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Early lead exposure (< 3 years old) prospectively predicts fourth grade school suspension in Milwaukee, Wisconsin (USA) ☆, ☆ ☆



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ABSTRACT

School suspensions are associated with negative student outcomes. Environmental lead exposure increases hyperactivity and sensory defensiveness, two traits likely to increase classroom misbehavior and subsequent discipline. Childhood Blood Lead Level (BLL) test results categorized urban fourth graders as exposed (2687; lifetime max BLL 10–20 µg/dL) or unexposed (1076; no lifetime BLL ≥ 5 µg/dL). Exposed children were over twice as likely as unexposed children to be suspended (OR=2.66, 95% CI=[2.12, 3.32]), controlling for covariates. African American children were more likely to be suspended than white children, but lead exposure explained 23% of the racial discipline gap. These results suggest that different rates of environmental lead exposure may contribute to the racial discipline gap.

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1. Introduction

One of the most frequently used disciplinary actions in United States schools is suspension. Nationally, approximately 1 out of 14 public school students (7%) are suspended each year (Planty et al., 2009), although variability between individual schools is high. In a comprehensive review of school disciplinary data in the state of Colorado for the years 2008–2010, Pflieger and Wiley (2012) found that out-of-school suspensions were the most commonly used form of discipline (53% of all actions taken), and in-school suspensions were the second most common (32%).

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Several quantitative studies have raised questions about the long term negative effects of suspension on students. Even after controlling for a variety of individual, family, and community level risk factors, students who receive one or more suspensions are at greater risk for dropping out of high school, compared to students who have never been suspended (Suh et al., 2007; Lee et al., 2011; Arcia, 2006). The number of times a student is suspended has been shown to be negatively related to subsequent reading achievement (Arcia, 2006). Negative consequences associated with suspension are not limited to educational outcomes, but extend to health and public safety as well. Using a longitudinal design and controlling for covariates, Hemphill et al. (2012) found that students suspended from school during the previous year were roughly twice as likely to use tobacco 12 months later as were students who had not been suspended. School suspension has also been found to be a strong predictor of violent behavior one year later (Hemphill et al., 2009).

African American students in the United States are suspended at higher rates than white students. The 2009–2010 Civil Rights Data Collection, a nationally representative survey of approximately 7000 school districts and more than 72,000 schools conducted annually by the U.S. Department of Education, found

that both African American boys and girls were three times more likely to receive an out of school suspension than their white peers (Office for Civil Rights, 2012). Similarly to national rates, in Colorado Pflieger and Wiley (2012) found that 17% of African American students received at least one disciplinary action, compared to 11% of Latino students and 7% of white students. Although the cause of the racial disparity in student suspension rates is unclear, three broad, non-exclusive hypotheses exist. The *differential behavior* hypothesis suggests that students from disproportionately suspended groups participate in misbehavior at higher rates than white students. The *differential selection* hypothesis suggests they are more likely to be subject to discipline than are white students committing the same offense. The *differential processing* hypothesis suggests the disparity is the result of more severe punishment for African American, Latino, and Native American students committing the same offense as white students. Gregory et al. (2010) reviewed the literature and found evidence suggesting that all three hypotheses may be correct.

Partial support for each was also found in McCarthy and Hoge (1987), which drew on findings from the domain of juvenile justice to suggest that consideration of factors other than the offending behavior itself may bias school officials in the process of discipline. Using longitudinal data from six public schools in a mid-Atlantic city, McCarthy and Hoge (1987) found that a student's likelihood of being suspended was primarily influenced by the seriousness of their misconduct, followed by the number of disciplinary incidents they had been involved in the previous year, followed by their grades, followed by their teacher-rated demeanor. When those four constructs were included in a regression, measures of race, gender, and socio-economic status were no longer significant predictors of suspension. However, although in their model a student's race was not directly predictive of suspensions, race was still correlated with student-level variables that were directly predictive of suspensions. African American students in their sample had poorer grades and were perceived by teachers as less well behaved, resulting in a greater number of prior disciplinary incidents, which predicted a higher likelihood of future suspension.

McCarthy and Hoge's (1987) results link the racial disparity in suspension rates to the racial achievement gap, and push the question of causality from "why are African American students suspended at higher rates" to "why do African American students have (1) poorer grades and (2) worse behavior as perceived by teachers?" One causal variable that has recently received attention as a partial contributor to both academic achievement and perception of student behavior, which is more prevalent in non-Hispanic black children than children from other groups in the United States, is environmental lead exposure (Jones et al., 2009; Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP), 2012; Wheeler and Brown, 2013).

