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CONCISE REVIEW

Minimal Difference in the Prevalence of Asthma in the Urban and Rural Environment

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Abstract: Multiple risk factors can be modified to decrease asthma incidence. It is important to understand early risks to decrease exposure to harmful conditions in the environment that can trigger asthma which may not be clinically evident in children until they reach adulthood. A retrospective literature review of articles on the prevalence of asthma in the urban versus rural environment was initiated in order to understand the effect of the environment on asthma. The urban-living effect is a global problem in the face of growing population, industrialization and pollution. The socioeconomic dichotomy in the urban versus rural environment also affects access and quality of health care.

Articles reviewed had differences in the urban versus rural prevalence of asthma. However, further analysis of specific risk factors and socioeconomic trends that increased susceptibility to asthma was the same in these studies. Some rural areas may have similar environmental and socioeconomic issues that place them at the same risk for the development of asthma as their urban counterparts.

Urban locations generally tend to have the prototype environment that can lead to the predisposition of asthma. Ultimately, the incidence of asthma can be decreased if these environmental and socioeconomic issues are addressed. However, every effort is needed from the level of the individual to the community at large.

Keywords: asthma, disparities, environment, rural, urban, allergens, prevalence, pollution, socioeconomic, healthcare

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Introduction

Asthma accounts for 13.9 million outpatient visits, 2 million Emergency Department (ED) visits, 500,000 hospitalizations and 5,000 deaths annually.[1] The environment has increased the risk for the development of asthma. Pollution from industrial chemicals, exhaust from vehicles, crowded living conditions, infection and bioterrorism are all environmental factors that have contributed to this sensitization.

Despite all these risk factors in the urban environment, the research articles reviewed showed mixed results in the prevalence of asthma in urban versus rural areas. However, the overall consensus is that environmental factors and socioeconomic issues predispose people to asthma. The hygiene hypothesis states that early exposure to infection for children may actually confer an advantage by regulating the immune system to protect against allergies.[2]

An Urban versus Rural Phenomenon

There were different outcomes on the prevalence of asthma in the literature reviewed. In Mississippi there were higher asthma hospitalizations in the rural Delta region compared to the urban Jackson, Mississippi metropolitan area.[3] However, another study in Maryland showed highest rates of ED visits for asthma in urban areas; Baltimore city had 2.4 times the national rate of asthma hospitalizations for 5–14 year olds in 1990.[4] There was no difference in asthma prevalence in rural and urban areas in Arkansas.[5]

In Mississippi the lower socioeconomic group resides in the rural region. Many of the urban living patterns were seen in the rural Delta region of Mississippi such as the limited access to health care, pollution, and other environmental factors.

In Arkansas, the use of health services was the same between the rural and urban group, but asthma morbidity was greater in the rural group; 85 percent of rural and 67 percent of urban children were black and 78 percent of rural and 37 percent of urban children had insurance from the state.[5]

The rural children in Arkansas were more commonly diagnosed with chronic bronchitis and likely to report moderate to severe asthma symptoms as compared to urban children.[5] The lower socioeconomic group in Arkansas resided in the rural areas and there may be some cultural and health plan barriers in the medical care that may account for the discrepancy in morbidity. Minorities make up the majority of the government health care plans that may limit preventive care or referral to specialists to curtail costs; this has resulted in higher mortality due to increased hospitalization rates and poor health care.[6]

Internationally, the prevalence of asthma related symptoms were higher among those adolescents living in the urban centers in comparison to the rural ones in Brazil.[7] Furthermore, rural Chinese children had significantly lower prevalence of asthma and atopic sensitization than urban children, using the validated ISAAC (International Study of Asthma and Allergies in Childhood) questionnaire and objective skin-prick tests.[8]

In Tamil Nadu, India, there was a higher prevalence of 'breathing difficulty' and nocturnal cough among urban children in the age group of 6–12 years.[9] A large study in a pediatric Medicaid population found that the rural children had increased asthma prevalence and similar asthma morbidity compared with urban children.[10] The prevalence of asthma in adults living in the rural areas of the Kirikkale Region in Central Turkey was significantly higher than that in the urban population.[11] In this study of 12,270 from Turkey, the prevalence of asthma was more common in rural areas than in urban areas (10.8 percent vs. 6.2 percent).

