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Evaluating the effectiveness of state specific lead-based paint hazard risk reduction laws in preventing recurring incidences of lead poisoning in children[☆]



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ABSTRACT

Background: Despite significant progress made in recent decades in preventing childhood lead poisoning in the United States through the control or elimination of lead sources in the environment, it continues to be an issue in many communities, primarily in low-income communities with a large percentage of deteriorating housing built before the elimination of lead in residential paint. The purpose of this study is to determine whether state laws aimed at preventing childhood lead poisoning are also effective in preventing recurring lead poisoning among children previously poisoned.

Methods: An evaluation was conducted to determine whether laws in two representative states, Massachusetts and Ohio, have been effective in preventing recurrent lead poisoning among children less than 72 months of age previously poisoned, compared to a representative state (Mississippi) which at the time of the study had yet to develop legislation to prevent childhood lead poisoning.

Results: Compared to no legislation, unadjusted estimates showed children less than 72 months old, living in Massachusetts, previously identified as being lead poisoned, were 73% less likely to develop recurrent lead poisoning. However, this statistically significant association did not remain after controlling for other confounding variables. We did not find such a significant association when analyzing data from Ohio.

Conclusions: While findings from unadjusted estimates indicated that state lead laws such as those in Massachusetts may be effective at preventing recurrent lead poisoning among young children, small numbers may have attenuated the power to obtain statistical significance during multivariate analysis. Our findings did not provide evidence that state lead laws, such as those in Ohio, were effective in preventing recurrent lead poisoning among young children. Further studies may be needed to confirm these findings.

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Introduction

Despite the significant progress made in recent decades in preventing childhood lead poisoning in the United States through the elimination of lead in paint and fuel, lead poisoning continues to

Abbreviations: CDC, Centers for Disease Control and Prevention; CLPPP, Childhood Lead Poisoning and Prevention Program; CBLS, Childhood Blood Lead Surveillance; EBLL, elevated blood lead level; HHLPPP, Healthy Homes and Lead Poisoning Prevention Program; MA, Massachusetts; MS, Mississippi; OH, Ohio.

[☆] The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the Centers for Disease Control and Prevention and the Agency for Toxic Substances and Disease Registry.

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be a problem in some communities, primarily low-income communities with a large percentage of deteriorating housing built before the elimination of lead in paint. Several community based randomized controlled trials have been conducted to examine the effectiveness of dust control (Lanphear et al., 1996a), soil abatement (Weitzman et al., 1993) and health education (Brown et al., 2006) in reducing blood lead levels (BLLs) among children living in urban neighborhoods with high incidence of childhood lead poisoning. Results suggest that these interventions did not significantly lower BLLs. Results from meta-analyses also seems to suggest that there's insufficient evidence that these interventions are effective in reducing blood lead levels in children (Yeoh et al., 2014).

In the two studies that examined the effectiveness of a state specific lead paint hazard risk reduction law in either preventing new cases of childhood lead poisoning in housing where previous cases

were identified (primary prevention) or in preventing recurring incidences of childhood lead poisoning among previously-poisoned children (secondary prevention), the evidence suggests that laws are effective in controlling or eliminating lead hazards found in housing units where previous hazards were observed (Brown et al., 2001; Korfmacher et al., 2012).

In 2009, 27 (64%) of 42 state health departments with lead poisoning prevention programs funded by the Centers for Disease Control and Prevention (CDC), implemented specific laws aimed at reducing or eliminating childhood lead poisoning. We conducted a study to examine the effectiveness of the lead risk reduction laws in two such states: Massachusetts (MA) and Ohio (OH). Both states have specific laws aimed at preventing or decreasing lead poisoning among children living in housing built prior to 1978 (i.e., when lead-based paint was banned from residential use in the US). Mississippi (MS), which does not have laws requiring lead hazard abatement even for housing where children with lead poisoning have been identified, served as the control state for comparison in this study. These three states were selected based on their willingness to participate in the study and, in the case of the two lead law states, on the strength of their lead laws and the length of time that these laws had been enacted (prior to 2000 for MA, and since 2004 for OH).

The Massachusetts Lead Law, promulgated in 1971 and amended in 1987 and 1993, focuses on primary and secondary prevention and requires disciplinary action at several levels. The owner of a dwelling occupied by children less than six (6) years of age and found to have lead-based paint hazards is responsible for complying with measures to contain or abate all such hazards in and around the residence, regardless of the BLL of the resident children. The owner is held liable for any damages sustained by a child who is lead poisoned due to the owner's failure to comply with provisions to contain or abate lead paint hazards (LPPCR, 2011).

