

Christopher Tomo

Professor Adolfo Cuevas

Introduction to Community Health

5 May 2021

Prevention of Childhood Asthma Among Families Living in Subsidized Housing

Problem Statement

Asthma is a chronic, non-communicable disease characterized by inflammation and swelling of the airways as a result of overproduction of mucus in the respiratory tract. The resulting symptoms include wheezing, breathlessness, chest tightening, and coughing fits at night or early in the morning. An asthma attack may occur when an environmental disturbance known as an asthma trigger irritates the lungs of an individual with asthma. Asthma attacks cause overproduction of mucus, leading to swollen, narrowed airways that can make it difficult for the individual to breathe. The triggers that cause asthma attacks vary from person to person, but common ones include secondhand tobacco smoke, dust mites, mold, pet hair, or infections that irritate the airways, like the common cold (CDC, 2019). If a person can recognize their asthma triggers, symptoms of asthma can easily be controlled; however, some people may live in environments that constantly expose them to these irritants and put them at an increased risk of developing the condition. Childhood asthma, or pediatric asthma, is the same as asthma physiologically, but because a child's lungs are still developing, the consequences of asthma attacks may be more severe. Of note in children is exercise-induced bronchospasm, a phenomenon where asthma attacks are triggered by moderate to vigorous physical activity such as playing sports, jogging, or riding a bike (David et al., 2018).

The exact causes of asthma remain somewhat uncertain, but most researchers believe that both an individual's genetics and environment can have a direct impact on whether or not they develop the condition (CDC, 2019). When considering pediatric asthma specifically, it is believed that the perinatal period (days/weeks immediately before and after a child is born) is the most crucial in terms of developing asthma. While there is a notable genetic basis to the development of asthma, it is also possible for one to develop the condition as an adult due to a variety of environmental exposures (Castro-Rodriguez et al., 2016).

Childhood asthma is a significant public health concern not only because it is deleterious to one's quality of life, but also because it is easily prevented, diagnosed, and treated. It is also a major focus because pediatric asthma is currently the most common serious chronic disease among infants and children (David et al, 2018). According to the CDC (2018), approximately 7.5% of U.S. children have been diagnosed with asthma, or about 5.5 million children in total. Childhood asthma also places a significant financial burden on both the U.S. healthcare system as a whole and families affected by the condition. Nationally, the direct costs associated with pediatric asthma totaled \$5.92 billion in 2013, with an average annual cost between \$3,076 and \$13,612 per affected child (Perry et al, 2013).

In terms of public health interventions, one benefit is that pediatric asthma is easily prevented and controlled. Despite this, inequities in both prevalence and treatment exist when considering both race and socioeconomic status. The prevalence of asthma among Black children (14.5%) is nearly twice that of White children (7.7%), and differences of this nature are also observed among adults (CDC, 2015). Additionally, the asthma mortality rate for Black Americans is more than double the mortality rate of the general population (Sullivan et al., 2020). When considering socioeconomic status, Boston, MA, is an especially segregated city,

and disparities in childhood asthma, especially severe cases, can be observed when comparing high and low-income neighborhoods. For example, the wealthy Back Bay/Beacon Hill neighborhood had an average of approximately 19.1 childhood asthma hospitalizations per 10,000 residents from 2011-2015, whereas lower-income neighborhoods like Roxbury and Dorchester had averages of 66.7 and 56.6 hospitalizations, respectively (Boston Public Health Commission, 2017). Individuals can take relatively simple steps to manage this chronic respiratory condition and reduce overall morbidity and mortality associated with the disease—as such, many public health interventions have been straightforward and very effective.

Epidemiology

Asthma is typically diagnosed using a variety of lung function tests, most commonly a spirometry test where patients are asked to breathe into a mouthpiece. If a patient's tests show extremely weak lung function or reduced lung function that significantly improves once they are given an inhaled bronchodilator (medication that opens up the airways), they are usually diagnosed with asthma (Hoch et al., 2019). The prevalence of asthma in the US is similar between adults and children, at 7.7% and 7.5%, respectively (CDC, 2018). Globally, asthma is the 28th leading contributor to the overall burden of disease, measured in disability-adjusted life years (DALYs). This burden on healthcare systems is due to the significant contribution to morbidities and co-morbidities that asthma tends to cause. In children, asthma can impede lung development and reduce respiratory function, which can have significant consequences in adulthood, especially in individuals whose asthma is left untreated. This is likely why the morbidity and mortality associated with adult asthma are much greater compared to pediatric asthma. In adults, reduced lung function caused by asthma can increase susceptibility to infection and worsen severe symptoms of respiratory diseases, like pneumonia caused by respiratory

infections. Individuals with asthma also have an increased likelihood of developing other chronic respiratory conditions such as COPD and pulmonary hypertension (Dharmage et al., 2019).