Furthermore, a recent European study from Cyprus showed that the prevalence of current wheeze nearly doubled between 2000 and 2008 in rural areas (5.4 percent vs. 9.7 percent) while no significant change was observed in urban areas (7.5 percent vs. 8.4 percent).[12] A study from Egypt showed the rural school children who had higher exposure to farm animals and who were fed on farm milk, had less allergic symptoms.[13] Rural students showed higher FEV_1, FEV_1 percentages and significant FVC versus urban students.[13] These results support the hygiene theory, ie, endotoxin exposure could be protective to asthma and atopy in school children.[13] On the other hand, a study in Mexico City found that an exposure to particulate matter at the level of 2.5 resulted in acute airway inflammation and decrease in lung function in both asthmatic and non-asthmatic children.[14]

Additionally, a Korean study that looked at 1819 elementary school students, and air pollution in metropolitan (Seongbuk), and semirural (Andong) areas found no significant difference in the prevalence of self-reported asthma.[15]

The data from various studies on the prevalence of asthma has been summarized in Table 1. The high costs of medications or copayments by federal health plans lower patient compliance. Studies have also shown that minorities may receive less inhaled corticosteroids or controller medications than Caucasians. Physicians need to practice evidence based medicine and avoid cultural stereotypes during clinical assessment and treatment.

Baltimore, Maryland, the prototype of the urban living environment, had the typical city living conditions, lower socioeconomic class and pollution. However, the suburban Howard County, Maryland also had high asthma ED visits. This affluent county is between two metropolitan centers and has a major interstate that increases exposure to exhaust from automobiles and other industrial chemicals.[4] This county also has a growing population, but the specific factors that led to increased suburban ED visits for asthma was not further investigated by this study. In fact, the article states that an urban environment alone cannot explain increased ED visits for asthma.[4]

A recent study found that the frequent use of the ED reflected the urban social issues of poverty, homelessness, chronic illness and alcohol abuse.[16] In addition, evidence suggests that the higher number of hospital admissions and ED visits may partially be due to the problems faced by single parents with limited resources in properly managing their child's asthma condition.[17]

A study in Texas showed that the majority of asthmatics who presented to the Texas ED Asthma Surveillance project's participating EDs were subclassified as having mild-acute severity and mild-intermittent chronic disease. The majority of these patients (almost up to one third) did not have health insurance.[18] In Baltimore, wealthy suburban counties were found to have the higher risk of an asthma ED visit.[19] Children from rural counties had fewer ED asthma related visits than children from urban and suburban counties.[19]

After reviewing the literature, it appears that places that share similar environmental and socioeconomic risk factors have a higher prevalence of asthma regardless of whether it is in a rural or urban location. In other words, some rural areas may have similar living conditions and socioeconomic situation that are comparable to the prototype urban environment (pollution, higher population, etc).

However, in most places urban areas tend to have the environmental risk factors that predispose populations to asthma. Other areas have unfortunately experienced bioterrorism that will have long-term health consequences.

Chinatown, New York experienced high asthma rates post 9/11.[20] Evidence suggests that the environment may affect an individual's genetic susceptibility for asthma and hay fever development at different ages inducing changes in the prevalence of atopic diseases in populations in a time- and age-dependent way.[21]

There are multiple factors that play a role in the development of asthma. Certain occupations may expose people to chemicals or other irritants that can

Table 1. Comparison of asthma prevalence in urban vs. rural populations based on symptoms.

