Prenatal exposure to Air Pollution and Birth Weight: A Review

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ABSTRACT

Background: Low birth weight has been associated with many negative health outcomes which pose a burden on the infant, the family of the infant, and the healthcare system. Identifying possible exposures and risk factors is a crucial step in helping to establish preventative measures.
Objective: The objective of this literature review was to determine if there is an association between prenatal exposure to air pollution and decreased birth weight (DBW) and/ or low birth weight (LBW).
Methods: This literature review utilized several online databases to collect research articles. After applying exclusion criteria and removing duplicates, only 30 articles were reviewed.
Results: A majority of the 30 articles reviewed supported the positive relationship of prenatal exposure to air pollution with LBW and DBW. The most common pollutants shown to have a positive association to both LBW and DBW across multiple studies include $PM_{2.5}$, PM_{10}, CO, SO_2, and NO_2. Furthermore, other articles found an insignificant relationship or no relationship between prenatal exposure to air pollution and LBW or DBW.
Conclusion: There is a general consensus in the literature that prenatal exposure to air pollution is associated with both LBW and DBW. This is a finding that should fuel future interventions and policy development.

INTRODUCTION

Research Question
- Does prenatal exposure to air pollution increase the likelihood of LBW or DBW?

Background and Rationale
- Many recent studies have drawn a link between exposure to air pollution and likelihood of decreased or LBW (<2500 g). LBW has been associated with negative outcomes. For instance, low and very low birth weight has been associated with many debilitating conditions such as cerebral palsy (Stanley, 1992), and deafness (Cristobal & Oghalai, 2008) respectively. Likewise LBW infants have more difficulty reaching developmental milestones which was concluded to be a predictor of emotional and behavioral problems in childhood and adolescence (Liu, Sun, Neiderhiser, Uchiyama, & Okawa, 2001).

- The incidence of LBW babies is increasing. In 2004, 8.1 %of all newborns in the U.S. were LBW, the highest rate reported since 1969. This was also a 16% increase from 1990 (Martin et al., 2006). This increasing rate is important to consider when examining the cost of LBW. The costs associated with LBW create a large burden on the health care system. LBW infant stays averaged $15100, with an average length of stay of 12.9 days compared to $600 and 1.9 days for uncomplicated newborns (Russell et al., 2007). This can pose many problems for the health care system.

- This research will investigate the link between exposure to air pollution and LBW or DBW. These findings may be useful when examining current regulations and may have implications for policy reform. Potential suggestions regarding policy will be addressed in the discussion.

METHODS

Study Design
- A structured literature review was carried out to assess the relationship between prenatal exposure to air pollution and LBW or DBW.

Search Strategy
- Four major databases were searched to collect the relevant literature addressing this relationship. These databases include: PubMed, CINAHL (Ebsco), Scopus and Web of Science. The search terms used to locate articles on the databases were “prenatal exposure air pollution” and “low birth weight”.

Exclusion Criteria
The first set of exclusion criteria was as follows:
Articles before the year 2000, articles not written in English, qualitative studies, editorials, expert opinions, and articles not accessible online.
The second set of exclusion criteria was:
Articles concerning smoking or tobacco exposure, articles concerning indoor air pollution, and articles concerning preterm birth or adverse birth outcomes without specifically evaluating LBW or DBW.

Analysis

Figure 1: Overview of search and article selection.

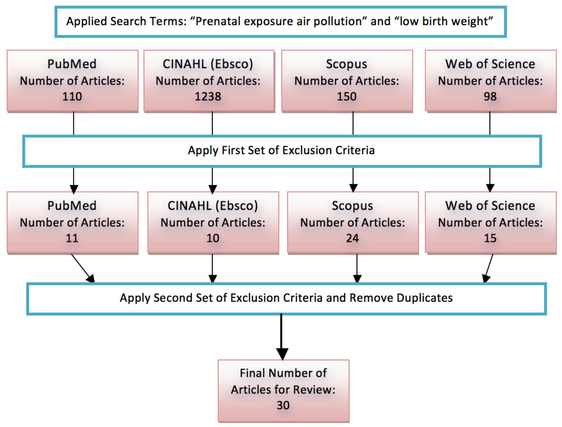


Figure 1 illustrates the screening process of the literature review. After applying exclusion criteria 30 articles were left for review. These articles were then read in full and summarized into **Table 1** for easier data extraction.