Risk Factors

As mentioned earlier, the etiology of asthma is not entirely understood by researchers but seems to rely on both genetics and environment. When referring to childhood asthma cases, environmental exposures during the perinatal period are especially significant in determining whether or not an individual develops asthma (Gur et al., 2017). Such exposures can include cigarette smoke, pests, mold, fungi, and air pollution, among many other factors (Wu et al., 2007). In addition to environmental impacts on one's health, genetics and family history can also play a role in the development of childhood asthma. Even though the inheritance of asthma is incredibly complex, involving multiple genes as well as epigenetic influences, there is clear evidence to support a hereditary basis for its development (Thomsen, 2015).

A 2016 systematic literature review and meta-analysis of 41 risk factor and etiology studies by Castro-Rodriguez et al. showed a common set of risk factors for many cases of pediatric asthma. Based on their findings, the most significant familial (hereditary) risk factors for pediatric asthma are parental asthma, maternal pre- or postnatal smoking, or maternal stress during pregnancy. The most common perinatal risk factors were neonatal hyperbilirubinemia (neonatal jaundice), preterm birth, low birthweight, and birth by Cesarean section. Finally, significant postnatal risk factors for childhood asthma included RSV (respiratory syncytial virus) hospitalization, antibiotic exposure, overweight and obesity, unhealthy exposures in the home (dampness, mold, PVC), and a slew of environmental exposures (carbon monoxide, environmental tobacco smoke, nitrogen dioxide, and sulfur dioxide). As evidenced by these findings, there is a large number of hereditary and environmental risk factors that can lead to the

development of pediatric asthma. Even though many of these risk factors are preventable (such as tobacco smoke and environmental factors in the home), various inequalities persist throughout American society that can make pediatric asthma prevention nearly impossible for children from particularly high-risk families.

Social Determinants of Health

When considering the prevention, diagnosis, treatment, and prevalence of childhood asthma, it is incredibly important to acknowledge the social determinants of health that may affect these factors for many individuals. Too often, these upstream factors are overlooked, and common public health and medical interventions rely on late-stage tertiary preventions rather than more structural primary preventative measures. One of the most commonly studied social determinants of health, especially concerning asthma, is socioeconomic status (SES), which is determined by annual income, occupational status, and level of educational attainment. Both globally and within the United States, lower SES is associated with an increased risk of developing asthma. The odds ratio of 1.38 for asthma prevalence between low SES and high SES individuals confirms this disparity (Uphoff et al., 2015). It is important to note that access to healthcare is not a significant contributor to these inequities, as countries like Sweden, the United Kingdom, and Canada, all of which have Universal Health Coverage, have observable differences in prevalence among socioeconomic positions.

Another significant social determinant related to pediatric asthma is race/ethnicity. Unfortunately, in the United States, race is often correlated with socioeconomic status, and the two social determinants may compound and particularly affect certain populations. It is important to acknowledge that racial disparities in asthma prevalence are related to environmental and social risk factors, rather than having a biological or hereditary basis. In 2016,

Beck et al. found that 53% of racial disparities in asthma prevalence could be explained by socioeconomic factors. When public health interventions are equally applied across all levels of SES, interventions tend to have a smaller impact on people of color, especially Black Americans, and often improve health outcomes for Whites to a much greater degree (Sullivan et al., 2020).

