Crime and Pregnancies: Does Area Crime Affect the Demand for Prenatal Care and the Health of Pregnant Women and Their Newborns?[1]

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Abstract

The consensus is that violence and violent crime are associated with worse infant health and that estimating these effects are complicated by selection bias. Existing studies are based on either extremely violent situations or small geographic areas and this paper contributes by estimating the association between crime (violent and property) and infant health in the U.S. on a national scale, where the mean level of crime is relatively low. It also sheds light on the behavioral mechanism underlying the relationship by including pregnancy-related decisions as outcomes. Birth data from 2000-2010 Natality Detail Files are merged with county crime data from the Uniform Crime Reporting Program. The estimation controls for individual characteristics, county fixed-effects, and time-variant county characteristics to address self-selection bias. Conducting this analysis by race/ethnicity reveals interesting differences: crime is associated with lower probability of first-trimester doctor visit and fewer prenatal visits for white, black and Hispanic mothers; and weight gain and smoking is positively associated with crime only for black and Hispanic mothers. Despite the results of the behavioral mechanisms and in contrast with the literature, we do not find strong evidence of an association between crime and infant health. These results are robust to using county police level as an instrumental variable for crime rate.

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1. Introduction

Crime rates have fallen considerably in the US since the 1980s. The violent crime rate per 100,000 population fell from 596.6 in 1980 to 506.5 in 2000 and to 386.9 in 2012.[2] Despite falling crime rates, crime remains an important public policy issue given the negative externalities, in particular on health. For example, Cornaglia and Leigh (2011) and Dustmann and Fasani (2012) both find large substantive negative effects of local area crime on mental health in Australia and the UK.

This paper examines the relationship between county-level crime rates (both violent and property crime) and infant health. It also examines pregnant women's healthcare use and health behaviors to shed light on the behavioral mechanism by which county crime affects infant health in the US. These are important outcomes to study because they are linked to both short and long term wellbeing of mother and child. For example, women who gain too much weight during pregnancy are more likely to retain the weight as many as 15 years after childbirth and the offspring have a higher likelihood of low Apgar score and high birthweight (Derbyshire 2008). In-utero conditions are linked to the health of the child, both at birth and later through fetal programming (Barker 1993; 1995). Health at birth is also associated with body mass index, education, and wages in adulthood, and may also be passed on to the next generation (Behrman and Rosenzweig 2004, Black et al. 2007, Royer 2009). We conduct this analysis by mother's race/ethnicity because there are notable differences in the infant health and pregnancy wellbeing of white, black, and Hispanic mothers.

[2] The figures are from "Crime in the US, 1960-2004, Bureau of Justice Statistics" and "Crime in the United States by Volume and Rate per 100,000 Inhabitants, 1992-2012"

Crime can affect pregnancy and infant health for a number of reasons. First, crime can lead to an increased level of stress/anxiety and fear of being victimized, which is a risk factor for low birthweight and preterm birth (Dole et al 2003). The psychological distress due to crime during pregnancy increases the cost of engaging in health-producing activities such as doctor visits and exercising. It may also increase the likelihood of engaging in (or decreases the likelihood of quitting) maladaptive health behaviors such as smoking, alcohol consumption and physical inactivity. Second, the location decisions of providers such as physicians and hospitals may be correlated with crime rate, which may add to the time and monetary cost of seeking care. Third, crime or fear of victimization may be related to mistrust and to fewer social ties and networks. These are important for health as they relate to diffusion of information about health, formation of norms about health behaviors, and stress management.

Despite the theoretical arguments for expecting crime to adversely affect pregnancy health, identifying causal effects is difficult because of self-selection bias. In particular, there are potentially unobserved community-level and individual characteristics that are correlated with community crime and pregnancy wellbeing. For example, norms and attitudes towards violence and substance use may be correlated with both crime prevalence and proclivity towards smoking, drinking and seeking medical care during pregnancy. Similarly, individuals who care strongly about health are more likely to choose to live in communities with low crime and take better care of their health during pregnancy.

Some studies have found that community violence is associated with worse infant health even after part of the self-selection bias is accounted, although, there is no clear consensus on the magnitude of the relationship. Camacho (2008) estimates the effect of

landmine explosions during pregnancy on birthweight in Columbia. Her first specification controls for community and time fixed effects, identifying the effect from within-community temporal variation in landmine explosions. She finds that landmine explosions in the first trimester of pregnancy is associated with a reduced birthweight of 7.7 grams. She also uses mother-fixed effects, which identifies the effect of landmine explosions by comparing the birthweight of two siblings who lived in the same community, but were exposed to different levels of landmine explosions. Results from the mother-fixed effect specification are similar to those from the community fixed-effects specification. Mansour and Rees (2012) investigate the effect of exposure to the al-Aqsa Intifada conflict in Palestine using mother fixed-effects. They find that exposure to the al-Aqsa Intifada in the first trimester of pregnancy is associated with a 0.0027 point increase in the probability of low birthweight; comparatively, the association between exposure to violence in the last two months of pregnancy and low birthweight is somewhat smaller (0.0019 point), which implies an increase of 2.3% or 1.6%, relative to the sample mean, respectively. Based on mother-fixed effect models, Brown (2014) finds that the escalation in crime due to the Mexican drug war (1 additional homicide per 10,000 in a year) reduced birthweight by 300 grams and increased the risk of low birthweight by 25-33%. Koppensteiner and Manacorda (2013) investigate the effect of homicide rates during pregnancy on infant health in Brazil. They find that 1 extra homicide during the first trimester of pregnancy reduces birthweight by 0.4%, and increases the probability of low birthweight by 6%.

The results from the above studies suggest that crime-prevention policies would have positive externalities in the form of improved prenatal and neonatal health. However, with the exception of Koppensteiner and Manacorda (2013), the evidence is

based on extremely violent events/conflicts. Moreover, there is very little U.S.-based evidence that crime has a strong negative effect on infant health. Existing studies that use U.S. data are based on small areas (Wake County, NC (Messer et al. 2006), Chicago, IL (Morenoff 2003; Masi et al. 2007), and Baltimore, MD (Schempf et al. 2009)) and do not take account of the self-selection bias. Two exceptions are Eccleston (2011) and Brown (2012) who both estimate in-utero exposure to the September 11th 2001 terrorist attacks and find that children exposed in the first or second trimester in utero had lower birthweight, but again the results are based on an extreme tragic event[3].

We contribute by using a large nationally-representative dataset (2000-10 Natality Detail Files) and estimating a model that controls for individual (child and mother) characteristics and time-invariant and -variant county characteristics, including county socioeconomics and healthcare supply. While this approach accounts for some of the sources of potential bias, it most notably lacks control for unobserved individual traits that are correlated with county crime and pregnancy wellbeing. We therefore interpret the results as associations rather than causal effects. Despite this limitation, this study is meaningful as it provides evidence on the relationship between crime and pregnancy wellbeing on a national scale. Moreover, the literature has focused almost exclusively on violent crime rates and this paper contributes to it by also considering the effect of property crime and the sum of violent and property crimes. *A priori* it seems plausible that property crimes adds to the cost of prenatal investments for the same reasons as violent crimes (e.g. by reducing access to resources like doctors, parks, and grocery stores who would be less likely to locate in high-crime areas).

[3] The main difference between Eccleston (2011) and Brown (2012) is that Eccleston (2011) only uses data on births in New York. Brown (2012) uses data in births in the entire U.S. and excludes New York and Washington D.C.

Whether property crimes are significantly related to pregnancy wellbeing and its importance relative to violent crimes is an empirical question that we put to test. Finally, we contribute by studying women's healthcare use and health behaviors during pregnancy in order to shed light on the little-studied behavioral mechanisms by which crime is associated with worse infant health.

In sharp contrast with the existing literature, we find that neither type of crime is associated with any measure of infant health considered in this study. We also find that violent crime is significantly associated with worse prenatal healthcare use and pregnancy behaviors and these results vary by mother's race/ethnicity: the probability of initiating care in the first trimester and number of prenatal care visits of all mothers – white, black, and Hispanic are negatively associated with crime rate, however, the probability of excessive weight gain and tobacco use is positively associated with crime rate only for black and Hispanic mothers. The results are policy relevant as they suggest that a community-level initiative geared towards crime reduction may also be used as a tool for improving maternal health.

The remainder of the paper is organized as follows. The data and empirical method are outlined in sections 2 and 3. The results are presented in section 4. Finally, section 5 concludes with a discussion of the results.

2. Data

The primary data for this analysis comes from 2000-2010 Natality Detail Files (NDF), which is a collection of birth certificates of the universe of children born in the U.S. in those years (NCHS 2000-2010). There are approximately 4 million live births in the U.S. each year, which leads to an extraordinarily large sample. We use a 15% random sample of births in years 2000 through 2010. Similar ways of selecting a random subset

of NDF for computation manageability have been used in the literature (e.g., Currie and Moretti 2003; Mayer and Sarin 2005; Lhila 2009; 2012; Bitler and Schmidt 2012). This leads to a dataset with approximately 6.7 million observations, which is sufficiently large to conduct statistically precise and meaningful subgroup analysis. Plural births (3.3% of the observations) are dropped from the analysis because sibling observations from multiple births are correlated and the standard clinical cutoffs for defining infant health outcomes such as low birthweight, preterm birth, and excessive weight gain do not apply to plurals.