Study author	Asthma symptoms studied	Urban	Rural	Total population	Statistical analysis
Chakravarthy et al[9]	Wheezing during the past 12 months	92 % (104/114)	77% (30/39)	153	$P < 0.01$
Solé et al[7]	Wheezy last 12 months	18.6% (497/2674)	12.5% (44/352)	3026	OR 1.6 (1.15–2.22)
Ma Y et al[8]	Wheezy last 12 months	7.2% (509)	1.1% (71)	7077	$P < 0.0001$
Lum EY et al[30]	Based on ICD-9 classification	87% (2671)	13% (401)	3072	$P < 0.01$
Pesek et al[5]	Wheezing	35%	46%		$P < 0.001$
Valet et al[10]	ICD-9	11% (12,878)	13% (15,220)	117,080	$P < 0.001$
Ekici et al[11]	Wheezing	6.2% (760)	10.8% (1325)	12,270	$P < 0.0001$
Kolokotroni et al[12]	Wheezing last 12 months	8.4% (186)	9.7% (215)	2216	$P = 0.04$
Morcos et al[13]	Wheezy last 12 months	40	40	80	OR 5.16; 95% [CI], 0.95–28
Hwang et al[15]	Wheezing	12.8% (232)	13.6% (247)	1819	OR = 2.12

cause permanent lung damage. Others may have a genetic predisposition to the development of asthma.

The decreased incidence of asthma and allergy in European farming children has to do with a genetic variation of toll like receptor 2.[2] There is also the protective farming effect that explains a lower risk of asthma due to close contact with large animals; there is Th-2 thymocyte suppression and Th-1 stimulation that reduces IgE production (prevents allergies) secondary to bacterial endotoxin exposure in the air from animals.[2] However, this type of farming environment is not common now in the United States due to increased industrialization and growing populations.

Currently, the increased risk of asthma is supported by an urban living effect.[22] Increased ED visits may also be due to lack of outpatient follow-up with primary care doctors. Some people who may benefit from referral to a specialist for asthma care may not be able to do so under their health care plan.

Environmental Factors in the Pathogenesis of Asthma

The pollution in urban environments can decrease lung growth and function by narrowing the airways; the pathogenesis of the effect of pollution on the airways may be caused by enzymes from dust mites that harm the lining of the airway and cause narrowing.[2]

Children may remain asymptomatic despite these changes. Decreased FEF50 is a more accurate indicator of small airway disease in urban residents exposed to pollution; children exposed to more pollution have lower FVC and decreased FEV_1 by the time they become adults.[2] The longer the duration of exposure, the more the lung damage.

In a study in Greece, eight to 10 year old children were followed into adolescence and watched for the development of asthma; there was no difference in asthma prevalence in the rural versus urban areas.[22] The urban children may have underlying air disease secondary to the pollution even though they may not have any clinical manifestation of disease. A limitation in the research was loss of follow-up on a number of students who were not present after graduation. There may be a higher prevalence of asthma in urban adult residents as symptoms become evident with longer duration of exposure.

Socioeconomic Factors and Access to Health Care

Forty one million Americans were uninsured in 2009 and asthma costs reached 37 billion dollars in 2007.[23] State Children's Health Insurance Plan (SCHIP), community health centers and quality improvement programs have already made some difference in management of asthma. Asthma mortality appears to be highest in the African American and Hispanic population than in Caucasians.[24]

Asthma prevalence is 39 percent higher in African Americans than in Caucasians in general and 20–25 percent higher in the ED setting.[1] There are increased recurrent ED visits from asthmatics that are non-white and have a low social economic status.[25] Racial disparities in asthma status and management practices exist in managed Medicaid populations. Disparities are also based on geographical distribution. There is a greater asthma prevalence in the urban setting (7.1 percent) than in the rural setting (5.7 percent) and in a low social economic status (9.8 percent) with incomes lower than $15 000 compared to 5.9 percent prevalence in incomes greater than $75 000.[26] A number of states have decreased Medicaid eligibility and lowered prescription drug benefits to save money; federal health plans like Medicare may refer less to specialists and preventive care in order to control budgets.[6] Disparities can affect parameters such as adherence to medication compliance which can be a problem among low-income and minority patients. Inhaled corticosteroid use in African-Americans is sometimes less than half compared to Caucasians due to lack of compliance.[27]

Preventable Asthma Risk Factors

Interventions to control asthma rates are critical. Changes in the areas of recycling, fuel efficient vehicles, carpooling and affordable public transportation will help. Carbon monoxide and nitrogen dioxide are high in cities secondary to vehicle emission. Formaldehyde, toluene and chloroform found in newer buildings are also common in cities, which can lead to asthma.[2]

Children should be educated on proper dietary habits early on. Fruits, vegetables, and omega-3 fatty acids have been shown to help lower the risk of allergies and asthma.[2] Families with smokers should

be encouraged to stop smoking due to the effect of second hand smoke. Increased security or surveillance in cities with high crime rates and counselors in schools can help reduce psychosocial stressors in children that may predispose to asthma.