Elevated stress levels are a common thread among groups particularly affected by social determinants like low socioeconomic status, low educational attainment, being a racial/ethnic minority, being female, or identifying as LGBTQ+ (Forrester et al, 2019). While not considered a social determinant of health, stress level seems to be an indicator of how strongly one is affected by these determinants. Elevated stress levels can come from food or housing insecurity, adverse childhood experiences (ACEs), experiences with discrimination or prejudice, frequent exposure to violence, or an unsafe home environment. The effects of these stressors can be particularly detrimental to children and young adults under 18 who are still developing healthy coping mechanisms in response to environmental stressors. In the context of pediatric asthma, children with frequent exposures to such stressors early in life were more than 1.5 times more likely (odds ratio of 1.53 for males, 1.60 for females) to develop asthma (Lee et al., 2016). Additionally, high amounts of prenatal and/or lifetime stress among mothers can significantly increase their child's risk of developing asthma (Rosa et al., 2018). Unfortunately, many children in the United States face negative exposures to several of these social determinants, and the deleterious effects of these stressors often compound. These children have high rates of asthma compared to those who have higher socioeconomic status and fewer continuous stressors.

Children Living in Public Housing as a Target Population for Pediatric Asthma

Intervention

Subsidized housing, also referred to as public housing, is a housing arrangement where low-income families live in buildings partially funded by federal, state, or local governments to provide reduced rent for families who may otherwise have difficulty finding an affordable place to live. According to the US Department of Housing and Urban Development (2020), approximately 31% of the nearly 5 million families living in subsidized housing have at least one child. This means that, based on the latest data, there are at least 1.42 million children currently living in subsidized housing, though that number is likely higher when considering families with multiple children and underreporting. Public housing residents, especially those in urban settings, are at an incredibly heightened risk of developing asthma due to conditions within subsidized housing buildings as well as the surrounding environment. One study found that among New York City residents, people with asthma were five times more likely to live in public housing than nonasthmatics (Corburn et al., 2006).

Many factors contribute to the increased risk of pediatric asthma among children living in subsidized housing. Of note, the high prevalence of smoking (and consequently, secondhand smoke exposure) within buildings is a significant contributor to the childhood asthma epidemic within public housing. Additionally, the living conditions in many buildings are subpar and many children are subject to a variety of environmental exposures, such as mold, fungus, unfiltered air, and a lack of adequate heating, though many of these exposures are not adequately measured by housing authorities. Exposure to pest allergens, such as those from cockroaches and mice, can also cause children to develop asthma (Ruel et al., 2010).

As mentioned earlier, a high amount of stress (especially maternal stress or postnatal stress) is a major risk factor for pediatric asthma. Unfortunately, subsidized housing buildings in urban settings tend to be some of the most stressful environments a child can live in. Not only

are the buildings typically in poor condition, but they also tend to be located in low-income neighborhoods. Children are exposed to violence, poverty, and potentially acts of racism and discrimination inside and outside the home. These stressors also affect adults, which can lead to increased domestic violence and smoking, which also increase a child's risk of developing asthma (Andrews et al., 2014). There are a variety of factors, including social determinants, risk factors, and environmental exposures, that make children living in subsidized housing the ideal target population for an evidence-based intervention for pediatric asthma.

Selected Intervention

One potential evidence-based intervention to effectively prevent future cases and address the burden of childhood asthma involves teams of trained and supervised community health workers (CHWs). These workers will be local community members of the areas they serve, and will largely work with individual families. Based on the needs of the community, CHWs would also be bilingual and able to assist families in their native language (and in a culturally sensitive manner) if they are not fluent in English. They would conduct home visits to monitor air quality and check for any potential environmental exposures (mold, fungus, PVC, poor air filtration, etc.) and if potentially unsafe levels were detected, it would be reported to a higher authority (the one overseeing the intervention) to be addressed immediately. CHWs would also check the lung function of children in the household, and would be trained to notice the signs of pediatric asthma. If they suspect a child has asthma, the child will be referred to a specialist who can give them a formal diagnosis and discuss treatment options with parents. If unsafe exposures are detected or a child is referred to a specialist, then CHWs will conduct follow-up visits to ensure that these issues have been appropriately handled.

In addition to smaller-scale home visits, CHWs will also be involved in an active education program that would take place within the subsidized housing communities they work at. They would educate parents, guardians, older siblings, and other community members on childhood asthma prevention methods, such as identifying mold and other environmental exposures, smoking cessation and the effect of tobacco smoke on asthma, and proper prenatal care. Additionally, mindfulness and meditation classes would be offered to residents to lower environmental stress and improve social cohesion within the community, reducing another significant risk factor. This educational component of the intervention aims to not only increase awareness about the current asthma epidemic within public housing but also to prevent or diminish the effects of future pediatric asthma cases.