NDF provides a variety of infant health information and standard clinical cutoffs are used to define infant health outcomes. Birthweight less than 2,500 grams is classified as low birthweight (LBW) and births that did not complete 37 weeks of gestation are categorized as preterm births (PTB) (Kowlessar et al, 2013). Five-minute Apgar score ranges from 0 to 10 and we create a dummy variable to indicate score below 7, which indicates that the newborn required resuscitation or was in intermediate physical health (Martin et al, 2013).

Maternal information available in the NDF include her demography – age, race, ethnicity, marital status, completed years of education, and parity. NDF also provides information on pregnancy-related health behaviors, such as timing of first prenatal care visit, number of prenatal care visits, tobacco use, and weight gain. Recommended weight gain depends upon weight at conception (IOM, 1990), however, since NDF does not provide conception weight we define excessive weight gain as a gain of 40 pounds or more (Currie et al 2010; Lhila 2011), which would be considered excessive for all women irrespective of conception weight.

One data limitation is worth noting. We have access to limited geographic identifiers for part of the study period. Particularly, for data years 2000 through 2004 county FIPS codes are available only for counties with populations 100,000 or more. Since county codes are used to merge NDF with crime data, we cannot utilize observations in counties will less than 100,000 population. This results in a loss of approximately 769,000 observations or 11.8% of the data. By necessity, births to mothers residing in large counties will encompass the entire study period, whereas births to mothers in small counties will use data from the latter half of the data years.

The crime information is obtained from the Uniform Crime Reporting Program Data: County-Level Detailed Arrest and Offense Data (UCR) for years 2000 through 2010. This data provides the annual counts of offenses for 8 different crimes in each county. The eight crimes are collectively called index or Part I crimes. Four of the eight crimes – murder, rape, robbery, and aggravated assault, are classified by the Federal Bureau of Investigation (FBI) as violent crimes; and the other four crimes – burglary, larceny, motor-vehicle theft, and arson, are classified as property crimes. The underlying data are collected by the FBI from various law enforcement agencies and converted into county-level counts of offenses by the United States Department of Justice (DOJ, 2000-2010). Approximately 6% of the county-year observations are missing crime offense data because law enforcement agencies did not report them; this resulted in a loss of 59.4 thousand birth observations, or 1% of the NDF sample after merging. These data are considered reliable and have been widely used in the economics literature on crime (e.g., Mocan and Bali 2010; Dave and Mukerjee 2011; Iyengar 2011; Marcotte and Markowitz 2011; Abrams 2012; Corman et al. 2013; Stemple and Meyer 2014). We use seven measures of crime to test the sensitivity of results to the type of

crime. The measures are counts of all index crimes, property crimes, violent crimes, and the four violent crimes per 1,000 people in the county of mother's residence at the time of child birth.

We merge the Area Health Resource File (AHRF), which is a collection of county-level data on health resources and socioeconomic characteristics that are correlated with the demand for those resources. The socioeconomic variables derived from AHRF are median household income and the percentage of population living below the federal poverty line. We also merge the county race distribution to NDF by year of birth, county of residence, race, and ethnicity to obtain the fraction of the county population that is the same race/ethnicity as the mother. We do so to measure the racial homogeneity the mother experiences. Two measures of health resources are the number of short-term general hospital beds and the number of obstetrician-gynecologists – both counts are rescaled to reflect the number per 1,000 reproductive-age (15-44 years old) females in the county to capture the resource availability for the relevant population. Annual county unemployment rate is obtained from the Bureau of Labor Statistics and merged to NDF data by county of residence and year of birth. After merging these data and dropping observations in the ways described, the final count of observations in the analytical sample is 5,691,030 births.

3. Empirical model

A simple reduced form model that can be used to estimate the effect of county crime on pregnancy health and infant health is given by equation (1).

$$H_{ict} = \beta_0 + \beta_1 C_{ct} + \tau_t + \varepsilon_{ict} \qquad (1)$$

In this equation, H_{ict} represents the health of infants (indicators for low birthweight, preterm birth, and low Apgar score) and measures of pregnancy-related healthcare and

health behaviors (dummy variable for first-trimester prenatal care visit, total number of prenatal care physician visits, and indicators for tobacco use and excessive weight gain) of mother *i*, who resides in county *c*, and gave birth in year *t*. C is the explanatory variable of interest – criminal offense rate in county *c* in birth year *t* and is alternately measured as counts of index crime, property crime, violent crime, murder, rape, robbery, and aggravated assault per 1,000 residents in the county. τ_t refers to time fixed effects and ε_{ict} is the error term.

The parameter of interest β_1 is estimated using variation in crime across all counties. However, β_1 will be potentially biased because of self-selection. Equation (1) ignores the possibility that place of residence and hence the characteristics of that place (including crime rate) is a choice. A negative correlation between crime rate and infant health could arise because women who are highly risk averse may both avoid high-crime neighborhoods and follow the prenatal care regimen. Similarly, there are likely to be unobserved county characteristics (e.g., health attitudes and norms) that are correlated with crime and health. Model (2) includes county fixed effects μ_c to control for the influence of time-invariant unobserved county characteristics.

$$H_{ict} = \beta_0 + \beta_1 C_{ct} + \mu_c + \tau_t + \varepsilon_{ict} \qquad (2)$$

A comparison of estimates of β_1 in models (1) and (2) sheds light on how the association between crime and infant health changes when county-level unobserved heterogeneity is accounted. In model (2), β_1 is interpreted as the change in LBW associated with change in within-county (over time) crime rate.

Model (2) does not account for time-variant county characteristics and individual characteristics that are correlated with crime and infant health. These are included in the fully specified model (3). The vector of variables X consists of child (sex and birth

order) and mother characteristics (age, educational attainment, race/ethnicity, marital status, and an indicator for father's information absent on birth certificate). Y_{ct} is a set of time-varying county characteristics, including socioeconomic characteristics (median household income, percent of the population below the federal poverty level, and fraction of population that is the same race/ethnicity as the mother, and unemployment rate) and healthcare supply (numbers of hospital beds and ob-gyns per 1,000 reproductive-age female) in county *c* in year *t*.

$$H_{ict} = \beta_0 + \beta_1 C_{ct} + \beta_2 X_{ict} + \beta_3 Y_{ct} + \mu_c + \tau_t + \varepsilon_{ict} \quad (3)$$

We estimate Models 1, 2, and 3 for the infant health outcomes using the full sample of mothers and estimate the fully-specified model (Model 3) for all other outcomes for three subsamples: non-Hispanic white (white henceforth), non-Hispanic black (black henceforth), and Hispanic mothers. All models are estimated by Ordinary Least Squares, including those with binary dependent variables because of the large sample size. Estimated standard errors are robust and clustered at the county level.

Identification and Potential Biases

For β_1 in model (3) to represent a causal parameter, we need to assume that after controlling for individual and county characteristics and county fixed effects, changes (over time) in other determinants of pregnancy outcomes are uncorrelated with changes in crime rate within counties. The major threat to identification is that we cannot account for unobserved heterogeneity at the individual mother level. Individuals hold private information (risk aversion, ability) that correlates with their neighborhood choice and pregnancy outcomes; we do not observe this information and cannot include in the model. If unobserved individual heterogeneity is negatively correlated with both crime and adverse infant health (like low birthweight) then our estimate of β_1 will be

upward biased. For example risk-averse individuals or individuals who care about health are likely to live in low-crime areas and independent of crime are less likely to have low birthweight infants. NDF was chosen for this study because it provides rich data on infant health and women's pregnancy experience; however, we cannot identify different births by the same mother and thus cannot include mother fixed effects that could arguably overcome this potential problem. County fixed effects purges the mean traits of women who reside in the county (e.g., mean risk aversion and ability of the women living in the county); to the extent that a randomly-selected mother's unobserved traits are highly correlated with the average traits of mothers residing in the county, county fixed effects at least partly accounts for individual heterogeneity.

The second problem is that county factors that are correlated with county crime and pregnancy outcomes are assumed to be fixed, when they actually change over time. In other words, there may be unobserved, time-variant county traits (an omitted error term such as η_{ct}) that are correlated with crime and pregnancy outcomes; county fixed effects would not purge these traits which could plausibly lead to biasing our estimate of β_1. This could result in a downward bias. For example, crime is likely to increase and adverse health (e.g. low birthweight) and health behaviors (such as smoking and excessive weight gain) improve as the macroeconomy worsens (Ruhm 2000; 2003; 2005; Dehejia and Lleras-Muney 2004). Our model includes county unemployment rate, which is the most commonly used measure of macroeconomy in the macroeconomy and health literature, and poverty rate to address this sort of possibility. Despite our best efforts, we acknowledge that there may be similar sources of bias that are not accounted in the model.

The third potential source of bias is measurement error in the crime rate variable. Measuring crime rate at the county level may not adequately represent the crime by which the mother is actually surrounded. It is plausible that crime is limited to certain blocks or is localized in certain regions of the county and women who do not reside in those areas do not actually experience this crime. Crime data at lower levels of aggregation are plausibly more meaningful, but county is the smallest level of geographic identifiers available to us on the NDF.

