Lead Exposure, Socioeconomic Status, and Cognitive Disparities

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Abstract

Do socioeconomic status and family circumstances mediate the adverse effects of childhood lead poisoning? Or put more precisely, holding early-life lead exposure constant, do individuals from disadvantaged backgrounds exhibit more serious cognitive and behavioral deficits than individuals from more privileged backgrounds? Using a unique data set that links U.S. army recruits to early life circumstances and random lead exposure among the urban population, we show that the answer to both of these questions is yes. Our estimating strategy exploits a non-monotonic relationship between the pH of drinking water and the water’s lead content. Understanding how early-life conditions mitigate or worsen the adverse consequences of environmental insults, particularly those arising from lead, contributes to our understanding of the economics of human capital formation and the continuity of human capital stocks across generations.
1. Introduction

This paper begins with a simple question: do socioeconomic status and family circumstances mediate the adverse effects of childhood lead poisoning? Or put more precisely, holding early-life lead exposure constant, do individuals from disadvantaged backgrounds exhibit more serious cognitive and behavioral deficits than individuals from more privileged backgrounds? Although these questions might seem better suited to the public health literature, understanding how early-life conditions mitigate or worsen the adverse consequences of environmental insults, particularly those arising from lead, contributes to our understanding of the economics of human capital formation and the continuity of human capital stocks across generations.

Recent economic research documents how gaps in cognitive and behavioral skills early in life persist into adulthood and how those gaps explain a large portion of the observed black-white wage deficit ( ). The significance of such premarket factors in sustaining social and economic inequality has been recognized since the War on Poverty. More recently, Heckman (2008) has called for policy interventions designed specifically for very-young at risk children. Blanden et al. (2007) even suggest that cognitive and non-cognitive skills partly explain the persistence in income observed across generations.

Genetic differences explain very little of the persistence in cognitive ability over time and across generations. Fryer and Levitt (forthcoming) show that for children eight to twelve months in age, there are small differences in cognitive ability across groups, and these differences quickly disappear once a small set of controls is included in the regressions. Differences in cognitive ability emerge only after children age and are exposed to different environmental conditions. Fryer and Levitt hypothesize that as environmental disadvantages and shocks accumulate, cognitive disparities widen.

Recent research implicates family structure and parental education in shaping the accumulation of human capital among children and perpetuating cognitive and educational disparities across generations. Black et al. (2010) show that unexpected changes in family size as caused by the birth of twins adversely affects intelligence, but other types of variation in the number of siblings has little impact on cognitive ability. Controlling for family-specific fixed effects with sibling pairs, multiple studies demonstrate that childhood health is a strong and significant predictor of adult well-being, including educational attainment and cognitive ability.\(^1\)

A parallel line of research uses birthweight as an indicator of health early in life and finds similar patterns (Black et al.; ). The available evidence suggests that children from poor socioeconomic backgrounds are more adversely affected by poor health, not because they have greater difficulty recovering from those shocks, but because the greater number of shocks they receive impedes their ability to recover from any one shock (Case, Lubotsky, and Paxson 2002; _______________________.

\(^1\)See, in particular, Case and Paxson (2008a, 2008b, 2009, and 2010), Parman (2010), and Schick and Steckel (2010). See also, Smith (2007).
Currie and Stabile 2003). Like Fryer and Levitt, this evidence suggests that as children age and physiological insults accumulate, cognitive disparities widen.

Among economists, there has been surprisingly little attention given to the possibility that environmental factors that impact health could even partly explain the cognitive disparities across socioeconomic groups. Yet there are many intuitive reasons to believe that children from disadvantaged families would be more vulnerable to environmental degradation than other groups, and not all of these reasons include residential choice and location. Accordingly, in this paper, we consider how and to what extent environmental lead exposure helped propagate socioeconomic differences in cognitive skills and educational attainment.

The novelty of our effort, however, resides not only in the question we consider, but also in the data we construct and the estimating strategy we employ, the combination of which allows us to identify and exploit a source of random variation in lead exposure. In nearly every previous study that we are aware of, it has been impossible to cleanly identify the effects of environmental lead exposure because exposure is in part a function of socioeconomic characteristics that might also influence intelligence and decisions to invest in education. This same phenomenon also confounds attempts to isolate and compare the consequences of lead exposure across socioeconomic groups.

We motivate our empirical analysis by appealing to two separate bodies of lead research. The first area of research involves a series of laboratory experiments where rats from enriched environments and deprived environments were randomly assigned to lead exposure or no lead exposure. Lead was transmitted to the treated rats through drinking water. Rats in enriched environments shared cages with other rats while deprived rats were isolated. Rats in enriched environments also had access to water mazes, exercise wheels, and/or other environmental stimuli. Strikingly, the neurological processing of lead-poisoned rats from enriched environments did not differ significantly (or differed relatively slightly) from that of non-lead-poisoned rats from enriched environments; large neurological disparities only emerged in rats from deprived environments. There is also suggestive evidence that diet might attenuate the neurotoxic effects of lead in laboratory animals.

The second relevant area of lead research—the area that allows us to make an argument for random assignment in lead exposure—has to do with the interaction between the pH of local water supplies and the pervasive use of lead plumbing in buildings constructed before 1970. Because lead plumbing was ubiquitous and non-neutral water supplies had the capacity to dissolve and absorb lead, pH was the single most important determinant of how much lead a person was exposed to through drinking water and historically drinking water was likely the single most important source of lead exposure ( ). Acidic and highly alkaline water supplies (i.e., those with a pH less than or much greater than 7) dissolved more lead from the interior of plumbing fixtures than did more neutral water supplies. This suggests a U-shaped relationship between water pH and water-related lead-exposure, and therefore, an inverted U-shaped relationship between water pH and intelligence.

Central to the analysis that follows is the claim that households were randomly assigned to water supplies with varying levels of pH. This claim is based on three observations
documented below. First, few individuals understood the chemistry behind water-related lead poisoning, and fewer still altered their locational choices because of it. Second, the threshold for what was considered a safe level of lead exposure during the early twentieth century was orders of magnitude higher than what is considered safe today, so that even individuals highly attuned to health issues and the dangers of lead considered water-related lead exposure a minor concern. Third, we can show that, within states, observable characteristics (e.g., father’s occupational status and maternal literacy) do not predict the alkalinity of a family’s water supply. Put another way, the data are consistent with random assignment across observable characteristics.