

Health disparities in allergic and immunologic conditions in racial and ethnic underserved populations: A Work Group Report of the AAAAI Committee on the Underserved



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Health disparities are health differences linked with economic, social, and environmental disadvantage. They adversely affect groups that have systematically experienced greater social or economic obstacles to health. Renewed efforts are needed to reduced health disparities in the United States, highlighted by the disparate impact on racial minorities during the coronavirus pandemic. Institutional or systemic patterns of racism are

promoted and legitimated through accepted societal standards, and organizational processes within the field of medicine, and contribute to health disparities. Herein, we review current evidence regarding health disparities in allergic rhinitis, asthma, atopic dermatitis, food allergy, drug allergy, and primary immune deficiency disease in racial and ethnic underserved populations. Best practices to address these


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disparities involve addressing social determinants of health and adopting policies to improve access to specialty care and treatment for the underserved through telemedicine and community partnerships, cross-cultural provider training to reduce implicit bias, inclusion of underserved patients in research, implementation of culturally competent patient education, and recruitment and training of health care providers from underserved communities. Addressing health disparities requires a multilevel approach involving patients, health providers, local agencies, professional societies, and national governmental agencies. (*J Allergy Clin Immunol* 2021;147:1579-93.)

Key words: Health disparities, allergic rhinitis, asthma, atopic dermatitis, primary immunodeficiency, drug allergy, food allergy, coronavirus disease 2019

Health disparities are defined as health differences linked with economic, social, and environmental disadvantage.^{1,2} They adversely affect groups that have systematically experienced greater social or economic obstacles to health based on race, ethnicity, religion, socioeconomic status (SES), sex, age, disability, sexual orientation, and/or geographic location, causing health inequities. Health disparities and inequities (see Fig 1) are inextricably linked with social determinants of health, conditions in the environments in which people are born, live, learn, work, play, worship, which affect a wide range of health, functioning, and quality-of-life (QOL) outcomes and risks (see Fig 2).³ These social determinants of health can negatively impact the delivery of medical care,^{4,5} and addressing social determinants of health is key to achieving health equity, defined by Healthy People 2020 as attainment of the highest level of health for all people¹⁻³ (see Figs 1 and 2).

Renewed efforts are needed to reduce health disparities in the United States, highlighted by the disparate impact on racial minorities during the recent coronavirus pandemic. Institutional or systemic patterns of racism are promoted and legitimated through accepted societal standards and organizational processes within the field of medicine and contribute to health disparities.⁴ As a structured system, racism interacts with other social institutions, such as political, legal, and economic institutions. Dynamic and interdependent are societal systems, including the housing market, the education system, the labor market, the criminal justice system, credit markets, the economy, and the health care system. The interaction of these institutions and subsystems creates unequal access to resources and opportunity, resulting in racial inequities in health.⁵ Reducing inequities in health requires dismantling these patterns and systems of racism. Addressing health disparities requires a multilevel approach involving patients, health providers, local agencies, professional societies, and national governmental agencies. Because disparities so greatly affect the field of allergy/immunology, greater emphasis must be placed toward addressing the changing needs of the specialty and patients served. This is a crucial task to improve the equity of the care that our specialty provides.

Almost 2 decades ago, inspired by the Institute of Medicine report titled "Unequal Treatment," the American Academy of Allergy, Asthma & Immunology participated in a Commission to End Health Disparities with the National Medical Association and the National Hispanic Medical Association.⁶ In 2009, Apter and Casillas⁷ wrote an editorial outlining how poverty, race, and

Abbreviations used

AD:	Atopic dermatitis
AIT:	Allergen immunotherapy
aOR:	Adjusted OR
AR:	Allergic rhinitis
ED:	Emergency department
FA:	Food allergy
MUD:	Matched unrelated donor
OR:	Odds ratio
PIDD:	Primary immune deficiency disease
QOL:	Quality of life
SES:	Socioeconomic status

health disparities were being addressed in allergy/immunology care and research. Unfortunately, current evidence in the United States shows a lack of progress in the past decade in the quest to reduce disparities.⁸

Herein, we describe current evidence regarding health disparities within allergy/immunology in racial and ethnic underserved populations, and how these are being addressed for patients with allergic rhinitis (AR), asthma, atopic dermatitis (AD), food allergy (FA), drug allergy, and primary immune deficiency disease (PIDD). For each topic, we have identified (1) what is known about health care disparities, (2) what interventions have been reported to date, and (3) what needs to be done to help further address the disparity for that disease. When there has not been significant interventional effort, only the established knowledge and suggestions for change are reviewed. (See Table I.) For this review, underserved populations refer to those who are disadvantaged because of inability to pay, to access care or comprehensive health care, or other reasons relating to race, religion, language group, or social status. Changes in our medical system and governmental support are needed to improve access to medical care and the current state of disparities. It is an ethical and moral imperative.

METHODS

This workgroup report is a narrative review. All authors performed a narrative review of the literature through PubMed, with a search strategy focused on the topic of health care disparities for each disease topic. The authors chose to include the highest quality evidence available for each topic. The review was performed without time frame restrictions. The only exclusion criterion was non-English publications. Many of the references herein are single-center studies, and the limitations of these studies should be considered in the assessment of the strength of the evidence. Because most studies in this narrative review address health disparities in the United States, the operationalization of the mitigating strategies may differ in other countries.

DISPARITIES IN AR

What is known?

As guidelines are evolving to improve care for patients with AR, it is still underdiagnosed and underappreciated in certain racial and ethnic populations.⁹⁻¹¹ AR prevalence among racial minorities reveals variability in self-reported disease. According to the 2017 National Health Information Survey, self-reported history of "hay fever" was 5% in black children, 5% in Hispanic children, compared with 9% in white children.¹²



FIG 1. Health equity is the attainment of the highest level of health, depicted by the apples on the tree, for all people. The ability for each person to reach the apple, or maximum health, is influenced by the conditions in the environments they are born, live, learn, work, play, and worship, called social determinants of health (SDOH). The differences in these conditions or SDOH are depicted by the various colors and sizes of the persons. The crates depict the innovative solutions that can mitigate SDOH's negative influence on the ability of a person to obtain maximum health, including increased patient awareness, education, access to specialists, and collaborative patient-clinician decision making, and cultural competency training for health care providers. Ethnic/racial populations need customized approaches to address health disparities to achieve health equity.

When prevalence rates are examined in urban or low-income cohorts, underdiagnosis is evident, especially in patients with asthma. Studies of urban populations of school-age children with persistent asthma demonstrate AR prevalence rates between 54% and 85%, indicating AR as a significant comorbidity among children with asthma.¹³⁻¹⁵ However, AR is not being readily addressed or diagnosed in underserved children with uncontrolled asthma. In Project Nocturnal Asthma and Performance in School, an urban cohort of children with uncontrolled asthma, 53% of AR participants were newly diagnosed at the clinic study visit, thought to be linked to physician underestimation of the impact of AR on patient daytime functioning and low awareness of guideline recommendations.¹⁶ Implicit bias could be contributory to this underrecognition of AR.

Sensitization to several allergens is a contributor to the burden of disease. When identified, black children without a personal or family history of atopy had a higher odds of sensitization to any allergen as well as discrete sensitization to mold, cockroach, grass, weed, and tree pollen compared with white children.¹⁷ In children with asthma, black race and low SES are independent risk factors for cockroach sensitization.^{18,19} More recently, mouse allergy has been shown to be a concern in urban areas. In the Mouse Allergy and Asthma Intervention Trial, active rhinitis and mouse-specific IgE were significantly associated in children with persistent asthma.^{15,20} Therefore, addressing the presence of mold, cockroaches, and mouse droppings in the homes of at-risk populations is important.

Latino populations are also significantly affected by AR with underdiagnosis in Puerto Rican and urban populations.^{21,22} An



FIG 2. Social determinants of health leading to health disparities.¹³⁵ The social factors that impact disparities include education access and quality, neighborhood and built environment, social and community context, economic stability, and health care and quality. Interventions in these areas can impact health.

analysis of Florida Medicaid claims data from 1997 to 2004 found Hispanic children at 16% higher odds of AR diagnosis compared with white children, and 52% higher odds of an AR diagnosis compared with black children.¹⁴ The Asthma Phenotypes in the Inner City study identified racial and ethnic differences in AR phenotypes in urban low-income populations.²² The lack of similar findings in higher income populations suggests poverty may be a significant driver of these disparities.

AR is known to have significant impact on QOL and morbidity in underserved populations. On the basis of Pediatric Rhinoconjunctivitis Quality of Life Questionnaire, Everhart et al¹⁵ found that urban-dwelling Hispanic and black children had poorer AR-related QOL compared with urban-dwelling non-Hispanic white children (1.91 vs 1.32, $P < .05$; 2.03 vs 1.32, $P < .05$). The higher scores in Hispanic/black children equal more impairment of QOL. Among a cohort of adult patients with chronic rhinosinusitis, black and Hispanic race were associated with a significantly higher odds of obstructive sleep apnea, compared with white race even after adjustment for age, sex, and body mass index (odds ratio [OR], 1.98 [95% CI, 1.19-3.29]; OR, 1.43 [95% CI, 0.67-3.04]).²¹⁻²³ AR control (measured by the Rhinitis Control Assessment Test) was noted to be associated with fewer school absences in an urban school-age cohort with asthma.^{24,25}

What has been done?

Clinical studies have demonstrated that low-income and minority groups are less likely to receive allergen immunotherapy (AIT), and Medicaid insurance is associated with more emergency room care for acute nasal symptoms compared to private insurance.²⁶ Administration of AIT to appropriate patients with AR, including low-income patients, is associated with reduced health care use and cost savings.¹⁴ A secondary analysis of urban school-age children with persistent asthma showed that AR was

underdiagnosed in half the patients and undertreated, with only one-third using appropriate treatment and only 16% of participants being treated with an intranasal corticosteroid. Sixty-percent should have been using this treatment according to guidelines.¹³

Differences in AIT treatment duration for AR vary in differing populations, with the possibility that unique cultural values may be responsible for the variation. In a Florida Medicaid population, the mean duration of AIT was 17 months, where approximately 40% received AIT for less than 6 months.¹⁴ Hispanic children were more than 2 times more likely to receive AIT compared with black and white children but received the shortest duration of treatment compared with white (mean of 429 days vs 613 days) and black (429 days vs 593 days) children. Hispanic children were also 1.5 times more likely to discontinue AIT within 2 years compared with white children. In an urban tertiary care setting, a retrospective review of nearly 200 patients' adherence to AIT based on insurance and SES between 2003 and 2016²⁷ revealed that payer status was significantly predictive of missed doses ($P = .02$). Medicaid patients missed the most (34.2%), followed by Medicare (24.4%), commercial insurance (19.9%), and a "Health Safety Network" in Massachusetts (18.5%; $P \leq .02$).