4. Results

4.1 Summary statistics

Table 1 presents summary statistics for the full sample and by mother's race/ethnicity. During the study period, 2000-2010, the average number of index crime offenses is 39.9 per 1,000 county residents. Of them, 34.9 are property crimes and 5 are violent crimes per 1,000 county residents. Among violent crimes, the prevalence of aggravated assaults is the highest (3 per 1,000 county residents), followed by robberies (1.6 per 1,000 county residents), rapes (0.3 per 1,000 county residents), and murders (0.1 per 1,000 county residents). The scale of crimes (per 1,000 county residents) is not mentioned henceforth but is maintained throughout the analysis. The distribution of crime by type of crime is similar across race/ethnicities; but the crimes rates tends to be higher than the overall mean in counties where black and Hispanic mothers reside.

Overall, 6.3% of infants are born low birthweight (less than 2500 grams), 10.5% are born preterm (less than 37 weeks gestation), and 1.4% have Apgar score less than 7 points. Comparing infant health outcomes by mother's race/ethnicity reveals that, on average, infants born to black women are in worse health than those born to white and Hispanic women. For example, the low birthweight rate is 5.1% for white infants, 11.5%

for black infants, and 5.6% for Hispanic infants. Similarly, the preterm birth rate is 9.1%, 10.8%, and 15.9% for white, Hispanic, and black infants, respectively.

In terms of prenatal care use, the mean number of prenatal care visits is 11.3 and 79.2% of the overall sample receive prenatal care in the first trimester. Tobacco use rate is 9.9% and 19.7% gain excessive weight (more than 40 pounds) during the prenatal period. Comparing prenatal care use and health behaviors across mother's race/ethnicity shows that white mothers have higher prenatal care use (in terms of number of visits and timing of first visit) and are more likely to smoke and gain more than 40 pounds than black and Hispanic mothers.

Mean mother's characteristics shows that black mothers are more likely to give birth at younger ages (13-18 years and 19-24 years) relative to white and Hispanic mothers, and white mothers are more like to give birth at older ages (35 years or higher) than black and Hispanic mothers. Eleven percent of white mothers, 23% of black mothers, and 46% of Hispanic mothers complete less than high school education; and 63% of white mothers, 40% of black mothers, and 24% of Hispanic mothers complete more than high school education. Father's information is unknown for 8% of white mothers, 33% of black mothers, and 12% of Hispanic mothers.

On average, the median household income in the county of residence is $49,411 and 13.3% of the residents in mother's county live below the federal poverty line. There are an average of 13.3 hospital beds and 0.66 obstetric-gynecologists per 1,000 reproductive-age females (15-44 years) in the county of residence. Comparing socioeconomic characteristics of mother's county by mother's race/ethnicity shows that poverty and unemployment rates are higher in black and Hispanic mothers' county of residence relative to the overall sample.

4.2 Effect of crime on infant health outcomes – overall sample

Table 2 shows the associations between various crime rates and infant health[4]. Although the models include various control variables, for succinctness we only report the regression coefficients on the seven crime variables along with their associated standard errors. The correlation between each crime rate variable and each infant health variable is estimated separately.

Comparing the regression coefficient on crime rate across the three models reveals how the relationship between crime rate and infant health changes as control variables are incrementally added. The results in Model 1, which are the cross-sectional correlations between the different crime rates and infant health measures (controlling for year dummies), show that crime is statistically significantly associated with worse infant health. Specifically, an additional index crime per 1,000 county residents is associated with 0.041 percentage point increase in low birthweight, 0.01 percentage point increase in the probability of low Apgar score, and 0.06 percentage point increase in preterm birth. The coefficients are of similar magnitude for property crimes but are considerably bigger for violent crimes. Since the means and standard deviations of each of the crime variables are vastly different, we calculate the percent change in infant health (relative to the mean of the dependent variables) when crime increases by one standard deviation. This shows that one-standard-deviation increase in index crimes is associated with 11.4% increase in low birthweight, which is fairly similar in magnitude to the change in LBW (10.2% and 12.5%) that accompanies one-standard-deviation increase in other crimes (property and violent crimes, respectively). Similarly, 12.3%,

[4] We considered other relevant infant health outcomes such as high birthweight (>4500 grams), very low birthweight (<1500 grams), and small-for-gestational-age and find no significant correlation between crime rate and these outcomes. For brevity these results are not reported but available upon request.

12.9%, and 8.7% increase in probability of low Apgar score and approximately 9% increase in preterm birth are associated with one-standard-deviation increase in index, property, and violent crimes, respectively. The magnitude of the relationship varies by type of violent crime, but the results of Model 1 unequivocally show that crime rate is associated with worse infant health.

The magnitude of the relationship and statistical significance of the relationships change dramatically when county fixed effects are included (Model 2). The associations between the seven measures of crime and three measures of infant health are, by and large, rendered statistically insignificant when we control for time-invariant county characteristics like attitudes, norms, and mean risk aversion and ability. The direction of the results continue to suggest that the various crime rates are associated with worse infant health and only preterm birth is statistically significantly associated with crime at the 10 percent level. Specifically, one-standard-deviation increases in index crime rate and aggravated assault rates are each associated with 1.2% and 1.8% increase in preterm birth rate, respectively.

Model 3 reveals that controlling for individual and county characteristics (including socioeconomics and healthcare supply) does not appreciably change the results from those in Model 2. The magnitudes of the relationship are somewhat smaller and the direction of the results continue to suggest that crime rates are associated with worse infant health, but none of the relationships are statistically significant.

4.3 Effect of crime on infant health outcomes – by mother's race/ethnicity

Table 3 tests whether the crime and infant health relationships vary by mother's race/ethnicity. We report the results of Model 3 and exclude Models 1 and 2 because the pattern of results by race/ethnicity are very similar to that seen in the full sample.

The table shows that like in the overall sample (Model 3), crime is not statistically significantly related to any measure of infant health for any racial/ethnic group. The coefficients are less precisely estimated than they were in the overall sample. This is particularly true when crime rate is broken down to the four types of crimes that constitute violent crimes. Low birthweight and preterm birth results are fairly stable and the direction continues to suggest that crime rates are associated with worse infant health. However, the results for Apgar scores are sometimes positive and sometimes negative; but the sole statistically significant relationship is that between rape rate and low Apgar score for Hispanic mothers. An additional rape per 1,000 county residents is associated with 0.58 percentage point increase in the probability of Apgar score less than 7 points; this is equivalent to 7.7% increase in low Apgar score (relative to the mean of 1.12%) when rape rate increases by one standard deviation (0.15 rapes per 1,000 residents).

4.4 Effect of crime on prenatal healthcare and health – by race/ethnicity

Table 4 follows the same set up as Table 3, showing the associations between the various types of crime rates and mother's healthcare behaviors and health outcomes in the fully-specified model (Model 3), by mother's race/ethnicity. The associations in this table are largely statistically insignificant, but there are some notable exceptions.

The probability of receiving prenatal care in the first trimester is not significantly correlated with any measure of crime, but the signs generally suggest that crime and first-trimester care initiation are negatively related. The number of prenatal care visits tends to be negatively associated with violent crime rates and the association between murder rate and number of prenatal care visits is statistically significant in all four samples – overall, white, black, and Hispanic mothers. The regression coefficient

suggests that an additional murder per 1,000 county residents is associated with an average decline of 1.1, 0.68, 1.3, and 0.88 visits for all, white, black, and Hispanic mothers, respectively.

Crime rate, particularly violent crime rate is associated with worsening maternal pregnancy health outcomes (weight gain in excess of 40 pounds, tobacco use) in all samples. But, the relationship is statistically significant for racial minority mothers – blacks and Hispanics. Two types of violent crimes – murders and robberies are related statistically significantly to excessive weight gain rate in the overall and Hispanic samples: an additional murder per 1,000 residents is associated with 2.6 (all women) and 7 point (Hispanic women) increase in the percentage of women who gain more than 40 pounds; this is approximately 13.3% and 44.1% increase in excessive weight gain rate relative to its mean of 19.7% and 15.8% in the overall and Hispanic samples, respectively. The magnitude of these results seem large, but they are more sensible when we consider that mean of murder rate is 0.06 in the overall sample and 0.07 in the Hispanic sample. Scaled differently, one-standard-deviation increase in murder rate is associated with 0.8% rise in excessive weight gain (relative to its mean) in the overall sample and 2.1% in the Hispanic sample. Similarly, a one-standard-deviation increase in robbery rate is associated with 3.1% and 8.6% increase in excessive weight gain rate in the overall and Hispanic samples, respectively.

Tobacco use rate during pregnancy is positively related to violent and aggravated assault rates, particularly in the black and Hispanic samples. The magnitudes of the regression coefficients suggest that an additional violent crime per 1,000 residents is associated with 0.13 and 0.09 percentage point increase in the tobacco use rate, which amounts to 1.4% and 3.8% increase in tobacco use relative to the mean prenatal

smoking rate (8.7 and 2.5) in the black and Hispanic samples, respectively. These results are driven by the aggravated assault rate that is also statistically significantly and positively associated with tobacco use rate in the black and Hispanic samples. One-standard-deviation rise in aggravated assault rate, which is 2.26 and 1.58 aggravated assaults per 1,000 residents (from Table 1) in the black and Hispanic samples, respectively, is associated with 4.3% and 8.3% increase in smoking rate for blacks and Hispanics, respectively[5].

