



Towards Personalized and Comprehensive Pediatric Asthma Management: Understanding the Role of Social Determinants and Environmental Factors

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AS ONE OF the most common chronic diagnoses of childhood, asthma is estimated to affect over six million children in the United States. The condition is heterogeneous, with a myriad of underlying inflammatory and socioenvironmental factors contributing to its prevalence, severity, control, and outcomes.^{1–3} This heterogeneity poses a challenge in implementing a universal treatment approach. While there are an increasing number of biologic medications targeted to specific inflammation pathways, they are expensive and not all children meet criteria for administration. Progress has been made toward understanding the genetics and epigenetics of asthma, but no treatments in this domain are available yet.

A crucial step is to identify and address modifiable social, adherence, mental health, and environmental factors, especially for at-risk families. National and international asthma guidelines published by the National Asthma Education and Prevention Program and the Global Initiative for Asthma emphasize the importance of incorporating these factors for a complete plan of care. These factors are also important because they may be immediately actionable, whereas medication development pipelines can take years. Addressing socioenvironmental aspects allow for a “whole person” model of care that is more personalized and comprehensive. Pediatric asthma management can be elevated by understanding all facets of a child’s life that may impact their asthma control.

In this issue of *Academic Pediatrics*, a compendium of articles highlight environmental and social determinants of health that impact asthma severity and control, with potential solutions to address these barriers. Kinghorn et al⁴ illustrate the relationship of poverty to asthma control in American Indians, an understudied population in the United States. In this case-control study, the authors use data from the Factors

Influencing Pediatric Asthma study, which evaluated genetic influences on pediatric asthma in South Dakota. Through in-home visits, the authors gather sociodemographic data alongside objective measures of lung function and asthma control using a standardized questionnaire (Asthma Control Test). They find that nearly two-thirds of the children live in households with an annual income below \$25,000 and those with asthma have significantly higher odds of living in a multi-unit dwelling and/or with pest infestations. They highlight that nearly half of the children reported poorly controlled asthma, but only half report using rescue inhalers and one-quarter use a controller medication. They also find that 80% of the children were responsible for their own medication use. Markedly, a key element of asthma management promoted by the Global Initiative for Asthma and National Institutes of Health asthma guidelines is proper inhaler technique education. However, high rates of unsupervised medication administration have been documented in other minority populations and inhaler technique is typically suboptimal across all unsupervised groups.⁵ This stresses the importance to identify risk factors that may impact asthma outcomes in minority and disadvantaged populations in the United States.

Increased supervision of medication delivery may be beneficial if both caregivers and children are properly trained – but there is often a portion of the day when they are physically separate (eg, school). Yet caregivers are typically asked to evaluate their child’s asthma in the clinical and research settings. Here, Islamovic et al⁶ contrast parents and patients’ roles in care participation and assessment of asthma symptoms. Their study analyzes younger children enrolled in a public school-based asthma intervention in Bronx, New York. Using in-person interviews, the authors find that children report more confidence than

parents in correctly using an inhaler. Notably, when reporting asthma control, children report significantly more asthma exacerbations than their parents – underscoring the need to involve the patient in the clinic interview process. The authors also find that children are significantly more likely to worry about developing an asthma attack or being teased about their medication use. While it is potentially reassuring that children feel confident in their medication use, other studies demonstrate that confidence does not always correlate with aptitude.⁷ Moreover, this study suggests that children experience mental health stressors, an important consideration given that psychosocial stress is itself a potential exacerbating factor for severe asthma.⁸

Concerning mental health, the American Academy of Pediatrics recommends depression screening for all children aged 12 and older. Urban adolescents are at a higher risk for depression and asthma, but the relationship's effect on asthma outcomes is not completely understood.⁹ Shankar et al¹⁰ focus on this relationship in a cross-sectional study based in Rochester, New York from a randomized school-based asthma care program for teenagers. Of the adolescents with depressive symptoms, the authors identify significantly lower quality of life scores and increased asthma severity. Those with depressive symptoms reported trends toward lower controller medication adherence and less controller medication prescriptions in general. The authors highlight the importance of addressing depressive symptoms in this population and emphasize the need to enhance preventive care. As not all children undergo routine physicals (only 30% indicated having one in this study cohort), this suggests the opportunity for school-based depression screening.

The environment plays a significant role in asthma control and lung health.¹¹ Li et al¹² explore the long-term relationship between air pollution (particulate matter, PM_{2.5}, and O₃) and pollen on pediatric asthma control. The study occurred over a 26-month period in Florida. PM_{2.5} and O₃ levels were obtained from US Environmental Protection Agency Air Quality System and the pollen levels were obtained from Intercontinental Marketing Services Health. Patient information was obtained through the Patient-Reported Outcomes Measurement Information System Pediatric Asthma Study. This study focused on daily symptoms of control using a standardized questionnaire (modified Pediatric Asthma Control and Communication Instrument) and the effect of both pollution and pollen. Using a linear mixed-effects model, the authors demonstrate that there is a worsening of asthma controls with higher levels of PM_{2.5} and pollen levels after adjusting for sociodemographics and season. There was a trend toward improved asthma control with higher levels of O₃, but the authors note that other negatively correlated pollutants with O₃ (eg, NO₂, CO, and SO₂) were not measured so the findings are unclear. The authors advocate for prevention of exposure to harmful pollutants and change at a policy level.

These pediatric asthma articles featured in this issue draw attention to the need for enhanced identification of psychosocial and environmental factors as well as intervention strategies. Because children have insight into their asthma pathology and spend most of their day at school, school-based monitoring and interventions are an attractive option gaining popularity.¹³ This will likely most benefit underserved and lower socioeconomic populations and those with barriers to adherence and access to preventive care.

Another approach is to incorporate technology and data-driven analytics into pediatric asthma management. These methods include real-time monitoring and wearable devices, such as represented by National Institutes of Health's Pediatric Research using Integrated Sensor Monitoring Systems (PRISMS) initiative to develop environmental sensors and wearable devices to capture detailed personalized data.¹⁴ In line with Huang et al's points, PRISMS enables environmental health and epidemiological studies that look to quantify and elucidate daily personal exposures across different microenvironments. These devices and sensors, when integrated, can gather more granular information about stress, pollution exposure in different locations (home, extracurriculars, and school), lung function, and more. A goal of PRISMS is to ultimately understand predictors of asthma exacerbations through detailed individual-level data.

Asthma is a multifaceted condition that requires a comprehensive and innovative approach for effective treatment, especially in regard to social and environmental determinants of health. The future of asthma management will benefit from a more personalized treatment approach that takes into consideration medical, genetic, social, and environmental factors.

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