METHODS

Table 1: Article review table for data extraction

Article Title	
Summary	Summary for quick referencing
Type of air pollutant	What kind (s) of air pollutant is study assessing (ex: $CO2$, NO_2)
Methodology of study	**a) COHORT DATA:** **b) POLLUTION DATA:** **c) STATISTICAL ANALYSIS:**
Results	Impact of each air pollutant on low birth weight
Conclusion	Suggested areas for further research
Limitations	Limitations of the study

Among the 30 articles, there were 12 air pollutant categories that were assessed for each article. The 12 categories are $PM_{2.5}$ (particulate matter 2.5 microns in diameter or less) , PM_{10} (particulate matter 10 microns in diameter or less), CO, NO_2, SO_2, Hydrocarbons, NO, NO_X, O_3, TAP (traffic air pollution), PWF(pollution from wildfire), and BC (black carbon). These are pollutants that appeared in the selected 30 articles. For each article and pollutant, the relationship was assessed and labeled as POS (positive association between exposure and LBW/ DBW), NEG (negative association between exposure and LBW/ DBW), NO (No association between exposure and LBW/ DBW) or N/A (not applicable indicates that the specific air pollutant was not assessed in that particular study). In total, 16 articles assessed LBW as an outcome and 14 articles focused on DBW.

- Since 12 pollutants were evaluated for all 30 studies a total of 360 relationships were assessed. 192 of these relationships were assessed for LBW (16 articles x 12 pollutants)
- 168 relationships were assessed for DBW (14 articles x 12 pollutants)

RESULTS

Results suggest that there is a positive association between exposure to air pollution and LBW/ DBW. $PM_{2.5}$, PM_{10}, NO_2,SO_2, and CO were the most frequently assessed pollutants that had an association to LBW and DBW.

Figure 2: Associations between Signficant Air Pollutants and Low Birth Weight (LBW)

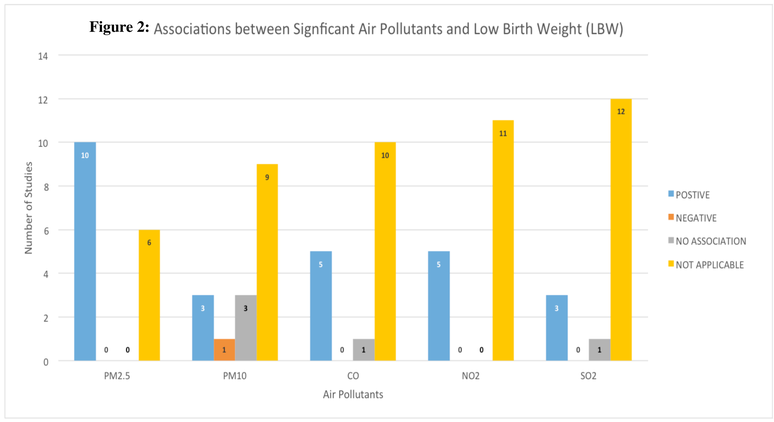
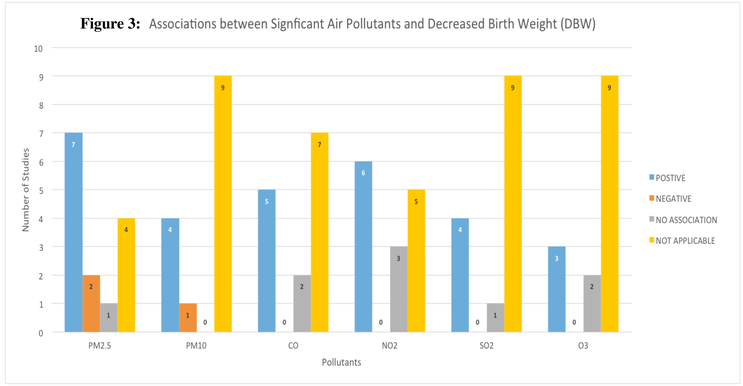


Figure 2 illustrates the positive association between LBW and exposure to the five significant pollutants previously mentioned ($PM_{2.5}$, PM_{10}, NO_2, SO_2, and CO). Only one negative association was found when examining PM_{10}.