4.5 Robustness test using instrumental variables

We acknowledge the potential biases that remain unaccounted in the fully-specified model (Model 3) and employ an instrumental variable to test the robustness of our results. We use the number of full-time equivalent police officers employed per 1,000 residents in the county (police level, henceforth). These data are obtained from the U.S. Census Bureau's Census of Governments for years 2002 and 2007. The Census Bureau surveys all state and local governments every 5 years and provides information on each unit's public finance and public employment, including the number of full-time and full-time equivalent police officers on payroll (Census of Governments 2002; 2007). These data are merged to the NDF data by county of mother's residence and year of birth and the analytical sample is limited to births in 2002 and 2007 as police data are only available for these two years.

The two-stage least squares (2SLS) model takes the following form:

First-stage: $C_{ict} = \gamma_0 + \gamma_1 P_{ct} + \gamma_2 X_{ict} + \gamma_3 Y_{ct} + \mu_c + \tau_t + \varepsilon_{ict}$ (4)

[5] NDF also provides information on certain pregnancy risk factors, including hypertension. Since stress may lead to hypertension through repeated elevations in blood pressure (Kulkarni et al. 1998; Matthews et al. 2004), we include an indicator for gestational hypertension as an outcome. However, we do not report the associations between our crime measures and the indicator for hypertension as they are largely statistically insignificant.

Second-stage: $H_{ict} = \delta_0 + \delta_1 \hat{C}_{ct} + \delta_2 X_{ict} + \delta_3 Y_{ct} + \mu_c + \tau_t + \varepsilon_{ict}$ (5)

In the first stage, the number of full-time equivalent police officers per 1,000 residents, P_{ct}, in county *c* in year *t* is used to predict crime rate per 1,000 experienced by the mother of infant *i* who resided in county *c* in year *t*. The second stage employs the predicted crime rate,$\hat{C}$, and δ_1 is the 2SLS estimate of the relationship between crime and pregnancy outcomes. Equation (5) is similar in every way to equation (3), except that it uses crime rate predicted by the police level instead of observed crime rate.

There is an extensive body of literature that has examined the causal relationship between police and crime rate (e.g., Worrall and Kovandzic 2010; Evans and Owens 2007; Kovandzic and Sloan 2002; Corman and Mocan 2000; Corman and Joyce 1990) and employed a variety of strategies to overcome the simultaneity bias in the relationship between crime and police levels. The bias in the crime-police relationship is less concerning in the current context as the assumption for a 2SLS model requires that the number of police officers be correlated (not causally related) to crime rate (Wooldridge 2009). Further, the validity of the instrument is based on the idea that police level in the county will be unrelated to infant health, except through its relationship with crime in the community. One argument against the validity of this instrument is that county investment in law enforcement may be correlated with investments in producing maternal and infant health. This criticism is less problematic in the current setting because the estimation equation controls for both unobserved, time-invariant county characteristics (through county fixed effects) and measures of healthcare supply that may vary over time.

Table 5 presents the results of the 2SLS estimation with index crime rate as the measure of crime in the county. We also use police level as an instrumental variable for

the rates of property crime, violent crime, murder, robbery, rape, and aggravated assault but these results are not reported. The second stage results for all the violent crime rate variables were imprecisely estimated and nonsensical, likely because violent crimes occur relatively infrequently with bunching around 0. Property crime results are meaningful (and very similar to index crime results) but not reported for the sake of brevity. The table is divided into two horizontal panels – one containing first-stage results and the other second-stage results. For the first stage we present the regression coefficient, standard error, and F-test statistic for the instrumental variable.

The upper panel of the table shows two things: first, police level in the county is negatively correlated with index crime rate for all race/ethnicities; and second, the F-statistic is almost always well above 10, the cutoff to pass the test of weak instrument (Stock and Staiger 1997). In the fully-specified model (Tables 3 and 4), index crime rate is not statistically significantly associated with any of the infant health or pregnancy behavior variables. But the second-stage of the IV results are often significant and very similar to the violent crime results from Tables 3 and 4, except the magnitude of the IV results is considerably larger than those in Tables 3 and 4. This table shows that crime rate is not statistically significantly associated with infant health, but it tends to worsen prenatal care use for white and black mothers both in terms of timing of first visit and the number of prenatal care visits. An additional index crime per 1,000 residents is associated with 18.4% and 21.5% decline in the first-trimester care rate and 23.3% and 24.3% decline in the number of prenatal care visits for whites and blacks, respectively. One anomaly is Hispanic mothers – index crime rate is not statistically significantly associated with first-trimester prenatal care visit, but is associated with 40.9% increase

in the number of prenatal care visits. Excessive weight gain also increases (particularly for Hispanic mothers) with increasing crime rate.

5. Conclusion

Previous studies based on extreme violent events/conflicts have found that in-utero exposure to violent crime is associated with worse infant health. This suggests that policies to reduce crime would generate positive spillovers for the next generation. However, there is little U.S. based evidence on a national scale. We attempt to fill the gap in the literature by using the 2000-2010 Natality Detail File, which yields an analytical sample of approximately 5.6 million births in the U.S., merged with counts of criminal offenses per 1,000 residents in mother's county of residence. We control for individual characteristics, county fixed-effects (to account for time-invariant county characteristics), time-variant county characteristics, and measures of county healthcare supply, to at least partly address the problem of self-selection bias. We also test the robustness of the results by using the number of full-time equivalent police officers per 1,000 county residents as an instrument for county-crime.

Based on the county fixed effects and instrumental variables results, the main contributions of this paper are as follows: first, it highlights the importance of unobserved, time-invariant county traits (county fixed effects) as its inclusion alters the results quite dramatically. Second, while the literature has by-and-large focused on infant health outcomes, this paper sheds light on the theorized behavioral mechanisms by which crime can affect health outcomes at birth. We find that crime is associated with worse prenatal care use (both in terms of timing of first visit and the number of visits) for all race/ethnicities. Further, crime is associated with worse health behaviors such as tobacco use for blacks and Hispanics and excessive weight gain for Hispanics. Third,

interestingly, we find that these behavioral associations do not translate into worse infant health. Crime – neither violent nor property crime, is statistically significantly or meaningfully associated with any of our measures of infant health for any of the racial/ethnic groups considered. Finally, this study also shows that property crimes do not tend to be associated with women's prenatal healthcare and health behaviors.

The lack of statistically significant association between crime and infant health and the small magnitudes in our analysis is puzzling, particularly because the violence and infant health relationship is fairly robust in the literature. Koppensteiner and Manacorda (2013) is the most comparable to our analysis in terms of the measure of violence and method used; they find that an additional homicide per 100,000 municipality (equivalent to U.S. county) residents is associated with 6% increase in low birthweight. Comparatively, we find that an additional violent (murder) crime per 1,000 residents is associated with 0.11% (1.1%) increase in low birthweight rate. We posit some explanations for this difference. First, the insignificant and small estimates for infant health could be a result of insufficient variation in within-county (over time) crime rates (see appendix Table 1). To test this, we repeat the analyses using births in county-years with mean-deviated crime rate in the 75th percentile as one might expect to detect significant/meaningful effects when there is large variation in the crime rate. However, the general conclusions do not change (the results are provided in appendix Tables 2A and 2B). We still find that crime is associated with lower prenatal healthcare use and worse health behaviors, but no large negative associations with infant health. Second, in this analysis, crime is an annual measure in the year of child's birth. The literature has shown that crime in the early part of the pregnancy affects infant health and that effect is ameliorated (in magnitude and statistical significance) when crime exposure later in

the pregnancy is considered (Mansour and Rees 2012; Koppensteiner and Manacorda 2013). Thus, we conjecture that our estimate of the association between crime and infant health may actually be picking up the effect of crime in the later part of the pregnancy. We cannot test this conjecture as UCR, the most reliable and consistent source of U.S. crime data, provides crime counts only at the annual level. Third, the literature on crime and infant health has focused on high-crime areas (e.g. Chicago, IL (Morenoff 2003; Masi et al. 2007) and Baltimore, MD (Schempf et al. 2009)), intensely violent situations (e.g., landmine explosions in Colombia (Camacho 2008), September 11 attack in New York City (Eccleston 2011; Brown 2012), and al-Aqsa Intifada in West Bank and Gaza (Mansour and Reese 2012)), or countries with high level of crime (Brazil (Koppensteiner and Manacorda 2013) and Mexico (Brown 2014)), whereas mean violent crime rate in this study is relatively low. This suggests that the estimates of this study may not be directly comparable to those of existing studies and that an increase in violent crime, when the mean level of crime is low, does not translate into adverse infant health. Finally, bias due to measurement error in our crime rate may be another reason for the infant health results. The existing U.S.-based studies examine the crime-infant health relationship in small geographical areas (e.g. census block (Messer et al. 2006), census tract (Masi et al. 2007)) and it is possible that measuring crime at the county level is too large a scale, which would bias our estimates towards zero.

Thus, we do not find any large negative associations between crime and infant health, but we cannot rule out the possibility that there is one. The takeaway message of this analysis that will be of interest to researchers and policymakers alike is that combatting crime, particularly violent crime may have the spillover benefit of improving women's prenatal healthcare use and health behaviors.

