

Introduction

Low birth weight has an important effect on the long-term wellbeing of children. Not only is low birth weight the leading cause of infant mortality, but it is also related to reduced cognitive outcomes, higher school drop-out rates, and more health problems in childhood and adolescence (Corman and Chaikind 1998; Conley and Bennett 2000; Currie and Hyson 1999). The impact of infant health extends into adulthood, affecting health, economic wellbeing, and longevity over the lifecourse (Currie and Hyson 1999; Hack and Borawski 2002; Hayward and Gorman 2004; Rich-Edwards et al. 2005; Risnes et al. 2011). We have long known that neighborhood environment has a key role in shaping infant outcomes (Yankauer 1950). Studies have demonstrated that neighborhood poverty, segregation, residential instability, and violent crime are all linked to lower infant birthweights and a greater risk for being born low birth-weight (Buka 2003; Roberts 1997; O'Campo et al. 1997; Pearl, Braveman, and Abrams 2001; Rauh, Andrews, and Garfinkel 2001; Gorman 1999; Sloggett and Joshi 1994; Masi et al. 2007; Morenoff 2003). Violent crime, in particular, provides an important explanatory link between neighborhood economic disadvantage and infant health (Masi et al. 2007). One proposed mechanism suggests that exposure to crime may generate maternal stress, which in turn can lead to low birth weight (Messer et al. 2006). Indeed, fear of crime, has been associated with poor health (Chandola 2001) and maladaptive stress behaviors such as drinking (Stafford, Chandola, and Marmot 2007).

However, neighborhoods are constantly changing, which may have an effect on crime and its relation to birth weights. Gentrification is related to reductions of violent crime as a result of demands from the new affluent residents (Barton 2016b), including greater police presence and improved maintenance (Freeman 2006; Maurrasse 2006; Steinmetz-Wood et al. 2017). Further, gentrification is commonly found to add new resources ranging from more potentially healthy stores and restaurants seeking to capitalize on the new residents (or potential of new residents) (Sullivan 2014; Zukin et al. 2009).

However, gentrification is also a controversial force as for how we understand the wellbeing of residents within cities. The Center for Disease Control (CDC) warns that gentrification is associated with a number of poor health outcomes including greater stress as a result of potential displacement and loss of community (Center for Disease Control 2013). This stress can in turn lead to a number of different personal health disparities such as low birth weight. However, the relationship between gentrification and displacement has been debated (Brown-Saracino, 2017; Zuk et al., 2017). Nonetheless, various sources have argued that the *fear* of displacement due to the increase of housing costs can be a considerable source of stress (Center for Disease Control 2013; Huynh and Maroko 2014; Shmool et al. 2015). Further, gentrification has also been associated with higher rates of property crime (Papachristos et al. 2011), which may also contribute towards stress and poorer birth outcomes.

There is a lack of research which links gentrification to crime and birth outcomes. The existing research has found no overall relationship between pre-term births (Huynh and Maroko 2014); however, this null finding masks an adverse relationship for Non-Hispanic Black infants and protective effect for White and Hispanic infants. It is not clear how gentrification may moderate the effects of crime on birth outcomes.

One key reason for the inconsistency in the past investigations is the lack of consensus on gentrification is to be measured. While gentrification is commonly conceptualized along the lines of “the process by which higher income households displace lower income [households], changing the essential character and flavor of the neighborhood” (Kennedy and Leonard 2001, 5), it has various operationalizations, potentially measuring home value, rent, college education, and other factors. The neighborhoods counted as 'gentrifying' can vary widely depending on the kind of gentrification measured used (Barton 2016a). Thus, the measure used can affect the kinds of results to which one arrives. This study addresses these limitations by engaging within a number of different measures of gentrification to see how it relates to crime and birthweight.