A similar intervention was carried out by Woods et al. in the low-income Boston, MA neighborhoods of Roxbury and Jamaica Plain, though not among public housing residents specifically. Study results were compared to data from Dorchester, a Boston neighborhood that had a similarly high childhood asthma prevalence. Among the participants, there was a 79% decrease in asthma-related hospitalizations, a 56% decrease in Emergency Room visits, and other notable decreases in missed school days (42%), missed adult workdays (46%), and days of limited physical activity (29%). Additionally, the supervised CHW-based model they used was found to build social cohesion between participating community members and local organizations (Woods et al., 2016).

A major strength of this intervention is that it involves CHWs that are members of the community. Many participants would likely have some level of mistrust or skepticism with medical professionals due to income status or racial/ethnic identity. Having a familiar face as a point of contact would likely make them more willing to learn, change habits, and let someone

into their home. This added level of trust not only improves the effectiveness of the intervention and the likelihood of follow-through on CHW instructions but has the additional benefits of building community trust and bringing much-needed jobs to low-income communities.

A notable limitation of this method is that it only addresses childhood asthma for this target population at the community level. A broader policy-level intervention, such as more stringent building codes/standards, anti-smoking policies, and mandated housing inspections, would likely be more effective at decreasing the rate of childhood asthma among residents of subsidized housing. Unfortunately, policy-level interventions are difficult to put into practice, so the intervention has to be taken one level down within a socioecological framework. Another disadvantage is that addressing home exposures or treating asthma comes with a cost that many of the participants simply cannot afford. This would ideally be funded by the local government or public health organization carrying out the intervention, but this is not a guarantee, especially long-term. Increased access to low-cost healthcare would be a better solution for this issue, which would, unfortunately, require major changes at the policy level.

Conclusion

Childhood asthma is a dire public health issue affecting millions of American children annually and putting financial burdens on their families, especially those living in subsidized housing where children are exposed to serious risk factors on a daily basis. While this chronic condition will likely remain prevalent among the population, the observed disparities in diagnosis and treatment based on race and socioeconomic status can be reduced with straightforward solutions. Pediatric asthma is easy to manage and even easier to prevent with an effective, evidence-based intervention that centers the needs of affected communities and prioritizes equity and patient outcomes over cost-effectiveness.

References

- Andrews, J. O., Mueller, M., Newman, S. D., Magwood, G., Ahluwalia, J. S., White, K., & Tingen, M. S. (2014). The association of individual and neighborhood social cohesion, stressors, and crime on smoking status among African-American women in southeastern US subsidized housing neighborhoods. *Journal of urban health : bulletin of the New York Academy of Medicine*, *91*(6), 1158–1174. <https://doi.org/10.1007/s11524-014-9911-6>
- Beck, A. F., Huang, B., Auger, K. A., Ryan, P. H., Chen, C., & Kahn, R. S. (2016). Explaining Racial Disparities in Child Asthma Readmission Using a Causal Inference Approach. *JAMA pediatrics*, *170*(7), 695–703. <https://doi.org/10.1001/jamapediatrics.2016.0269>
- Boston Public Health Commission (2017). Health of Boston 2016-2017: Environmental Health. *Boston Public Health Commission, Massachusetts Department of Public Health*.
- Castro-Rodriguez, J. A., Forno, E., Rodriguez-Martinez, C. E., & Celedón, J. C. (2016). Risk and Protective Factors for Childhood Asthma: What Is the Evidence?. *The journal of allergy and clinical immunology. In practice*, *4*(6), 1111–1122. <https://doi.org/10.1016/j.jaip.2016.05.003>
- Centers for Disease Control and Prevention (2019). Asthma FAQs. *Centers for Disease Control and Prevention, US Department of Health and Human Services*.
- Centers for Disease Control and Prevention (2015). Childhood Asthma Prevalence. *Behavioral Risk Factor Surveillance System, Centers for Disease Control and Prevention, US Department of Health and Human Services*.
- Centers for Disease Control and Prevention (2018). Summary Health Statistics Tables for U.S. Children: National Health Survey Interview, 2018. *National Center for Health Statistics, Centers for Disease Control and Prevention, US Department of Health and Human Services*.
- Corburn, J., Osleeb, J., & Porter, M. (2006). Urban asthma and the neighbourhood environment in New York City. *Health & place*, *12*(2), 167–179. <https://doi.org/10.1016/j.healthplace.2004.11.002>
- David, M., Gomes, E., Mello, M. C., & Costa, D. (2018). Noninvasive ventilation and respiratory physical therapy reduce exercise-induced bronchospasm and pulmonary inflammation in children with asthma: randomized clinical trial. *Therapeutic advances in respiratory disease*, *12*, 1753466618777723. <https://doi.org/10.1177/1753466618777723>