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Table 1: Descriptive Statistics, by Mother's Race/Ethnicity
Means, percentages and associated standard deviations

	Overall		Non-Hispanic white		Non-Hispanic black		Hispanic	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Sample size	5,691,030		3,033,067		851,609		1,419,851	
Infant health [1]								
Percent low birthweight (<2500g)	6.26	24.22	5.07	21.94	11.48	31.88	5.61	23.01
Percent very low birthweight (<1500g)	1.10	10.42	0.80	8.91	2.55	15.76	0.94	9.63
Percent high birthweight (>4500g)	1.20	10.87	1.43	11.88	0.65	8.03	1.13	10.56
Percent preterm births (<37 weeks gestation)	10.53	30.70	9.05	28.69	15.85	36.52	10.77	31.00
Five-minute Apgar score	8.86	0.73	8.88	0.70	8.79	0.90	8.88	0.66
Small-for-Gestational Age	9.46	29.27	7.74	26.73	15.10	35.81	9.06	28.71
Percent low Apgar score (<7 points)	1.41	11.81	1.30	11.32	2.35	15.14	1.12	10.51
Pregnancy-related health behaviors and outcomes [1]								
Number of prenatal care visits	11.28	3.94	11.72	3.70	10.64	4.43	10.73	4.04
Percent with prenatal care in 1st trimester	79.22	40.58	84.71	35.99	71.04	45.36	71.87	44.96
Percent used tobacco	9.89	29.85	13.77	34.46	8.74	28.25	2.49	15.57
Percent weight gain > 40 lbs	19.68	39.76	21.77	41.27	19.44	39.57	15.77	36.45
Percent cesarean births	27.47	44.64	27.33	44.57	29.21	45.47	26.80	44.29
Percent Downs syndrome births	0.05	2.15	0.06	2.37	0.03	1.72	0.04	2.03
Percent pregnancy-associated hypertension	3.66	18.77	4.08	19.78	4.40	20.51	2.66	16.08
Criminal offenses in county [2]								
No. of index crimes per 1,000 county residents	39.92	17.37	36.86	17.06	47.79	19.02	42.18	15.52
No. of violent crimes per 1,000 county residents	4.98	3.08	4.23	2.88	6.79	3.67	5.53	2.57
No. of property crimes per 1,000 county residents	34.94	15.21	32.63	14.93	41.00	16.45	36.65	14.06
No. of murders per 1,000 county residents	0.06	0.06	0.05	0.05	0.10	0.09	0.07	0.05
No. of rapes per 1,000 county residents	0.30	0.17	0.30	0.18	0.33	0.18	0.29	0.15
No. of robberies per 1,000 county residents	1.60	1.33	1.24	1.17	2.46	1.61	1.83	1.17
No. of aggravated assaults per 1,000 county residents	3.02	1.90	2.63	1.85	3.91	2.26	3.34	1.58
Child characteristics [1]								
Male	0.51	0.50	0.51	0.50	0.51	0.50	0.51	0.50
Birth order=1	0.41	0.49	0.43	0.49	0.39	0.49	0.36	0.48
Birth order=2	0.32	0.47	0.33	0.47	0.29	0.45	0.30	0.46
Birth order=3	0.16	0.37	0.15	0.36	0.17	0.38	0.19	0.39
Birth order=4	0.07	0.25	0.05	0.23	0.08	0.27	0.09	0.28
Birth order=5	0.02	0.15	0.02	0.13	0.04	0.19	0.03	0.18
Birth order=6	0.01	0.10	0.01	0.08	0.02	0.13	0.01	0.11
Birth order=7	0.004	0.07	0.003	0.06	0.01	0.09	0.005	0.07
Birth order >=8	0.004	0.07	0.004	0.06	0.01	0.09	0.004	0.06
Mother characteristics [1]								
Non-Hispanic white	0.53	0.50	1.00	0.00	0.00	0.00	0.00	0.00
Non-Hispanic black	0.15	0.36	0.00	0.00	1.00	0.00	0.00	0.00
Hispanic	0.25	0.43	0.00	0.00	0.00	0.00	1.00	0.00
Other race/ethnicity	0.07	0.25	0.00	0.00	0.00	0.00	0.00	0.00
Age 13-18 years	0.06	0.24	0.04	0.19	0.11	0.31	0.09	0.29
Age 19-24 years	0.29	0.45	0.25	0.43	0.38	0.49	0.34	0.47
Age 25-34 years	0.51	0.50	0.55	0.50	0.40	0.49	0.46	0.50
Age >= 35 years	0.14	0.35	0.16	0.37	0.10	0.30	0.11	0.31
Married	0.62	0.48	0.74	0.44	0.30	0.46	0.51	0.50
High school dropout	0.21	0.41	0.11	0.31	0.23	0.42	0.46	0.50
High school graduate	0.28	0.45	0.26	0.44	0.37	0.48	0.29	0.46
More than high school education	0.50	0.50	0.63	0.48	0.40	0.49	0.24	0.43
Father information absent	0.12	0.33	0.08	0.26	0.33	0.47	0.12	0.32
County characteristics [3]								
Percent of county residents of mother's race/ethnicity	51.26	29.18	72.15	18.23	25.89	16.45	31.71	20.45
Median household income	49412	12622	49946	12490	46148	11580	48863	12384
Percent residents living below povery line	13.34	5.37	12.25	4.79	15.02	5.45	14.88	5.87
Unemployment rate [4]	6.09	2.54	5.87	2.44	6.25	2.46	6.49	2.75
No. of hospital beds per 1,000 15-44 year females	13.00	8.71	13.01	9.47	15.83	9.77	11.67	5.94
No. of ob-gyns per 1,000 15-44 year females	0.66	0.33	0.64	0.35	0.75	0.33	0.64	0.29
No. of full-time equivalent police officers per 1,000 [5]	0.60	0.47	0.59	0.48	0.64	0.52	0.61	0.43

Notes:
1. Data obtained from 15% random sample of 2000-10 Natality Detail Files; restricted to singleton births
2. Obtained from 2000-10 Uniform Crime Reporting Program
3. All county characteristics, except unemployment and police data are obtained from Area Health Resource File
4. Annual county unemployment rate obtained from Bureau of Labor Statistics
5. No. of police officers obtained from 2002 and 2007 Census of Governments

Table 2: Effect of Crime Rate on Infant Health Outcomes as Variables are Added Incrementally, by Type of Crime

	Birthweight < 2500 grams			Five-Minute Apgar Score < 7			Gestation < 37 weeks		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Sample mean		6.26			1.41			10.53	
Index crimes									
	0.041***	0.002	0.0003	0.010***	-0.001	-0.001	0.057***	0.007*	0.004
	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
	11.4%	0.56%	0.08%	12.3%	-1.2%	-1.2%	9.4%	1.2%	0.7%
Property crimes									
	0.042***	0.002	0.00008	0.012***	-0.002	-0.002	0.062***	0.007	0.004
	(0.004)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.005)	(0.004)	(0.004)
	10.2%	0.5%	0.02%	12.9%	7.5%	4.3%	9.0%	1.0%	0.6%
Violent crimes									
	0.254***	0.023	0.007	0.040***	0.016	0.005	0.307***	0.042	0.020
	(0.020)	(0.016)	(0.016)	(0.009)	(0.017)	(0.016)	(0.026)	(0.028)	(0.029)
	12.5%	1.1%	0.3%	8.7%	3.5%	1.1%	9.0%	1.2%	0.6%
Murders									
	13.386***	0.478	0.071	1.637***	0.307	0.048	15.796***	0.929	0.396
	(1.054)	(0.564)	(0.486)	(0.382)	(0.311)	(0.297)	(1.452)	(0.584)	(0.580)
	12.82%	0.46%	0.07%	7.0%	1.3%	0.2%	9.0%	0.5%	0.2%
Rapes									
	1.969***	-0.160	-0.133	1.341***	0.044	0.053	2.621***	-0.175	-0.141
	(0.487)	(0.141)	(0.138)	(0.130)	(0.137)	(0.127)	(0.547)	(0.210)	(0.208)
	5.5%	-0.4%	-0.4%	16.5%	0.5%	0.7%	4.3%	-0.3%	-0.2%
Robberies									
	0.553***	0.076	0.024	0.048*	0.071	0.043	0.590***	0.075	-0.003
	(0.053)	(0.051)	(0.052)	(0.027)	(0.057)	(0.052)	(0.070)	(0.090)	(0.093)
	11.7%	1.6%	0.5%	4.5%	6.7%	4.0%	7.4%	0.9%	-0.04%
Aggravated assaults									
	0.363***	0.025	0.010	0.069***	0.011	-0.002	0.474***	0.058*	0.036
	(0.031)	(0.021)	(0.020)	(0.013)	(0.021)	(0.021)	(0.038)	(0.034)	(0.035)
	11.0%	0.8%	0.3%	9.3%	0.3%	-0.1%	8.6%	1.8%	1.1%
Sample si		5,691,030			4,924,577			5,655,832	

Notes:

1. Sample is 15% random sample of 2000-10 Natality Detail Files; restricted to singleton births
2. Crime rate is number of criminal offenses per 1,000 county residents
3. Each point estimate and associated standard error obtained from a different regression; % reports the mean change in the dependent variable if crime increased by 1 standard deviation, relative to the sample mean of the dependent variable
4. Model 1 includes year of birth fixed effects
5. Model 2 includes county of residence and year of birth fixed effects
6. Model 3 includes individual characteristics (child sex, birth order dummies, mother's age categories, race/ethnicity, educational attainment categories, marital status, indicator for father absent), county socioeconomic characteristics (pct of population of mother's race/ethnicity, poverty rate, median household income, unemployment rate), county healthcare supply (no. of hospitla beds and no. of obstetric-gynecologists per 1,000 females 15-44 years), and year of birth and county of residence fixed effects
7. Standard errors are robust and clustered at county level
8. *(**)(***) indicates statistical significance at 0.1(0.05)(0.01) level, respectively

