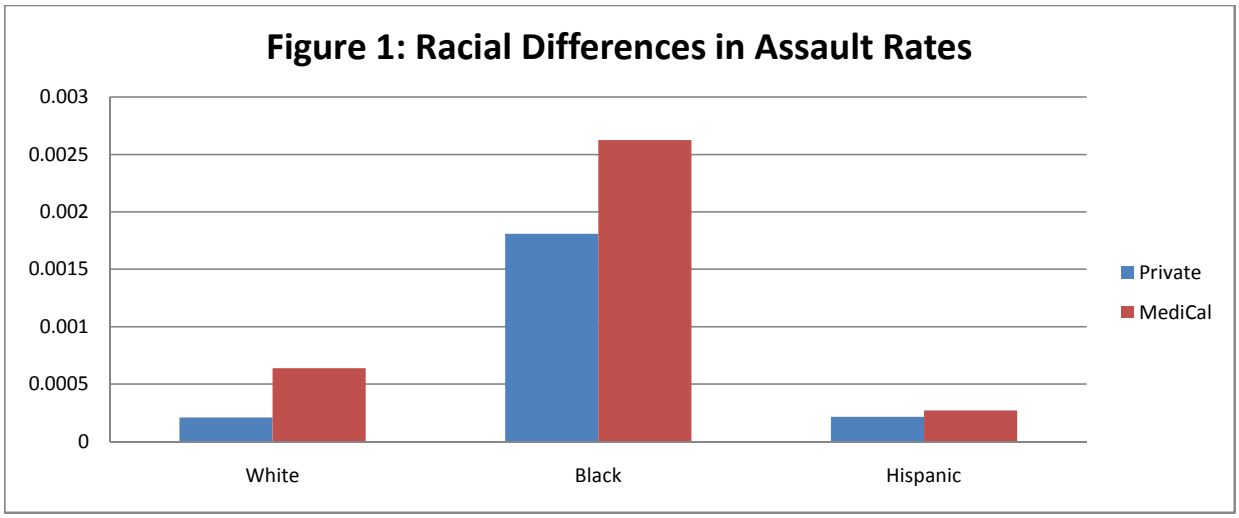
Figure 1: Racial Differences in Assault Rates
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
White
Black
Hispanic
Private
MediCal

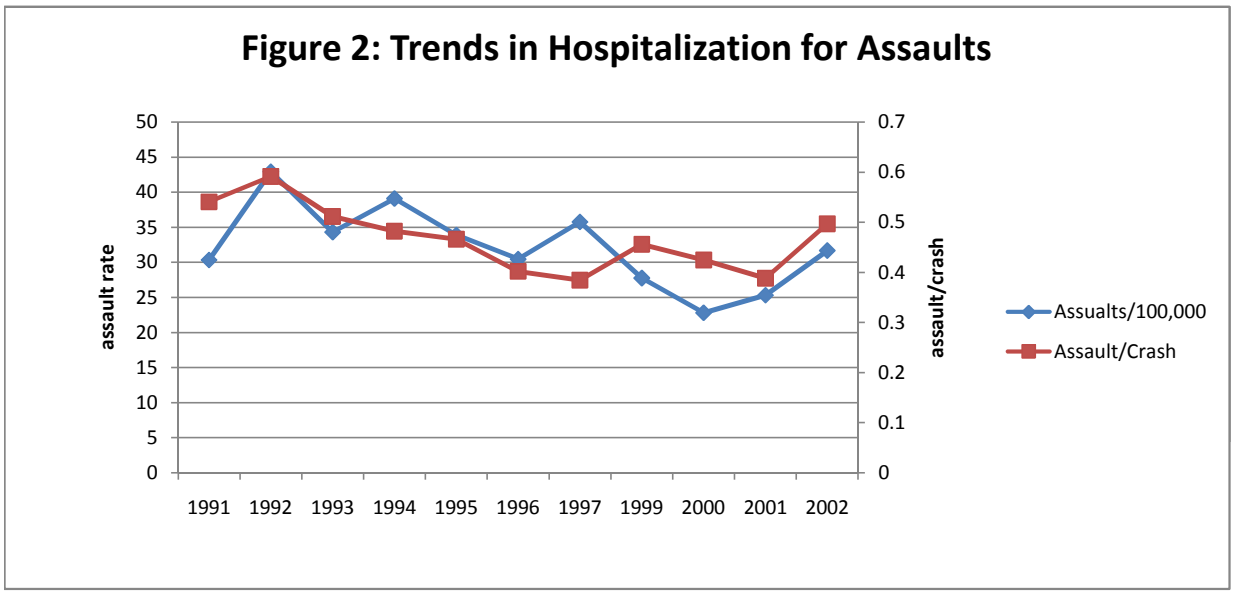
Figure 2: Trends in Hospitalization for Assaults
assault rate
assault/crash
50
45
40
35
30
25
20
15
10
5
0
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1991
1992
1993
1994
1995
1996
1997
1999
2000
2001
2002
Assualts/100,000
Assault/Crash