



4-1-2019

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### Recommended Citation

Garner, Lyndsay, "Does Living in a Rural vs an Urban Environment During Childhood Increase the Risk of Developing or Exacerbating Asthma?" (2019). *Physician's Assistant Program Capstones*. 18.

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**Does Living in a Rural vs an Urban Environment During Childhood Increase the Risk of  
Developing or Exacerbating Asthma?**

By

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Capstone Project

Submitted to the Faculty of the  
Department of Physician Assistant Education  
of University of the Pacific  
in partial fulfilment of the requirements  
for the degree of  
MASTER OF PHYSICIAN ASSISTANT STUDIES

April, 2019

## INTRODUCTION

Asthma in children is an ongoing concern because it is one of the most common chronic diseases in childhood. Asthma is characterized by reversible airway obstruction, airway inflammation, and increased airway reactivity to different types of stimuli.<sup>1</sup> Symptoms can range from wheezing and coughing to chest pain and breathlessness. It can be classified further by the severity of the disease and the frequency of symptoms. Diagnosing asthma in children under five years of age is difficult due to the fact they are not able to use a spirometer effectively. When using spirometry, the diagnosis of asthma is confirmed when the patients' symptoms and spirometric results improve post an inhaled bronchodilator, such as albuterol. Management of symptoms includes pulmonary inhalers containing bronchodilators and, in children with more persistent symptoms, corticosteroids. In addition, determining the types of exposures is important in order to elucidate factors that may precipitate asthma exacerbations. After potential triggers are identified and isolated, the overall treatment can be focused on avoiding those factors as much as possible.

Known triggers for asthma exacerbations include tobacco smoke, indoor and outdoor allergens, cold weather, and exercise. The correlation between higher environmental pollutants and an increased number of asthma incidents has led to the premise that a polluted environment is a trigger for asthma. Some common components of environmental pollutants are known as "particulate matter," which can affect the lungs differently depending on their size, smaller size (PM<sub>2.5</sub>) or larger size (PM<sub>10</sub>). Thus, different levels and types of environmental pollutants may affect the incidence of asthma and the frequency of asthma exacerbations. Research comparing urban and rural environments versus rural only environments in children with asthma may

provide evidence to guide disease management. The purpose of such comparisons would be to determine which environment is more likely to cause children to develop asthma or to experience increased frequency of severe asthma exacerbations. This identification of environmental conditions that are associated with new onset or exacerbation of asthma will help stratify patients' asthma risks depending on the climate and environment in which they live.

## **DISCUSSION**

Medical literature that explored the relationship between asthma and differing environments was reviewed. The majority of the studies available involved case-control, cross-sectional studies and systematic reviews. Evidence revolving around this topic is contradictory, including the effects of rural and urban environment on asthma as well as the effects of air pollution on asthma exacerbations, was inconclusive.

### **The Effects of Rural versus Non-Rural on Asthma**

Two cross-sectional studies analyzed together, GABRIELA and PARSIFAL, investigated whether growing up in a farming environment protected children from asthma and atopy. Children between the ages of six to thirteen years old were included. Both studies had large sample sizes which helped fortify the results. Questionnaires were used to assess for asthma and allergies based on the diagnosis of asthma by a doctor or a diagnosis of wheezy bronchitis. PARSIFAL used samples of mattress dust and GABRIELA used settled dust in the children's rooms, both from children in rural and suburban areas. The dust from both studies were analyzed for bacteria and fungus. However, GABRIELA was limited because the analysis of the bacteria was a broad assessment on Gram's stain and morphology, not able to be refined further. The evidence in this study involving PARSIFAL and GABRIELA showed that children who lived in more rural areas

such as farms had a lower incidence of asthma and atopy. In addition, an inverse relationship between microbial exposure and the risk of asthma was found, showing the protective effect due to microbial exposure.<sup>2</sup> Similar findings were discovered in a cross-sectional study done in Finland on a large sample size of students aged eighteen to twenty-four years old. The effects of farm, rural non-farm and urban environments on asthma were assessed by sending postal questionnaires to the students who fit their criteria. Although limited by possible recall bias, the evidence showed that those persons who spent their childhood in a farm environment experienced a reduced risk of diagnosed asthma.<sup>3</sup>

Some research showed that living in a rural environment protected against asthma whereas other investigators evidence showed the opposite. A cross-sectional study done in China with a large sample size assessed the relationship between ambient PM<sub>2.5</sub> levels with asthma and allergic diseases in preschool children. The results in this cross-sectional study indicated that non-urban areas had a higher risk of PM<sub>2.5</sub> exposure and worse indoor air pollution due to the burning of organic materials.<sup>4</sup> This exposure was associated with an increased risk of asthma due to long-term exposure to PM<sub>2.5</sub>. This study was limited because wheezing was not assessed in the participants. Wheezing is one of the main symptoms of asthma, which could affect the results.