Table 3: Effect of Crime Rate on Infant Health Outcomes, by Type of Crime and Mother's Race/Ethnicity

	Birthweight < 2500 grams			Five-Minute Apgar Score < 7			Gestation < 37 weeks		
	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Non-Hispanic, White	Non-Hispanic, Black	Hispanic
Sample mean	5.07	11.48	5.61	1.30	2.35	1.12	9.05	15.85	10.77
Index crimes									
	0.002	0.003	-0.004	-0.003	0.0001	-0.002	0.005	0.007	0.001
	(0.003)	(0.008)	(0.006)	(0.003)	(0.005)	(0.005)	(0.004)	(0.010)	(0.007)
	0.8%	0.5%	-1.2%	-3.7%	0.1%	-2.9%	0.9%	0.9%	0.1%
Property crimes									
	0.002	0.002	-0.005	-0.004	0.0001	-0.003	0.004	0.008	0.001
	(0.003)	(0.010)	(0.006)	(0.003)	(0.006)	(0.005)	(0.005)	(0.011)	(0.007)
	0.6%	0.3%	-1.2%	-4.1%	0.1%	-3.5%	0.7%	0.8%	0.1%
Violent crimes									
	0.021	0.035	-0.021	0.007	-0.001	0.010	0.031	0.041	0.011
	(0.019)	(0.041)	(0.025)	(0.015)	(0.026)	(0.030)	(0.030)	(0.059)	(0.053)
	1.2%	1.1%	-0.9%	1.5%	-0.1%	2.4%	1.0%	1.0%	0.3%
Murders									
	-0.004	0.078	-0.270	-0.045	0.193	0.314	0.405	1.128	0.049
	(0.648)	(0.957)	(0.708)	(0.327)	(0.612)	(1.391)	(0.712)	(1.102)	(0.458)
	-0.004%	0.1%	-0.2%	-0.2%	0.7%	1.3%	0.2%	0.6%	0.02%
Rapes									
	-0.010	-0.864	-0.185	-0.023	-0.038	0.583**	-0.172	-0.454	0.303
	(0.158)	(0.544)	(0.344)	(0.113)	(0.370)	(0.288)	(0.217)	(0.686)	(0.553)
	-0.04%	-1.4%	-0.5%	-0.3%	-0.3%	7.7%	-0.3%	-0.5%	0.4%
Robberies									
	0.054	0.074	-0.047	0.054	0.094	-0.016	0.034	0.056	-0.055
	(0.057)	(0.111)	(0.080)	(0.051)	(0.082)	(0.080)	(0.106)	(0.155)	(0.168)
	1.2%	1.0%	-1.0%	4.9%	6.5%	-1.6%	0.4%	0.6%	-0.6%
Aggravated assaults									
	0.025	0.054	-0.023	0.002	-0.029	0.013	0.048	0.065	0.026
	(0.025)	(0.055)	(0.032)	(0.020)	(0.036)	(0.042)	(0.035)	(0.077)	(0.063)
	0.9%	1.1%	-0.7%	0.3%	-2.8%	1.9%	1.0%	0.9%	0.4%
Sample size	3,033,067	851,609	1,419,851	2,791,118	790,899	1,033,997	3,022,831	847,994	1,401,858

Notes:

1. Sample is 15% random sample of 2000-10 Natality Detail Files; restricted to singleton births
2. Crime rate is number of criminal offenses per 1,000 county residents
3. Each point estimate and associated standard error obtained from a different regression; % reports the mean change in the dependent variable if crime increased by 1 standard deviation, relative to the sample mean of the race/ethnicity, educational attainment categories, marital status, indicator for father absent), county socioeconomic characteristics (pct of population of mother's race/ethnicity, poverty rate, median household income, unemployment rate), county healthcare supply (no. of hospitla beds and no. of obstetric-gynecologists per 1,000 females 15-44 years), year of birth fixed effects, and county of residence fixed effects
5. Standard errors are robust and clustered at county level
6. *(**)(***) indicates statistical significance at 0.1(0.05)(0.01) level, respectively

Table 4: Effect of Crime Rate on Prenatal Healthcare and Health Behaviors, by Type of Crime and Mother's Race/Ethnicity

	First-Trimester Prenatal Care Visit				Num. of Prenatal Care Visits				Weight Gain > 40 Pounds				Tobacco Use			
	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic
Sample mean	79.22	84.71	71.04	71.87	11.28	11.72	10.64	10.73	19.68	21.77	19.44	15.77	9.89	13.77	8.74	2.49
Index crimes																
	0.001	-0.018	-0.055	-0.103	-0.041	0.002	-0.001	0.001	0.013	-0.0005	-0.001	0.032	-0.002	-0.0002	-0.003	0.004
	(0.003)	(0.022)	(0.040)	(0.082)	(0.036)	(0.002)	(0.004)	(0.005)	(0.012)	(0.012)	(0.012)	(0.022)	(0.006)	(0.008)	(0.014)	(0.006)
	0.02%	-0.4%	-1.5%	-2.2%	-6.3%	0.2%	-0.2%	0.2%	1.1%	-0.04%	-0.1%	3.1%	-0.3%	-0.03%	-0.7%	2.6%
Property crimes																
	-0.046	-0.018	-0.069	-0.121	0.002	0.002	-0.001	0.002	0.011	-0.003	-0.003	0.030	-0.004	-0.002	-0.009	0.002
	(0.039)	(0.024)	(0.043)	(0.090)	(0.003)	(0.003)	(0.004)	(0.005)	(0.013)	(0.013)	(0.013)	(0.022)	(0.007)	(0.009)	(0.016)	(0.006)
	-0.9%	-0.3%	-1.6%	-2.4%	0.2%	0.3%	-0.2%	0.3%	0.9%	-0.2%	-0.3%	2.7%	-0.5%	-0.2%	-1.7%	1.3%
Violent crimes																
	-0.112	-0.005	-0.034	-0.059	-0.013	-0.102	-0.0004	-0.009	0.141	0.075	0.051	0.263	0.057	0.066	0.126*	0.094**
	(0.204)	(0.016)	(0.268)	(0.377)	(0.020)	(0.119)	(0.029)	(0.026)	(0.087)	(0.077)	(0.077)	(0.220)	(0.042)	(0.053)	(0.067)	(0.036)
	-0.4%	-0.02%	-0.2%	-0.2%	-0.3%	-2.5%	-0.01%	-0.2%	2.2%	1.0%	1.0%	4.3%	1.8%	1.4%	5.3%	9.7%
Murders																
	-4.205	-3.282	-1.694	-1.725	-1.101***	-0.680***	-1.312***	-0.878*	2.609**	0.700	1.092	6.950***	0.244	0.723	1.218	0.968
	(3.351)	(2.582)	(3.999)	(6.622)	(0.296)	(0.261)	(0.407)	(0.460)	(1.276)	(1.509)	(1.793)	(2.561)	(0.820)	(1.158)	(1.564)	(0.657)
	-0.3%	-0.2%	-0.2%	-0.1%	-0.6%	-0.3%	-1.1%	-0.4%	0.8%	0.2%	0.5%	2.1%	0.1%	0.3%	1.2%	1.9%
Rapes																
	-0.468	-0.677	-1.000	0.256	0.056	0.070	0.181	-0.097	0.468	0.194	-0.421	0.724	0.013	0.209	-0.760	-0.172
	(1.017)	(0.705)	(2.366)	(2.281)	(0.122)	(0.101)	(0.216)	(0.233)	(0.415)	(0.435)	(0.880)	(0.868)	(0.302)	(0.348)	(0.845)	(0.392)
	-0.1%	-0.1%	-0.3%	0.05%	0.1%	0.1%	0.3%	-0.1%	0.4%	0.2%	-0.4%	0.7%	0.02%	0.3%	-1.6%	-1.0%
Robberies																
	-0.447	-0.425	-0.591	-0.057	-0.068	-0.050	-0.049	0.237	0.454**	0.200	0.227	1.153**	0.073	0.141	0.278	0.145
	(0.590)	(0.374)	(0.624)	(0.089)	(0.063)	(0.052)	(0.069)	(1.161)	(0.226)	(0.228)	(0.176)	(0.567)	(0.111)	(0.145)	(0.176)	(0.095)
	-0.7%	-0.6%	-1.3%	-0.1%	-0.8%	-0.5%	-0.7%	2.6%	3.1%	1.1%	1.9%	8.6%	1.0%	1.2%	5.1%	6.8%
Aggravated assaults																
	-0.085	-0.073	0.119	-0.141	-0.007	0.0001	0.014	-0.002	0.134	0.081	0.033	0.169	0.083	0.076	0.165*	0.131**
	(0.242)	(0.146)	(0.355)	(0.430)	(0.023)	(0.019)	(0.038)	(0.034)	(0.110)	(0.095)	(0.116)	(0.268)	(0.057)	(0.069)	(0.099)	(0.052)
	-0.2%	-0.2%	0.4%	-0.3%	-0.1%	0.002%	0.3%	-0.03%	1.3%	0.7%	0.4%	1.7%	1.6%	1.0%	4.3%	8.3%
Sample size	5,530,264	2,949,655	815,257	1,376,334	5,510,238	2,964,285	811,269	1,375,300	4,867,427	2,744,783	760,054	1,064,514	4,809,051	2,696,445	739,846	1,066,434