These studies highlight that additional burdens faced by lower income families can contribute to a lack of resources necessary to adhere to AIT rigorous schedules. Limited resources and a lack of work flexibility can contribute to the inability to adhere to frequent appointments, pay for transportation to visits, and obtain child care. The above studies suggest that adherence could be improved when medical resources are provided to increase access to specialty care in underserved communities through reimbursement for transportation, child care, and community health care worker services.

What needs to be done?

There is a critical need for increased access to AR care. Improved availability of treatment resources within the communities is an important part of the solution. Strong relationships with community organizations, schools, faith-based organizations and/or community health workers who could improve medication adherence and office visit follow-up, and community primary care providers who could administer immunotherapy would improve access to these resources.

Focused observational and interventional studies addressing AR diagnosis, management, and outcomes for underserved populations are also important. Racial and ethnic minorities are underrepresented in US studies. All underserved populations should be considered for all future cohort studies. As treatment options expand, it is increasingly important to study outcomes in underserved populations to assist in identifying treatment strategies. Interventional studies are needed in underserved populations. AR contributes to the morbidity of sleep disruption/obstructive sleep apnea, asthma, and other conditions, so including AR outcomes in clinical trials of other conditions will improve our understanding of this common disease. In addition, a plan for access for continued care once studies are completed is important for long-term outcomes.

DISPARITIES IN ASTHMA

What is known?

Asthma is a serious public health problem, especially in minority and underserved communities, and the burden of asthma

in the United States remains high. Asthma prevalence has been increasing since the early 1980s in all age, sex, and racial groups.²⁸ This is a long-term problem, and the gap has only grown wider with time. Asthma morbidity (hospitalizations, emergency department [ED] visits) remains at higher rates in underserved populations for reasons discussed below. Despite this fact, according to the Centers for Disease Control and Prevention, asthma episodes defined as an asthma attack in the past 12 months, have declined in children from all races and ethnicities from 2001 to 2016.²⁹

Asthma prevalence is higher among persons with family income below the poverty level.³⁰ The practice of racial segregation, economic oppression, and systemic racism has contributed to poor housing conditions and increased air pollution exposure known to exacerbate asthma in low-income communities. Black people in the United States have higher asthma mortality rates than do other races or ethnicities.³¹ Asthma is more prevalent in black and American Indian adults than adults of other races or ethnicities.³² Black people are 3 times more likely to be hospitalized from asthma.³³ In young black children, the asthma mortality disparity appears to be heightened. From 2007 to 2009, the death rate for black children 14 years or younger was approximately 8 times greater than for white children in that age group.³⁰ Moreover, ED and urgent care center visits are highest among black children younger than 4 years.³³ Children with high mortality risk, including history of intensive care unit admission, are twice as likely to live in extreme poverty, have atopy (particularly mouse allergy), use combination controller therapy, and overuse albuterol.³⁴

A number of factors have contributed to poor asthma outcomes in impoverished, minority populations. The Centers for Disease Control and Prevention reported that 34.8% of children and 50% of adults with asthma are uncontrolled as defined by US guidelines.³⁵ Suboptimal prescribing and/or use of appropriate asthma clinical practice guideline-based controller therapy have been well documented in inner-city children with asthma, resulting in increased morbidity and mortality in this high-risk population.³⁶ Some data suggest that childhood SES relates to the pathophysiology of asthma. Lower familial assets (family savings, investments, etc) in a diverse population of 50% nonwhite children are associated with larger PBMC T_H1 , T_H2 , and proinflammatory cytokine responses after *ex vivo* stimulation with phorbol 12-myristate 13-acetate/ionomycin, as well as less sensitivity to glucocorticoid inhibition of T_H1 and T_H2 cytokine production.³⁷

What has been done?

There have been various behavioral, educational, and asthma management programs designed specifically for minorities³⁸⁻⁴² with development and refinement of school-based, institutions of faith, and community asthma education and management programs, including web-based telemedicine interventions.

Although school-based asthma awareness and medical management interventions have been shown to positively impact asthma outcomes, lack of effective communication between primary care providers and school nurses, limited access to school nurses, and lack of reliable information on asthma-related absenteeism and health services utilization persist.⁴³ In the future, collaboration between primary care providers, school nurses and other personnel, parents or guardians, payers, and policymakers

need to help us understand the true impact of school-based interventions on clinical and cost outcomes of asthma.

National, state, and local policy changes are essential. On the national level, recent approval for reimbursement of school-based health care services allows for children to receive treatment at schools. School-based health care may help to improve asthma outcomes.⁴⁴ Multicomponent medical and behavioral interventional program delivered by video-based telehealth has been shown to significantly improve asthma outcomes in underserved populations, with improvement in daytime and nighttime symptoms, exacerbations, and adherence. The school system can be supportive in reinforcing key messages in the asthma action and medical treatment plan. Several studies have tested the effectiveness of having the child take their asthma controller medications in school.⁴⁴ Community health workers or school nurses should be a part of an asthma care team in a circle of support. Congress bill House of Representatives 2468 establishes preferences for grants under the children's asthma treatment program for states that require schools to establish allergy and asthma management programs that include individual action plans for students diagnosed with allergies or asthma. Asthma management plans, emergency treatment plans, individualized asthma action plans, and school environmental asthma plans are provided through the School-based Asthma, Allergy & Anaphylaxis Management Program (<https://www.aaaai.org/sampro>) website.

Environmental injustice from pollution in North America was well documented by the 2018 The Lancet Commission on Pollution and Health,⁴⁵ resulting in recurrent racial and ethnic disparities. In the New York City Harlem neighborhood, almost all diesel bus depots, places where buses idle their engines for hours while emitting pollutants, are in minority, mostly disadvantaged neighborhoods. These places have a disproportionately increased prevalence of asthma and other respiratory diseases.⁴⁶

Environmental control of dust mite, cockroach, mold, and mouse allergen has been an important intervention to reduce exposure to asthma triggers. Various programs have been implemented to reduce allergen and pollutant exposures in homes.^{39,47,48} Some of these programs include testing for allergen sensitization and identification of potential asthma triggers. There have been several interventions to improve patients' homes.³⁹ Community health workers who win the trust and confidence of patients have been used to successfully deliver interventions.⁴⁹ There are now projects underway improving the structural soundness of homes and coordinate participation of all settings in management of asthma: home, school, community, and primary care.

Other interventions in racial and ethnic minority groups that are effective include telemedicine or web-based self-care,⁵⁰ multidisciplinary team education in the community and hospital settings,⁵¹ and home health care visits using community health workers.⁵² These interventions may decrease utilization of health care resources because patients are empowered to participate in their own asthma management.

Shared decision making is another helpful tool explored in black populations with asthma, with the observation that adequate health literacy is a key component to effective shared decision making.⁵³ A novel shared decision-making interventional randomized trial (BRief Evaluation of Asthma Therapy)⁵⁴ delivered in a real-world setting to address erroneous disease and medication beliefs as a means of improving asthma control in black adults has been started using motivational interviewing, a patient-centered counseling approach that elicits behavioral change

by engaging patients in collaborative partnerships, focusing on connecting behavior to outcomes, evoking the individual's internal motivation to change, and planning a course of action. These kinds of studies will be critical to document efficacy of specific interventional methods.

What needs to be done?

"Best practice" community programs such as the School-based Asthma Management Program (www.aaaai.org/SAMPRO) should be established and implemented to improve access to quality care and develop collaborations with community health resources and schools. There is clear evidence at the population level that use of asthma-preventive medications (ie, inhaled corticosteroids) and adherence to asthma prescriptions are lower in black versus white patients. This is hypothesized to stem from negative beliefs about inhaled corticosteroids, a preference for complementary and alternative medicine approaches, rising costs of inhaled corticosteroids, and the effects of rebranding generic to brand-label molecules in use for decades through different delivery devices.⁵⁵⁻⁶⁰ Facilitation of appropriate use of controller medications coupled with adherence monitoring and timely referral to an asthma specialist is needed to help reduce the disparities in asthma outcomes. Evaluation of patient social determinants of health, such as the physical environment including the place of residence, crowding conditions, and built environment (ie, buildings, spaces, transportation systems), along with implementation of greenspaces to encourage healthy behavior, is needed. Collaborative programs between medical agencies, specialty national associations, and federal programs offering governmental support should be established.

Advancing the concept that there are population differences in drug response and recognizing that there may also be multiethnic and socioeconomic differences in biologic agent response may help eliminate imprecise prescribing practices that may keep some patients from receiving the right drug or biologic.⁶¹⁻⁶⁴ This approach is fraught with challenges, including rising costs of drugs, which is transferred to the patient. Effective drugs in subpopulations are likely to be more expensive and, therefore, unavailable to low socioeconomic populations, even those who are insured. Availability of allergy/immunology specialists who see Medicaid patients and can prescribe biologic agents will be important. To mitigate the disparities in asthma care, Medicaid reimbursement should be increased.

Because asthma racial disparities are not likely to be fully explained by nongenetic factors alone, large-scale genetic and epigenetic studies of asthma in African ancestry populations may be helpful.⁶⁵ Given that race is a social construct and there is great genetic diversity among populations that crosses over racial lines, studies to determine the contribution of genetic ancestry to disease burden would bring further understanding. Large-scale genome-wide association studies will be necessary to benefit from building polygenic risk scores for asthma.⁶⁶ As precision medicine evolves, it is imperative to incorporate into asthma prescribing practices knowledge about the following: environmental influences, coexisting conditions, genomic predispositions, drug-drug interactions, and accurate indicators of drug response.

The Institute of Medicine recommendations to address racial and ethnic disparities in health care include correction of sources of racial and ethnic disparities in the clinical care encounter at the patient and system level, given black patients

are hospitalized more often than white patients for asthma and are more likely to receive inadequate therapy despite higher rates of health care visits.⁶ Race-adjusted algorithms that guide clinical decision making in ways that may direct more attention or resources to white patients than to members of racial and ethnic minorities should be reexamined. To correct asthma disparities, we must correct the lack of reimbursement for current clinical encounters, especially as it relates to the time spent in asthma education, because this is an impediment to ideal care. Use of community health workers/asthma educators could be performed in the community setting. Maximizing the use of available asthma medications before considering the more-expensive alternatives (including improved methods to enhance adherence to conventional therapy)⁶⁷⁻⁶⁹ and ensuring access to mobile technology for the implementation of telemedicine in homes, clinics, and schools would help.^{68,70-72} Telemedicine will be particularly beneficial in rural, underserved communities because 94% of the population has broadband access, but ensuring reliable access to racial and ethnic minority groups in rural areas will be necessary. In urban settings, because indoor allergen and pollutant triggers in the built environment can exacerbate asthma, home visits can be an important adjunct to the medical evaluation.^{39,69-72} In academic, private, and institutional health system settings, cross-cultural education to reduce provider bias is crucial.⁶ More interventional studies such as the BRief Evaluation of Asthma Therapy study will be instrumental in the future to help inform efforts to correct asthma disparities and inequities.