The age at which a child is exposed to an environment may also play a role. A large population-based case-control study in California investigated whether the timing of environmental exposures in early life was associated with the development of asthma by five years of age. The gathering of diagnoses of asthma was done through questionnaires sent to parents of children either in non-urban or urban environments. The odds ratios showed that proximity to herbicide, pesticide, farm animal and crops resulted in the largest occurrences of

children with early-onset persistent asthma.<sup>5</sup> This finding suggests that farming environmental exposures increased the risk of asthma in these children. Limitations in this study included possible inaccurate recall by the parents during assessment and lack of information on exposures such as fungi, molds, and gas stoves. Another study done in Portugal evaluated the incidence of asthma and the risk factors among infants and preschoolers. This cross-sectional study assessed over one-thousand children from seventeen different nursery schools by using a questionnaire given to the parents of the children. The results revealed that children living in non-rural areas compared to rural areas had a higher chance of developing asthma.<sup>6</sup> Although this study had a large sample size over a diverse range of nurseries, there may have been recall bias from the parents.

### **The Effects of an Urban Environment on Asthma**

The urban environment has also been shown to have an effect on the lungs of children. A case control study performed in Kuala Lumpur researched the association between air pollutants and the occurrence of asthma in children. A modified questionnaire from the International Study of Asthma and Allergies in Childhood was used for data. Although this study was unable to generalize the findings due to a small sample size of the population, the results indicated that children who live within 200 meters of heavy traffic compared to those who live in rural areas are at an increased risk of asthma.<sup>7</sup> In Malaysia, road traffic has the most impact on air pollution in urban areas. A systematic review of multiple cross-sectional, cohort and longitudinal studies from many countries aimed at studying how traffic-related air pollution has an effect on lung function in children and adolescents ranging from the age of four to twenty-four. This systematic review chose a wide variety of relevant key words but did not account for publication bias. The

evidence showed a negative impact on lung function from traffic-related air pollution and early exposure as well as lifetime exposure to PM<sub>10</sub> and NO<sub>2</sub>.<sup>8</sup> An interesting result in this study is that moving to less polluted areas may help the lungs somewhat recover from the effects of pollution. This hypothesis that moving to a less polluted area will have a positive effect on lungs will need further research in order to test its accuracy and external validity.

### **The Effects of Air Pollution on Asthma Exacerbations**

Whether different environments affected asthma can be determined by assessing the frequency of asthma exacerbations as well as the diagnoses of asthma. A systematic review across multiple cities in the United Kingdom assessed risk factors for asthma to identify children at the highest risk for asthma exacerbation. Children with a diagnosis of asthma between the ages of five and twelve were assessed. Overall the study analyzed a large number of articles with respect to major risk factors for asthma exacerbations. The results revealed that the greatest risk factors involved previous asthma attacks, persistent symptoms and poor access to care.<sup>9</sup> In addition to these risks, a slightly increased risk of asthma attacks was found in children who lived in an urban residence close to a major road. However, this study was limited by the small sample of urban residents.

In a systematic review, a large sample of children from eight different cities in North America was examined over long periods for the frequency of asthma exacerbations relative to five different air pollutants. Despite the possibility of seasonal confounding, the results indicated that urban environments may be associated with asthma more than rural environments due to the mobile-source emissions which involved motor vehicles, trains, and airplanes.<sup>10</sup> Another meta-analysis assessed the relationship between outdoor air pollutants with moderate to severe

asthma exacerbations in children and adults. Although a potential bias may have occurred due to non-randomization of the case-crossover observational study, the strength was in the design of the study which discovered increased asthma exacerbations in children with exposure to NO<sub>2</sub>, SO<sub>2</sub>, and PM<sub>2.5</sub> which are pollutants mainly found in urban environments.<sup>11</sup>

### **Summary of evidence**

The studies analyzed ranged from conflicting to similar outcomes. The two cross-sectional studies, GABRIELA and PARSIFAL, and the Finland study revealed the same conclusion that children growing up in a farming environment have a decreased risk for developing asthma. On the other hand, the cross-sectional study done in China and the large California cross-sectional study both concluded that a non-urban environment has an increased risk for developing asthma.

In urban environments, the study in Kuala Lumpur and the large systematic review across multiple countries both resulted in an increased risk of asthma for children who live close to heavy traffic. The evidence from the study in Portugal also signified an increased risk of developing asthma in non-rural environments. In addition, the various studies analyzed for asthma exacerbations all indicated a higher chance of having an asthma exacerbation if one lives in an urban environment, especially close to major roads.

### **CONCLUSION**

Determining the risk factors for asthma is difficult to study since most of the information is gathered through observation instead of double-blinded, randomized controlled trials. Filtering the environmental factors to fully identify and isolate which parts have an effect on asthma is necessary but challenging. While an answer based on the evidence in these studies is not



definitive, the results do suggest that the rural environment has a reduced rate of asthma when compared to the urban environment. For better quality evidence, more research on the environmental effect on asthma needs to be conducted with prospective, rather than retrospective studies. A prospective design will be complicated due to all of the possible confounding factors, which would be difficult to control. Each study would need to focus on a different, specific element in order to provide a more accurate answer.

While more studies are needed for examining the development of asthma in different environments, the evidence from the available studies indicated that living in an urban environment had a higher risk for asthma exacerbations. Thus, children or adults with diagnosed asthma should be encouraged to live away from highly polluted cities.

Understanding the role of environment in the development and exacerbation of asthma is helpful for the prevention and control of asthma. Clinicians can encourage patients and parents to live in areas that will not predispose to asthma or exacerbate its symptoms. Furthermore, knowing which environments have detrimental effects on the lungs can aid environmental groups in their efforts to expand research for air quality improvement. This increased knowledge of environment on asthma will not only enhance an asthmatic patient's quality of life for both children and adults but it may even prevent asthma from occurring.

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