Decreasing exposure to allergens at work can also be extremely beneficial. A recent study examined 2,746 employees in 18 Norwegian smelters and found that dust exposure was associated with an increased incidence of work-related asthma-like symptoms.[28]

A study of 79,888 school-aged children found that a traditional farm (ie, with cows and cultivation) was protective against asthma, hay fever, and atopy.[29]

SCHIP has improved health care access for children who could not afford insurance and are unable to qualify for Medicaid. Community health choice (CHC) are federal nonprofit programs that also provide coverage to uninsured.

Programs such as quality improvement (QI) projects increase awareness of cultural and health disparities in different patients and this will provide more effective medical care. The efforts of community health care workers help educate people on how to manage their asthma.

Medicaid has allowed patients of lower socioeconomic class to receive access to health care. However, patients may not receive proper preventive care and referral to specialists. It should be mentioned that even though most studies show a difference in prevalence of asthma in rural and urban centers, the management of asthma in the rural settings was comparable to that of urban setting in Alberta, Canada.[30]

Higher copayments make it difficult to afford medications and lead to asthma exacerbation. Less than half of the children with Medicaid used controller medications recommended by the National Institutes of Health (NIH) and only had a beta agonist inhaler for symptomatic relief.[23]

Children with asthma account for three times the health care expenses compared to children without asthma.[17] A recent study showed that children under 2 years of age or with persistent asthma or lower asthma quality-of-life were at greater risk for ED revisits after management of their acute asthma symptoms in the ED.[31]

National Cooperative Inner-City Asthma (NCICAS) and Inner-City Asthma Intervention (ICAI) Studies

One of the largest studies on asthma was the 1997 NCICAS. It examined the issues related to significantly higher rates of asthma hospitalization and mortality among poor urban children and black Americans compared with white Americans.[32,33]

The NCICAS was the largest funded US-based initiative and emphasized the particular social, environmental, and medical care issues associated with urban pediatric asthma.[34–37]

The ICAI attempted to implement the NCICAS guidelines in community settings.[38] Of the 4,174 children enrolled, 1,035 (25 percent) completed the entire 12-month ICAI protocol, while 1,355 children (32 percent) completed at least the core activities of the intervention. The ICAI study had lower compliance (57 percent) compared with the original NCICAS compliance (80 percent) because NCICAS protocols involved careful screening and provided monetary and childcare incentives.

A study by Wood et al[38] in the inner city population focused on factors that predicted retention and provision of allergy testing.

In terms of morbidity, Warman et al[39] found that a little more than half of all the families reported high risks of asthma morbidity. The ICAI study showed that implementation of the protocol was possible but retention of participants was challenging. Master's degree level social workers matched well with health care professionals to address various issues involved in caring for children with asthma and their families. Collaboration between community partners and team members was critical to successful implementation. The sustainability of the interventions was possible beyond external funding if local funding was sought and outcome measures were considered.[39]

Discussion

Health care providers should follow national asthma education and prevention program (NAEPP) guidelines for all patients. Education on proper use of inhalers and patient reiteration of the treatment plan, in order to reinforce their comprehension, is important.

Physicians need to practice evidence based medicine and overcome language and cultural barriers.

At the same time, patients have to do their part and adhere to the plan. Ultimately, a collaborative effort is needed to protect children from health risks like asthma that may be preventable.

Author Contributions

Conceived and designed the experiments: HM, KK, MF. Analysed the data: HM, MF. Wrote the first draft of the manuscript: HM, MF. Contributed to the writing of the manuscript: HM, KK, MF. Agree with manuscript results and conclusions: HM, KK, MF. Jointly developed the structure and arguments for the paper: HM, MF. Made critical revisions and approved final version: HM, KK, MF. All authors reviewed and approved of the final manuscript.

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