DISPARITIES IN AD

What is known?

In the US AD population,^{73,74} a higher persistence and prevalence of AD among female and black children in urban areas exist,^{75,76} but there are limited studies addressing disparities among patients with AD.⁷⁷ One study looked at 78 clinical trials from 2000 to 2009 for prevention, treatment, or management of AD, and only 46 (59%) included information on race and ethnicity.⁷⁸ Only 10.3% of the studies reporting race and ethnicity factored these demographic characteristics into interpretation of the results.⁷⁹ Despite increased recommendations for more inclusion of minorities and demographic descriptions in health care studies, there has been no increase in such reporting with AD.⁸⁰

Studies have demonstrated a higher prevalence as well as higher severity and more impaired QOL in AD among black adults and children.^{75,79} Black and Asian children are seen for office encounters for AD at a higher frequency than white children.⁸⁰ Other demographic characteristics associated with increased risk of childhood AD include urban setting, health insurance status, smaller family size, and single-mother household.^{50,55,81} Genes encoding for the skin structural protein, filaggrin, are associated with skin barrier defects in many patients with AD.^{81,82} Filaggrin mutations appear to be less common in black patients compared with white patients; however, their effect on the persistence of AD is similar.⁸²⁻⁸⁴ In addition, differences in skin *Staphylococcus aureus* colonization may differ in various ethnic populations.^{83,85}

AD classically presents with pruritic erythematous plaques with scale on flexor surfaces.^{81,84} Black patients are less likely to have flexural dermatitis and more commonly present with extensor dermatitis.⁸¹ Perifollicular prominence and distinct papules on trunk and extensors also tend to be more common in

patients of African descent.⁸² A lichen-planus–type presentation of AD has been reported in black patients, and Dennie-Morgan lines, diffuse xerosis, periorbital dark circles, prurigo nodularis, and palmar hyperlinearity are commonly seen in this group.^{81,86} Erythema in black patients may not be as well appreciated, and common scoring systems may underestimate the severity of AD.⁸¹

Health care education may be insufficient with regard to treatment of dermatologic conditions, including AD in minorities.⁸⁰ Less than 40% of residents in primary care believed their medical school curriculum adequately trained them to manage common skin conditions, and 47% of dermatologists reported their medical training was inadequate in preparing them to manage skin conditions in black patients.⁸⁰ These findings highlight the need to expose primary care, allergy/immunology, and dermatology residents to a diverse patient population as well as provide them with the didactics, textbooks, and peer-reviewed literature necessary to prepare them to address special considerations in skin of color to prevent disparities in quality of care. Other complicating factors include distrust in medical research and reduced access to allergy/immunology, primary care, and dermatology specialists.^{80,85}

What has been and needs to be done?

There is a paucity of interventional studies in AD, so effective strategies in other atopic disease should be implemented for AD.⁸⁷ Improving access to health care, potentially by telemedicine, has tremendous potential.^{88,89} Additional postgraduate medical training on AD, specifically in underserved populations, could improve access to care. Addressing these issues represents an opportunity for allergists/immunologists to help alleviate these barriers to AD care in underserved populations.

DISPARITIES IN FA

What is known?

Although it is widely suspected that there are significant racial and ethnic disparities in FA care, the data that we have to assess this are exceptionally limited by indirect diagnosis and lack studies in which cases are validated by the use of oral food challenge. Through self-report data, disparities in FA are predominately seen among minority and lower income populations in the United States. Data suggest increasing FA prevalence, with rates up to 8% to 10% depending on age, geography, and criteria used to define FA,^{90,91} with disproportionate increases among different ethnic/racial groups. The drivers of increased prevalence need better characterization and might include lack of awareness of FA and/or access to health care, racial/ethnic or socioeconomic influences on childhood feeding practices, or environmental exposures.⁹⁰ In a nationally representative cross-sectional survey of caregiver-reported FA, black (adjusted OR [aOR], 1.8 [1.6-2.1]) and Asian (aOR, 1.4 [1.2-1.7]) children had significantly higher odds of reported FA compared with white children.⁹² Caregiver-reported FA was significantly lower among children in households with incomes less than \$50,000 versus \$50,000 or higher (aOR, 0.5 [0.4-0.7]).⁹² Another study⁹³ highlighted the fastest increase in self-reported FA among non-Hispanic black adults between 1988 and 2011 (2.1% increase per decade; 95% CI, 1.5%-2.7%) compared with 1.2% for Hispanic adults and 1.0% for non-Hispanic white adults. Similarly, FA prevalence

TABLE I. Summary of racial and ethnic health disparities in allergic and immunologic conditions

Condition	Current knowledge of health disparities	Proven interventions for health disparities	Future interventions needed for health disparities
AR	<ol style="list-style-type: none"> 1. AR is underdiagnosed in patients with asthma¹⁵ 2. Allergen sensitization is higher in black children and AR is higher in Hispanic children with asthma compared with whites^{14,17,19} 3. Cockroach and mouse allergens are contributor to disease burden^{15,17} 4. Nasal microbiome composition differs among racial/ethnic groups²³ 5. Poor QOL is associated with AR in underserved populations²⁴ 	<ol style="list-style-type: none"> 1. Treatment with intranasal corticosteroid for chronic disease improves outcomes¹³ 2. AIT in low-income patients is associated with reduced health care use and cost savings¹⁴ 	<ol style="list-style-type: none"> 1. Lower out-of-pocket costs for AIT, especially for Medicaid-insured patients 2. Improve access to specialty care in underserved communities 3. Culturally sensitive education on disease for patients should be provided 4. Increased research studies addressing AR diagnosis, management, and outcomes for underserved populations
Asthma	<ol style="list-style-type: none"> 1. Asthma prevalence has been increasing and morbidity is high in underserved populations²⁷ 2. Racial/ethnic differences in asthma frequency, asthma morbidity, and mortality are directly connected to poverty, indoor and outdoor air quality, indoor and outdoor allergens, suboptimal patient education, and poor health care³⁰ 3. Blacks and Hispanics, especially Puerto Ricans, are more likely than whites to have higher mortality from asthma 4. Children with high mortality risk, including history of intensive care unit admission, are twice as likely to live in extreme poverty, have atopy (particularly mouse allergen), use combination controller therapy, and overuse albuterol³⁴ 5. Suboptimal prescribing and/or use of controller therapy has been well documented in inner-city children with asthma, resulting in increased morbidity and mortality in this high-risk population³⁶ 	<ol style="list-style-type: none"> 1. School-based asthma awareness and medical management interventions have been shown as positively impacting asthma outcomes.⁴³ School-based Asthma Management Program (www.aaaai.org/SAMPRO) has been established 2. Environmental control interventions have been implemented to reduce exposure to asthma triggers^{39,47,48} 3. Telemedicine or web-based self-care,⁵⁰ multidisciplinary team education in the community and hospital settings,⁵¹ and home health care visits⁵² 4. Community health workers who win the trust and confidence of patients have been used to successfully deliver education and interventions^{49,52} 5. A shared decision-making interventional randomized trial has been started⁵⁴ 	<ol style="list-style-type: none"> 1. More community programs should be established to improve access to care, especially for high-risk individuals 2. Facilitation of appropriate use of controller medications and adherence monitoring 3. Increase allergy/immunology specialists who see Medicaid patients and can prescribe biologic agents 4. Initiate large-scale genetic studies of asthma in African ancestry populations 5. Address health care system contribution to disparities by providing time in clinical encounters for asthma education and implement telemedicine in patient-convenient settings 6. Give health care provider training with cross-cultural education to reduce implicit bias 7. Culturally sensitive education on disease for patients should be provided
AD	<ol style="list-style-type: none"> 1. There is a higher persistence and prevalence of AD among female and black children in urban areas^{75,76} 2. Higher prevalence as well as higher severity and more impaired QOL in AD exists among blacks compared with whites^{75,79} 3. Black and Asian children are seen for office encounters for AD at a higher frequency than white children⁸⁰ 4. Increased risk of childhood AD is associated with urban setting, health insurance status, smaller family size, and single-mother household^{50,55} 5. Common scoring systems may underestimate the severity of AD in black patients⁸¹ 6. Because AD presents differently in ethnic and racial populations, health care education should include consideration of skin color 	<ol style="list-style-type: none"> 1. The differences in AD in varying racial/ethnic groups and skin color have been reported⁸⁷ 2. Tele-dermatology is effective in low-resource settings with a multilingual tele-expertise platform increasing access⁸⁸ 	<ol style="list-style-type: none"> 1. Provide additional postgraduate medical training on AD, specifically in underserved populations 2. Improve access to health care through telemedicine, and community and social workers 3. Implement culturally competent patient education efforts and collaborative patient-clinician decision-making process to improve patient trust in medical research and health care⁸⁹ 4. Collaboration with pediatric colleagues to increase referrals of difficult-to-manage patients

(Continued)

TABLE I. (Continued)

