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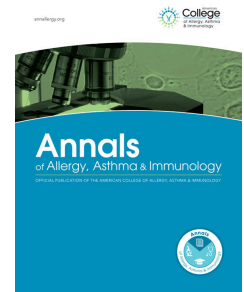
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Eliminating health disparities in asthma: are we at the end of the beginning?

Christian Rosas-Salazar, MD, MPH,¹ Juan C. Celedón, MD, DrPH²

¹Division of Pediatric Allergy, Immunology, and Pulmonary Medicine, Vanderbilt University School of Medicine, Nashville, TN

²Division of Pediatric Pulmonary Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA

Corresponding Author

Juan C. Celedón, MD, DrPH

4401 Penn Ave, Rangos Research Building Suite 9130

Pittsburgh, PA 15224

Phone: (412) 692-8429

Fax: (412) 692-7636

E-mail: juan.celedon@chp.edu

Conflicts of Interest

Dr. Celedón has received research materials from GSK and Merck (inhaled steroids) and Pharmavite (vitamin D and placebo capsules) to provide medications free of cost to participants in NIH-funded studies, unrelated to the current work.

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Health equity, defined as “the attainment of the highest level of health for all people”,¹ continues to be a fundamental but difficult-to-achieve goal in the United States (U.S.), where some racial and ethnic minority groups are disproportionately affected by respiratory diseases such as asthma. Indeed, the prevalence of asthma is higher in Puerto Ricans (14.3%) and African Americans (11.6%) than in non-Hispanic whites (8.3%) or Mexican-Americans (5.7%).² Moreover, Puerto Ricans and African Americans have higher morbidity and mortality from asthma than non-Hispanic whites^{2,3}. For example, the mortality rate in African Americans (23.3 per million) is nearly thrice as high as that in non-Hispanic whites (8.2 per million)². Over the last decade, we have gained insights into the intertwined causes of health disparities in asthma, including racial ancestry, genetics and epigenetics, psychosocial stressors, prematurity, second-hand smoke (SHS), obesity, diet, and air pollutants⁴.

Race and ethnicity are strongly correlated with socioeconomic status (SES) due to historical and political reasons. Poverty affects domains that negatively impact asthma outcomes (e.g., literacy, housing, and healthcare access) but is not the sole explanation for asthma disparities, as ethnic groups that are over-represented among the economically disadvantaged (i.e. Puerto Ricans and Mexican Americans) have a widely divergent asthma burden⁴. Recent studies in racially admixed populations such as Hispanics and African Americans have shown that African ancestry (determined by genetic markers) is associated with asthma and lower lung function, while Native American ancestry is linked to lower risk of asthma and higher lung function⁴. Such ancestry-related disparities cannot be fully explained by genetics and are likely due to insufficiently understood socio-cultural and environmental factors correlated with racial ancestry, which could cause or worsen asthma through epigenetic regulation⁵. For example, Puerto Ricans and Mexican

Americans differ for SHS exposure, preterm births, diet, and exposure to and coping mechanisms for psychosocial stressors^{3,4}.

Racial and ethnic minorities are often exposed to psychosocial stressors such as poverty, discrimination, and violence. Such exposures can lead to chronic stress and mental illnesses (i.e. depression and post-traumatic stress disorder (PTSD)), which have been recently implicated in the pathogenesis of asthma and morbidity from asthma. For example, exposure to violence at the individual and community levels has been associated with childhood asthma in Puerto Ricans, perhaps through genetic and epigenetic mechanisms⁶. Moreover, chronic stress is linked to reduced response to short-acting β_2 -agonists in minority and non-minority children⁷, and depression and PTSD have been linked to asthma in multi-ethnic studies of adults^{8,9}. Thus, a growing body of evidence supports a causal role for chronic stress on asthma disparities.

Both an imbalanced diet and obesity are common in Puerto Ricans and African Americans⁴. Obesity is a strong risk factor for asthma and poor asthma outcomes, and the management of patients with co-existing obesity and asthma is made challenging by co-morbidities and reduced response to usual therapies³. In minorities, obesity can be due to both an unhealthy diet and limited physical activity due to non-access to recreational areas or (in children) physical education at public schools. Although specific nutrients or vitamins that may cause or protect against asthma have yet to be identified, a growing body of evidence supports a link between a dietary profile characterized by high intake of saturated fats or sweets and poor intake of fruits and vegetables and asthma⁴.

Members of minority groups that are heavily affected by asthma are frequently exposed to multiple known or potential risk factors. This is highly relevant, as we and others have shown that childhood asthma is more likely as the number of risk factors increases¹⁰. For example, a minority child living in an urban area may have an imbalanced diet and be obese, while also being exposed to SHS, air pollutants, and chronic stressors. If such a child were to develop asthma, he or she could receive suboptimal treatment due to factors including but not limited to lack of health insurance, poor health literacy, language or transportation barriers, and cultural beliefs. Thus, eradication of multifactorial asthma disparities requires multifaceted approaches involving all key stakeholders (i.e. patients, researchers, healthcare providers and healthcare systems, funding agencies, professional societies, and health policy makers; **Figure 1**).

The Institute of Medicine's Unequal Treatment Report and the Agency for Healthcare Research and Quality's National Healthcare Quality and Disparities Report provide a roadmap to examine, monitor, and achieve health equity in the U.S. Similar documents have been published by other national and international organizations, including some on asthma. Such reports have been helpful in raising public awareness, providing achievable benchmarks, and identifying steps on how to translate research into clinical practice.

Regarding research, vigorous advocacy is needed to increase funding for studies of underserved populations. Future observational studies and clinical trials of asthma in minorities must effectively engage the affected communities, while accounting for the complex etiology of asthma disparities. Such studies should help characterize the interactions and relative contributions of various risk factors, while also identifying the most cost-effective multipronged

70 interventions. However, research and innovation do not suffice without achieving the fair
71 treatment of all people with respect to the development, implementation, and enforcement
72 of environmental laws, regulations, and policies (“environmental justice”), while also ensuring
73 high-quality healthcare for all.

74
75 Ongoing and emerging environmental risk factors for asthma disparities must be reduced or
76 eliminated, including tobacco use and SHS, and outdoor air pollutants. Along with such
77 environmental policies, we must continue to advocate for broad access to high-quality
78 healthcare, regardless of race, ethnicity, or SES. Since 2010, the Affordable Care Act (ACA) has
79 substantially reduced the proportion of individuals lacking health insurance in the U.S., and
80 every effort should be made to enhance and expand universal health coverage, while also
81 overcoming other obstacles to optimal healthcare. To achieve this goal, our healthcare system
82 should strive to develop and maintain a diverse and culturally competent workforce, educate
83 patients of all literacy levels, and facilitate access to strategically located healthcare centers and
84 clinics.

85
86 In the U.S., asthma-related costs exceed \$80 billion per year, due to medication costs, emergency
87 department visits and hospitalizations, and loss of productivity. Reducing health disparities in
88 asthma is not only an ethical but fiscally sound goal, as substantial savings would result from
89 achieving asthma control and preventing severe asthma exacerbations in members of minority
90 groups and economically disadvantaged populations. While much remains to be done to achieve
91 this goal, recent advances in research and healthcare access gives us reason to believe that we are
92 now, in Churchill’s words, “at the end of the beginning”.

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Figure 1. Health disparities in asthma are multifactorial, and their elimination will require multifaceted approaches by all key stakeholders (i.e. patients, researchers, healthcare providers and healthcare systems, funding agencies, professional societies, and health policy makers).