The Ohio law, enacted in 2004, stipulates that when a child is identified as lead poisoned, the Ohio Department of Health may enter the suspected offending dwelling with the permission of the occupant or owner, or can obtain a court order to enter the property if the occupant or owner does not grant permission, to conduct a risk assessment at the property. If the risk assessment reveals lead hazards, a lead hazard control order may be issued, and until the time at which a clearance examination has been passed, the control order may include a requirement that occupants vacate the unit. The owner or manager can choose a method of controlling each lead hazard, which must be approved by the Ohio Department of Health. Criminal and civil action can be taken if any licensing or work practice requirements are violated in the course of correcting lead hazards (Law Writer, 2005).

While there is evidence suggesting that state laws aimed at primary prevention of lead poisoning among children less than 72 months of age have been effective in achieving this goal (Brown et al., 2001; Kennedy et al., 2014), no evidence was available at the time of this study demonstrating these laws were also effective in preventing recurrent poisoning in children who were previously poisoned. This study therefore sought to determine whether state laws aimed at preventing lead poisoning among young children were also effective in preventing recurring lead poisoning among those poisoned previously.

Methods

Design and data sources

CDC conducted a cross-sectional study to examine the effectiveness of the lead risk reduction laws in preventing recurring lead poisoning among confirmed cases in the two states with

laws requiring control of lead paint hazards in housing with a child who meets the state definition of childhood lead poisoning (Massachusetts and Ohio) compared to the state without lead laws (Mississippi). Previously published evidence using this data suggests that lead risk reduction laws were effective in primary prevention of lead poisoning among young children (Kennedy et al., 2014). The methods used in the acquisition of data used in this study have been described elsewhere (Kennedy et al., 2014). Briefly, data for this study were obtained through examination of records from the Childhood Blood Lead Surveillance (CBLIS) database. The CBLIS is the central repository of blood lead surveillance data, submitted on a quarterly basis by state and local childhood lead Poisoning Prevention Programs (CLPPPs), who are supported through cooperative agreement with the CDC. Data provided to the CBLIS include results of blood lead tests performed by public and private clinical laboratories as well as case management and environmental data.

The definition of a lead poisoned case was based on a state-specified threshold that would have triggered an environmental investigation. In MA, $BLL \geq 25 \mu\text{g/dL}$ would have triggered an environmental investigation, whereas in MS and OH, $BLL \geq 15 \mu\text{g/dL}$ was the threshold value. Each case file was randomly selected to give each child an equal opportunity of being selected into the study. The specific method used for randomization has been described elsewhere (Kennedy et al., 2014).

Institutional Review Board (IRB) approvals or waivers were sought for and obtained from the Centers for Disease Control and Prevention, the Battelle Memorial Institute, the Massachusetts Department of Public Health, the Mississippi State Department of Health and the Ohio Department of Health. All statistical analyses of study data were conducted using SAS[®] version 9.3, SAS Institute, Cary N.C.

Variable definitions

The following variable definitions were used during analyses.

Lead poisoning: Because this analysis examines whether the rates of recurring lead poisoning among previously-poisoned children are declining as a result of actions taken under existing state lead laws, the term "lead poisoning" has a specific meaning in this report. Here, a child is determined to be "lead poisoned" if his or her blood lead concentration is at or above a specified threshold set by the state in which the child resides, for which an environmental investigation would be deemed necessary. For the three states considered in this study, the threshold levels for determining lead poisoning are as follows:

- Massachusetts: $\geq 25 \mu\text{g/dL}$,
- Ohio: $\geq 15 \mu\text{g/dL}$, and
- Mississippi (the control state): $\geq 15 \mu\text{g/dL}$.

Confirmed case of lead poisoning: Based on the outcome of a specific blood sample analysis, a child is classified as a "confirmed" lead poisoning case if the blood lead measurement is at or above the threshold level of the state in which the child resides. The sample must also satisfy one of the following two criteria: the blood sample was collected using venous technique or the sample was collected using capillary techniques and the measurement associated with a previous capillary blood sample, collected no more than 12 weeks (84 days) earlier, and is at or above the state threshold. If the blood lead measurement was lower for the venous sample, deference was always given to the venous blood lead sample.

Recurrent lead poisoning: Any identified lead poisoning case occurring over 2 or more non-consecutive years.

Cohort year: The year in which a confirmed case of lead poisoning was selected for this study is labeled the case's "cohort year." A child could be selected as a case multiple times, corresponding to

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