Condition	Current knowledge of health disparities	Proven interventions for health disparities	Future interventions needed for health disparities
FA	<ol style="list-style-type: none"> Disparities in FA are predominately seen among minority and lower income populations in the United States, with higher rates of FA-related anaphylaxis and ED visits^{92,93,97,100} In a birth cohort study, no differences in IgE-mediated FA were noted when considering multiple foods; however, a higher proportion of black children were designated as having peanut allergy, black children were 3 times more likely than nonblack children to have peanut-IgE >95% predictive decision point, and race/ethnicity was associated with sensitization to more than 1 of the food allergens^{95,96} Black children have higher odds of wheat, soy, corn, fish, and shellfish allergy, and Hispanic children have higher odds of corn, fish, and shellfish allergy⁹⁷ In New York City, physician-diagnosed FA was significantly higher (17.5%) among private school respondents compared with public school respondents (7.4%)⁹⁸ The prevalence of physician-diagnosed FA in urban minority children was 3.4%, significantly lower than reported national estimates⁹⁹ 	<ol style="list-style-type: none"> Disparities in FA management have been documented, with black and Hispanic parents less likely to correctly identify signs of FA reactions and less likely to identify food triggers¹⁰¹ Food insecurity has been established as a risk factor in milk and egg allergy and is associated with lower health literacy¹⁰³ Underdiagnosis and/or gaps in management of FA among minority, low-income, and rural children exist^{104,105} Education for school nurses about FA increased the availability of epinephrine autoinjectors, so this may be a way to improve management of food-allergic disease in schools¹⁰⁵ 	<ol style="list-style-type: none"> FA education should occur through allergy specialists in partnership with primary care clinicians, patient advocacy groups, and other stakeholders in high-risk communities¹⁰⁹ Food insecurity should be addressed during visits in patients with FA FA action plans and epinephrine autoinjectors should be supplied for all patients with FA regardless of race, ethnicity, or geographical location Culturally sensitive education on disease for patients should be provided
Drug allergy	<ol style="list-style-type: none"> Drug allergy identification in the medical record was missed in a larger proportion of minority groups who lacked English proficiency compared with whites (62%; $P < .001$)¹¹¹ In urban settings, 41% of the black population had discrepancy between self-report of drug reactions and the EMR documentation¹¹² Risk factors for fatal drug anaphylaxis include black race and older age^{113,114} In US hospitalizations from 2009 to 2013, Asians and blacks had a substantially higher risk of Stevens-Johnson syndrome and toxic epidermal necrolysis in the context of urate-lowering drug adverse events than whites (or Hispanics), with genetic predisposition explaining the difference¹¹⁵ Black African/Caribbean Americans can have a 3 to 4 times higher incidence of ACE inhibitor angioedema than white patients¹¹⁷ 	<ol style="list-style-type: none"> Risk of hospitalizations for allopurinol-associated severe cutaneous reactions is higher among blacks, Asians, Native Hawaiians/Pacific-Islanders, and older women, with resultant current recommendations to initiate allopurinol at a low dose (≤ 100 mg/d)¹¹⁵ Disparities in allergy documentation, fatal anaphylaxis, and drug-induced adverse severe cutaneous reactions have been documented 	<ol style="list-style-type: none"> Interpreters and coordination of the electronic health record systems are potential solutions to decrease the number of fatal anaphylaxis episodes Knowledge of vulnerable populations treated with allopurinol and low-dose drug initiation should reduce disparities in reactions and improve the current state of drug allergy health inequity Clinicians should be aware of ACE-induced angioedema in black patients and discontinue the medication promptly with occurrence Partnering with hospitalists and ED clinicians to increase referrals to the allergist for evaluation of drug allergies in underserved populations

(Continued)

TABLE I. (Continued)

Condition	Current knowledge of health disparities	Proven interventions for health disparities	Future interventions needed for health disparities
PIDD	<ol style="list-style-type: none"> 1. The prevalence of any PIDD diagnosis noted through administrative health care databases is highest in privately insured patients¹¹⁸ 2. B-cell defects predominate PIDD diagnosis, and prevalence of any PIDD is >2× as high in whites as in blacks or Hispanics, a pattern observed for all diagnosis groups except neutrophil defects¹¹⁹⁻¹²² 3. Several studies of PIDD diagnoses in urban clinical settings have reported underrepresentation of PIDD among minorities^{118,123,124} 4. When a scoring algorithm on the basis of ICD-9 codes to identify all hospitalized patients age ≤60 y with a diagnosis of ≥2 of 174 ICD-9-coded complications associated with immunodeficiency was used, 61% were insured by Medicaid, disproportionately higher than the general inpatient population ($P < .0001$), and 86% of immunodeficient subjects were Hispanic or black, identifying an undiagnosed cohort¹²⁴ 5. Southern Europeans received 8/8 URD transplants (41%) at rates similar to those of Asians (34%) and white Hispanics (35%); Africans were the least likely (18%) to undergo 8/8 URD transplantation 	<ol style="list-style-type: none"> 1. Race/ethnicity have been reported in a few epidemiologic studies of PIDD 2. Bone marrow transplantation registry participation of diverse populations has been encouraged through public awareness campaigns 	<ol style="list-style-type: none"> 1. Various strategies and efforts to diversify the bone marrow donor pool are needed to improve the odds of a match in disadvantaged patients with PIDD 2. Use of cord blood donors could extend the availability of curative therapy to ethnic minorities¹²⁸ 3. Registries should report the prevalence of specific PIDDs by race/ethnicity 4. Nonbiased methods of identifying PIDDs, such as EMR algorithms, should be implemented to identify potential immunodeficient patients from underserved populations

ACE, Angiotensin-converting enzyme; EMR, electronic medical record; ICD-9, International Classification of Disease, Ninth Revision; SAMPRO, School-based Asthma, Allergy & Anaphylaxis Management Program; URD, unrelated donor.

for adults is higher among all ethnic/racial groups other than white.⁹³ Even among FA-associated disease such as eosinophilic esophagitis, there is evidence of increasing prevalence of disease over time. Overall, evidence suggests that black patients with eosinophilic esophagitis may be underdiagnosed given less typical symptoms and more subtle or absent endoscopic findings.⁹⁴

Accurate prevalence rates are challenging to estimate because rates vary depending on criteria used to diagnose FA. A systematic review⁹⁵ reported increased adjusted odds of FA among black populations, but noted that differing criteria used to diagnose FA precluded identification of a definitive racial/ethnic disparity. In a birth cohort study,⁹⁶ no significant differences in IgE-mediated FA were noted when considering multiple foods; however, a higher proportion of black children were designated as having peanut allergy, black children were 3 times more likely than nonblack children to have peanut-IgE higher than 95% predictive decision point, and race/ethnicity was associated with sensitization to more than 1 of the food allergens (aOR, 1.80; 95% CI, 1.22-2.65; $P = .003$).⁹⁷ In addition, food allergens differ across races/ethnicities. In a study that required convincing symptoms (cutaneous, respiratory, gastrointestinal, or systemic) of an IgE-mediated reaction to a specific food and either an elevated serum-specific IgE or a positive skin test result to that specific food(s) for the diagnosis of FA,⁹⁸ compared with white children, black children have higher odds of wheat, soy, corn, fish, and shellfish allergy and Hispanic children have higher odds of corn, fish, and shellfish allergy.

Disparities are also seen when assessing physician-diagnosed FA. A cross-sectional study compared 2 private and 2 public charter schools in New York City, NY, that differed in racial/ethnic composition and SES, with more black and lower income children in public charter schools.⁹⁹ Physician-diagnosed FA was significantly higher (17.5%) among private school respondents compared with public school respondents (7.4%). Even among those with a history of severe reaction to food, nearly half the children in the public schools lacked a physician diagnosis. In a study of urban minority children, prevalence of physician-diagnosed FA was 3.4%, which is significantly lower than reported national estimates.¹⁰⁰ These findings suggest underdiagnosis and/or inadequate access to specialty care for FA for some.

Disparities in FA management also exist. Minority children are less likely to have prescribed FA action plans,¹⁰⁰ have a shorter duration of specialist follow-up, and have higher rates of FA-related anaphylaxis and ED visits.⁹⁸ Another study reported that children in the lowest income stratum incurred 2.5 times more costs associated with ED visits and hospitalizations.¹⁰¹ Families with lower income spend significantly less on specialty visits and out-of-pocket preventive measures (medications and special foods) as compared with higher income children. Disparities in parental FA knowledge have been identified, which may influence behaviors. Black and Hispanic parents were found less likely to correctly identify signs of FA reactions and less likely to identify triggers.¹⁰² Lower health literacy correlates with lower educational attainment and poverty where people of color are overrepresented and is associated with knowledge gaps related to

TABLE II. Recommendations for patients, physicians, payers, communities, and government agencies to impact social determinants of health and health disparities in allergic and immunologic conditions in racial and ethnic underserved populations^{5,132,133}

	Action
Individual patient	<ol style="list-style-type: none"> 1. Communicate openly with health care providers about needs, cultural differences, and social network dynamics that affect family decisions 2. Obtain a primary care physician to coordinate medical care 3. Request educational resources on disease and treatment 4. Share with health care providers challenges and barriers to care 5. Join patient advocacy groups that are addressing disparities 6. Advocate for government representatives to enact policy changes to increase insurance coverage and reimbursement rates for specialty care and treatments
Physicians	<ol style="list-style-type: none"> 1. Identify and engage with community organizations/health care community workers/nurses/schools/faith-based organizations to partner for the development of team-based care to improve access to and coordination of care for underserved groups 2. Recruit and hire diverse patient-facing faculty and staff 3. Identify systemic and other barriers to care for underserved populations in your practice/institution and develop strategies to address them 4. Engage in implicit bias and cultural competency training to increase self-awareness, because 70% of physicians have an implicit preference for whites over blacks, which affects medical decision making, communication, and nonverbal behavior 5. Screening for social determinants of health (SDOH) should be provided with a nonbiased approach and addressed in office visits (https://www.aafp.org/journals/fpm/blogs/inpractice/entry/social_determinants.html). Give patient education about SDOH and provide clinical care resources to address them; re: social service resources such as auntbertha (www.findhelp.org) and 211 (www.211.org) 6. Culturally sensitive education on disease for patients should be provided 7. Interventions should address the entire spectrum of health care treatment from prevention and primary care to specialty care, hospitalization, and postdischarge treatment 8. Measure the durability of intervention effects over time 9. Join and advocate through medical societies and lay organizations for policy change in insurance coverage for underserved communities 10. Engage trainees from minority communities for training and mentoring opportunities
Communities	<ol style="list-style-type: none"> 1. Adopt the School-based Asthma, Allergy & Anaphylaxis Management Program (https://www.aaaai.org/sampro) 2. Provide resources within the local communities, such as fresh food markets, smoking cessation, exercise and nutrition classes, and free support groups that can be suggested to patients by medical providers 3. Build partnerships between health systems and community-based organizations to offer social services and education 4. Schools and faith-based organizations partner with health care facilities to provide education and access to medical care in the school setting (ie, educational sessions, telemedicine visits, and community health worker or nurse medication administration) 5. Provide health care forums and meetings for community members to express concerns and community health care needs to inform health care providers, systems, payers, and legislators
Medical organizations	<ol style="list-style-type: none"> 1. Optimize the use of data sources and health information technology to improve access of underserved groups to medical care 2. Promote CME courses and tools to help promote disease control (https://education.aaaai.org/allergy-office-practice/VAM20_2309; https://www.cdc.gov/healthyschools/trainingtools.htm) 3. Provide implicit bias training and cultural competency workshops for free at organizational meetings and in ongoing educational programs 4. Advocate for health professionals' communication skills and cultural competence (reducing the impact of biases against underserved groups) as a critical component of all training programs 5. Leaders should focus on equity as an essential element in quality improvement 6. Research funding opportunities should be provided to address health disparities to discover underlying scientific and socially driven mechanisms 7. Advocate for removal of race-adjusted algorithms that guide clinical decision making in ways that may direct more attention or resources to white patients than to members of racial and ethnic minorities 8. Implement programs to diversify the health care workforce through a Task Force or other policy-making committees 9. Provide community health worker training for providers that want to participate in community health initiatives 10. Promote inclusivity in disease guideline development 11. Incentivize physicians and practices to care for underserved communities through reputational incentives (ie, awards) and social incentives (eg, matching donations to charity for charity care)¹³⁴ 12. Educational institutions should develop policies to recruit and retain minorities for education and completion of training in allergy/immunology specialties 13. Diversify leadership in all levels of the organization 14. Support an antiracist policy agenda at the local, state, and national levels
Insurance/payers	<ol style="list-style-type: none"> 1. Increase Medicaid and Medicare reimbursement rate comparable to other payers 2. Increase focus and coverage for healthy behaviors linked to improved outcomes 3. Reimburse for physician education costs and time 4. Increase coverage and decrease barriers to receipt of effective medications and therapies, such as biologic mAbs and immunotherapy