Data and Methods

Our analyses estimate a series of logistic regression models, with standard errors clustered at the census tract level. Our independent variable of interest in these models is gentrification. We calculated gentrification with the 2000 Census and 2006-2010 American Community Survey. We are interested in comparing places that gentrified to those which had the potential, but so far have 'failed' to gentrify. By pairing gentrifying communities to non-gentrifying places, we could better determine how exclusive the disruptive effects of gentrification were to neighborhoods identified as gentrifying (Gibbons and Barton 2016). Gentrification is measured two ways in this study. First, we measure gentrification based on socio-economic change (Ding et al. 2015). Not gentrifiable tracts were those that featured a median household income above the citywide median in 2000. Gentrifiable neighborhoods had a median household income below the citywide median in 2000. A neighborhood was deemed gentrifying if it was determined gentrifiable in 2000 and experienced an increase in gross rent or median home value above the citywide median and an increase in college-educated residents above the citywide median over the time span. Non-gentrified neighborhoods were those deemed gentrifiable but failed to meet the criteria of gentrifying over the study time (reference group). Second, we included an income-driven measure of gentrification (Ellen and O'Regan 2011). This measure uses a ratio of average household income to the metropolitan area for every decade. The bottom two quintiles of this ratio for a metropolitan area are considered to be "low income." A gentrifying tract was one that was 'low income' time t_1 and had a 5% gain in their ratio by t_2 . A non-gentrifying tract failed to experience a measurable change.

Our dependent variable of interest in these models is low birthweight. Birth outcome data were obtained through a restricted data agreement with the California Department of Public Health. The data set we draw on for this study is the Birth Cohort File for 2009-2012, which includes standard birth certificate information (i.e. parental demographic characteristics, pregnancy conditions, mother's address, the sex and birthweight of the child) for all live births that were reported in California during the calendar years 2009 through 2012. Based on the birthweight data included in this file, we constructed a dichotomous measure of our key dependent variable of interest: low birthweight (0=greater than 2499 grams, 1=less than 2500 grams). We excluded from our sample all records with extreme values for birthweight (<500 grams or >5500 grams) or gestation length (<22 weeks or \geq 45 weeks).

Our analyses also control for a series of demographic characteristics and pregnancy conditions recorded in the Birth Cohort File. The demographic controls include: sex of child (0=male, 1=female), type of payer for birth (0=private insurance, 1=government, 2=self-pay,

3=other, 4=unattended, none, no charge, 5=missing), mother's race/ethnicity (0=Non-Hispanic White, 1=Non-Hispanic Black, 2=Non-Hispanic Other, 3=Hispanic, 4=Missing), father's race/ethnicity (0=Non-Hispanic White, 1=Non-Hispanic Black, 2=Non-Hispanic Other, 3=Hispanic, 4=Missing), mother's age (0=<20, 1=20-34, 2=35-39, 3=40+), mother's education level (0=<high school degree, 1=high school degree, 2=BA or more, 3=missing), nativity (0=foreign born, 1=U.S. born), parity (0=first birth, 1=low, 2=high), and pre-pregnancy BMI (0=underweight, 1=normal, 2=overweight, 3=obese, 4=missing). The pregnancy condition controls include: WIC participation (0=no, 1=yes, 2=missing), mother's smoking behavior during pregnancy (0=did not smoke, 1=smoked, 2=missing), weight gain during pregnancy (0=<16 lbs, 1=16-40 lbs, 2=>40 lbs, 3=missing), and adequacy of prenatal care (0=inadequate, 1=adequate, 2=intermediate, 3=adequate plus).

Lastly, our analyses control for local counts of violent crimes that occurred within one mile of each mother's address during her gestational period. The starting point of a gestational period was calculated by subtracting the number of gestation days reported in the Birth Cohort File from date of birth. Counts of violent crime were calculated based on incident-level crime data made publicly available in six-month intervals by the Los Angeles Police Department and archived, starting in 2009, by the *Los Angeles Times*'s "Mapping L.A." project. Incidents were geo-coded by the *L.A. Times* and classified by the *L.A. Times* as "aggravated assault," "burglary/theft from motor vehicle," "burglary," "grand theft," "homicide," "theft," "rape," "robbery," or "other" based on the most severe offense reported. We coded any crime classified as "aggravated assault," "homicide," "rape," or "robbery" as a violent crime and included it in our violent crime count. For each mother, we then used the violent crime geocodes to overlay violent crimes that occurred during the gestational period onto a map of the mother's geo-coded address. This allowed us to identify all violent crimes that occurred within a one-mile buffer of the mother's address during her gestational period.

