Air Quality and Children's Health: A Call for Serious Action

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Introduction

According to the World Health Organization, it is estimated that in 2016, 600,000 children died from acute lower respiratory infection caused by polluted air[1]. On a domestic scale, in the United States, approximately 8.3% of children had asthma in 2016[2]. The health impacts of air pollution are pervasive, ranging from acute respiratory infection to permanent, adverse neurodevelopment. Children are the most sensitive population to air pollution as they are not only developmentally vulnerable but are also exposed to higher levels of air pollutants than adults in similar environments[3]. While the health outcomes are alarming, the human capital lost as a result of missing days of school or direct health costs only further highlight the ubiquitous impact of exposure to air pollution in childhood[4]. Rising temperatures and fossil fuel combustion are not only actors in climate change but also work to increase levels of air pollutants. The health risks observed for children will only continue to worsen if air pollutant levels are not mitigated. The purpose of this policy brief is to synthesize what we know about the health and social impacts of air pollution on children, analyze currently policy efforts, and propose new policy recommendations to address this public health risk.

Background

Causes of Air Pollution

In 2018, the US emitted an estimated 76 million tons of pollution into the atmosphere[5]. The most abundant components of air pollution are nitrogen dioxide (NO_2), ozone (O_3), and fine particulate matter ($PM_{2.5}$)[5]. When considering the sources of these pollutants, fingers are generally pointed to industrial emissions. 80% of air pollutants are emitted from combusting hydrocarbons like coal and gasoline for electricity production, heating, and transportation[7]. Energy-related fossil fuel combustion also generates 85% of $PM_{2.5}$ and nearly all NO_2 emission[6]. While it is true that power plants are major sources of sulfur and nitrogen dioxide that lead to the formation of O_3 and $PM_{2.5}$, other climate change factors are also at play[4]. Climate change affects air quality through weather's ability to create more pollution. Ozone, for example, can be formed by the combination of heat and volatile organic compounds and nitrogen oxides[4]. Thus, as we see increasing temperatures each year, we can expect to see an increase in ozone levels.

Air Pollution Trends Over Time

Annual pollutant emissions have decreased over time. According to the Environmental Protection Agency (EPA), between 1980 and 2018, total emissions of the six principal air pollutants dropped by 68 percent[5]. However, despite these improvements in air quality, in 2018, approximately 137 million people in the US lived in counties with pollution levels above the National Ambient Air Quality Standards[5]. Recent analysis of EPA data in a working paper in the National Bureau of Economic Research found that $PM_{2.5}$ levels increased 5.5 percent on average nationwide between 2016 and 2018, after decreasing nearly 25 percent over the past 7 years[8]. This increase was associated with an estimated 10,000 additional premature deaths over the two-year period. This is a cause of concern for many, especially given the proposed weakening or rollbacks on environmental safeguards by the Trump administration[9].

Impacts of Air Pollution

A few questions raised thus far might be: why are children more at risk of negative health outcomes from pollution, and more importantly, how are these pollutants impacting health? Mechanistically, children are at a greater risk of exposure to air pollution as a result of their naïve respiratory and immune systems. Children, breathing mostly through their mouths, bypassing nasal filtration systems, do so at a faster rate than adults, inhaling a higher volume of air per kilogram of body weight[10]. Children also spend more time outside, experiencing more pollutant exposure time and are generally closer to the ground, where particulate matter concentrations are higher[10]. In regard to pollutant impact on health, ozone primarily affects the body by irritating the lungs, causing shortness of breath, coughing, and further aggravating lung diseases such as asthma[4]. $PM_{2.5}$ can infiltrate deep into the lungs, passing into the bloodstream and affecting both respiratory and cardiovascular function, inducing heart attacks or irregular heart beats[4]. To paint a clearer picture, a study conducted on 5443 Korean children aged 6-14 years during 2005-2006 suggested that exposure to traffic-induced air pollution may be associated with heightened risk of asthma, allergic rhinitis, and allergic sensitization[11].