(Continued)

TABLE II. (Continued)

	Action
Government	<ol style="list-style-type: none"> 1. Policymakers should seek/provide funding and other resources to engage and empower patient and community stakeholders in sustainable, generalizable interventions 2. Collect data on health care reform and other state and national policies to monitor and report their impact on disparities over time 3. Supplement reimbursement rate to equalize the access of underserved populations to medical and specialty care 4. Provide funding for health-promoting efforts, aligning with a value-based health care system. Support an antiracist research agenda as set forth by the National Institute of Minority Health and Health Disparities 5. Extend Supplemental Nutrition Assistance Program benefits for more low-income populations 6. Provide tax incentives for physicians providing charity care and those who join with community organizations to provide care in medically underserved areas

management of allergic reactions and epinephrine autoinjector use.¹⁰³ Food insecurity is a risk factor in milk and egg allergy and was associated with lower health literacy.¹⁰⁴

Disparities in FA emergency preparedness in schools disproportionately affect low-income, rural, and minority children. Lack of epinephrine availability and anaphylaxis training is more prevalent in rural and low-income schools. In a cross-sectional online survey of Illinois school nurses/aides representing more than 1000 schools,¹⁰⁵ rural schools were least likely to have any undesignated epinephrine available to treat severe allergic reactions compared with urban and suburban schools and least likely to have a written plan or protocol to outline staff procedures in the event of a severe allergic reaction (59.4% at rural schools vs 81.7% suburban vs 71.9% urban). Rural schools were also least likely to report undesignated epinephrine policies (35.6% rural, 47.5% suburban, 64.0% urban schools). In a cross-sectional study of elementary school nurses (n = 170), higher SES schools were 6 times more likely to have epinephrine autoinjectors available, even when accounting for the number of students with FA.¹⁰⁶ Fewer epinephrine autoinjectors in schools were associated with higher prevalence of Hispanic children and limited English proficiency in low-SES schools. In a school nurse survey in 3 Massachusetts school districts,¹⁰⁷ white children were 5 times more likely to have been dispensed epinephrine autoinjectors compared with nonwhite children for peanut or tree nut allergy (OR, 4.5). Collectively, these studies highlight significant underdiagnosis and/or gaps in management of FA among minority, low-income, and rural children. Education for nurses about FA increased the availability of epinephrine autoinjectors, so this may be a way to improve management of food-allergic disease.¹⁰⁶

What has been and needs to be done?

Although there are uncertainties regarding disparities in FA prevalence, there is strong evidence suggesting increased FA disease and emergency room visits among minority, low-income, and rural populations. Current literature demonstrates decreased access to specialty providers and differences in the care received by these populations. FA can be associated with food insecurity so this should be addressed. Furthermore, these populations have less access to FA action plans and epinephrine autoinjectors at home and school. Accidental and nonaccidental ingestions occur frequently among patients with known FA,¹⁰⁸ and FA reactions commonly occur outside of medical settings.¹⁰⁹ Therefore, it is imperative that all patients regardless of race, ethnicity, or geographic location be properly diagnosed, educated, and equipped to manage their FA. It is incumbent on

allergy specialists to further explore the extent and impact of these disparities and to partner with primary care clinicians, patient advocacy groups, and other stakeholders to improve FA education and dissemination of guidelines-based FA care¹¹⁰ in high-risk communities. Specific suggestions are provided for stakeholders (Table II).

DISPARITIES IN DRUG ALLERGY

What is known?

Drug allergy treatment is ultimately dependent on accurate documentation.¹¹¹ The rate of documentation discrepancies has been evaluated during hospitalizations and ED visits. Drug allergy identification in the medical record was missed in a large proportion of minority groups who lacked English proficiency (62.5%) compared with white patients (12%) ($P < .001$).¹¹² This was true for all classes of drugs, including cephalosporin, aspirin, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, penicillin, and sulfonamides. Asian and Hispanic subjects did not have the same level of allergy ascertainment as white patients when admitted into the hospital.¹¹² In the urban ED setting, in a prospective observational study, there was a discrepancy among 41% of the black population between self-report of allergy/adverse drug reaction and the electronic medical record documentation, with omissions being a more frequent discrepancy. Only 18% of patients had a full complete allergy record and 6% were given a medication in the ED that could have caused an adverse drug reaction. This indicates a need for better attentiveness in taking and documenting a medication allergy in disadvantaged communities.¹¹³

There are disparities in US mortality rate for fatal drug anaphylaxis. Risk factors include black race and older age ($P < .001$) according to data obtained from the Vital Statistics of the National Center for Health Statistics Multiple Cause of Death Data from 1999 to 2010.¹¹⁴ Higher rates of drug anaphylaxis were observed with increasing age and in black people: 0.05 (95% CI, 0.04-0.07) per million among 19 years or younger versus 1.28 (95% CI, 1.09-1.50) per million among people 80 years or older, and 0.54 (95% CI, 0.47-0.61) per million in black people, with 0.19 per million (95% CI, 0.15-0.23) in Hispanic people and 0.45 per million (95% CI, 0.43-0.48) in white people ($P < .001$).¹¹⁵

Severe non-IgE-mediated reactions are also disproportionately experienced in ethnic populations, where there may be evidence of genetic predisposition explaining the difference. The HLA-B*5801 allele is differentially expressed in various racial populations and is a determinant of the allopurinol

hypersensitivity syndrome. In US hospitalizations from 2009 to 2013, Asian and black patients had a substantially higher risk of Stevens-Johnson syndrome and toxic epidermal necrolysis in the context of urate-lowering drug adverse events than white (or Hispanic) patients, correlating well with corresponding frequencies of HLA-B*5801 in the US population (ie, 7.4%, 4%, 1%, and 1%, respectively).¹¹⁶ The hospitalization rate ratios for Stevens-Johnson syndrome/toxic epidermal necrolysis among Asian, black, and white patients were 11.9, 5.0, and 1.0, respectively. Allopurinol as a urate-lowering drug should be used with vigilance in minority populations.¹¹⁷ Risk of hospitalizations for allopurinol-associated severe cutaneous reactions is higher among black, Asian, and Native Hawaiians/Pacific-Islander adults, and older women, with resultant current recommendations to initiate allopurinol at a low dose (≤ 100 mg/day).^{116,117} In addition, the incidence of angiotensin-converting enzyme inhibitor-induced angioedema is higher among black adult patients. Black African/Caribbean Americans can have a 3 to 4 times higher incidence of angiotensin-converting enzyme inhibitor-induced angioedema than white patients.¹¹⁸

What has been or needs to be done?

Disparities in allergy documentation, fatal anaphylaxis, and drug-induced adverse severe cutaneous reactions warrant proactive measures to protect vulnerable patients. Interpreters and coordination of the electronic health record systems are potential solutions to decrease the number of fatal anaphylaxis episodes. Increased educational time for minority populations may also impact disease morbidity. Knowledge of vulnerable populations treated with allopurinol and low-dose drug initiation should reduce disparities in reactions and improve the current state of drug allergy health inequity. Clinicians should be aware of angiotensin-converting enzyme inhibitor-induced angioedema in black patients and discontinue the medication promptly with occurrence. Partnering with hospitalists and ED clinicians to increase referrals to the allergist for evaluation of drug allergies is another strategy to increase the care in underserved populations.

DISPARITIES IN PIDD

What is known?

When administrative health care databases were used to estimate the prevalence of PIDD diagnoses in the United States in 2007, the prevalence of any PIDD diagnosis was 5.1/10,000 persons, with higher prevalence in privately insured.¹¹⁹ This prevalence has increased with time to 9.6 to 11.7/10,000 persons, possibly due to the identification of more genetically defined PIDDs.¹¹⁸ B-cell defects predominate, and prevalence of any PIDD is more than twice as high in white as in black or Hispanic patients, a pattern observed for all diagnosis groups except neutrophil defects.¹¹⁹⁻¹²² Some genetically homogeneous populations have an increased prevalence of specific PIDD (eg, Artemis severe combined immunodeficiency in Navajo Native Americans), but few registries have reported prevalence of specific PIDD (eg, X-linked agammaglobulinemia, hyper-IgM, and chronic granulomatous disease) by race.^{120,121}

Underdiagnoses among black and Hispanic populations as a result of barriers to health care or diagnostic bias can occur. Several studies of PIDD diagnoses in urban clinical settings have reported underrepresentation of PIDD among

minorities.^{119,124,125} The recent approval of newborn screening in the United States will help identify patients with T-cell defects in a less biased fashion, but disparities may exist in more subtle immunodysregulation disorders and non-T-cell-mediated diseases. When a scoring algorithm was used on the basis of *International Classification of Disease, Ninth Revision* codes to identify all hospitalized patients 60 years or younger with a diagnosis of 2 or more of 174 *International Classification of Disease, Ninth Revision*-coded complications associated with immunodeficiency, 0.4% of all inpatients were identified and these patients had a median age of 6.6 years. Sixty-one percent were insured by Medicaid, disproportionately higher than the general inpatient population ($P < .0001$), and 86% of immunodeficient subjects were Hispanic or black, identifying an undiagnosed cohort of minority patients with immunodeficiency.¹²⁵

What has been or needs to be done?