Notes:

1. Sample is 15% random sample of 2000-10 Natality Detail Files; restricted to singleton births
2. Crime rate is number of criminal offenses per 1,000 county residents
3. Each point estimate and associated standard error obtained from a different regression; % reports the mean change in the dependent variable if crime increased by 1 standard deviation, relative to the sample mean of the dependent variable
4. Regression controls for individual characteristics (child sex, birth order dummies, mother's age categories, race/ethnicity, educational attainment categories, marital status, indicator for father absent), county socioeconomic characteristics (pct of population of mother's race/ethnicity, poverty rate, median household income, unemployment rate), county healthcare supply (no. of hospitla beds and no. of obstetric-gynecologists per 1,000 females 15-44 years), year of birth fixed effects, and county of residence fixed effects
5. Standard errors are robust and clustered at county level
6. *(**)(***) indicates statistical significance at 0.1(0.05)(0.01) level, respectively

Table 5: Effect of Index Crime Rate on Infant Health and Women's Prenatal Healthcare and Health Behaviors Using an Instrumental Variable, by Mother's Race/Ethnicity

	First Stage			
	Overall	Non-Hispanic White	Non-Hispanic Black	Hispanic
Index crimes				
	-2.80	-2.53	-4.51	-3.00
	(0.04)	(0.05)	(0.13)	(0.07)
	5123.6	*2158.0*	*1237.3*	*2067.1*
	Second Stage			
Birthweight < 2500 grams				
	0.028	-0.024	-0.154	0.155
	(0.11)	(0.17)	(0.27)	(0.18)
	7.91%	-8.15%	-26.00%	43.15%
Five-minute Apgar score < 7				
	-0.052	-0.131	-0.091	0.052
	(0.07)	(0.11)	(0.15)	(0.09)
	-68.54%	-186.80%	-77.27%	76.39%
Gestation < 37 weeks				
	-0.099	-0.051	-0.428	-0.012
	(0.15)	(0.22)	(0.32)	(0.24)
	-16.40%	-9.70%	-51.76%	-1.78%
First-trimester prenatal care				
	-0.588***	-0.903***	-0.797**	0.031
	(0.18)	(0.26)	(0.35)	(0.33)
	-13.03%	-18.35%	-21.51%	0.67%
Num. of prenatal care visits				
	-0.002	-0.158***	-0.134***	0.280***
	(0.02)	(0.03)	(0.04)	(0.03)
	-0.31%	-23.32%	-24.31%	40.92%
Weight gain > 40 pounds				
	0.541**	0.037	0.412	1.325***
	(0.21)	(0.32)	(0.34)	(0.37)
	48.57%	2.92%	40.82%	129.38%
Tobacco use				
	-0.076	-0.165	-0.262	0.196
	(0.13)	(0.20)	(0.22)	(0.13)
	-13.79%	-20.79%	-59.65%	130.12%
Sample size	905,248	488,818	122,849	235,423

Notes:

1. Sample is 15% random sample of 2002 and 2007 Natality Detail Files; restricted to singleton births
2. Index crime rate is number of index criminal offenses per 1,000 county residents
3. First stage: Number of full-time-equivalent police officers employed per 1,000 county residents used to instrument index crime rate variable; each point estimate, associated standard error (in parentheses), and F-statistic (in italics) obtained from a different regression
4. Second stage: Uses predicted index crime rate from first stage; 2SLS point estimate and associated standard error (in parentheses) reported
5. Both 1st and 2nd stage regressions control for individual characteristics (child sex, birth order dummies, mother's age categories, race/ethnicity, educational attainment categories, marital status, indicator for father absent), county socioeconomic characteristics (pct of population of mother's race/ethnicity, poverty rate, median household income, unemployment rate), county healthcare supply (no. of hospitla beds and no. of obstetric-gynecologists per 1,000 females 15-44 years), and county of residence and year of birth fixed effects
6. % reports the mean change in the dependent variable if crime increased by 1 standard deviation, relative to the sample mean of the dependent variable
7. All 1st stage results are statistically significant at 0.01 level
8. *(**)(***) indicates statistical significance at 0.1(0.05)(0.01) level, respectively

Appendix Table 1: Within-County (Over Time) Variation in Crime Rate

Distribution of mean-deviated county crime rate

	Index crimes	Property crimes	Violent crimes	Murders	Rapes	Robberies	Aggravated assaults
Percentiles							
1%	0.049	0.047	0.005	0.000	0.000	0.001	0.004
5%	0.271	0.234	0.028	0.001	0.003	0.007	0.019
10%	0.498	0.458	0.053	0.001	0.006	0.016	0.042
25%	1.246	1.139	0.140	0.004	0.015	0.043	0.110
50%	2.675	2.458	0.336	0.009	0.033	0.101	0.268
75%	4.963	4.559	0.753	0.017	0.062	0.221	0.573
90%	8.300	7.519	1.388	0.030	0.110	0.434	1.039
95%	10.733	9.914	1.861	0.040	0.152	0.615	1.375
99%	17.105	15.660	2.723	0.085	0.272	1.076	2.053
Mean	3.768	3.409	0.562	0.014	0.049	0.177	0.426
Std. Dev.	3.785	3.445	0.631	0.024	0.061	0.224	0.476

Notes:

1. Crime rate is number of criminal offenses per 1,000 county residents

2. Mean-deviated county crime rate is the absolute value of (annual county crime rate - mean county crime rate over the study period)

Appendix Table 2A: Effect of Crime Rate on Infant Health Outcomes in Counties with High Degree of Variation in Crime Rate, by Type of Crime and Mother's Race/Ethnicity

	Birthweight < 2500 grams				Five-Minute Apgar Score < 7				Gestation < 37 weeks			
	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic
Index crimes												
	0.004	0.001	0.014	0.003	0.001	-0.001	0.003	-0.002	0.009*	0.007	0.022**	-0.003
	(0.003)	(0.004)	(0.008)	(0.008)	(0.003)	(0.003)	(0.005)	(0.006)	(0.005)	(0.005)	(0.011)	(0.008)
	0.2%	0.1%	0.5%	0.1%	0.3%	-0.1%	0.5%	-0.5%	0.3%	0.3%	0.6%	-0.1%
	1,464,221	720,781	275,097	373,136	1,363,624	688,493	264,252	321,519	1,460,183	719,494	274,491	371,361
Property crimes												
	0.005	0.002	0.017*	0.005	0.002	0.0001	0.003	0.001	0.011**	0.010*	0.024**	-0.001
	(0.003)	(0.004)	(0.010)	(0.009)	(0.003)	(0.003)	(0.006)	(0.006)	(0.005)	(0.006)	(0.011)	(0.009)
	1.2%	0.7%	2.5%	1.3%	2.0%	0.1%	2.2%	1.4%	1.7%	1.8%	2.6%	-0.1%
	1,446,970	728,914	265,491	359,962	1,331,137	691,012	253,534	301,259	1,441,998	727,291	264,819	357,775
Violent crimes												
	0.016	0.023	0.063	-0.005	-0.0005	0.004	-0.012	-0.020	0.033	0.019	0.061	0.079
	(0.022)	(0.024)	(0.053)	(0.038)	(0.016)	(0.016)	(0.028)	(0.031)	(0.033)	(0.033)	(0.068)	(0.063)
	0.8%	1.5%	2.1%	-0.2%	-0.1%	1.2%	-2.0%	-4.9%	1.0%	0.7%	1.5%	1.8%
	1,428,027	587,377	303,397	438,576	1,203,072	531,941	282,628	312,428	1,417,114	584,852	301,975	432,584
Murders												
	0.116	0.124	0.102	0.134	-0.001	0.043	-0.537	0.047	0.674	1.517*	1.213	-0.793
	(0.563)	(0.726)	(1.133)	(0.882)	(0.300)	(0.376)	(0.581)	(0.460)	(0.701)	(0.788)	(1.308)	(1.510)
	0.1%	0.2%	0.1%	0.2%	-0.005%	0.2%	-2.5%	0.3%	0.5%	1.1%	0.8%	-0.5%
	1,482,623	717,752	325,422	348,589	1,378,465	686,949	315,704	294,394	1,477,460	716,239	324,629	346,151
Rapes												
	-0.195	-0.013	-1.102*	-0.222	0.026	-0.100	0.096	0.732**	-0.097	-0.114	-0.457	0.445
	(0.151)	(0.175)	(0.583)	(0.415)	(0.123)	(0.115)	(0.368)	(0.315)	(0.201)	(0.224)	(0.677)	(0.543)
	-0.6%	-0.1%	-1.8%	-0.7%	0.3%	-1.5%	0.7%	9.7%	-0.2%	-0.3%	-0.5%	0.8%
	1,471,683	885,879	250,345	264,686	1,402,074	858,702	244,596	233,219	1,468,523	884,597	249,918	263,556
Robberies												
	0.051	0.028	0.190*	-0.026	0.060	0.100	0.054	-0.005	0.044	0.061	0.235	-0.150
	(0.063)	(0.067)	(0.110)	(0.108)	(0.062)	(0.063)	(0.083)	(0.106)	(0.105)	(0.119)	(0.171)	(0.196)
	1.0%	0.7%	2.7%	-0.5%	5.8%	11.2%	3.7%	-0.6%	0.5%	0.9%	2.4%	-1.5%
	1,432,233	604,679	358,156	372,043	1,262,231	556,140	338,335	289,941	1,424,217	602,669	356,895	368,042
Aggravated assaults												
	0.021	0.018	0.091	0.020	-0.003	0.000	-0.014	-0.018	0.052	0.028	0.108	0.126
	(0.026)	(0.031)	(0.065)	(0.046)	(0.019)	(0.019)	(0.038)	(0.040)	(0.040)	(0.040)	(0.084)	(0.087)
	0.7%	0.7%	1.9%	0.6%	-0.4%	-0.1%	-1.5%	-2.7%	1.0%	0.7%	1.7%	1.9%
	1,430,118	603,444	278,377	457,130	1,171,859	538,962	256,355	308,487	1,417,095	600,328	276,859	449,880