Dharmage, S. C., Perret, J. L., & Custovic, A. (2019). Epidemiology of Asthma in Children and Adults. *Frontiers in Pediatrics*, 7, 246. <https://doi.org/10.3389/fped.2019.00246>

Forrester, S. N., Gallo, J. J., Whitfield, K. E., & Thorpe, R. J. (2019). A Framework of Minority Stress: From Physiological Manifestations to Cognitive Outcomes. *The Gerontologist*, 59(6), 1017–1023. <https://doi.org/10.1093/geront/gny104>

Gur, M., Hakim, F., & Bentur, L. (2017). Better understanding of childhood asthma, towards primary prevention - are we there yet? Consideration of pertinent literature. *F1000Research*, 6, 2152. <https://doi.org/10.12688/f1000research.11601.1>

Hoch, H. E., Houin, P. R., & Stillwell, P. C. (2019). Asthma in Children: A Brief Review for Primary Care Providers. *Pediatric annals*, 48(3), e103–e109. <https://doi.org/10.3928/19382359-20190219-01>

Lee, A., Mathilda Chiu, Y. H., Rosa, M. J., Jara, C., Wright, R. O., Coull, B. A., & Wright, R. J. (2016). Prenatal and postnatal stress and asthma in children: Temporal- and sex-specific associations. *The Journal of allergy and clinical immunology*, 138(3), 740–747.e3. <https://doi.org/10.1016/j.jaci.2016.01.014>

Office of Policy Development and Research (2020). Picture of Subsidized Households. *HUD User, US Department of Housing and Urban Development*.

Perry R., Braileanu G., Palmer T., Stevens P. (2019). The Economic Burden of Pediatric Asthma in the United States: Literature Review of Current Evidence. *Pharmacoeconomics*. 2019 Feb; 37(2): 155-167. doi: 10.1007/s40273-018-0726-2.

Rosa, M. J., Lee, A. G., & Wright, R. J. (2018). Evidence establishing a link between prenatal and early-life stress and asthma development. *Current opinion in allergy and clinical immunology*, 18(2), 148–158. <https://doi.org/10.1097/ACI.0000000000000421>

Ruel, E., Oakley, D., Wilson, G. E., & Maddox, R. (2010). Is public housing the cause of poor health or a safety net for the unhealthy poor?. *Journal of urban health : bulletin of the New York Academy of Medicine*, 87(5), 827–838. <https://doi.org/10.1007/s11524-010-9484-y>

Sullivan, K., & Thakur, N. (2020). Structural and Social Determinants of Health in Asthma in Developed Economies: a Scoping Review of Literature Published Between 2014 and 2019. *Current allergy and asthma reports*, 20(2), 5. <https://doi.org/10.1007/s11882-020-0899-6>

Thomsen S. F. (2015). Genetics of asthma: an introduction for the clinician. *European Clinical Respiratory Journal*, 2, 10.3402/ecrj.v2.24643. <https://doi.org/10.3402/ecrj.v2.24643>

Uphoff E., Cabieses B., Pinart M., Valdés M., Antó J. M., Wright J. (2015). A systematic review of socioeconomic position in relation to asthma and allergic diseases. *European Respiratory Journal*, 46 (2) 364-374; doi: 10.1183/09031936.00114514

Woods, E.R., Bhaumik, U., Sommer, S.J., Chan, E., Tsopelas, L., Fleegler, E.W., Lorenzi, M., Klemets, E.M., Dickerson, D.U., Nethersole, S., Dulin, R. (2016). Community Asthma Initiative to Improve Health Outcomes and Reduce Disparities Among Children with Asthma. *MMWR Supplements* 65(1), 11-20. <http://dx.doi.org/10.15585/mmwr.su6501a4>

Wu, F., & Takaro, T. K. (2007). Childhood asthma and environmental interventions. *Environmental health perspectives*, 115(6), 971–975. <https://doi.org/10.1289/ehp.8989>