Several studies have demonstrated a negative relationship between lead exposure during the first years of life and subsequent school exam scores. With a sample of students enrolled in Milwaukee, Wisconsin, public schools, Amato et al. (2012) found that moderately elevated blood lead levels (BLL) during development were associated with end-of-grade exam deficits at 4th grade in reading, mathematics, language arts, science, and social studies. Similar negative relationships between lead exposure and standardized test scores have been found in New Orleans (Zahran et al., 2009), in North Carolina (Miranda et al., 2007), in New York State (Strayhorn and Strayhorn, 2012), and in Massachusetts (Reyes, 2011).

There is also reason to believe that children exposed to elevated BLLs may be perceived by teachers as less well behaved than unexposed children. Pioneering work by Needleman and colleagues found a negative association between dentine lead and

teacher-rated classroom behavior in a sample of 3329 first and second grade students in Massachusetts (Needleman et al., 1979). More recently, lead exposure has been linked to increased risk of an Attention Deficit Hyperactivity Disorder diagnosis (Braun et al., 2006), and increased risk of a Learning or Behavioral Exception Designation (Miranda et al., 2010) in children. Those epidemiological results are supported by animal research, which suggest that disrupted sensory gating processes may be the neurological mechanism by which lead exposure reduces attention and focus (Moore et al., 2008). Students who have difficulty paying attention and controlling their impulses are likely to be disruptive in class, increasing the likelihood that their teacher will perceive them as poorly behaved. A survey of middle and high school students who had been suspended found that a majority attributed their suspension to a lack of self-control (Costenbader and Markson, 1998).

The current study examines student-level disciplinary data for 4th graders in an urban school district to investigate the role of childhood lead exposure in the racial discipline gap. We operationalize the discipline gap using an unduplicated suspension count, which is the most common operationalization among the studies cited above. An unduplicated count provides a binary classification of students into those never suspended, and those suspended one or more times. We use a series of logistic regressions to model the relationship between lead exposure and school suspension, and the extent to which apparent racial differences in suspension rates can be attributed to differences in exposure.

2. Method

2.1. Participants

We used data from the Wisconsin Childhood Lead Poisoning Prevention Project (WCLPPP) to identify children who had a maximum blood lead test result during the first 3 years of life indicating either moderate exposure (*exposed group*: $BLL \geq 10 \mu\text{g}/\text{dl}$ and $< 20 \mu\text{g}/\text{dl}$), or a maximum test result indicating low or unquantifiable exposure (*unexposed group*: $BLL < 5 \mu\text{g}/\text{dl}$). We chose to examine data from children who resided in Milwaukee at the time of their blood test because Milwaukee (1) is the largest city in Wisconsin, providing an adequate sample size, and (2) has the highest prevalence of childhood lead poisoning (6.1%) of any municipality in the state (Wisconsin Department of Health and Family Services [DHFS], 2008). The protocol for this study was approved by the University of Wisconsin–Madison Education Research Institutional Review Board.

The upper bound of the exposed group was operationalized based on the level required for state mandated intervention in Wisconsin as well as several neighboring states ($20 \mu\text{g}/\text{dl}$); although many counties and municipalities intervene at lower levels. The lower bound was chosen based on the Centers for Disease Control and Prevention (CDC) Level of Concern at the time of data collection ($10 \mu\text{g}/\text{dl}$). In 2012 the CDC accepted the recommendation of the Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP, 2012), and replaced the previous level of concern ($10 \text{mg}/\text{dL}$) with a new reference value calculated every 4 years as the 97.5th percentile of BLLs in the two most recent National Health and Nutrition Examination Survey datasets. This change was made in response to an accumulation of evidence that there is no safe level of lead exposure (Centers for Disease Control and Prevention (CDC), 2012), with the effect of increasing the number of children that the CDC considers at risk for negative consequences of lead exposure. Although the criteria used to create the sample of exposed children in the current study do not reflect the new CDC reference value, they nonetheless demarcate a range of BLLs that are above the reference value but below the level required for state mandated intervention, and represent a group of children that may be considered "moderately exposed".

2.2. Data

Blood lead data were available because health care providers and laboratories are required to report all BLL results to WCLPPP. There is substantial variation in the limits of quantification (LOQ) established by individual laboratories. The Wisconsin State Laboratory of Hygiene (WSLH), which analyzes more than one-quarter of all samples, established an LOQ of $5 \mu\text{g}/\text{dl}$ for all blood lead analysis prior to 2000, and we used this to anchor the low end of the quantifiable lead exposure spectrum. Although the WSLH has lowered their LOQ since 2000, there remains a high degree of uncertainty in individual results at BLL concentrations below $5 \mu\text{g}/\text{dl}$. The CDC

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