Further study is needed to identify possible impediments to diagnosis. Hematopoietic cell transfusion is a potential curative treatment for many PIDDs, but minority populations frequently encounter barriers in accessing this life-saving therapy. In a prospective study of complete (8/8) HLA-allele matched unrelated donors (MUDs) between 2005 and 2017, a marked racial disparity in MUD access was identified. Southern European patients received 8/8 unrelated donor transplants (41%) at rates similar to those of Asian (34%) and white Hispanic (35%) patients; African patients were the least likely (18%) to undergo 8/8 unrelated donor transplantation. This disparity persisted despite increased bone marrow registry participation, implicating other methods are necessary to improve access to transplantation in minority populations.^{126,127} In a cohort of PIDDs referred for hematopoietic cell transfusion at the National Institutes of Health, where donor options included matched sibling donors or matched related donors, HLA-haploidentical, or 7-8/8 HLA MUDs, the donor searches for those of non-European ancestry compared with European ancestry were less favorable ($P = .002$).¹²⁸ Most patients of Hispanic or African ancestry had very poor/futile MUD searches (71% and 63%, respectively).¹²⁸ Efforts to diversify the bone marrow donor pool are needed to improve the odds of a match in disadvantaged patients with PIDD. In addition, use of cord blood donors could extend the availability of curative therapy to ethnic and racial minorities.¹²⁹

DISPARITIES IN THE CORONAVIRUS DISEASE 2019 PANDEMIC

The coronavirus disease 2019 pandemic has disproportionately affected underserved populations, and the adverse impact has been linked to the SES of patients and asthma characteristics, rather than health behaviors or patient attitudes. Minority patients are more likely to have lost health insurance due to unemployment and live in communities with a high prevalence of coronavirus disease 2019 cases, resulting in decreased access to care and increased challenges in care.¹³⁰ Vaccine administration has been hindered by lack of access. There is a need to educate patients regarding vaccine safety and address myths to mitigate inequities. The economic impact of systemic and institutional racism, implicit bias, and discrimination has played a significant role.¹³¹ Addressing these economic factors through community

resources (Table II) will be essential to the effort to reduce disparities.

CONCLUSIONS

Health disparities affect all aspects of health care especially with regard to access, delivery, and outcomes.¹³¹ Despite improvement in health of the US population over time, disparities persist.¹³⁰ Addressing this problem involves equipping all underserved populations to facilitate their individual ability to achieve the highest level of health. This report illustrates the impact of racial and ethnic disparities in AR, asthma, AD, FA, drug allergy, and PIDD and serves as a call to action to address these disparities.

Addressing gaps in health care and developing innovative solutions to narrow these gaps are paramount. Although these challenges are of significant magnitude, providers in the specialty of allergy/immunology are well equipped to rise to the challenge and poised to be leaders in addressing health disparities and achieving health equity. Commitment is necessary to implement the actions that will make a difference.

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REFERENCES

- Braveman P. What are health disparities and health equity? We need to be clear. *Public Health Rep* 2014;129:5-8.
- Penman-Aguilar A, Talih M, Huang D, Moonesinghe R, Bouye K, Beckles G. Measurement of health disparities, health inequities, and social determinants of health to support the advancement of health equity. *J Public Health Manag Pract* 2016;22:S33-42.
- Healthy people 2020. Available at: <https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health>. Accessed January 21, 2021.
- King G. Institutional racism and the medical/health complex: a conceptual analysis. *Ethn Dis* 1996;6:30-46.
- Williams DR, Cooper LA. Reducing racial inequities in health: using what we already know to take action. *Int J Environ Res Public Health* 2019;16:606.
- Unequal treatment. Confronting racial and ethnic disparities in health care. Washington, DC: Institute of Medicine, The National Academies Press; 2003. Available at: <https://doi.org/10.17226/12875>.
- Apter AJ, Casillas AM. Eliminating health disparities: what have we done and what do we do next? *J Allergy Clin Immunol* 2009;123:1237-9.
- Zimmerman FJ, Anderson NW. Trends in health equity in the United States by race/ethnicity, sex, and income, 1993-2017. *JAMA Netw Open* 2019;2:e196386.
- Wallace DV, Dykewicz MS, Bernstein DI, Blessing-Moore J, Cox L, Khan DA, et al. The diagnosis and management of rhinitis: an updated practice parameter. *J Allergy Clin Immunol* 2008;122:S1-84.
- Wheatley LM, Togias A. Allergic rhinitis. *N Engl J Med* 2015;372:456-63.
- Dykewicz MS, Wallace DV, Baroody F, Bernstein J, Craig T, Finegold I, et al. Treatment of seasonal allergic rhinitis: an evidence-based focused 2017 guideline update. *Ann Allergy Asthma Immunol* 2017;119:489-511.e441.
- Bloom B, Dey AN, Freeman G. Summary health statistics for US children; National Health Interview Survey, 2005. *Vital Health Stat* 10 2006;(231):1-84.
- Esteban CA, Klein RB, Kopel SJ, McQuaid EL, Fritz GK, Seifer R, et al. Underdiagnosed and undertreated allergic rhinitis in urban school-aged children with asthma. *Pediatr Allergy Immunol Pulmonol* 2014;27:75-81.
- Hankin CS, Cox L, Lang D, Levin A, Gross G, Eavy G, et al. Allergy immunotherapy among Medicaid-enrolled children with allergic rhinitis: patterns of care, resource use, and costs. *J Allergy Clin Immunol* 2008;121:227-32.
- Everhart RS, Kopel SJ, Esteban CA, McQuaid EL, Klein R, McCue CE, et al. Allergic rhinitis quality of life in urban children with asthma. *Ann Allergy Asthma Immunol* 2014;112:365-70.e361.
- Meltzer EO. Allergic rhinitis: the impact of discordant perspectives of patient and physician on treatment decisions. *Clin Ther* 2007;29:1428-40.
- Nolte H, Nepper-Christensen S, Backer V. Unawareness and undertreatment of asthma and allergic rhinitis in a general population. *Respir Med* 2006;100:354-62.
- Stevenson MD, Sellins S, Grube E, Schroer K, Gupta J, Wang N, et al. Aeroallergen sensitization in healthy children: racial and socioeconomic correlates. *J Pediatr* 2007;151:187-91.
- Sarpong SB, Hamilton RG, Eggleston PA, Adkinson NF Jr. Socioeconomic status and race as risk factors for cockroach allergen exposure and sensitization in children with asthma. *J Allergy Clin Immunol* 1996;97:1393-401.
- Sedaghat AR, Matsui EC, Baxi SN, Bollinger ME, Miller R, Perzanowski M, et al. Mouse sensitivity is an independent risk factor for rhinitis in children with asthma. *J Allergy Clin Immunol Pract* 2016;4:82-8.e81.
- Jacobs TS, Forno E, Brehm JM, Acosta-Pérez E, Han YY, Blatter J, et al. Underdiagnosis of allergic rhinitis in underserved children. *J Allergy Clin Immunol* 2014;134:737-9.e736.
- Togias A, Gergen PJ, Hu JW, Babineau DC, Wood RA, Cohen RT, et al. Rhinitis in children and adolescents with asthma: ubiquitous, difficult to control, and associated with asthma outcomes. *J Allergy Clin Immunol* 2019;143:1003-11.e1010.
- Hui JW, Ong J, Herdegen JJ, Kim H, Codispori CD, Kalantari V, et al. Risk of obstructive sleep apnea in African American patients with chronic rhinosinusitis. *Ann Allergy Asthma Immunol* 2017;118:685-8.e1.
- Louisiana M, Petty CR, Sheehan W, Lai P, Phipatanakul W. Use of a school-based survey to screen students for symptoms concerning for asthma. *Clin Pediatr* 2019;58:586-9.
- Reynolds KC, Boergers J, Kopel SJ, Koinis-Mitchell D. Multiple comorbid conditions, sleep quality and duration, and academic performance in urban children with asthma. *J Pediatr Psychol* 2018;43:943-54.
- Bergmark RW, Sedaghat AR. Presentation to emergency departments for acute rhinosinusitis: disparities in symptoms by race and insurance status. *Otolaryngol Head Neck Surg* 2016;155:790-6.
- Keefe KR, Ngo-Howard M, Platt MP, Brook CD. Compliance with subcutaneous immunotherapy appointments in an urban tertiary care setting. *Am J Rhinol Allergy* 2018;32:473-7.
- CDC.gov. CDC – Asthma – Data and surveillance – Asthma surveillance data. 2019 Available at: <http://www.cdc.gov/asthma/asthmadata.htm>. Accessed May 9, 2019.
- Zahran H, Bailey C, Damon S, Breyse P. Vital signs: asthma in children – United States, 2001 – 2016. 2018 Available at: <https://doi.org/10.15585/mmwr.mm670e1>. Accessed May 8, 2019.
- Akinbami LJ, Moorman JE, Bailey C, Zahran HS, King M, Johnson CA. Trends in asthma prevalence, health care use, and mortality in the United States, 2001 – 2010. Available at: www.cdc.gov/nchs/ata/databriefs/db94.pdf. Accessed May 9, 2019.
- The Asthma and Allergy Foundation of America and The National Pharmaceutical Council. Ethnic disparities in the burden and treatment of asthma. Available at: <https://www.aafa.org/media/1633/ethnic-disparities-burden-treatment-asthma-report.pdf>. Accessed March 29, 2021.
- Centers for Disease Control and Prevention (CDC). National Center for Health Statistics, National Health Interview Survey. Available at: [https://ftp.cdc.gov/pub/Health Statistics/NCHS/NHIS/SHS/2015SHSTable_A-2.pdf](https://ftp.cdc.gov/pub/Health%20Statistics/NCHS/NHIS/SHS/2015SHSTable_A-2.pdf). Accessed May 8, 2019.
- CDC.gov. CDC – Asthma – Most recent asthma data. 2019 Available at: <https://www.cdc.gov/asthma/most-recent-data.htm>. Accessed May 9, 2019.
- Bollinger ME, Butz A, Tsoukleris M, Lewis-Land C, Mudd S, Morphew T. Characteristics of inner-city children with life-threatening asthma. *Ann Allergy Asthma Immunol* 2019;122:381-6.
- Centers for Disease Control and Prevention. Asthma stats. Uncontrolled asthma among persons with current asthma. Available at: https://www.cdc.gov/asthma/asthma_stats/uncontrolled_asthma.htm. Accessed January 21, 2021.
- Hasegawa K, Ahn J, Brown MA, Press VG, Gabriel S, Herrera V, et al. Underuse of guideline-recommended long-term asthma management in children hospitalized to the intensive care unit: a multicenter observational study. *Ann Allergy Asthma Immunol* 2015;115:106.e1.
- Chen E, Shalowitz MU, Story RE, Ehrlich KB, Levine CS, Hayen R, et al. Dimensions of socioeconomic status and childhood asthma outcomes: evidence for distinct behavioral and biological associations. *Psychosom Med* 2016;78:1043-52.
- Bryant-Stephens T, Kurian, Chen Z. Brief report of a low-cost street-corner methodology used to assess inner-city residents' awareness and knowledge about asthma. *J Urban Health* 2011;88:156-63.
- Bryant-Stephens T, Kurian C, Guo R, Zhao H. Impact of a household environmental intervention delivered by lay health workers on asthma symptom control