Other than respiratory health, a growing body of work provides evidence of the neurodevelopmental effects of exposure to combustion-related air pollution. Various studies have associated exposure to $PM_{2.5}$, NO_2, and other air pollutants with serious negative effects on brain development including deficits in intelligence, memory, and behavior[12]. The estimated annual cost, from medical care and lost economic productivity, as a result of environmentally mediated neurodevelopmental disorders in US children is $74.3 billion[12]. Exposure to polycyclic hydrocarbons, a component of $PM_{2.5}$, during fetal development not only negatively effects cognitive and behavioral outcomes but these outcomes are magnified by material hardship or maternal demoralization[12]. While this brief does not go into depth on this aspect, it is worth noting that pollution is not a random process. A review of numerous studies by Hajat et al. consistently show that low SES individuals and communities are exposed to higher concentrations of air pollutants and are therefore more at risk of severe health outcomes[13]. For example, depending on residency location, average outdoor NO_2 levels are 38% greater for people of color than non-Hispanic white individuals[14]. Reducing concentrations to the level experienced by white individuals would reduce ischemic heart disease mortality by approximately 7,000 deaths per year[14]. Higher pollutant concentrations as well as economic and familial hardships further compound the negative health outcomes that we see in low income communities. This is an important note to consider when deciding where to implement policy interventions and which populations these interventions might affect.

Past Policies Targeting Air Pollution

Given the pervasive nature of air pollution, the most famous policy to date is the Clean Air Act. The Clean Air Act of 1970 set standards for six pollutants, many of which are highlighted in this brief, including NO_2, O_3, and $PM_{2.5}$. The act delineated requirements regarding the implementation of air quality programs and expanded the enforcement of motor vehicle emissions limits[15]. Even though the Clean Air Act is a federal policy that sets air quality standards in the U.S., states write their own State Implementation Plan (SIP) that outlines how they will monitor air pollution in the state.

The EPA must approve the SIP, ensuring it is in compliance with EPA requirements, otherwise states face sanctions[15]. The autonomy states have regarding how they will reduce emissions gives rise to a variety of solutions, most notably California's cap and trade system, implemented in 2013. This market-based approach caps the amount that a company is allowed to pollute while giving polluters the ability to trade caps. The equity of this system, however, has been called into question. A recent study by Cushing et al. found that facilities regulated under the California cap-and-trade system are not only disproportionately located in disadvantaged neighborhoods, but the most regulated facilities reported higher annual average local emissions after initiation of trading, even though the total emissions remained under the cap[16]. Although emission reductions could significantly improve air quality and health benefits for California's disadvantaged residents, the state's cap and trade program has yet to produce such localized advances in environmental equity[16].

Current Policy Interventions

To date there are no policies that address air quality as it pertains specifically to child health. Despite lobbying from the fossil fuel industry and other special interest groups, many measures have been implemented or proposed that target air quality. The most recent proposal is the Green New Deal. A joint resolution put forth by Representative Alexandria Ocasio-Cortez and Senator Ed Markey, the proposal has an ambitious set of goals including direct climate action and adaptive measures such as reaching zero emissions from the power sector in the next 10 years[17]. On a more local scale, a few states have implemented their own climate measures, including Illinois' Future Energy Jobs Act (effective June 1, 2017) that among other things, sets new energy efficiency standards and creates jobs, supporting the local economy[18]. In 2017, California enacted the Buy Clean Law that requires the state to prioritize companies that limit climate pollution throughout their supply chain when the state spends taxpayer dollars on steel, glass, and insulation for infrastructure projects[18].

Policy Recommendations

While there have been efforts in the past to alleviate air pollution and improve air quality, there is still considerable work to be done. A movement towards more dramatic measures is necessary if we want to reverse the damage of air pollution and improve the health of children. Given the brevity of this policy brief, two recommendations will be discussed in order of priority, but it should be noted that there are many possible solutions and states are working to implement their own interventions.

The first recommendation is for state and local governments to move towards alternative sources of energy for transportation. States should transition to zero-emission transportation plans for both passenger and goods movement. Significant reductions in transportation related air pollution are possible and can be enhanced with public policies as demonstrated by reduction in air pollution in California from transportation sources[19].

The second recommendation is for regional air pollution control agencies to restrict allowing new sources of combustion-related air pollutants near residential areas and sensitive populations. Considering the history and evidence of disadvantaged communities located in or nearby heavily polluted areas, better land use and siting guidelines should be implemented to avoid poor land use choices. The implementation of better land use guidelines would reduce

children's exposure to combustion-related pollutants[9].

Ultimately, with the advent of climate change and the panic and partisanship that has entrenched policy discussions, we must not forget who these policies, or absence of, affects. The health of children, a vulnerable population without a political voice, rests in our hands.

Additional Resources

- Environmental Protection Agency https://www.epa.gov/
- WHO Report on Air Pollution and Child Health https://www.who.int/ceh/publications/air-pollution-child-health/en/
- Green New Deal https://www.dataforprogress.org/green-new-deal-report
- Take Action with Sierra Club https://www.sierraclub.org/take-action

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