Results

We report the coefficients for the focal predictors and interactions from our analysis in Table 1. These results are broken down by models which included a measure of gentrification based on socio-economics (Ding, Hwang, and Divringi 2015) and income (Ellen and O'Regan 2011). First, we find that both forms of measures of gentrification are not significant on their own. In other words, regardless of the measure there is no significant difference in how gentrifying and non-gentrifying neighborhoods relate to low birth weight compared to non-gentrifiable neighborhoods. However, with the introduction of the violent crime measure both forms of gentrification have significant and positive coefficients. There is some difference in the gentrification measure coefficients. Neighborhoods determined to be gentrifying based on socio-economic measures have a smaller coefficient compared to those which are not gentrifying. This suggests that gentrifying neighborhoods have less of a relationship to low birthweight compared to neighborhoods which are non-gentrifying. Meanwhile, neighborhoods which were determined to be gentrifying based on income measures have a higher coefficient compared to non-gentrifying neighborhoods, suggesting gentrification has more of an effect on low-birthweight compared to non-gentrifying neighborhoods. Also of note, violent crime has a significant and *negative* relationship to low-birthweight, although the magnitude of this coefficient is low suggesting this effect is limited.

Next, we find that gentrification significantly interacts with violent crime, regardless of the measure, though the magnitude is again low. This interaction does reveal some differences between gentrification measurement type. While socio-economic gentrification does not have significance with this interaction, the income-based measure of gentrification maintains its significance.

Discussion

These results reveal some unexpended findings. Gentrification independently has no relationship with low birth weights. As opposed to offsetting crime, we find instead that the positive effect of local crime appears to suppress the adverse effect of living in a gentrified/gentrifiable neighborhood on birth outcomes. This relationship is further unpacked with the interactions, which show that violent crime has more of an adverse effect on birthweight solely in areas measured to be gentrified based on income. The relationship of gentrification to crime calls us to question the previous assumptions about gentrification's negative relationship to violent crime (Barton 2016b), calling for more research.

The relationship between gentrification and crime may have less to do with crime rates themselves and instead with gentrification's effects onto neighborhoods. For one, gentrification may have a relationship with stress that would make residents more vulnerable to crime's effects (Center for Disease Control 2013). Alternatively, gentrification has been cited for its effects in weakening the overall community bonds (Schlichtman, Patch, and Hill 2017). However, we do not have sufficient data to verify either of these possibilities. Nonetheless, these results make important contributions to how we understand gentrification's relationship to health. These findings offer some support to the view that gentrification can be detrimental to health, though the exact nature of gentrification's effects are related to how the gentrification is measured.

Table 1. Select OLS Results of Low Birth weight and Gentrification Type

	Socio-Economic			Income		
	(1)	(2)	(3)	(4)	(5)	(6)
Gentrification Status (Ref: Not Gentrifiable)						
Gentrifying	0.009	0.185***	0.040	-0.018	0.268***	0.182***
Not Gentrifying	0.033	0.037	0.062	0.027	0.040	0.056
Violent Crime	0.047	0.276***	0.118***	-0.011	0.245***	0.158
Gentrifying X Violent Crime	0.030	0.038	0.055	0.046	0.056	0.095
Not Gentrifying X Violent Crime		-0.001***	-0.003***		-0.001***	-0.001***
Gentrifying X Violent Crime		0.000	0.001		0.001	0.001
Not Gentrifying X Violent Crime			0.002***			0.001*
Log Likelihood			0.001			0.003
			0.002***			0.001
			0.001			0.001
	-37589.11	-37475.078	-37456.920	-37590.537	-37476.095	-37470.887

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