- in urban, disadvantaged children with asthma. *Am J Public Health* 2009;99: S657-65.
40. Janevic MR, Baptist AP, Bryant-Stephens T, Lara M, Persky V, Ramos-Valencia G, et al. Effects of pediatric asthma care coordination in underserved communities on parent perceptions of care and asthma-management confidence. *J Asthma* 2017;54:514-9.
 41. Janevic MR, Stoll S, Wilkin M, Song PX, Baptist A, Lara M, et al. Pediatric asthma care coordination in underserved communities: a quasiexperimental study. *Am J Public Health* 2016;106:2012-8.
 42. Karnick P, Margellos-Anast H, Seals G, Whitman S, Aljadeff G, Johnson D. The pediatric asthma intervention: a comprehensive cost-effective approach to asthma management in a disadvantaged inner-city community. *J Asthma* 2007; 44:39-44.
 43. Hollenbach JP, Cloutier MM. Implementing school asthma programs: lessons learned and recommendations. *J Allergy Clin Immunol* 2014;134:1245-9.
 44. Bruzzese J-M, Kattan M. School-based interventions: where do we go from here? *J Allergy Clin Immunol* 2019;143:550-1.
 45. Landrigan PJ, Fuller R, Acosta NJR. The Lancet Commission on pollution and health [published correction appears in *Lancet* 2018;391:430. *Lancet* 2018;391: 462-512.
 46. Kinney PL, Aggarwal M, Northridge ME, Janssen NA, Shepard P. Airborne concentrations of PM(2.5) and diesel exhaust particles on Harlem sidewalks: a community-based pilot study. *Environ Health Perspect* 2000;108:213-8.
 47. Matsui EC, Perzanowski M, Peng RD, Wise RA, Balcer-Whaley S, Newman M, et al. Effect of an integrated pest management intervention on asthma symptoms among mouse-sensitized children and adolescents with asthma: a randomized clinical trial. *JAMA* 2017;317:1027-36.
 48. Bryant-Stephens T, Reed-Wells S, Canales M, Perez L, Rogers M, Localio AR, et al. Home visits are needed to address asthma health disparities in adult. *J Allergy Clin Immunol* 2016;138:1526-30.
 49. Parekh TM, Copeland CR, Dransfield MT, Cherrington A. Application of the community health worker model in adult asthma and COPD in the U.S.: a systematic review. *BMC Pulm Med* 2019;19:116.
 50. Turnbull S, Cabral C, Hay A, Lucas PJ. Health equity in the effectiveness of web-based health interventions for the self-care of people with chronic health conditions: systematic review. *J Med Internet Res* 2020;22:e17849.
 51. Ali A, Pena SG, Huggins C, Lugo F, Khaja M, Diaz-Fuentes G. Impact of group asthma education on asthma control and emergency room visits in an underserved New York community. *Can Respir J* 2019;2019:5165189.
 52. Apter AJ, Localio AR, Morales KH, Han X, Perez L, Mullen AN, et al. Home visits for uncontrolled asthma among low-income adults with patient portal access. *J Allergy Clin Immunol* 2019;144:846-53.e11.
 53. Melton C, Graff C, Holmes GN, Brown L, Bailey J. Health literacy and asthma management among African-American adults: an interpretative phenomenological analysis. *J Asthma* 2014;51:703-13.
 54. George M, Pantalon MV, Sommers MLS, Glanz K, Jia H, Chung A, et al. Shared decision-making in the BREATHE asthma intervention trial: a research protocol. *J Adv Nurs* 2019;75:876-87.
 55. Fitzpatrick AM, Gillespie SE, Mauger DT, Phillips BR, Bleecker ER, Israel E, et al. Racial disparities in asthma-related health care use in the National Heart, Lung, and Blood Institute's Severe Asthma Research Program. *J Allergy Clin Immunol* 2019;143:2052-61.
 56. Kit BK, Simon AE, Ogden CL, Akinbami LJ. Trends in preventive asthma medication use among children and adolescents, 1988-2008. *Pediatrics* 2012;129:62-9.
 57. Wu CL, Andrews AL, Teufel RJ II, Basco WT Jr. Demographic predictors of leukotriene antagonist monotherapy among children with persistent asthma. *J Pediatr* 2014;164:827-31.e1.
 58. Lu D, Qiao Y, Johnson KC, Wang J. Racial and ethnic disparities in meeting MTM eligibility criteria among patients with asthma. *J Asthma* 2017;54:504-13.
 59. Wells KE, Cajigal S, Peterson EL, Ahmedani BK, Kumar R, Lanfear DE, et al. Assessing differences in inhaled corticosteroid response by self-reported race/ethnicity and genetic ancestry among asthmatic subjects. *J Allergy Clin Immunol* 2016;137:1364-9.e2.
 60. George M, Topaz M, Rand C, Sommers ML, Glanz K, Pantalon MV, et al. Inhaled corticosteroid beliefs, complementary and alternative medicine, and uncontrolled asthma in urban minority adults. *J Allergy Clin Immunol* 2014;134:1252-9.
 61. Bonham VL, Callier SL, Royal CD. Will precision medicine move us beyond race? *N Engl J Med* 2016;374:2003-5.
 62. Ramamoorthy A, Pacanowski MA, Bull J. Racial/ethnic differences in drug disposition and response: review of recently approved drugs. *Clin Pharmacol Ther* 2015;97:263-73.
 63. Ortega VE, Hawkins GA, Moore WC, Hastie AT, Ampleford EJ, Busse WW, et al. Effect of rare variants in ADRB2 on risk of severe exacerbations and symptom control during longacting β agonist treatment in a multiethnic asthma population: a genetic study. *Lancet Respir Med* 2014;2:204-13.
 64. Blake K, Cury JD, Hossain J, Tantisira K, Wang J, Mougey E, et al. Methacholine PC20 in African Americans and whites with asthma with homozygous genotypes at ADRB2 codon 16. *Pulm Pharmacol Ther* 2013;26: 342-7.
 65. Daya M, Barnes KC. African American ancestry contribution to asthma and atopic dermatitis. *Ann Allergy Asthma Immunol* 2019;122:456-62.
 66. Khera AV, Chaffin M, Aragam KG, Haas ME, Roselli C, Choi SH, et al. Genome-wide polygenic scores for common diseases identify individuals with risk equivalent to monogenic mutations. *Nat Genet* 2018;50:1219-24.
 67. Anderson WC III, Szeffler SJ. Cost-effectiveness and comparative effectiveness of biologics therapy for asthma: to biologic or not to biologic? *Ann Allergy Asthma Immunol* 2019;122:367-72.
 68. Szeffler SJ. Examining causes of the urban (inner city) asthma epidemic: implementing new management strategies. *Allergy Asthma Proc* 2016;37:4-8.
 69. Su JG, Barrett MA, Henderson K, Humblet O, Smith T, Sublett JW, et al. Feasibility of deploying inhaler sensors to identify the impacts of environmental triggers and built environment factors on asthma short-acting bronchodilator use. *Environ Health Perspect* 2017;125:254-61.
 70. Halterman JS, Fagnano M, Tajon RS, Tremblay P, Wang H, Butz A, et al. Effect of the School-Based Telemedicine Enhanced Asthma Management (SB-TEAM) program on asthma morbidity: a randomized clinical trial. *JAMA Pediatr* 2018; 172:e174938.
 71. Kim CH, Lieng MK, Rylee TL, Gee KA, Marcin JP, Melnikow JA. School-based telemedicine interventions for asthma: a systematic review. *Acad Pediatr* 2020; 20:893-901.
 72. Harris K, Kneale D, Lasserson TJ, McDonald VM, Grigg J, Thomas J. School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review. *Cochrane Database Syst Rev* 2019;1: CD011651.
 73. Boguniewicz M, Alexis A, Beck L, Block J, Eichenfield L, Fonacier L, et al. Expert perspectives on management of moderate-to-severe atopic dermatitis: a multidisciplinary consensus addressing current and emerging therapies. *J Allergy Clin Immunol Pract* 2017;5:1519-31.
 74. Silverberg J, Simpson E. Association between severe eczema in children and multiple comorbid conditions and increased healthcare utilization. *Pediatr Allergy Immunol* 2013;24:476-86.
 75. Silverberg J, Hanifin J. Adult eczema prevalence and associations with asthma and other health and demographic factors: a US population-based study. *J Allergy Clin Immunol* 2013;132:1132-8.
 76. Shaw T, Currie G, Koudelka C, Simpson E. Eczema prevalence in the United States: data from the 2003 National Survey of Children's Health. *J Invest Dermatol* 2011;131:67-73.
 77. McKenzie C, Silverberg J. The prevalence and persistence of atopic dermatitis in urban United States children. *Ann Allergy Asthma Immunol* 2019;123:173-8.
 78. Charrow A, Xia F, Joyce C, Mostaghimi A. Diversity in dermatology clinical trials: a systematic review. *JAMA Dermatol* 2017;153:193-8.
 79. Hirano S, Murray S, Harvey V. Reporting, representation, and subgroup analysis of race and ethnicity in published clinical trials of atopic dermatitis in the United States between 2000 and 2009. *Pediatr Dermatol* 2012;29:749-55.
 80. Bhattacharya T, Silverberg J. Efficacy of systemic treatments for atopic dermatitis in racial and ethnic minorities in the United States. *JAMA Dermatol* 2014;150: 1232-4.
 81. Buster K, Stevens E, Elmetts C. Dermatologic health disparities. *Dermatol Clin* 2012;30:53-9.
 82. Kaufman B, Guttman-Yassky E, Alexis A. Atopic dermatitis in diverse racial and ethnic groups—variations in epidemiology, genetics, clinical presentation and treatment. *Exp Dermatol* 2018;27:340-57.
 83. Margolis D, Apter A, Gupta J, Hoffstad O, Papadopoulos M, Campbell L, et al. The persistence of atopic dermatitis and filaggrin (FLG) mutations in a US longitudinal cohort. *J Allergy Clin Immunol* 2012;130:912-7.
 84. Margolis D, Gupta J, Apter A, Ganguly T, Hoffstad O, Papadopoulos M, et al. Filaggrin-2 variation is associated with more persistent atopic dermatitis in African American subjects. *J Allergy Clin Immunol* 2014;133:784-9.
 85. Merriman J, Mueller E, Cahill M, Beck L, Paller A, Hanifin J, et al. Temporal and racial differences associated with atopic dermatitis, *Staphylococcus aureus* and encoded virulence factors. *mSphere* 2016;6:e00295-316.
 86. Abuabara K, You Y, Margolis D, Hoffman T, Risch N, Jorgenson E. Genetic ancestry does not explain increased atopic dermatitis susceptibility or worse disease control among African American subjects in 2 large US cohorts. *J Allergy Clin Immunol* 2020;145:192-8.e11.