Figure 3: Associations between Signficant Air Pollutants and Decreased Birth Weight (DBW)



As shown in **Figure 3**, there were many positive associations between pollutant exposure to the five significant pollutants previously mentioned ($PM_{2.5}$, PM_{10}, NO_2, SO_2, and CO) and DBW. Additionally, there was a moderate positive association with between O_3 an DBW.

Chris Carroll/Corbis, [photograph of an infant on a scale] Retrieved December 2nd 2015 from http://www.theguardian.com/society/2011/jul/13/asthma-pregnant-complications-low-birth-weight

[Untitled image of industrial pollution] retrieved on December 2nd 2015 from https://www.dosomething.org/facts/11-facts-about-pollution

DISCUSSION

- There were few instances in where a negative association between LBW/DBW and pollutant exposure was observed. These were outliers and often contradicted by other studies.

- A common limitation between most studies was the assumption that maternal residence did not change during pregnancy. Data on residential mobility for most study subjects was not available to assess the extent to which this assumption is true.

- In the case of air pollution, a clear and understandable description of exposure creates some particular difficulties: the data collected depends exclusively on outdoor measurements of pollutants. But, such measurements are subject to biases because most people spend much more of their time indoors than out, and air pollutant concentrations are often much higher inside buildings than outside (Spengler, Letz& Sexton 1983). In addition, available evidence indicates that personal exposure to many pollutants is not adequately characterized because the time people spend in different locations and their activities vary dramatically with age, gender, occupation, and socioeconomic status (Spengler, Letz& Sexton 1983). Accurate estimates of human exposure to inhaled air pollutants are necessary for a realistic appraisal of the risks these pollutants pose, and for the design/ implementation of strategies to control and limit those risks. Except in occupational settings, such estimates are usually based on measurements of pollutant concentrations in outside (ambient) air, recorded with outdoor fixed-site monitors (Watson, Bates & Kennedy, 1988)

- Lastly, limitations of our literature review: limited resources (ex. Time), generalization (if the pollutants effected any specific trimester, it was not specified, just categorized as positive association)

- After looking at studies on improving air pollution control policies; recycling, composting and landfilling, seems to be an effective solution for dealing with municipal solid waste (MSW- a major environmental problem globally) in Vientiane to decrease air pollution. It is also environmentally friendly (Babel & Vilaysouk, 2015).

- Similarly, to mitigate serious air pollution, the State Council of China propagated the cost-effective Air Pollution Prevention and Control Action Plan in 2013 (Gao et al., 2016). First, enhancing overall treatment and reducing discharges of multiple pollutants. Second, adjusting and optimizing industrial structure and promoting upgrade of economic transition. Third, speeding up technological reform of enterprises and improving the capability of scientific innovation. Finally, quickening the step to adjust energy structure and increase the supply of clean energy. These findings may have significant implications for improving China's air pollution prevention policy. By using these methods and implementing them all over the world, overall air quality can be improved.

- Likewise, local initiatives can be taken. This may include setting tolls throughout cities to encourage car pooling or the use of public transportation. This can help decrease motor vehicle emissions. Similarly, as previously mentioned, recycling is also a very easy and cost effective method in decreasing air pollution and municipal solid waste.

CONCLUSION

- Most studies reviewed indicated that air pollution is associated with low birth weight (LBW) and/ or DBW. The most common air pollutants assessed included pm2.5, pm10, CO, SO2, and NO2. Exposure to all of these, had a positive association to LBW/DBW. In other words, there is substantial evidence supporting an association between prenatal exposure to air pollution and LBW and/or DBW.

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