Notes:

1. Sample is 15% random sample of 2000-10 Natality Detail Files; restricted to singleton births
2. Crime rate is number of criminal offenses per 1,000 county residents
3. Outlier counties are those county-years where deviation from county-specific mean is in the 75th percentile
4. Each point estimate and associated standard error and sample size is obtained from a different regression
5. Regression controls for individual characteristics (child sex, birth order dummies, mother's age categories, race/ethnicity, educational attainment categories, marital status, indicator for father absent), county socioeconomic characteristics (pct of population of mother's race/ethnicity, poverty rate, median household income, unemployment rate), county healthcare supply (no. of hospitla beds and no. of obstetric-gynecologists per 1,000 females 15-44 years), year of birth fixed effects, and county of residence fixed effects
6. Standard errors are robust and clustered at county level
7. *(**)(***) indicates statistical significance at 0.1(0.05)(0.01) level, respectively

Appendix Table 2B: Effect of Crime Rate on Prenatal Healthcare and Health Behaviors in Counties with Degree of Variation in Crime Rate, by Type of Crime and Mother's Race/Ethnicity

	First-Trimester Prenatal Care Visit				Num. of Prenatal Care Visits				Weight Gain > 40 Pounds				Tobacco Use			
	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic	Overall	Non-Hispanic, White	Non-Hispanic, Black	Hispanic
Index crimes																
	-0.061**	-0.040*	-0.056	-0.159**	-0.001	0.000002	-0.004	-0.002	0.010	0.004	-0.003	0.021	0.004	0.008	0.010	0.002
	(0.030)	(0.021)	(0.037)	(0.067)	(0.003)	(0.002)	(0.004)	(0.006)	(0.012)	(0.013)	(0.013)	(0.028)	(0.008)	(0.009)	(0.016)	(0.007)
	-0.3%	-0.2%	-0.3%	-0.6%	-0.03%	0.0001%	-0.2%	-0.1%	0.2%	0.1%	-0.1%	0.4%	0.2%	0.2%	0.5%	0.2%
	1,415,888	702,537	261,946	360,052	1,410,978	699,149	260,954	359,708	1,343,144	677,907	252,139	328,250	1,350,716	672,811	251,256	337,651
Property crimes																
	-0.086***	-0.049**	-0.078*	-0.192***	-0.002	0.0002	-0.005	-0.005	0.010	0.002	0.002	0.031	0.003	0.008	0.015	-0.0003
	(0.033)	(0.023)	(0.040)	(0.073)	(0.003)	(0.002)	(0.004)	(0.007)	(0.013)	(0.013)	(0.015)	(0.033)	(0.009)	(0.010)	(0.017)	(0.008)
	-1.8%	-1.0%	-1.9%	-4.1%	-0.3%	0.04%	-0.9%	-0.7%	0.9%	0.1%	0.2%	2.9%	0.6%	1.0%	3.0%	-0.2%
	1,400,944	711,018	253,222	347,853	1,394,440	707,237	251,879	346,796	1,314,477	680,890	242,588	309,980	1,319,920	676,351	239,738	318,768
Violent crimes																
	-0.041	-0.170	-0.068	0.398	0.007	-0.004	0.017	0.040	0.045	0.041	-0.014	0.0002	0.068	0.047	0.153**	0.081*
	(0.197)	(0.114)	(0.271)	(0.317)	(0.020)	(0.017)	(0.031)	(0.025)	(0.079)	(0.082)	(0.085)	(0.143)	(0.047)	(0.063)	(0.068)	(0.046)
	-0.2%	-0.7%	-0.4%	1.3%	0.2%	-0.1%	0.6%	0.9%	0.8%	0.6%	-0.3%	0.003%	2.6%	1.2%	7.4%	9.8%
	1,379,019	572,385	289,089	422,240	1,379,188	570,821	289,421	423,282	1,185,867	524,595	269,510	318,949	1,171,135	509,546	265,851	320,670
Murders																
	-2.976	-2.654	-4.747	3.304	-1.159***	-0.778***	-1.508***	-0.617	1.677	0.806	1.470	2.582*	0.300	1.070	1.595	0.774
	(2.334)	(2.370)	(3.466)	(5.223)	(0.243)	(0.229)	(0.426)	(0.436)	(1.079)	(1.463)	(1.708)	(1.452)	(0.942)	(1.334)	(1.644)	(0.838)
	-0.3%	-0.2%	-0.7%	0.3%	-0.9%	-0.5%	-1.6%	-0.4%	0.7%	0.3%	0.9%	1.1%	0.2%	0.5%	2.2%	2.2%
	1,436,892	701,335	310,815	336,967	1,432,640	698,069	310,002	336,651	1,342,794	671,355	298,422	295,081	1,328,641	653,723	296,076	299,143
Rapes																
	-1.348*	-1.028	-2.854	-1.806	0.048	0.075	0.066	-0.055	0.202	0.124	-0.073	-0.121	0.075	0.143	0.444	-0.085
	(0.800)	(0.627)	(2.139)	(1.679)	(0.106)	(0.095)	(0.182)	(0.201)	(0.379)	(0.427)	(0.827)	(0.813)	(0.331)	(0.369)	(0.837)	(0.450)
	-0.4%	-0.3%	-0.8%	-0.5%	0.1%	0.1%	0.1%	-0.1%	0.2%	0.1%	-0.1%	-0.1%	0.1%	0.2%	0.9%	-0.5%
	1,430,590	867,380	239,345	255,725	1,426,774	862,971	238,882	256,890	1,365,743	839,268	231,376	233,177	1,320,274	812,809	219,750	224,813
Robberies																
	-1.116*	-0.873**	-0.994	-1.677	-0.095	-0.056	-0.059	-0.116	0.410*	0.164	0.233	1.074**	0.228*	0.231	0.436**	0.184*
	(0.625)	(0.425)	(0.656)	(1.070)	(0.066)	(0.057)	(0.076)	(0.093)	(0.222)	(0.278)	(0.190)	(0.443)	(0.125)	(0.167)	(0.190)	(0.106)
	-2.0%	-1.4%	-2.3%	-2.6%	-1.2%	-0.7%	-0.9%	-1.2%	3.0%	1.0%	2.0%	7.6%	3.8%	2.5%	8.7%	8.9%
	1,378,419	587,278	340,593	356,760	1,373,773	584,620	338,650	356,695	1,234,616	545,485	320,703	293,347	1,215,594	533,306	317,100	288,678
Aggravated assaults																
	0.091	-0.058	0.197	0.547*	0.013	0.002	0.038	0.047	-0.015	-0.051	0.030	-0.134	0.078	0.041	0.164	0.118*
	(0.207)	(0.129)	(0.338)	(0.311)	(0.022)	(0.020)	(0.040)	(0.029)	(0.101)	(0.097)	(0.121)	(0.179)	(0.063)	(0.080)	(0.101)	(0.065)
	0.2%	-0.2%	0.7%	1.2%	0.2%	0.05%	0.9%	0.7%	-0.2%	-0.5%	0.4%	-1.4%	1.8%	0.6%	4.9%	9.1%
	1,383,742	588,951	265,928	440,766	1,382,624	587,253	265,659	441,471	1,162,304	534,388	245,344	317,244	1,136,490	513,294	240,569	315,513

Notes:

1. Sample is 15% random sample of 2000-10 Natality Detail Files; restricted to singleton births
2. Crime rate is number of criminal offenses per 1,000 county residents
3. Outlier counties are those county-years where deviation from county-specific mean is in the 75th percentile
4. Each point estimate and associated standard error and sample size is obtained from a different regression
5. Regression controls for individual characteristics (child sex, birth order dummies, mother's age categories, race/ethnicity, educational attainment categories, marital status, indicator for father absent), county socioeconomic characteristics (pct of population of mother's race/ethnicity, poverty rate, median household income, unemployment rate), county healthcare supply (no. of hospitla beds and no. of obstetric-gynecologists per 1,000 females 15-44 years), year of birth fixed effects, and county of residence fixed effects
6. Standard errors are robust and clustered at county level
7. *(**)(***) indicates statistical significance at 0.1(0.05)(0.01) level, respectively