87. Shaw M, Morrell D, Corbie-Smith G, Goldsmith L. Perceptions of pediatric clinical research among African American and Caucasian parents. *J Natl Med Assoc* 2009;9:900-7.
88. Vachiramon V, Tey H, Thompson A, Yosipovitch G. Atopic dermatitis in African American children: addressing unmet needs of a common disease. *Pediatr Dermatol* 2012;4:395-402.
89. Delaigue S, Morand JJ, Olson D, Wootton R, Bonnardot L. Teledermatology in low-resource settings: the MSF experience with a multilingual tele-expertise platform. *Front Public Health* 2014;2:1-9.
90. Sicherer SH, Sampson HA. Food allergy: a review and update on epidemiology, pathogenesis, diagnosis, prevention, and management. *J Allergy Clin Immunol* 2018;141:41-58.
91. Dunlop JH, Keet CA. Epidemiology of food allergy. *Immunol Allergy Clin North Am* 2018;38:13-25.
92. Keet CA, Savage JH, Seopaul S, Peng RD, Wood RA, Matsui EC. Temporal trends and racial/ethnic disparity in self-reported pediatric food allergy in the United States. *Ann Allergy Asthma Immunol* 2014;112:222-9.e3.
93. Gupta RS, Warren CM, Smith BM, Jiang J, Blumenstock JA, Davis MM, et al. Prevalence and severity of food allergies among US adults. *JAMA Netw Open* 2019;2:e185630.
94. McGowan EC, Keller JP, Dellon ES, Peng R, Keet CA. Prevalence and geographic distribution of pediatric eosinophilic esophagitis in the 2012 US Medicaid population. *J Allergy Clin Immunol Pract* 2020;8:2796-8.e4.
95. Greenhawt M, Weiss C, Conte ML, Doucet M, Engler A, Camargo CA Jr. Racial and ethnic disparity in food allergy in the United States: a systematic review. *J Allergy Clin Immunol Pract* 2013;1:378-86.
96. Joseph CL, Zoratti EM, Ownby DR, Havstad S, Nicholas C, Nageotte C, et al. Exploring racial differences in IgE-mediated food allergy in the WHEALS birth cohort. *Ann Allergy Asthma Immunol* 2016;116:219-24.e1.
97. Sampson HA. Utility of food-specific IgE concentrations in predicting symptomatic food allergy. *J Allergy Clin Immunol* 2001;107:891-6.
98. Mahdavinia M, Fox SR, Smith BM, James C, Palmisano EL, Mohammed A, et al. Racial differences in food allergy phenotype and health care utilization among US children. *J Allergy Clin Immunol Pract* 2017;5:352-7.e1.
99. Taylor-Black SA, Mehta H, Weiderpass E, Boffetta P, Sicherer SH, Wang J. Prevalence of food allergy in New York City school children. *Ann Allergy Asthma Immunol* 2014;112:554-6.e1.
100. Taylor-Black S, Wang J. The prevalence and characteristics of food allergy in urban minority children. *Ann Allergy Asthma Immunol* 2012;109:431-7.
101. Bilaver LA, Kester KM, Smith BM, Gupta RS. Socioeconomic disparities in the economic impact of childhood food allergy. *Pediatrics* 2016;137:e20153678.
102. Gupta RS, Kim JS, Springston EE, Smith B, Pongracic JA, Wang X, et al. Food allergy knowledge, attitudes, and beliefs in the United States. *Ann Allergy Asthma Immunol* 2009;103:43-50.
103. Egan M, Yin HS, Greenhawt M, Wang J. Low caregiver health literacy among pediatric food-allergic patients is associated with poorer food allergy management knowledge. *J Allergy Clin Immunol Pract* 2019;7:655-8.
104. Dilley MA, Rettiganti M, Christie L, O'Brien E, Patterson M, Weeks C, et al. Impact of food allergy on food insecurity and health literacy in a tertiary care pediatric allergy population. *Pediatr Allergy Immunol* 2019;30:363-9.
105. Szychliński C, Schmeissing KA, Fuleihan Z, Qamar N, Syed M, Pongracic JA, et al. Food allergy emergency preparedness in Illinois schools: rural disparity in guideline implementation. *J Allergy Clin Immunol Pract* 2015;3:805-7.e8.
106. Shah SS, Parker CL, O'Brian Smith E, Davis CM. Disparity in the availability of injectable epinephrine in a large, diverse US school district. *J Allergy Clin Immunol Pract* 2014;2:288-93.e1.
107. Hannaway PJ, Connelly ME, Cobbett RM, Dobrow PJ. Differences in race, ethnicity, and socioeconomic status in schoolchildren dispensed injectable epinephrine in 3 Massachusetts school districts. *Ann Allergy Asthma Immunol* 2005;95:143-8.
108. Fleischer DM, Perry TT, Atkins D, Wood RA, Burks AW, Jones SM, et al. Allergic reactions to foods in preschool-aged children in a prospective observational food allergy study. *Pediatrics* 2012;130:e25-32.
109. Bird JA, Lack G, Perry TT. Clinical management of food allergy. *J Allergy Clin Immunol Pract* 2015;3:1-11; quiz 2.
110. Boyce JA, Assa'ad A, Burks AW, Jones SM, Sampson HA, Wood RA, et al. Guidelines for the diagnosis and management of food allergy in the United States: report of the NIAID-sponsored expert panel. *J Allergy Clin Immunol* 2010;126:S1-58.
111. Sousa-Pinto B, Fonseca JA, Gomes ER. Frequency of self-reported drug allergy: a systematic review and meta-analysis with meta-regression. *Ann Allergy Asthma Immunol* 2017;119:362-73.e2.
112. Reinhart K, Corbo T, Ewen E, White CM. The impact of ethnicity and gender on agreement of severe allergy history between inpatient and outpatient electronic medical records. *Pharm Pract (Granada)* 2008;6:197-200.
113. Kiechle ES, McKenna CM, Carter H, Zeymo A, Gelfand BW, DeGeorge LM, et al. Medication allergy and adverse drug reaction documentation discrepancies in an urban, academic emergency department. *J Med Toxicol* 2018;14:272-7.
114. Turner PJ, Jerschow E, Umasunthar T, Lin R, Campbell DE, Boyle RJ. Fatal anaphylaxis: mortality rate and risk factors. *J Allergy Clin Immunol Pract* 2017;5:1169-78.
115. Jerschow E, Lin RY, Scaperotti MM, McGinn AP. Fatal anaphylaxis in the United States, 1999-2010: temporal patterns and demographic associations. *J Allergy Clin Immunol* 2014;134:1318-28.e7.
116. Lu N, Rai SK, Terkeltaub R, Kim SC, Menendez ME, Choi HK. Racial disparities in the risk of Stevens-Johnson syndrome and toxic epidermal necrolysis as urate-lowering drug adverse events in the United States. *Semin Arthritis Rheum* 2016;46:253-8.
117. Keller SF, Lu N, Blumenthal KG, Rai SK, Yokose C, Choi JWJ, et al. Racial/ethnic variation and risk factors for allopurinol-associated severe cutaneous adverse reactions: a cohort study. *Ann Rheum Dis* 2018;77:1187-93.
118. Baram M, Kommuri A, Sellers SA, Cohn JR. ACE inhibitor-induced angioedema. *J Allergy Clin Immunol Pract* 2013;1:442-5.
119. Kobrynski L, Powell RW, Bowen S. Prevalence and morbidity of primary immunodeficiency diseases, United States 2001-2007. *J Clin Immunol* 2014;34:954-61.
120. Leung J, Sullivan KE, Perelygina L, Icenogle JP, Fuleihan RL, Lanzieri TM. Prevalence of granulomas in patients with primary immunodeficiency disorders, United States: data from National Health Care Claims and the US Immunodeficiency Network Registry. *J Clin Immunol* 2018;38:717-26.
121. Winkelstein JA, Marino MC, Johnston RB, Boyle J, Curnutte J, Gallin JI, et al. Chronic granulomatous disease: a report on a national registry of 368 patients. *Medicine* 2000;79:155-69.
122. Winkelstein JA, Marino MC, Ochs H, Fuleihan R, Scholl PR, Geha R, et al. The X-linked hyper-IgM syndrome: clinical and immunologic features of 79 patients. *Medicine* 2003;82:373-84.
123. Winkelstein JA, Marino M, Lederman H, Jones SM, Sullivan K, Burks AW, et al. X-linked agammaglobulinemia: report on a United States registry of 201 patients. *Medicine* 2006;85:193-207.
124. Cunningham-Rundles C, Bodian L. Common variable immunodeficiency: clinical and immunological features of 248 patients. *Clin Immunol* 1999;92:34-48.
125. Cunningham-Rundles C, Sidi P, Estrella L, Doucette J. Identifying undiagnosed primary immunodeficiency diseases in minority subjects using computer sorting of diagnosis codes. *J Allergy Clin Immunol* 2004;113:747-56.
126. Barker JN, Boughan K, Dahi PB, Devlin SM, Maloy MA, Naputo K, et al. Racial disparities in access to HLA-matched unrelated donor transplants: a prospective 1312-patient analysis. *Blood Adv* 2019;3:939-44.
127. Hansen JA, Anasetti C, Petersdorf E, Clift RA, Martin PJ. Marrow transplants from unrelated donors. *Transplant Proc* 1994;26:1710-2.
128. Acevedo MJ, Wilder JS, Adams S, Davis J, Kelly C, Hilligoss D, et al. Outcomes of related and unrelated donor searches among patients with primary immunodeficiency diseases referred for allogeneic hematopoietic cell transplantation. *Biol Blood Marrow Transplant* 2019;25:1666-73.
129. Barker JN, Byam CE, Kernan NA, Lee SS, Hawke RM, Doshi KA, et al. Availability of cord blood extends allogeneic hematopoietic stem cell transplant access to racial and ethnic minorities. *Biol Blood Marrow Transplant* 2010;16:1541-8.
130. Baptist AP, Lowe D, Sarsour N, Jaffee H, Eftekhari S, Carpenter LM, et al. Asthma disparities during the COVID-19 pandemic: a survey of patients and physicians. *J Allergy Clin Immunol Pract* 2020;8:3371-7.e1.
131. Weinstein JN, Geller A, Negussie Y, Baciu A. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Population Health and Public Health Practice; Committee on Community-Based Solutions to Promote Health Equity in the United States. Washington, DC: National Academies Press; 2017.
132. Purnell TS, Calhoun EA, Golden SH, Halladay JR, Krok-Schoen JL, Appelhans BM, et al. Achieving health equity: closing the gaps in health care disparities, interventions, and research. *Health Aff (Millwood)* 2016;35:1410-5.
133. Adler NE, Glymour MM, Fielding J. Addressing Social determinants of health and health inequalities. *JAMA* 2016;316:1641-2.
134. Lagarde M, Blaauw D. Physicians' responses to financial and social incentives: A medically framed real effort experiment. *Soc Sci Med* 2017;179:147-59.
135. U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Healthy People 2030. Available at: <https://health.gov/healthypeople/objectives-and-data/social-determinants-health>. Accessed March 29, 2021.